

# **Environmental Assessment DRAFT**

## **Terran 1 Launch Program Cape Canaveral Air Force Station**

Prepared for:

**Relativity**

and

**45<sup>TH</sup> Space Wing  
Patrick Air Force Base, FL**

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## **Acronyms and Abbreviations**

45 SW	45 <sup>TH</sup> Space Wing
45 WS	45 <sup>TH</sup> Weather Squadron
AASHTO	American Association of State Highway Transportation Officials
ACOE	Army Corps of Engineers
AFB	Air Force Base
AFI	Air Force Instruction
AFSPCMAN	Air Force Space Command Manual
AI	Artificial Intelligence
AIRFA	American Indian Religious Freedom Act
ALTRV	Altitude Reservation
ARPA	Archaeological Resources Protection Act
ASOC	Atlas V Spaceflight Operation Center
BASH	Bird/Wildlife Aircraft Strike Hazard
BLS	Below Land Surface
BMPs	Best Management Practices
BO	Biological Opinion
BRRC	Blue Ridge Research and Consulting
CAA	Clean Air Act
C&D	Construction and Demolition
CCAFS	Cape Canaveral Air Force Station
CDNL	C-Weighted Day-Night Level
CEMP	Comprehensive Emergency Management Plan
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CH <sub>4</sub>	Methane
CLOIS	Cape Launch Operations and Infrastructure Support
CO	Carbon Monoxide
CSEL	C-Weighted Sound Exposure Level
CWA	Clean Water Act
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
dB	Decibel
dBA	“A-weighted” Logarithmic Scale Decibel
dBC	Decibels Relative to the Carrier Signal
DERP	Defense Environmental Restoration Program
DESR	Defense Explosives Safety Regulation

DNL	Day-Night Average Noise Level
DoD	Department of Defense
DOT	Department of Transportation
EA	Environmental Assessment
ECS	Environmental Control System
EELV	Evolved Expendable Launch Vehicle
EFH	Essential Fish Habitat
EIAP	Environmental Impact Analysis Process
EIS	Environmental Impact Statement
EISA	Energy Independence and Security Act
EO	Executive Order
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ERP	Environmental Resource Permits
ESA	Endangered Species Act
ETL	Engineering Technical Letter
EWR	Eastern and Western Range
FAA	Federal Aviation Administration
FAC	Florida Administrative Code
FCMA	Florida Coastal Management Act
FCMP	Florida Coastal Management Program
FDCA	Florida Department of Community Affairs
FDEP	Florida Department of Environmental Protection
FEIS	Final Environmental Impact Statement
FETSA	Florida Endangered and Threatened Species Act
FONPA	Finding of No Practical Alternative
FONSI	Finding of No Significant Impact
FPL	Florida Power and Light
FWCC	Fish and Wildlife Conservation Commission
GHG	Greenhouse Gas
GN2	Gaseous Nitrogen
GTO	Geosynchronous Transfer Orbit
HAP	Hazardous Air Pollutant
HAZCOM	Hazardous Communication
HMTA	Hazardous Materials Transportation Act
HPGSA	High Pressure Gas Storage Area
ICBM	Intercontinental Ballistic Missile
ICRMP	Integrated Cultural Resources Management Plan
IIP	Instantaneous Surface Impact Point
IM	Interim Measure

INRMP	Integrated Natural Resources Management Plan
IPA	Isopropyl Alcohol
IPCC	International Panel on Climate Change
IRP	Installation Restoration Program
kg	Kilogram
km	Kilometer
KSC	Kennedy Space Center
kV	Kilovolt
LAeq	Long-Term Equivalent A-Weighted Sound Level
LAm <sub>ax</sub>	Maximum A-weighted Sound Level
LC-16	Launch Complex 16
LCC	Launch Control Center
LED	Light Emitting Diode
LEO	Low Earth Orbit
LMP	Light Management Plan
LN <sub>2</sub>	Liquid Nitrogen
LNG	Liquified Natural Gas
LOX	Liquid Oxygen
LRM	Liquid Rocket Motor
LTDP	Long Term Development Plans
LUC	Land Use Control
LUCIP	Land Use Control Implementation Plan
MBTA	Migratory Bird Treaty Act
MDC	Mission Duty Cycle
MGD	Million Gallons Per Day
MINWR	Merritt Island National Wildlife Refuge
MMPA	Marine Mammal Protection Act
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	Mean Sea Level
MT	Metric Tons
MVA	Megavolt Ampere
N <sub>2</sub> O	Nitrous Oxide
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO <sub>x</sub>	Nitrogen Oxides

NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
NSS	NASA Safety Standard
NAVD88	North American Vertical Datum of 1988
NOA	Notice of Availability
NRP	NASA Routine Payloads
ODS	Ozone-Depleting Substances
OFW	Outstanding Florida Water
OSHA	Occupational Safety and Health Administration
PAFB	Patrick Air Force Base
PCBs	Polychlorinated Biphenyls
PEL	Permissible Exposure Limit
PFDp	Preliminary Flight Data Package
PM	Particulate Matter
psf	Pounds Per Square Foot
Q3	Third Quarter
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RMP	Risk Management Plan
ROI	Region of Influence
RP-1	Rocket Propellant 1
RUMBLE	Launch Vehicle Acoustic Simulation Model
S1	Stage 1
S2	Stage2
SAFMC	South Atlantic Fishery Management Council
SARA	Superfund Amendments and Reauthorization Act
SEIS	Supplemental Environmental Impact Statement
SEL	Sound Exposure Level
SF	Square Feet
SHPO	State Historic Preservation Office
SJRWMD	St. Johns River Water Management District
SLC	Space Launch Complex
SO <sub>x</sub>	Sulfur Oxide
SO <sub>2</sub>	Sulfur Dioxide
SR	State Road
SRMs	Solid Rocket Motors
SSA	Space Situational Awareness
SSC	Species of Special Concern
SSO	Sun-synchronous Orbit

SWI	Space Wing Instruction
SWMU	Solid Waste Management Unit
SWPPP	Stormwater Pollution Prevention Plan
T&E	Threatened and Endangered
TE	Transporter-Erector
THA	Toxic Hazard Assessment
THC	Toxic Hazard Corridors
TNT	Trinitrotoluene
TSCA	Toxic Substance Control Act
US	United States
U.S.C.	United States Code
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USFWS	United States Fish and Wildlife Service
USGODMSP	US Government Orbital Debris Mitigation Standard Practices
USSF	United States Space Force
VAC	Vacuum
VAFB	Vandenberg Air Force Base
VOC	Volatile Organic Compound
WDC	Wet Dress Rehearsal
WWTP	Wastewater Treatment Plant

## 1 Introduction

This Environmental Assessment (EA) is prepared to evaluate the impacts associated with implementing Relativity Space, Inc.'s (Relativity's) proposed Terran 1 Space Launch Program operations. The proposed action (Terran 1 Space Launch Program) is to launch up to 12 Terran 1 Launch Vehicles per year from Launch Complex 16 (LC-16) at Cape Canaveral Air Force Station (CCAFS), starting in the third quarter (Q3) of 2021. This action includes modifications (construction) to LC-16 described in Section 2, Description of the Proposed Actions and Alternatives.

Relativity is a private, American aerospace manufacturer company headquartered in Los Angeles County, CA that is creating an entirely reimagined process to iterate and scale rockets quickly and build the future of humanity in space. Relativity plans to deploy and resupply satellite constellations and to connect and improve our planet. They are taking a fundamentally new approach to build and fly rockets. Extensive use of 3D printing allows Relativity to iterate designs quickly, using less tooling and human labor. To 3D print large objects, Relativity has created a system called Stargate, which is believed to be the world's largest 3D printer of metals. Using its 3D printing technology, Terran 1 is among the most cost-effective launch vehicles in the world.

The Terran 1 Launch Vehicle diagram is shown in *Appendix A, Figure 1. Terran 1 Launch Vehicle*. The 66 feet tall, 7.5 feet diameter, first stage is powered by nine (9) Aeon 1 engines that consume liquid oxygen (LOX) and liquified natural gas (LNG). The 9 feet tall, 7.5 feet diameter interstage connects the first stage to the second stage. The 13.5 feet tall, 7.5 feet diameter second stage is powered by one Aeon vacuum engine. The 22 feet tall, 10 feet diameter fairing encapsulates the payload.

Terran 1's payload delivery capability is 1,250 kilograms (kg) maximum payload to 185 kilometers (km) Low Earth Orbit (LEO), 900 kg nominal payload to 500 km Sun-synchronous orbit (SSO) and 700 kg High Altitude Payload to 1,200 km SSO.

Relativity plans to launch the Terran 1 vehicle from LC-16 on CCAFS and has requested use of the existing launch pad infrastructure. LC-16 was constructed in 1959 for use by the United States (US) military to launch United States Air Force (USAF) Titan and US Army Pershing intercontinental ballistic missiles (ICBMs). The site was transferred to National Aeronautics and Space Administration (NASA) from 1963 through 1972 to conduct Gemini crew processing and Apollo Service Module propulsion engine static test firings. LC-16 was transferred back to the USAF from 1972 through 1988 in support of the Pershing missile system. No launch activities have occurred since 1988. LC-16 was deactivated and decommissioned in 1988 and has remained unused since that time.

To support Terran 1 launches, modifications and additions to LC-16 will be made to the Launch Pad, Propellant Farms and Gas Storage, Integration Hangar / Payload Processing Facility and Logistics Area. Details are described in Section 2.3 LC-16 Facilities.

This EA has been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code [U.S.C.] §4321 et seq.); the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations [CFR] Parts 1500-1508); USAF Environmental Impact Analysis Process (EIAP) (32 CFR Part 989); Department of Defense (DoD) Directive 6050, Environmental Effects Abroad of

Major DoD Actions; Executive Order (EO) 12114, Environmental Effects Abroad of Major Federal Actions; and Federal Aviation Administration (FAA) Order 1050.1F, *Environmental Impacts: Policies and Procedures*. These regulations require a lead agency to prepare or supervise preparation of an EA for a federal action (including an action occurring on federal property) that does not qualify for a categorical exemption or may not require preparation of an Environmental Impact Statement (EIS). A Finding of No Significant Impact (FONSI) will be issued if, as a result of this EA, the environmental impacts of implementing the Proposed Action are determined to be not significant. If a FONSI cannot be issued, the USAF will publish a Notice of Intent to prepare an EIS.

The USAF is the lead agency for the preparation and coordination of this EA (40 CFR § 1501.5), and the FAA and NASA are acting as cooperating agencies (40 CFR § 1501.6). The USAF is the owner of the real property where the Proposed Action will occur. The FAA's role is licensing commercial space launch operations. Relativity will be required to obtain a license from the FAA prior to conducting launches from LC-16 with commercial payloads. The FAA has no action related to the modifications and additions to LC-16. Additional details on FAA requirements are contained in Section 1.4.1, Lead and Cooperating Agency Actions.

In addition to commercial payloads, both the USAF and NASA may be Relativity's customers, using Terran 1 for access to space for Government payloads. Thus, NASA was added as a cooperating agency.

## **1.1 Background**

The Terran 1 Program was developed to support the US Government and commercial space exploration, development and use with the guidance of the Commercial Space Launch Act and its Amendments.

The Commercial Space Launch Act Amendments of 1988 (Public Law 100-657) amended the Commercial Space Launch Act of 1984 (Public Law 98-575), which "directs the Secretary of Transportation, in facilitating and encouraging private sector acquisition of US surplus launch property, to take into account the availability of comparable property under reasonable terms from domestic non-Government sources."<sup>1</sup> The Amendments of 1988 direct the Administrator of NASA to: "(1) design a program to support research into launch systems component technologies to develop higher performance and lower costs for commercial and Government launches; and (2) report to the Congress outlining the program."<sup>2</sup>

Recognizing that space transportation costs must be significantly reduced to make continued exploration, development and use of space sustainable, the US Government developed the National Space Policy of June 28, 2010. A policy principle is a commitment to encourage and facilitate the growth of a US commercial space sector. Key elements of the commercial aspects of the National Space Policy include:

- "The United States is committed to a robust and competitive industrial base. In support of its critical domestic aerospace industry, the US Government will use commercial space products and services in fulfilling governmental needs, invest in new and advanced technologies and concepts, and use a broad array of partnerships with industry to promote innovation. The US Government will actively promote the purchase and use of US commercial space goods and services within international cooperative agreements."<sup>3</sup>



- “The United States will advance a bold new approach to space exploration. The National Aeronautics and Space Administration will engage in a program of human and robotic exploration of the solar system, develop new and transformative technologies for more affordable human exploration beyond the Earth, seek partnerships with the private sector to enable commercial spaceflight capabilities for the transport of crew and cargo to and from the International Space Station, and begin human missions to new destinations by 2025.”<sup>4</sup>

President Donald Trump defined the America First National Space Strategy (Fact Sheet issued March 23, 2018).<sup>5</sup> Elements of this strategy key to the Terran 1 Program include:

- “The United States will partner with the commercial sector to ensure that American companies remain world leaders in space technology.”
- “The new strategy ensures that international agreements put the interests of American people, workers, and businesses first.”

The first Terran 1 Program launch from LC-16 is anticipated in the Q3 of 2021.

## 1.2 Project Location

CCAFS, under the United States Space Force (USSF) 45<sup>TH</sup> Space Wing (45 SW), is located on the east coast of Florida on approximately 16,200 acres of land in Brevard County, Florida on the Canaveral Peninsula. Port Canaveral borders CCAFS to the south, Kennedy Space Center (KSC) borders CCAFS to the north and west and the Atlantic Ocean borders CCAFS to the east. CCAFS is accessible from the south by US Highway 401 and from the west and north via KSC roads.

LC-16 is located on CCAFS approximately 8,000 feet east of the Banana River (designated an Outstanding Florida Waterway) and 600 feet west of the Atlantic Ocean, as shown in *Appendix A, Figure 2. LC-16 General Site Location* and *Figure 3. LC-16 Area Aerial Photograph*. LC-16 is located on the east side of ICBM Road approximately one (1) mile south of the Cape Road intersection at latitude 28° 30' 43" N and longitude 80° 33' 24" W. LC-15 is the adjacent launch complex to the south and LC-19 is the adjacent launch complex to the north. Jacksonville is approximately 150 miles north; Miami is approximately 190 miles south, and Orlando is approximately 50 miles west of LC-16.

## 1.3 Purpose of and Need for Proposed Action

The purpose of the Proposed Action is to provide a versatile Terran 1 Launch Service from CCAFS LC-16 that will support the U.S. Commercial Space Launch Competitiveness Act and its Amendments to deploy and resupply satellite constellations for both Government and commercial sector payload delivery to LEO and SSO.

The Proposed Action allows continued fulfillment of the National Space Policy to actively promote the purchase and use of US commercial space goods and services and reduce space transportation costs. The Proposed Action is needed to allow Relativity to bring extensive use of 3D printing to the commercial space launch market to provide a more cost-competitive commercial space launch vehicle, to ensure that US space launch capability is not reduced or limited and to ensure that the US remains the leader in space launch technology.

The FAA's action of issuing a license to Relativity for commercial space launches of Terran 1 at LC-16 is considered part of the Proposed Action analyzed in this EA. The purpose of FAA's action

is to fulfill the FAA's responsibilities as authorized by the Commercial Space Launch Act (51 U.S.C. Subtitle V, CH. 509, §§ 50901-50923) for oversight of commercial space launch activities, including licensing launch activities. The need for FAA's action results from the statutory direction from Congress under the Commercial Space Launch Act, 51 U.S.C 50901(b), to, in part, "protect the public health and safety, safety of property, and national security and foreign policy interests of the United States" while "strengthening and [expanding] the United States space transportation infrastructure, including the enhancement of United States launch sites and launch-site support facilities, and development of reentry sites, with Government, State, and private sector involvement, to support the full range of United States space-related activities."

#### **1.4 Scope of the Environmental Assessment**

This EA evaluates the potential site-specific environmental consequences associated with Terran 1 Program and operations at CCAFS. The scope includes evaluating the environmental impacts of the Terran 1 Program from receipt of vehicle components from vehicle component transportation to LC-16 and vehicle preparation, launch preparation, payload integration and final launch from LC-16. No Terran 1 vehicle components are reused.

##### **1.4.1 Lead and Cooperating Agency Actions**

This Relativity Terran 1 CCAFS Program EA was developed with the USAF as the lead agency and the FAA and NASA as cooperating agencies.

The USAF would be the lease or license holder for the real property where the Action will occur (LC-16). If, after the public's review of the EA, the USAF determines that the Proposed Action would not individually or cumulatively result in significant impacts on the human or natural environments, the USAF would issue a final FONSI.

The FAA is a cooperating agency because of its role in licensing commercial space launch operations. The FAA expects to receive a launch license application(s) from Relativity for Terran 1 operations at LC-16. The FAA intends to adopt this EA to support its environmental review when evaluating Relativity's launch license application(s). If, after reviewing the launch license application and this EA, the FAA determines that Relativity's proposed operations fall within the scope of this EA and that the FAA's action of issuing a launch license to Relativity for Terran 1 operations at LC-16 would not individually or cumulatively result in significant impacts on the human or natural environment, the FAA would adopt this EA and issue its own FONSI to support issuing a launch license to Relativity for Terran 1. The FAA will draw its own conclusions from the analysis presented in this EA and assume responsibility for its environmental decision and any related mitigation measures. For the FAA to completely rely on this EA to satisfy its NEPA obligations, the EA must meet the requirements of FAA Order 1050.1F, which contains the FAA's policies and procedures for compliance with NEPA.

NASA is a cooperating agency and would rely on the analysis contained in this EA to support its environmental review process as a potential future customer of Relativity's Terran 1 vehicle.

##### **1.4.2 EA Structure**

Section 1 of this EA contains an introduction to the Terran 1 Program and the scope of the proposed action. Section 2 of this EA describes the Proposed Action and the No Action Alternative. Section 3 describes the 16 environmental aspects identified for analysis: 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, Environmental Justice and Department of Transportation Act Section 4(f) Properties. Section 4 describes the potential impacts associated with each of the 16 environmental aspects under the Proposed Action and the No Action Alternative. Section 4.17 summarizes the impacts in each of the 16 environmental aspect areas and Section 5 describes cumulative environmental impacts.

This EA was produced using available Terran 1 Program Launch Vehicle and CCAFS launch operations information. All applicable environmental data necessary was collected to describe current environmental conditions.

## 2 Description of the Proposed Action and Alternatives

This section describes the Proposed Action, location and facilities for Terran 1 Program operations, and the No Action Alternative. The proposed action is to launch up to 12 Terran 1 Launch Vehicles per year from CCAFS LC-16, starting in the Q3 of 2021. The Proposed Action includes modifications (construction) to LC-16 described in Section 2.3, LC-16 Facilities. Section 2.9 describes the Alternatives Considered but Eliminated from Further Study and details the rationale for their elimination.

### 2.1 Terran 1 Program

Relativity announced the Terran 1 Program in 2015 to take advantage of advances in 3D printing and Artificial Intelligence (AI) driven controls. 3D printing significantly reduces cost and improves manufacturing flexibility, allowing faster iteration of new designs and facilitating scaling to larger vehicles. 3D printing will also allow Relativity to generate customized mission-specific space access solutions in 60 days from raw materials to flight.

Relativity's Terran 1 launch vehicle will efficiently and cost-effectively serve customers whose payloads require LEO access of 1,250 kg or less or SSO access of 700 kg or less. This market is currently not served by smaller commercial launch providers limited to approximately 500 kg payload to LEO capability. Commercial companies such as SpaceX, United Launch Alliance and Blue Origin offer much larger launch vehicles with the capability to deliver over 20,000 kg payloads to LEO. Relativity is targeting smaller payload customers and providing schedule flexibility and mission customization made possible by Relativity's 3D printing technology.

The first Terran 1 launch is scheduled for Q3 of 2021.

Relativity intends to use existing CCAFS LC-16 and modify it as required (see Section 2.3) to conduct operations in support of the Terran 1 Launch Program.

### 2.2 Terran 1 Launch Vehicle

The Terran 1 Launch Vehicle diagram is shown in *Appendix A, Figure 1. Terran 1 Vehicle*. The 66 feet tall, 7.5 feet diameter first stage is powered by nine (9) Aeon 1 engines that consume LOX and LNG (Methane [ $\text{CH}_4$ ]). The 9 feet tall, 7.5 feet diameter interstage connects the first stage to the second stage. The 13.5 feet tall, 7.5 feet diameter second stage is powered by one Aeon vacuum (VAC) re-startable engine. The 22 feet tall, 10 feet diameter fairing encapsulates the payload.

The majority of the components of Terran 1 are 3D printed using proprietary materials in Relativity's Stargate factory located in Los Angeles County, CA.

The nine Stage 1 Aeon 1 engines each produce 23,000 pounds of sea level thrust, for a total of 207,000 pounds of lift-off thrust.

Terran 1's payload delivery capability is 1,250 kg maximum payload to 185 km LEO, 900 kg nominal payload to 500 km SSO and 700 kg High Altitude Payload to 1,200 km SSO.

### 2.3 LC-16 Facilities

The Proposed Action to support Terran 1 Program operations requires modifications to existing facilities and construction of new systems and facilities at LC-16. *Appendix A, Figure 3. LC-16 Area Aerial Photograph* and *Figure 4. LC-16 Current (2018) Condition* show aerial views of LC-16. Refurbishment of the site includes adding LNG Storage, LOX Storage, High Pressure Gas

Storage Area (HPGSA), Fire and Noise Suppression Systems, Integration Hangar / Payload Processing Facility, Instrumentation Bay and Engineering Support Facilities (office space) as shown in *Appendix A, Figure 5. LC-16 Conceptual Drawing of Terran 1 Launch Site Modifications* and *Figure 6. LC-16 Conceptual Rendering of Terran 1 Program Modifications*.

The lease area is 138.5 acres and the project area is 31.02 acres. Less than 40,000 square feet of new impervious surfaces will be added. Construction is expected to take 18 months.

### **2.3.1 LC-16 Entrance and Security**

Relativity will use the existing LC-16 entrance from ICBM Road. A new 148 feet by 74 feet paved parking and security staging area and Badge Exchange shelter will be located on the north side of the entrance road. Existing Facility 13125, the former Ready Building, is an approximately 5000 square feet (SF) one-story timber-framed building located south of the entrance road. Relativity plans to use Facility 13125 for Shipping and Receiving, Security Office, and general office space. The 31-acre launch complex will have a new security fence with a new security gate at the existing entrance road.

### **2.3.2 Launch Pad**

The existing concrete Launch Pad, ramp to the Launch Pad and flume will be used and refurbished as necessary. A new lighting protection system will be constructed at the pad to protect the launch vehicle. A new 40 feet by 40 feet Environmental Control System (ECS) Facility and 60 feet by 50 feet Pad Support Building will be constructed west of the launch pad. An existing concrete cable raceway connects the Launch Pad and the existing Blockhouse.

### **2.3.3 Propellant Farms and High-Pressure Gas Storage Area**

The new 65 feet by 125 feet LOX Storage Farm located west of the pad ramp will contain LOX storage tanks totaling 39,000 gallons, tanker station, pumps and appurtenances to support launch vehicle oxidizer loading. A new LOX dump basin will be constructed within the LOX Storage Farm area vicinity. The new 65 feet by 125 feet LNG Storage Farm located east of the launch pad ramp will contain LNG storage tanks totaling 39,000 gallons, tanker station, LNG vaporizer and appurtenances to support launch vehicle fuel loading. The LNG flare will be located 100 feet to the north of the LNG Farm. An LNG impoundment basin, required by code, will be constructed to contain 110% of the volume of the largest vessel in the event of a leak or spill.

The new HPGSA will be located between the Pad Support Building and the Launch Pad. Gaseous nitrogen (GN2) will be generated directly from liquid nitrogen (LN2). GN2 and LN2 will be used for pressurization of systems, cleanliness purges and cooling purges.

### **2.3.4 Integration Hangar and Logistics Area**

The new Integration Hangar is a 180 feet by 60 feet prefabricated single story high bay building where the Terran 1 vehicle components are integrated prior to rollout to the pad for testing and launch. The facility will contain an overhead crane for use in vehicle and payload integration.

Payloads will be encapsulated and mated to the launch vehicle in the Integration Hangar, which includes a Payload Processing Facility with a Class 100,000 cleanroom. Payloads will not be fueled on-site and no on-site storage for payload propellants will be provided. Fueled payloads containing up to 400 kilograms of monomethyl hydrazine (MMH), hydrazine, and/or nitrogen tetroxide (N2O4) will be transported from external payload processing facilities to the LC-16

Integration Facility, where the payload will be encapsulated and mated to the launch vehicle and readied for launch.

Relativity will coordinate proper placement of operations and storage within the Integration Hangar and Payload Processing Facility with the 45 SW.

### **2.3.5 Blockhouse (Facility 13122)**

The existing Blockhouse, Facility 13122, is a two-story concrete facility that Relativity intends to use for instrument bays, local pad controls and pad office space.

### **2.3.6 Pad Support Building and ECS Facility**

ECS Facility will contain equipment to condition air to meet launch vehicle and payload temperature and humidity requirements while at the pad. The Pad Support Building contains pad operations support equipment. The two buildings have a total footprint of approximately 100 feet by 45 feet and are located west of the launch pad.

### **2.3.7 Water Tank and Pump House**

New water storage tanks and a pump house will provide deluge, sound suppression and fire suppression water and will be located west of the launch pad.

### **2.3.8 Utilities**

Fire water, electrical, communications and GN2 utilities are available to support LC-16. Offsite and onsite improvements are required to provide GN2, potable water and sanitary sewer services to LC-16.

Relativity plans to connect to CCAFS fire water, electrical, and communications to support LC-16 operations. In the future, Relativity may connect to CCAFS GN2 utility. Self-contained safety showers will be sited in hazardous areas and bottled water will be provided for drinking.

The existing septic tank systems serving the former Ready Building (Facility 13125) and the Blockhouse (Facility 13122) were inspected and are in overall good condition. Relativity plans to refurbish and reactivate both of the septic systems.

## **2.4 LC-16 Launch Operations**

Terran 1 components will arrive at LC-16 via over-the-road transport from either the factory in Los Angeles County, CA or Relativity's test site at Stennis Space Center, MS<sup>1</sup>. At the LC-16 Integration Hangar, the launch vehicle will undergo checkouts and the two stages will be integrated together. The launch vehicle will then be integrated into the Transporter-Erector (TE). The integrated Stage 1 (S1), Stage 2 (S2) and TE will roll out from the Integration Hangar to the pad, where the launch vehicle will be erected to the vertical position. Static fire testing will be performed to provide a thorough test of all systems. The vehicle will then be lowered to the horizontal position and rolled back into the Integration Hangar. The encapsulated payload will be mated to the vehicle. The integrated payload and launch vehicle will roll out to the pad and be erected to the vertical orientation for launch.

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<sup>1</sup> See Record of Environmental Consideration, John C. Stennis Space Center, SSAA-1053-0148, October, 2013.

### **2.4.1 Launch Vehicle Components**

Terran 1 vehicle stages and payloads will arrive at CCAFS loaded on standard over-the-road tractor-trailers fitted with specialized cradles and transportation hardware. Axle loading is anticipated to be less than American Association of State Highway Transportation Officials (AASHTO) HS-20 design criteria loading.

No vehicle components will be reused; the Terran 1 Program vehicles are completely expendable.

### **2.4.2 Ground Support Operations**

Terran 1 pre-launch operations will consist of Stage Checkouts, Stage Mate and Integration into TE, Functional Checkouts, Fairing Mate and Stage Test / Static Fire.

***Arrival on-site*** - The Terran 1 first stage, second stage, fairing, and additional hardware such as spare components or nozzles will arrive separately, via truck, from the Los Angeles County, CA manufacturing facility and delivered to the LC-16 Integration Hangar.

***Payload Preparation*** - Payload processing activities such as fueling and checkouts will be performed at off-site processing facilities. Encapsulated payloads will be delivered by truck to the Integration Hangar, where the payload will be mated to the launch vehicle and readied for launch. Payloads may contain up to 400 kilograms of monomethyl hydrazine (MMH), hydrazine, and/or nitrogen tetroxide (N<sub>2</sub>O<sub>4</sub>).

***Vehicle Stage Integration*** - Stage 1 and Stage 2 will be placed on individual integration carts, allowing for checkouts, closeout, alignment and mating. No more than 500 grams of 1.4 ordnance will be handled during launch vehicle preparation within the Integration Hangar. Small quantities (less than five (5) gallons of lubricants, aerosols and cleaning agents needed for launch vehicle integration will be maintained in approved chemical lockers in the Integration Hangar.

***Vehicle to TE Integration*** - The integrated launch vehicle will be lifted and suspended via overhead crane while the TE is rolled into the hangar and moved under the rocket. Once in place, the launch vehicle is lowered and mated to the TE.

***Fairing to Vehicle Integration*** - The encapsulated payload arrives at the Integration Hangar and break-over tooling is installed around the fairing assembly. The fairing assembly is lifted with an overhead crane to break-over to the horizontal position, mating fairing to the integrated vehicle on the TE.

***Transporter Erector (TE) Roll-out*** - The TE transports Terran 1 from the hangar to the pad, and the TE is pinned into pad launch table. Hydraulic lift cylinders are pinned to the TE once at the pad.

***Pad Operations*** - Additional checkouts are performed on the vehicle. The TE rotates to vertical position on pad and ground-side commodities and electrical connections are made to the TE. Additional checkouts may be performed once in vertical orientation. The Launch Vehicle may be raised and lowered multiple times, as well as mated and de-mated prior to launch.

***Final Checkouts*** - The vehicle will be erected and final checkouts completed. After final system checkouts, mission rehearsals (dry without propellants or wet with propellants) will typically occur to allow for team training and coordination with CCAFS:

**Static Test Fire** – The Static Test Fire consists of fully fueling the vehicle and igniting the engines to provide a thorough test of all systems. Typical run-time is up to five (5) seconds to 172 seconds, depending on the test being performed.

**Vehicle Fueling** - LNG and LOX are filled into the vehicle's first and second stages using zero-leak quick disconnect fittings.

### **2.4.3 Launch Operations Personnel**

On average, a full-time staff of approximately 25 persons will be onsite for operations, ramping up to approximately 30 essential personnel during peak launch operations at LC-16, not including customer payload support personnel or launch control center personnel.

### **2.4.4 Operations Safety Plan**

A specific Operations Safety Plan will be developed for the Terran 1 Launch Vehicle program to ensure that launch operations are in compliance with applicable regulations, as specified in compliance documents, including (but not limited to):

- Air Force Space Command Manual (AFSPCMAN) 91-710, Range Safety Requirements, as tailored for the Terran program
- Defense Explosives Safety Regulation (DESR) 6055.09 (previously DoD 6055.09, Ammunition and Explosives Safety Standard)
- Space Wing Instruction (SWI) 32-102, Fire Prevention
- Air Force Instruction (AFI) 91-110, Nuclear Safety Review and Launch Approval for Space or Missile Use of Radioactive Material and Nuclear Systems
- SWI 31-101, Installation Security Instruction
- AFI 31-101, Air Force Installation Security Program
- DoD 5220.22-M, National Industrial Security Program Operating Manual
- AFI 32-1023, Design and Construction Standards and Execution of Facility Construction Projects
- Applicable FAA regulations (e.g. 14 CFR Chapter III)
- National Fire Protection Association Standards
- American National Standards Institute Standards
- Occupational Safety and Health Administration (OSHA) Standards.

## **2.5 Launch Trajectories**

Terran 1 Program launch vehicle trajectories will be specific to each particular mission. Flight trajectories vary based on mission specifics such as payload and desired orbit. Terran 1 launch azimuths will range from 35 degrees northeast to 120 degrees southeast, with due east from CCAFS as 90 degrees.

## **2.6 Projected Launch Schedule**

The first Terran 1 Program launch from LC-16 is anticipated in Q3 2021. Up to three (3) launches of the Terran 1 orbital launch vehicle will occur in the year of 2021, ramping up to six (6) launches in the year of 2022, and up to twelve (12) launches per year beginning in 2023. For purposes of this EA, a maximum launch rate of 12 Terran 1 launches per year from CCAFS is used.



Up to three (3) launches of the Terran 1 orbital launch vehicle will occur in 2021, ramping up to six (6) launches in 2022 and up to twelve (12) launches per year beginning in 2023. Depending on mission requirements, launches could occur during daylight or nighttime hours. The anticipated lifespan for the Terran 1 Program is ten (10) years.

## 2.7 Payloads

Terran 1 Program payloads will be similar to current commercial and government payloads expected over the next 10 years. Payloads will be processed offsite and transported to the LC-16 Integration Hangar and Payload Processing Facility in accordance with Department of Transportation (DOT) requirements.

In November 2011, NASA prepared an EA for *Launch of NASA Routine Payloads (NRP) on Expendable Launch Vehicles*.<sup>6</sup> The abstract from this document verifies that no new or substantial environmental impacts or hazards were identified:

“This Final EA updates the Final EA for Launch of NRP on Expendable Launch Vehicles from CCAFS, Florida and Vandenberg Air Force Base (VAFB), California (June 2002) and addresses NASA’s proposed action to launch a variety of spacecraft missions. The spacecraft used in these missions are considered routine payloads; the same threshold quantities and characteristics describe them all, and they would present no new or substantial environmental impacts or hazards as compared to previously analyzed and documented impacts. These scientific and technology demonstration missions are needed for US space and Earth exploration. All spacecraft (referred to as NRP) examined in this EA would meet rigorously defined criteria to ensure that the spacecraft and their launch and operation would not present any new or substantial environmental or safety concerns. The NRPs would launch from existing launch facilities (or those currently under construction) at CCAFS, Florida; VAFB, California; the Ronald Reagan Ballistic Missile Defense Test Site at US Army Kwajalein Atoll in the Republic of the Marshall Islands; NASA Wallops Flight Facility, Virginia; and Kodiak LC, Alaska. NEPA documentation exists that analyze the potential environmental impacts at each of these launch sites for the evaluated launch vehicles.”

An assessment of potential Terran 1 payloads determined that anticipated payloads fit within the scope of the 2011 NASA Routine Payload EA as determined using Table C-2. Summary of Envelope Payload Characteristics by Spacecraft Subsystems as shown in **Table 2-1**.

**Table 2-1: NASA Routine Payload EA Table C-2. Summary of Envelope Payload Characteristics by Spacecraft Subsystems<sup>7</sup>**

Characteristic	Description
<b>Structure</b>	Unlimited: aluminum, beryllium, carbon resin composites, magnesium, titanium, and other materials unless specified as limited.
<b>Propulsion <sup>a</sup></b>	Liquid propellant(s); 3,200 kilograms (7,055 pounds) combined hydrazine, monomethylhydrazine and/or nitrogen tetroxide. Solid Rocket Motor (SRM) propellant; 3,000 kilograms (6,614 pounds) Ammonium Perchlorate (AP)-based solid propellant (examples of SRM propellant that might be on a spacecraft are a Star-48 kick stage, descent engines, an extra-terrestrial ascent vehicle, etc.)
<b>Communications</b>	Various 10-100 Watt (RF) transmitters

Characteristic	Description
	Unlimited Solar cells; 5 kilowatt-Hour (kW-hr) Nickel-Hydrogen (NiH2) or Lithium ion (Li-ion) battery, 300 Ampere-hour (A-hr) Lithium-Thionyl Chloride (LiSOCl), or 150 A-hr Hydrogen, Nickel-Cadmium (NiCd), or Nickel-hydrogen (Ni-H2) battery.
<b>Power</b>	Unlimited Solar cells; 5 kilowatt-Hour (kW-hr) Nickel-Hydrogen (NiH2) or Lithium ion (Li-ion) battery, 300 Ampere-hour (A-hr) Lithium-Thionyl Chloride (LiSOCl), or 150 A-hr Hydrogen, Nickel-Cadmium (NiCd), or Nickel-hydrogen (Ni-H2) battery.
<b>Science Instruments</b>	10 kilowatt radar American National Standards Institute safe lasers
<b>Other</b>	U. S. Department of Transportation Class 1.4 Electro-Explosive Devices (EEDs) for mechanical systems deployment Radioactive materials in quantities that produce an A2 mission multiple value of less than 10 Propulsion system exhaust and inert gas venting Sample returns are considered outside of the scope of this environmental assessment

## 2.8 No Action Alternative

Under the No Action alternative, Relativity would not construct a launch site for the Terran 1 vehicle at CCAFS LC-16 and thus would not apply to the FAA for a launch license for Terran 1 launches at LC-16. The No Action alternative would not allow Relativity to provide significantly reduced cost and flexible schedule commercial access to space for 1,250 kg payloads to LEO and 700 kg to SSO from LC-16. Relativity could not meet its goal of evolving 3D printing to allow larger payload capabilities and improve potential for cost reductions for large payloads or beyond LEO access from LC-16. The No Action Alternative would not allow Relativity to meet the National Space Transportation Policy's goal of providing low-cost and reliable access to space at LC-16.

## 2.9 Alternatives Considered but Eliminated from Further Study

Relativity considered and evaluated alternative Terran 1 launch sites. In accordance with Title 32 CFR 989.8, alternative launch sites were evaluated for reasonableness using the following selection criteria:

1. US location on a site with some existing infrastructure (i.e. no greenfield sites),
2. Ability to safely support LEO and SSO launch trajectories that impose minimal risk to the public,
3. Minimize capital expense,
4. Site development and construction schedule able to meet first Terran 1 launch in 2021,
5. Fully operational available Range Safety support capabilities, and
6. Single-user site required based on number of launches per year anticipated.

No existing space launch facilities outside of CCAFS were found that could meet all six of the selection criteria. Other existing, no-longer operational CCAFS launch sites were evaluated,

located as shown in *Appendix A Figure 2*. The following CCAFS sites were investigated but eliminated as detailed below.

- **Launch Complex 20 (LC-20)** – The USAF is coordinating a license for LC-20, built in the late 1950s, with Space Florida. Space Florida required that LC-20 was not available for exclusive use and would need to be a shared, multi-user site. Relativity was unable to negotiate a single user license and LC-20 will ultimately be sub-licensed to FireFly Aerospace, Inc.
- **Launch Complex 46 (LC-46)** - The USAF licensed LC-46, built in the late 1980s, to Space Florida. Space Florida requires that LC-46 is unavailable for exclusive use and would need to be a shared, multi-user site. With the frequency of Terran 1 launches expected, sharing a site was determined to be infeasible. In addition, permanent modifications to the current pad infrastructure were not allowed by Space Florida. Relativity's required modifications to the site for propellant storage and adjustments to the flame duct and pad deck to support vehicle size were could not be accommodated. Relativity was unable to come to terms with Space Florida during lease negotiations for LC-46.
- **Launch Complex 15 (LC-15)** – LC-15 was considered at the same time as LC-16 as they are almost identical in layout. However, the existing infrastructure at LC-16 is in better condition than LC-15. LC-16 has a usable Ready Building and Blockhouse that Relativity plans to remodel for their use. Both those facilities on LC-15 have been demolished. The reusable infrastructure allows Relativity to reduce their construction scope while meeting cost and scheduling milestones for the Terran 1 Program.

## 2.10 LC-16 Selection Rationale

CCAFS LC-16 was selected for Relativity's Terran 1 Space Launch Program because:

1. LC-16's east coast location, away from populated areas, supports safe low, mid, and high inclination launch trajectories that minimize overflight and risk to the public.
2. LC-16's location on CCAFS provides access to existing support infrastructure and existing payload processing facilities.
3. LC-16 was previously used as a Space Launch Complex (SLC), has existing usable utilities, infrastructure and buildings, such as electrical service, roads and a blockhouse.
4. The USAF prefers the LC-16 location and development and launches can be supported by existing experienced CCAFS Range Safety personnel and assets.
5. LC-16 is available for use as a single-user site and is supportive of all other project requirements (technical, schedule and cost minimization).

### **3 Affected Environment**

In compliance with NEPA and CEQ guidelines, this Section describes the existing environment for the Proposed Action and No Action Alternative.

Sixteen (16) environmental aspects are identified for analysis: 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, Environmental Justice and Department of Transportation Act Section 4(f) Properties. For each resource area, a region of influence (ROI) is established that defines an area where the federal action, program or activity may cause an impact. The ROI for this assessment is LC-16 on CCAFS and the wider CCAFS area.

As stated in Section 1, this EA complies with FAA Order 1050.1F (the FAA's NEPA-implementing policies and procedures), so the FAA can easily adopt this EA and issue its own FONSI, if applicable. FAA Order 1050.1F, Paragraph 4-1, lists environmental impact categories (i.e., resource areas) for which the FAA considers in its NEPA documents. This EA analyzes all of the FAA's environmental impact categories except farmlands, children's environmental health and safety risks, and natural resources. The Proposed Action would not convert prime agricultural land to other uses or result in a decrease in the land's productivity. Given the location of LC-16 and the activities proposed, the Proposed Action would not disproportionately affect children. As defined by the FAA, the Proposed Action would not have a measurable effect on natural resources, such as water, asphalt, aggregate, or wood.<sup>8</sup> Therefore, these impact categories are dismissed from detailed analysis because the Proposed Action would not affect them.

#### **3.1 Land Use / Visual Resources**

Land use is defined as the human usage of land resources for uses such as economic production, natural resources protection, residential or commercial uses. Compatible land use is achieved when the Proposed Action fits within the land use patterns (such as vehicle launches, residential, commercial, industrial, recreational), land ownership (federal, state, private), and land use management plans. Zoning, management plans and policies regulate how land is used. Land uses described are regional land use and zoning, on-station/base land use and zoning and coastal zone management (CZM). Visual resources are any naturally occurring or manmade feature that contributes to the aesthetic value of an area. The term coastal zone is defined as the coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder) strongly influenced by each other and in proximity to the shorelines of the several coastal states, and includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches (16 U.S.C. 1453).

The Land Use ROI includes LC-16 and surrounding areas as applicable on CCAFS.

##### **3.1.1 Regional Land Use and Zoning**

Brevard County and the City of Cape Canaveral are the local planning authorities for incorporated and unincorporated areas near CCAFS and designate compatible land uses and zoning around CCAFS. CCAFS designates its own land use and zoning regulations since they are federal-owned and are not included under the land use or zoning authority of Brevard County or the City of Cape Canaveral. Port Canaveral planned uses include continued commercial and industrial uses and

expansion. The federal-owned section of Port Canaveral is used by NASA, the US Navy, USAF, the US Coast Guard and commercial space launch companies to support space launches, shipping, vessel maintenance and other related activities.

Uses of the river and ocean water areas surrounding CCAFS include commercial fishing, marine recreation and marine transportation. KSC is north and west of CCAFS and includes predominantly industrial uses associated with NASA launch programs and recent commercial aerospace ventures and open space associated with the Merritt Island National Wildlife Refuge (MINWR). The Canaveral National Seashore is located directly north of KSC and is operated by the National Park Service.

### **3.1.2 Land Use and Zoning**

CCAFS encompasses approximately 16,200 acres (25 square miles), representing approximately two percent Brevard County's total land area. Land uses at CCAFS include an airfield, port operations, launch operations, launch and range support, commercial aerospace ventures, station support and maintenance areas and open space. The launch operations land use category along the Atlantic Ocean shoreline includes both inactive and active launch sites and support facilities. The launch and range support areas are west of the launch operations land use areas and are divided into two sections by the Skid Strip (airfield). The port operations area is in southern CCAFS and includes facilities for government, commercial and industrial shipping activities. The Industrial Area is centrally located in the western portion of CCAFS, near the Banana River, and is identified as a CCAFS support area category. Land use at CCAFS also includes administrative, recreational, historic lighthouse, monuments and museum and range support functions. Open space is dispersed throughout CCAFS. CCAFS has no public beaches.

LC-16 is designated as Solid Waste Management Unit (SWMU) 40. Land Use Controls (LUC) were implemented as a result of a Resource Conservation and Recovery Act Facility Investigation (RFI) conducted at LC-16. The property is prohibited from residential or other non-industrial development. Additional information on SWMU-40 is included in Section 3.8.4.

Undeveloped land west, south and north of LC-16 is subject to Wildland Fire Operations. AFI 32-7064, Integrated Natural Resources Management, outlines the USAF Wildland Fire Management.

### **3.1.3 Coastal Zone Management**

The Coastal Zone Management Act (CZMA), enacted in 1972, encourages states to preserve, protect, develop, and, where possible, restore or enhance valuable natural coastal resources such as wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as the fish and wildlife using those habitats. Federal activity in, or affecting, a coastal zone requires preparation of a Coastal Zone Consistency Determination, in accordance with the federal CZMA of 1972, as amended (P.L. 92-583), and implemented by the National Oceanic and Atmospheric Administration (NOAA). CZMA program administration is delegated to states that develop state specific guidelines and requirements. The Office of Ocean and Coastal Resource Management administers individual state programs. Federal property is exempt from the definition of states coastal zones, but activities occurring on federal property that directly affect state coastal zones must comply with the CZMA. Section 307(c)(1)(A), Coordination and Cooperation, mandates that each federal agency activity within or outside the coastal zone that affects any land or water use or natural resource of the coastal zone is carried out in a manner consistent, to the maximum extent practicable, with the enforceable policies of approved state management programs.

Applicable federal actions must be consistent with NOAA's federal consistency regulations (15 CFR Part 930). Federal consistency is required for federal actions that are defined as federal activities, including any development projects (15 CFR Part 930, Subpart C). Subpart C regulations require consistency of all federal activities and development projects, to the maximum extent practicable, with federal-approved state CZMA programs as indicated in *Table 3-1*.

**Table 3-1: Summary of Land Use and Zoning Requirements**

Law or Rule	Permit/Action(s)	Requirement	Agency or Organization
CZMA	Development projects must be consistent to the maximum extent practicable with Florida's CZMA Program	Preserve, protect, develop, and, where possible, restore or enhance valuable natural coastal resources such as floodplains, and dunes	Florida Department of Environmental Protection (FDEP), USAF
Florida Statutes, Section 373.428	Federal Consistency	When an activity regulated under this part is subject to federal consistency review under Section 380.23, the final agency action on a permit application submitted under this part shall constitute the state's determination as to whether the activity is consistent with the federal-approved Florida Coastal Management Program (FCMP). Agencies with authority to review and comment on such activity pursuant to the FCMP shall review such activity for consistency with only those statutes and rules incorporated into the FCMP and implemented by that agency.	NOAA
Florida Statutes, Section 380.23	Federal Consistency	(1) When a federal-licensed or permitted activity subject to federal consistency review requires a state license, the issuance or renewal of a state license shall automatically constitute the state's concurrence that the licensed activity or use, as licensed, is consistent with the federal-approved program.	NOAA
Florida Administrative Code (FAC) 62B-33.004 (2) (b)	Exemptions from Permit Requirements, Coastal Construction and Excavation	(3) In addition to the exemptions provided in Section 161.053(11), F.S., the following are exempt from the provisions of Section 161.053, F.S., and this rule chapter: (b) Construction, excavation, and damage or destruction of vegetation conducted by the US Government on lands owned and maintained by the US Government.	FDEP

In Brevard County, the FCMP, formed by the Florida Coastal Management Act (FCMA), applies to activities occurring in or affecting the coastal zone. The entire state of Florida is within the coastal zone. For planning purposes, a No Development zone has been established in Brevard County and extends from the mean high-water level inland 75 feet.

CCAFS has additional siting and facility design standards for construction that require new facilities to be set back at least 150 feet from the coast. LC-16 pad centerline is approximately 1,000 feet west of the Atlantic shoreline. Land uses are addressed by the CCAFS General Plan,<sup>9</sup> which contains existing land use maps, future land use maps, and siting standards to guide development. The FDEP is the state's lead coastal management agency. The FDEP, along with FCMP member agencies, review the coastal zone consistency determination. The USAF is

responsible for making the final coastal zone consistency determinations for its activities within the state and the FDEP along with FCMP member agencies will review the Florida CZMA plan to ensure the proposed action is consistent with the coastal zone consistency determination through submittal of this EA to the Florida Clearinghouse.

### 3.1.4 Visual Effects

#### 3.1.4.1 Light Emissions

The ROI for light emission effects includes people, wildlife and land uses in the LC-16 area. Light emissions from the proposed Terran 1 Launch Program will be within two thousand feet of the Atlantic Ocean.

The ROI for light emissions includes most of CCAFS Atlantic coastline due to sensitivity of nesting adult and emerging hatchling sea turtles to artificial lighting. Section 3.3.5.2, Marine Turtles, provides additional details on compliance with Section 7 of the Endangered Species Act (ESA). The USAF developed 45<sup>TH</sup> SWI 32-7001, Exterior Lighting Management, for all areas and facilities on CCAFS to protect sea turtles.

#### 3.1.4.2 Visual Resources and Visual Character

Visual resources include buildings, sites, traditional cultural properties, and other natural or manmade landscape features that are visually important or have unique characteristics. Historical and Cultural Resources are detailed in Section 3.4. Natural landscape features include the Atlantic Ocean coastline and the Banana River and surrounding wetlands. Visual character refers to the overall visual makeup of the existing environment where the proposed action would be located. The visual character of the area surrounding LC-16 Area facilities is described in Section 3.3.1.5, Vegetation and also includes the Atlantic Ocean coastline and the Banana River and surrounding wetlands.

### 3.2 Noise

Noise is usually defined as unwanted sound. The decibel (dB) is the accepted standard unit for the measurement of sound and is a logarithmic unit that accounts for the large variation in sound pressure amplitudes. Environmental noise is often expressed in terms of A-weighted (dBA) noise levels. A-weighting simulates the frequency response of the human hearing mechanism. The Environmental Protection Agency (EPA) administers the Noise Control Act of 1972 and has identified 65 dB Day Night Average Noise Level (DNL) as an acceptable noise level for compatible land uses. The DNL is essentially a 24-hour average of noise levels with 10 dB added to nighttime noise levels (10 pm to 7 am). The 10 dB correction accounts for increased sensitivity to nighttime noise. **Table 3-2** contains common sound examples.

**Table 3-2: A-weighted Sound Levels of Common Sounds**

Common Sounds	Sound Level Range (dB)	Region of Comfort
Threshold of Hearing	0-10	Just Audible
Recording Studio	10-20	
Bedroom at Night	20-30	
Quiet Urban Nighttime	30-40	Quiet
Average Office	40-50	
Air Conditioner at 100 ft (30.5m)	50-60	

Common Sounds	Sound Level Range (dB)	Region of Comfort
Conversational speech Normal Piano Practice	60-70	Moderate
Heavy Truck at 50 ft (15.2m)	70-80	
Riding Mower	80-90	
Light-duty Bulldozer	90-100	Very Loud
Textile Mill or Discotheque	100-110	
Oxygen Torch	110-120	Uncomfortable
Chain Saw	120-130	
Jet Aircraft at takeoff	140	
Primary Source <sup>10</sup>		

Descriptors are used to assess and correlate the various effects of noise on humans, including land use compatibility, sleep and speech interference, annoyance, hearing loss, and startle effects. Although derived for humans, these descriptors can also be used to qualitatively assess the effects of noise on wildlife. These descriptors are shown in **Table 3-3**.

**Table 3-3: Sound Level Descriptors**

Descriptor	Description
A-Weighted Sound Level	The momentary magnitude of sound weighted to approximate the human ear's frequency sensitivity. A-weighted sound levels are typically measured between 20 hertz and 20 kilohertz.
Day-Night Average Noise Level (DNL)	An A-weighted equivalent sound level averaged over a 24-hour period with a 10-dB "penalty" added to nighttime sounds (10:00 p.m. to 7:00 a.m.). The 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 adjustment to the noise level over most of the audible frequency range except for a slight de-emphasis of the signal below 100 hertz and above 3,000 hertz. It is used as a descriptor of low-frequency noise sources, such as blast noise and sonic booms.
C-Weighted Day-Night Level (CDNL)	The C-weighted sound level averaged over a 24-hour period; with a 10-dB penalty added for noise occurring between 10:00 p.m. and 7:00 a.m. CDNL is similar to DNL, except that C-weighting is used rather than A-weighting.
Sound Exposure Level (SEL)	A-weighted SEL. The total sound energy in a sound event if that event could be compressed into one 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.
C-Weighted Sound Exposure Level (CSEL)	C-weighted SEL. The same as SEL except the measurement is in C-weighting rather than A-weighting.
Peak Overpressure	A measure of changes in air pressure and is 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.

The ROI for noise includes the area around LC-16, CCAFS and the closest populated areas, which are Cape Canaveral and Cocoa Beach to the south and Merritt Island to the southwest. Three noise areas associated with the Proposed Action are evaluated, Construction Noise, Launch Operations Noise and Launch and Ascent Noise.

Noise levels around industrial facilities at CCAFS approximate those of any urban industrial area, reaching levels of 60 to 80 dBA. Additional on-site sources of noise are the aircraft landing facilities at the CCAFS Skid Strip. Other less frequent but more intense sources of noise in the region are launches from CCAFS. The closest residential areas to CCAFS are in Merritt Island and Cape Canaveral, approximately 8 miles and 12 miles respectively, from LC-16. The distance from



these communities reduces the effect of potential noise generated from the Proposed Action. Expected sound levels in these areas are normally low, with higher levels occurring in industrial areas such as Port Canaveral and 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 CCAFS would be expected to increase noise levels for short periods of time.

The largest portion of the total acoustic energy produced by a launch vehicle is usually contained in the low-frequency end of the spectrum (1 to 100 Hertz). Launch vehicles also generate sonic booms. A sonic boom, the shock wave resulting from the displacement of air in supersonic flight, differs from other sounds in that it is impulsive and very brief.

### **3.2.1 Launch Operations Noise**

Operation-related noise refers to noise generated from activities such as actual launches and also temporary noise during construction, maintenance or refurbishment activities and ongoing noise generated from worker traffic to and from the selected site. The highest recorded levels at the spaceport were produced by the Space Shuttle and could exceed 160 dBA. However, Terran 1 will produce less than 3% of the Space Shuttle's thrust at liftoff.

Launch is the major source of all operational noise. Three distinct noise events are associated with launch and ascent of a launch vehicle: on-pad engine noise (including static-fire testing of the Terran 1 first stage), in-flight engine noise, and sonic booms. Operations-related noise from the actual launches are summarized below.

#### **3.2.1.1 On-pad Noise**

On-pad engine noise occurs when engines are firing during a static-fire test or just before flight, but the vehicle is still on the pad. The engine exhaust is deflected horizontally by an exhaust tunnel or flame duct. Noise is highly directional, with maximum levels in lobes that are about 45 degrees from the main direction of the deflected exhaust. Noise levels at the vehicle and within the launch are high. Because the sound source is at or near ground level, propagation from the launch vehicle to off-site locations is along the ground, with significant attenuation over distance. On-pad noise levels are typically much lower than in-flight noise levels because sound propagates in close proximity to the ground and undergoes significant attenuation when the vehicle is on or near the pad.

#### **3.2.1.2 In-flight 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 circular, particularly for the higher levels near the center. The outer contours tend to be somewhat distorted. They 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, it is often adequate to summarize noise by giving the sound levels at a few distances from the launch site. The in-flight sound source is also well above the ground and therefore there is less attenuation of the sound as it propagates to large distances.

The major source of in-flight noise is from mixing of the exhaust flow with the atmosphere, combustion noise in the combustion chamber, shock waves and turbulence in the exhaust flow, and occasional combustion noise from the post-burning of fuel-rich combustion products in the

atmosphere. 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 hertz).

### **3.2.1.3 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. It differs from other sounds in that it is impulsive and very brief. In many cases an ascending launch vehicle's orientation at the 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.

### **3.2.2 Construction Noise**

Temporary noise impacts from the operation of construction equipment (e.g., earth moving machinery, dump trucks, power tools) are usually limited to a distance of 1,000 feet or less. Vehicles associated with construction typically generate between 65 and 100 dBA at a distance of 50 feet.<sup>11</sup> In addition, noise diminishes at a rate about 6 dBA for each doubling of distance from the source. CCAFS has no sensitive receptors (e.g., schools, hospitals) in its vicinity. All construction work would be conducted as normal activities on CCAFS.

## **3.3 Biological Resources**

Much of the detailed Biological Resource information included was extracted from the *45 SW Integrated Natural Resources Management Plan* (INRMP)<sup>12</sup> and the *Biological Assessment for the Relativity Launch Complex-16 Project Site Construction and Operation at CCAFS, Florida* by Atlantic Environmental of Florida, LLC in October, 2019. Biological resources covered in this section include native and nonnative vegetation communities, upland or wetland habitats, threatened and endangered (T&E) species and species of special concern (SSC) that occur or could potentially occur in the ROI, which is considered to be the areas surrounding LC-16 area, and could be affected by construction activities and the effects of launch operations. Sensitive and protected biological resources include plant and animal species listed as threatened or endangered by the United States Fish and Wildlife Service (USFWS) and the Florida Fish and Wildlife Conservation Commission (FWCC). Natural areas around LC-16 are managed by the USAF.

### **3.3.1 Regulatory Framework**

#### **3.3.1.1 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, both through federal action and by encouraging the establishment of state programs. Section 7 of the ESA requires federal agencies to ensure that any action authorized, funded or carried out by them is not likely to jeopardize the continued existence of listed species or modify their critical habitat.

**Marine Mammal Protection Act (MMPA).** This Act protects mammals including cetaceans (whales, dolphins, and porpoises) and other marine mammals in US waters.

**Migratory Bird Treaty Act (MBTA).** Under this Act, taking, killing or possessing migratory birds is unlawful.

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

### 3.3.1.2 State Regulatory Requirements

**Florida Endangered and Threatened Species Act (FETSA).** This Act includes no specific prohibitions or penalties but does establish the conservation and wise management of endangered and threatened species as state policy.

**Endangered Species Act.** This Act prohibits the intentional wounding or killing of any fish or wildlife species designated by the FWCC as "endangered", "threatened" or of "special concern". This prohibition also extends to the intentional destruction of the nests of any such species.

In addition, Florida has an Imperiled Species Management Plan, implemented in 2016, that provides a comprehensive, integrated approach for the conservation of state-listed species.<sup>13</sup>

### 3.3.2 CCAFS INRMP

AFI 32-7064, Integrated Natural Resources Management, commits the USAF to the long-term management of all natural areas on the installation. Long-term management objectives are identified in the 45 SW's INRMP, with specific land management objectives identified in the Scrub-jay and Sea Turtle Management Plans in the appendices.

Section 3.3.4 provides details of the threatened, endangered and special concern species at CCAFS that may include areas surrounding the LC-16.

### 3.3.3 Vegetation

#### 3.3.3.1 Native Species

Native vegetation communities on CCAFS are somewhat fragmented by construction and clearing activities. CCAFS contains a series of ridges and swales parallel to the coastline to support the communities. At least 10 high-quality natural communities of vegetation exist on CCAFS, including the oak scrub, rosemary scrub, maritime hammock, coastal strand, coastal dunes, grasslands, sea grasses, and three wetland communities (hydric hammock, interdunal swales, and estuarine tidal swamps and marshes). Vegetation on CCAFS, including areas near LC-16, consists mainly of the indigenous Florida coastal scrub (including oak and rosemary scrub) and xeric and maritime hammocks. Native vegetation communities have been invaded by the Brazilian pepper, which is a nonnative aggressive plant that invades communities along disturbed areas and subsequently out-competes native species.

CCAFS has no federally-listed threatened or endangered plant species. **Table 3-4** contains the State of Florida T&E species for plants that have been documented as present on CCAFS.

**Table 3-4: Florida T&E Vegetation Species Found on CCAFS**

Common Name	Scientific Name	State of Florida	
		Threatened	Endangered
Sea-Lavender	<i>Argusia gnaphalodes</i>		E
Curtiss's Milkweed	<i>Asclepias curtissii</i>		E
Sand Dune Spurge	<i>Chamaesyce cumulicola</i>		E
Satin-Leaf	<i>Chrysophyllum oliviforme</i>	T	

Common Name	Scientific Name	State of Florida	
		Threatened	Endangered
Coastal Vervain	<i>Glandularia maritima</i>		E
Pineland Florida Lantana	<i>Lantana depressa</i> var. <i>floridana</i>		E
Simpson's Stopper	<i>Myrcianthes fragrans</i>	T	
Shell Mound Prickly-Pear Cactus	<i>Opuntia stricta</i>	T	
Beach-Star	<i>Remirea maritima</i>		E
Inkberry	<i>Scaevola plumieri</i>	T	
Common Wild-Pine	<i>Tillandsia fasciculata</i>		E

### 3.3.3.2 Invasive Species

LC-16 contains Brazilian pepper (*Schinus terebinthifolius*), an invasive species.<sup>14</sup> **Table 3-5** contains a comprehensive list of 45 SW priority invasive plant species requiring management.<sup>15</sup> Brazilian pepper is the dominant invasive flora at CCAFS, followed by Australian pine trees growing singly or as small, dense groves scattered across the base.

**Table 3-5: 45 SW Priority Invasive Plant Species Managed**

Common Name	Scientific Name
Brazilian pepper	<i>Schinus terebinthifolius</i>
Australian pine	<i>Casuarina equisetifolia</i>
Cogon grass	<i>Imperata cylindrica</i>
Torpedo Grass	<i>Panicum repens</i>
Melaleuca	<i>Melaleuca quinquenervia</i>
Mimosa	<i>Albizia julibrissin</i>
Hydrilla	<i>Hydrilla verticillata</i>
Earleaf acacia	<i>Acacia auriculiformis</i>
Chaste tree	<i>Vitex trifolia</i>
Common guava	<i>Psidium guajava</i>
Old World climbing fern	<i>Lygodium microphyllum</i>
Schefflera	<i>Schefflera actinophylla</i>
Wedelia	<i>Schageticola trilobata</i>

### 3.3.4 Species of Special Concern (SSC)

In Florida, only six SSC exist and none have been seen on CCAFS property.

### 3.3.5 Wildlife

Brevard County, Florida is home to a vast network of native and non-native wildlife due to its varying ecosystems including beaches, salt marshes, fresh waters streams and lakes, brackish water lagoons, and coastal and inland scrub. Typical wildlife in the area include the American Alligator (*Alligator mississippiensis*), numerous species of fish, common birds such as seagulls, crows, mockingbirds, and various types of wading birds and herons, land mammals including the wild pig (*Sus scrofa*), white-tailed deer (*Odocoileus virginianus*), various rodents and other small mammals. The gopher frog (*Lithobates capito*) is part of the Imperiled Species Management Plan in Florida and may reside within gopher tortoise burrows.

Cape Canaveral is situated along a major flyway route for neo-tropical migratory birds that breed in eastern North America. The habitat on CCAFS that is suitable for migrant birds is of conservation concern and is home to numerous birds listed on the USFWS migratory bird list, all of which are protected at the federal level by the MBTA. All but a few bird species (e.g. pigeons, European starlings (*Sturnus vulgaris*) found on CCAFS are on this list. The Air Force is not required to have a state permit to remove migratory birds, however, in the event a nest/bird/eggs needs to be removed, a federal depredation permit from USFWS would be required. The USAF natural resources office would decide on a case-by-case basis if/when a nest would require removal. The Air Force currently has a depredation permit that covers Bird/Wildlife Aircraft Strike Hazard (BASH) issues and removal of birds/nests that if left in place could result in harm to human life.

### 3.3.6 Threatened and Endangered (T&E) Species

CCAFS contains habitat used by many federal and state-listed species. It is located on a barrier island ecosystem that is an important natural area that supports many plants and animals. Barrier islands along the Atlantic coast are especially important for nesting sea turtles, populations of small mammals and foraging and loafing habitat for a variety of resident and migratory shorebirds, wading birds and songbirds. This section presents the federal and state regulatory requirements for vegetation and wildlife and identifies the federal and state-listed species that may be present on CCAFS.

#### 3.3.6.1 Birds

The **Florida Scrub-jay** (*Aphelocoma coerulescens*) is a federal-protected ESA threatened species. Distribution of the Florida Scrub-jay is restricted to scrub communities associated with relic dunal deposits on peninsular Florida. The scrub-jay shows an obligatory reliance on oak species, especially those growing in low dense thickets interspersed with open sandy areas.

The **Piping Plover** (*Charadrius melodus*) is a small pale federal-threatened shorebird that has the potential to exist on Brevard beaches during the non-breeding season (July-March). The main threat to this species in Florida is disturbance by humans on their primary habitat, the open beaches.

The rufa **Red Knot** (*Calidris canutus rufa*) is a medium-sized federal-threatened shorebird that winters at the tip of South America in Tierra del Fuego and breeds in the tundra of the central Canadian Arctic Circle. During the spring and fall migrations, red knots habitually travel in nonstop segments of 1,500 miles or more along the Atlantic coast using the same stopover sites year and after year to rest and refuel. These birds have been seen north of LC-37 at CCAFS.

The **Bald Eagle** (*Haliaeetus leucocephalus*) was removed from federal-threatened species list in 2007. They are regularly seen using CCAFS as a foraging area. The nests are usually built in tall pine trees near lakes, marshes or coastlines. Bald eagles are regularly observed on CCAFS between September and April.

**Wood Storks** (*Mycteria americana*) are a federal-listed threatened species. Wood storks have been observed feeding in the CCAFS drainage canal system, foraging along the beach shoreline and in other bodies of water on CCAFS. In addition, these birds rest along the canal banks and in adjacent fields.

**Wilson's Plovers** (*Charadrius wilsonia*) are included on the 2014 State of the Birds Watch List and have been recommended to be federal-listed under ESA. They are coastal waders that frequent

beaches, lagoons, and salt flats. Their diet consists of crustaceans, insects, and worms located along shorelines. It is a migratory bird in all areas of the eastern seaboard except Florida, where it remains year-round.

**Table 3-6** contains a complete list of federal and state listed birds in the ROI.

**Table 3-6: ROI Federal and State Listed Birds**

Common Name	Scientific Name	Federal	State
American Oystercatcher	<i>Haematopus palliatus</i>		T
Black Skimmer	<i>Rynchops niger</i>		T
Crested Caracara	<i>Caracara cheriway</i>	T	
Florida Scrub-Jay	<i>Aphelocoma coerulescens</i>	T	
Least Tern	<i>Sternula antillarum</i>		T
Little Blue Heron	<i>Egretta caerulea</i>		T
Piping Plover	<i>Charadrius melodus</i>	T	
Red Knot	<i>Calidris canutus rufa</i>	T	
Reddish Egret	<i>Egretta rufescens</i>		T
Roseate Spoonbill	<i>Platalea ajaja</i>		T
Roseate Tern	<i>Sterna dougallii</i>	T	
Snowy Plover	<i>Charadrius nivosus</i>		T
Southeastern-American Kestrel	<i>Falco sparverius paulus</i>		T
Tricolored Heron	<i>Egretta tricolor</i>		T
Wood Stork	<i>Mycteria americana</i>	T	

### 3.3.6.2 Marine Turtles

Four species of federal-protected sea turtles have been documented as nesting on CCAFS: loggerhead turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) and leatherback turtle (*Dermochelys coriacea*). Based on the 2018 nest surveys, CCAFS has a total of 1,767 loggerhead turtle nests, 31 green sea turtle nests and two leatherback sea turtle nests.<sup>16</sup> The 2019 survey reported 3382 loggerhead turtle nests, 675 green sea turtle nests and 15 leatherback sea turtle nests.<sup>17</sup>

While sea turtles spend much of their lives in the ocean, females come ashore each year to nest. Research has shown that females will avoid highly illuminated beaches and postpone nesting. Artificial lights have also resulted in hatchling mortality as disoriented hatchlings move toward these light sources rather than the ocean. In 1988, in compliance with Section 7 of the ESA, the USAF developed 45 SWI 32-7001, Exterior Lighting Management for all areas and facilities on CCAFS to protect sea turtles. A Biological Opinion (BO) issued by the USFWS requires development of Light Management Plans (LMPs) for all new facilities that are in close proximity to the beach, are not compliant with 45 SW lighting policies, have lighting directly visible from the beach, and/or may cause significant sky glow. In addition, USAF biologists conduct nighttime inspections to ensure all exterior lighting is operated in accordance with policies. The BO authorizes no more than 2% incidental take of turtles as the result of disorientation.

In 2015, the **Kemp's Ridley Sea Turtle** was found nesting on CCAFS for the first time. This resulted in more than 170 hatchlings.<sup>18</sup> Two (2) Kemp's Ridley nests were observed on CCAFS beaches between 1986 and 2019. Although the endangered **Atlantic Hawksbill Sea Turtles**

(*Eretmochelys imbricata*) are not known to nest on CCAFS beaches, they have been known to occur in the waters off the Florida coast and near shore areas.

**Loggerhead Sea Turtles** are listed as an ESA threatened species. Approximately 90 percent of loggerhead nesting in the southeastern US occurs in Florida. Between May and August, an average of 2,252 Atlantic loggerhead turtle nests are deposited annually on CCAFS beaches (based on nesting surveys conducted between 1986 and 2019).

The **Green Sea Turtle** was federal-listed as a threatened species in Florida and along the Pacific Coast of Mexico. Each summer, an average of 108 green turtle nests are deposited on CCAFS beaches (based on nesting surveys conducted between 1986 and 2019).

The USFWS listed the **Leatherback Sea Turtle** as an endangered species in 1970. Leatherback nests can be found along the shores of the Atlantic, Pacific, and Indian Oceans. Nesting on CCAFS was first documented in 1986 when a single leatherback nest was recorded by CCAFS biologists. 128 total leatherback nests were observed on CCAFS beaches between 1986 and 2019.

### 3.3.6.3 Other Reptiles and Amphibians

The **Eastern Indigo Snake** (*Drymarchon couperi*) is federal-listed as a threatened species. It is a large non-venomous snake that is widely distributed throughout Central and South Florida. Gopher tortoise and other animal burrows have been found throughout CCAFS, including in and around LC-16 area. Indigo snakes have been known to use these burrows as shelter from cold and intense heat in other areas, however snakes have not been observed in the burrows found on CCAFS. Eastern indigo snakes have been identified on CCAFS from road kills and field observations. The major threats to the indigo snake on CCAFS are habitat loss and vehicle traffic. Eastern indigo snakes frequent pine flatwoods, high pine, dry prairie, tropical hardwood hammocks, edges of freshwater marshes and coastal dunes.

The **Florida Pine Snake** (*Pituophis melanoleucus*) is a state-listed threatened species. This is one of the largest eastern snakes in North America reaching up to 84 inches. The Florida Pine Snake has been found on CCAFS.

The **Gopher Tortoise** (*Gopherus Polyphemus*) is a state-listed threatened species, as well as a candidate for federal-listing. Gopher tortoises are common on CCAFS. Burrows can be quite deep and long with average depth at 6.5 feet and average length at 15 feet and can be used by more than 350 other commensal species such as frogs, mice, snakes and insects. The Gopher Tortoise can live from 40 to 60 years, and is commonly found in habitats such as sandhill, pine flatwoods, scrub, scrubby flatwoods, dry prairies, xeric hammock, pine-mixed hardwoods and coastal dunes.

### 3.3.6.4 Fish

**Smalltooth Sawfish** (*Pristis pectinate*) is a federally-listed endangered fish reportedly living in Atlantic Ocean. The US population is found along the east coast of Florida from about Charlotte Harbor through the Everglades region. The Smalltooth Sawfish inhabits shallow coastal waters of tropical seas and estuaries. They are usually found in shallow waters very close to shore over muddy and sandy bottoms. It is very rare in this area and is unlikely to occur in the ocean off CCAFS.<sup>19</sup>

In March 2018, the **Oceanic Whitetip Shark** (*Carcharhinus longimanus*) was listed as a threatened species under the ESA and is found in tropical and subtropical oceans. This species has been seen off the Atlantic Coast of Florida and lives near the surface in warm waters.

The **Giant Manta Ray** (*Manta birostris*) is federally-listed as a threatened species under the ESA in January 2017. In Florida, the Giant Manta Ray is also listed as protected in Florida state waters. The habitat is found near shore waters and coral or rocky reefs.

### 3.3.6.5 Mammals

The **North Atlantic Right Whale** (*Eubalaena glacialis*) is federally-listed as endangered under the ESA throughout its range. It is rarest of all large whale species and is among the rarest of all marine mammal species. They primarily occur in the northwest Atlantic and in coastal or shelf waters during the winter in both hemispheres. Calving takes place in the lower latitudes and coastal waters. Part of the critical habitat includes coastal Florida and Georgia, from Sebastian Inlet in Florida to the Altamaha River in Georgia.

The **Humpback Whale** (*Megaptera novaeangliae*) is federally-listed as an endangered species under the ESA throughout its range which includes the North Atlantic Ocean. They live at the surface of the ocean, specifically in shallow coastal waters. Their breeding grounds are in warm, tropical waters and occur mostly in the winter through early spring and they have been known to transit north and south in the Atlantic off the coast of Florida.

The **Florida Manatee** (*Trichechus*) (a subspecies of the West Indian Manatee) is one of the few marine mammals known to inhabit the local salt-water lagoon system that is found in marine, estuarine and freshwater habitats. Manatees are generally restricted to the southeastern US habitat areas including foraging, freshwater drinking and resting sites as well as travel corridors. Manatees are herbivores that feed opportunistically on a wide variety of plants including submerged, floating and emergent vegetation. Manatees have been found to transit along near-shore waters where submerged aquatic vegetation may grow or where channels provide immediate deep water or freshwater access. In June 2004, the FWCC approved new boat speed zones to protect manatees in Brevard County. They are federally-listed as endangered due to the low population level (at least 6,300) within the continental US. The USFWS has designated the Indian and Banana Rivers as critical manatee habitat.

The **Southeastern Beach Mouse** (*Peromyscus polionotus niveiventris*) was listed by the USFWS as a threatened species in 1989. The beach mouse is a subspecies of the numerous, widely distributed field mouse. Beach mice populations are typically found in the coastal dune and coastal strand communities along Florida's east coast, however they have been found as far inland as the CCAFS industrial area. Beach mice have been found at launch sites on CCAFS.<sup>20</sup> The BA states that the Southeastern Beach Mouse would not significantly be impacted by clearing or construction at LC-16.

### 3.3.7 Marine Wildlife and Essential Fish Habitat (EFH)

Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (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 National Marine Fisheries Service (NMFS) and identify EFH. The Act defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity."



Regional Fishery Management Councils under the NMFS are responsible for designating EFH in their management plans. The South Atlantic Fishery Management Council (SAFMC) currently manages several species in the vicinity of CCAFS including the South Atlantic Snapper-Grouper complex, South Atlantic shrimps, Coastal Migratory Pelagic species, Highly Migratory species, Red Drum (*Sciaenops ocellatus*), Spiny Lobsters, Golden Crab (*Chaceon fenneri*), Calico Scallop (*Argopecten gibbus*) and Sargassum (*Histrio histrio*).

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 offshore along the coastline.

Areas inshore of the 100-foot 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.

### **3.4 Historical and Cultural Resources**

Cultural resources include prehistoric-archaeological, historic, architectural, Native American resources, and any physical evidence of human presence considered important to a culture, subculture, or community for scientific, traditional, religious or any other reasons. Areas potentially impacted include properties, structures, landscapes, or traditional cultural sites that qualify for listing in the National Register of Historic Places (NRHP).

#### **3.4.1 Regulatory Framework**

Section 106 of the National Historic Preservation Act (NHPA) of 1966 (as amended) requires federal agencies to consider the effects of their actions on historic properties. AFI 32-7065, *Cultural Resources Management*, provides guidelines for the protection and management of cultural resources on USAF-managed lands.

Federal cultural resource preservation statutes (including the Native American Graves Protection and Repatriation Act (NAGPRA) (1990)) mandate that if prehistoric or historic artifacts are unexpectedly discovered during construction or excavation, such materials would be identified and evaluated by an archaeologist. Should human remains or cultural artifacts be encountered, federal statutes specify that work would cease immediately and the proper authorities be notified. The 45 SW Cultural Resource Manager and archaeologist work with the State Historic Preservation Office (SHPO) should unexpected discoveries occur and project re-commencement would only be authorized once the SHPO clears the site.

In addition to the NEPA, the primary laws that pertain to the treatment of cultural resources during environmental analysis are the NHPA (1966) (especially Sections 106 and 110), the Archaeological Resources Protection Act (ARPA) (1979), the American Indian Religious Freedom Act (AIRFA) (1978) and the NAGPRA (1990).

Only those cultural resources determined to be potentially significant under the above-cited legislation are subject to protection from adverse impacts resulting from an undertaking. To be considered significant, a cultural resource must meet one or more of the criteria established by the National Park Service that would make that resource eligible for inclusion in the NRHP. The term "eligible for inclusion in the National Register" includes all properties that meet the National Register listing criteria, which are specified in the Department of the Interior Regulations Title 36

CFR 60.4 and National Register Bulletin 15. Sites not yet evaluated, and at least 50 years old, may be considered potentially eligible for inclusion in the National Register and are afforded the same regulatory consideration as nominated properties. Whether prehistoric, historic, or traditional, significant cultural resources are referred to as historic properties.

### **3.4.2 Prehistoric and Historic Archaeological Resources**

Archaeological investigations at CCAFS reflect that human inhabitation first occurred approximately 4,000 years ago. Early settlement was established within the Banana River salt marsh environment. Over time, site dispensation and size fluctuated, and archaeological evidence indicates that the entire peninsula was used for a wide variety of marine, estuarine, and terrestrial resources. Occupation of the peninsula is divided into seven cultural periods, the Archaic Period, the Orange Period, the Transitional Period, the Malabar I, IIA, and IIB Periods and the Protohistoric (A.D. 1450-1650) or Seminole Period.

### **3.4.3 Historic Buildings and Structures**

The Cape Canaveral Long-Range Proving Ground was formally established in 1949 under the direction of the USAF. Construction began on the first missile launch pads, support facilities, and down-range tracking stations in 1950, and during this decade military facilities and activities developed at a rapid pace. During these years, various cruise-type missiles were tested and the installation began to support the Intermediate Range and ICBM programs. CCAFS LCs were also used to support manned Mercury and Gemini Program launches. In 1966 during the peak installation period, more than 30 operational LCs were completed.

A Cultural Resources Assessment Survey was conducted at LC-16 in 2015.<sup>21</sup> The survey identified eight resources (Facility 13100N (Cableway), Facility 13100P Flume & Catchment Basin, Facility 13112 (Missile Launch Test Facility), Facility 13114 (Instrumentation Building), Facility 13122 (Blockhouse), Facility 13125 (Ready Building), Barton Freeway and the Pershing Missile Test Site) eligible for listing on the NRHP as contributing resources to LC-16. However, the Florida SHPO determined that LC-16 did not have sufficient integrity to possess historical significance and that only Facility 13122 (Blockhouse) was eligible for listing on the National Register.

### **3.4.4 Native Populations/Traditional Resources**

The Cape Canaveral and Banana River areas were populated by the Ais Native American tribe at the time of European contact.<sup>22</sup> The Ais were one of the most influential and powerful tribes in Florida during the time of the Spaniards. Description of settlements were located from Cape Canaveral to St. Lucie River and extended perhaps as many as 30 miles inland. The Ais settlements closest to CCAFS were the Ulumay villages along the Banana River. These Ais settlements were numerous, changed with the seasons and reflected fishing and gathering subsistence. Agriculture was not practiced. Tools and utensils were typically fashioned of conch shells or gourds. Dwellings were temporary.<sup>23</sup> Ais Indians no longer remain, but they are represented by the Seminole Tribe of Florida, the Seminole Nation of Oklahoma and the Miccosukee Tribe.

Traditional sites are subject to the same regulations and are afforded the same protection as all historical properties. Traditional resources related to the Ais could include archaeological sites, burial sites, mounds, ceremonial areas, caves, hillocks, water sources, plant habitat or gathering areas or any other natural area important to the Ais for religious or heritage reasons. Traditional resources sites often overlap with (or are components of) archaeological sites. The National

Register listed or eligible sites (as well as any archaeologically sensitive areas) could also be considered traditional sites or could contain traditional resource elements.

### **3.4.5 Cultural Resources Associated with LC-16**

LC-16 has one site, Facility 13122 (Blockhouse), that is eligible for listing on the NRHP. Section 4.4 contains additional historical and cultural resource information.

No Traditional Cultural Properties, inclusive of the project area, exist on CCAFS, according to the Seminole Tribe of Florida, the Seminole Nation of Oklahoma, the Miccosukee Tribe<sup>24</sup> and 2015 45 SW Integrated Cultural Resources Management Plan (ICRMP) review.

## **3.5 Air Quality**

This section describes air quality resources at CCAFS for the atmosphere at altitudes below 3,000 feet, which contains the atmospheric boundary layer for CCAFS. Rapid mixing within the atmospheric boundary layer ensures that chemicals released within the atmospheric boundary layer quickly mix throughout the atmospheric boundary layer. The ROI is defined as the atmospheric boundary layer on CCAFS where people work.

National Ambient Air Quality Standards (NAAQS) 40 CFR Part 50-51, Title V of the Clean Air Act (CAA) Part 70, Title 40 CFR 61 and 63 (National Emission Standards for Hazardous Air Pollutants [NESHAPs]), Title 40 CFR 70 (Operating Permits), and Florida Administrative Code (FAC) Chapter 62 set standards for pollutants to attempt to control levels that may affect public health and the environment.

Section 112(r) of the CAA and 40 CFR Part 68 require preparation of a Risk Management Plan (RMP) if reportable quantities of regulated and extremely hazardous chemicals are used. Relativity uses no listed chemicals at or above reportable thresholds and is not required to prepare an RMP.

Specific regulations that are applicable to industrial activities in Florida include:

- Rule 62- 210, FAC *Stationary Source - General Requirements*: Establishes general requirements for stationary sources of air pollutant emissions and provides criteria for determining the need to obtain an air construction or air operation permit
- Rule 62 -212, FAC *Stationary Sources - Preconstruction Review*
- Rule 62 -213, FAC *Operation Permits for Major Source of Air Pollution*.

In Florida, regional air quality is assessed at the county level. CCAFS is located within Brevard County which has been designated by both EPA and FDEP to be in attainment for all CAA Criteria Pollutants (carbon monoxide [CO]), lead, nitrogen dioxide, ground-level ozone, particulate matter (PM), and sulfur dioxide (SO<sub>2</sub>)). Ambient air monitoring records from monitoring stations maintained by the appropriate state or local agency for the affected environment are examined to characterize the existing air quality. Brevard County has two monitoring stations, Melbourne and Cocoa Beach. For the past three years, the only monitoring at these stations was for ozone and PM as shown in **Table 3-7**.<sup>25</sup>

**Table 3-7: Measured Ambient Air Concentrations of Criteria Pollutants Brevard County**

Pollutant	Average Time	Nearest Monitoring Station	Maximum Measured Concentration (ppm, except PM in $\mu\text{m}^3$ )		
			2017	2018	2019
Ozone	1 Hour	Cocoa Beach	75	84	71
Ozone	8 Hour	Cocoa Beach	69	79	67
Ozone	1 Hour	Melbourne	69	64	97
Ozone	8 Hour	Melbourne	66	60	55
PM <sub>2.5</sub> micron	24 Hour	Melbourne	26.8	no monitoring	19.7
PM <sub>10</sub> micron	24 Hour	Melbourne	53.9	27.3	67.1

The 45 SW surrendered the CCAFS Title V Air Permit, 0090005-016-AV on March 20, 2017 and is no longer required to submit Annual Operating Emissions Reports to the FDEP. The 45 SW continues to track air emissions to ensure operational changes remain below permitting thresholds.<sup>26</sup> The latest CCAFS data available are shown in *Table 3-8*.

**Table 3-8: Criteria Pollutants and HAP Emissions at CCAFS**

Pollutant	Maximum Measured Concentration (ppm, except PM in $\mu\text{m}^3$ )	
	2014	2015
CO	5.329	5.916
Nitrogen Oxides (NO <sub>x</sub> )	6.8	8.284
Sulfur Oxides (SO <sub>x</sub> )	0.081	0.318
Volatile Organic Compounds (VOC)	3.805	5.23
PM <sub>2.5</sub>	0.657	0.662
PM <sub>10</sub>	0.723	0.692
HAP (Tons/Year)	0.719	0.171

Use of Class I ozone depleting chemicals (ODC) is prohibited at CCAFS. Relativity will not use Class I or II ODCs in any part of the Terran 1 Program.

Vehicles will emit exhaust CO, NO<sub>x</sub>, and SO<sub>2</sub> during project construction and launch operation activities. PMs are generated during construction activities. Equipment used to grade, dig, and perform other construction related activities emit exhaust and dust particulates. The two main pollutants of concern in diesel exhaust that affect human health are NO<sub>x</sub> and PM.

### 3.6 Climate

Brevard County has one of the most diverse ecosystems in North America due to the rare combination of climates. Brevard County is exposed to a temperate climate to the north and a warm subtropical climate to the south, combining the habitat and environmental needs for a wide variety of animal life.

Summers are hot and humid with temperatures in the mid- to- upper 90s (degrees Fahrenheit). Winters are mild with average day-time temperatures in the 60-70 degrees Fahrenheit range, with January being the coldest month on average. Hurricane season runs from June through November and is normally most active between August and October. Central Florida is a transition zone between a tropical climate to the south and a humid subtropical climate to the north. The Florida Peninsula is surrounded by oceanic currents of the Gulf Stream that influences the state's weather, which is punctuated by thunderstorms, lightning and hurricanes.

The principal meteorological conditions that control dispersion are atmospheric winds and turbulence (or mixing ability). The wind direction determines which locations would be affected by a given source. The wind speed, along with the degree of turbulence, controls the volume of air available for pollutant dilution. Atmospheric stability is a measure of the mixing ability of the atmosphere and, therefore, its ability to disperse pollutants. Greater turbulence and mixing are possible as the atmosphere becomes less stable, and thus pollutant dispersion increases. In general, stable conditions occur most frequently during the nighttime and early morning hours.

Localized meteorological effects are measured on a meso-scale basis pre-launch and post launch to document weather conditions both at lower atmosphere and upper atmosphere currently. Various computer models are used by the USAF 45<sup>TH</sup> Weather Squadron (45 WS). The 45 WS provides weather support to the space program at CCAFS and KSC. They provide technical and climatological consultations to 45 SW customers. Range safety requirements are followed prior to and post launch to determine and measure required meteorological conditions such as temperature, barometric pressure and wind speeds. Various computer modeling is conducted to predict conditions in the event of a launch failure or accident on surrounding populations. NOAA, in cooperation with several related federal agencies, develops and improves stratospheric and tropospheric wind profiler models that help to access upper-air short-period wind changes to continually improve pre-launch risk assessments. NOAA Environmental Technology Laboratory developed wind profilers (such as the KSC 50 megahertz and 915 megahertz profilers) for characterization of wind and temperature fields for toxic hazard assessments (THA) that support risk assessment forecasts for low level winds on all Eastern Range CCAFS launch vehicles. Extensive forecasting is conducted to minimize possible negative short-term effects in air quality in the event of a launch failure or accident.

Greenhouse Gases (GHGs) are gas emissions that trap heat in the atmosphere. Natural processes and human activities create emissions. Climate is presumed to be impacted by increases in GHG. Aviation or Commercial space launch GHG emissions have no significance thresholds. The FAA has not identified specific factors which should be considered in making a significance determination for GHG emissions. Currently, no accepted methods to determine significance applicable to aviation or commercial projects for space launches exists. **Table 3-9** summarizes the most current CCAFS GHGs Emissions data. CCAFS is not a mandatory reporting installation for GHG emissions.<sup>27</sup> CCAFS emissions are small compared to global emissions, so the cumulative impact should not be significant.

**Table 3-9: Summary of Greenhouse Gases Emissions for CCAFS (Years 2011 through 2013)**

GHG	2011 GHG Emissions		
	Ton (Short)	Ton (Metric)	MTCO <sub>2</sub> e
Carbon Dioxide (CO <sub>2</sub> )	3,160.034	2,866.735	2,866.735
Nitrous Oxide (N <sub>2</sub> O)	0.052	0.047	14.624
Methane (CH <sub>4</sub> )	122.215	110.872	2,328.303
Total Reportable GHG for 2011			<b>5,209.662</b>
GHG	2012 GHG Emissions		
	Ton (Short)	Ton (Metric)	MTCO <sub>2</sub> e
CO <sub>2</sub>	2,827.9	2,565.43	2,565.42
N <sub>2</sub> O	0.05	0.04	13.21
CH <sub>4</sub>	211.41	191.79	4,027.65
Total Reportable GHG for 2012			<b>6,606.28</b>
GHG	2013 GHG Emissions for 2013		
	Ton (Short)	Ton (Metric)	MTCO <sub>2</sub> e
CO <sub>2</sub>	6,148.266	5,577.651	5,577.651
N <sub>2</sub> O	227.900	206.500	61,153.000
CH <sub>4</sub>	241.542	219.085	5,433.214
R-22	0.085	0.077	0.004
R-123	0.076	0.069	0.002
Total Reportable GHG for 2013			<b>72,547.870</b>
Source: EA Blue Origin Orbital Launch Site at CCAFS, 2016 Note: MTCO <sub>2</sub> e: Metric Ton Carbon Dioxide Equivalent R-22: Chlorodifluoromethane or difluoromonochloromethane (HCFC-22) is a hydrochlorofluorocarbon refrigerant that has been phased-out of production. R-123: 2,2-Dichloro-1,1,1-trifluoroethane (HCFC-123) is a refrigerant and fire-extinguishing agent that will be phased out of production and use by 2040.			

Because LC-16 is near the Atlantic Ocean (pad centerline 1,000 feet to the east) and Banana River (8,000 feet to the west), sea and estuary level increases are of concern. An eustatic sea level change is that which is caused by an alteration to the volume of water in the world oceans. According to the International Panel on Climate Change (IPCC), global MSL continues to rise due to thermal expansion of the oceans and the loss of mass from glaciers, ice caps and the Greenland and Antarctic ice sheets.<sup>28</sup>

At CCAFS, mean sea level (MSL) is approximately 0.587 feet North American Vertical Datum of 1988 (NAVD88). Mean water level of the Indian River Lagoon (includes the Banana River) is estimated at -0.7 feet NAVD88, based on analyses of data from historic and current NOAA tide gauges. Water levels at CCAFS fluctuate cyclically, with maximum heights generally in October and minimal elevations in February and March.<sup>29</sup>

### 3.7 Orbital and De-Orbiting Debris

Manmade orbital and de-orbiting debris pose potential hazards and environmental impacts. Orbital and de-orbiting debris is a concern as a potential collision hazard to spacecraft including Terran 1. Large pieces of debris are of concern if they re-enter Earth's atmosphere and impact ground surface.

Space debris can be classified as either natural or manmade objects. The measured amount of manmade debris equals or exceeds that of natural meteoroids at most low LEO altitudes (i.e., below 2,000 km (1,243 miles)). Manmade debris consists of material left in Earth orbit from the launch, deployment, and deactivation of spacecraft. It exists at all inclinations and primarily at LEO altitudes of approximately 800 to 1000 km (500 to 625 miles).<sup>30</sup> Orbital and de-orbiting debris moves in many different orbits and directions, at velocities ranging from three to over 75 km per second (1.9 to over 47 miles per second) relative to Earth.<sup>31</sup> Although space debris is not explicitly mentioned in any US legislation, an Executive Branch policy directive, National Space Policy,<sup>32</sup> identifies the following guidance to support major US space policy objectives:

“...the United States shall:

- Lead the continued development and adoption of international and industry standards and policies to minimize debris, such as the United Nations Space Debris Mitigation Guidelines;
- Develop, maintain, and use space situational awareness (SSA) information from commercial, civil, and national security sources to detect, identify, and attribute actions in space that are contrary to responsible use and the long-term sustainability of the space environment;
- Continue to follow the US Government Orbital Debris Mitigation Standard Practices (USGODMSP), consistent with mission requirements and cost effectiveness, in the procurement and operation of spacecraft, launch services, and the conduct of tests and experiments in space;
- Pursue research and development of technologies and techniques, through the Administrator of the NASA and the Secretary of Defense, to mitigate and remove on-orbit debris, reduce hazards, and increase understanding of the current and future debris environment; and
- Require the head of the sponsoring department or agency to approve exceptions to the USGODMSP and notify the Secretary of State.”

### **3.7.1 Characteristics of Orbital and De-Orbiting Debris**

Orbiting objects lose energy through friction with the upper reaches of the atmosphere and various other orbit-perturbing forces. Over time, the object falls into progressively lower orbits and eventually falls to Earth. Once the object enters the measurable atmosphere, atmospheric drag slows it down rapidly and causes it either to burn up or de-orbit and fall to Earth. Satellites with circular orbital altitudes of less than 400 km (248 miles) may re-enter the atmosphere within a few months, whereas satellites with orbital altitudes greater than 900 km (559 miles) may have lifetimes of 500 years or more.<sup>33</sup>

It is estimated that more than 10,000 objects greater than 4 inches in size, tens of millions of objects between 0.039 and 4 inches in size, and trillions of objects less than 0.039 inch in size are in orbit.<sup>34</sup> Most cataloged orbital debris occur in LEO because most space activity has occurred at those altitudes. LEO occurs at altitudes less than 2,000 km (1,243 miles). The quantity of orbital debris has been growing at a roughly linear rate and growth is projected to continue into the future.<sup>35</sup>

### **3.7.2 Hazards to Space Operation from Debris**

The effects of launch vehicle-generated orbital debris impact on other spacecraft including the Terran 1 Vehicle depend on the altitude, orbit, velocity, angle of impact, and mass of the debris. Debris less than about 0.004 inch in diameter can cause surface pitting and erosion. Long-term exposure of payloads to such particles is likely to cause erosion of exterior surfaces and chemical contamination and may degrade operations of vulnerable components. Debris between 0.004 and 0.4 inch in diameter would produce impact damage that can be serious. Objects larger than 0.4 inch in diameter can produce catastrophic damage.<sup>36</sup>

### **3.8 Hazardous Materials and Solid and Hazardous Waste**

Proposed Terran 1 operations at LC-16 will use hazardous materials and produce solid or potentially hazardous wastes and will require proper management of hazardous materials and proper disposal of wastes.

#### **3.8.1 Hazardous Materials Management**

Hazardous materials include all chemicals identified and regulated under the Emergency Planning and Community Right-to-Know Act (EPCRA), OSHA, Hazardous Communication (HAZCOM) Standard, Hazardous Materials Transportation Act (HMTA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Toxic Substance Control Act (TSCA) and the CAA. Relativity will purchase and manage all hazardous materials proposed for use at LC-16 through its internal supply system.

In the event of a spill of hazardous materials, Relativity would determine if the situation is an emergency. If it is an emergency, Relativity would notify the USAF. The USAF 45 SW has the primary responsibility for Emergency Response at CCAFS. They would provide emergency spill response and situation stabilization. Once stabilized, corrective and cleanup actions would be the responsibility of Relativity. Response to an emergency situation will be conducted in accordance with the 45 SW Comprehensive Emergency Management Plan (CEMP) 10-2 Vol. I. The CEMP provides details, policies, procedures, responsibilities, and required actions that govern the emergency response of USAF, DoD, government contractor employees and commercial operations, for actual or potential accidental release or spill of hazardous materials/chemicals. Response to major aerospace vehicle incidents is as directed in the CEMP. Relativity is responsible for providing personnel who have specialized knowledge of launch processing systems to support the 45 SW HAZMAT Response Team. The CEMP contains the required organizational chart; job descriptions, detailed description of information flow; and description of the formation of a unified command within the response management system. Relativity is responsible for the coordination of all environmental emergency response actions on its leased premises.

Relativity will maintain a specific spill response plan to cover Terran 1 operations. This plan will cover response to non-emergency spills and leaks and clean-up of all spill or leak incidents. Relativity would also be responsible for completing all state and EPA notifications if a spill/release exceeds reporting thresholds.

#### **3.8.2 Solid Waste Management**

Solid waste from LC-16 operations will be managed by a contract with an outside waste management company. Proper management and disposal of solid waste from construction will be the responsibility of the construction contractor.



### 3.8.3 Hazardous Waste Management

Hazardous waste is defined in RCRA as any solid, liquid, contained gaseous or semi-solid waste, or any combination of wastes that could or do pose a substantial hazard to human health or the environment. Waste may be classified as hazardous because of its toxicity, reactivity, ignitability or corrosivity. In addition, certain types of waste are “listed” or identified as hazardous in 40 CFR 263. In regulatory terms, a RCRA hazardous waste is a waste that appears on one of the four hazardous waste lists (F-list, K-list, P-list, or U-list) or exhibits at least one of four characteristics: ignitability, corrosivity, reactivity, or toxicity.

Hazardous waste management at CCAFS is regulated under RCRA (40 CFR 260-280) and FDEP (Rule 62-730, FAC). If required, Relativity will obtain an EPA hazardous waste generator identification number and will be responsible for managing and disposing of all hazardous waste generated. Relativity will manage all Terran I hazardous waste generated from its operations in accordance with all local, state, and federal regulations. All organizations that generate hazardous waste at CCAFS are responsible for complying with all applicable hazardous waste regulations.

### 3.8.4 Installation Restoration Program

The Installation Restoration Program (IRP) is an USAF program that identifies, characterizes and remediates past environmental contamination on USAF installations. The program has established a process to evaluate past disposal sites, control the migration of contaminants, and control potential hazards to human health and the environment. In response to the CERCLA and requirements of Section 211 of the Superfund Amendments and Reauthorization Act (SARA), DoD established the Defense Environmental Restoration Program (DERP) to facilitate cleanup of past hazardous waste disposal and spill sites nationwide. Section 105 of SARA mandates that response actions follow the National Oil and Hazardous Substances Pollution Contingency Plan, as promulgated by the EPA. AFI 32-7020, Environmental Restoration Program, implements the DERP as outlined in DoD Manual 500.52-M, Environmental Restoration Program Manual. The DoD established the IRP to identify, characterize, and evaluate past disposal sites and remediate associated contamination as needed to protect human health and the environment. The IRP was initiated at CCAFS in 1984.<sup>37</sup>

**Appendix A; Figure 7. LC-16, SWMU C040** shows the extents of contamination in the LC-16 area included within SWMU C040<sup>38</sup>. A Land Use Control Implementation Plan (LUCIP) is in place due to polychlorinated biphenyls (PCBs) soil contamination. In 1996, an Interim Measure (IM) was conducted to remove contaminated soil to below FDEP Soil Cleanup Target Industrial Levels. The LUCs remain in effect until the soil contamination is removed or is naturally attenuated to acceptable regulatory levels.<sup>39</sup> Soils may not be disturbed or moved off site during property development or construction without meeting the following conditions of the IRP-negotiated LUCs:

- USAF review, coordination, and approval of the proposed construction/development plans via AF Form 103 (Base Civil Engineer Work Clearance Request), 332 (Base Civil Engineering Work Request), 813 (Request for Environmental Impact Analysis) or similar process.
- Ensure proper engineering controls are in place so that unauthorized release or disposal of the affected media does not occur. This includes conducting appropriate testing, developing a disposal plan and obtaining IRP prior to off-site disposal.

- Use of proper personal protection equipment by site workers, as determined by the project proponent's occupational health and safety advisor.

Groundwater at LC-16 is contaminated with industrial solvents including trichloroethylene, cis-1,2-dichloroethane, vinyl chloride and 1,4-dioxane. Initially, a long-term monitoring plan was managed by the CCAFS IRP to allow natural degradation of contaminants. In 2009, a previously unassessed solvent source area was identified that required additional investigation and identification of plume boundaries. Interim monitoring, additional characterization and source treatment (expected implemented in the early 2020s) are planned. Groundwater LUCs are also in effect.<sup>40</sup> During construction, if dewatering is required, authorization through the CCAFS IRP would be required to ensure groundwater is not impacted.

### **3.8.5 Pollution Prevention**

Pollution prevention is reducing or eliminating waste at the source by promoting the use of non-toxic or less toxic substances, modifying production processes, reusing materials to reduce waste and implementing conservation techniques. The Federal Compliance with Pollution Control Standard (EO 12088) and the USAF Pollution Prevention Management Action Plan (AFI 32-7080) give guidance on measures for pollution. Relativity policy is to reduce hazardous material use and minimize waste generation. Relativity launch programs consider pollution prevention in the design of both the launch system and vehicle. Environmental aspects of design decisions are considered during all design phases.

## **3.9 Water Resources**

Water resources located at CCAFS and LC-16 area include groundwater and surface waters. The ROI for groundwater includes the local aquifers that are directly or indirectly used by CCAFS. The ROI for surface water is the drainage system/watershed in which LC-16 is located. Groundwater contamination is discussed in Section 3.8.4.

The federal Clean Water Act (CWA) provides the basic structure for regulating the discharge of pollutants from point sources to waters of the US as implemented by the EPA through pollution control programs such as the National Pollutant Discharge Elimination System (NPDES) and industry standards set for wastewater. Permitting through the United States Army Corps of Engineers (USACE) is required where waters are regulated under Section 404 of the CWA (33 U.S.C. 1344). The 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 permitting, including stormwater permits, stormwater construction permits and wastewater construction and operation permits. St. Johns River Water Management District (SJRWMD) regulates stormwater construction and operation permits. The FDEP regulates NPDES stormwater construction permits for land disturbing activities greater than one acre. The FDEP also has authority to regulate wastewater discharges, both surface water and groundwater discharges, related to state water quality.

### **3.9.1 Surface Water**

LC-16 is located on a barrier island within the Florida Middle East Coast Basin approximately 8,000 feet east of the Banana River and approximately 1,000 feet west of the Atlantic Ocean. The Basin contains three major bodies of water; the Banana River to the immediate west, Mosquito

Lagoon to the north, and the Indian River to the west. Many man-made canals and ditches facilitate surface water runoff from CCAFS developed areas. All three water bodies are estuarine lagoons, with circulation provided mainly by wind-induced currents.<sup>41</sup> CCAFS areas designated as Outstanding Florida Waters (OFW) per FAC 62-3 include most of Mosquito Lagoon of the Banana River, Indian River Aquatic Preserve, Banana River State Aquatic Preserve, and Canaveral National Seashore. These water bodies are afforded the highest level of protection and any compromise of ambient water is prohibited.

The Indian River Lagoon System has also been designated an Estuary of National Significance by the EPA. Estuaries of national significance are identified to balance conflicting uses of the nation's estuaries while restoring or maintaining their natural character. The Banana River has been designated a Class III surface water, as described by the CWA. Class III standards are intended to maintain a level of water quality suitable for recreation and the production of fish and wildlife communities. No wild and scenic rivers are located on or near CCAFS.

On LC-16, surface water drains by overland flow to the manmade low-lying percolation areas, and drainage swales. The percolation areas and swales consist primarily of natural landscape and surface water typically recharges the groundwater system through infiltration.

The route between ICBM Road and the LC-16 is a paved road. Runoff discharges to the surrounding undeveloped vegetated scrub and wetland areas that are connected to the Banana River.

### **3.9.2 Groundwater**

Groundwater at CCAFS occurs under unconfined (water table), semi-confined and confined (artesian) conditions. The unconfined aquifer, composed of Holocene and Pleistocene age surficial deposits of marine sand, shell fragments, and sand conglomerate of the Anastasia Formation, is approximately 70 feet thick and is recharged by direct infiltration or rainfall. The generalized direction of groundwater flow in the surficial aquifer is westward, toward the Banana River. Localized flow in the surficial aquifer is from topographic highs (mounds, swells, dune ridges) toward surface water bodies (creeks, ponds, drainage canals). The surficial aquifer at LC-16 consists of groundwater that occurs at depths a few feet Below Land Surface (BLS).

A confining unit composed of clays, sands and limestone separates the surficial aquifer from the underlying Floridan aquifer. The confining unit is generally 18 to 120 feet thick. The relatively low hydraulic conductivity of the confining unit restricts the vertical exchange of water between the surficial aquifer and the confined Floridan aquifer. The Floridan aquifer is the primary source of potable water in central Florida and is composed of several carbonate units with highly permeable zones. The top of the first carbonate unit occurs at a depth of approximately 180 feet below ground surface, and the carbonate units extend to a depth of several hundred feet. The Floridan aquifer is used for water in Cocoa Beach, the water is extracted from the Floridan Aquifer on the mainland and there are no public supplies wells on or near CCAFS or Cocoa Beach.

### **3.9.3 Floodplains and Wetlands**

Wetland and floodplains require compliance with the following regulations:

- CWA, Section 404. Section 404 regulates applicable waterways such that no discharge of dredged or fill material can be permitted if a practicable alternative exists which is less

damaging to the aquatic environment or if the nation's waters would be significantly degraded.

- EO 11990, Protection of Wetlands. This EO requires avoidance, to the extent possible, 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.
- EO 11988, Floodplain Management. This EO requires consideration of alternatives to avoid adverse impacts associated with occupancy, modifications and incompatible development in Floodplains whenever a practical alternative exists.

### **3.9.3.1 Floodplains**

Floodplains are lowland and relatively flat areas adjoining inland and coastal waters that are subject to flooding. Since CCAFS does not have a significant change in topography, the floodplains include the coastal dunes, wetlands and all areas of CCAFS. The 100-year floodplain extends to seven (7) feet above MSL on the ocean side and four (4) feet above MSL on the Banana River side. The 500-year floodplain elevations are ten (10) feet above MSL on the ocean side of CCAFS and six (6) feet above MSL along the Banana River.<sup>42</sup>

The 100-year floodplain is not present within the boundary of LC-16. The floodplain boundary is presented in *Appendix A, Error! Reference source not found.*<sup>43</sup>

### **3.9.3.2 Wetlands**

Wetlands are the transition zones between dry upland ecosystems and deeper aquatic habitats. Each wetland area is unique according to its surrounding geologic, hydrologic, and climatic conditions. Wetlands are defined in AFI 32-1067, Water and Fuel Systems,<sup>44</sup> as those areas inundated by surface or groundwaters that support plants and animals that need saturated or seasonally saturated soil to grow and reproduce. Wetlands provide flood control, aquifer recharge, coastal protection and act to help filter pollutants from the ecosystem. Section 1 of EO 11990, *Protection of Wetlands*, directs each federal agency to provide leadership and take action and include all practical measures to minimize destruction, loss, degradation or harm to wetlands. Per EO 11990, the Proposed Action's effect on wetlands should consider factors such as public health, safety, water supply, pollution, long term productivity of existing flora and fauna, habitat diversity and recreational use. Wetlands were delineated during the Biological Assessment conducted by Atlantic Environmental in 2019<sup>45</sup> and are shown in *Appendix A, Figure 9. LC-16 Wetlands Map*<sup>38</sup>.

## **3.10 Geology and Soils**

### **3.10.1 Geology**

The geology underlying CCAFS can be generally defined by four stratigraphic units: the surficial sands, the Caloosahatchee Marl, the Hawthorn Formation, and the limestone formations of the Floridan aquifer. The surficial sands immediately underlying the surface are marine deposits that typically extend to depths of approximately 10 to 30 feet below the surface. The Caloosahatchee Marl underlies the surficial sands and consists of sandy shell marl that extends to a depth of 70 feet below the surface. The Hawthorn Formation, which consists of sandy limestone and clays, underlies the Caloosahatchee Marl and is the regional confining unit for the Floridan aquifer. This formation is generally 80 to 120 feet thick, typically extending to a depth of approximately 180

feet below the surface. Beneath the Hawthorn Formation lie the limestone formations of the Floridan aquifer, which extend several thousand feet below the surface at CCAFS.<sup>46</sup>

Bedrock at CCAFS ranges from a hard to dense limestone that is a principal part of one of the major Florida Artesian Aquifers, located 75 to 300 feet below the surface. It is overlain by sandy limestone, calcareous clay with fragments of shells, coquinoïd limestone and unconsolidated, well-graded quartz sand.<sup>47</sup>

### **3.10.2 Topography and Soils**

CCAFS topography consists of a series of relic dune ridges formed by gradual beach deposits that occurred throughout time. The higher naturally occurring elevations occur along the eastern portion of CCAFS, with a gentle slope to lower elevations toward the marshlands along the Banana River. Land surfaces are level to gently sloping along the LCs with elevations that range from sea level to approximately 20 feet above MSL.<sup>48</sup>

CCAFS has 11 different soil types. The three most prominent soil types comprise the Canaveral-Palm Beach-Welaka association, which is generally characterized as nearly level and gently sloping ridges interspersed with narrow wet sloughs that generally parallel the ridges and extends the entire length of the county along the coast near the Atlantic Ocean.

LC-16 soils are somewhat or very poorly drained and are primarily gently undulating Canaveral-Anclote Complex soil type, a rapidly permeable soil found along Florida's coast and in the South Central Florida Ridge. LC-16 disturbed areas are considered Urban Land, 0 to 2 per cent slopes.<sup>49</sup>

As noted in Section 3.8.4, LC-16 soils are contaminated (in excess of the FDEP residential Soil Cleanup Target Levels) and LUCs have been implemented to ensure industrial-only use.

## **3.11 Transportation**

A transportation network provides access to CCAFS. The ROI focuses on the roadways and railroads on CCAFS reaching LC-16 and the regional area immediately surrounding CCAFS.

### **3.11.1 Roadways**

#### **3.11.1.1 Regional Access**

The CCAFS 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 State Road (SR) 528; and from Miami approximately 187 miles to the south via US 1 or Interstate 95.

#### **3.11.1.2 Local Access**

The majority of the employees and other related support services providers for CCAFS reside within the unincorporated areas of north and central Brevard County and in the cities of Cape Canaveral, Cocoa, Cocoa Beach and Rockledge, which are all within 20 miles of the CCAFS south Gate 1. The key roads providing access to CCAFS from the local communities include State Route (SR) A1A, SR 520, SR 528, SR 401, SR 3 and SR 405. The NASA Causeway (SR 405), Beach Road, and SR 528 connect CCAFS with KSC, the inner barrier islands and the mainland. Access roads include:

- Northern access into CCAFS 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 CCAFS and subsequently turns into Samuel C. Phillips Parkway.

- Southern access into CCAFS occurs through Gate 1. Gate 1 is accessed by SR 401 via SR A1A, SR 520, and SR 528.
- SR 401 becomes Samuel C. Phillips Parkway as it approaches Gate 1 and is a 5-lane road that narrows to a 4-lane divided road.
- SR A1A is a north-south, 4-lane divided highway to the south of CCAFS that connects SR 401 and Gate 1 with the cities of Cape Canaveral, Cocoa Beach, and Patrick Air Force Base (PAFB) to the south.
- Western access onto CCAFS is provided by SR 3 and SR 405.
- SR 3 is a north-south highway located on the south side of KSC that provides access to Gate 2. It becomes Kennedy Parkway once on KSC property.
- SR 405 is a 4-lane road providing access to CCAFS from the west. It turns into the NASA Causeway after entering KSC at Gate 3, just before crossing the Indian River Lagoon. After continuing through KSC, SR 405 crosses the Banana River, entering CCAFS and intersecting SR 401 (Samuel Phillips Parkway).

SR 520 is a 4-lane/6-lane, east-west urban roadway that crosses the Banana River and the Indian River Lagoon and connects SR A1A, US 1 and Interstate 95 as well as the city of Cocoa to Merritt Island.

SR 528 is a 4-lane, limited-access toll road that connects the Orlando urban area to the coast. It intersects the southern portion of CCAFS from the west, connecting the mainland to Merritt Island and the barrier islands. SR 528 and SR A1A merge into SR 401 just south of CCAFS.

### **3.11.1.3 On-Site Roadways**

The major on-site roadway on CCAFS is Samuel C. Phillips Parkway, a 4-lane divided highway that accommodates most of the north-south traffic. At its intersection with Skid Strip Road, Samuel C. Phillips Parkway becomes a one-way northbound arterial, with Hangar Road serving as the southbound arterial. East-west roadways provide additional internal access. To the north and south of CCAFS, Samuel C. Phillips Parkway becomes SR 401. The general work force using these roadways is increasing because of new commercial development at CCAFS.

LC-16 is located on the east side of ICBM Road south of the intersection of ICBM Road and Samuel C. Phillips Parkway.

### **3.11.2 Railways**

Florida East Coast Railway provides rail service to Brevard County through the cities of Titusville, Cocoa and Melbourne. KSC has rail service from Titusville. CCAFS has only limited rail service to the Integrate, Transfer, Launch area through KSC. No other areas on CCAFS have rail service and Relativity has no plans to use railways to support the Terran 1 Program.

### **3.11.3 Port Canaveral**

The CCAFS Wharf, part of Port Canaveral, is used by the US Navy, the US Coast Guard and other commercial space launch recovery vessels. A significant amount of ocean-going transportation goes through Port Canaveral, including commercial shipping and cruise lines and commercial and private fishing and pleasure boats. Relativity has no plans to use waterways to support the Terran 1 Program.

### **3.12 Utilities**

#### **3.12.1 Water Supply**

The City of Cocoa's municipal potable water distribution system supplies water under a single long-term contract with the US Government to CCAFS, KSC and PAFB. CCAFS recovers a portion of the costs through its contracts with commercial contractors operating on-site. A total of 6.5 million gallons per day (MGD), 17.5% of the City's capacity, is allocated for all three sites. Total water consumption for all three sites averages 3.7 MGD historically.

Water is used at CCAFS for both potable and non-potable purposes. Non-potable use includes fire protection, limited irrigation and launch-related consumption. Launch pad use of non-potable water includes noise abatement, cooling and shock wave attenuation associated with the deluge system and pre and post launch testing.

No potable water service is available immediately adjacent to LC-16 and no service is planned. An 8-inch fire main is routed parallel along the east side of ICBM Road. The water service along ICBM Road is not suitable for potable service due to potential cross-connection contamination. The closest potable water services are at LC-14, approximately 3,700 linear feet south and LC-20, approximately 4,000 linear feet north.

#### **3.12.2 Wastewater**

No CCAFS sanitary sewer services are available at LC-16 or in the immediate vicinity along ICBM Road and no service is planned. The nearest sanitary sewer force main connection point is located northwest of the Cape Road and ICBM Road intersection, approximately 5,800 linear feet north of LC-16.

#### **3.12.3 Electric Power**

CCAFS receives 115 kilovolt (kV) power from the Florida Power and Light (FPL) transmission system at the New Glenn, North, South and Titan substations. The substations convert the 115kV power to 13.2kV or 23.2kV for the feeders, load break switches, and vacuum fault interrupters that make up the CCAFS-owned distribution system. Individual unit substations convert the distributed 13.2kV or 23.2kV power to user level 480V or 208V power.

LC-16 currently does not have electrical service. New infrastructure will be required to connect LC-16 to the CCAFS power grid.

#### **3.12.4 Stormwater**

SJRWMD regulates stormwater discharges through SJRWMD Rule 40C-4, FAC. SJRWMD issues Environmental Resource Permits (ERP) for all proposed work in, on or over wetlands or other surface waters. The Terran 1 Launch Program will require a SJRWMD permit. The FDEP grants NPDES construction stormwater permits for sites that disturb one or more acres and LC-16 construction will require this permit.

### **3.13 Health and Safety**

Range safety organizations review, approve, monitor and impose safety holds, when necessary, on all pre-launch and launch operations in accordance with AFSPCMAN 91 -710. The objective of the range safety program is to ensure that the general public, launch area personnel, foreign land

masses and launch area resources are provided an acceptable level of safety and that all aspects of pre-launch and launch operations adhere to public laws.

### **3.13.1 Operations Safety**

Relativity will comply with OSHA Standards 29 CFR 1910, *Occupational, Safety, and Health Standards* requirements for the protection of health and safety and 29 CFR 1926, *Safety and Health Regulations for Construction* during project construction. Fire protection systems will comply with NFPA requirements as applied by the CCAFS Authority Having Jurisdiction and DoD Engineering Technical Letter (ETL) guidance and direction. Fire protection alarms will be monitored by the CCAFS Fire Department. Hazardous materials such as propellants, ordnance, chemicals and other payload components must be transported to CCAFS in accordance with DOT regulations for interstate shipment of hazardous substances (Title 49 CFR 100-199). Hazardous materials such as LOX and LNG must be transported in specially designed containers to reduce the potential of a mishap should an accident occur. For some hazardous materials, each state may have its own required transportation routes, time of shipments, and permits. To date, no major accidents involving the shipment of hazardous materials associated with launch vehicles at CCAFS have occurred.

### **3.13.2 CCAFS Safety Requirements**

Launches are not allowed to proceed if an undue hazard exists for persons and property due to potential dispersion of hazardous materials or propagation of blast overpressure. The 45 SW has prepared detailed procedures to be used to control toxic gas hazards. Atmospheric dispersion computer models are run to predict toxic hazard corridors (THCs) for both nominal and aborted launches, as well as spills or releases of toxic materials from storage tanks or that occur during loading or unloading of tanks. Range Safety uses the THCs to reduce the risk of exposure of CCAFS personnel and the general public to toxic materials, including toxic gases.

Emergency response to major aerospace vehicle and hazardous material incidents is provided by the CCAFS Emergency Response Team as directed in the Air Force Emergency Management Program, AFI 10-2501.

#### **3.13.2.1 Range Safety Procedures**

AFSPCMAN 91-710 Range Safety Requirements directs overall safety regulations for CCAFS. It outlines the process for reviews, approvals and operation safety including monitors, safety holds on all launch operations.

Impact debris corridors would be established for the Terran 1 Vehicle on a mission (launch) basis as part of the program's safety review using the results of a debris analysis. Impact debris corridors would be established off the Brevard County, Florida coast over the Atlantic Ocean to meet security requirements and reduce the hazard to persons and property during a launch-related activity. Impact debris corridors are established through the designation of debris impact areas for each specific launch within the Preliminary Flight Data Package (PFDP) document.

The 45 SW Flight Analysis notifies the 1<sup>st</sup> Range Squadron of areas that are hazardous to aircraft (i.e., impact debris corridors) for all normally jettisoned and impacting stages by 30 working days prior to launch. The 1<sup>st</sup> Range Squadron notifies the FAA so that the appropriate Altitude Reservation (ALTRV) or Notice to Airmen can be disseminated. Restricted and Warning Areas would be active and controlled according to AFSPCMAN 91- 710, Range Safety Requirements.



Mission reliability is measured from launch commit and is defined as the probability of successfully placing the payload into its delivery orbit with the required accuracy, and then executing a collision avoidance maneuver. Adherence to specific standards for mission/vehicle reliability are contained in AFSPCMAN 91- 710, Range Safety Requirements is required.

#### **3.13.2.2 45 SW Regulations and FAA Directives and Regulations**

Control of air traffic in FAA-designated areas around the launch head is maintained and coordinated between the Military Radar Unit and FAA to ensure that non-participating aircraft are not endangered by launches. The Military Radar Unit restricts aircraft movement in Restricted Airspace and Warning Areas beginning 15 minutes prior to the scheduled launch time and until the launch is complete.

Zone closures are announced daily over various radio frequencies and posted in harbors along the coast. The 45 SW Flight Analysis notifies the 1<sup>st</sup> Range Squadron of areas that are hazardous to shipping for all normally jettisoned and impacting stages by 30 working days prior to launch. This information is published weekly in the US Coast Guard Broadcast to Mariners. Broadcasts by US Coast Guard Cape Canaveral provide the latest available hazard information to offshore surface vessels. CCAFS in conjunction with PAFB would assume control of and could set-up a national defense area if protected material were involved in any launch vehicle accident. In the event of a launch vehicle impacting areas outside CCAFS, the on-scene emergency response team from CCAFS would respond to the accident upon request of the county. County agencies would be requested to help in the evacuation and possible fire control for such an incident. Military personnel would assume responsibility for disaster control in the immediate impact area.

#### **3.13.2.3 Quantity Distance Criteria Requirements**

Explosive safety quantity-distance criteria are used to establish safe distances from LCs and associated support facilities to non-related facilities and roadways. DoD and Air Force Explosive Safety Standards establish these regulations. The criteria use the trinitrotoluene (TNT) explosive equivalent of propellant to determine safe distances from space launch operations or processing and holding areas. As specified in AFSPCMAN 91-710, all LC-16 facilities will be properly sited and approved in accordance with DoD quantity distance criteria and explosives safety standards.

#### **3.13.2.4 Security Requirements**

Access to CCAFS is secured by manned guard stations and fencing. All employees and visitors must have access badges to gain entrance to CCAFS. CCAFS is responsible for ensuring USAF security requirements are maintained, including addressing terrorist threats. LC-16 will have site security requirements, including Relativity access badging, LC fencing and security lighting.

Further Antiterrorism procedures would be established by Relativity as required, in concert with USAF guidance, to improve the safe transport of any vehicle, payload or other item entering CCAFS.

### **3.14 Socioeconomics**

The influence of launch programs at CCAFS on population and employment varies widely within several counties. CCAFS generally influences eastern Brevard County, which includes the cities of Melbourne, Cocoa Beach, Titusville, Rockledge and Cocoa and unincorporated areas in Brevard County including Merritt Island, Port St. John and Viera. CCAFS also draws commuters from

Orange County (Orlando) and Volusia County (Daytona Beach). Based on the 2010 Census of Population and Housing, Brevard County had a population of 543,376 persons.<sup>50</sup>

Statewide, the Aerospace Industry employs over 130,000 workers as of 2017.<sup>51</sup> Most of the employees are based out of Brevard County, making CCAFS/KSC Brevard County's major employer with a combined work force of military, civil service, other governmental and contract employees. The presence of these employers causes a chain of economic reactions throughout the local region and nearby counties. It is estimated that for each job in the Space Industry, another two are created within the region. This economic force generates over \$2.2 billion in household income, \$1.8 billion in wages and commodity purchases within the state of Florida, as well as \$4.1 billion in total output in the Florida economy annually.<sup>52</sup>

Encouraging commercial space launch companies such as Relativity to expand CCAFS' existing launch capabilities ensures continuation of positive impacts on Brevard County economics.

### **3.15 Environmental Justice**

Environmental justice is defined by the EPA as "The fair treatment and meaningful involvement of all people regardless of race, color, national origin or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies."

Title 32 CFR 989.33, Environmental Justice and AFI 32-7061, EIAP require that a project proponent comply with EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*. The EO requires federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations and to ensure that these types of impacts are considered in EAs and other environmental documents. DOT Order 5610.2(a), *Final DOT Environmental Justice Order*, requires FAA to analyze impacts on low-income and minority populations.

The 2010 Census of Population and Housing reports numbers of minority residents. Minority populations included in the census are identified as Black or African American, American Indian and Alaskan Native, Asian, Native Hawaiian/Other Pacific Islander, Hispanic or Other. Based upon the 2010 Census of Population and Housing, Brevard County had a population of 543,376 persons. Of this total, 122,022 persons, or 22.5 %, were minority. Orange County had a population of 1,145,956 persons, of this total, 686,080 persons or 59.9% were minority. The largest segment of the minority population is Hispanic at 26.9%.<sup>53</sup>

### **3.16 Department of Transportation Act Section 4(f) Properties**

Section 4(f) of the U.S. Department of Transportation Act of 1966 (now codified at 49 U.S.C. § 303) protects significant publicly owned parks, recreational areas, wildlife and waterfowl refuges, and public and private historic sites listed or eligible for listing on the NRHP. As FAA is a cooperating agency, this section is included in this EA to document FAA compliance with Section 4(f) requirements.

Section 4(f) provides that the Secretary of Transportation may approve a transportation program or project requiring the use of publicly owned land off a public park, recreation area, or wildlife and waterfowl refuge of national, state, or local significance, or land of an historic site of national, state, or local significance, only if there is no feasible and prudent alternative to the use of such

land and the program or project includes all possible planning to minimize harm resulting from the use.

No designated Section 4(f) properties exist within the boundaries of CCAFS. Public parks and recreation areas adjacent to CCAFS and the Canaveral National Seashore adjacent to KSC north of CCAFS. The nearest public park, Jetty Park, is located about 6 miles south of LC-16 in the City of Cape Canaveral. Other public parks within an approximate 15 mile (24.1 km) radius of LC-16 include Kelly Park, KARS Park, Canaveral City Park, Sandpiper Park, Veteran's Memorial Park, Center Street Park, George McLeod Memorial Park, Cherie Down Park, Banana River Park, Kings Park, Manatee Sanctuary Park and Manatee Cove Park. and Tosohatchee State Game Preserve are located west of Interstate 95 in Orange County is approximately 20 miles from LC-16.

## 4 Environmental Consequences

This section describes the potential environmental impacts associated with the Proposed Action and No Action Alternative. Components of the affected environment that are of greater concern are described in greater detail.

Guidelines established by the CEQ (40 CFR 1508.27) specify that significance should be determined in relationship to both context and intensity (severity). The assessment of potential impacts and the determination of their significance are based on the requirements in 40 CFR 1508.27. The three levels of impact are:

- No Impact - No impact is predicted
- No Significant Impact - An impact is predicted, but the impact does not meet the intensity/context significance criteria for the specific resource
- Significant Impact - An impact is predicted that meets the intensity/context significance criteria for the specific resource.

Factors contributing to the intensity or severity of the impact include:

- The degree to which the action affects public health or safety;
- Unique characteristics of the geographic area such as proximity to cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers or ecologically critical areas;
- The degree to which effects of the action on the quality of the human environment are likely to be highly uncertain or controversial;
- The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration;
- Whether the action is related to other actions with individually insignificant, but cumulatively significant impacts;
- The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the ESA.

Sixteen (16) environmental aspects are analyzed to assess potential impacts of the Proposed Action and No Action Alternative: 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, Environmental Justice and Department of Transportation Act Section 4(f) Properties. Thresholds for determining impact significance are based on the applicable compliance standard, federal or state recommended guidance or professional standards/best professional judgment. In addition, the FAA uses thresholds that serve as specific indicators of significant impact for some impact categories. FAA actions that would result in impacts at or above these thresholds require the preparation of an EIS, unless impacts can be reduced below threshold levels. Quantitative significance thresholds do not exist for all impact categories; however, consistent with the CEQ Regulations, the FAA has identified factors that should be considered in evaluating the context and intensity of potential environmental impacts (FAA Order 1050.1F, Paragraph 4-3.3). Because the FAA plans to adopt this EA to support its

environmental review of Relativity's license application, the FAA's significance thresholds are considered in the assessment of potential environmental consequences in this EA.

#### **4.1 Land Use / Visual Resources**

Applicable topics include land use, coastal resources, light emissions, and visual resources/visual character. The FAA has not established a significance threshold for these topics.

##### **4.1.1 Proposed Action**

The Proposed Action would occur solely at LC-16, which is designated for space launch activities and operations. Operations would be consistent with both the Base General Plan and the Air Force mission at CCAFS. The Proposed Action would not convert prime agricultural land to other uses; result in a decrease in the land's productivity; or conflict with existing uses or values of the project area or other base properties.

Site-specific LUCs are required at SWMU C040, including LC-16, to protect against exposure from contaminated paint residue, soil, and shallow groundwater.<sup>54</sup> These LUCs include:

- Soils will not be disturbed or moved during property development, maintenance or construction without USAF review, coordination, and approval.
- Paint residues from the actuator pit that may delaminate from the structure are periodically maintained, collected, contained and properly disposed of.
- Groundwater will not be contacted, pumped, or discharged during property development, maintenance, or construction, without USAF review, coordination, and approval.

The Proposed Action will generate no significant impacts on CCAFS land use. Activities at LC-16 will be in conformance with the designated use for space launch activities.

Relativity's facilities will not be visible by the public except potentially from the ocean or from the viewing structure built by the KSC Visitor Complex specifically for tourists. The proposed Terran 1 Program construction, refurbishment and operation activities are within the existing launch complex footprint (see *Appendix A: Figure 6. LC-16 Conceptual Rendering of Terran 1 Program Modifications*) and at heights similar to or lower than other active launch sites at CCAFS. Therefore, the Proposed Action would generate no significant impacts on visual resources.

Terran 1 Program operations and launch activities are similar to previous and current launch activities that occur on CCAFS. All Terran 1 Program construction, refurbishment, operations and launch activities will be coordinated with CCAFS. Coordination with KSC, FAA, FDEP and FCMP member agencies will be conducted as required to ensure the Proposed Action is consistent with meeting the Florida CZMA plan objectives. Issuance of a federal license or permit for an activity in or affecting a coastal zone must be consistent with the CZMA, which is managed by the Florida Department of Community Affairs (FDCA). The Florida State Clearinghouse review will determine whether the Proposed Action is consistent with the FCMP. Thus, the Proposed Action would have no significant impacts to land use, zoning, natural shoreline processes and coastal resources.

#### **4.1.2 No Action Alternative**

Under the No Action Alternative, the Terran 1 Program would not be implemented; thus, no change to visual resources, land use, zoning, natural shoreline processes and coastal resources impacts would occur.

#### **4.2 Noise**

The EPA administers the Noise Control Act of 1972, 40 CFR part 209 and has identified 65 DNL (dBA) or a CDNL of 61 decibels relative to the carrier (dBC) for sonic booms or rocket noise as an acceptable noise level for compatible land uses. This level is not regarded as a noise standard, but as a basis to set appropriate standards that should also factor in local considerations and issues. For project-related overpressures at one (1) psf, the probability of a window breaking ranges from one in a billion to one in a million. In general, the threshold for building damage due to sonic booms is 2 psf,<sup>55</sup> below which damage is unlikely.

Per FAA Order 1050.1F, impacts are considered significant if the 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 will 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. For example, an increase from DNL 65.5 dB to 67 dB is considered a significant impact, as is an increase from DNL 63.5 dB to 65 dB.

Noise impacts from the operation of construction equipment are usually limited to a distance of 1,000 feet or less. Vehicles associated with the Proposed Action typically have noise levels between 65 dBA and 100 dBA at 50 feet.<sup>56</sup>

Temporary noise sources such as refurbishment and demolition would be considered significant if they resulted in noise levels 10 dB or more above the 85 dB, a noise threshold limit value for construction workers in an eight-hour day.

In accordance with 29 CFR 1910, protection against the effects of noise exposure would be provided. When employees are subjected to elevated sound levels from construction activities, feasible administrative or engineering controls would be used. If such controls do not reduce sound levels to the levels presented in *Table 3-3: Sound Level Descriptors*, hearing protection would be provided and used to reduce exposure.

Noise impact criteria are based on land use compatibility guidelines and on factors related to the duration and magnitude of noise level changes. Annoyance effects are the primary consideration for most noise impact assessments on humans. Noise impacts on wildlife are discussed in Section 4.3.1.3, Launch Impacts.

##### **4.2.1 Proposed Action**

Noise generated during Proposed Action launch and construction operations includes static fire (engine), launch (engine), sonic boom and construction noise.

###### **4.2.1.1 Launch Noise and Sonic Booms**

Relativity contracted with Blue Ridge Research and Consulting, LLC (BRRC) to develop the technical report Noise Study for Relativity's Terran 1 Launch Vehicle Operations at CCAFS CX-16<sup>57</sup> to address launch and sonic boom noise. A review was completed by the FAA with comments addressed in the final revised report contained in *Appendix B*. The results are summarized in the

following sections. BRRC developed and used their Launch Vehicle Acoustic Simulation Model (RUMBLE) noise model to predict the noise associated with the proposed Terran 1 launch operations. The FAA's Office of Environment and Energy has approved the use of BRRC's launch noise methodology for this project and the approval is contained in **Appendix C**. Based on BRRC's analysis, Terran 1 noise due to static fire, launch and sonic booms is not considered to be a significant impact as detailed below.

#### **4.2.1.1.1 Launch and Static Fire Test Operations Noise**

A single Terran 1 launch event may generate levels at or above a maximum A-weighted sound level ( $L_{A,max}$ ) of 115 dBA within 0.3 miles of the launch pad, as shown by the orange contour in **Appendix A, Figure 10. Terran 1 Launch Maximum A-Weighted Sound Level ( $L_{A,max}$ ) Contours**.<sup>58</sup> The entire land area encompassed by the 115 dB noise contours resulting from Terran 1 launches lies within CCAFS.

For Terran 1 static fire operations, noise contours are more directive than for launches because the plume is redirected in-line with the deflector heading during the testing. A receptor located within the peak directivity angle may experience a  $L_{A,max}$  of 115 dBA at approximately 0.2 miles from LC-16, shown in **Appendix A, Figure 11. Terran 1 Static Operations Maximum A-Weighted Sound Level ( $L_{A,max}$ ) Contours**.

Relativity will conduct approximately 12 mission duty cycle (MDC) hot fire operations plus 12 static fire operations for a total of 24 hot fire operations annually in a manner similar to wet dress rehearsal (WDR) operations. A hazard clear area will be established prior to the start of operations to ensure the safety of neighboring operations personnel. The hazard area will be controlled by use of roadblocks on ICBM Road. Access to LC-19 to the north and LC-15 to the south will be restricted via roadblocks along ICBM Road. No currently occupied structures will need to be evacuated for static fire or MDC hot fire tests.

Structural damages were assessed by analyzing the 111 dB and 120 dB  $L_{max}$  contours generated by a Terran 1 launch event. 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. For Terran 1 launch events,  $L_{max}$  in excess of 120 dB and 111 dB would be limited to a radius of 0.6 miles and 1.7 miles from the launch pad, respectively. The 120-dB contour and 111 dB contour are entirely within the boundaries of CCAFS and NASA KSC, as shown in **Appendix A, Figure 12. Terran 1 Launch Maximum Unweighted Sound Level ( $L_{max}$ ) Contours**.

During a Terran 1 static fire test operation, a receptor located along the peak directivity angle may experience  $L_{max}$  values of 120 dB approximately 0.7 miles from LC-16 and 111dB at 1.6 miles from LC-16, as shown in **Appendix A, Figure 13. Terran 1 Static Operations Maximum Unweighted Sound Level ( $L_{max}$ ) Contours**.

As shown in BRRC's noise report, the DNL 65 and 60 dBA contours extend approximately 0.7 and 1.1 miles from the launch pad, respectively. This area does not encompass land outside the boundaries of CCAFS and KSC, and thus no noise sensitive areas are impacted. Therefore, Terran 1 static fire tests and launches would not result in significant noise impacts.

#### **4.2.1.1.2 Sonic Boom**

Sonic booms resulting from the Terran 1 nominal launch trajectory would be directed easterly out over the Atlantic Ocean in the direction of the launch azimuth, making them inaudible on the

mainland. With respect to human annoyance, health and safety, or structural damage; noise impacts due to sonic booms for the launch trajectory are not expected. To provide more perspective, modeled and measured sonic boom levels of similar vehicles are discussed in the BRRC report and summarized here. Modeled sonic boom levels for a liquid-fueled medium class launch vehicle and liquid-fueled heavy class launch vehicle at other launch sites ranged from 3.0 and 5.25 psf, respectively. A sonic boom due to the overflight of a Titan IV from VAFB was measured at a number of locations in the Channel Islands, 30 to 40 miles from the launch pad. The over pressures recorded at these locations were less than 2.4 psf, with the exception of one site which recorded an 8.4 psf focused sonic boom. However, the Terran 1 vehicle produces only six percent (6%) of the thrust produced by a Titan IV launch vehicle. Heavy-class vehicles such as the Space Shuttle and Saturn V have been launched from CCAFS and KSC, so the community is familiar with the sonic boom impacts.<sup>59</sup>

The sonic boom footprint of Terran 1 Program launches has a narrow, forward-facing, crescent-shaped focus boom beginning 38 miles from the launch site. The maximum peak overpressure along the focus boom is predicted to be approximately 5.9 psf. However, this amount of pressure would only occur in small areas along the focus boom region. As the rocket gains altitude, the sonic boom peak overpressure decreases. Noise impacts to human annoyance and structures are not expected as the modeled sonic boom footprint is completely over the Atlantic Ocean, as shown in *Appendix A, Figure 14. Terran 1 Sonic Boom Peak Overpressure Contours*.

Since the entire boom footprint is over water, the only potential impacts would be to wildlife (refer to Section 4.3 Biological Resources). However, no current or past launch programs on CCAFS, including Atlas, Titan, or Delta launches, have been documented as causing any animal mortality or significant impact to wildlife habitat on CCAFS.

Underwater penetration of sonic booms off the shore of CCAFS was analyzed in the Final Supplemental Environmental Impact Statement (SEIS) for the Evolved Expendable Launch Vehicle (EELV) Program, U.S. Air Force, March 2000. Maximum EELV sonic boom sea-level overpressure for the EELV was calculated at 7.3 psf whereas Terran 1 sonic boom maximum overpressure was calculated to be 5.9 psf.<sup>60</sup> The Proposed Action would therefore fit within the bounds of the EELV analysis and its conclusion that no significant impacts are expected to occur from the underwater penetration of sonic booms.<sup>61</sup>

#### **4.2.1.2 Construction and Refurbishment Impacts**

A temporary increase in ambient noise levels would occur at LC-16 and the surrounding area during the construction and modifications to the launch pad and support facilities due to the operation of any heavy equipment (e.g., earth moving machinery, dump trucks). Noise impacts from the operation of construction equipment are usually limited to 1,000 feet or less. No residential areas or other sensitive receptors occur at, or near, LC-16; therefore, refurbishment noise would not impact the public or sensitive receptors.

When employees are subject to sound exceeding OSHA limits, engineering or administrative controls would be used and/or personal protective equipment, such as approved hearing protection, will be provided. Therefore, noise effects on construction workers would have no significant impact under the Proposed Action. OSHA noise level standards and protections will be followed to protect worker safety and health. Monitoring of worker exposure to noise will be conducted as required by OSHA.



#### 4.2.2 No Action Alternative

Under the No Action Alternative, no construction or refurbishment noise would occur. Operational noise and sonic booms would not occur from operations at LC-16.

#### 4.3 Biological Resources

Per FAA Order 1050.1F, impacts would be significant if the U.S. Fish and Wildlife Service or the NMFS determines that the action would be likely to jeopardize the continued existence of a federally-listed threatened or endangered species, or would result in the destruction or adverse modification of federally-designated critical habitat.

The USAF is committed to the long-term management of all-natural areas on its installations, as directed by the Sikes Act and AFI 32-7064, *Integrated Natural Resources Management*. Long-term management objectives are identified in the 45 SW's INRMP with specific land-management objectives such as wetland protection, conservation of T&E species and habitat restoration.

Any operation that may affect federally listed species or their critical habitats involves consultation with the USFWS under Section 7 of the ESA of 1973 (as amended). The MMPA of 1972 also prohibits the taking of marine mammals, including tormenting them, and may require consultation with the NMFS. The NMFS is also responsible for evaluating potential impacts to EFH and enforcing the provisions of the 1996 amendments to the MSFCMA. A Section 7 Consultation for Terran 1 Program launches and LC-16 construction assessed the Proposed Action's effects on federally-listed species and the resulting Biological Opinion is contained in **Appendix D**. Specific requirements identified in **Table 4-1** would be used to minimize impacts to biological resources.

**Table 4-1: Summary of Requirements to Protect Biological Resources**

Law or Rule	Permit/Action(s)	Requirement	Agency or Organization
Endangered Species Act (ESA)	Consultation with USFWS and NMFS to determine no effect or not likely to adversely affect some T&E species. Determine if species under USFWS jurisdiction are impacted.	Conserve ecosystems that support T&E species. Section 7 requires federal agencies to ensure that any action authorized, funded or carried out by them is not likely to jeopardize the continued existence of listed species or modify critical habitat.	USFWS
Magnuson-Stevens Act	Consultation with NMFS to determine no impact or no significant adverse impact	Conserve/protect EFH. Federal agencies must ensure that any action authorized, funded or carried out by them will not adversely impact EFH otherwise mitigation will be required	NMFS
EO 11988	LC-16 is not located within the 100-year floodplain. No construction is proposed within the 100-year floodplain.	Reduce the risk of flood loss, minimize the impact of floods on human safety, health and welfare, and restore and preserve the natural and beneficial values served by floodplains. Consider alternatives to avoid adverse effects in the floodplains. Prepare Finding of No Practicable Alternative (USAF)	DoD

Law or Rule	Permit/Action(s)	Requirement	Agency or Organization
EO 11990	Directs each federal agency to provide leadership and take action to minimize destruction, loss or degradation of wetlands	Minimize loss, destruction or degradation of wetlands and restore and preserve the natural and beneficial values served by wetlands. Consider alternatives to avoid adverse effects to wetlands. Prepare a Finding of No Practicable Alternative (USAF)	DoD
EO 13112	Remove and control invasive species	Prevent the introduction of invasive species and provide for their control and minimize the economic, ecological, and human health impacts that invasive species cause.	DoD
MBTA	Consult with USFWS as necessary and comply with applicable permits	Prohibits harassment or harm to migratory birds, and destruction of the eggs or nests without a permit.	USFWS
AFI 32-7064	Long-term management of all-natural areas on the Installation	Protect listed species, biodiversity, wetlands.	USFWS
45 SWI 32-7001	Use full cut off, well shielded, low wattage, or amber Light Emitting Diode (LED) lights or prevent use of lighting from 1 May to 31 October	Reduce the amount of exterior lighting visible from the beach during the sea turtle nesting season (1 May – 31 October) from 2100 to 0600 to reduce sea turtle hatchling mortality caused by disorientation (in accordance with the ESA).	45 SW

#### 4.3.1 Proposed Action

Potential impacts to Biological Resources due to the Proposed Action include construction, launch operations and launch impacts. No state or federally listed T&E plant species have been documented in the Proposed Action area. Gopher tortoises, southeastern beach mice and scrub-jays have historically been on or in the vicinity of LC-16. Four species of endangered sea turtles' nest on the beaches in the LC-16 vicinity. **Table 4-2** summarizes the potential impacts to listed wildlife species potentially present within LC-16.

**Table 4-2: Potential Impacts to Federal and State Protected Wildlife Species within Proposed Action ROI**

Common Name Scientific Name	USFWS	FWCC	Occurrence	Potential Impacts
Florida Scrub-Jay <i>Aphelocoma coerulescens</i>	T	T	Documented	Loss of breeding habitat. Disruption due to noise.
Gopher Tortoise <i>Gopherus polyphemus</i>	C	T	Documented	Crushing by equipment. Disruption due to noise.
Eastern Indigo Snake <i>Drymarchon corais couperi</i>	T	T	Potential	Crushing by equipment. Loss of habitat. Disruption due to noise.
Southeastern Beach Mouse <i>Peromyscus polionotus niveiventris</i>	T	T	Documented	Crushing by equipment. Disruption due to noise.

Common Name Scientific Name	USFWS	FWCC	Occurrence	Potential Impacts
Marine Turtle: Leatherback ( <i>Dermochelys coriacea</i> ); Green ( <i>Chelona mydas</i> ); Loggerhead ( <i>Caretta caretta</i> ); Kemps Ridley ( <i>Lepidochelys kempii</i> ); Hawksbill Sea Turtle ( <i>Eretmochelys imbricate</i> )	E E/T	E T	Documented	Disruption and disorientation due to light.
Manatee <i>Trichechus manatus latirostris</i>	T	T	Documented	Disruption due to noise. Potential falling debris.
Wood Stork <i>Mycteria americana</i>	T	T	Potential	Disruption due to noise.
Piping Plover <i>Charadrius melodus</i>	T	T	Documented	Disruption due to noise.
Red Knot <i>Calidris canutus</i>	T	-	Documented	Disruption due to noise.
Legend: (C) Candidate; (SSC) Species of Special Concern; (T) Threatened; (E) Endangered				

#### 4.3.1.1 Construction Impacts

Potential impacts to biological resources during construction would be minor. All construction will occur within the LC-16 perimeter boundary or on the road leading to LC-16, which has been previously disturbed. The Proposed Action will include vegetation clearing and earthwork for the LNG Storage, LOX Storage, HPGSA, Fire and Noise Suppression Systems, Integration Hangar / Payload Processing Facility, Instrumentation Bay and Engineering Support Facilities (office space). Other than the common “startle response”, no impacts to wildlife (including federally and state-listed wildlife species) due to construction noise are anticipated. Construction considerations and mitigation measures for each listed species are provided below.

##### *Florida Scrub-Jay*

Approximately 2.35 acres of potential scrub-jay habitat along the southern portion of LC-16 will be impacted by vegetation clearing. The 2018 Florida scrub-jay census did not reveal the presence of any scrub-jay groups or individuals within the Proposed Action area, therefore direct impacts are not expected. These impact areas consist of primarily invasive species with lesser amounts of inhabitable scrub-jay vegetation. The Proposed Action will result in the removal of unoccupied potential FL scrub-jay habitat.

Relativity proposed to provide funding to treat invasive floral species in nearby Land Management Unit 23 as mitigation for loss of unoccupied potential FL scrub-jay habitat. However, the USAF has noted that mitigation in this area would be of little benefit. Instead, this funding will assist the USAF in continuing efforts to restore and enhance habitat for beach mice in Land Management Unit 22.<sup>62</sup>

##### *Gopher Tortoise*

The Proposed Action will result in the loss of up to approximately 25 acres of occupied gopher tortoise habitat. Clearing activities and construction are likely to disturb tortoises, therefore pre-construction surveys will be completed to identify any occupied burrows and tortoises that may require relocation. Tortoises will be excavated and relocated by an FWC authorized gopher tortoise agent to an approved site on CCAFS. All excavations will follow state protocols and guidelines. Educational posters will also be provided for equipment personnel to continually monitor for any

tortoises that enter the construction site. With these measures implemented, the Proposed Action will have no significant impact to gopher tortoises on CCAFS.

#### *Eastern Indigo Snake*

The Proposed Action will result in the loss of approximately 25 acres of potential eastern indigo snake habitat, including previously disturbed lands. A take may occur as the result of habitat loss, although adjacent habitat is available.<sup>63</sup> All construction personnel will be provided with the 45th SW Indigo Snake Protection/Education Plan prior to work. Education signs will be displayed at the site informing personnel of the snake's appearance, its protected status, and who to contact if any are spotted in the area. If any indigo snakes are encountered during clearing activities, they will be allowed to safely move out of the project area. With these measures in place, the Proposed Action will have no significant impact on eastern indigo snakes on CCAFS.

#### *Southeastern Beach Mouse*

The Proposed Action will include construction that occurs at least 425 feet west of the beach dune area, the typical habitat of the beach mouse. The Proposed Action could result in a take of beach mice due to a loss of potential habitat and the destruction of beach mice burrows from equipment conducting limited clearing and construction activities in areas further inland. Relativity will provide funding to assist the USAF in continuing efforts to restore and enhance habitat for beach mice in Land Management Unit 22. The Biological Opinion (see **Appendix D**) contains all requirements relative to beach mice.

Considering that southeastern beach mice have been documented inside facilities throughout CCAFS, the USAF has a Programmatic BO that covers pest management activities within and around such facilities. Relativity will be required to live trap and release the southeastern beach mouse within and around its facilities on LC-16 per the existing BO.

With these measures and BO in place, the Proposed Action is expected to have no significant impact on southeastern beach mice on CCAFS.

#### *Marine Turtle*

The proposed clearing and construction of new facilities would not directly impact the nesting beach. Exterior lighting proposed for the new facilities has the potential to be visible from the beach and could result in adult and/or hatchling disorientation adjacent to LC-16. Lighting impact would be limited by the implementation of a LMP in accordance with 45 SWI 32-001 *Exterior Lighting Management*.

Clearing of vegetation at the LC-16 area would not have an impact on nesting or hatchling sea turtles; therefore, no mitigation is required for those activities.

#### *Manatee*

Since the area where the West Indian Manatee may be present is well offshore to the east of the Proposed Action area, negligible impacts are expected, therefore mitigation measures are not needed. The Proposed Action would not adversely affect the West Indian Manatee in the waters off CCAFS.

### *Wood Stork*

No nests have been observed within the LC-16 project site. Wood storks have not been observed foraging within the construction area, and because the nearby wetlands and surface waters that do exist within LC-16 are made up of poor-quality wood stork foraging habitat, impact to this species' habitat is expected to be negligible. Therefore, no impacts are expected.

### *Piping Plover*

No earthwork, clearing, or construction will occur on the beach itself; therefore, no impacts are expected to Piping Plover habitat during construction.

### *Red Knot*

No earthwork, clearing, or construction will occur on the beach itself; therefore, no impacts are expected to Red Knot habitat during construction.

Relativity construction activities for the Terran 1 Program will have no significant impact on Biological Resources within the ROI.

#### **4.3.1.2 Operations Impacts**

Potential impacts to biological resources during launch preparations would be minor. Other than the common “startle response”, no impacts to wildlife (including federally and state-listed wildlife species) due to the noise of daily operations are anticipated.

Night lighting at the launch pads has been a concern at CCAFS because of the potential for sea turtle hatchlings at the beach to be drawn toward the lights instead of toward the surf. Potential negative impacts by lighting are reduced and managed by 45 SWI 32-7001, Exterior Lighting Management which will require Relativity to develop a specific LMP for LC-16 operations and launch.

LMPs require the use of amber LED, shielding and special light management steps where lights are visible from beach areas. All construction and operational activities must have an LMP approved by the USFWS. LC-16 exterior lighting would comply with established lighting policy for minimizing disorienting effects on sea turtle hatchlings. The Relativity LMP will be completed once design is complete and sent to USFWS for approval prior to new or temporary lighting construction.

Given proposed mitigations, Relativity launch preparation and operation activities will have no significant impacts on Biological Resources.

#### **4.3.1.3 Launch Impacts**

##### **4.3.1.3.1 Vegetation**

Terran 1 launches will have some small impacts near the launch pad associated with fire and scorching of vegetation, similar to previous launch activities at CCAFS. NASA has mapped the effects on local vegetation of 14 Delta II/III, 20 Atlas V and 8 Titan launches from CCAFS.<sup>64</sup> Vegetation scorching was limited to small areas (less than 2.67 acres) within 492 feet of the launch pad. Since Terran 1 is a much smaller vehicle (less than 10% of the thrust of the vehicles analyzed by NASA), vegetation scorching is expected to be much less than 2.67 acres. Past vegetation scorching has not permanently affected the vegetation near other LC and this same impact is expected to apply to Terran 1 launches.

Acid deposition is associated with solid rocket motor use. Relativity's Terran 1 engines consume LOX and LNG and unmeasurable to no particulate depositions are expected on vegetation from the Proposed Action.

An anomaly on the launch pad would present potential impacts to biological resources from the possibility of extreme heat and fire, percussive effects of the explosion and debris that might impact land or surface waters. The 2000 EELV SEIS concluded that damaged vegetation resulting from a launch anomaly would be expected to regrow within the same growing season because no lingering effects would be present.<sup>65</sup> Similar results are expected for Terran 1 Program launch anomalies. Terran 1 launches will have no significant impact on vegetation resources.

#### **4.3.1.3.2 Wildlife and Marine Life**

No animal mortality has been observed at CCAFS that could be attributed to Delta, Atlas or Titan launches.<sup>66</sup> Similar results are expected for Terran 1 Program launches. Scrub-jays, gopher tortoise, southeastern beach mice, indigo snakes and sea turtle nesting occur in the vicinity of LC-16. Post launch monitoring conducted on previous launches, and previous environmental analyses concluded that launch impacts to these species are minimal. The behavior of scrub-jays observed after Delta, Atlas and Titan launches has been normal, indicating no noise-related effects.

An anomaly on the launch pad would present potential impacts to biological resources from the possibility of extreme heat and fire, percussive effects of the explosion and debris that might impact land or surface waters. The explosion could injure or kill wildlife found adjacent to the launch pad or within debris impact areas. Potential fires started from the anomaly could result in a temporary loss of habitat and mortality of less mobile species.<sup>67</sup>

During a nominal launch, the launch vehicle and spacecraft would be carried over the coastal waters of the Atlantic Ocean and through the Earth's atmosphere. When expended, the Aeon engines and booster disengage and fall into the Atlantic Ocean. The payload fairings separate, re-enter the Earth's atmosphere and fall into the Atlantic Ocean. The second stage, powered by the Aeon VAC Engine, delivers the payload into orbit. The Terran 1 Program plans no recovery of any segments.

An improbable mishap downrange would occur over the open ocean and would not likely jeopardize any marine life, given the relatively low density of species within the surface waters of these open ocean areas. Debris from launch failures has a small potential to adversely affect managed fish species and their habitats in the vicinity of the project area. After a 1998 EIS EELV consultation with the NMFS, the Air Force found "no greater than minimal adverse effects" to EFH under NMFS regulations.<sup>68</sup>

In August 2016, NASA and the FAA conducted an ESA consultation with NMFS on waterborne landings of spacecraft that included landings in the Atlantic Ocean and addressed marine turtles, mammals and fish included in Section 3.3 of this EA. NMFS concluded potential project effects to listed species and critical habitat were found to be discountable, insignificant, or beneficial, and that the proposed action is not likely to adversely affect listed species and critical habitat under NMFS's purview.<sup>69</sup>

In the event of an early launch abort or failure, spacecraft and launch vehicle debris would fall onto land surface or into the ocean and cause potential impacts. Launch vehicle debris from a liquid propellant vehicle is considered a negligible hazard because virtually all hazardous materials

are consumed in the destruct action or dispersed in the air and only structural debris would strike the water. In a destruct action, the Terran 1 vehicle may survive to impact the water essentially intact, presenting some potential for habitat impact if the spacecraft (payload) contains hypergolic propellants or other chemicals that are toxic to marine organisms. Payload hazards are covered in NASA's 2011 Routine Payload EA.<sup>70</sup> Terran 1 payloads are expected to be covered by NASA's EA.

Sonic booms created by launches from CCAFS LCs occur over the open Atlantic Ocean. The effects of a sonic boom on whales or other open ocean species are not known. Because these sonic booms are infrequent, the marine species in the ocean's surface waters are present in low densities (although spring and fall migration would see periodic groups of migrating whales that follow the coastline), and the sonic boom footprint lies over 30 miles from CCAFS, the sonic booms from launches are not expected to negatively affect the survival of any marine species.<sup>71</sup>

Terran 1 launches would have no significant impact on wildlife and marine life resources.

#### **4.3.2 No Action Alternative**

Under the No Action Alternative, the Terran 1 Program would not be implemented. No impacts to Biological Resources, T&E species, or wildlife and marine habitat would occur.

#### **4.4 Historical and Cultural Resources**

The FAA has not established a significance threshold for historical and cultural resources.

##### **4.4.1 Proposed Action**

As described in Section 3.4, a Cultural Resources Assessment Survey conducted at LC-16 and surrounding areas in 2015 that resulted in the determination by the Florida SHPO that LC-16 did not have sufficient integrity to possess historical significance and that only the Blockhouse was eligible for listing on the National Register.

In September 2019, the Florida Department of State Division of Historic Resources and SHPO performed a Sections 106 and 110 NHPA of 1966 review of the Proposed Action that included the land surrounding the complex. They determined that Facility 13122, LC-16 Blockhouse (8BR2322) appears to meet the criteria for listing on the National Register. However, their conclusion concurs with the 45 SW that the Proposed Action will have no effect on the historic character of the blockhouse.<sup>72</sup> Documentation of this letter is contained in *Appendix E. Sections 106 and 110 National Historic Preservation Act of 1966 Consultation Documentation*.

No Traditional Cultural Properties are on CCAFS inclusive of the project area according to the Seminole Tribe of Florida, the Seminole Nation of Oklahoma, and the Miccosukee Tribe.<sup>73</sup> These three consulting Tribes notified CCAFS that they will not consult on projects unless the project could potentially affect Native American archaeological sites as documented in the 45 SW ICRMP. The Proposed Action will have no effect on traditional cultural resources.

There are no cultural resources adjacent to the complex within the lands that were subjected to an archaeological survey and this conclusion was approved by both the SHPO and the Tribal Historic Preservation Office (THPO).<sup>74</sup>

##### **4.4.2 No Action Alternative**

Under the No Action Alternative, no impact to Historical or Cultural resources would occur.

## **4.5 Air Quality**

The ROI for air quality includes all CCAFS and Brevard County, including both lower and upper atmospheres. Per FAA Order 1050.1F, impacts would be significant if the action would cause pollutant concentrations to exceed one or more of the NAAQS, as established by the EPA under the CAA, for any of the time periods analyzed, or to increase the frequency or severity of any such existing violations.

### **4.5.1 Proposed Action**

Air emissions from the Proposed Action include construction emissions, operations emissions and launch emissions. The Terran 1 Program introduces no listed chemicals at or above CAA RMP Rule reportable thresholds and will not require preparation of an RMP.

#### **4.5.1.1 Construction**

Air emissions from construction activities (described in Section 2.3) would cause a minor increase in PM emissions due to demolition, excavations, minor clearing, construction vehicles and diesel generators. Carbon dioxide would be released by fossil fuel powered equipment and vehicles. Diesel-powered equipment would emit CO, hydrocarbons, NO<sub>x</sub> and CO<sub>2</sub>. Emissions are expected to be minor from these sources over the expected 18 months of construction. Construction activities are not expected to significantly change regional (Brevard County) or local (CCAFS) air emissions. No NAAQS exceedances are expected during construction.

#### **4.5.1.2 Operations**

Proposed Action air emissions from Terran 1 launch preparations and daily operations include PM, VOC, NO<sub>x</sub>, SO<sub>x</sub>, HAPs and CO<sub>2</sub>/CO from sources such as:

- Fugitive emissions due to road dust or modification of existing facilities
- Vehicle, mobile equipment emissions
- Battery charging emissions
- Surface coating launch structures, ground support equipment, other equipment and structures
- Sandblasting, hand-sanding of launch structures, ground support equipment, other equipment and structures
- Engine-driven electrical emergency generators
- Diesel fuel storage tanks for emergency generators
- Diesel powered engines
- LNG flare stack
- LNG, LN<sub>2</sub>, LOX storage and supply fugitive emissions
- Isopropyl Alcohol (IPA) flush carts
- Fugitive emissions from hand-wipe cleaning, application of adhesives, and other maintenance activities.

No air emissions permitting is anticipated for Proposed Action implementation. All emissions described would be designed and constructed such that they are exempt from FDEP air permitting pursuant to Paragraph 62-210.300(3)(a) or (b), or Rule 62-4.040, FAC.

Relativity launch operations use no ozone-depleting substances (ODS).



Terran 1 launch preparation and operations support emissions are expected to be well under CCAFS Criteria Pollutant and HAP emissions detailed in **Table 3-8: Criteria Pollutants and HAP Emissions at CCAFS** (latest data available). Proposed Action emissions are not expected to significantly change the existing air emissions on CCAFS. No NAAQS exceedances during operations are expected.

The potential for an accidental release of fuels or other hazardous liquids would be minimized by adherence to Relativity's safety and operating procedures. All spills would be managed in accordance with CCAFS and Relativity spill response plans.

#### **4.5.1.3 Launch**

The Terran 1 vehicle is equipped with nine first stage Aeon 1 and one second stage vacuum Aeon LNG/LOX engines. LNG is a cleaner-burning fuel with fewer byproducts than Rocket Propellant 1 (RP-1). Combustion byproducts are carbon dioxide and water vapor with trace amounts of PM. CO is also produced; however, the majority is oxidized to carbon dioxide during afterburning in the exhaust plume. Water vapor is not highly reactive but participates in chemical reactions creating radicals that destroy stratospheric ozone that protects against the Sun's ultraviolet radiation. Particulate emissions may also enable reactions creating radicals that deplete stratospheric ozone concentrations. The 2000 SEIS noted that a conservative estimate of the yearly EELV contribution to the total annual global ozone decrease, based on the maximum expected launches of vehicles with solid rocket motors, is less than 0.1 percent of existing conditions. LOX/LNG rocket engines would contribute an even lower percentage than solid rockets motors to decreases in global ozone. Terran 1 launch emissions would not contribute significantly to stratospheric ozone depletion or negatively affect regional air quality.

#### **4.5.2 No Action Alternative**

Under the No Action Alternative, the Terran 1 Program would not be implemented and no air emissions would be produced from LC-16.

### **4.6 Climate**

The effects on climate of the Proposed Action or the No Action Alternative covers the potential effects of currently understood climate change issues. The CEQ specifically asked agencies in 2016 to consider:

- The potential effects of a proposed action on climate change as indicated by its GHG emissions
- The implications of climate change for the environmental effects of a Proposed Action.

GHGs trap heat in the atmosphere. Increasing global temperatures trending over the past century have been scientifically correlated to increasing GHG emissions due to human activities. Climate change induced by global warming may result in rising sea levels, more severe weather events, loss of habitat and economic and socio-political effects such as reduced food security.

The FAA has not established a significance threshold for climate.

#### **4.6.1 Proposed Action**

Generation of GHG emissions from construction and launch preparation and daily operations include CO<sub>2</sub> generation from vehicles and fugitive CH<sub>4</sub> emissions. These emissions are

insignificant compared to total US GHG emissions (six billion metric tons CO<sub>2</sub> equivalent<sup>75</sup>) and CCAFS GHG emissions (see *Table 3-9: Summary of Greenhouse Gases Emissions for CCAFS (Years 2011 through 2013)*).

Terran 1 launches emit GHGs CO<sub>2</sub> and water vapor. Emissions of GHGs from the Proposed Action would not cause any appreciable global warming that may lead to climate change. However, these emissions would slightly increase the atmospheric concentration of GHGs. At present, no methodology exists that would enable estimating the specific impacts that this increment of warming would produce locally or globally. The impact to the climate would still not be significant.

Emissions of carbon dioxide to the stratosphere under the Proposed Action would be negligible in comparison with U.S. annual emissions of CO<sub>2</sub> and would not have a significant impact on global climate change.

Conservative climate models project that the seas off KSC and CCAFS will rise five (5) to eight (8) inches by the 2050s and nine (9) to 15 inches by the 2080s. If ice sheets in Greenland and Antarctica continue to melt as quickly as current measurements indicate, those numbers could become 21 to 24 inches by the 2050s and 43 to 49 inches by the 2080s.<sup>76</sup> The launch pad is somewhat protected from sea level rise inundation due to its elevation. However, sea level rise is expected to intrude within the outer boundary of the LC-16 by 2100 using the Army Corps of Engineers (ACOE) predictions.

#### **4.6.2 No Action Alternative**

Under the No Action Alternative, LC-16 would remain an inactive launch site with no GHG emissions.

#### **4.7 Orbital and De-Orbiting Debris**

Because orbital debris may re-enter the Earth's atmosphere, NASA's policy is to employ design and operations practices that limit the generation of orbital debris, consistent with mission requirements and cost-effectiveness. NASA Safety Standard (NSS) 1740.14 "Guidelines and Assessment Procedures for Limiting Orbital Debris" requires conducting a formal assessment of the potential to generate orbital debris.

Terran 1 Program payloads would comply with all requirements of NASA Policy Directive (NPD) 8710.3, *NASA Policy for Limiting Orbital Debris Generation*, USGODMSP, DoD I 3100.12, *Space Policy* and NASA-STD 8719.14A, *Process for Limiting Orbital Debris*. An assessment of potential Terran 1 payloads determined that anticipated payloads fit within the scope of the 2011 NASA Routine Payload EA<sup>77</sup> (see Section 2.7).

Environmental and safety impacts resulting from the normal and errant burnout of launch vehicle stages would be controlled at CCAFS in accordance with AFSPCMAN 91-710V2. That document requires a trajectory analysis to predict the instantaneous surface impact point (IIP) at any moment during launch for either normal flight or debris from a flight terminated by range safety action. This IIP would be overlaid on range maps indicating populated or environmentally sensitive areas, and a launch corridor would be developed. This package of data, called the PFDP, is developed for each mission well in advance of the launch activity. During the actual launch of the Terran 1 Vehicle, tracking data and IIP plots would be monitored to assure the launch trajectory stays within the corridor. If a flight approaches corridor limits, it would be destroyed by Range Safety. This

assures that spent stages or debris would only impact broad ocean areas cleared of shipping or air traffic.

#### **4.7.1 Proposed Action**

Since anticipated Terran 1 payloads fit within the scope of the 2011 NASA Routine Payload EA and the proposed launch rate of 12 per year, the environmental consequences of orbiting and deorbiting debris<sup>78</sup> from Terran 1 payloads were determined to have no significant impact.

For all Terran 1 Program missions, the upper stage would be placed in a disposal orbit. Disposal orbits are orbits that, as a result of current and projected missions and technologies, are effectively useless except as regions of the space environment where spent hardware can be disposed of without impacting current or projected space systems. The Terran 1 upper stage would also be vented to preclude debris creation resulting from explosive overpressure. These techniques are in accordance with the EELV program System Performance Document and international agreements on space debris minimization.<sup>79</sup>

The first Terran 1 Program launch from LC-16 is anticipated in Q3 2021, ramping up to 12 anticipated maximum annual launches per year. The anticipated lifespan for the Terran 1 Program is ten (10) years.

Implementation of the Proposed Action would result in a small increase in the total number of worldwide space launches. One-hundred and two (102) launches took place in 2019<sup>80</sup> with the trend increasing even without the Proposed Action.<sup>81</sup> Thus, no significant global effect on orbital/deorbiting debris would be incurred from the implementation of the Proposed Action.

#### **4.7.2 No Action Alternative**

Under the No Action Alternative, the Terran 1 Program would not be implemented; thus, orbital debris impacts would not change from the existing conditions.

### **4.8 Hazardous Materials and Solid and Hazardous Waste**

The FAA has not established a significance threshold for hazardous wastes and solid waste.

#### **4.8.1 Proposed Action**

##### **4.8.1.1 Hazardous Materials, Solid and Hazardous Waste**

Construction activities require the use of hazardous materials. Hazardous materials expected to be used include diesel fuel, gasoline and propane to fuel the construction equipment; hydraulic fluids, oils, and lubricants; welding gases; paints and solvents; adhesives and batteries. Hazardous materials associated with construction activities would be delivered and stored to prevent leaking, spilling and potentially polluting soils, groundwater, and surface waters, and in accordance with applicable federal, state, and local environmental and public and occupational health and safety regulations. Public transportation routes would be used for the conveyance of hazardous materials during construction. Transportation of all materials would be conducted in compliance with DOT regulations.

Construction activities will also generate Construction and Demolition (C&D) debris and solid wastes. The construction contractor is required to properly manage and dispose of C&D debris and solid waste in accordance with state and federal regulations. In accordance with the LUCIP, no soil may be removed from LC-16 without prior 45 SW review and approval.

Launch operations, routine maintenance and flight support activities would require the use and storage of hazardous materials. Hazardous materials used on the Terran 1 Program would include cryogenic propellants (LNG and LOX) and flight batteries, typical operations and maintenance activities would require use of products containing paints, solvents, oils, lubricants, acids, batteries, surface coating, and cleaning compounds. These materials would be handled, stored, and disposed of in accordance with the Safety Data Sheet recommendations and storage in accordance with applicable federal and state regulations would minimize the potential for impacts to the launch pad and surrounding areas. Hazardous materials such as propellants, chemicals and other hazardous material payload components would be transported in accordance with DOT regulations (e.g., 49 CFR 100-199) governing interstate and intrastate shipment of hazardous materials, as applicable.

Hazardous materials used for maintenance or in-flight preparation would be stored in their original containers with their original product labels and stored under cover with appropriate secondary containment or in appropriate hazardous material cabinets. Incompatible materials would not be stored together, and enough space would be provided between stored containers to allow for spill cleanup and emergency response access. Storage units would meet building and fire code requirements and would be located away from vehicle traffic. Storage instructions would be posted and construction and operations employees would be trained in proper receiving, handling and storage procedures. Safety Data Sheets for all materials stored on the site would be provided and available to all site personnel. Diesel fuel may be required for emergency generators or a fire pump and would be stored in approved containers.

Relativity will not store ordnance at LC-16. Class 1.4 ordnance will be delivered, installed and safed on the launch vehicle in the Integration Hangar.

With the implementation of appropriate storage, handling and management procedures, hazardous materials used during the Proposed Action construction, operation and maintenance would have no significant impacts on the environment.

#### **4.8.1.2 Hazardous Waste and Hazardous Waste Management**

Hazardous waste generated during Proposed Action construction activities would be expected to include empty containers, spent solvents, paints, sealants, adhesives, waste oil, spill cleanup materials, lead acid batteries and various universal wastes. Other hazardous materials such as welding gases are expected to be consumed in their entirety and the empty gas cylinders returned to the suppliers. Construction contractors would be responsible for safely removing construction-generated wastes and for arranging for recycling or disposal in accordance with applicable regulations.

The total monthly generation of hazardous waste during construction is anticipated to be less than 100 kg during a calendar month. The construction contractor would be (contractually) responsible for determining their regulatory status regarding hazardous waste generation (during construction and obtaining and maintaining compliance) in accordance with federal and state laws and complying with the applicable regulations.

Small quantities of hazardous waste would be generated during routine operations and maintenance. Most hazardous materials would be consumed, so no substantial volumes of hazardous waste would require disposal. Launch vehicle maintenance, propellant and fuel storage and dispensing, and facility and grounds maintenance may generate very small quantities of

hazardous wastes. The sources of hazardous waste include waste fuel, waste oils, spent solvents, paint waste, spill response materials, and used batteries.

With the implementation of appropriate handling and management procedures, hazardous wastes generated during the Proposed Action construction, operation and maintenance would have no significant impacts on the environment.

#### **4.8.1.3 Spills**

The storage and transport of hazardous materials or waste would have the potential to result in accidental spills that could adversely impact soil, surface water, and groundwater adjacent to transportation routes or down-gradient from the construction or operations areas. Potential impacts to water resources with regards to spills are discussed in Section 4.9, Water Resources. Soils adversely affected by spills would be treated on site or would be removed and disposed of in accordance with applicable federal and state regulations. Hazardous wastes associated with construction and operations activities would be stored in a manner (per applicable regulations) that would prevent these materials from polluting soils, groundwater and surface waters and in accordance with applicable federal, state, and local environmental and public and occupational health and safety regulations. During construction, individual contractors would be responsible for the safe and compliant collection, management, and transport of their hazardous wastes to offsite permitted waste disposal facilities.

To minimize the potential for surface water or groundwater contamination, Relativity plans to implement an emergency and spill response plan to ensure that adequate and appropriate guidance, policies and protocols regarding hazardous material incidents and associated emergency response are available to and followed by all personnel. Emergency response and cleanup procedures contained in the plan would reduce the magnitude and duration of any impacts both on and off site.

#### **4.8.1.4 Installation Restoration Program**

LC-16 is contained within SWMU C040, as covered in Section 3.8.4 IRP. Construction at LC-16 will require earthwork for grading and sitework to support new facilities and infrastructure. LUCs prohibit the disturbance of soil without prior coordination with and approval from the 45 SW, which would be completed prior to work at LC-16 to ensure protection of human health and the environment.

Groundwater disturbance is also prohibited during construction unless approved by the 45 SW. No groundwater contact or disturbance is expected during the Proposed Action.

With proper coordination and compliance with the LUCs for SWMU C040, the Proposed Action would not impact ongoing IRP investigations or activities at LC-16.

#### **4.8.1.5 Pollution Prevention**

Pollution Prevention Best Management Practices (BMPs) will be implemented in accordance with the Pollution Prevention Act of 1990. Relativity will prevent pollution via source reduction whenever feasible. Polluting substances whose use cannot be avoided will be recycled and/or treated and disposed of in accordance with applicable laws. All accidental releases of polluting substances will be responded to quickly and appropriate clean up measures implemented in accordance with applicable laws to minimize impacts to the environment.

#### **4.8.1.6 Solid Waste Management**

The Proposed Action construction and launch operations would generate solid waste, such as construction and demolition debris, office waste, break room waste, packaging from supplies and launch operations waste that is not hazardous.

Construction and demolition solid waste, including concrete and some scrap metal, would be generated during construction. Management of construction and demolition debris is the responsibility of the construction contractor. Contract documents would require solid waste to be recycled if feasible; or disposed of at an existing, permitted off-site landfill. Construction actions are anticipated to generate minimal amounts of solid waste compared with the capacity of local construction and demolition debris landfills.

The EPA estimates that one person generates 4.40 pounds of waste per day. Based on an average of 25 fulltime Terran 1 Program employees, it is expected that approximately 110 pounds of solid waste would be generated per day, resulting in approximately 14 tons of solid waste generated per year (assuming 260 workdays). Relativity would use a contracted waste service for solid waste collection and disposal.

Solid waste generated from Terran 1 launch support activities would be in small quantities and disposed off-site by construction contractors or independent waste disposal services. No impact to CCAFS solid waste management is expected.

#### **4.8.2 No Action Alternative**

Under the No Action Alternative, the Terran 1 Program would not be implemented, thus no hazardous materials and hazardous and solid waste impacts at LC-16 would occur.

### **4.9 Water Resources**

This section describes the potential effects to surface water and groundwater, including hydrology, water quality, wetlands and floodplains, resulting from either implementation of the Proposed Action or the No Action Alternative. The FAA has established the following significance thresholds for water resources.

- **Surface Waters** – The action would:
  - Exceed water quality standards established by federal, state, local, and tribal regulatory agencies; or
  - Contaminate public drinking water supply such that public health may be adversely affected.
- **Groundwater** – The action would:
  - Exceed groundwater quality standards established by federal, state, local, and tribal regulatory agencies; or
  - Contaminate an aquifer used for public water supply such that public health may be adversely affected.
- **Wetlands** – The action would:
  - 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 or economically important timber, food, or fiber resources of the affected or surrounding wetlands;
  - Promote development of secondary activities or services that would cause the circumstances listed above to occur; or
  - Be inconsistent with applicable state wetland strategies.
- **Floodplains** – The action would cause notable adverse impacts on natural and beneficial floodplain values. Natural and beneficial floodplain values are defined in Paragraph 4.k of DOT Order 5650.2, *Floodplain Management and Protection*.

#### 4.9.1 Proposed Action

##### 4.9.1.1 Surface Water

Under the Proposed Action, launch deluge water would be contained in the impermeable concrete flame trench, sampled, and pumped to a percolation pond, separate from all permitted stormwater management areas, in accordance with an FDEP Industrial Wastewater Discharge Permit. Inadvertent discharge of industrial wastewater (deluge water) into jurisdictional waters of the US due to flame trench proximity to the retention basin will be reviewed during the permitting process and implemented into the launch pad refurbishment design. Terran 1's combined deluge and sound suppression water is expected to be approximately 200,000 gallons during static operations and 100,000 gallons during launches. No impacts on surface water are expected to occur from the Proposed Action launch industrial wastewater.

In the event of an early launch abort or failure, spacecraft and launch vehicle debris could fall into the ocean and cause potential impacts. Launch vehicle debris from a liquid propellant vehicle is considered a negligible hazard because virtually all hazardous materials are consumed in the destruct action or dispersed in the air and only structural debris would strike the water. In a destruct action, the Terran 1 vehicle may survive to impact the water essentially intact, presenting some potential for localized surface water impact if the spacecraft contains hypergolic propellants that were released into the water. Any resulting pH changes would be very temporary and very localized.

The drainage from LC-16 could be affected by the exhaust cloud that would form near the launch pad at liftoff as a result of the exhaust plume and evaporation and subsequent condensation of deluge water. Because the Terran 1 booster uses LOX and LNG propellants, the exhaust cloud would consist of primarily of steam and would not consist of any significant amounts of hazardous materials. As the volume of water condensing from the exhaust cloud is expected to be minimal and temporary, the exhaust cloud would generate no significant impacts on surface water quality at or near LC-16.

No significant impacts to surface waters are expected as a result of the Proposed Action.

#### **4.9.1.2 Groundwater**

The Proposed Action does not use groundwater for any purpose. Groundwater at LC-16 is contaminated with industrial solvents (see Section 3.8.4). A long-term monitoring plan is managed by the CCAFS IRP to ensure natural degradation of contaminants. During construction, if dewatering is required, authorization through the CCAFS IRP would be required to ensure groundwater is not impacted.

Groundwater contamination could occur during Relativity construction or operations if petroleum products or other hazardous liquids are spilled in significant quantities. The potential for an accidental release or spills would be minimized by adherence to Relativity safety and operating procedures. All spills would be managed in accordance with the CCAFS and Relativity spill response plans and would address prevention of groundwater contamination. No significant impacts to groundwater are expected as a result of the Proposed Action.

#### **4.9.1.3 Floodplains and Wetlands**

Terran 1 Program modifications to LC-16 are not expected to disturb wetlands or affect any floodplains within the LC-16 perimeter. No 100-Year floodplains occur within the current boundary of LC-16 (see *Appendix A, Figure 8. LC-16 Floodplain Map*).

*Appendix A, Figure 9. LC-16 Wetlands Map* identifies the location of wetlands around LC-16. Wetlands and drainage canals are present outside the north, east, south, and southwest of the LC-16 boundary. All wetlands are outside of the area of construction. 1.16 acres of freshwater emergent wetland are present 181 feet north of the launch complex boundary, 2.5 acres of freshwater forested/shrub wetland located 395 feet to the southwest, and drainage canals are 131 feet to the east of LC-16 and 150 feet south of the proposed Integration Hangar / Payload Processing Facility.<sup>82</sup> No wetland encroachment is expected during the Proposed Action.

#### **4.9.2 No Action Alternative**

Under the No Action Alternative, the Terran 1 Program would not be implemented. Impacts on water resources would be unchanged from current conditions.

### **4.10 Geology and Soils**

This section addresses any potential geologic impact of the Proposed Action to foundation instability, land subsidence or other geologic aspects.

#### **4.10.1 Proposed Action**

No unique geologic features of exceptional interest or mineral resources occur in the project area; thus, no impacts would occur to these resources. Proposed Action construction will impact soils at LC-16. In accordance with the LUCIP, no soil will be removed from the site without 45 SW approval and required engineering controls. The development and implementation of a Stormwater Pollution Prevention Plan (SWPPP) in accordance with the NPDES Construction Stormwater permit would specify methods to control erosion. Thus, no significant impacts to geology or soils would occur.

#### **4.10.2 No Action Alternative**

Under the No Action Alternative, the Terran 1 Program would not be implemented; thus, no impacts to geology or soils would occur.



## **4.11 Transportation**

This analysis covers the projected transportation and traffic conditions along roadways affected by the construction, operation and launch Proposed Action activities.

### **4.11.1 Proposed Action**

#### **4.11.1.1 Construction Impacts**

During the Proposed Action construction activities, 100 people, on average, would be working at Terran 1 Program facilities within LC-16. The current construction schedule is approximately 18 months. Seventy (70) of the 100 people would be directly involved in construction. Assuming the worst-case scenario, an addition of 70 people (or 70 daily vehicle trips) traveling on key roadways within CCAFS would not constitute a significant increase in the traffic volume. Construction vehicles would generally be stored and maintained on-site during construction activities. Dump trucks, cranes and large transportation vehicles would occasionally travel to and from the LC-16 area via the CCAFS roadways, however, the increase in construction vehicle traffic would not significantly accelerate the normal wear and tear of the roadways on CCAFS. Proposed Action construction would not have a significant impact on transportation assets.

#### **4.11.1.2 Operations**

Terran 1 Program vehicle stages and payloads will arrive at CCAFS loaded on standard over-the-road tractor-trailers fitted with specialized cradles and transportation hardware. Axle loading is anticipated to be less than AASHTO HS-20 design criteria loading. The transportation routes used for Terran 1 vehicle components are illustrated in *Appendix A, Figure 16. Transportation Route for Terran 1 Vehicle through CCAFS*. Proposed Action vehicle component transportation would not have a significant impact on transportation assets.

Approximately 25-30 people are required on-site at LC-16 to support Terran 1 vehicle launches. The Terran 1 Program operation would have no impact on CCAFS and local or regional traffic patterns or transportation assets.

#### **4.11.1.3 Launch Viewing Related Traffic Impacts**

Traffic volume increases for a Terran 1 Program launch is expected to be similar to recent Atlas, Delta or SpaceX launches. Impacts from increased visitor or public observers are routinely managed and would cause no significant impacts on CCAFS and local traffic patterns.

### **4.11.2 No Action Alternative**

Under the No Action Alternative, the Terran 1 Program would not be implemented; therefore, no impacts to roadways or transportation routes would occur.

## **4.12 Utilities**

This section describes the potential impacts on the potable water supply, wastewater (industrial and sanitary sewer) and electrical supply by implementing the Proposed Action or No Action Alternatives. The FAA has not established a significance threshold for energy supply.

#### **4.12.1 Proposed Action**

##### **4.12.1.1 Water Supply**

No potable water service is available within or immediately adjacent to LC-16. CCAFS does not have immediate plans to provide potable water service to LC-16. Relativity does not intend to extend potable water service to LC-16. Bottled drinking water will be provided, safety showers and eyewashes will be self-contained and restrooms will have independent handwash stations.

Relativity proposes to use the existing fire main service for deluge/sound suppression water and fire suppression as needed. The fire water pipeline capacity may limit its ability to provide on-demand deluge water.<sup>83</sup> Thus, Relativity plans to construct a 250,000-gallon water storage tank and pump house to store deluge water. It is estimated that 200,000 gallons of water would be required for static fire tests and 100,000 gallons of water for launch. Section 2.7 contains the proposed launch rates for Terran 1 launches. At the peak yearly rate of 12, Terran 1 launches would require approximately 1.2 million gallons per year of water for deluge/sound suppression. This is in comparison to the 3.7 MGD historic average consumption for CCAFS, KSC and PAFB combined.

The Proposed Action will not have significant impacts on the CCAFS water supply.

##### **4.12.1.2 Wastewater**

Under the Proposed Action, deluge and sound suppression industrial wastewater would be captured within a containment and disposal system. This system would be designed to satisfy FDEP Industrial Wastewater Permit requirements for on-site disposal of launch-related wastewater. Deluge water would be contained within an impervious deluge basin until permit water quality criteria were met and then released into an approved pervious area for percolation into the water table. Water containing prohibited levels of chemicals would be pumped from the deluge basin and transported to an approved industrial wastewater treatment facility outside of CCAFS. CCAFS Wastewater Treatment Plant (WWTP) does not have the capacity to treat additional industrial wastewater and no connections to the CCAFS sanitary sewer at LC-16 will be made.

Given approximately 200,000 gallons of deluge water for static fire test operations and 100,000 gallons for launches and assuming approximately half is vaporized at launch, at the peak yearly rate of 12 launches per year, the Terran 1 Program will generate approximately 0.6 million gallons of industrial wastewater.

Relativity plans to upgrade or replace existing septic systems at LC-16 to manage sanitary sewage.

With the completion and implementation of an Industrial Wastewater Permit through FDEP, the Proposed Action would have no significant impacts at LC-16.

##### **4.12.1.3 Electric Power**

LC-16 currently does not have electrical service. The Proposed Action will require installation of new electrical infrastructure. An electrical infrastructure investigation<sup>84</sup> indicated that Feeder 3N from the 25-megavolt ampere (MVA) North Substation could be accessed through a spare position on switch 3N10 to supply 13.2kV utility power to LC-16. An alternative power source from the newly constructed New Glenn Substation located south of LC-16 on ICBM Road could supply

23.2kV power to the site. The New Glenn Substation has two (2) 55 MVA transformers and approximately 40 MVA of additional capacity to support CCAFS customers.

The Proposed Action would have no significant impact on available electrical power supply.

#### **4.12.1.4 Stormwater**

All construction and stormwater management would comply with Section 438 of the Energy Independence and Security Act (EISA) (2007), which requires all federal development that exceeds 5,000 square feet to maintain or restore pre-development hydrology.

Because the LC-16 disturbed area is greater than one acre, a NPDES Stormwater Construction Permit would be required by FDEP and a SWPPP would be implemented. SWPPP execution mitigates impacts from erosion and implements specific measures to control both wind and water erosion of soils during and after construction.

Relativity is in the process of obtaining required permits for stormwater management and compliance at LC-16. Compliance with SJRWMD and NPDES stormwater regulations ensure that the Proposed Action will not have a significant impact on storm or surface water resources at CCAFS.

#### **4.12.2 No Action Alternative**

Under the No Action Alternative, the Terran 1 Program would not be implemented, with no impact on current utility services.

### **4.13 Health and Safety**

#### **4.13.1 Proposed Action**

##### **4.13.1.1 On-site Safety and Health**

The Terran 1 Program would adhere to OSHA regulation 29 CFR 1910, *Occupational Safety and Health Standards*, for the protection of personnel health and safety. The Proposed Action entails common safety hazards associated with potential exposure to hazardous materials, heavy equipment operation and construction activities, requiring precautions for workers. All appropriate regulations, including OSHA regulation 29 CFR 1926, *Safety and Health Regulations for Construction*, would be followed during project activities to minimize potential impacts. No significant adverse impacts are anticipated to human safety and health.

As described in Section 3.13.2, CCAFS Range Safety regulations ensure that the general public and launch area personnel are provided an acceptable level of safety and that all aspects of pre-launch and launch operations adhere to public laws. Range Safety organizations review, approve, monitor, and impose safety holds, when necessary, on all pre-launch and launch operations.

Launch facilities used to store, handle, or process ordnance items or propellants must have an Explosive Quantity-Distance Site Plan. Relativity is in the process of completing this site plan through coordination with the 45 SW. A THA must also be prepared for each facility that uses toxic propellants. The THA identifies the safety areas to be controlled during the storage, handling and transfer of the toxic propellants.

Hazardous materials such as propellants, ordnance, chemicals, and booster/payload components are transported in accordance with DOT regulations for interstate shipment of hazardous substances (Title 49 CFR 100- 199). Hazardous materials such as liquid rocket propellant is

transported in specially designed containers to reduce the potential of a mishap should an accident occur.

The Terran 1 Program will adhere to all Relativity, USAF, CCAFS, state and federal safety and health regulations and requirements. The Terran 1 Program construction and launch operations will have no significant impacts on on-site personnel health and safety.

#### **4.13.1.2 Launch Vehicle Impacts**

CCAFS Range Safety models predict launch hazards to the public and on-site personnel prior to every launch. These models calculate the risk of injury resulting from toxic gases, debris, and blast overpressure both from nominal launches and launch failures. Launches are postponed if predicted risk of injury exceeds acceptable limits. The CCAFS allowable collective public risk limit is less than or equal to  $30 \times 10^{-6}$  with an individual risk of  $1 \times 10^{-6}$  over the varying population densities, accounting for concentration, location, dwell time, and emergency preparedness procedures.

Although unlikely, a launch could fail. A launch failure could occur on the launch pad or after the launch vehicle has traveled several miles into the atmosphere. Other scenarios could occur including the entire launch vehicle, with onboard propellants, being consumed in a destruct action during flight. In this case, the launch vehicle is largely consumed in the destruct action, but residual propellant escapes and vaporizes into an airborne cloud. The 1998 EELV EIS and 2000 SEIS document modeling and analysis of the effects of EELV launch failures, including modeling the maximum downwind concentrations of pollutants for launch failures. The EELV EIS and SEIS estimated launch failure releases of hydrochloric acid (from solid motors), anhydrous hydrazine ( $N_2H_4$ ), unsymmetrical dimethylhydrazine, Aerozine-50 (50 percent by weight unsymmetrical dimethylhydrazine and anhydrous hydrazine), monomethyl hydrazine and nitrogen dioxide. Terran 1 uses only LNG/LOX engines and payloads may contain up to 400 kilograms of monomethyl hydrazine, hydrazine, and/or nitrogen tetroxide. Terran 1 Vehicle failure (including the payload) would release fewer and less hazardous materials and thus generally fits within the EIS and SEIS conclusion that all predicted launch failure emissions concentrations are less than the regulatory air emission standards or permissible exposure limit (PEL) for exposure of an employee to a chemical substance.

Catastrophic failure of a payload and the release of hazardous substances due to a launch failure will be mitigated by implementation of Relativity's pad safety and emergency response procedures.

USAF has a rigorous launch safety certification process which would require a launch license from the FAA prior to the start of launch operations. This will ensure that the public will not be exposed to greater risk than the launches currently at approved at CCAFS. Thus, the Proposed Action would not have a significant impact to the health and safety of the public.

#### **4.13.2 No Action Alternative**

Under the No Action Alternative, the Terran 1 Program would not be implemented, with no impacts on Health and Safety.

#### **4.14 Socioeconomics**

Socioeconomics impacts would be considered significant if LC-16 Terran 1 Program construction and operations substantially alter the location and distribution of the local population, economic

growth rates, the local housing market and the need for new social services and support facilities. The FAA has not established a significance threshold for socioeconomics.

#### **4.14.1 Proposed Action**

For approximately one week during launch preparations, a maximum of 30 people, not including payload support and LCC personnel, support the Terran 1 Program launches at LC-16. Between launch campaigns, twenty-five employees are present at the site on average. The Terran 1 launch preparation timeframe and personnel requirements are anticipated to be far less than other launch operations currently at CCAFS. The Terran 1 Program will not impact population or growth rate of the region. The Proposed Action would not affect the local housing market or the need for new social services or support facilities. The Proposed Action would generate no negative socioeconomic impacts on the region.

Construction and refurbishment activities for the Proposed Action would result in a temporary and minor increase in the number of personnel on CCAFS. This increase would not represent a significant increase in the population or growth rate of the region, since most construction personnel already live and work in the area. The local housing market would not be substantially affected, and no new social services or support facilities would be required. Construction and refurbishment activities of the Proposed Action would generate no negative socioeconomic impacts on the region.

#### **4.14.2 No Action Alternative**

Under the No Action Alternative, the Terran 1 Program would not be implemented, with no impacts on socioeconomics.

### **4.15 Environmental Justice**

A significant impact to environmental justice would occur if:

- A significant adverse impact occurs to the natural or physical environment or to health that affected a minority or low-income population;
- A significant adverse environmental impact occurs on minority or low-income populations that appreciably exceeded those on the general population or other comparison group;
- The risk or rate of environmental hazard exposure by a minority or low-income population was significant and exceeded those by the general population or other comparison group; or
- A health or environmental effect occurred in a minority or low-income population affected by cumulative or multiple adverse exposures from environmental hazards.

The FAA has not established a significance threshold for environmental justice.

#### **4.15.1 Proposed Action**

The construction of Relativity facilities and operations of Terran 1 will occur in the same area as the existing LC-16. The area is not located adjacent to or near minority populations or low-income population centers. The City of Cape Canaveral is the closest populated area at approximately eight miles south of Proposed Action activities. The proposed construction activities would not produce excessive pollution or create a hazardous situation that would impact the surrounding community, regardless of economic background. The Proposed Action would not substantially affect human health or the environment and would not disproportionately affect any population

group, including minority or low-income populations. The proposed action would not have impacts on Environmental Justice.

#### **4.15.2 No Action Alternative**

Under the No Action Alternative, the Terran 1 Program would not be implemented and no Environmental Justice impacts would occur.

#### **4.16 Department of Transportation Act Section 4(f) Properties**

Impacts to Section 4(f) properties can include physical use (e.g., an actual physical taking of Section 4(f) property through purchase of land or a permanent easement, physical occupation of a portion or all the property, or alteration of structures or facilities on the property) or constructive use. Constructive use occurs when the impacts of a project on a Section 4(f) property (e.g., noise) are so severe that the activities, features, or attributes that qualify the property for protection under Section 4(f) are substantially impaired (see FAA Order 1050.1F, Appendix B-2). Impacts would be significant if the action involves more than a minimal physical use of a Section 4(f) resource or constitutes a constructive use based on an FAA determination that the project would substantially impair the Section 4(f) resource.

##### **4.16.1 Proposed Action**

No Section 4(f) properties will be closed during a launch or static fire. Due to the proximity of the potential Section 4(f) properties mentioned in Section 3.16 to LC-16, these properties may experience temporary increases in noise from proposed Terran 1 launches. The increased noise level would only last a few minutes. For decades, these properties have been experiencing increased noise levels during launches taking place at KSC and CCAFS. Due to the long history of these properties experiencing noise from launches at CCAFS and KSC, the FAA has determined the Proposed Action would not substantially diminish the protected activities, features, or attributes of any of the properties identified, and thus would not result in substantial impairment of the properties. Therefore, the Proposed Action would not be considered a constructive use of these properties and would not invoke Section 4(f) of the DOT Act. The Proposed Action would not result in significant impacts on Section 4(f) properties.

##### **4.16.2 No Action Alternative**

Under the No Action Alternative, the Terran 1 Program would not be implemented. No impacts on Section 4(f) properties would occur.

#### **4.17 Summary of Potential Environmental Effects**

*Table 4-3* summarizes the potential environmental effects in the 16 categories for the Proposed Action and No Action Alternative.

**Table 4-3: Summary of Potential Environmental Impacts from the Proposed Action and the No Action Alternative**

Aspect Area	Proposed Action Environmental Impacts	No Action Alternative
1. Land Use Zoning/ Visual Resources	<p>Launches would not result in significant impacts to land use compatibility at CCAFS. LC-16 is designated for space launch activities consistent with the CCAFS General Plan. The Proposed Action would not impact or require changes to land use.</p> <p>Facilities built for the Terran 1 Program will be within the existing launch complex footprint. The Proposed Action has no change to coastal zone impacts and will be consistent in meeting Florida CZMA plan objectives. The Proposed Action would generate no significant impacts on visual resources.</p>	No change to existing LC-16 land use or visual resource impacts.
2. Noise	<p>Construction: Noise impacts from the operation of construction equipment are usually limited to a distance of 1,000 feet or less. No residential areas or other sensitive receptors occur at or near LC-16; refurbishment noise would not impact the public or sensitive receptors. When employees or construction workers are subject to sound exceeding OSHA limits, engineering or administrative controls would be used and/or personal protective equipment such as approved ear plugs would be provided. Noise impacts on construction or other workers would not be significant under the Proposed Action.</p> <p>Operations and Launch: Based on modeled launch noise levels, noise impacts would not be significant based on the DNL 65 dB noise contour for the Proposed Action. Operations and launch noise would not exceed the 85-dBA noise threshold limit value recommended for workers in an 8-hour day.</p> <p>The sonic booms modeled for Terran 1 would intercept the surface more than 30 miles off the coast over Atlantic Ocean with a maximum sonic boom overpressure of 5.9 psf and would not be heard on land. No significant impacts from launch effect noise including sonic booms is anticipated.</p>	No LC-16 noise impacts.

Aspect Area	Proposed Action Environmental Impacts	No Action Alternative
3. Biological Resources	<p>Relativity would be required to continue to adhere to all requirements of the past, current and ongoing consultations with the USFWS and NMFS to avoid significant adverse impacts to species. With these measures, the Proposed Action would not be expected to have a significant impact on biological resources. No significant impacts to vegetation are anticipated as a result of the Proposed Action based on similarity to current launches at CCAFS.</p> <p>Exterior construction will occur within the LC-16 previously disturbed area. Other than the common “startle response”, no impacts to wildlife due to construction noise are anticipated.</p> <p>Potential negative impacts of lighting on sea turtle survivability are reduced and managed by a 45 SWI 32-7001 which addresses exterior Lighting Management.</p> <p>An anomaly (explosion) on the launch pad could injure or kill wildlife found adjacent to the launch pad or within debris impact areas. Potential fires started from the anomaly could result in a temporary loss of habitat and mortality of less mobile species. Debris from launch failures has a very small potential to adversely affect managed fish species and their habitats in the vicinity of the project area. Sonic booms from launches are not expected to negatively affect the survival of any marine species.</p> <p>Post launch monitoring conducted on previous launches and previous environmental analyses concluded that launch impacts to T&amp;E species are minimal and insignificant.</p> <p>Overall impacts on Biological Resources are anticipated to be insignificant.</p>	No biological resource impacts.
4. Historical and Cultural Resources	The 45 SW Cultural Resources Manager evaluated the Proposed Action affected areas and no historical or cultural resource issues were found within LC-16 or surrounding areas. The Proposed Action would have no effect on Historical or Cultural Resources.	No cultural resources impact.



Aspect Area	Proposed Action Environmental Impacts	No Action Alternative
5. Air Quality	<p>Construction: Air emissions from construction activities would cause a minor increase in PM emissions due to demolition, excavations, minor clearing, construction vehicles and diesel generators. Carbon dioxide would be released by fossil fuel powered equipment and vehicles. Diesel-powered equipment would emit CO, hydrocarbons, NOx and CO<sub>2</sub>. Emissions are expected to be minor from these sources over the expected 18 months of construction. Construction activities are not expected to significantly change regional (Brevard County) or local (CCAFS) air emissions.</p> <p>Operations and Launch: Relativity operations at LC-16 are not a major source of air pollutants and do not currently require a Title V or non-Title V air operating permit.</p> <p>As documented in previous EAs and EISs performed for the launch vehicles at CCAFS, emissions from nominal launches, catastrophic launch failures, or spills of liquid propellants would not substantially impact ambient air quality.</p> <p>Air emissions from Terran 1 launches with LNG/LOX engines are expected to be lower than launches with solids. LNG is a cleaner burning fuel than RP-1, with anticipated reductions in PM. Terran 1 operations at CCAFS would not be expected to have a significant impact on air quality.</p>	No air quality impacts.
6. Climate	<p>Emissions of GHGs from the construction, operations and launch of the Proposed Action would not cause any appreciable global warming that may lead to climate change. At present, no methodology exists that would enable estimating the specific impacts that this increment of warming would produce locally or globally. The impact to the climate would still not be significant. The Proposed Action would not be significantly impacted by sea level rise due to climate change in the next 30 years because of its elevation.</p> <p>The Proposed Action GHG emissions would be essentially unmeasurable and not have a climate change impact.</p>	No climate impacts would occur.
7. Orbital and De-Orbiting Debris	<p>The environmental consequences of orbiting and deorbiting debris from payloads potentially launched on Terran 1 Program vehicles will .</p> <p>Implementation of the Proposed Action would not significantly change the total number of worldwide space launches and thus would not significantly have an impact on the global amount of orbital/deorbiting debris.</p> <p>The Terran 1 upper stage would be placed in a disposal orbit so as not to interfere with usable space orbits.</p> <p>No significant global effect on orbital/deorbiting debris would be incurred from Proposed Action implementation.</p>	No Terran 1 Program orbital/deorbiting debris impacts would occur.

Aspect Area	Proposed Action Environmental Impacts	No Action Alternative
8. Hazardous Materials/Solid and Hazardous Waste	<p>Construction: The construction activities at LC-16 would result in a small increase in overall hazardous material use and solid waste and hazardous wastes generated but would have no significant impacts on the environment. Implementation of proper engineering controls are required during construction to prevent contact with, or unauthorized release or disposal of, existing contaminated soils or groundwater.</p> <p>Operations and Launch: Launch operations, routine maintenance and flight support activities would require the use and storage of hazardous materials and generation of solid and hazardous waste in small quantities. Use and generation of hazardous materials and solid or hazardous waste would be somewhat less than EELV-class launch programs at CCAFS since Terran 1 is a smaller vehicle.</p> <p>The Proposed Action poses no significant impact on hazardous material use or solid or hazardous waste generated.</p>	No hazardous material or solid/hazardous waste impacts would occur.
9. Water Resources	<p>The Proposed Action would have no significant impact on surface water, groundwater and floodplains and wetlands.</p> <p>The Proposed Action will collect and treat all deluge water in accordance with FDEP Industrial Wastewater requirements and therefore no significant impacts on surface waters are expected.</p> <p>In a launch abort or failure, debris could land in the ocean or other surface waters. Impacts to surface waters from a launch anomaly are similar to current CCAFS launches.</p> <p>Relativity's safety and operating procedures minimize the risk of groundwater contamination by fuels or other hazardous liquids. Compliance to SJRWMD requirements and implementation of BMPs ensures no impacts to floodplains or wetlands.</p> <p>No significant water resource impacts are expected to result from the Proposed Action.</p>	No LC-16 water resources impacts would occur.
10. Geology and Soils	<p>No unique geologic features of exceptional interest or mineral resources occur in the project area; therefore, no impacts would occur to these resources.</p> <p>The Proposed Action would have no direct impacts on geology or soils.</p>	No geology or soil impacts would occur.
11. Transportation	<p>A slight increase in the traffic during the approximate 18-month period of construction is anticipated but it would not significantly impact CCAFS roadways. Transportation of Terran 1 Program components to assembly areas is not expected to have a significant impact on CCAFS transportation routes. During launches, the increase in traffic should be similar to existing launches and would not be significant.</p> <p>No significant transportation impacts are expected to result from the Proposed Action.</p>	No transportation impacts.

Aspect Area	Proposed Action Environmental Impacts	No Action Alternative
12. Utilities	<p>Construction and/or refurbishment personnel do not add appreciably to utility loads.</p> <p>Proposed Action impacts on electrical power needs have no significant impacts compared to existing availability and capacity. Potable water and wastewater service are not connected to LC-16. No potable water or wastewater impacts due to the Proposed Action are expected.</p> <p>Relativity will use industrial water provided by CCAFS for fire protection and exhaust deluge and sound suppression. No significant impact to CCAFS industrial water supply is anticipated.</p> <p>Stormwater permitting at LC-16 will occur due to the Proposed Action. Since the construction area exceeds one acre, a NPDES Stormwater Construction Permit would be required and a SWPPP would be implemented.</p>	No utility impacts.
13. Health and Safety	<p>Relativity requires all employees and contractors to follow all OSHA and applicable USAF regulations (as determined by 45 SW/SE and/or 45 SW/CONS (Contracting Squadron)) during construction activities. No significant impacts to health and safety of workers during construction is anticipated.</p> <p>The Terran 1 Program will adhere to all Relativity, CCAFS, state and federal safety and health regulations and requirements, as well as applicable USAF regulations as determined by 45 SW/SE and/or 45 SW/CONS.. The Terran 1 Program construction and launch operations will have no significant impacts on on-site personnel health and safety.</p>	No health and safety impacts.
14. Socioeconomics	<p>The Terran 1 Program launch preparation timeframe and personnel requirements are not anticipated to impact population or growth rate of the region. Construction and refurbishment activities for the Proposed Action would result in a temporary and minor increase in the number of personnel on CCAFS. This increase would not represent a significant increase in the population or growth rate of the region, since most construction personnel already live and work in the area.</p> <p>The Proposed Action would generate no negative socioeconomic impacts on the region.</p>	No socioeconomic impacts would occur.
15. Environmental Justice	<p>Environmental impacts generated by construction, refurbishment, operations or launch activities for the Proposed Action would have no significant impacts and would not affect minority or low-income populations or children and would not cause any environmental justice impacts.</p> <p>Use of the LC-16 site would also not have an impact on any Environmental Justice subject groups.</p>	No impacts to minority or low-income populations would occur.
16. Section 4(f) Properties	<p>No designated 4(f) properties, including public parks, recreation areas, or wildlife refuges, exist within the boundaries of CCAFS. No Section 4(f) properties would be significantly impacted by noise levels from Terran 1 launches.</p> <p>The Proposed Action would generate no negative Section 4(f) publicly-owned land impacts on the region.</p>	No impacts would occur to publicly-owned land.



## 5 Cumulative Impacts

According to 40 CFR § 1508.7, cumulative impacts are defined as “...the incremental impact of the actions when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions.” Cumulative impacts include impacts from construction and operation of the Terran 1 vehicle that will be launched from LC-16, CCAFS and other past, present and reasonably foreseeable future activities that could affect the resources impacted by the Proposed Action. Due to the nature of the Proposed Action and its location on the coast within CCAFS, only launch-related actions occurring at CCAFS and KSC would meaningfully interact in time and space with the Proposed Action such that potential cumulative impacts could result.

### 5.1 Reasonably Foreseeable Future Actions

The new CCAFS General Plan states that future development would be guided by sustainability. To accomplish this, 50-year Long Term Development Plans (LTDP) were created for each installation. The LTDP are the 45 SW’s vision for future development. The 45 SW strategic plans illustrate how increases in launch tempo and associated support activities can occur sustainably and compatibly with the efficient use of land and energy, the conservation of natural resources and the safe operation of launch vehicles and processing facilities.

NASA’s 2012 Future Development Concept envisions the transition of KSC to a multi-user spaceport managed by an independent spaceport authority. Development of the former Shuttle Landing Facility at KSC could also attract new launch capabilities.

The past, present, and reasonably foreseeable launch actions at CCAFS and KSC are listed in **Table 5-1** and **Table 5-2** and are assumed to still be accurate and applicable to the Cumulative Impacts analysis in this EA. The launch rate since 2010 is shown below in **Table 5-1**.

**Table 5-1: Past Vehicle Launches at KSC and CCAFS**

Year	Launch Vehicles (Number of Launches)				Total
	Shuttle	Delta IV	Atlas V	Falcon 9 (LC 40) and Falcon Heavy (LC 39A)	
2010	3	3	3	2	11
2011	3	3*	4	0	10
2012	-	3	5	2	10
2013	-	2	6	2	10
2014	-	4	6	6	16
2015	-	2	8	8	18
2016	-	3	7	8	18
2017	-	1	4	13	18
2018	-	1	4	15	20
2019	-	2	2	11	15
Total Launches	6	24	49	67	146
Note: * One Delta Launch in 2011 was a Delta II 7000					

The forecast for CCAFS launches during the next four years is presented in **Table 5-2**.

**Table 5-2: Future Planned and Projected Vehicle Launches CCAFS**

Year	Launch Vehicles (Number of Launches)					Total
	Delta IV	Terran 1	Atlas V/Vulcan	Falcon 9 (LC 40 and LC39A) and Falcon Heavy (LC 39A)	Blue Origin	
2020	1	-	9	38	-	48
2021	0	3	4	64	6	77
2022		6	2	63	12	83
2023		12	2	50	12	76
Total Launches	1	21	17	215	30	284
Notes: Launch rates are approximate only. SpaceX' future mission launch rates are from Table 2.2, Draft Environmental Assessment for SpaceX Falcon Launches at Kennedy Space Center and Cape Canaveral Air Force Station, February 2020. Terran 1 first launch is scheduled for mid-2021. Blue Origin's New Glenn manifest shows New Glenn Flight 1-6 in 2021. <sup>85</sup> Space Florida also operates LC-46 that has an FAA license for space launches, but no specific launch data. NASA has not recently announced Space Launch System launch target dates. Sources: <a href="http://www.spacex.com">www.spacex.com</a> <a href="http://www.rocketlaunch.live">www.rocketlaunch.live</a> <a href="http://www.nasa.gov/exploration/systems/sls/index.html">www.nasa.gov/exploration/systems/sls/index.html</a> Draft Environmental Assessment for SpaceX Falcon Launches at Kennedy Space Center and Cape Canaveral Air Force Station						

Documents reviewed for reasonable foreseen actions include:

- CCAFS Master Plan, 2015
- EIS EELV Program, April 1998
- Supplemental EIS for the EELV Program, March 2000
- EA Blue Origin Orbital Launch Site at CCAFS Florida, November 2016
- Draft Environmental Assessment for SpaceX Falcon Launches at Kennedy Space Center and Cape Canaveral Air Force Station, February 2020
- FAA Record of Decision Launch Operator Licenses, EELV Program Atlas V and Delta IV, August 2011
- FAA FONSI, Finding of No Practical Alternative (FONPA) EA for the Blue Origin Orbital Launch Site Construction at LC 11 and 36, December 2016
- EA Final, Vulcan Centaur Program Operations and Launch on Cape Canaveral Air Force Station, June 2019
- FAA, The Annual Compendium of Commercial Space Transportation: 2014, February 2015.

## 5.2 Cumulative Impact Analysis on Resource Areas

The launch actions listed in *Table 5-1* and *Table 5-2*, as well as the projects described above, are considered in conjunction with the Proposed Action and form the basis for the cumulative impacts analysis. This section analyzes the incremental interaction that the Proposed Action may have with the actions described in Section 5.1 Reasonably Foreseeable Future Actions and evaluates the potential cumulative impacts resulting from these interactions. With the exception of air quality and noise, the ROI for each resource area discussed below is limited to CCAFS. The ROIs for air quality and noise extend beyond CCAFS boundaries. As described in the Section 4, no direct

impacts were identified on Historical and Cultural Resources, Geology and Soils, Health and Safety, Environmental Justice and Section 4(f) Properties. When considered with other past, present, and foreseeable future actions, the Proposed Action would not contribute to any cumulative impacts associated with these resource categories and they are not considered further in this analysis.

### **5.2.1 Land Use/Visual Resources**

The proposed action would not result in any additional impacts to land use compatibility since CCAFS's current use includes launching space vehicles. The Proposed Action would not generate additional impacts on visual resources within the flight range of the Terran 1 Vehicle.

The Proposed Action is consistent with existing land use within the ROI as well as with the Base General Plan and the Air Force mission at CCAFS. The visual presence of the proposed infrastructure is within the existing LC-16 footprint.

When considered with other past, present, and foreseeable future actions, the Proposed Action would not change the overall, cumulative negligible and less than significant effect on land use and visual resources.

### **5.2.2 Noise**

DNL is used to estimate the potential long-term community annoyance from the proposed Terran 1 Vehicle launch operations. 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 dB[A] or more for a noise sensitive area that is exposed to noise at or above the DNL 65 dB[A] noise exposure level, or that will be exposed at or above this level due to the increase. The DNL contours from 60 dBA to 85 dBA are presented in *Appendix A, Figure 15. DNL Contours for Terran 1 Launch and Static Operations*. The DNL 65 and 60 dBA contours extend approximately 0.7 and 1.1 miles from the launch pad, respectively. This area does not encompass land outside of the boundaries of CCAFS and no residences are impacted.<sup>86</sup> The BRRC report concluded that noise impacts would not be significant based on the DNL 65 dB noise contour for the Proposed Action.<sup>87</sup>

Sonic booms generated by these launch events would impact over the ocean surface beyond 30 miles off the coast and would not be audible on land; therefore, sonic booms would not produce any significant impacts in the surrounding areas.

Construction and refurbishment impacts would increase noise levels temporarily and would not be a significant impact.

The proposed Terran 1 Vehicle launches are not expected to generate significant propulsion noise or sonic boom impacts in the community. Community noise exposure will be less than that from previous and current CCAFS and KSC launches. Given the overall cumulative effect of past, present, and foreseeable future actions, the Proposed Action would not have a significant impact from noise.<sup>88</sup>

### **5.2.3 Biological Resources**

The Proposed Action would not have a significant impact on terrestrial vegetation and wildlife, marine species or protected species. Terran 1 Program construction activities will have minimal

impact on Biological Resources since construction activities will be within the previously developed LC-16 area.

Relativity's Terran 1 engines consume LOX and LNG and unmeasurable to no particulate depositions on vegetation are expected from the Proposed Action.

An anomaly on the launch pad would present potential impacts to biological resources from the possibility of extreme heat and fire, percussive effects of the explosion and debris that might impact land or surface waters. The explosion could injure or kill wildlife found adjacent to the launch pad or within debris impact areas. Potential fires started from the anomaly could result in a temporary loss of habitat and mortality of less mobile species.

An improbable mishap downrange would occur over the open ocean and would not likely jeopardize any wildlife, given the relatively low density of species within the surface waters of these open ocean areas. Debris from Terran 1 launch failures has a small potential to adversely affect managed fish species and their habitats in the vicinity of the project area. During the 1998 EELV EIS, a consultation with NMFS determined that "no greater than minimal adverse effects" to EFH would occur under NMFS regulations. The same conclusions are expected for Terran 1 Vehicle launch mishaps.

As a result, the overall cumulative effect of other past, present, and reasonably foreseeable future actions on Biological Resources are considered minor, not significant and similar to the current CCAFS launch activities. When considered with other past, present, and foreseeable future actions, it is not anticipated that the Proposed Action would contribute a noticeable impact on Biological Resources.

#### **5.2.4 Air Quality**

CCAFS and Brevard County are in an "Attainment" area and the operational emissions for the proposed Terran 1 Program vehicle launch represent an extremely small percentage of the Brevard County regional emissions and would not cause an exceedance of any NAAQS or GHG. The air quality ROI covers all of CCAFS and Brevard County. This includes both lower and upper atmospheres. The Proposed Action includes air emissions for construction, operations and launch.

During construction, a slight increase in PM due to construction activities or equipment is expected but air emissions impact on Brevard County or CCAFS air quality would not be measurable.

No air emissions permitting is anticipated for Proposed Action implementation. Operations air emissions described in Section 4.5 would be exempt from FDEP air permitting. Operations air emissions are not expected to insignificantly impact existing air emissions at CCAFS or in Brevard County.

Terran 1 launch emissions from its LNG/LOX engines would not contribute significantly to stratospheric ozone depletion or negatively affect regional air quality.

The overall cumulative effect when combined with other past, present and reasonably foreseeable future actions for air quality is considered to be minor. It is not anticipated that the Proposed Action would contribute significantly to overall cumulative impacts on air quality.

#### **5.2.5 Climate**

The Proposed Action construction, launch preparation and daily operations GHG emissions are insignificant compared to the total US GHG emissions. CCAFS GHG emission totals would be



unmeasurable and would not have a climate change impact. The impact of sea level rise is mitigated because of the LC-16 elevation. Regional and global impacts of the Proposed Action are not significant.

The overall, cumulative effect when combined with other past, present, and reasonably foreseeable future actions on Climate is considered not significant and it is not anticipated that the Proposed Action would noticeably impact Climate.

#### **5.2.6 Orbital and De-orbiting Debris**

Implementation of the Proposed Action would not significantly change the total number of worldwide space launches. No significant global effect on orbital/deorbiting debris from either payloads or the launch vehicle would be incurred from the implementation of the Proposed Action.

As a result, the overall cumulative effect of other past, present, and reasonably foreseeable future actions from orbital and de-orbiting debris are considered to be minor. When considered with other past, present, and foreseeable future actions, it is not anticipated that the Proposed Action would contribute a noticeable incremental impact on orbital and de-orbiting debris globally.

#### **5.2.7 Hazardous Materials and Solid and Hazardous Waste**

Hazardous materials proposed for use in launch operations and construction supporting the Terran 1 Program are those typical to other active launch sites at CCAFS, with the exception of LNG and LOX. These materials would be handled, stored and disposed of with manufacturer and federal and state regulations. Handling and management procedures for hazardous materials, hazardous wastes and solid wastes will be applied during to the Terran 1 Program, limiting the potential for impacts.

When considered with other past, present, and foreseeable future actions, the Proposed Action would a negligible contribution to impacts from hazardous materials and solid and hazardous waste.

#### **5.2.8 Water Resources**

The Proposed Action would have no significant impact on surface water, groundwater, floodplains or wetlands.

The Proposed Action is not expected to have a significant impact on surface water resources. Water usage quantities for sound suppression and deluge water are estimated to be 200,00 gallons for static operations and 100,000 gallons per launch. Compliance with FDEP Industrial Wastewater regulations will ensure protection of surface waters.

In a launch abort or failure, debris could land in the ocean or other surface waters. Impacts to surface waters from a launch anomaly are negligible because virtually all hazardous materials are consumed in the destruct action. Only structural debris would impact surface waters in a localized area. LOX and LNG propellants used within the Terran 1 Vehicle would create an exhaust cloud that consist of primarily steam and would not consist of significant amounts of hazardous materials. As the volume of water condensing from the exhaust cloud is expected to be minimal and temporary, the exhaust cloud would generate no significant impacts on surface water quality at or near LC-16.

Relativity's safety and operating procedures minimize the risk of groundwater contamination by fuels or other hazardous liquids. No significant impact is expected to groundwater from the Proposed Action.

No impact to wetlands and floodplains is anticipated.

The overall cumulative effect of other past, present, and reasonably foreseeable future actions on water resources are not significant. When considered with other past, present, and foreseeable future actions, it is not anticipated that the Proposed Action would not contribute a noticeable incremental impact on water resources.

### **5.2.9 Transportation**

Transportation consists of construction, operations and launch impacts. A slight increase in the traffic during the approximate 18-month period of construction is anticipated, but it would not significantly impact CCAFS roadways. Terran 1 Program vehicle stages and payloads will arrive at CCAFS loaded on standard over-the road tractor-trailers fitted with specialized cradles and transportation hardware. The transportation routes used for Terran 1 vehicle components are illustrated in *Appendix A, Figure 16. Transportation Routes for Terran 1 Vehicle Through KSC and CCAFS*. Proposed Action vehicle component transportation would not have a significant impact on transportation assets. During launches, the increase in traffic should be similar to existing launches and would not be significant.

The cumulative effect of other past, present, and reasonably foreseeable future actions would not be significant to CCAFS roadways. When considered with other past, present, and foreseeable future actions, it is anticipated that the Proposed Action would not contribute a noticeable incremental impact to regional or local transportation assets.

### **5.2.10 Utilities**

#### **5.2.10.1 Water Supply**

Neither CCAFS nor Relativity plan to extend potable water services to LC-16. Bottled drinking water will be provided, safety showers and eyewashes will be self-contained and restrooms will have independent handwash stations. No impacts to potable water supply are expected from the Proposed Action.

Relativity proposes to use the existing fire main service for deluge/sound suppression water and fire suppression as needed. The fire water pipeline capacity may limit its ability to provide on-demand deluge and fire suppression water<sup>89</sup>, so Relativity is planning to provide on-site water storage. No impacts to the industrial water supply are expected from the Proposed Action.

#### **5.2.10.2 Wastewater**

Relativity plans to upgrade or replace existing septic systems at LC-16 to manage sanitary sewage. Construction personnel do not add appreciably to the sanitary sewer load as the contractor is required to provide on-site sanitary facilities.

Sound suppression and deluge water will be disposed of in accordance with a FDEP Industrial Wastewater Discharge requirements, in an area separate from all permitted stormwater management areas. No connections to the CCAFS sanitary sewer at LC-16 will be made.

No impacts to wastewater systems are expected from the Proposed Action.

### **5.2.10.3 Electrical**

The Proposed Action will require installation of new electrical infrastructure to support LC-16 through connections to existing nearby substations.<sup>90</sup> The Proposed Action would have no significant impact on available electrical power supply.

### **5.2.10.4 Stormwater**

The Proposed Action requires stormwater permitting at LC-16. Since the construction area exceeds one acre, a NPDES Stormwater Construction Permit would be required by FDEP and a SWPPP would be implemented. The Proposed Action is not expected to have a significant impact on stormwater systems.

As a result, the overall cumulative effect of other past, present, and reasonably foreseeable future actions on utilities are considered negligible and not significant in the context of supply. When considered with other past, present, and foreseeable future actions, it is not anticipated that the Proposed Action would contribute a noticeable incremental impact on utilities.

### **5.2.11 Socioeconomics**

The Terran 1 launch preparation timeframe and personnel requirements are anticipated to be negligible and will not impact population or growth rate of the region. Construction and refurbishment activities for the Proposed Action would result in a temporary and minor increase in the number of personnel on CCAFS. This increase would not represent a significant increase in the population or growth rate of the region, since most construction personnel already live and work in the area. The Proposed Action would generate no negative socioeconomic impacts on the region.

The Proposed Action will have a slightly positive influence on socioeconomics, through contributions to the local economy. As a result, the overall cumulative effect of other past, present, and reasonably foreseeable future actions on socioeconomics is considered beneficial and not significant. When considered with other past, present, and foreseeable future actions, it is anticipated that the Proposed Action would contribute a noticeable incremental beneficial minor and less than significant impact on socioeconomics.

## **6 Applicable Environmental Requirements**

### **6.1 Federal Regulations Regarding Environmental Quality**

The NEPA (42 U.S.C. 4321-4347 as amended) requires federal agencies to analyze the potential environmental impacts of major federal actions and alternatives and to use these analyses as a decision-making tool on whether and how to proceed with the Proposed Action or Alternatives.

EO 13766 (January 24, 2017), Expediting Environmental Reviews and Approvals for High Priority Infrastructure Projects, establishes a new system to fast-track construction of infrastructure projects.

EO 13807 (August 15, 2017), Establishing Discipline and Accountability in the Environmental Review and Permitting Process for Infrastructure, seeks to reduce the time required for processing environmental reviews and authorization decisions for new major infrastructure projects.

EO 13840 (June 19, 2018), Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States, “maintains and enhances ... benefits to the Nation through improved public access to marine data and information, efficient interagency coordination on ocean-related matters, and engagement with marine industries, the science and technology community, and other ocean stakeholders.”<sup>91</sup>

### **6.2 Federal Regulations Regarding Biological Resources**

Public Law 93-205 requires military installations to protect and conserve federally-listed, endangered, and threatened plants and wildlife.

The ESA of 1973 declares the intention of the Congress to conserve T&E species and the ecosystems on which those species depend. The Act requires that federal agencies, in consultation with the USFWS and NOAA Fisheries, use their authorities in furtherance of its purposes by carrying out programs for the conservation of T&E species. Section 7 of the ESA (16 U.S.C. 1536) contains provisions that require federal agencies to consult with the Secretary of Interior and to take necessary actions to ensure that actions authorized, funded, or carried out by them do not jeopardize the continued existence of endangered species and threatened species. Federal agencies must ensure that actions taken will not result in the destruction or modification of the habitat of endangered species.

MMPA (16 U.S.C. 1361 et seq.), Section 101(a)(5)(A) directs the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of marine mammals by US citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and regulations are issued. Permission may be granted for periods of 5 years or less if the NMFS finds that the taking will have a negligible impact on the species or stock(s); will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses; and the permissible methods of taking and requirements pertaining to the monitoring and reporting of such taking are set forth.

The FETSA establishes the conservation and wise management of T&E species as state policy. Agencies are required to consider impacts to T&E species when planning and implementing projects, as mandated by the FWCC.

The MSFCMA (Sustainable Fisheries Act) identifies EFH and threats to EFH. This Act requires consultation with NMFS to ameliorate any threats to EFH from non-fishing activities.

The MMPA prohibits the harassing or killing of any marine mammal. Harassment is any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but observation of distance requirements from marine mammals as imposed by the NMFS.

### **6.3 Federal Regulations Regarding Cultural Resources**

The NHPA of 1966 (Public Law 89-665), as amended; EO 11593 of 1971 (36 CFR 154); the AIRFA of 1978 (Public Law 95-341); the ARPA of 1979 (Public Law 96-95); the NAGPRA of 1990 (Public Law 101-601); and the AFI for cultural resource management of 1994 (AFI 32-7065). On a day-to-day basis, cultural resource management CCAFS is guided primarily by the NHPA and its implementing regulations, 36 CFR 800. Briefly, Section 106 requires federal agencies to consider the effect of any undertaking on any district, site, building, structure, or object that is on or eligible for the National Register. An undertaking is defined as "a project, activity, or program funded in whole or part under the direct or indirect jurisdiction of a federal agency, including those carried out by or on behalf of a Federal Agency; those carried out with federal financial assistance; those requiring a federal permit, license, or approval; and those subject to state or local regulation administered pursuant to a delegation or approval by a federal agency" (36 CFR 800.16[y]). For any undertaking, the Section 106 process requires identification of historic properties (i.e., those on or eligible for the National Register), assessment of potential adverse project effects on any historic properties, and resolution of adverse effects in consultation with the SHPO and/or, if necessary, the Advisory Council on Historic Preservation.

The Archaeological Resource Protection Act was passed in 1979 to protect archaeological resources and sites on public lands and requires a permit for any excavation or removal of archaeological resources from public lands.

The NAGPRA and its implementing regulations, 43 CFR 10, provides ownership or control of Native American human remains and selected cultural items excavated or discovered on federal lands with designated Native American tribes, organizations, or groups. If human remains or selected cultural items are discovered on federal lands, the appropriate Native American group must be notified. AFI 32-7065 provides detailed guidance for compliance with relevant extant authorities.

### **6.4 Federal Regulations Regarding Air Quality**

The Proposed Action is regulated by the following federal CFR Titles listed and discussed below:

**Title 40 CFR 50 National Ambient Air Quality Standards (NAAQS):** The CAA required the EPA to establish ambient ceilings for certain criteria pollutants. Subsequently, the EPA promulgated regulations that set NAAQS. Two classes of standards were established: primary and secondary. Primary standards prescribe the maximum permissible concentration in the ambient air required to protect public health. Secondary standards specify levels of air quality required to protect public welfare, including materials, soils, vegetation, and wildlife, from any known or anticipated adverse effects. The criteria pollutants for which the NAAQS have been established include CO, nitrogen dioxide, ozone, PM10, PM2.5, and SO<sub>2</sub>.

The EPA classifies air quality within each Air Quality Control Region with regard to its attainment of federal primary and secondary NAAQS. According to EPA guidelines, an area with air quality better than the NAAQS for a specific pollutant is designated as in attainment for that pollutant.

Any area not meeting ambient air quality standards is classified as nonattainment. When there is a lack of data for the EPA to define an area, the area is designated as unclassified and treated as an attainment area until proven otherwise.

**Title 40 CFR 51 Subpart W (General Conformity):** General conformity rule applies to federal actions that are not covered by transportation conformity rule, with several listed exceptions. Other than the listed exemptions and presumptions of conformity, general conformity applies to actions in which projected emissions exceed applicable conformity de minimis thresholds. However, if the emissions from a federal action do not equal or exceed de minimis thresholds but do represent 10 percent or more of a nonattainment or maintenance area's total emissions of any criteria pollutant, the action is considered "regionally significant" and the requirements of conformity determination apply.

**Title 40 CFR 61 (NESHAP):** NESHAP regulates stationary sources with a prescribed standard under Title 40 CFR 61. Such stationary sources may be required to obtain an operating permit issued by an authorized Air Pollution Control agency or by EPA in accordance with Title V of the CAA. The NESHAP identifies and list a variety of HAPs that are regulated.

**Title 50 CFR 63 Subpart GG** for manufacturers of commercial, civil, or military aerospace vehicles or components and that are major sources of hazardous air emissions. Such emissions would result from cleaning operations, surface coating with primers and topcoats, paint removal, and waste storage.

Hazardous wastes that are subject to RCRA requirements would be exempt from the subpart. Those wastes would include specialty coatings, adhesives, primers, and sealant materials at aerospace facilities. Other exemptions would include HAPs or VOC contents less than 0.1 percent for carcinogens or 1.0 percent for non-carcinogens and low volume coatings.

**Title 40 CFR 70 (State Operating Permit Programs):** In accordance with Title V of the CAA large facilities that are capable of producing large amounts of air pollution are required to obtain an operating permit. Permits are issued by the District. Typical activities that require the CAA Title V permit include any major source (source that emits more than 100 tons per year of criteria pollutant in a nonattainment area for that pollutant or is otherwise defined in Title I as a major source); affected sources as defined in Title IV; sources subject to Section 111 regarding New Source Performance Standards; sources of air toxics regulated under Section 112 of the CAA; sources required to have new source or modification permits under Parts C or D of Title I of the CAA; and any other source such as hazardous waste pollutants designated by EPA regulations.

Part 70 Federal Operating Permits are issued to specific emission sources. Sources requiring permits are determined based on the source's potential to emit certain threshold levels of pollution given their equipment and processes. Facilities requiring Part 70 Federal Operating Permits include sources with the potential to emit the following:

HAP amounts equal to or greater than: 100 tons/year of any regulated air pollutant; 10 tons/year of any individual HAP or 25 tons/year of a combination of HAPs; or lesser quantity thresholds for any HAP established by the EPA rulemaking. Any stationary source defined by the EPA as major for the District under Title I, Part D (Plans for Nonattainment Areas) of the CAA and its implementing regulations including:

For ozone nonattainment areas, sources with the potential to emit 100 tons per year or more of VOCs or oxides of nitrogen in areas classified as "marginal" or "moderate," 50 tons per year or more in areas classified as "serious," 25 tons per year or more in areas classified as "severe," and 10 tons per year or more in areas classified as "extreme";

- Acid rain sources included under the provisions of Title IV of the CAA and its implementing regulations.
- Any source required to have a pre-construction review permit pursuant to the requirements of the New Source Review/Prevention of Significant Deterioration program under Title I, Parts C and D of the CAA and its implementing regulations;
- Any solid waste incineration unit required to obtain a Part 70 permit pursuant to Section 129(e) of the CAA and its implementing regulations; and
- Any stationary source in a source category required to obtain a Part 70 permit pursuant to regulations promulgated by the EPA Administrator.

**Title 49 CFR Parts 100-199:** Liquid propellants for the Terran 1 Vehicle must be shipped and handled in accordance with Title 49 CFR Parts 100-199. The liquid propellants would be shipped directly from the production location to the launch site.

## **6.5 Federal Regulations Regarding Hazardous Waste/Hazardous Materials**

The CERCLA of 1980 responds to the immediate cleanup of hazardous waste contamination from accidental spills or from waste disposal sites that may result in long-term environmental damage.

The RCRA of 1974 (42 U.S.C. 6901 et seq.) was designed to control the handling and disposal of hazardous substances by responsible parties. Hazardous waste, as defined by RCRA, is a "waste that may cause or significantly contribute to serious illness or death, or that poses a substantial threat to human health or the environment when improperly disposed." The treatment, storage, and disposal of solid waste (both hazardous and nonhazardous) is regulated under the Solid Waste Disposal Act as amended by RCRA and the Hazardous and Solid Waste Amendments of 1984.

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

Under 49 CFR Section 170 are DOT requirements for the shipment of hazardous materials. This section specifies the proper container type, shipping name, and labeling requirements for the transportation of hazardous materials.

The Toxic Substances Control Act of 1976 regulates chemical substances and mixtures that present an unreasonable risk of injury to health, or the environment, and acts with respect to chemical substances and mixtures which are imminent hazards.

## **6.6 Federal Regulations Regarding Water Resources**

The CWA (33 U.S.C. 1251 et seq.) prohibits the discharge of pollutants from a point source into navigable waters of the US, except in compliance with a NPDES (40 CFR Part 122) permit. The navigable waters of the US are considered to encompass any body of water whose use, degradation, or destruction will affect interstate or foreign commerce.

Section 402 of the CWA requires that the EPA establish regulations for issuing permits for stormwater discharges associated with industrial activity. A NPDES permit is required if activities involve the disturbance of one to five acres of land. A Notice of Intent must be submitted to the SJRWMD by Relativity and a SWPPP must be developed.

Section 404 establishes a program to regulate the discharge of dredged and fill materials into waters of the US, including wetlands. Activities in waters of the US that are regulated under this program include fills for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports), and conversion of wetlands to uplands for farming and forestry. EPA and the USACE jointly administer the program. In addition, the USFWS, NOAA Fisheries, and state resource agencies have important advisory roles.

## **6.7 Federal Regulations Regarding Environmental Justice**

EO 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations) requires that all federal agencies develop environmental justice strategies and make environmental justice a part of their mission by identifying and addressing, as appropriate, any disproportionate and adverse human health or environmental effects of their activities on minority or low-income populations.

The CZMA of 1972 (16 U.S.C. 2452-24645) FDCA plays a significant role in water quality management. Under the CZMA, a federal action that may affect the coastal zone must be carried out in a manner that is consistent with state CZM Programs.

## **6.8 State of Florida Regulations**

State regulations are contained generally in the FACs. Pertinent requirements include obtaining NPDES permits for construction, Title V Air construction and operation permits, and Stormwater Management requirements. The latter is managed within the SJRWMD as part of the ERP program. Requirements that apply to the biological impact aspects of construction and operations, including listed T&E species and SSC are managed by the FWCC.



## 7 Persons and Agencies Contacted

**Table 7-1: Persons and Agencies Contacted**

Name / Title	Company / Agency	Address
Chambers, Angy / Natural Resources Program Manager	45 CES/CEIE	1224 Jupiter Street Patrick AFB, FL 32925-2231
Phillips, Andrew / Air Quality and Storage Tanks Program Manager	45 CES/CEIE	1224 Jupiter Street Patrick AFB, FL 32925-2231
Wallace, Brian / Project Manager	45 CES/CEMP	1224 Jupiter Street Patrick AFB, FL 32925-2231
Langett, John / IRP	45 CES/CEIE	1224 Jupiter Street Patrick AFB, FL 32925-2231
Long, Eva / NEPA Specialist, Environmental Planning and Conservation	45 CES/CEIE	1224 Jupiter Street Patrick AFB, FL 32925-2231
Penders, Thomas / Cultural Resources Program Manager	45 CES/CEIE	1224 Jupiter Street Patrick AFB, FL 32925-2231
Czelusniak, Daniel / Environmental Specialist	FAA	800 Independence Ave. SW Suite 325 Washington, DC 20591
Dankert, Donald / Technical Lead	NASA / KSC Environmental Management Branch	John F. Kennedy Space Center, NASA Kennedy Space Center, FL 32899
Brooks, James / Biological Scientist	NASA / KSC Environmental Management Branch	John F. Kennedy Space Center, NASA Kennedy Space Center, FL 32899
Anderson, Kathleen / Cape Launch Operations and Infrastructure Support (CLOIS) CCAFS Water and Wastewater Lead	USAF AFSPC / CLOIS, ASRC Federal	CCAFS

The Florida State Clearinghouse reviews EAs for projects planned in Florida pursuant to Gubernatorial EO 95-359; the CZMA; 16 U.S.C. SS 1451-1464 as amended; and NEPA, 42 U.S.C. §4321, §§4331–4335, and §§4341–4347. The State of Florida Clearinghouse sends copies of the draft EA to applicable state regulatory agencies for review and submits any comments to be addressed in the final EA. Florida State Clearinghouse responses to this EA will be added to **Appendix F**. The Clearinghouse letter provides general permitting and other regulatory compliance requirements. Relativity Space will comply with all regulatory requirements and obtain all permits necessary to implement the Proposed Action in accordance with the Clearinghouse review.

Other federal and state agency coordination, approval and permits included as necessary:

- Consultation with the USFWS pursuant to the federal ESA and the MBTA.
- Informal Consultation with the NMFS pursuant to the federal MSFCMA, MMPA, and ESA
- Coordination with DOT to renew and/or maintain transportation permits

- Consultation with SHPO
- SJRWMD ERP
- FDEP Pre-Construction Permit
- USACE CWA Section 404 permit and tribal consultations.

The USAF invites public participation in decision-making on new proposals through the NEPA process. Public participation with respect to decision-making on the Proposed Action is guided by 32 CFR Part 989.

Consideration of the views and information of all interested persons promotes open communication and enables better decision-making. Copies of the draft final EA and FONSI will be made available to the public in the 45 SW Public Affairs Office at PAFB, PAFB internet site and a Relativity internet site. A Notice of Availability (NOA) will be published in the local newspaper (Florida Today) announcing the availability of the documents for a 30-day review period.

## 8 List of Preparers

**Table 8-1: Preparer Details**

<b>Name / Company</b>	<b>Title / Responsibility</b>	<b>Education</b>	<b>Years of Experience</b>
Burns, Imogene Nelson Engineering Co.	Environmental Specialist	B.B.A.	15
Seringer, Carolyn, PE Nelson Engineering Co.	Vice President	B.S. Chemical Engineering	39
Henderson, Steven, Nelson Engineering Co.	Environmental Engineer, E.I.	B.S. Environmental Engineering	4
Newton, Christopher Relativity Space Inc	Director of Launch & Infrastructure	M.S. Mechanical Engineering	16
Lund, Jonathan, PE Relativity Space Inc	Principal Engineer, Infrastructure	M.S. Structural Engineering	12

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# **APPENDIX A**

## **Figures**

**Figure 1. Terran 1 Launch Vehicle**

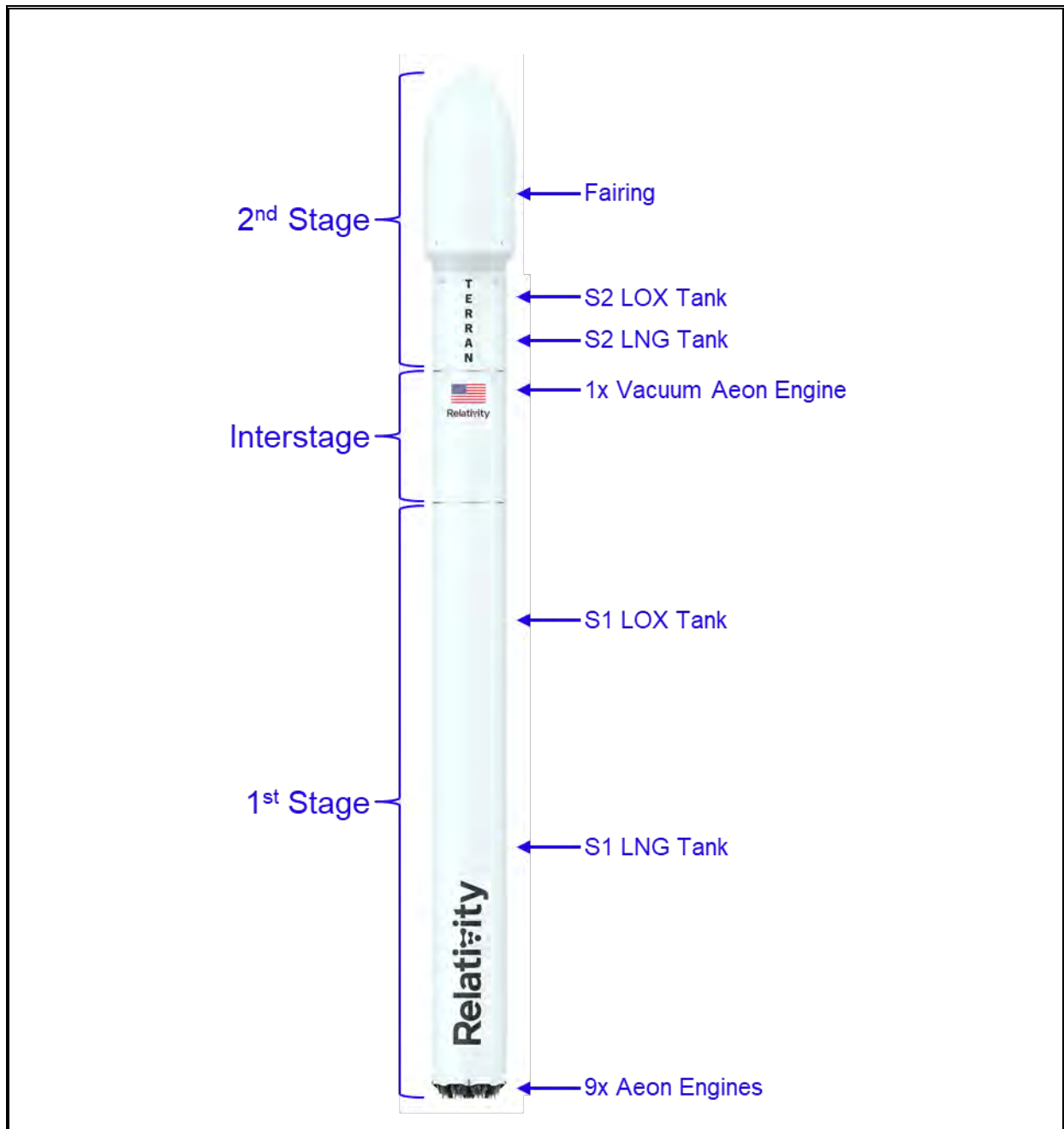
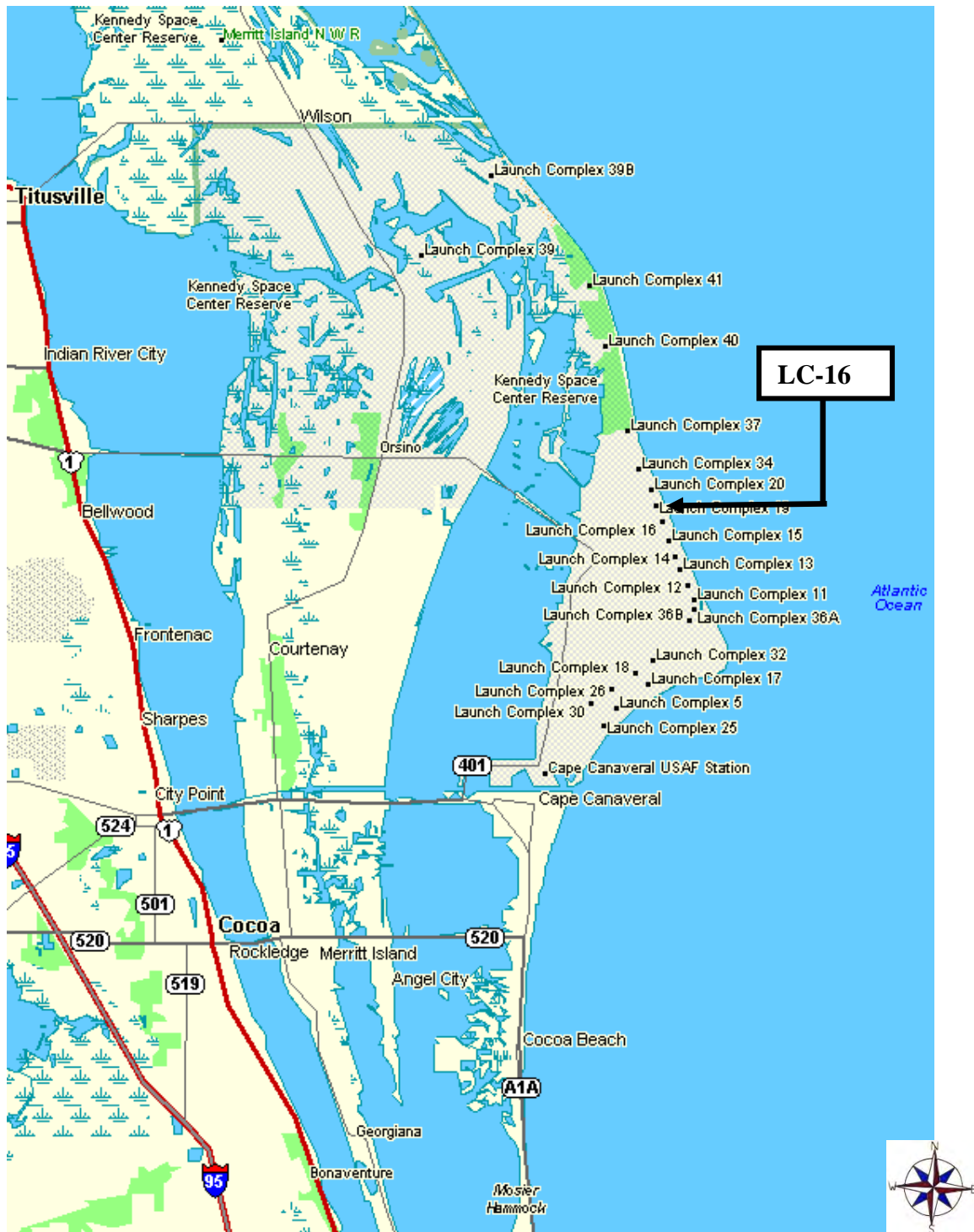
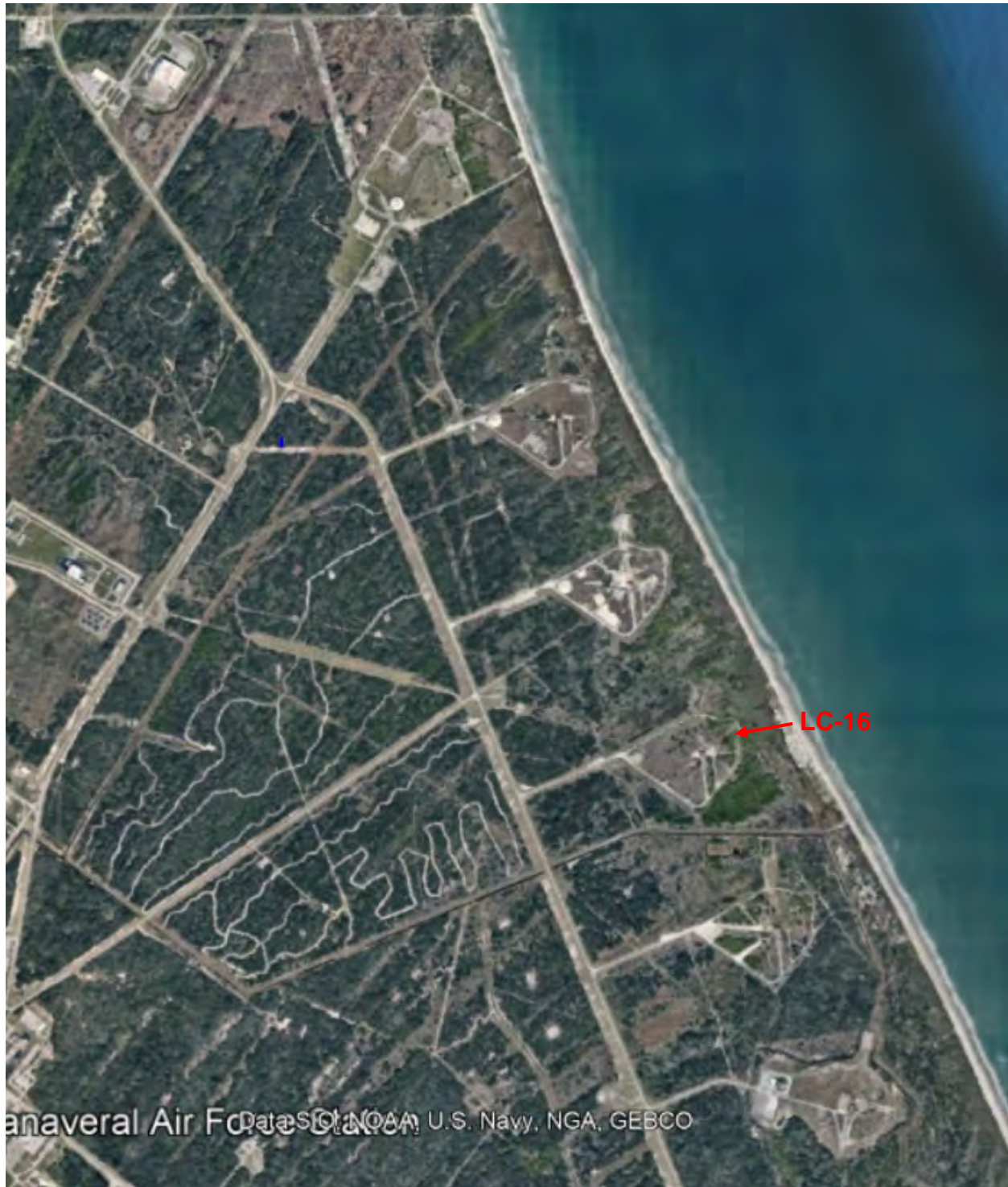


Figure 2. LC-16 General Site Location



**Figure 3. LC-16 Area Aerial Photograph**



Google Earth, 2018

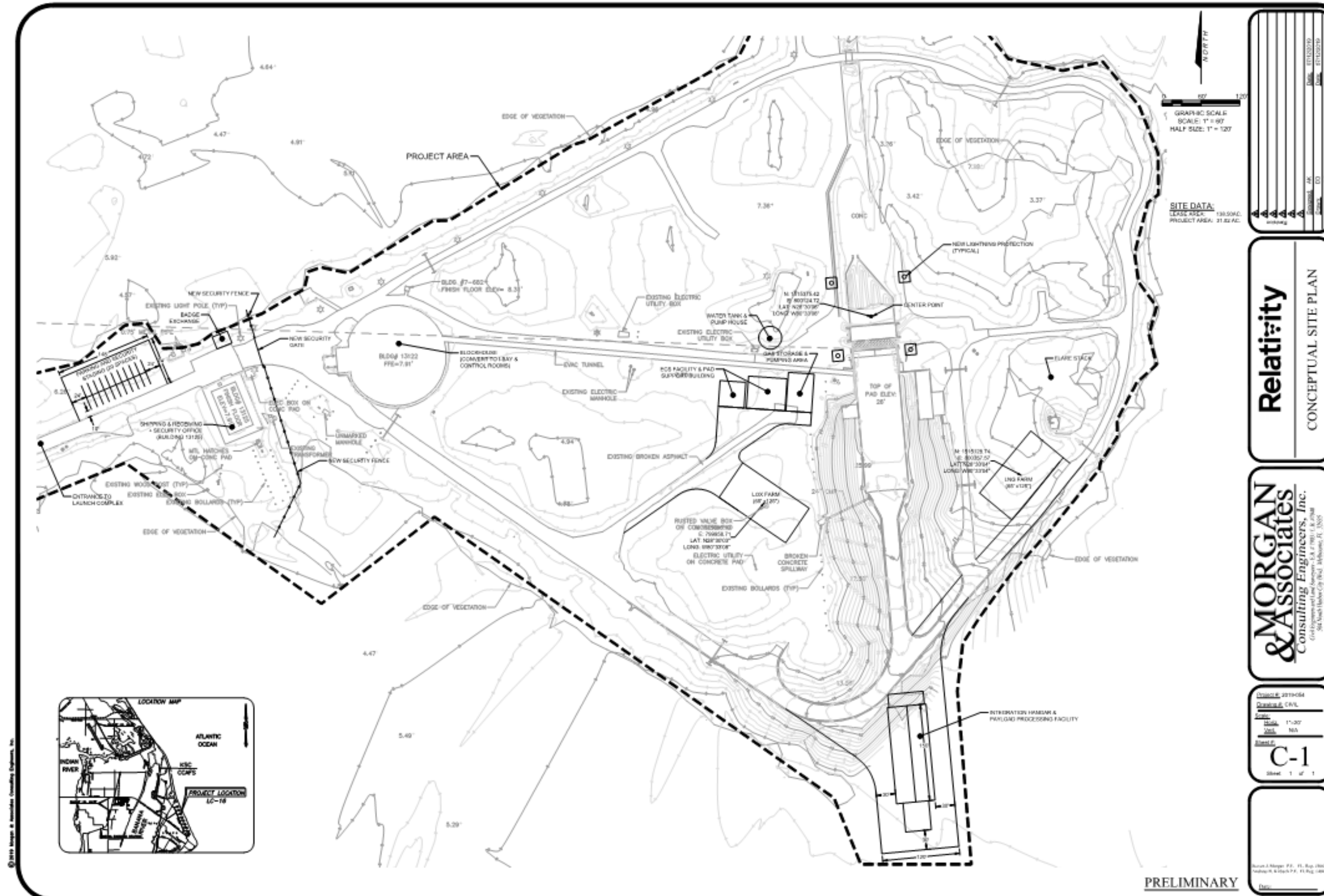


**Figure 4. LC-16 Current (2018) Condition**



Google Earth, 2018

**Figure 5. LC-16 Conceptual Drawing of Terran 1 Launch Site Modifications**



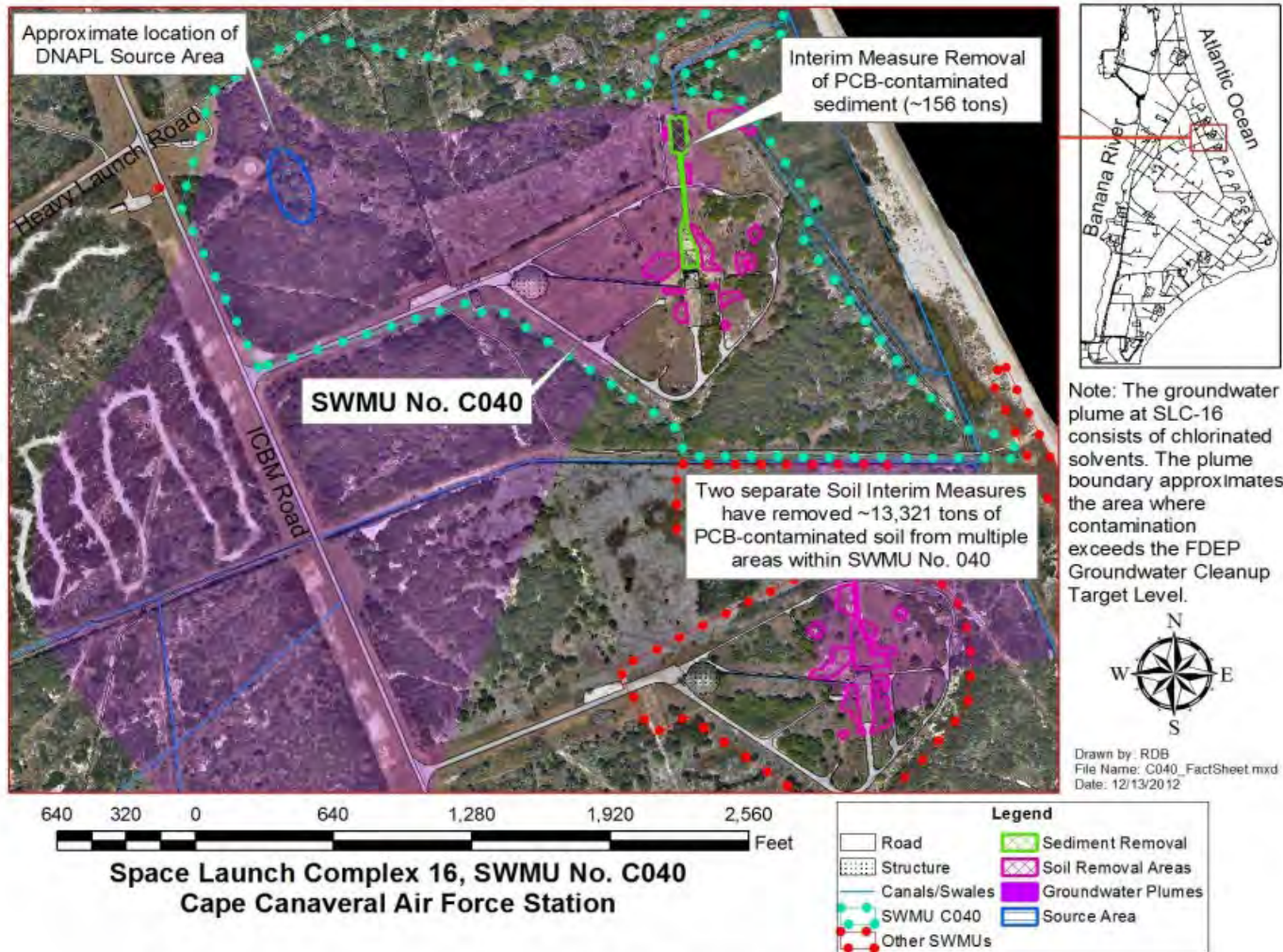


**Figure 6. LC-16 Conceptual Rendering of Terran 1 Program Modifications**



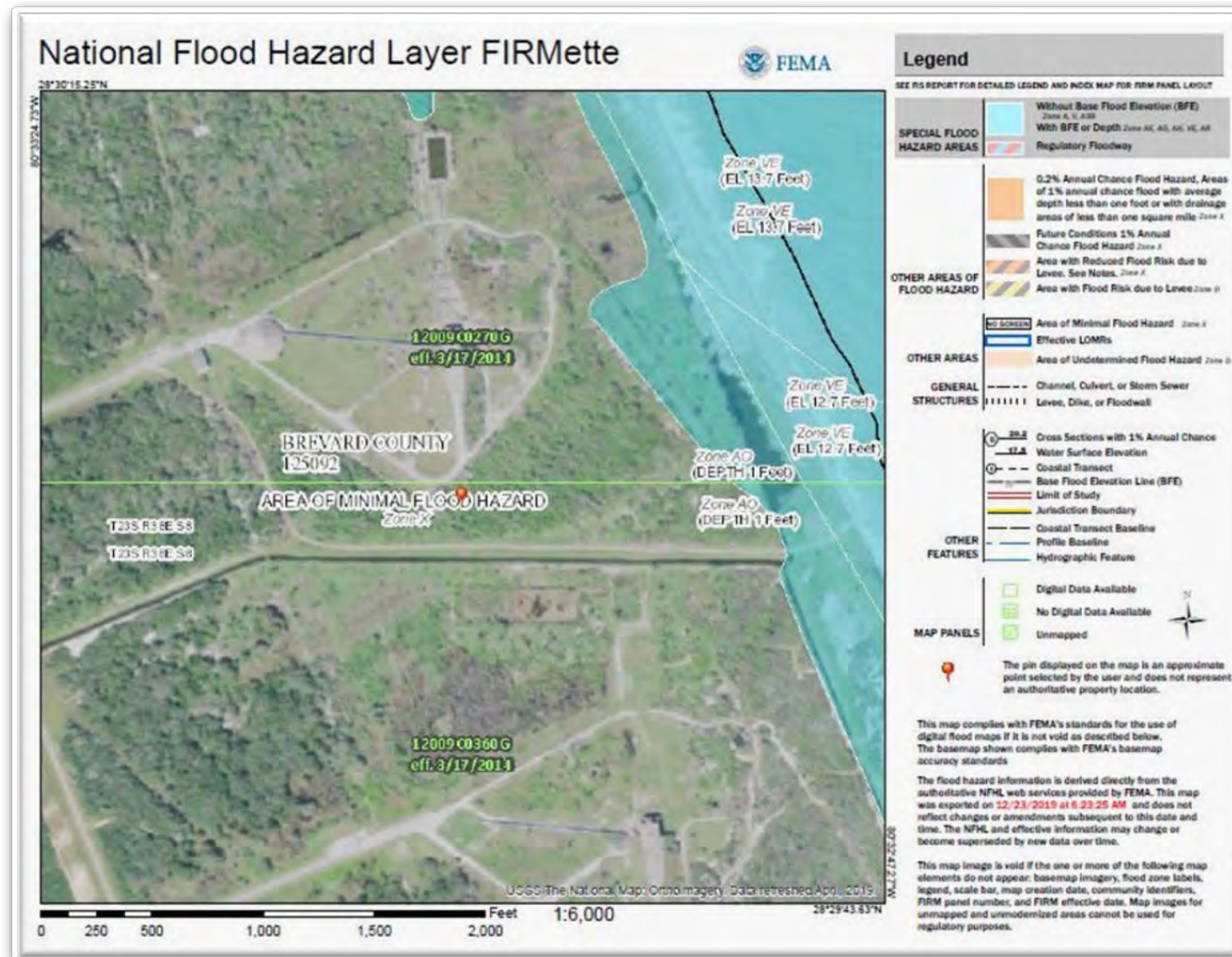


**Figure 7. LC-16, SWMU C040**



*Fact sheets are a summary provided for convenience. They are not intended as definitive documentation of official status.  
 For definitive site data, regulatory documents pertaining to the various phases of work should be consulted.  
 For further information regarding this site please contact the 45<sup>th</sup> SW IRP Office at 321-853-6578.*

Figure 8. LC-16 Floodplain Map

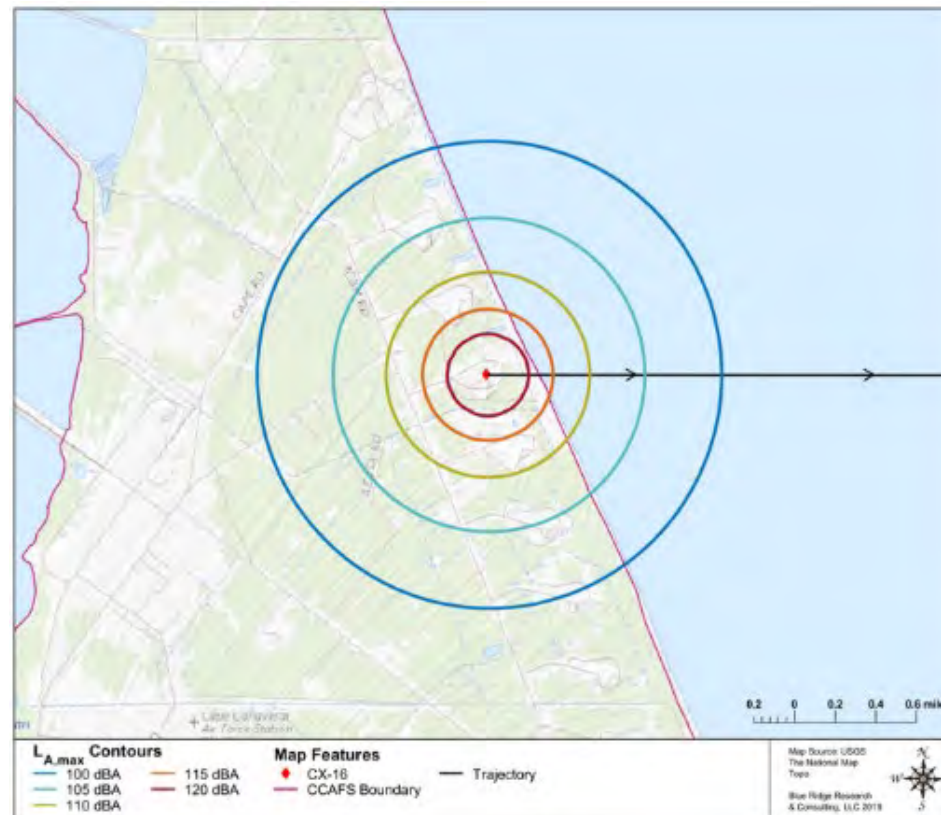




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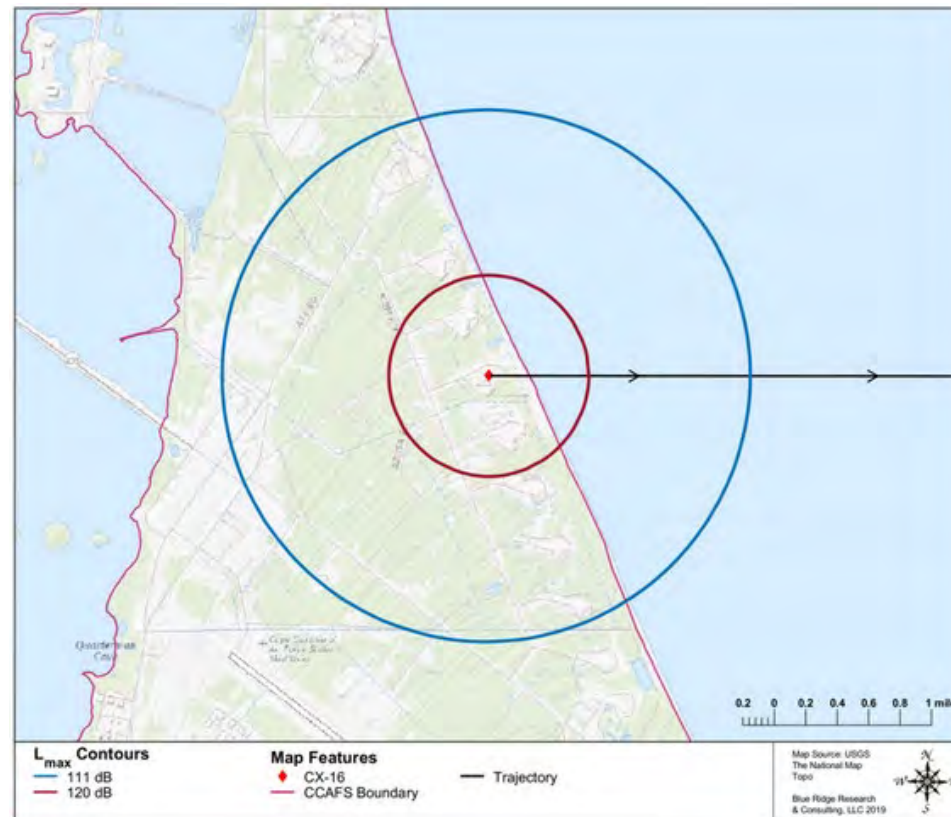
**Figure 10. Terran 1 Launch Maximum A-Weighted Sound Level ( $L_{A,max}$ ) Contours**



**Figure 11. Terran 1 Static Operations Maximum A-Weighted Sound Level ( $L_{A_{max}}$ ) Contours**

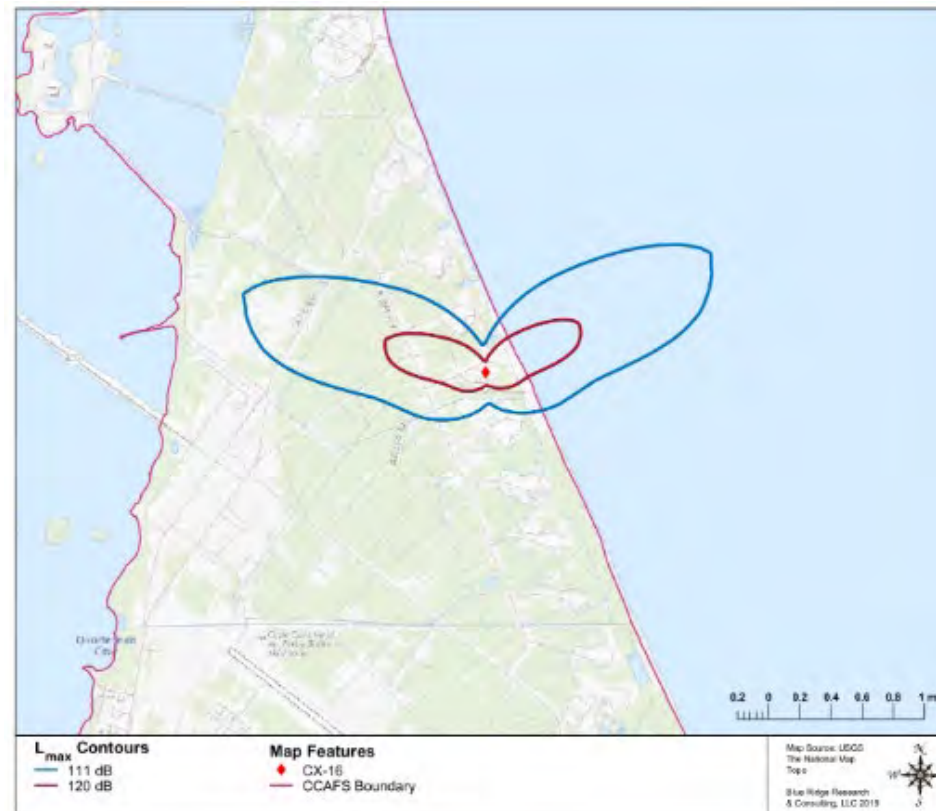


**Figure 12. Terran 1 Launch Maximum Unweighted Sound Level ( $L_{max}$ ) Contours**

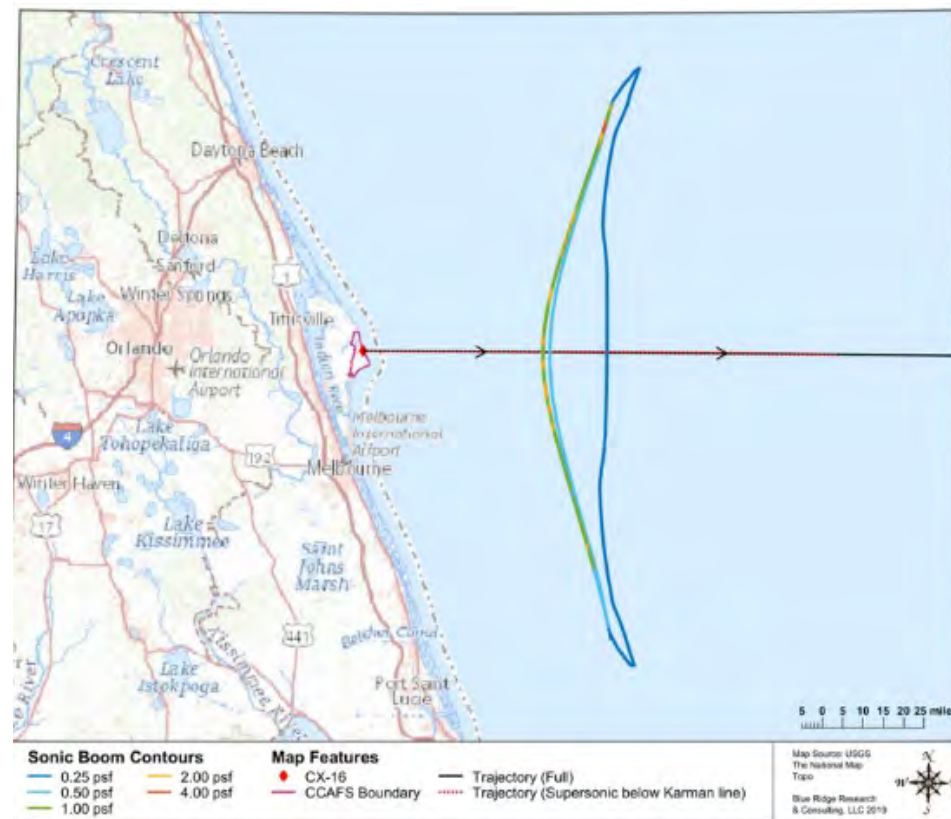




**Figure 13. Terran 1 Static Operations Maximum Unweighted Sound Level ( $L_{max}$ ) Contours**

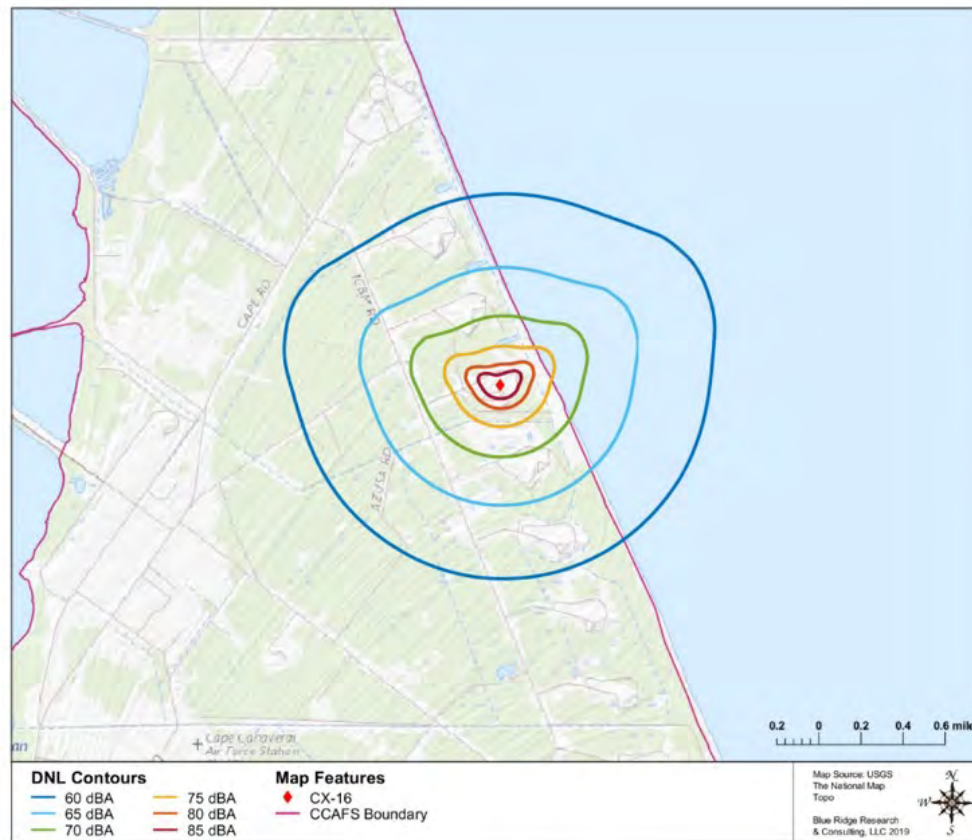


**Figure 14. Terran 1 Sonic Boom Peak Overpressure Contours**

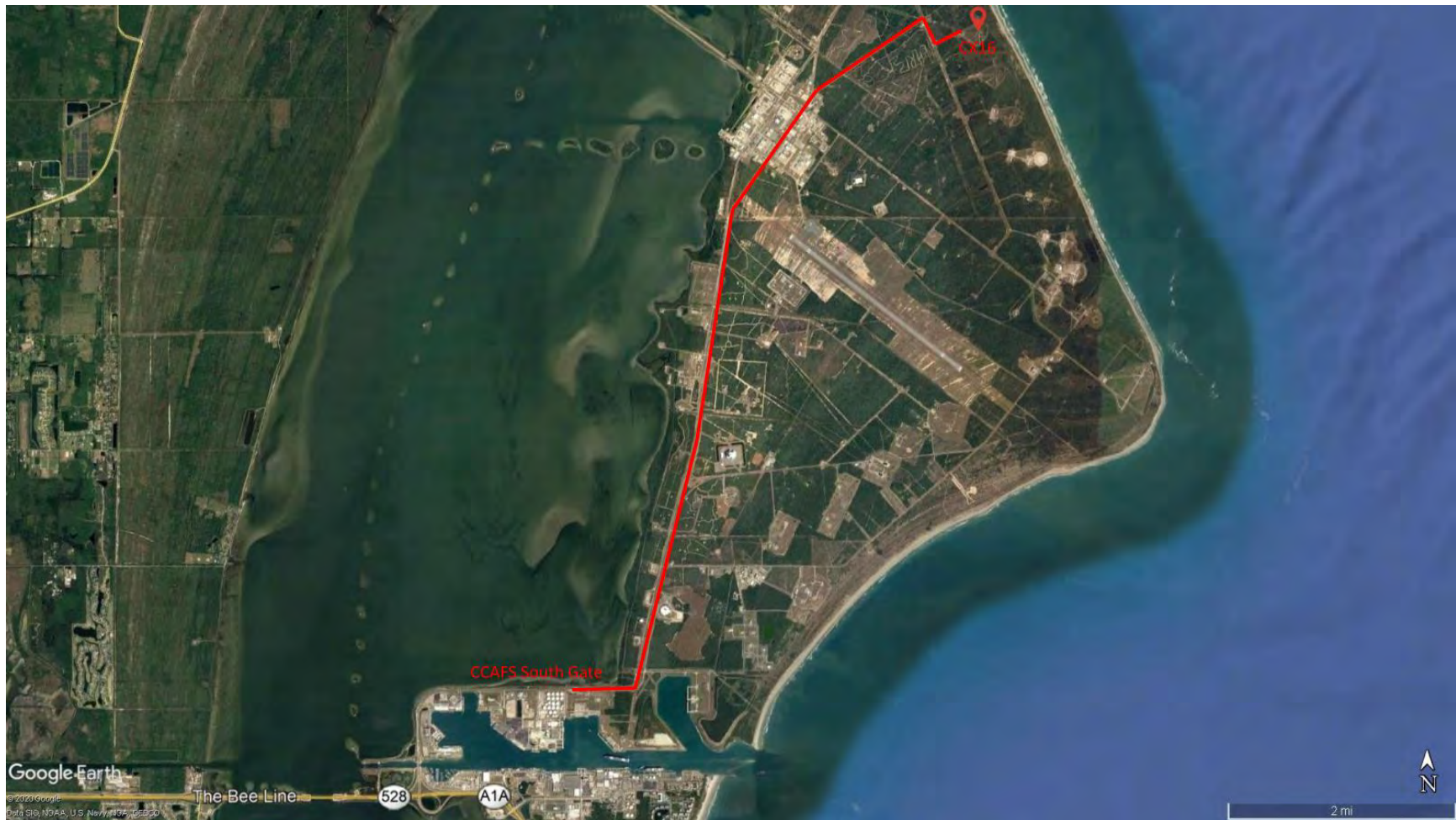




**Figure 15. DNL Contours for Terran 1 Launch and Static Operations**



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## **APPENDIX B**

# **Noise Study for Relativity's Launch Vehicle Operations at CCAFS CX-16, Blue Ridge Research and Consulting, LLC**

# Blue Ridge Research and Consulting, LLC

## *Technical Report*

# Noise Study for Relativity Space's Terran 1 Launch Vehicle Operations at CCAFS CX-16

*March 13, 2020 (Final)*

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## Acronyms and Abbreviations

The following acronyms and abbreviations are used in the report:

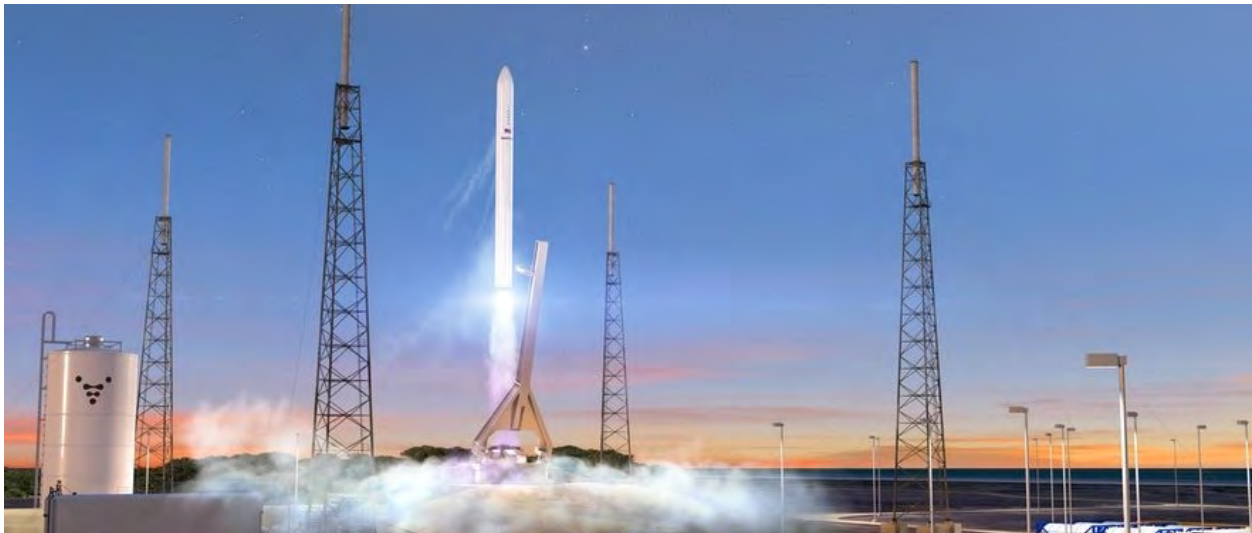
BRRC	Blue Ridge Research and Consulting, LLC
CCAFS	Cape Canaveral Air Force Station
dB	Decibel
dBA	A-weighted Decibel Level
dBc	C-weighted Decibel Level
DI	Directivity Indices
DNL	Day-Night Average Sound Level
DoD	Department of Defense
DSM-1	Distributed Source Method 1
FAA	Federal Aviation Administration
ft	Foot/Feet
Hz	Hertz
lbf	Pound Force
lbs	Pound Mass
$L_{A,max}$	Maximum A-weighted OASPL in Decibels
$L_{max}$	Maximum Unweighted OASPL in Decibels
$L_{pk}$	Peak Sound Pressure Level in Decibels
NIHL	Noise-Induced Hearing Loss
NIOSH	National Institute for Occupational Safety and Health
OASPL	Overall Sound Pressure Level in Decibels
OSHA	Occupational Safety and Health Administration
EA	Environmental Assessment
Pa	Pascal
psf	Pounds per Square Foot
RUMBLE	The Launch Vehicle Acoustic Simulation Model
S.L.	Sea Level



## 1 Introduction

This report documents the noise study performed as part of Relativity Space's (Relativity's) efforts on the Environmental Assessment (EA) for proposed Terran 1 launch operations at Cape Canaveral Air Force Station (CCAFS). Relativity plans to conduct launch and static operations of the Terran 1 launch vehicle from CCAFS Launch Complex 16 (CX-16). The potential impacts from propulsion noise and sonic booms are evaluated in relation to human annoyance, hearing conservation, and structural damage.

This noise study describes the environmental noise associated with the proposed Terran 1 operations. Section 2 describes the proposed Terran 1 operations; Section 3 summarizes the basics of sound and describes the noise metrics and impact criteria discussed throughout this report; Section 4 describes the general methodology of the propulsion noise and sonic boom modeling; and Section 5 presents the propulsion noise and sonic boom modeling results. A summary is provided in Section 6 to document the notable findings of this noise study.



**Figure 1. Rendering of Relativity's Terran 1 launch vehicle (credit: Relativity)**

## 2 Terran 1 Operations

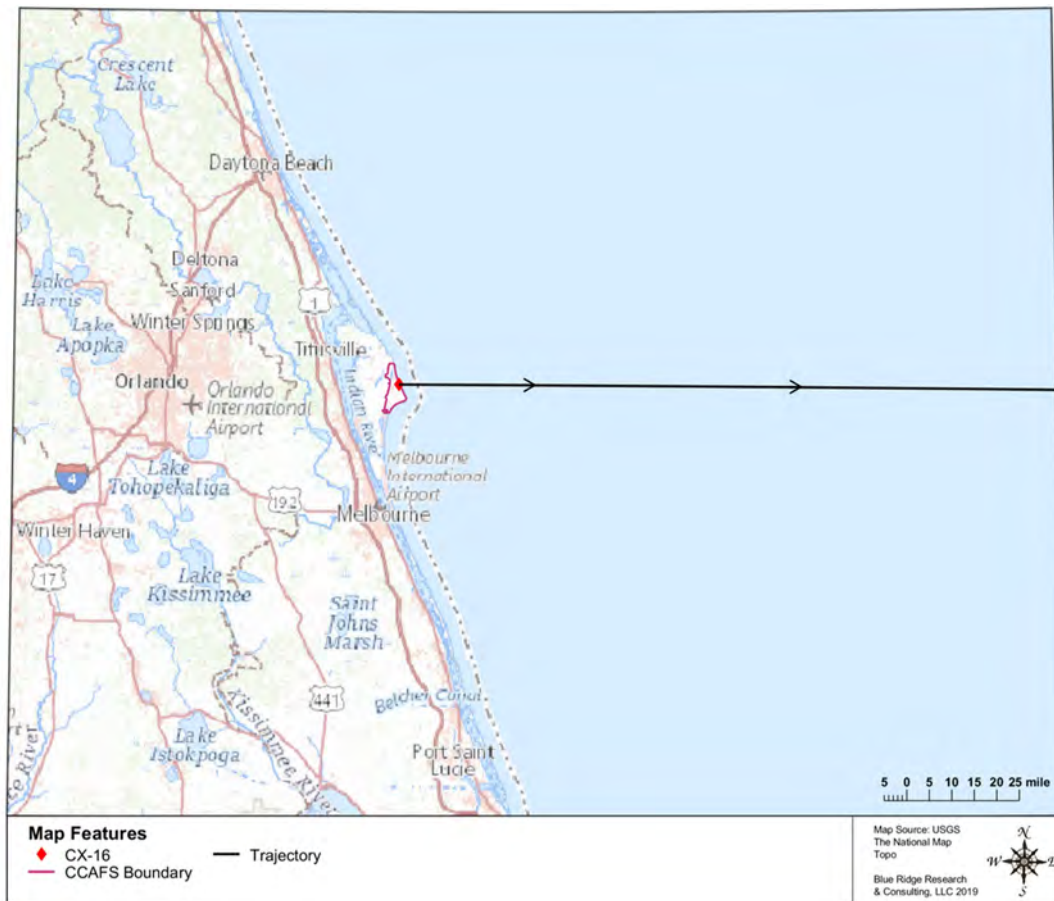
Relativity plans to conduct up to 24 launch, static fire, and mission duty cycle (MDC) hot fire operations of the Terran 1 launch vehicle per year. The annual operations are presented in Table 1 in terms of acoustic time of day. All operations will occur at CCAFS CX-16 (28.501710°N, 80.551790°W). Terran 1 launch trajectories departing from CX-16 will be unique to the vehicle configuration, mission, and environmental conditions. For the purposes of this study, the noise modeling utilized a nominal launch trajectory provided by Relativity [1] with an azimuth of approximately 90°, relative to true north. An overview of the facility and nominal trajectory is shown in Figure 2.

The Terran 1 launch vehicle parameters are presented in Table 2. Although the vehicle weight and engine thrust are provided in Table 2, the model uses the time varying weight and thrust profiles provided in the nominal Terran 1 launch trajectory. All operational modeling parameters were provided by Relativity.



**Table 1. Proposed Relativity Terran 1 operations**

Vehicle	Event	Duration	Annual Operations		Total
			Daytime 0700 – 1900	Nighttime 2200 – 0700	
Terran 1	Launch	--	18	6	24
	Static Fire	7 seconds	18	6	24
	MDC Hot Fire	162 seconds	24	0	24



**Figure 2. Overview of the CCAFS facility boundary and nominal trajectory from CX-16**

**Table 2. Terran 1 modeling parameters**

Modeling Parameters	Values
Manufacturer	Relativity Space
Name	Terran 1
Length	111 ft
Vehicle Diameter	7.5 ft
Payload Diameter	10 ft
Dry Vehicle Weight	22,154 lbs
Engines	Aeon-1 (Qty. 9) 23,000 lbf S.L. Thrust/Engine (207,000 lbf combined S.L. Thrust)

### 3 Acoustics Overview

An overview of sound-related terms, metrics, and effects, which are pertinent to this study, is provided to assist the reader in understanding the terminology used in this noise study.

#### 3.1 Fundamentals 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 [2].

- **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.

##### 3.1.1 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 [3].

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 [2]. 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" [4].

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 [5].

### 3.1.2 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 3, 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.

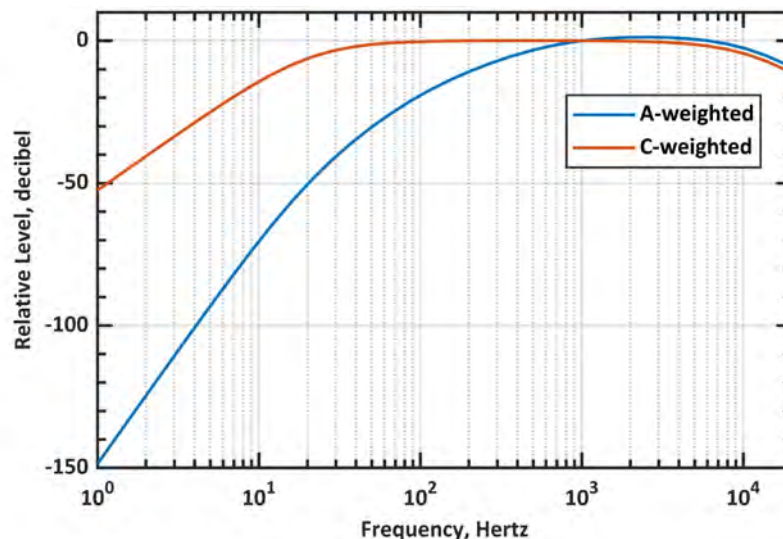


Figure 3. Frequency adjustments for A-weighting and C-weighting [6]

### 3.1.3 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. These are discussed in detail in Section 3.2.

### 3.1.4 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 [7] is shown in Figure 4. 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 4) are averages over extended periods [8]. Per the US 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” [9].

A chart of typical impulsive events along with their corresponding peak overpressures in terms of psf and peak dB values are shown in Figure 5. 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 [10].

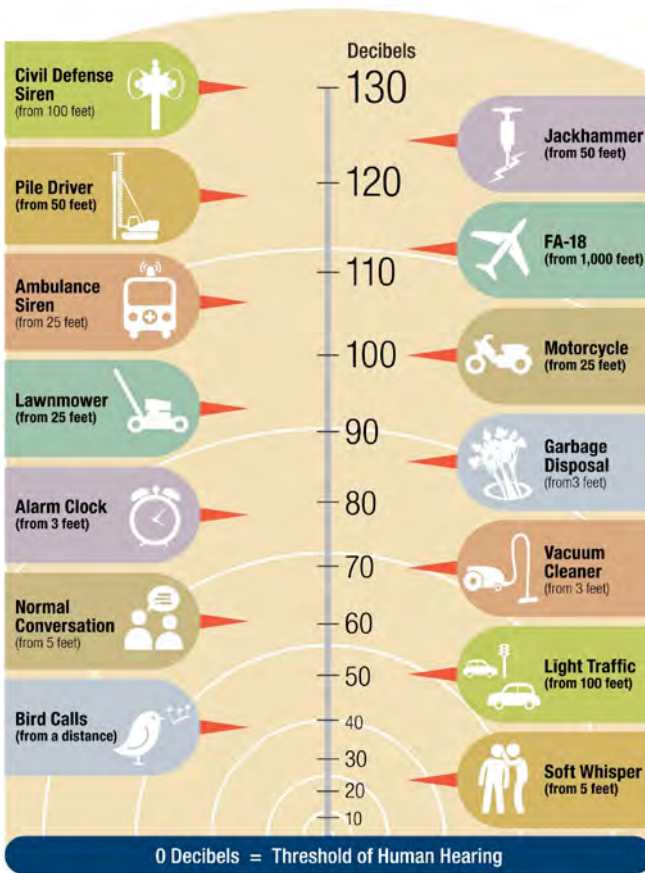


Figure 4. Typical A-weighted levels of common sounds [11]

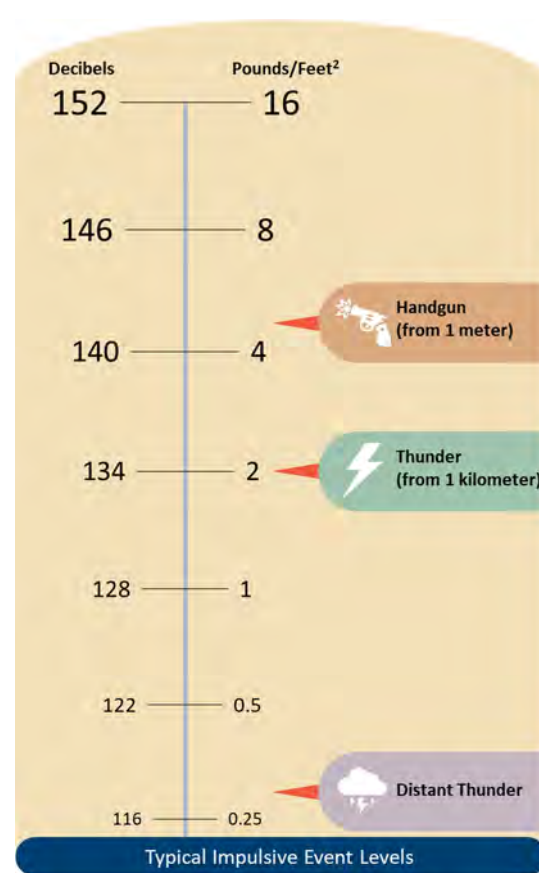


Figure 5. Typical impulsive event levels [10]

## 3.2 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 ( $L_{max}$ )*

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.

### *Peak Sound Level ( $L_{pk}$ )*

For impulsive sounds, the true instantaneous peak sound pressure level, which lasts for only a fraction of a second, is important in determining impacts. The peak pressure 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.

### *Day-Night Average Sound Level (DNL)*

Day-Night Average Sound Level is a cumulative metric that accounts for 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. DNL does not represent a level heard at any given time but represents long term exposure to noise.

## 3.3 Noise Effects

Noise criteria have been developed to protect the public health and welfare of the surrounding communities. The impacts of launch vehicle noise and sonic booms are evaluated on a cumulative basis in terms of human annoyance. In addition, the launch vehicle noise and sonic boom impacts are evaluated on a single-event basis in relation to hearing conservation and potential structural damage. Although FAA Order 1050.1F does not have guidance on hearing conservation or structural damage criteria, it recognizes the use of supplemental noise analysis to describe the noise impact and assist the public's understanding of the potential noise impact.

### 3.3.1 Human Annoyance

A significant noise impact would occur if the "action would increase noise by DNL 1.5 dB[A] or more for a noise sensitive area that is exposed to noise at or above the DNL 65 dB[A] noise exposure level, or that will be exposed at or above this level due to the increase, when compared to the No Action Alternative for the same timeframe" [12].

DNL is based on long-term cumulative noise exposure and has been found to correlate well with long-term community annoyance for regularly occurring events including aircraft, rail, and road noise [13, 14]. Noise studies used in the development of the DNL metric did not include rockets, which are historically irregularly occurring events. Thus, it is acknowledged that the suitability of DNL for infrequent rocket noise



events is uncertain. Additionally, it has been noted that 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” [12]. However, DNL is the most widely accepted metric to estimate the potential changes in long-term community annoyance. For launch propulsion noise, A-weighted DNL is used to assess the community impacts with regards to human annoyance. For impulsive noise sources with significant low-frequency content such as sonic booms, C-weighted DNL is preferred over A-weighted DNL [15]. In terms of percent highly annoyed, DNL 65 dBA is equivalent to CDNL 60 dBC [16].

### 3.3.2 Hearing Conservation

#### *Launch Vehicle Noise*

U.S. government agencies have provided guidelines on permissible noise exposure limits. These documented 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) [17], National Institute for Occupational Safety and Health (NIOSH) [18], and the Department of Defense (DoD) Occupational Hearing Conservation Program [19]. The most conservative of these upper noise level limits has been set by OSHA at 115 dBA. At 115 dBA, the allowable exposure duration is 15 minutes for OSHA and 28 seconds for NIOSH and DoD.  $L_{A,max}$  contours are used to identify potential locations where hearing protection should be considered for rocket operations.

#### *Sonic Booms*

Multiple federal government agencies have provided guidelines on permissible noise exposure limits on impulsive noise such as sonic booms. In terms of upper limits on impulsive or impact noise levels, NIOSH [18] and OSHA [20] have stated that levels should not exceed 140 dB peak sound pressure level, which equates to a sonic boom level of approximately 4 psf.

### 3.3.3 Structural Damage

#### *Launch Vehicle Noise*

Typically, the most sensitive components of a structure to launch vehicle noise are windows, and infrequently, the plastered walls and ceilings. The potential for damage to a structure is unique interaction among the incident sound, the condition of the structure, and the material of each element and its respective boundary conditions. A report from the National Research Council on the “Guidelines for Preparing Environmental Impact Statements on Noise” [21] states that one may conservatively consider all sound lasting more than one second with levels exceeding 130 dB (unweighted) as potentially damaging to structures.

A NASA technical memo examined the relationship between structural damage claims and overall sound pressure level and concluded “the probability of structural damage [was] proportional to the intensity of the low frequency sound” [22]. This relationship estimated that one damage claim in 100 households exposed is expected at an average continuous sound level of 120 dB (unweighted), and one in 1,000 households at 111 dB (unweighted). The study was 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 sound levels used to develop the criteria were modeled mean sound levels.

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 engine/motor 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 [22] damage claim criteria represents 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.

### ***Sonic Booms***

High-level sonic booms are also associated with structural damage. Most damage claims are for brittle objects, such as glass and plaster. Table 3 summarizes the threshold of damage that may be expected at various overpressures [23]. Additionally, Table 3 describes example impulsive events for each level range. A large degree of variability exists in damage experience, and much of the damage depends on the pre-existing condition of a structure. Breakage data for glass, for example, spans a range of two to three orders of magnitude at a given overpressure. The probability of a window breaking at 1 psf ranges from one in a billion [24] to one in a million [25]. These damage rates are associated with a combination of boom load and glass condition. At 10 psf, the probability of breakage is between one in 100 and one in 1,000. Laboratory tests involving glass [26] have shown that properly installed window glass will not break at overpressures below 10 psf, even when subjected to repeated booms. However, in the real world, glass is not always in pristine condition.

Damage to plaster occurs at similar ranges to glass damage. Plaster has a compounding issue in that it will often crack due to shrinkage while curing or from stresses as a structure settles, even in the absence of outside loads. Sonic boom damage to plaster often occurs when internal stresses are high as a result of these factors. In general, for well-maintained structures, the threshold for damage from sonic booms is 2 psf [23], below which damage is unlikely.

**Table 3. Possible damage to structures from sonic booms [23]**

Nominal level	Damage Type	Item Affected
<i>0.5 – 2 psf piledriver at construction site</i>	Plaster	Fine cracks; extension of existing cracks; more in ceilings; over doorframes; between some plasterboards.
	Glass	Rarely shattered; either partial or extension of existing.
	Roof	Slippage of existing loose tiles/slates; sometimes new cracking of old slates at nail hole.
	Damage to outside walls	Existing cracks in stucco extended.
	Bric-a-brac	Those carefully balanced or on edges can fall; fine glass, such as large goblets, can fall and break.
	Other	Dust falls in chimneys.
<i>2 – 4 psf cap gun/firecracker near ear</i>	Glass, plaster, roofs, ceilings	Failures show that would have been difficult to forecast in terms of their existing localized condition. Nominally in good condition.
<i>4 – 10 psf handgun at shooter's ear</i>	Glass	Regular failures within a population of well-installed glass; industrial as well as domestic greenhouses.
	Plaster	Partial ceiling collapse of good plaster; complete collapse of very new, incompletely cured, or very old plaster.
	Roofs	High probability rate of failure in nominally good state, slurry-wash; some chance of failures in tiles on modern roofs; light roofs (bungalow) or large area can move bodily.
	Walls (out)	Old, free standing, in fairly good condition can collapse.
	Walls (in)	Inside ("party") walls known to move at 10 psf.
<i>&gt; 10 psf fireworks display from viewing stand</i>	Glass	Some good glass will fail regularly to sonic booms from the same direction. Glass with existing faults could shatter and fly. Large window frames move.
	Plaster	Most plaster affected.
	Ceilings	Plasterboards displaced by nail popping.
	Roofs	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; domestic chimneys dislodged if not in good condition.
	Walls	Internal party walls can move even if carrying fittings such as hand basins or taps; secondary damage due to water leakage.
	Bric-a-brac	Some nominally secure items can fall; e.g., large pictures, especially if fixed to party walls.



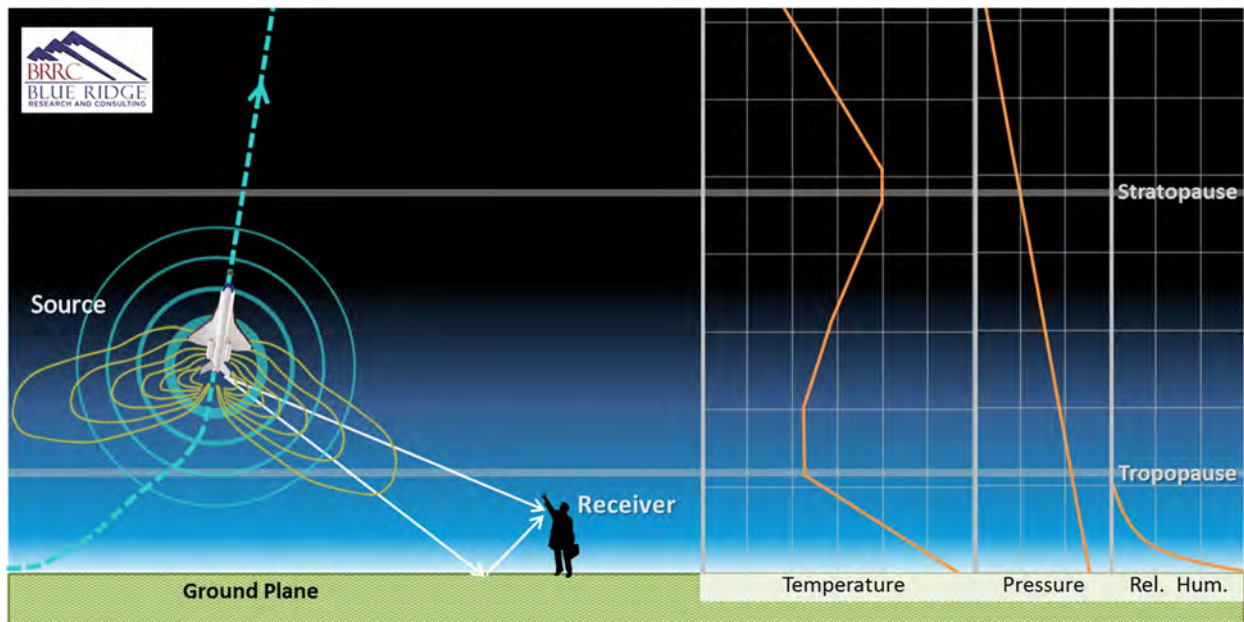
## 4 Noise Modeling

An overview of the propulsion noise and sonic boom modeling methodologies used in this noise study are presented in Section 4.1 and 4.2, respectively.

### 4.1 Propulsion Noise Modeling

Launch vehicle propulsion systems, such as solid rocket motors and liquid-propellant rocket 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.

The Launch Vehicle Acoustic Simulation Model (RUMBLE), 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 6 and are described in the following subsections.



**Figure 6. Conceptual overview of rocket noise prediction model methodology**

#### 4.1.1 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) [27] is utilized for the source characterization. The DSM-1 model determines the launch vehicle's total sound power based on its total thrust, exhaust velocity, and the engine/motor's acoustic efficiency. BRRC's recent validation of the DSM-1 model showed very good agreement between full-scale rocket noise measurements and the empirical source curves [28]. 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 [29]. Typical acoustic efficiency values range from 0.2% to 1.0% [27]. 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, launch vehicle propulsion systems with multiple tightly clustered equivalent engines can be modeled as a single engine with an effective exit diameter and total thrust [27]. 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 [30, 31, 32, 33]. 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.

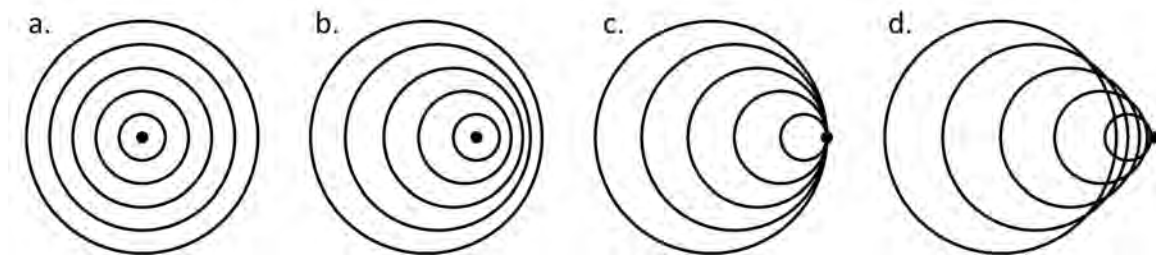
### *Directivity*

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 launch vehicle directivity of the reusable solid rocket motor (RSRM) [34]. The RSRM directivity indices (DI) incorporate a larger range of frequencies and angles than previously available data. Subsequently, improvements were made to the formulation of the RSRM DI [35] 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, it is identical at the instant of passing by, and it 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. The relative changes in frequency can be explained as follows: when the source of the waves is moving toward the observer, each successive wave crest is emitted from a position closer to the observer than the previous wave. Therefore, each wave takes slightly less time to reach the observer than the previous wave, and the time between the arrivals of successive wave crests at the observer is reduced, causing an increase in the frequency. While they are traveling, the distance between successive wave fronts is reduced such that the waves "bunch together." Conversely, if the source of waves is moving away

from the observer, then each wave is emitted from a position farther from the observer than the previous wave; the arrival time between successive waves is increased, reducing the frequency. Likewise, the distance between successive wave fronts increases, so the waves "spread out." Figure 7 illustrates this spreading effect for an observer in a series of images, where a) the source is stationary, b) the source is moving less than the speed of sound, c) the source is moving at the speed of sound, and d) the source is moving faster than the speed of sound. As the frequency is shifted lower, the A-weighting filtering on the spectrum results in a decreased A-weighted sound level. For unweighted overall sound levels, the Doppler effect does not change the levels since all frequencies are accounted for equally.



**Figure 7. Effect of expanding wavefronts (decrease in frequency) that an observer would notice for higher relative speeds of the rocket relative to the observer for: a) stationary source b) source velocity < speed of sound c) source velocity = speed of sound d) source velocity > speed of sound**

#### 4.1.2 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 launch vehicle noise model components are calculated based on the specific geometry between source (launch vehicle trajectory point) to receiver (grid point). The position of the launch 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 [36, 37, 38, 39] 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 [40] as they travel through the medium. These nonlinear effects are counter to the effect of atmospheric absorption [41, 42]. However, recent research shows that nonlinear propagation effects change the perception of the received sound [43, 44], but the standard acoustical metrics are not strongly influenced by nonlinear effects [45, 46]. 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 6. 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 [47, 48] when estimating the received noise. The model assumes a five-foot receiver height and a homogeneous grass ground surface. However, it should be noted that noise levels may be 3 dB louder over water surfaces compared to the predicted levels over the homogeneous grass ground surfaces assumed in the modeling. To account for the random fluctuations of wind and temperature on the direct and reflected wave, the effect of atmospheric turbulence is also included [47, 49].

#### **4.1.3 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.

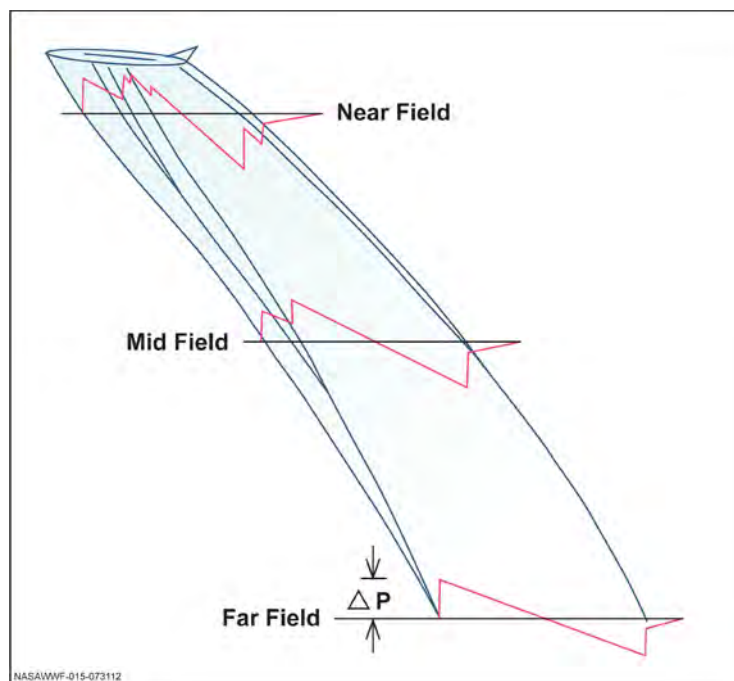
## 4.2 Sonic Boom Modeling

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 4.2.1 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 4.2.2.

### 4.2.1 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 8 shows the generation and evolution of a sonic boom N-wave under the vehicle.

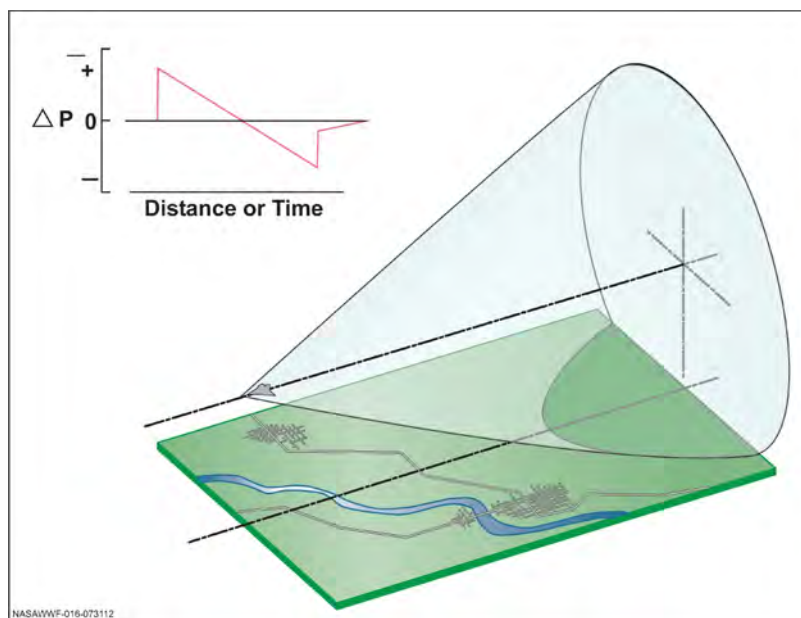


**Figure 8. Sonic boom generation and evolution to N-wave [50]**



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 9 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.”

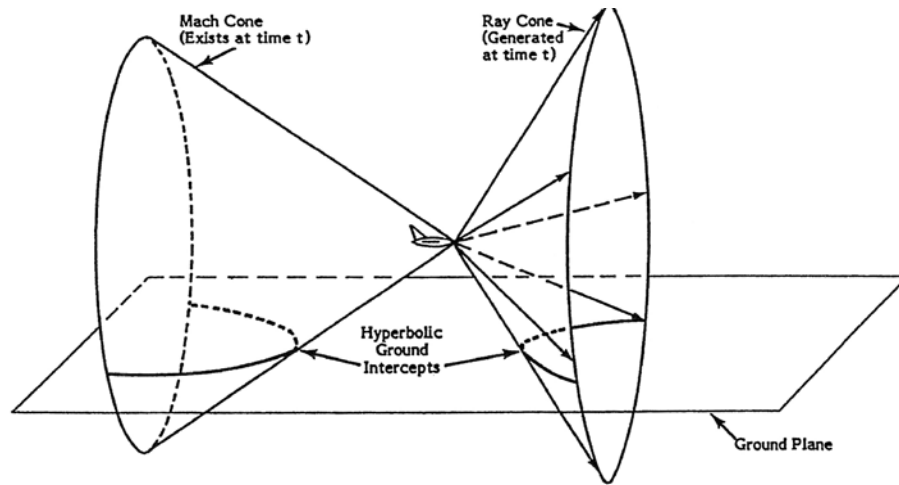


**Figure 9. Sonic boom carpet for a vehicle in steady flight [51]**

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 [52]. Both perspectives are shown in Figure 10. The difference in wave versus ray perspectives is described for level, climbing, and diving flight, in the PCBoom Sonic Boom Model User Guide [52]:

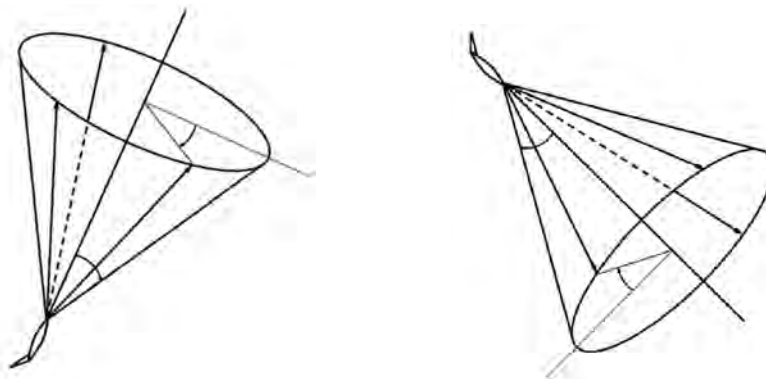
Sonic boom wave cones are not generated fully formed at a single point in time, instead resulting from the accumulation of all previous disturbance events that occurred during the vehicle's time history. [...] Unlike wave cones, ray cones are fully determined at a single point in time and are independent 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 10] 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 10. Mach cone vs ray cone viewpoints**

Figure 9 and Figure 10 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 10. For a vehicle climbing at an angle steeper than the ray cone half angle, such as in the left image of Figure 11, 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 11, 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 11. Ray cone in climbing (left) and diving (right) flight**

#### **4.2.2 PCBoom**

The single-event prediction model, PCBoom [53, 54, 55], 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, PCBoom accounts for the effect of rocket exhaust plumes on the boom [56].

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 that includes the mean temperature, wind speed, and wind direction [57].



## 5 Results

The following sections present the results of the environmental propulsion noise and sonic boom impacts associated with the proposed Terran 1 operations. Note, for static operation of the Terran 1, the planned use of water mitigation on the pad may reduce the noise levels below what is presented here. Additionally, noise levels over water may be higher because of the acoustical hardness of the water surface. Single event and cumulative launch vehicle noise results are presented in Section 5.1 and Section 5.2, respectively.

### 5.1 Single Event Noise

Single event propulsion noise and sonic boom modeling results are presented in Sections 5.1.1 and 5.1.2, respectively.

#### 5.1.1 Propulsion Noise

Single event propulsion noise events are evaluated using maximum A-weighted and unweighted levels.

##### *Maximum A-weighted Sound Level ( $L_{A,max}$ )*

The modeled  $L_{A,max}$  contours associated with Terran 1 operations from CX-16 are presented in Figure 12 and Figure 13. An upper limit noise level of 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 dB noise contours resulting from Terran 1 operations lies within the boundaries of CCAFS. Thus, the potential for impacts to people in the community with regards to hearing conservation is negligible.

Launch Operations – The Terran 1 launch event generates modeled levels at or above an  $L_{A,max}$  of 115 dBA within 0.3 miles of CX-16. The 115 dBA contour for Terran 1 launch events is shown in Figure 12.

Static Operations (Static Fire/Hot Fire) – The Terran 1 static event noise contours are more directive than the launch event noise contours because the plume is redirected in-line with the deflector heading for the entire duration of the event. A receptor located along the peak directivity angle may experience an  $L_{A,max}$  of 115 dBA at approximately 0.2 miles from CX-16 during a static event. The 115 dBA contour for Terran 1 static events is shown in Figure 13. Note, the levels produced by static events will remain constant over the duration of the event, whereas the levels produced by launch events will decrease as the rocket moves further away from the receptor.

##### *Maximum Unweighted Sound Level ( $L_{max}$ )*

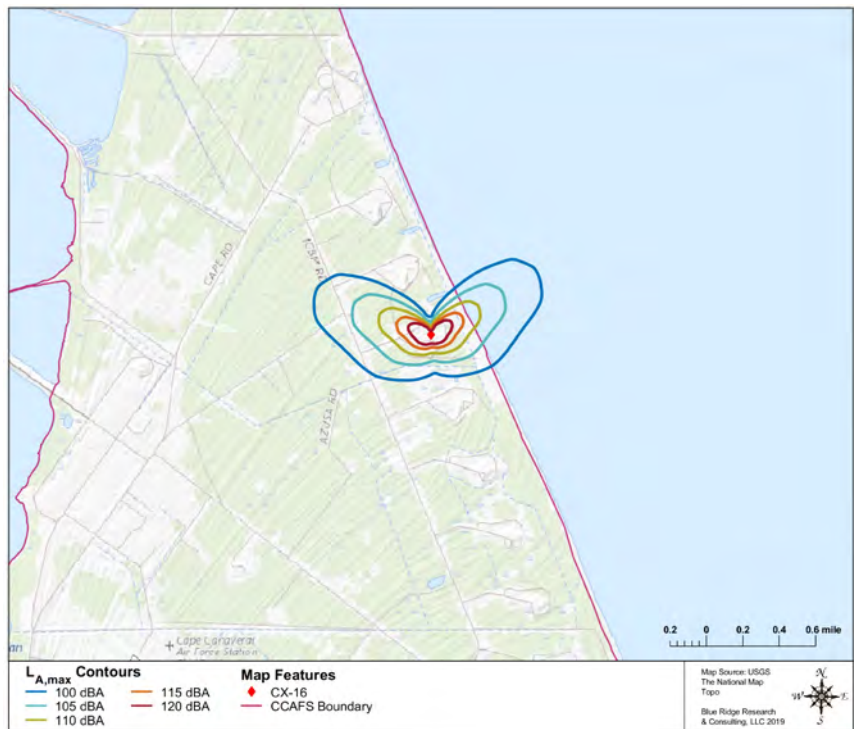
The modeled  $L_{max}$  contours associated with Terran 1 operations from CX-16 are presented in Figure 14 and Figure 15. Note, the map scale of Figure 14 and Figure 15 is larger than Figure 12 and Figure 13. For reference, the potential for structural damage claims is approximately one damage claim per 100 households exposed at 120 dB and one in 1,000 households at 111 dB [22]. The entire land area encompassed by the 111 dB noise contours resulting from Terran 1 operations lies within the CCAFS boundaries.

Launch Operations – For a Terran 1 launch event, the modeled 120 dB and 111 dB  $L_{max}$  contours are limited to radii of 0.6 miles and 1.7 miles from CX-16, respectively, as shown in Figure 14.

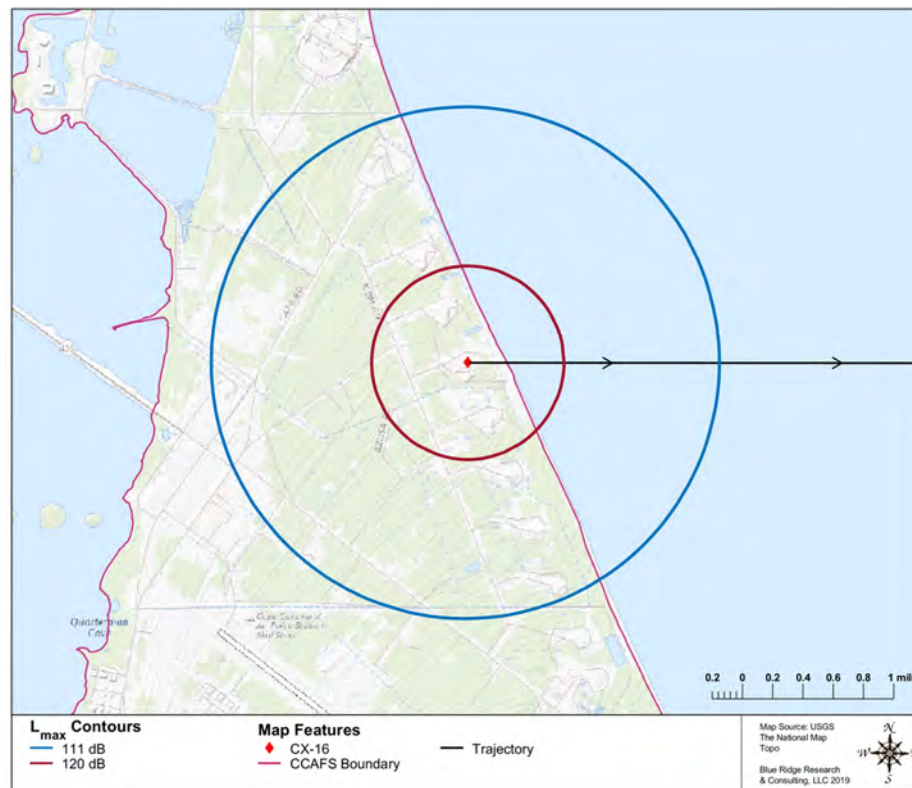
**Static Operations (Static Fire/Hot Fire)** – For a Terran 1 static event, a receptor located along the peak directivity angle may experience  $L_{max}$  values of 120 dB and 111 dB at approximately 0.7 miles and 1.6 miles from CX-16, respectively, as shown in Figure 15.



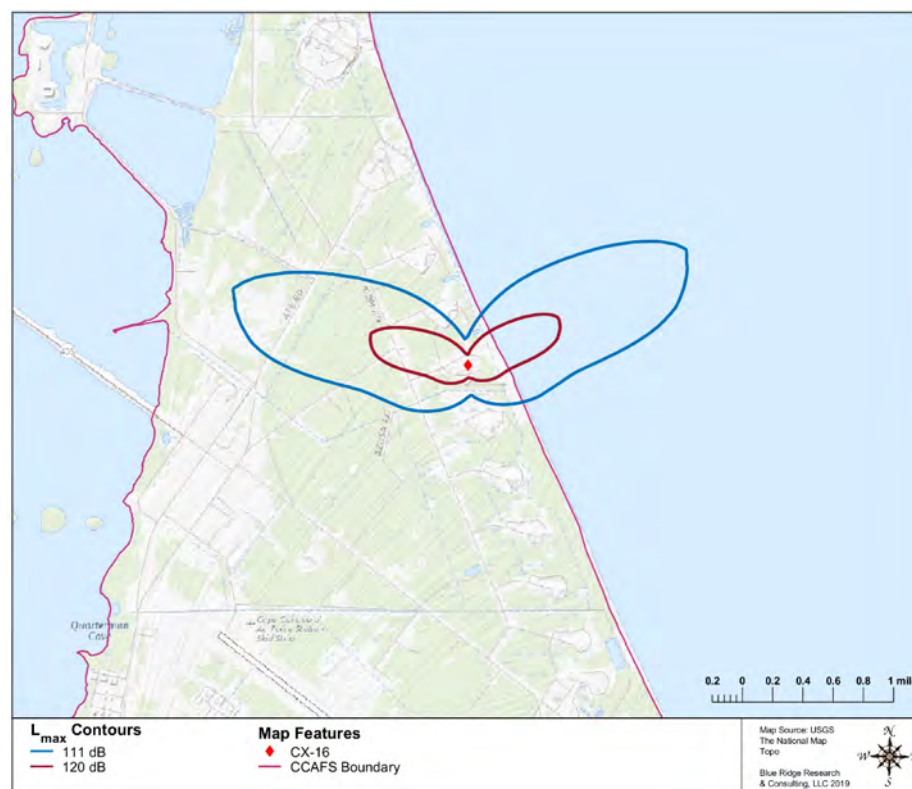
**Figure 12.  $L_{A,max}$  contours for a Terran 1 launch from Relativity's CCAFS CX-16**



**Figure 13.  $L_{A,max}$  contours for a Terran 1 static fire/hot fire from Relativity's CCAFS CX-16**



**Figure 14. L<sub>max</sub> contours for a Terran 1 launch from Relativity's CCAFS CX-16**



**Figure 15. L<sub>max</sub> contours for a Terran 1 static fire/hot fire from Relativity's CCAFS CX-16**

### 5.1.2 Sonic Booms

Individual launch site operations are evaluated using maximum peak overpressure for sonic booms.

#### *Maximum Peak Overpressure (psf)*

The sonic boom peak overpressure contours for the modeled Terran 1 launch operations are presented in Figure 16. The sonic boom footprint produced by the Terran 1 launch vehicle has a long, narrow, forward-facing, crescent-shaped focus boom region beginning 38 miles downrange of the launch site. The focus boom region is generated because the launch vehicle continuously accelerates and pitches downward as it ascends. The maximum peak overpressure along the focus boom region is predicted to be approximately 5.9 psf. However, these high levels would only occur in extremely small areas along the focus boom region. As the rocket gains altitude, the sonic boom peak overpressure gradually decreases, and the crescent-shaped contours become slightly wider.

The sonic booms were modeled based on a single launch trajectory at a nominal azimuth of 90° relative to true north. A site-specific atmospheric profile that includes winds was used to propagate the starting signatures to the ground. The sonic boom peak overpressure contours for the modeled Terran 1 launch operation are predicted to be entirely over water. Thus, the potential for structural damage or hearing damage (with regards to humans) is negligible. The exact location of the sonic boom footprint produced by each Terran 1 launch operation will be highly dependent on the vehicle configuration, trajectory, and atmospheric conditions at the time of flight.

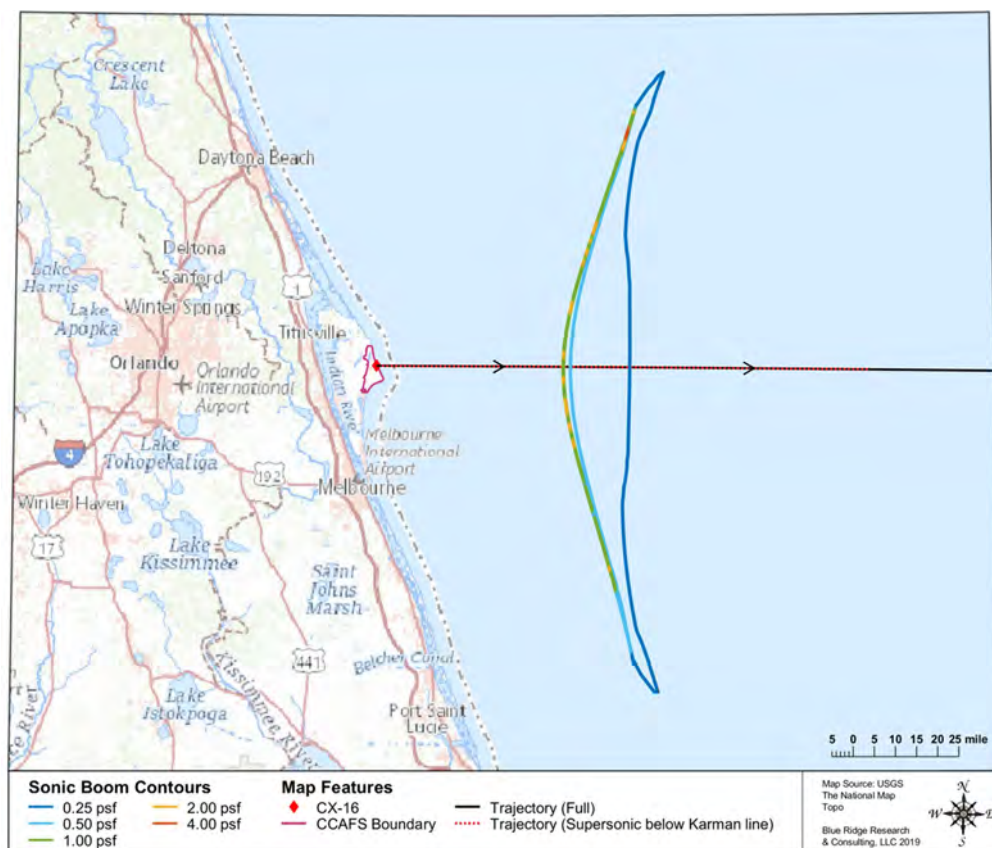


Figure 16. Sonic boom peak overpressure contours for a nominal Terran 1 launch from CX-16

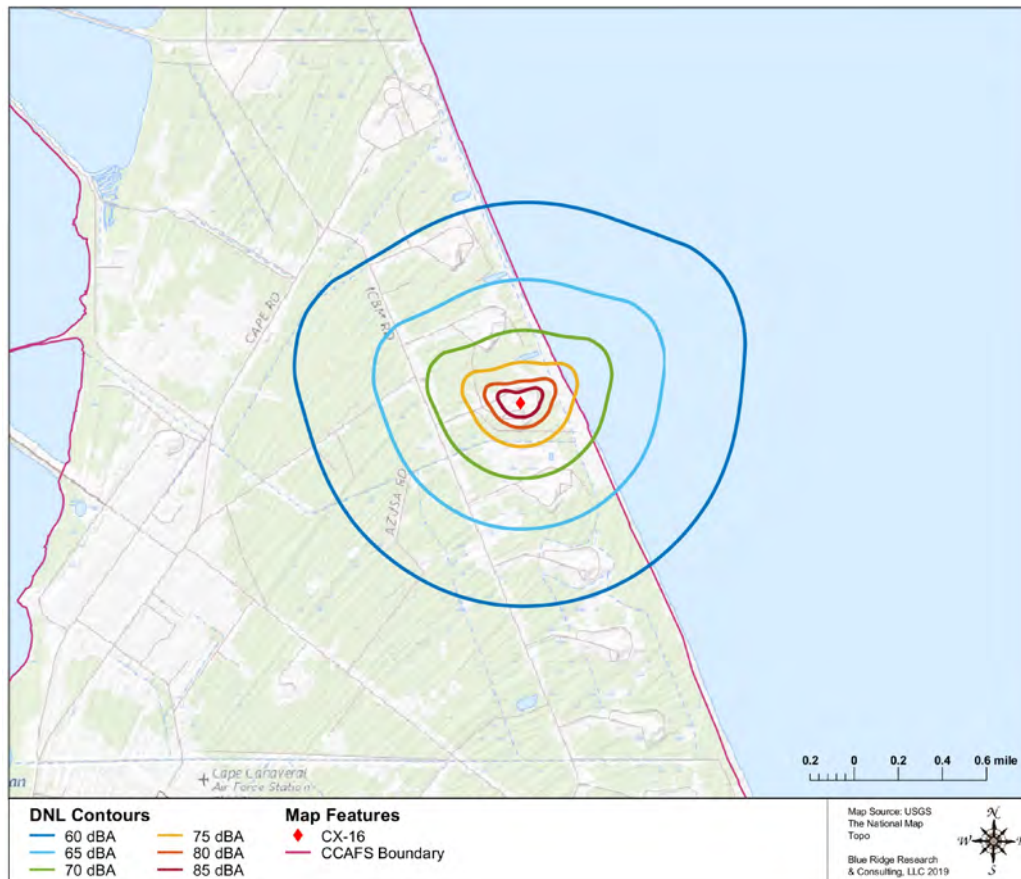


## 5.2 Cumulative Noise

The potential for long-term community annoyance is assessed using A-weighted DNL for launch vehicle noise and C-weighted DNL for sonic booms.

### Launch Site Operations

As DNL contours representing the no action alternative at CCAFS are unavailable, 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 dB[A] or more for a noise sensitive area that is exposed to noise at or above the DNL 65 dB[A] noise exposure level, or that will be exposed at or above this level due to the increase” [12]. The DNL contours from 60 dBA to 85 dBA are presented in Figure 17. The DNL 65 and 60 dBA contours extend approximately 0.7 and 1.1 miles from the launch pad, respectively. This area does not encompass land outside of the boundary of CCAFS, and, thus, no residences are impacted.



**Figure 17. DNL contours for Terran 1 launch and static operations from Relativity's CCAFS CX-16**

The sonic booms resulting from the modeled launch trajectory occur entirely over water. Therefore, with respect to human annoyance, health and safety, or structural damage, noise impacts due to sonic booms for the launch trajectory are not expected. Thus, a quantitative DNL analysis was not performed.

## 6 Summary

This report documents the noise study performed as part of Relativity's efforts on the EA for the proposed Terran 1 operations from CCAFS. Relativity plans to conduct launch and static operations of the Terran 1 launch vehicle from CCAFS CX-16. The potential impacts from propulsion noise and sonic boom are evaluated on a single-event and cumulative basis in relation to hearing conservation, structural damage, and human annoyance.

### Single Event Noise Results with respect to 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 noise contours resulting from Terran 1 operations lie within CCAFS boundaries.

For impulsive noise events such as sonic booms, noise impacts to human annoyance and health and safety are not expected as the modeled sonic boom footprint is entirely over water. Thus, the potential for impacts to people in the community with regards to hearing conservation is negligible.

### Single Event Noise Results with respect to 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 [22]. The entire land area encompassed by the 111 dB noise contours resulting from Terran 1 operations lie within CCAFS boundaries.

For impulsive noise events such as sonic booms, noise impacts to structures are not expected as the modeled sonic boom footprint is entirely over water. Thus, the potential for structural damage is negligible.

### Cumulative Noise Results

The DNL 60 dBA contour is used to conservatively identify the potential for significant noise impacts resulting from the propulsion noise generated by Terran 1 operations. The area identified within the 60 dBA contour for cumulative noise does not encompass land outside of the boundary of CCAFS, and, thus, no residences are impacted.

For impulsive noise events such as sonic booms, cumulative noise impacts with respect to human annoyance are not expected as the modeled sonic boom footprint is entirely over water.

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# **APPENDIX C**

## **FAA Noise Analysis Methodology Approval**



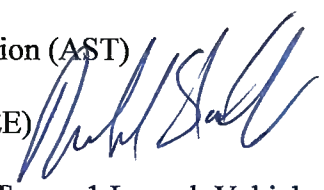
## Federal Aviation Administration

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# Memorandum

Date: March 5, 2020

To: Leslie Grey, Office of Commercial Space Transportation (AST)

From: Donald Scata, Office of Environment and Energy (AEE) 

Subject: Noise methodology approval request for Relativity's Terran 1 Launch Vehicle Operations at Cape Canaveral Air Force Station (CCAFS), Florida

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The Office of Environment and Energy (AEE) has reviewed of the noise methodology used by U.S. Air Force (USAF) in preparation of an environmental assessment (EA) for Relativity Space's (Relativity's) Terran 1 launch vehicle operations at CCAFS.

As the FAA does not currently have an approved propulsion noise model for launch vehicles. In accordance with FAA Order 1050.1E, 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 method proposed in the Technical Memo "20200103\_Relativity\_Terran1\_CCAFS\_CX16\_EA\_BRRC\_Noise\_Model\_Technical\_Memo" you provided for our review.

The noise levels generated from commercial space launch vehicles model engine noise impacts is predicted using the Launch Vehicle Acoustic Simulation Model (RUMBLE), a fully featured time-simulation model developed by Blue Ridge Research and Consulting (BRRC).

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

# **APPENDIX D**

## **Biological Opinion**

# Biological Opinion

## For Relativity Launch Complex -16 At Cape Canaveral Air Force Station

FWS Log #: 04EF1000-2020-F-0399



Prepared by:

U.S. Fish and Wildlife Service  
North Florida Ecological Services  
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Jay B. Herrington - Field Supervisor

3/20/2020  
Date

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## CONSULTATION HISTORY

This section lists key events and correspondence during the course of this consultation. A complete administrative record of this consultation is on file in the U.S. Fish and Wildlife North Florida Ecological Services' Office (Service).

2019-10-18 – 45<sup>th</sup> Space Wing (SW) sent a biological assessment requesting formal consultation for southeastern beach mouse (*Peromyscus polionotus niveiventris*), eastern indigo snake (*Drymarchon corais couperi*).

2020-12-06- Air Force liaison and Service biologist had a call with the SW to discuss two projects, Space Florida Launch Complex-20, Relativity Launch Complex-16, and the proposed compensation. AF Liaison discussed swapping the proposed compensation to support southeastern beach mice habitat restoration near the launch pads and an opportunity to collaborate with Florida Fish and Wildlife Commission to monitor the beach mice near the launch facilities.

2020-01-24- The Service provided a tentative timeframe for the biological opinion (BO), end of February, and asked questions about species presence near or within the Action Area.

2020-01-27 – The Service sent a table that uses the information in BA to deconstruct the action, the new BO template, and a topic sheet on deconstructing the action.

2020-01-30 – The Service responded to SW regarding the determination for eastern indigo snake.

2020-02-04 - SW sent an email revising the effect determinations for two species, the eastern indigo snake determination to “may affect, but is not likely to adversely affect” and the Florida Scrub-Jay (*Aphelocoma coerulescens*) to “may affect, and is likely to adversely affect.”

2020-02-05 - SW sent an email with the proposed area for southeastern beach mouse habitat enhancement at land management unit 27.

2020-02-11- SW sent an email with the revised map for southeastern beach mouse habitat enhancement/restoration compensation. Habitat enhancement area is between Launch Complex-16 and Launch Complex-19.

2020-02-18 - The Service sent concurrence letter for the following species: eastern indigo snake, gopher tortoise, marine turtles: leatherback (*Dermochelys coriacea*), green (*Chelona mydas*), loggerhead (*Caretta caretta*), Kemps Ridley (*Lepidochelys kempii*), and hawksbill (*Eretmochelys imbricata*), West Indian manatee (*Trichechus manatus latirostris*), Wood stork (*Mytheria americana*), Piping Plover (*Charadrius melodus*), and Red knot (*Calidris canutus*). The letter also requested more information to support the effect determination for the Florida Scrub-Jay,

including a breakdown of projected days for operational closures, table with the habitat quality, and proposed habitat management targets.

2020-02-24- AF Liaison and Florida Scrub-Jay recovery biologist met with the SW and members of the space industry, including Relativity Space, to discuss future compatibility of prescribed fire habitat management and operations of the launch facilities.

2020-02-26 - SW revised the determination and sent supporting information to the Service. The supporting documentation for the determinations described that SW will establish an operational window for prescribed fire in the launch schedule.

2020-02-28 - The Service sent a letter to the SW concurring with the may affect, but is not likely to adversely affect determination for Florida Scrub-Jay and requested a 20-day extension for the BO.

2020-03-04 – Relativity Space and the SW agreed to the 20-day extension for the BO. The Service provided a draft project description of the proposed action for review.

2020-03-19 – The Service provided SW the complete draft to review.



## BIOLOGICAL OPINION

### 1. INTRODUCTION

A biological opinion (BO) is the document that states the opinion of the U.S. Fish and Wildlife Service (Service) under the Endangered Species Act of 1973, as amended (ESA), as to whether a Federal action is likely to:

- jeopardize the continued existence of species listed as endangered or threatened; or
- result in the destruction or adverse modification of designated critical habitat.

The Federal action addressed in this BO is the refurbishment of the Launch Complex 16, Relativity Launch Complex at Cape Canaveral Air Force Station (the Action). This BO considers the effects of the Action on the southeastern beach mice (*Peromyscus polionotus niveiventris*). The Action does not affect designated critical habitat; therefore, this BO does not address critical habitat.

The 45<sup>th</sup> Space Wing (SW) has determined that the Action may affect, but is not likely to adversely affect the eastern indigo snake (*Drymarchon corais couperi*), West Indian manatee (*Trichechus manatus latirostris*), Wood stork (*Mytheria americana*), Piping Plover (*Charadrius melodus*), and Red knot (*Calidris canutus*). The Service concurs with these determinations in a letter sent on February 18, 2020.

The SW revised the determination for the Florida Scrub-Jay (*Aphelocoma coerulescens*) to may affect, and is likely to adversely affect the species. The Service asked for more information to support the determination in the concurrence letter sent on February 18, 2020. SW revised the determination to may affect, but is not likely to adversely affect the Florida Scrub-Jay on February 26, 2020, and the Service concurred on February 28, 2020.

SW has determined that the Action may affect, and is likely to adversely affect nesting marine turtles: leatherback (*Dermochelys coriacea*), green (*Chelona mydas*), loggerhead (*Caretta caretta*), Kemps Ridley (*Lepidochelys kempii*), and hawksbill (*Eretmochelys imbricata*). The Service has analyzed programmatically the effects of facility lighting adjacent to nesting marine turtle habitat and has exempted incidental take under the BO, FWS Log. 2009-F-0087. The applicant and the SW have agreed to implement the measures outlined in the opinion and the Service has determined programmatically that such actions that implement all the terms and conditions of the BO will not jeopardize the continued existence of nesting marine turtles.

This BO uses hierarchical numeric section headings. Primary (level-1) sections are labeled sequentially with a single digit (e.g., 1. PROPOSED ACTION). Secondary (level-2) sections within each primary section are labeled with two digits (e.g., 1.1. Action Area), and so on for level-3 sections.

## **BO Analytical Framework**

A BO that concludes a proposed Federal action is *not* likely to *jeopardize the continued existence* of listed species and is *not* likely to result in the *destruction or adverse modification* of critical habitat fulfills the Federal agency's responsibilities under §7(a)(2) of the ESA.

*"Jeopardize the continued existence* means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR §402.02).

*"Destruction or adverse modification* means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR §402.02).

The Service determines in a BO whether we expect an action to satisfy these definitions using the best available relevant data in the following analytical framework (see 50 CFR §402.02 for the regulatory definitions of *action*, *action area*, *environmental baseline*, *effects of the action*, and *cumulative effects*).

- a. *Proposed Action*. Review the proposed Federal action and describe the environmental changes its implementation would cause, which defines the action area.
- b. *Status*. Review and describe the current range-wide status of the species or critical habitat.
- c. *Environmental Baseline*. Describe the condition of the species or critical habitat in the action area, without the consequences to the listed species caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early consultation, and the impacts of State or private actions which are contemporaneous with the consultation.
- d. *Effects of the Action*. Predict all consequences to species or critical habitat caused by the proposed action, including the consequences of other activities caused by the proposed action, which are reasonably certain to occur. Activities caused by the proposed action would not occur but for the proposed action. Effects of the action may occur later in time and may include consequences that occur outside the action area.
- e. *Cumulative Effects*. Predict all consequences to listed species or critical habitat caused by future non-Federal activities that are reasonably certain to occur within the action area.
- f. *Conclusion*. Add the effects of the action and cumulative effects to the environmental baseline, and in light of the status of the species, formulate the Service's opinion as to whether the action is likely to jeopardize species or adversely modify critical habitat.

## **2. PROPOSED ACTION**

The proposed action (Action) includes the refurbishment of existing facilities at Launch Complex 16 (LC-16), as well as new construction activities. Refurbishment of existing facilities will include the interior remodel of the existing Ready Building for new office space, interior remodel of the existing Block House structure for new instrumentation racks and workstations, reuse of the existing cable tunnel for running new conduit, and interior remodeling of the existing pad structure and buildings.

New construction will include the construction of a horizontal integration facility (hangar structure), a payload processing building, a LOX farm area, a LNG farm area, a LNG flare stack, a new high pressure gas storage area, a new water tank area, an environmental control system building and pad support building, new pad lightning protection poles, and a new parking lot. New construction will also include a steel launch mount structure, flame deflector, and noise suppression system.

External improvements include exterior retrofitting of the launch pad area to support Relativity Space's Terran 1 launch vehicle, as well as general existing site improvements that include roadway repairs and existing concrete surface repairs.

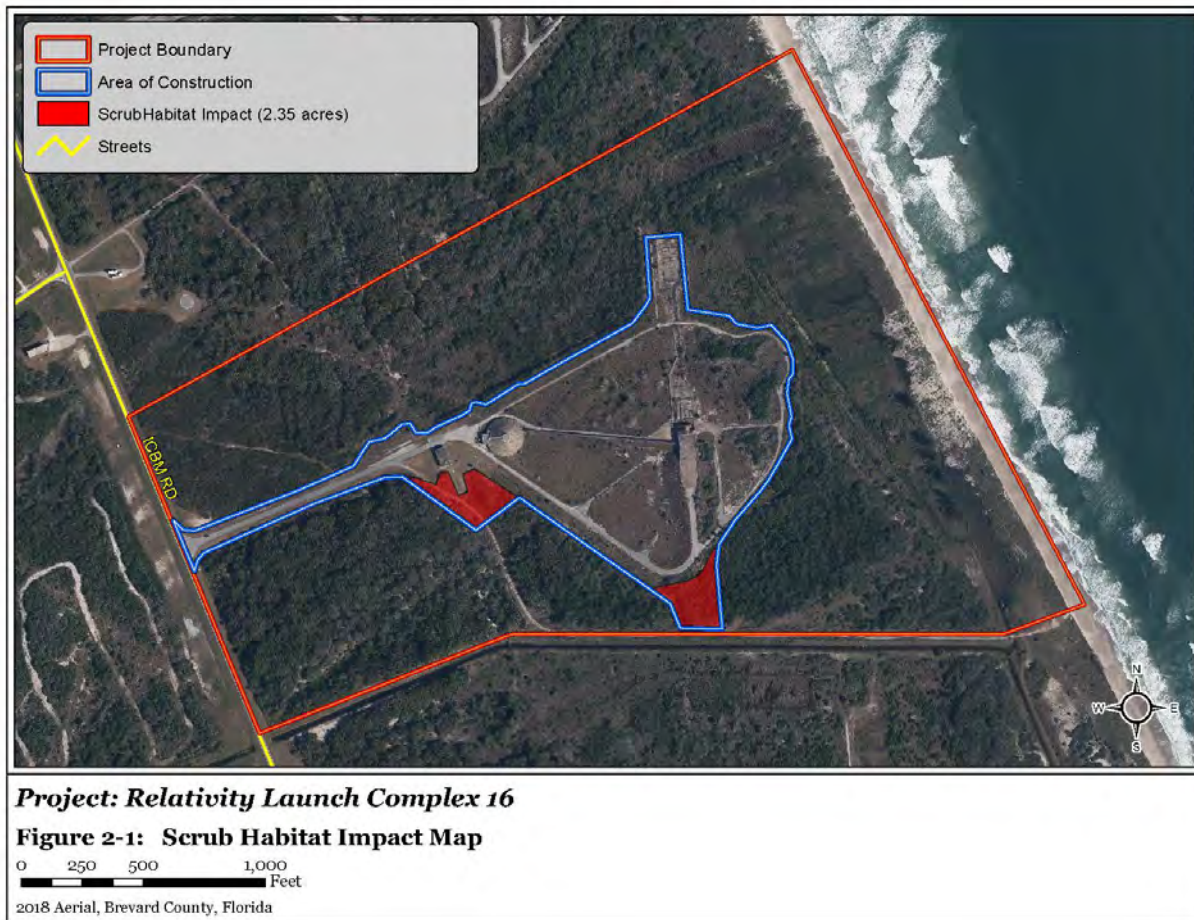
The following sections deconstruct the Action in three parts: Construction, Habitat Enhancement, and Operations.

### **2.1. Construction**

The LC-16 lease area is 138.5 acres but most of the area proposed for construction has been previously disturbed and developed in areas. The Action will reuse as much of the existing impervious concrete for planned roads and structures. Construction of the hangar structure, new payload processing building, and new parking lot area requires vegetation clearing and earthwork. The proposed area of construction, 33.91 acres, Figure 2-1, includes 2.35 acres is native coastal scrub or xeric oak habitat that will be cleared.

Within the area of construction there will be heavy machinery and staging areas for construction equipment. The limits within the area of construction will be cleared using heavy machinery. Cleared material will be placed in wheeled dump trucks for removal from that area. Once vegetation is removed from this area using heavy machinery, much of the site will be graded using large, heavy tracked bulldozers. Material will either be transferred to a suitable off-site area or burned on location in accordance with SW regulations as schedule and burn conditions permit. It is anticipated that all excavated soil will remain onsite within the area of construction. The duration of proposed construction activities is expected to be approximately 15 months.

Any new or improved roadway will be constructed of compacted soil and appropriate impervious pavement material to support large equipment.



**Figure 2-1. Boundary LC-16, area of construction, and proposed habitat removal**

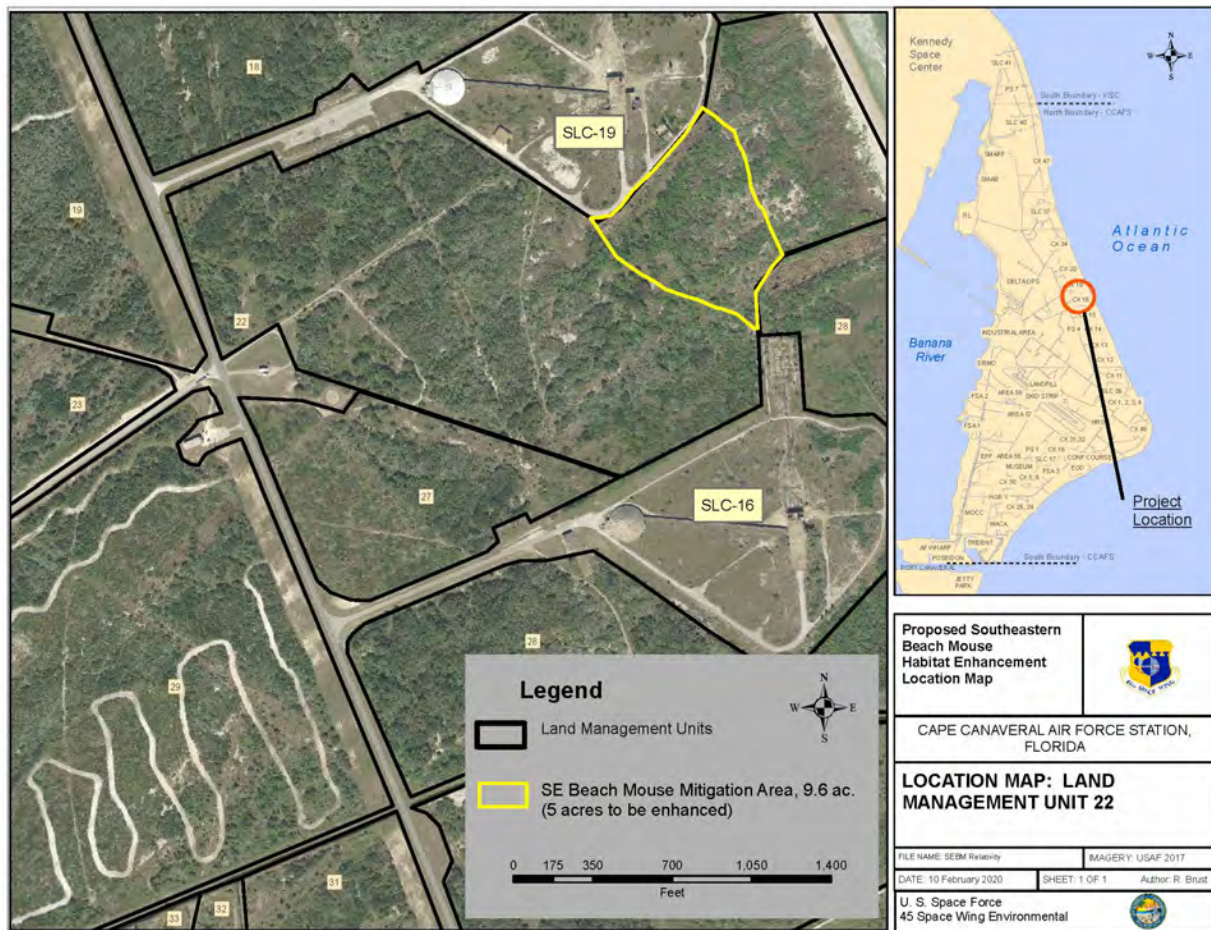
## **2.2. Southeastern Beach Mouse Habitat Enhancement**

The habitat enhancement for southeastern beach mouse (SEBM) will be done within a 9.5 acre plot (Figure 2-2). The exact acreage and methodology will be outlined in the scope of work. The SW, the Service, and Relativity Space will be collaborating on a scope of work for the proposed area that will focus on the following:

1. Improve the condition of the ecotone between the primary and secondary habitat, thus improving the condition of the seaward edge of the secondary habitat.
2. Provide corridors from the primary habitat into good and fair condition scrub and other landward habitats.

The scope of work may include track mechanical thinning or hand clearing of coastal scrub habitat and clearing to create corridors to landward scrub habitat. Vegetation will either be removed to a suitable off-site area or incinerated on location in accordance with SW regulations as schedule and conditions permit.





**Figure 2-2. The proposed SEBM habitat enhancement area outlined yellow**

## 2.3. Operations

Relativity may conduct pre-launch testing with the potential to result in a hazard area which exceeds the launch pad boundaries (i.e. outside the fence line) and drives the need to establish procedural controls to ensure the safety of the general public and non-related personnel.

Up to three launches of the Terran 1 orbital launch vehicle will occur in the year of 2021, ramping up to six launches in the year of 2022, and up to 12 launches per year beginning in 2023. Dependent on mission requirements, launches could occur during daylight hours or during nighttime hours. Nighttime hour launching will require operational lighting to support the mission. Launches from LC-16 would require public access controls be put in place to ensure the public remains a safe distance from the launch vehicle during its entire flight.

To maintain the vegetation adjacent to the facility roadways and within the improved areas of LC-16 (area of construction limits in Figure 2-1), standard large-scale grass mowing equipment will be used on a periodic basis. Vegetation will be maintained to about 3 to 5 inches in height in this area.

## **2.4. Other Activities Caused by the Action**

A BO evaluates all consequences to species or critical habitat caused by the proposed Federal action, including the consequences of other activities caused by the proposed action, that are reasonably certain to occur (see definition of “effects of the action” at 50 CFR §402.02). Additional regulations at 50 CFR §402.17(a) identify factors to consider when determining whether activities caused by the proposed action (but not part of the proposed action) are reasonably certain to occur. These factors include, but are not limited to:

- (1) past experiences with activities that have resulted from actions that are similar in scope, nature, and magnitude to the proposed action;
- (2) existing plans for the activity; and
- (3) any remaining economic, administrative, and legal requirements necessary for the activity to go forward.

In its request for consultation, the SW did not describe, and the Service is not aware of, any additional activities caused by the Action that are not included in the previous description of the proposed Action. Therefore, this BO does not address further the topic of “other activities” caused by the Action.

## **2.5. Action Area**

The action area is defined as “all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action” (50 CFR §402.02). Delineating the action area is necessary for the Federal action agency to obtain a list of species and critical habitats that may occur in that area, which necessarily precedes any subsequent analyses of the effects of the action to the species or critical habitats.

It is practical to treat the action area for a proposed Federal action as the spatial extent of its direct and indirect “modifications to the land, water, or air” (a key phrase from the definition of “action” at 50 CFR §402.02). Indirect modifications include those caused by other activities that would not occur but for the action under consultation. The action area determines any overlap with critical habitat and the physical and biological features therein that we defined as essential to the species’ conservation in the designation final rule. For species, the action area establishes the bounds for an analysis of individuals’ exposure to action-caused changes, but the subsequent consequences of such exposure to those individuals are not necessarily limited to the action area.

Figures 2-1 and 2-2 shows the locations of all activities that the proposed Action that would cause changes to land, water, or air caused by these activities. The action area for this BO is the LC- 16 lease area boundary, 138.5 acres, of which 33.91 acres is the proposed area of construction - and the proposed 9.5 acre habitat enhancement area.

### **3. SOURCES OF CUMULATIVE EFFECTS**

A BO must predict the consequences to species caused by future non-Federal activities within the action area, *i.e.*, cumulative effects. “Cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation” (50 CFR §402.02). Additional regulations at 50 CFR §402.17(a) identify factors to consider when determining whether activities are reasonably certain to occur. These factors include, but are not limited to: existing plans for the activity; and any remaining economic, administrative, and legal requirements necessary for the activity to go forward.

In its request for consultation, the SW did not describe, and the Service is not aware of, any future non-Federal activities that are reasonably certain to occur within the action area. Therefore, we anticipate no cumulative effects that we must consider in formulating our opinion for the Action.

### **4. STATUS OF SOUTHEASTERN BEACH MOUSE**

This section summarizes best available data about the biology and current condition of the throughout its range that are relevant to formulating an opinion about the Action. Most of this information is taken directly from the draft Status Species Assessment (SSA) that is currently under peer-review.

The Service published its decision to list the southeastern beach mouse (SEBM) as threatened species under the Act in 1989 (54 FR 20598). Critical habitat is not designated for this subspecies, and therefore will not be analyzed in this opinion.

#### **4.1. Species Description**

The SEBM is one of 16 recognized subspecies of old field mice *Peromyscus polionotus* (Hall 1981); it is one of the eight of those subspecies that are called beach mice. The SEBM is a small mouse that reaches an average length of 136 mm with an average body mass of 14.5 g (Stout 1992). Southeastern beach mice have pale, buffy coloration from the back of their head to their tail, and their underparts are white.

#### **4.2. Life History**

SEBM are generally nocturnal, semifossorial, and monogamous. The subspecies occupies foredunes (*i.e.*, frontal, primary, and secondary), transitional (*i.e.*, coastal grasslands and coastal strand) dunes, coastal scrub dunes. SEBM also occur in interior scrub and other landward habitats, though the extent to which these areas utilized is unclear. Below is a summary of the

various elements of the SEBM life history, including reproduction, survival and mortality, foraging, home range, burrowing behavior, and habitat.

#### **4.2.1. Survival and Mortality**

The average life span of beach mice in the wild is 9 months to one year (Bird et al. 2016, Oddy 2000, Swilling 2000), although a few individuals have been known to live longer than two years. Studies at CCAFS found the mean longevity of SEBM on across study grids was 113 days with no significant differences between sexes (Oddy 2000). Maximum longevity in this study was 596 days. Swilling and Wooten (2002) found longer persistence times associated with mice dispersing further away from their natal home range, perhaps a result of reduced predation rates.

#### **4.2.2. Foraging**

Beach mice are food generalists and feed on a variety of seeds of dune and scrub plants and insects (Moyers 1996, Sneckenberger 2001, Keserauskis 2007).

Studies show that the diet of the SEBM varies seasonally and among and within habitats, and fruits, seeds and arthropods that feed on them comprise most of their diet (Keserauskis 2007).

In most cases, fruits and seeds that are consumed by beach mice are produced by low growing, prostrate plants, on supple stems easily manipulated by mice, or as the fruits and seeds become available as fallen seeds (Moyers 1996). Beach mice also consume invertebrates, especially during late winter or early spring when seeds are scarce (Ehrhart 1978).

#### **4.2.3. Home Range**

Beach mouse home range size varies among subspecies (USFWS 2010) and may vary seasonally and in relation to density as well as habitat and food resources. Beach mouse home ranges average approximately 1.2 acres (Bird 2016). Swilling and Wooten (2002) found the mean home range for Anastasia beach mice (ABM) (both sexes) was approximately 0.89 acres, whereas using radio telemetry data, Lynn (2000) found home ranges of 1.68 acres and 1.73 acres for males and females respectively; neither study noted significant differences in home range size between males and females.

Blair (1951) found home ranges of beach mice living in the comparatively dense cover of the beach dunes averaged significantly larger in the spring than in the fall. Beach mice tend to inhabit a single home range throughout their lifetime and will often maintain several burrows within their home range (Blair 1951). Extine and Stout (1987, USFWS 1999) reported movements of the SEBM between the primary dunes and interior scrub on Kennedy Space Center (KSC) and Merritt Island National Wildlife Refuge (MINWR) and concluded that home ranges can overlap and reach high densities within preferred habitats.



#### 4.2.4. Burrows

While multiple species of *Peromyscus* will excavate burrows, *P. polionotus* is the only member of the genus that excavates its own burrow, which is extensive (Ehrhart 1978, USFWS 1999). Beach mice are semifossorial, and may utilize as many as 20 burrows within their home range (USFWS 1999). Beach mice will use burrows as a place to rest during the day and between nightly foraging bouts. Burrows are also used for escape from predators, birthing and caring for young.

Burrows generally consist of an entrance tunnel, nest chamber, and escape tunnel (Weber et al. 2013). High predation risk and the harsh coastal environment make selection of quality burrow sites critical for survival of beach mice (Swilling and Wooten 2002). Beach mice have been found to select burrow sites based on a suite of biotic and abiotic features. (Lynn 2000; Sneckenberger 2001).

Bird et al. (2004) in a study exploring the effects of artificial illumination on the behaviors of beach mice found that patch use was affected by the presence of illumination, light type, and distance from light source. In this study, foraging frequency was significantly higher in dark arrays and that more seeds were removed from resource patches as distance from illumination increased. This is consistent with the observation that beach mice activity decreases in response to increased levels of moonlight due to elevated risk perceptions (Stoddard et al. 2018).

#### 4.2.5. Habitat

Beach mouse habitat includes a heterogeneous mix of interconnected coastal communities on barrier islands. Holler (1992) described beach mouse habitat at the time as including primary and secondary dunes vegetated by sea oats, beach grass (*Panicum amarum*), and blue stem (*Andropogon maritimus*). Contemporary understandings of the geographic distribution of beach mouse habitat is that beach mice inhabit coastal dune, strand, and scrub habitats (where available) that range from being comprised mostly of grasses to mostly shrubs (Sneckenberger 2001, Suazo et al. 2009, Stout et al 2012, Wilkinson et al. 2012, Breining et al. 2018). Additionally, the coastal strand and scrub plant communities (e.g. Cape Canaveral area) likely serve as refugia for and sources of individuals that disperse into dune systems after storm events (Stout et al. 2012).

Coastal communities of Florida can be classified into three general zones. These zones, as described by Johnson and Barbour (1990) and used in the draft Species Status Assessment include **foredunes** (frontal, primary, and secondary), **transitional dunes** (coastal grasslands and strands), and **coastal scrub dunes**. Additionally, beach mice are known to utilize adjacent or connected landward habitats including **interior scrub** (particularly within the Cape Canaveral), ruderal or old-field environments, and mowed roadside edges and rights-of-way.

**Foredunes** occur in the zone nearest the shoreline, but beyond the limits of the forces of annual wave action (Johnson and Barbour 1990) and include dunes frequently referred to as frontal, primary, and secondary. There is considerable uncertainty regarding optimal ranges of habitat conditions for SEBM in foredune areas. Given the differences in beach mouse habitats between

the Gulf and Atlantic coasts, additional research is needed to accurately define optimal habitat conditions within foredune areas specific to SEBM.

**Transitional dunes** are in the zone situated between the foredunes and more distinct natural communities such as coastal scrub or maritime hammock (FNAI 2010). Transitional dunes may include herbaceous natural communities such as coastal grasslands as well as areas with a higher prevalence of woody plants such as coastal strand.

**Coastal scrub dunes** are typically located behind the foredunes. In addition to the shrubbier form of live oak, plant assemblages in this community include myrtle oak (*Q. myrtifolia*), saw palmetto, and yaupon holly (*Ilex vomitoria*) (Kurz 1942, Johnson and Barbour 1990) within a matrix of open sand areas. The low stature of coastal scrub is maintained via the effects of salt spray to terminal buds of plants (Johnson and Barbour 1990). Similarly, to inland scrub habitats (described below), periodic fires are integral to the maintenance of coastal scrub systems. In the absence of fire or in combination with fire, mechanical treatments may be used to manipulate the structure of vegetation within scrub communities.

While the predominance of SEBM occurrence within scrub type habitats is in the coastal scrub dunes, SEBM are known to occur in more interior scrub environments within the Cape Canaveral Complex. The cape feature at Cape Canaveral is unique among SEBM habitats as it includes a broad expanse of upland habitats between the Atlantic coast and the Banana and Indian Rivers. Beyond the Cape Canaveral, SEBM habitat generally occurs in narrow stretches along the shoreline.

While seasonally abundant, the availability of food resources in the foredunes fluctuates (Sneckenberger 2001). In contrast, the scrub habitat provides a more stable level of food resources, which becomes crucial when food is scarce or nonexistent in the primary and secondary dunes. Furthermore, the coastal scrub dunes appear to serve as refugia for beach mice during and after tropical storm events (Holliman 1983, Swilling et al. 1998), from which recolonization of the foredunes takes place (Swilling et al. 1998, Sneckenberger 2001). This suggests that access to primary, secondary, and coastal scrub habitat is essential to beach mice at the individual and population levels and to some extent at the range wide level. Additionally, studies have found no detectable differences between scrub and frontal dunes in beach mouse body mass, home range size, dispersal, reproduction, survival, food quality, and burrow site availability (Swilling et al. 1998, Swilling 2000, Sneckenberger 2001). It should be noted that the presence of “scrub” habitat with or without storm events as a driving factor for SEBM is known only for the Cape Canaveral area and portions of the panhandle; the entire dune system of the CNS and other areas of SEBM habitat mostly lack this feature.

Beyond the foredunes, transitional areas and coastal scrub, barrier islands often grade into stabilized dunes where shrubby plant communities give way to canopied forests. Stable dune areas may include maritime hammocks and forests that are not considered suitable beach mouse habitat. SEBM rarely, if ever, occur in areas where woody vegetation >2m is dominant (Stout 1992). Additionally, while Toombs’ (2001) captured SEBM in the primary dunes and none were captured in dense areas of saw palmetto where it may be more difficult to burrow, this does not

appear to be representative of occupancy of SEBM within the Cape Canaveral Complex in more dense and unmanaged coastal habitats (Oddy personal communication, 2019). There is research that provides evidence of long-term occupancy of interior scrub habitats by SEBM within the CCAFS (Stout 1979, Suazo et al. 2009, Simmons 2008).

The three general zones can be classified into two habitat classes for SEMB. **Primary habitat** identifies the characteristic dune habitats typically occupied by SEBM (foredunes, transitional dunes, and coastal scrub dunes). **Secondary habitats** include interior scrub and other natural and human-altered landscapes landward of the dunes that provide critical refugia habitat and may support SEBM resource needs, may provide movement corridors, or may support an extension of a population.

### **4.3. Numbers, Reproduction, and Distribution**

#### **4.3.1. Numbers and Distribution**

SEBM are found in coastal habitats of Florida's east coast. The 1989 Final Listing Rule states that the subspecies was known to occur on Canaveral National Seashore (CNS), MINWR, CCAFS, the north and south ends of Orchid Island at Sebastian Inlet area and Fort Pierce Inlet State Park (also known as north Hutchinson Island) on the north side of Ft. Pierce Inlet.

The Recovery Plan for the Anastasia Island Beach Mouse and the Southeastern Beach Mouse (USFWS 1993) described the limits of occurrence of SEBM from Volusia County at Canaveral National Seashore south to 7 miles north of the Brevard County line and including scattered localities in Indian River County, and St. Lucie County. At the time of listing, in areas south of St. Lucie Inlet, nearly all dune habitat was developed and unsuitable for beach mice (USFWS 1988). Some potentially suitable habitat remains within public conservation lands on Jupiter Island, St. Lucie Inlet Preserve State Park, Hobe Sound National Wildlife Refuge and in Palm Beach County at John D. MacArthur Beach State Park.

In the draft SSA, the Service reviewed the extant and historic distribution of the species range wide and grouped the populations into geographic segments: Canaveral North, Canaveral South, Orchid Island/ Hutchinson Island North, Hutchinson Island, Jupiter Island, Jupiter South, Palm Beach, Boynton, and Hillsboro. The geographic segments are illustrated in Figure 4-1. and includes inlet locations associated with limits of historic range (light grey box), limits of range at the time of federal listing (1989; medium grey box), current range where two extant populations are known to occur (dark grey box), and areas of uncertain occupancy (red dashed lines).

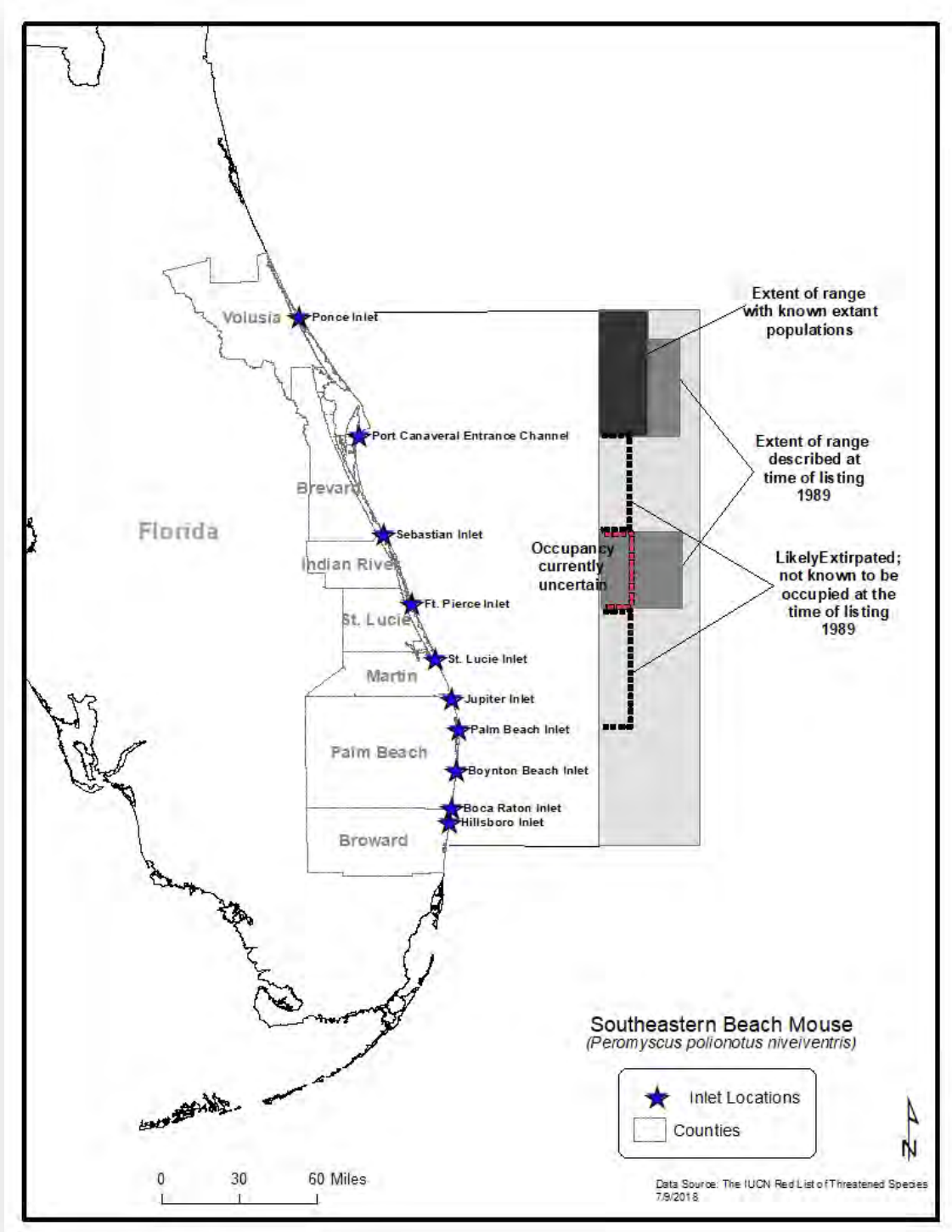


FIGURE 4.1 SEBM RANGE MAP – Extant and Likely Extirpated.

To assess current condition of the species, the draft SSA characterizes the amount of primary and secondary habitat within the geographic segments across the range of species. The geographic segments are parsed in eight different resilience units. The Canaveral Complex resilience unit is the most important for the recovery of the species.

The Canaveral Complex Unit is a metapopulation and has the most habitat to support the species. The Canaveral Complex has 89% of the total protected habitat, with the most acres of primary habitat, 3,377 acres, and 11,897 secondary habitats. Within the secondary habitat, the natural communities within occur at a fine-scale mosaic of conditions that may or may not be suitable for SEBM.

#### **4.3.2. Reproduction**

Beach mice have a monogamous mating system (Blair, 1951, Smith 1966, Lynn 2000). Mated pairs tend to remain associated in acquiring food and sharing burrows (Blair 1951). Beach mice reach sexual maturity at 55 days of age; however, some mice are capable of breeding earlier (Ehrhart 1978).

Peak breeding season for beach mice appears to occur between November and early January (Blair 1951) and appears to coincide with increased availability of food from the previous growing season (Rave and Holler 1992); although pregnant and lactating SEBM have been observed in all seasons (Stout 1979, Oddy et al. 1999, Oddy 2000, Bard personal communication, 2019).

While the reproductive potential of beach mice is generally high, Blair (1951) reported only 19.5 percent of beach mice within his study survived from January to May in the same year indicating that mortality of adult beach mice is also quite high.

### **4.4. Conservation Needs and Threats**

#### **4.4.1. Conservation Needs**

There is considerable uncertainty regarding beach mouse use of the scrub and more stable, interior habitats, particularly within the CCAFS. Future research is needed to better define optimal habitat conditions for SEBM in coastal scrub and interior scrub habitats. Habitat conditions within the interior scrub areas that benefit the threatened Florida Scrub-jay (*Aphelocoma coerulescens*) may also benefit SEBM (Suazo et al. 2009). While ranges of habitat conditions occur as a result of management regimes and techniques, optimal habitat conditions for Florida Scrub-jays within the interior scrub within the Canaveral Complex includes a more open habitat structure (Breininger 1992, Breininger et al. 2003, USFWS 2007) that is ideally maintained with use of periodic prescribed fire. Optimal fire-return intervals may be shorter in coastal scrub habitats than in more interior locations (Schmalzer and Hinkle 1992), which may result in less desirable SEBM conditions in the more interior areas. Depending on the matrix of vegetation within the coastal scrub and adjacent habitats, fire return frequencies vary from 3 to

10 years (USFWS 2007). In the absence of fire, the cover and stature of woody vegetation increases, often resulting in the loss of open areas.

#### **4.4.2. Threats**

Habitat loss and fragmentation due to destruction associated with residential and commercial development has created disjunct and isolated populations of SEBM along the east coast of Florida. South of the Port Canaveral Entrance Channel, five inlets between Indian River and Broward Counties create additional barriers to dispersal. Most remaining SEBM habitat occurs on public conservation lands, though some private lands also support areas of natural dune vegetation that could be occupied by beach mice (e.g. St. Lucie Nuclear Power Plant, undeveloped lots, and undeveloped portions of residential and commercial lots). As a result, extant populations of SEBM are geographically and thus genetically, isolated. Within the current landscape configuration, natural dispersal between existing populations is highly unlikely.

Other threats to the species include shoreline armoring to protect coastal properties from erosion, coastal lighting at facilities or residential development, vehicular or foot traffic near developments, and climate change.

### **5. ENVIRONMENTAL BASELINE FOR SOUTHEASTERN BEACH MICE**

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the southeastern beach mice its habitat, and ecosystem within the action area. The environmental baseline is a “snapshot” of the species’ health in the action area at the time of the consultation and does not include the effects of the Action under review.

#### **5.1. Action Area Numbers, Reproduction, and Distribution**

At CCAFS mice typically occur from the coastal dunes inland to the west side of Samuel C. Phillips Parkway, and are generally found where the sand is suitable for burrows, coastal scrub is present, and the water table is not close to the surface. SEBM have also been documented inside facilities throughout CCAFS. Inland populations abundance varies from site to site inland of the dune system. Nearly every coastal scrub site surveyed on CCAFS supports beach mice. The SW collects SEBM presence data via tracking tubes. The action area has a tracking tube detection station within primary habitat, station 24. This station has had detections in 4 of the 9 years sampled (2011, 2012, 2014, 2018).

Using the GIS layer created for the draft SSA, we reviewed distribution the primary and secondary habitat within the action area (Figure 5.1). The lease area is 138.5 acres with 9 acres of primary habitat (foredunes), and 39 acres secondary habitat (human altered habitat landward of the dune). The area of construction has about 3 acres of secondary habitat, mostly found on the entrance road and around the launch facility structures.

To estimate the number of individuals within the action area, we reviewed home range data and acres of habitat. Beach mouse home ranges average approximately 1.2 acres (Bird 2016), .89 acres for both male and female (Swilling and Wooten 2000), and 1.68 acres and 1.73 acres for males and females respectively (Lynn 2000). Using the 9 acres of primary habitat (light blue), we estimate the action area has between 4 – 10 individuals. We expect those individuals may utilize the secondary habitat (pink) and the coastal scrub (red) for foraging, burrows, and travel corridors.

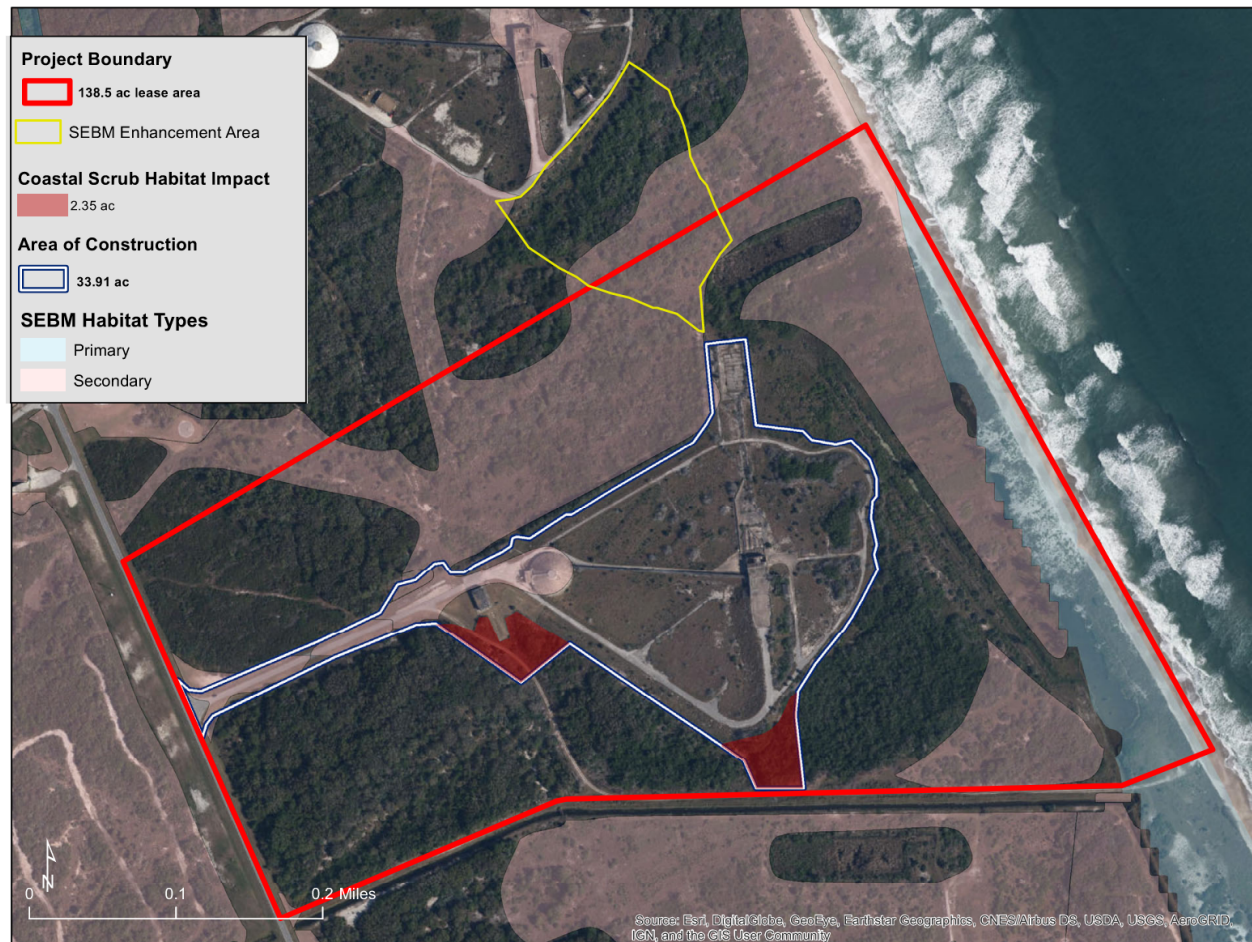


Figure 5-1. Habitat types (primary and secondary) within the action area

## 5.2. Action Area Conservation Needs

The proposed construction area for LC-16 is situated 425 feet west of the beach dune area; outside the primary SEBM habitat. The eastern edge (outside the defined area of construction) has beach dune systems dominated by sea oats. The coastal scrub encompasses much of the eastern portion of LC-16. Figure 5-1 shows the habitat types within the action area.

To support SEBM, the coastal scrub should be managed, particularly areas that connect to seaward edge of the secondary habitat. Restoration and management of the primary and



secondary habitat may provide increased connectivity, allow for storm refugia, and diverse forage.

SEBM are at increased risk to predation and modify their foraging behavior when exposed to artificial lighting. Lighting should be managed to protect coastal species including SEBM which are vulnerable to excessive coastal lighting.

## **6. EFFECTS OF THE ACTION ON SOUTHEASTERN BEACH MICE**

In a BO for a listed species, the effects of the proposed action are all reasonably certain consequences to the species caused by the action, including the consequences of other activities caused by the action. Activities caused by the action would not occur but for the action. Consequences to species may occur later in time and may occur outside the Action Area.

We identified and described the activities included in the proposed Action in sections 2.1–2.3. Our analyses of the consequences caused by each of these activities follows.

### **6.1. Facility Construction and Refurbishment**

Construction activities will include heavy equipment to clear coastal scrub and xeric oak in inland areas. The consequences of the action, i.e. removing suitable habitat where the species is known to be present, will likely result in the destruction of secondary habitat that may support resource needs such as foraging and a movement corridor. The habitat could also support burrows and nesting. Construction duration, approximately 15 months, will cover at least one peak breeding season (November –January), possibly two depending on when construction starts.

Based on plans for construction, clearing 2.35 acres of coastal scrub and xeric oak is required for facility construction. The Service expects harm to any individuals or destruction of burrows during clearing activity. Individuals may also be harmed if they are utilizing the 3 acres of secondary habitat within the construction area. We anticipate not all the species within the action area will be exposed to the effects based on the location of the work and habitat type (e.g. outside of the dune or primary habitat). Using action area baseline estimates outlined in section 5.1, we expect no more than two monogamous pair and nestlings will be exposed to the consequences of the action where the coastal scrub clearing will occur. There is also some risk that construction activities within the 33.91 acres of the project area may adversely affect the SEBM that may be using the area as a movement corridor. However, most, if not all, of the construction will occur within the daytime periods when mice are typically inside burrowing habitat and not out moving within the habitat.

The scale of the action area is a small fraction of the geographic segment of the Canaveral Complex Unit. The loss of up to four individuals will not result in adverse population effects or reduce appreciably the species' likelihood of survival and recovery. Additionally, the refurbishment of the launch facility and loss of coastal scrub will not place barrier for species movement, a threat to the species described in section 4.4. After construction activities, we



expect the species will have access and can use the secondary habitat within the lease area as a corridor for movement, refugia, or forage opportunities.

To set a standard for determining when the level of anticipated take has been exceeded, the Service can establish a causal link to habitat clearing (e.g., coastal scrub) to the harm or “taking” of the species. The linking of this habitat type within the action area will allow the Service to have a clear standard for determining when the level of anticipated take has been exceeded.

## **6.2. Southeastern Beach Mouse Habitat Enhancement**

The purpose of the SEBM habitat enhancement plan is to address the conservation needs of the species within the action area. The habitat enhancement plan and monitoring shall be developed with the Service, Florida Fish and Wildlife Conservation Commission (FWC), and SW with support of Relativity Space. The plan will include an FWC monitoring component to monitor how the species is using the coastal scrub habitat between the space launch facilities.

The removal dense woody vegetation and coastal scrub management will allow for species movement and increase forage quality in the secondary habitat. If project timing allows, the Service is recommending that the habitat enhancement area serve as a recipient site for mice found within the construction area (described in Section 8, Conservation Recommendations). The recommendation includes saturation trapping of SEBM in areas that are slated for construction, roadways or anywhere habitat modification shall occur. To minimize adverse effects to the species, saturation trapping should be completed by a qualified biologist, thus minimizing the likelihood that the species is harmed via trapping or relocating activities. Because we anticipate that several individuals would be harmed during construction, the salvaging all individuals via trapping and moving the newly restored area would be a net benefit to the species.

If salvage activities cannot occur due to project timelines or the timeline of the habitat restoration component, the restoration and enhancement of coastal scrub will still provide a net benefit to the species and addresses the conservation needs of the species range wide and within the action area.

## **6.3. Operations**

SEBM have been documented inside facilities throughout CCAFS, the SW has a Programmatic BO that covers pest management activities within and around such facilities. Per the Programmatic BO, Relativity Space will be required to live trap and release mice within and around its facilities on LC-16.

During facility operations, rocket launches may startle SEBM, and noise associated with landing, though not as loud, may do the same. Noise impact to wildlife is expected to be minimal and discountable. Current and past launch programs at CCAFS, the Atlas, Titan, and Delta launches did not document any animal mortality associated with noise.

Operational lighting at the facility may have adverse effects to the species by disrupting foraging behavior. Nighttime launches and the lighting needed to support these events will have some adverse effects, but it is anticipated not to last more than a few days to support the launch activity. We expect that the lighting will be managed to standards outlined in the Programmatic Sea Turtle Biological Opinion, 2009-F-0087 and conform to the SW Instruction 32-7001. This will minimize lighting and restrict lighting visible to the beaches during sea turtle nesting season (1 May through 31 October). Beach mice will likely benefit from these restrictions, but the period does not cover the wintertime, a peak period for SEBM.

## **7. CONCLUSION**

*“Jeopardize the continued existence”* means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02). After reviewing the current status of the species, the environmental baseline for the Action Area, the effects of the Action and the cumulative effects, it is the Service’s BO that the Action is not likely to jeopardize the continued existence of the southeastern beach mice.

The Service has come to this conclusion based on the following:

- The loss of up to four individuals within the action area will not result in adverse population effects or reduce appreciably the species’ likelihood of survival and recovery.
- The refurbishment of the launch facility and loss of coastal scrub will not place barrier for species movement that will preclude or delay recovery goals.
- After construction activities, we expect the species will access and use the remaining or newly restored secondary habitat within the lease area as a corridor for movement, refugia, or forage opportunities.
- Restoration of coastal scrub addresses conservation needs of the species within the action area and recovery needs for the species range wide.

## **8. INCIDENTAL TAKE STATEMENT**

ESA §9(a)(1) and regulations issued under §4(d) prohibit the take of endangered and threatened fish and wildlife species without special exemption. The term “take” in the ESA means “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct” (ESA §3(19)). In regulations, the Service further defines:

- “harm” as “an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering;” (50 CFR §17.3) and

- “incidental take” as “takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant” (50 CFR §402.02).

Under the terms of ESA §7(b)(4) and §7(o)(2), taking that is incidental to a Federal agency action that would not violate ESA §7(a)(2) is not considered prohibited, provided that such taking is in compliance with the terms and conditions of an incidental take statement (ITS).

The Action considered in this BO includes the refurbishment of the SLC-16, Relativity Launch Complex at Cape Canaveral and the SEBM habitat enhancement area. This BO considers the effects of the Action on the southeastern beach mice (*Peromyscus polionotus niveiventris*). The Action does not affect designated critical habitat; therefore, this BO does not address critical habitat.

For the exemption in ESA §7(o)(2) to apply to the Action considered in this BO, the SW and the Relativity Space must undertake the non-discretionary measures described in this ITS, and these measures must become binding conditions of any permit, contract, or grant issued for implementing the Action. Consistent with ESA section 7(b)(4)(C)(iv), the SW has a continuing duty to regulate the Action activities covered by this ITS that are under its jurisdiction. The Applicant is responsible for the Action activities covered by this ITS that are under its control and are not under SW jurisdiction. The protective coverage of §7(o)(2) may lapse if the SW or Relativity Space fails to:

- assume and implement the terms and conditions; or
- require a permittee, contractor, or grantee to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit, contract, or grant document.

In order to monitor the impact of incidental take, the 45<sup>th</sup> SW and Relativity Space must report the progress of the Action and its impact on the species to the Service as specified in this ITS.

## 8.1. Amount or Extent of Take

This section specifies the amount or extent of take of listed wildlife species that the Action is reasonably certain to cause, which we estimated in the “Effects of the Action” section of this BO. Table 8-1 identifies the species, life stage(s), estimated number of individuals, the form of take anticipated, and the section of the BO that contains the supporting analysis.

**Table 8-1.** Estimates of the amount of take (# of individuals) caused by the Action, by species, life stage, and form of take, collated from the cited BO effects analyses.

Common Name	Life Stage	# of Individuals	Form of Take	BO Effects Analysis Section
Southeastern Beach Mice	ALL	4 plus any nestlings that may be in the	Harm	6.1

		burrows that are collapsed during time of construction		
Southeastern Beach Mice	Adult or Juvenile	10*	Capture	6.2

\* Capture may occur only if the Conservation Recommendations are undertaken by the SW. This is the estimated number of species within the entire action area, section 5.1, and capture success will likely to be less within the coastal scrub habitat where the construction actions will occur.

### **Surrogate Measures for Monitoring**

For the SEBM, detecting take that occurs incidental to the Action is not practical. SEBM are semi-fossorial during the day so locating all individuals within the area slated for construction is impractical. However, we do know that 2.35 acres of coastal scrub habitat will be impacted where beach mice are reasonably certain to occur. The Service will monitor take using the loss of this habitat as the surrogate.

When it is not practical to monitor take in terms of individuals of the listed species, the regulations at 50 CFR §402.14(i)(1)(i) indicate that an ITS may express the amount or extent of take using a surrogate (*e.g.*, a similarly affected species, habitat, or ecological conditions), provided that the Service also:

- describes the causal link between the surrogate and take of the listed species; and
- sets a clear standard for determining when the level of anticipated take has been exceeded.

We have identified surrogate measures in our analyses of effects that satisfy these criteria for monitoring take of the species named above during Action implementation. Table 8-2 lists the species, life stage, surrogate measure, and the section of the BO that explains the causal link between the surrogate and the anticipated taking. We describe procedures for this monitoring in section 8.4.

**Table 8-2.** Surrogate measures for monitoring take of listed wildlife species caused by the Action, based on the cited BO effects analyses.

Common Name	Life Stage	Surrogate (units)	Quantity	BO Effects Analysis Section
Southeastern Beach Mice	All	Coastal scrub acres	2.35	6.1

## **8.2. Reasonable and Prudent Measures**

The Service believes that no reasonable and prudent measures are necessary or appropriate to minimize the impact, *i.e.*, the amount or extent, of incidental take of southeastern beach mice caused by the Action. Minor changes that do not alter the basic design, location, scope, duration, or timing of the Action would not reduce incidental take below the amount or extent anticipated for the Action as proposed. Therefore, this ITS does not provide RPMs for these species.

## **8.3. Terms and Conditions**

No reasonable and prudent measures to minimize the impacts of incidental take caused by the Action are provided in this ITS; therefore, no terms and conditions for carrying out such measures are necessary.

## **8.4. Monitoring and Reporting Requirements**

In order to monitor the impacts of incidental take, the SW must report the progress of the Action and its impact on the species to the Service as specified in the incidental take statement (50 CFR §402.14(i)(3)). This section provides the specific instructions for such monitoring and reporting. As necessary and appropriate to fulfill this responsibility, the SW must require any permittee, contractor, or grantee to accomplish the monitoring and reporting through enforceable terms that are added to the permit, contract, or grant document. Such enforceable terms must include a requirement to immediately notify the SW and the Service if the amount or extent of incidental take specified in this ITS is exceeded during Action implementation.

**M&R 1. Reporting Coastal Scrub (ac) Cleared** After construction is completed, report to the Service the sum (in acres) of coastal scrub habitat that was modified or cleared within the area of construction.

**M&R 2. Disposition of Dead or Injured** Upon locating a dead, injured, or sick threatened or endangered species, notification must be made to the North Florida Ecological Services Field Office at 904-731-3336 and by email to Jaxregs@FWS.gov within 24 hours. If an injured or sick specimen is found and North Florida Ecological Services Field Office staff is unable to be reached, contact the Florida Fish and Wildlife Conservation Commission Wildlife Alert Hotline at 1-888-404-3922.

Care should be taken in handling dead specimens to ensure biological material is preserved in the best possible state for later analysis as to the cause of death. If a dead specimen is found in the project area, the specimen should be thoroughly soaked in water and frozen for later analysis of cause of death. In conjunction with the preservation of biological materials from a dead animal, the finder has the responsibility to carry out instructions provided by Law Enforcement to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.

## **9. CONSERVATION RECOMMENDATIONS**

§7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by conducting conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary activities that an action agency may undertake to avoid or minimize the adverse effects of a proposed action, implement recovery plans, or develop information that is useful for the conservation of listed species.

1. Salvage any SEBM that would otherwise be harmed by the action.  
If project timing allows, complete the habitat enhancement before clearing the coastal scrub at LC-16. The habitat enhancement area would serve as a recipient site for SEBM residing within the construction area. Saturation trapping of SEBM (conducted by a qualified biologist) should be completed within the area of construction before construction activities commence. Mice found within the area of construction may be relocated to the habitat enhancement areas between LC-16 and LC-19. If the habitat enhancement area is not completed, SEBM may be moved to nearby low to non-occupied suitable habitats.
2. Collaborate with FWC to monitor SEBM within the habitat enhancement area between LC-16 and LC-19 and other areas of interest at Cape Canaveral Complex.

## **10. REINITIATION NOTICE**

Formal consultation for the Action considered in this BO is concluded. Reinitiating consultation is required if the SW retains discretionary involvement or control over the Action (or is authorized by law) when:

- a. the amount or extent of incidental take is exceeded;
- b. new information reveals that the Action may affect listed species or designated critical habitat in a manner or to an extent not considered in this BO;
- c. the Action is modified in a manner that causes effects to listed species or designated critical habitat not considered in this BO; or
- d. a new species is listed or critical habitat designated that the Action may affect.

In instances where the amount or extent of incidental take is exceeded, SW is required to immediately request a reinitiation of formal consultation.

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# **APPENDIX E**

## **Sections 106 and 110 National Historic Preservation Act of 1966 Consultation Documentation**



## 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.: 2019-5052  
*Proposed Reuse of Launch Complex 16 (LC-16)*  
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 13122 - LC-16 Blockhouse (8BR2322) 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.

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

Sincerely,

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

# **APPENDIX F**

## **Florida Clearinghouse Review**