DRAFT
FINDING OF NO SIGNIFICANT IMPACT (FONSI)
AND
FINDING OF NO PRACTICABLE ALTERNATIVE (FONPA)

Supplemental Environmental Assessment (SEA) for the Relativity Space
Terran R Launch Program
Cape Canaveral Space Force Station (CCSFS), FL

INTRODUCTION

Pursuant to provisions of the National Environmental Policy Act (NEPA), Title 42 United States Code (USC) Sections 4321 to 4347, implemented by Council on Environmental Quality (CEQ) Regulations, Title 40, Code of Federal Regulations (CFR) Parts 1500-1508, and 32 CFR Part 989, Environmental Impact Analysis Process (EIAP), the United States Space Force (USSF) has prepared a Supplemental Environmental Assessment (SEA) to identify and evaluate the potential impacts on the natural and human environment associated with the proposed launches, landing, recovery, and launch pad improvements, associated with the Terran R Launch Program from Cape Canaveral Space Force Station (CCSFS) Space Launch Complex 16 (SLC-16), Florida. *Supplemental Environmental Assessment for the Terran R Launch Program at Cape Canaveral Space Force Station*, July 2023, is attached and incorporated by reference. This SEA will supplement the Environmental Assessment (EA) for Relativity's existing *Terran 1 Space Launch Program Operations at SLC-16*.

PURPOSE OF AND NEED FOR PROPOSED ACTION

The purpose of the Terran R Program is to modify launch capabilities within Relativity's existing licensed property boundary following the retirement of the Terran 1 Program. The Proposed Action is needed to provide a more cost-competitive commercial space launch vehicle, to increase US space launch capability and to ensure the US remains the leader in space launch technology. The Terran R Program would transport medium class payloads from the Eastern Range to low earth orbit (LEO) and beyond for commercial companies and government entities. The Terran R Program requires new infrastructure to support the larger sized launch vehicle and payload capacities, when compared to the previous Terran 1 launch vehicle. New infrastructure includes a launch pad and flume, Horizontal Integration Facility (HIF), Environmental Control System (ECS) Facility, instrumentation bay, tech workshop, office, lightning protection towers, two (2) flare stacks, vehicle lighting, liquefied natural gas (LNG) and liquified oxygen (LOX) storage tanks, and roadway infrastructure.

The Terran R Program supports the U.S. Commercial Space Launch Competitiveness Act of 2015 and allows for continued compliance with the National Space Policy to actively promote the purchase and use of US commercial space goods and services and reduce space transportation costs. Relativity's 3D printing technology, first stage reusability, and medium class payload transportation capabilities would increase the innovation, availability, and competitiveness of the global space industry for private and government entities.

DESCRIPTION OF THE PROPOSED ACTION/ALTERNATIVES

This FONSI applies solely to the impacts associated with the following direct action in the SEA:

- Launch pad improvements at SLC-16, CCSFS. These improvements include a launch pad and flume, HIF, ECS, instrumentation bay, tech workshop, office, lightning protection towers, two (2) flare stacks, vehicle lighting, LNG and LOX storage tanks, and roadway infrastructure.
- Expected 2026 Stage 1 Mission Duty Cycle testing and static fire of the Terran R launch vehicle from SLC-16, CCSFS.

- Expected 2026 Terran R launch from SLC-16, CCSFS.
- Expected 2026 Terran R booster re-entry and landing on an ocean-going barge approximately 300-500 miles offshore. The barge would have an onboard propulsion system controlled via a commercial-off-the-shelf dynamic positioning system. No anchoring would be required to maintain the position of the ocean-going barge.
    - Landing operations will include both landings onto an ocean-going barge and soft-water landings in the Atlantic for missions early in the program development. For planned expendable missions, stage 1 will nominally perform a controlled, vertical landing at low velocities for a soft-water landing (~10 feet per second) with only residual propellant remaining in the tanks at the time of impact.
    - For all Terran R Program missions, stage 2 would be placed in a disposal orbit. Disposal orbits are orbits that, because 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 R stage 2 would also be passivated to preclude debris creation resulting from explosive overpressure or electric discharge. These techniques are in accordance with the National Security Space Launch Program System Performance Document and international agreements on space debris minimization.

Alternatives Eliminated from Further Consideration (EA Section 2.3)

Other existing, no-longer operational CCSFS launch sites were evaluated. SLCs are limited in availability and Space Launch Delta 45 (SLD 45) is not able to allocate another SLC to Relativity for Terran R; therefore, due to limited asset availability Terran R would need to stay within Relativity's current licensed boundary that was previously issued for Terran 1. Therefore, further evaluation of alternative launch site locations was eliminated from this analysis.

The following CCSFS and Kennedy Space Center (KSC) sites were considered but eliminated as detailed below.

- ***SLC-20*** – The USSF has a real property license for SLC-20 with Space Florida. SLC-20 is currently sub-licensed to FireFly Aerospace, Inc. SLC-20 also did not provide efficiencies in launch commodities and infrastructure in order to minimize the extent of capital expenditures needed to build out the launch site. The extent of construction required at SLC-20 necessary to meet the requirements of the Terran R Launch Program would result in significant capital costs and extended buildout timelines that would not meet the projected launch schedule. SLC-20 is also not within Relativity’s current real property boundary.
- ***SLC-46*** - The USSF has a real property license for SLC-46 with Space Florida. 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 could not be accommodated. Relativity was unable to come to terms with Space Florida during lease negotiations for SLC-46. No opportunities were present at SLC-46 for capitalizing on existing efficiencies in launch equipment or other commodities. Additionally, this launch complex is not within the current real property license boundary.
- ***SLC-15*** – SLC-15 was considered at the same time as SLC-16 as they are similar in layout. However, this launch complex was allocated to another launch service provider and the existing infrastructure at SLC-15 requires larger expenditures of time and construction scope. SLC-15’s current allocation and additional construction requirements and lack of existing launch commodities does not allow site development to meet the Terran R launch requirement for minimized capital expenditures. SLC-15 is also not within the current Relativity real property boundary.
- ***SLC-34*** **–** SLC-34 was considered but is outside of the license area and has no existing usable infrastructure or potential efficiencies. Furthermore, this location is not ideal due to the extremely

close proximity to SLC-37. Explosive safety quantity-distance criteria are used to establish safe distances from SLCs and associated support facilities to non-related facilities and roadways (through Department of Defense [DoD]) and Air Force Explosive Safety Standards). Based on the explosive equivalent of propellant associated with the Terran R Program and considering related QD's, SLC-34 is not ideal to support Terran R due to the ongoing missions at SLC-37. Additionally, SLC-34 would not allow the Terran R Program to minimize capital expenses nor is SLC-37 within the real property boundary.

- ***SLC-48*** – SLC-48 was considered but is outside of the license area and has no existing usable infrastructure or potential efficiencies that would allow the Terran R Program to minimize capital expenses. Necessary improvements would require excessive capital expenditures.
- ***SLC-49*** – SLC-49 was considered but is outside of Relativity's current license boundary area. SLC-49 is a greenfield site with no existing infrastructure. Necessary improvements would require excessive capital expenditures. Additionally, the timeline to bring SLC-49 to a functional state does not meet the timeline to support earlier Terran R launches.

No existing CCSFS space launch facilities outside of SLC-16 were found to meet all selection criteria.

Description of the No-Action Alternative (SEA Section 2.4.1)

The CEQ regulations, 40 CFR 1502.14, require agencies to consider a No Action alternative in their NEPA analyses. The No Action alternative serves as the baseline to compare the impacts of the Proposed Action and is analyzed in this SEA.

Under the No Action Alternative, the Terran R Program would not be implemented, and a new license would not be issued by the FAA. Under the No Action Alternative, no launch services would be provided by Relativity at SLC-16. The No Action alternative would not allow the DAF to capitalize on Relativity's technology and capabilities in order to support the purposes of the National Space Policy by actively promoting the purchase and use of US commercial space goods and services, nor would it reduce space transportation costs.

SUMMARY OF ENVIRONMENTAL FINDINGS

Environmental analyses focused on the following areas: air quality and climate; water resources; noise; soils and geological resources; historical and cultural resources; biological resources; land use and visual/coastal zone resources; infrastructure (transportation and utilities); health and safety; hazardous materials and wastes; socioeconomics; environmental justice; Section 4(f) properties, and airspace. USSF has concluded that no significant impacts would result to these resources as summarized below.

Air Quality and Climate (SEA Section 3.1)

No significant impacts have been identified. Air emissions from construction activities would cause a minor increase in Particulate Matter (PM) emissions due to demolition, excavations, minor clearing, construction vehicles and diesel generators. Carbon dioxide (CO_2) would be released by fossil fuel powered equipment and vehicles. Diesel-powered equipment would emit Carbon Monoxide (CO), hydrocarbons, Oxides of Nitrogen (NO_x) and CO_2. Emissions are expected to be minor from these sources over the expected 24 months of construction. Construction activities are not expected to significantly change regional (Brevard County) or local (CCSFS) air emissions.

As documented in the *Terran 1 Space Launch Program Operations at SLC-16* EA and previous Environmental Impacts Statements performed for launch vehicles at CCSFS, emissions from nominal launches, catastrophic launch failures, or spills of liquid propellants would not significantly impact ambient air quality. Analysis of potential emissions discussed in the SEA reach the same conclusions with respect to the Terran R Program.

Air emissions from Terran R launches with LNG/LOX engines are expected to be lower than launches with solids. LNG is a cleaner burning fuel than other rocket fuels such as Rocket Propellant-1, with anticipated reductions in PM. Terran R operations at CCSFS would not be expected to have a significant impact on air quality.

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 warning 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. The Proposed Action GHG emissions were analyzed and because they would be relatively short-term, they would be essentially unmeasurable and not have a climate change impact.

Water Resources (SEA Section 3.2)
No significant impacts have been identified. Approximately 1.63 acres of wetlands along the northern portion of SLC-16 would be impacted for roadway rerouting and the new flame trench. Roads in this area must be rerouted to facilitate Terran R vehicle transport around the site. Locations of the pad, flame trench, and roadways have been designed accommodate this transport. Numerous Terran R site layouts were reviewed considering the minimization of floodplain and wetland impacts, utilization of existing infrastructure facilities and utilities, compliance with applicable regulatory requirements, and overall Terran R programmatic needs. The proposed site layout minimizes wetland impacts considering all requirements in the construction of the SLC-16 improvements.

Permitting through St. Johns River Water Management District (SJRWMD's) Environmental Resource Permit (ERP) Program as well as a Section 404 No Permit Required determination with Florida Department of Environmental Protection (FDEP) would be completed prior to construction to determine compensatory mitigation requirements to offset wetland impacts. Mitigation credits required for wetland impacts would be determined using the FDEP's Uniform Mitigation Assessment Method (UMAM).

Stormwater permitting at SLC-16 would occur due to the Proposed Action. Since the construction area exceeds one acre, a National Pollutant Discharge Elimination System (NPDES) Stormwater Construction Permit would be required and a Stormwater Pollution Prevention Plan (SWPPP) would be implemented.

Contaminated groundwater dewatering may be required as part of the Proposed Action. Impacts would be minimized however, through the coordination with CCSFS Installation Restoration Program (IRP) and approval of a dewatering plan by the IRP and FDEP to ensure groundwater handling and disposal requirements are met.

The Proposed Action would collect and treat all deluge water in accordance with FDEP Industrial Wastewater requirements and therefore no significant impacts on surface waters are expected.

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 CCSFS launches. 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 Best Management Practices (BMPs) ensures no impacts to floodplains or wetlands. No significant water resource impacts are expected to result from the Proposed Action.

Soils and Geological Resources (SEA Section 3.3)
No significant impacts have been identified. No unique geologic features of exceptional interest or mineral

resources occur in the project area; therefore, no impacts would occur to these resources. The Proposed Action would have no direct impacts on geology or soils.

Historical and Cultural Resources (SEA Section 3.4)

No significant impacts have been identified. The SLD 45 Cultural Resources Manager evaluated the Proposed Action affected areas and no historical or cultural resource issues were found. The Proposed Action would have no effect on Historical or Cultural Resources.

Biological Resources (SEA Section 3.5)

No significant impacts have been identified. Relativity would be required to continue to adhere to all requirements of the past, current and ongoing consultations with the United States Fish and Wildlife Service (USFWS) and National Marine Fishery Service (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 CCSFS.

Exterior construction would occur within the SLC-16 previously disturbed area and adjacent areas. Other than the common “startle response”, no impacts to wildlife due to construction noise are anticipated.

The clearing for the Proposed Action would result in the loss of approximately 33.01-acres of potential Scrub-Jay habitat. The 2022 Florida Scrub-Jay census did not reveal the presence of any Scrub-Jay groups or individuals within the Proposed Action area and therefore direct impacts are not expected. The site does contain suboptimal habitat in the form of coastal scrub, wetlands, and other natural areas that are not considered capable of being managed and occupied by the Florida Scrub-Jay. The Proposed Action would result in the taking of unoccupied Florida Scrub-Jay habitat. In lieu of habitat restoration as mitigation for loss of unoccupied potential Florida Scrub-Jay habitat, Relativity Space proposes to provide funding to enhance unoccupied scrub-jay habitat adjacent to occupied jay habitat in Land Management Unit (LMU) 22 or another LMU to be designated by the USSF.

The clearing for the Proposed Action would result in the loss of approximately 33.01 acres of potential southeastern beach mouse habitat and direct impacts are possible. 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 clearing within the Proposed Action Area. While there could be a take of a southeastern beach mouse, proposed habitat enhancement within scrub habitat in LMU 22 or another LMU to be designated by the USSF will offset impacts to the occupied southeastern beach mouse habitat.

The +33.68 acres contained within the Proposed Action Area will be cleared using heavy machinery while the area (+1.83 acres) within the range of the proposed heat plume influence will remain naturally vegetated and only be affected for short durations during launch operations.

Potential negative impacts of lighting on sea turtle survivability are reduced and managed by 45 Space Wing Instruction (SWI) 32-7001 which addresses exterior Lighting Management.

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. Post launch monitoring conducted on previous launches and previous environmental analyses concluded that launch impacts to Threatened and Endangered species are minimal and insignificant.

Land Use, Visual Effects and Coastal Resources (SEA Section 3.6)

No significant impacts have been identified. Launches would not result in significant impacts to land use compatibility at CCSFS. SLC-16 is designated for space launch activities consistent with the CCSFS General Plan. The Proposed Action would not impact or require changes to land use.

Facilities built for the Terran R Program would be within or directly adjacent the existing launch complex footprint. The Proposed Action has no change to coastal zone impacts and would be consistent in meeting Florida CZMA plan objectives. The Proposed Action would generate no significant impacts on visual resources.

Noise (SEA Section 3.7)

No significant impacts have been identified. 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 SLC-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.

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.

The modeled nominal Terran R launch generates a sonic boom over a narrow, forward facing crescent shaped focus boom region. The focus boom region is created due to continuous acceleration and downward pitch as the launch vehicle ascends. As the launch vehicle ascends, the sonic boom levels decrease, resulting in the crescent shape becoming slightly longer and wider. The focus boom region begins approximately 35 miles downrange from the launch pad. The maximum modeled sonic boom peak overpressure (measuring changes in air pressure) along the focus boom region is 11 pounds per square foot (psf). However, the focus boom region is entirely over water, and these high levels would only occur in small areas along the focus boom region.

The modeled Terran R ocean-going barge landing also generates a sonic boom. The maximum modeled sonic boom peak overpressure along this focus boom region is 47 psf. Sonic booms for landing on an ocean-going barge would occur more than 250 nautical miles offshore.

Since the entire boom footprint for nominal launches is over water, the only potential impacts would be to wildlife. As discussed in the SEA, the peak overpressures for SLC-16 launches and ocean-based barge landings are far below the harassment thresholds for marine mammals and therefore launch operations are not expected to affect marine species underwater. The Proposed Action would generate no significant noise impacts.

Transportation Infrastructure (SEA Section 3.8)

No significant impacts have been identified. A slight increase in the traffic during the approximate 24-month period of construction is anticipated but it would not significantly impact CCSFS roadways. Transportation of the Terran R Program components to assembly areas is not expected to have a significant impact on CCSFS transportation routes. During launches, the increase in traffic should be similar to existing launches and would not be significant. No significant transportation impacts are expected to result from the Proposed Action.

Utilities Infrastructure (SEA Section 3.9)
No significant impacts have been identified. Construction personnel do not add appreciably to utility loads. Proposed Action impacts on electrical power requirements would not result in significant impacts compared to existing availability and capacity.

Potable water and wastewater service are not connected to SLC-16. No potable water or wastewater impacts due to the Proposed Action are expected. Relativity would use industrial water provided by CCSFS for fire protection and exhaust deluge and sound suppression. No significant impact to CCSFS industrial water supply is anticipated.

Public Health and Safety (SEA Section 3.10)
No significant impacts have been identified. Relativity requires all employees and contractors to follow all USSF and Occupation Safety and Health Administration (OSHA) regulations during construction activities. No significant impacts to health and safety of workers during construction is anticipated.

The Terran R Program would adhere to all Relativity, USSF, CCSFS, state and federal safety and health regulations and requirements. The Terran R Program construction and launch operations would have no significant impacts on on-site personnel health and safety.

Hazardous Materials, Solid Waste and Hazardous Waste (SEA Section 3.11)
No significant impacts have been identified. The construction activities at SLC-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.

Ground support operations, stage MDC testing, static fire, launch and ocean-going barge landing operations 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 similar to other Evolved Expendable Launch Vehicle (EELV) class launch programs. The Proposed Action poses no significant impact on hazardous material use or solid or hazardous waste generated.

Socioeconomics (SEA Section 3.12)
No significant impacts have been identified. The Terran R Launch Program 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 CCSFS. 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.

Temporary closures of airspace and navigable waterways have the potential to impact private businesses who operate in the closure areas such as airlines, cruise ships, and commercial fishermen. Taking into account the maximum of 24 launches per year (<500 hours of access restrictions per year), short duration of airspace and waterway closures, and the advanced notification for pilots and mariners to anticipate such closures, significant impacts to socioeconomic conditions due to launch activities within Brevard County would not be anticipated. The Proposed Action would generate negligible socioeconomic impacts on the region.

Environmental Justice (SEA Section 3.13)
No significant impacts have been identified. The construction of Relativity facilities and operations of Terran R are not located adjacent to or near minority populations or low-income population centers. Therefore, environmental impacts generated by construction, ground support operations, and 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. Use of the SLC-16 site would also not have an impact on any Environmental Justice subject groups.

Section 4(f) Properties (SEA Section 3.14)

No significant impacts have been identified. No designated 4(f) properties, including public parks, recreation areas, or wildlife refuges, exist within the boundaries of CCSFS. No Section 4(f) properties would be significantly impacted by noise levels from Terran R launches. The Proposed Action would generate no negative Section 4(f) publicly owned land impacts on the region.

Airspace (SEA Section 3.15)

No significant impacts have been identified. Due to the redesigned airspace temporary flight restriction areas, a limited amount of commercial and private flights would be impacted during launches from CCSFS. The 24 annual Terran R Program launches would not require a significant number of airspace closures. The Proposed Action would not have a significant impact on airspace.

Cumulative Effects (SEA Section 4)

Overall, the Proposed Action would result in short- and long- term, minor to moderate, direct and indirect, adverse impacts that would be below significance thresholds described for each resource area. Impacts of the Proposed Action would be minimized using BMPs. Compensatory mitigation would be provided for unavoidable impacts as determined through consultation and coordination with federal and state regulatory agencies. As such, the Proposed Action would not significantly contribute to cumulative impacts when considered with other past, present, and reasonably foreseeable future actions occurring at or in the vicinity of CCSFS.

MITIGATIONS

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

- Avoidance and minimization measures, as well as reporting requirements, identified in Endangered Species Act consultations with NMFS and USFWS.
- Perform monitoring within the heat plume region of influence to better understand any potential impacts. Monitoring would include temperature sensors, as well as visual review of the potentially affected area after both static and launch events. Results from this monitoring would be reviewed with SLD 45.
- Comply with Installation Restoration Program (IRP) land use controls (LUCs) for site soils and geology resources administered under Solid Waste Management Unit (SWMU) C040.
- A functional loss of up to 1.10 herbaceous units is generated from the proposed impacts to Wetlands. Credits to offset this impact are reserved through Neo Verde Mitigation Bank.

PUBLIC REVIEW

In January 2023, an Early Public Notice was published in the *Florida Today* newspaper announcing commencement of the SEA, detailing that the Proposed Action may occur in a floodplain/wetland, and seeking advanced public comment. USSF received comment from three entities during the review period. When requested, additional information was provided and comments were addressed in the Draft SEA. Copies of public comment are provided in Appendix J-2.

Tribal consultation with the Seminole Tribe of Florida (STOF) was initiated on April 4, 2023. The STOF provided a response indicating that the Proposed Action was within the STOF Area of Interest, but that the STOF had no objections to the Proposed Action based on the information provided on April 27, 2023. Appendix I-1 of the SEA includes records of correspondence with the STOF.

In March 2023, letters and emails were sent to federal, state, and local agencies and municipalities potentially affected by the Proposed Action informing them of the intent to prepare the SEA and requesting input. USSF received comments from three agencies during this period. A list of the agencies contacted is included in Chapter 6 of the SEA.

40 CFR Parts 1500-1508 and 32 CFR Part 989 require that the public have an opportunity to review and comment on draft NEPA documents. A notice of Availability for public review of the Draft SEA and Draft FONSI/FONPA was published in the *Florida Today* and the *Hometown News (Beaches and North Brevard Editions)* in August 2023. The documents were also made available on the internet at https://patrick.spaceforce.mil and at the following locations:

Cape Canaveral Public Library 201 Pol Ave. Cape Canaveral, FL 32920	Titusville Public Library 2121 S. Hopkins Ave. Titusville, FL 32780	Port St John Public Library 6500 Carole Ave. Cocoa, FL 32927
Cocoa Beach Public Library 550 North Brevard Ave. Cocoa Beach, FL 32931	PSFB Library Building 722 842 Falcon Ave. Patrick SFB, FL 32925	Merritt Island Public Library 1195 North Courtenay Parkway Merritt Island, FL 32953

The public comment period was 30 days. All substantial comments received regarding the Draft SEA were incorporated into the Final SEA.

FINDING OF NO SIGNIFICANT IMPACT

Based on my review of the facts and analyses contained in the attached SEA, conducted under the provisions of NEPA, CEQ Regulations, and 32 CFR 989, I conclude that the implementation of the Proposed Action would not have a significant environmental impact, either by itself or cumulatively with other known projects. Accordingly, an Environmental Impact Statement is not required. This analysis fulfills the requirements of NEPA, the CEQ regulations, 32 CFR Part 989. The signing of this Finding of No Significant Impact completes the EIAP.

FINDING OF NO PRACTICABLE ALTERNATIVE

Pursuant to Executive Order(s) 11988, 11990, and 13690, and considering all supporting information, I find there is no practicable alternative to the Proposed Action, which will impact floodplains and wetlands. As noted in the attached SEA, there are no practicable alternatives that would avoid all impacts or further minimize impacts to wetlands based on conceptual siting requirements and existing environmental constraints. Wetland impacts would be avoided and minimized to the greatest extent practical during project design and permitting. The proposed improvements would be located within the floodplain as the entirety of SLC-16 is located in the 100-year floodplain. The location of existing facilities and utilities, limited developable area outside of the floodplain, and the requirement to avoid listed species habitat to the greatest extent possible preclude placing these improvements outside of the floodplain. This finding fulfills both the requirements of the referenced Executive Orders and the EIAP regulation, 32 CFR 989.14 for a Finding of No Practicable Alternative.

PAUL G. FILCEK   Date
Colonel, USAF
Chief, Space Force Mission Sustainment
(Engineering, Logistics, & Force Protection)

Draft Supplemental Environmental Assessment

Terran R Launch Program Cape Canaveral Space Force Station

Prepared for:

Relativity

and

Space Launch Delta (SLD) 45

Cape Canaveral Space Force Station (CCSFS), FL

August 6, 2023

PRIVACY ADVISORY

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

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

Public commenting allows the USSF to make better, informed decisions. Letters or other written or oral comments provided may be published in the SEA. As required by law, comments provided will be addressed in the SEA and made available to the public. Providing personal information is voluntary. Private addresses will be compiled to develop a mailing list for those requesting copies of the SEA. However, only the names of the individuals making comments and their specific comments will be disclosed. Personal home addresses and phone numbers will not be published in the Final SEA.

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Appendix C – Terran R Programmatic Concurrence for Launch Vehicle & Reentry Operations

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Appendix I – Cultural/Historical Consultation

Appendix J – Public Notice and Comments

Acronyms and Abbreviations

45 WS	45TH Weather Squadron
AASHTO	American Association of State Highway Transportation Officials
ABS	American Bureau of Shipping
ACAM	Air Conformity Applicability Model
ADI	Area of Direct Impact
AFB	Air Force Base
AFCEC	Air Force Civil Engineering Center
AFI	Air Force Instruction
AI	Artificial Intelligence
AIRFA	American Indian Religious Freedom Act
AIS	Automatic Identification System
ALTRV	Altitude Reservation
APE	Area of Potential Effect
APZs	Accident Potential Zones
ARPA	Archaeological Resources Protection Act
ARTCC	Air Route Traffic Control Center
BLS	Below Land Surface
BMPs	Best Management Practices
BA	Biological Assessment
BC	Black Carbon
BO	Biological Opinion
BRRC	Blue Ridge Research and Consulting
BSL	Below Sea Level
CAA	Clean Air Act
CCSFS	Cape Canaveral Space 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
CFM	Cubic Feet per Minute
CFR	Code of Federal Regulations
CH4	Methane
CLOIS	Cape Launch Operations and Infrastructure Support
CO	Carbon Monoxide
CSEL	C-Weighted Sound Exposure Level
CSLA	Commercial Space Launch Act
CWA	Clean Water Act

CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
DAF	Department of the Air Force
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
HAP	Hazardous Air Pollutant

HAZCOM	Hazardous Communication
HIF	Horizontal Integration Facility
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	Intergovernmental Panel on Climate Change
IRP	Installation Restoration Program
ISS	International Space Station
kg	Kilogram
km	Kilometer
KSC	Kennedy Space Center
kV	Kilovolt
kW-hr	Kilowatt-hour
LA_{eq}	Long-Term Equivalent A-Weighted Sound Level
LA_{max}	Maximum A-weighted Sound Level
LAA	Likely to Adversely Affect
Lbm	Pound Mass
LCC	Launch Control Center
LEO	Low Earth Orbit
LMP	Light Management Plan
LN2	Liquid Nitrogen
LNG	Liquified Natural Gas
LOA	Letter of Agreement
LOX	Liquid Oxygen
LRM	Liquid Rocket Motor
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
MMH	Monomethyl hydrazine
MMPA	Marine Mammal Protection Act
MSC	Marine Safety Center
MSD	Marine Safety Detachment

MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	Mean Sea Level
MT	Metric Tons
N2H4	Anhydrous Hydrazine
N2O	Nitrous Oxide
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NGA	National Geospatial Intelligence Agency
NHPA	National Historic Preservation Act
NLAA	Not Likely to Adversely Affect
NMFS	National Marine Fisheries Service
NOTAM	Notice to Air Missions
NOTMAR	Notice to Mariners
NOx	Nitrogen Oxides
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPR	NASA Procedural Requirements
NPS	National Park Service
NRHP	National Register of Historic Places
NAVD88	North American Vertical Datum of 1988
NOA	Notice of Availability
NRP	NASA Routine Payloads
OFW	Outstanding Florida Water
OSHA	Occupational Safety and Health Administration
OSTDS	Onsite Sewage Treatment and Disposal Systems
PAH	Polycyclic Aromatic Hydrocarbon
PSFB	Patrick Space Force Base
PCBs	Polychlorinated Biphenyls
PEL	Permissible Exposure Limit
PFDP	Preliminary Flight Data Package
PM	Particulate Matter
PPF	Payload Processing Facility
psi	Pounds per Square Inch
psf	Pounds Per Square Foot
PWS	Public Water System
PWSA	Ports and Waterways Safety Act

re	Referenced
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RMP	Risk Management Plan
ROI	Region of Influence
ROTF	Range of the Future
RUMBLE	Launch Vehicle Acoustic Simulation Model
RWWTP	Regional Wastewater Treatment Plant
S1	Stage 1
S2	Stage 2
SAFMC	South Atlantic Fishery Management Council
SARA	Superfund Amendments and Reauthorization Act
SEA	Supplemental Environmental Assessment
SEIS	Supplemental Environmental Impact Statement
SEL	Sound Exposure Level
SF	Square Feet
SHA	Ship Hazard Area
SHPO	State Historic Preservation Office
SJRWMD	St. Johns River Water Management District
SLC	Space Launch Complex
SLC-16	Space Launch Complex 16
SLD 45	Space Launch Delta 45
SO_X	Sulfur Oxide
SO_2	Sulfur Dioxide
SPCC	Spill Prevention, Control, and Countermeasures Plan
SR	State Road
SRM	Solid Rocket Motor
SSA	Space Situational Awareness
SSC	Species of Special Concern
SSCMAN	Space System Command Manual
SSO	Sun-synchronous Orbit
STOF	Seminole Tribe of Florida
SWI	Space Wing Instruction
SWMU	Solid Waste Management Unit
SWPPP	Stormwater Pollution Prevention Plan
T&E	Threatened and Endangered
TE	Transporter-Erector
TFR	Temporary Flight Restrictions
THA	Toxic Hazard Assessment
THC	Toxic Hazard Corridors

THPO	Tribal Historic Preservation Office
TNT	Trinitrotoluene
TSCA	Toxic Substance Control Act
UMAM	Uniform Mitigation Assessment Method
US	United States
USACE	United States Army Corps of Engineers
USAF	United States Air Force
U.S.C.	United States Code
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
USSF	United States Space Force
VAC	Vacuum
VOC	Volatile Organic Compound
WDR	Wet Dress Rehearsal
WWTP	Wastewater Treatment Plant

1 Purpose of and Need for the Proposed Action

1.1 Introduction and Background

This Supplemental Environmental Assessment (SEA) for Relativity Space Inc.'s (Relativity) Terran R Program is to evaluate the impacts associated with implementing Relativity's proposed Terran R Space Launch Program operations at Space Launch Complex (SLC) 16 at Cape Canaveral Space Force Station (CCSFS). This SEA is a supplement to the *Finding of No Significant Impact (FONSI*) (dated September 21, 2021) related to the *Environmental Assessment for the Relativity Terran 1 Program Launch Complex 16, Cape Canaveral Space Force Station, FL*, dated June 2020, as noted in ***Section 1.5***. As of May 2023, the Terran 1 Program has been discontinued to make way for Relativity's new Terran R Program. Various operations evaluated in the Terran 1 EA apply to the Terran R Program, however due to the increased launch vehicle size, capabilities, and support infrastructure required, a supplemental environmental analysis is needed. This SEA will evaluate potential impacts associated with site modifications, new construction, and launch operations for the new Terran R Program at CCSFS.

Relativity is a private United States (US) aerospace manufacturing company headquartered in Los Angeles County, CA creating a new manufacturing process to iterate and scale rockets quickly for access to space. Relativity plans to deploy and resupply satellite constellations for a variety of Government and commercial sector clients. Other missions may include deep space probes, International Space Station (ISS) cargo resupply missions, and launch of commercial space station modules. Capsules would be specialized depending on the mission. 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. Using its 3D printing technology, Terran R engines, Stage 1 (S1), Stage 2 (S2) and payload fairings would be capable of launching over 33,500 kilograms (kg) to low Earth orbit (LEO) and beyond.

The United States Space Force (USSF) is the owner of the real property where the Proposed Action would occur. Per agreements between the USSF, National Aeronautics and Space Administration (NASA), the Federal Aviation Administration (FAA), and the United States Coast Guard (USCG), the USSF is the lead agency for the preparation and coordination of this SEA (40 CFR 1501.7). NASA, the USCG and the FAA are acting as cooperating agencies (40 CFR 1501.8). Additional details on lead and cooperating agency roles are contained in ***Section 1.7***.

1.2 Location

CCSFS, controlled by the USSF Space Launch Delta 45 (SLD 45), is located on the east coast of Florida on approximately 16,200 acres of land in Brevard County on the Canaveral Peninsula. CCSFS is bordered by Port Canaveral to the south, Kennedy Space Center (KSC) to the north, and the Atlantic Ocean to the east. CCSFS is accessible from the south by US Highway 401 and from the west and north via KSC roads.

SLC-16 is located on CCSFS approximately 8,000 feet east of the Banana River and 1,000 feet west of the Atlantic Ocean, as shown in ***Figure 1.*** SLC-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. SLC-15 is the adjacent launch complex to the south and SLC-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 SLC-16.

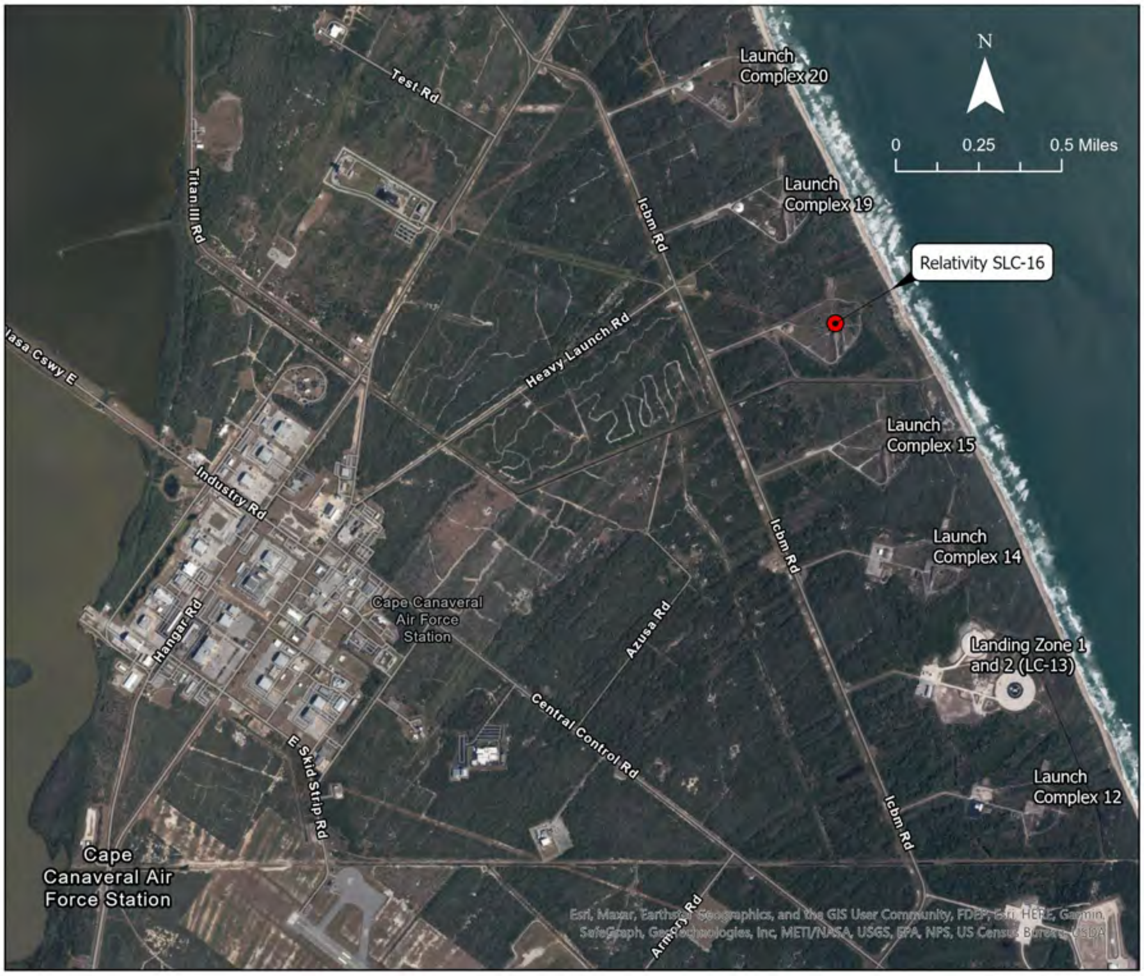


Figure 1. SLC-16 General Location

1.3 Purpose of and Need for the Proposed Action

The purpose of the Terran R Program is to modify launch capabilities within Relativity's existing licensed property boundary following the retirement of the Terran 1 Program. The Proposed Action is needed to provide a more cost-competitive commercial space launch vehicle, to increase US space launch capability and to ensure the US remains the leader in space launch technology. The Terran R Program would transport medium class payloads from the Eastern Range to LEO and beyond for commercial companies and government entities. The Terran R Program requires new infrastructure to support the larger sized launch vehicle and payload capacities, when compared to the previous Terran 1 launch vehicle. These improvements include a launch pad and flume, Horizontal Integration Facility (HIF), Environmental Control System (ECS) Facility, instrumentation bay, tech workshop, office, lightning protection towers, two (2) flare stacks, vehicle lighting, liquefied natural gas (LNG), and liquified oxygen (LOX) storage tanks, and roadway infrastructure.

The Terran R Program supports the US Commercial Space Launch Competitiveness Act of 2015 (CSLCA, Public Law 114-90) and allows for continued compliance with the National Space Policy to actively promote the purchase and use of US commercial space goods and services and reduce space transportation costs. Relativity's 3D printing technology, first stage reusability, and medium class payload transportation capabilities would increase the innovation, availability, and competitiveness of the global space industry for private and government entities.

The USSF's federal action would be the issuance of a lease or license for the real property where the Action would occur (SLC-16), subsequent approval of site modifications, and approval of launch operations. If, after the public's review of the SEA, the USSF determines that the Proposed Action would not individually or cumulatively result in significant impacts on the human or natural environments, the USSF would issue a final FONSI.

1.4 Scope of Environmental Analysis

This SEA evaluates various alternatives considered for the Terran R launch site as well as the potential site-specific environmental consequences associated with the implementation of the Terran R Program and operations at CCSFS SLC-16. The scope includes evaluating the environmental impacts of the Terran R Program associated with renovations to SLC-16, launch vehicle transportation and preparation, payload integration, ground support operations, launch from SLC-16, booster landing on an ocean-going barge, S1 impacts when expended in the ocean (which may be required for early operations or as needed after the program is developed), post-launch booster ground support operations and booster transportation.

1.5 Documents Incorporated by Reference

This SEA is a supplement to USSF's Environmental Assessment for the *Relativity Terran 1 Program Launch Complex 16, Cape Canaveral Space Force Station, FL* (USSF, 2020) which resulted in a FONSI on Sep 21, 2021. The Terran 1 EA evaluated construction impacts associated with the refurbishment and renovation of SLC-16, as well as launch operation impacts from the Terran 1 launch vehicle. This SEA is required to evaluate the impacts associated with construction of additional launch support infrastructure for the new Terran R launch vehicle, along with the associated launch operations. Various existing Terran 1 infrastructure and operations would remain for the Terran R Program, however additional impacts and operations, such as reusability and booster landing, require evaluation.

Other documents referenced within the SEA include the Biological Assessment (BA) and Wetlands Assessment completed by Atlantic Environmental (Atlantic, 2023). These documents identify impacts to natural resources as a result of the Terran R Program and mitigation measures. During the Section 7 consultation with United States Fish and Wildlife Service (USFWS), a concurrence with the effect determinations within the BA was requested. The resulting Biological Opinion (BO) is referenced within this environmental analysis. A copy of the BO is provided in ***Appendix H.*** Terran R air emissions and noise modeling information is incorporated into this SEA via reports provided by Blue Ridge Research and Consulting, LLC. (BRRC) (BRRC, 2023). Section 106 Consultation with the State Historic Preservation Office (SHPO) was completed to identify any historical or archaeological resources impacts (SHPO, 2023). Copies of these documents are provided in ***Appendix I.***

1.6 Relevant Laws and Regulations

The Terran R Program would support US Government and commercial space exploration in accordance with the guidance of the Commercial Space Launch Act. 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" (GPO, 1984). 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" (GPO, 1988).

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. On March 23, 2018, the America First National Space Strategy was established, encouraging collaboration amongst the national security, commercial, and civil space sectors.

This SEA has been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code [U.S.C.] Part 4321 et seq.); the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508); Department of the Air Force (DAF) Environmental Impact Analysis Process (EIAP) (32 CFR Part 989); Executive Order (EO) 12114, Environmental Effects Abroad of Major Federal Actions; FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures* and NASA NEPA Program regulations, NASA Procedural Requirements (NPR) 8580.1A, *Implementing the National Environmental Policy Act and Executive Order 12114*. These regulations require a lead agency to prepare or supervise preparation of an EA or SEA for a federal action (including an action occurring on federal property) that does not qualify for a categorical exclusion or may not require preparation of an Environmental Impact Statement (EIS). The USSF owns the real property where the Action would occur (SLC-16) and has thus been designated the lead agency. A FONSI would be issued if, as a result of this SEA, the environmental impacts of implementing the Proposed Action are determined to be not significant. If, at any time during the process of developing this SEA, it becomes apparent that a FONSI cannot be issued, the USSF would publish a Notice of Intent to prepare an EIS.

1.7 Intergovernmental Coordination, Public and Agency Participation

This Relativity Terran R CCSFS Program SEA was developed with the USSF as the lead agency and NASA, the FAA and USCG as cooperating agencies.

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

Within the DOT, the Secretary of Transportation's authority under the CSLA has been delegated to the FAA Office of Commercial Space Transportation. The FAA expects to receive a Vehicle

Operator License application(s) from Relativity for Terran R operations at SLC-16. The FAA's Federal Action includes 1) issuing a Vehicle Operator License to Relativity, as well as potential future renewals or modifications to the Vehicle Operator License for operations that are within the scope analyzed in this SEA, and 2) developing Letter(s) of Agreement (LOAs) with Relativity to outline notification procedures prior to, during, and after an operation as well as procedures for issuing a Notice to Air Missions (NOTAM).

The FAA intends to adopt this SEA to support its environmental review when evaluating Relativity's launch license application(s) for operations at CCSFS and related airspace closures. The FAA will draw its own conclusions from the analysis presented in this SEA and assume responsibility for its environmental decision and any related mitigation measures. For the FAA to use this analysis to support its determination for licensing, the SEA must demonstrate compliance with the requirements of FAA Order 1050.1F, which contains the FAA's policies and procedures for NEPA compliance. The successful completion of the environmental review process does not guarantee that the FAA would issue a Vehicle Operator License to Relativity, issue an LOA, or approve related airspace closures.

NASA is a cooperating agency and would rely on the analysis contained in this SEA to support its environmental review process as a potential future customer of Relativity's Terran R vehicle. NASA provides special expertise with respect to environmental issues concerning space launch operations.

The USCG is a cooperating agency because of their regulatory authority over waters subject to jurisdiction of the US pursuant to the Ports and Waterways Safety Act (PWSA), Title 46 U.S.C., chapter 700 (46 U.S.C 700), regulatory authority of US and foreign flagged vessels as outlined in 33 and 46 CFR, and to review/advise SLD 45 on all launch and reentry site evaluation risk assessments with focus on vessel navigation safety. USCG also supports SLD 45 with early warning communication to the maritime industry with notice to mariners (NOTMAR) as outlined in 33 CFR Part 72. SLD 45 and USCG have entered into a Memorandum of Agreement to assist with maritime safety and space operational review that have a maritime nexus. The USCG evaluates every launch and reentry activity for risk to waterway users and the environment under this process.

SLD 45 notified and consulted with relevant federal and state agencies on the Proposed Action and alternatives to identify potential environmental issues and regulatory requirements associated with project implementation. This coordination fulfills the Interagency Coordination Act and EO 12372, Intergovernmental Review of Federal Programs (14 July 1982). The following discussions summarize the agency coordination and consultations that have been completed.

The Proposed Action is a federal action subject to compliance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended. Section 7 consultation is required when a federal action has the potential to affect listed species directly or indirectly or destroy or adversely modify critical habitat. SLD 45 initiated Section 7 consultation with the USFWS and received concurrence with our effect determinations for federally listed species (***Appendix H***).

SLD 45 initiated informal consultation with the National Marine Fisheries Service (NMFS) to ensure consistency with the NMFS Programmatic Consultation for Launch and Reentry Vehicle Operations in the Marine Environment with FAA, NASA, and the USSF (Refer to NMFS No: OPR-2021-02908) dated April 14, 2023, for potential impacts on Marine Mammal Protection Act

(MMPA), federally listed threatened and endangered marine species. NMFS issued SLD 45 concurrence with the determination that the proposed activities may affect but are not likely to adversely affect MMPA and ESA-listed marine species (***Appendix C***).

The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act in 1996, provides National Oceanic and Atmospheric Administration (NOAA) Fisheries legislative authority to regulate fisheries and protect Essential Fish Habitat (EFH). The Proposed Action would not adversely affect any EFH; therefore, further consultation under the Magnuson-Stevens Fishery Conservation and Management Act is not required.

The Proposed Action is an undertaking subject to compliance with Section 106 of the National Historic Preservation Act (NHPA) of 1966 per regulations at 36 CFR Part 800. SLD 45 initiated Section 106 consultation with Florida SHPO for the project and determined that the Proposed Action would have no adverse effect on archaeological sites or historic structures listed in or potentially listed in the National Register of Historic Places (NRHP). The Florida SHPO concurred with the USSF's determination of eligibility and findings of no adverse effect to NRHP eligible or listed cultural resources (***Appendix I***).

Per 40 CFR 1501.2(b)(4)(ii) and EO 13175, consultations with appropriate State, Tribal, and local governments are required as part of the NEPA process. EO 13175, *Consultation and Coordination with Indian Tribal Governments* directs Federal agencies to coordinate and consult with Native American tribal governments whose interests might be directly and substantially affected by activities on Federally administered lands. Consistent with that EO, DoDI 4710.02, *Interactions with Federally Recognized Tribes*, and AFI 90-2002, *Air Force Interaction with Federally Recognized Tribes*, the USSF solicited early comment from three (3) Native American Tribal governments that may be impacted or have an interest in the Proposed Action: the Seminole Nation of Oklahoma, Miccosukee Tribe of Indians of Florida, and the Seminole Tribe of Florida. One (1) of the three (3) tribes responded to the early comment request. All applicable EO 12898 Government-to-Government correspondence including notification letters and replies with the Native American tribal governments regarding the Proposed Action are included in ***Appendix I***.

1.8 Public and Agency Review of EA

Pursuant to Title 40, CFR 1506.6, opportunities for public involvement and the availability of environmental documents must be made to inform those persons and agencies who may be interested in or affected by the Proposed Project.

The Proposed Action may impact wetlands and/or floodplains; therefore, it is subject to the requirements of EO 11990, Protection of Wetlands, EO 11988, Floodplain Management, and EO 13690, Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input. In January 2023, USSF published an early notice that the Proposed Action may occur in a floodplain/wetland in Florida Today (***Appendix J***). The comment period for public input was 30 days. Three (3) comments were received.

In March 2023, letters and emails were sent to federal, state, and local agencies and municipalities potentially affected by the Proposed Action informing them of the intent to prepare the SEA and requesting input. USSF received comments from three agencies during this period.

A Notice of Availability (NOA) of the Draft SEA and FONSI/Finding of No Practical Alternative (FONPA) was published in Florida Today (08 August 2023; 13 August 2023) and The Hometown

News (11 August 2023) [North Brevard and Beaches Edition] as well as the locations noted below, announcing the availability of the SEA for review on. The NOA invited the public to review and comment on the Draft SEA. The public and agency review period ended on 07 September 2023. The NOA and public and agency comments are provided in ***Appendix J***.

Copies of the Draft SEA and FONSI/FONPA were also made available for review on the CCSFS website (https://www.patrick.spaceforce.mil/) and at the following locations:

Cape Canaveral Public Library 201 Pol Avenue Cape Canaveral, FL 32920	Titusville Public Library 2121 S. Hopkins Ave. Titusville, FL 32780	Port St John Public Library 6500 Carole Ave Cocoa, FL 32927
Cocoa Beach Public Library 550 North Brevard Ave. Cocoa Beach, FL 32931	PSFB Library Building 722 842 Falcon Ave Patrick SFB, FL 32925	Merritt Island Public 1195 North Courtenay Parkway Merritt Island, FL 32953

2 Proposed Action and Alternatives

This section describes the Proposed Action for Terran R Program operations, and the No Action Alternative. ***Section 2.3*** describes the Alternatives Considered but Eliminated from Further Study and details the rationale for their elimination. ***Section 2.4.2*** provides the rationale for selection of the Proposed Action.

2.1 Proposed Action – Terran R Program

The Proposed Action, the Terran R Program, would supersede the Terran 1 Program. The Terran R Program would deliver payloads of up to 33,500 kg max to LEO or 23,500 kg under a reusable configuration, compared to Terran 1's payload capacity of 1,250 kg. Relativity announced the Terran R Program in 2021 to meet overwhelming commercial and government demand for medium-heavy lift launch capability, while taking advantage of advances in 3D printing and Artificial Intelligence (AI) driven controls to manufacture fully reusable rockets. 3D printing significantly reduces cost and improves manufacturing flexibility, allowing faster iteration of new designs and facilitating scaling to larger vehicles.

Relativity's Terran R launch vehicle would efficiently and cost-effectively serve government entities and commercial sectors whose payloads require access of up to 33,500 kg. Relativity is targeting medium-class payload customers and providing schedule flexibility and mission customization made possible by Relativity's 3D printing technology. The first Terran R launch is scheduled for 2026, with an anticipated future maximum launch rate of 24 per year. Relativity intends to use existing CCSFS SLC-16 and modify it as required (see ***Section 2.4.2***) to conduct operations in support of the Terran R Program. The Terran 1 Program was retired in May of 2023.

The Proposed Action allows continued fulfillment of the National Space Policy goals of promoting a robust commercial space industry and strengthening the US leadership as the country of choice for conducting commercial space activities. The Proposed Action would allow Relativity Space to grow within the current SLC-16 boundary, as analyzed previously under the *Relativity Terran 1 Program Launch Complex 16, Cape Canaveral Space Force Station, FL*. The Terran R Program requires new infrastructure to support the larger sized launch vehicle. These improvements include a launch pad and flume, HIF, ECS, Instrumentation Bay, tech workshop, office, lightning protection towers, two (2) flare stacks, vehicle lighting, LNG and LOX storage tanks, and roadway infrastructure. ***Table 1*** in ***Section 2.1.1*** provides a comparison of the Terran R and Terran 1 launch vehicles.

2.1.1 Terran R Launch Vehicle

The Terran R Launch Vehicle is shown in ***Figure 2*** below. The Terran R launch vehicle has an upper bound design that results in S1 measuring up to 175-feet tall, 18-feet in diameter, powered by up to 14 engines fueled with LOX and LNG. The interstage is designed to measure up to 45 feet tall and 18 feet in diameter. S2 is designed to measure up to 35-feet tall, 18 feet in diameter, powered by one (1) Aeon R VAC re-startable engine. Lastly, the payload fairing is designed to measure up to 65 feet tall, 18 feet in diameter. This results in the fully integrated Terran R launch vehicle configurable to up to approximately 320-feet in length. For the purposes of this analysis, the representative vehicle analyzed includes the upper bound parameters.

3D printed components on Terran R are manufactured using proprietary materials in Relativity's Stargate factory located in Los Angeles County, CA. The 14 S1 Aeon R engines each produce 320,000 pounds of sea level thrust, for a total of up to 4,480,000 pounds of lift-off thrust. S2 would use an updated Aeon R engine with a copper chamber. The heat plume generated from Terran R launches would travel away from launch pad at the diverter, with temperatures < 600°F reaching the edge of the property boundary at SLC-16, 400°F approximately 0.25 mile from the launch pad, and temperatures reaching ambient temperature (86°F) approximately 0.5 miles from the launch pad. Due to the diverter and concrete flume angle, it is anticipated that the heat plume would have minimal impacts at ground level. Instead, the heat plume would extend above the tree line for the conservatively estimated 1.83-acre swath of land of potentially impacted area. The heat plumes and increased temperatures in this area would be temporary in nature and would only occur during engine ignition and dissipate rapidly. Terran R's payload delivery capability is up to 33,500 kg to 185 kilometers (km) LEO. The Terran R launch vehicle would fly in launch azimuths ranging from 41° to 105° for block 1 of the Terran R vehicle. ***Table 1*** below, provides size and engine comparisons between the Terran R and Terran 1 launch vehicles. ***Table 2*** below, provides comparison between propellant requirements between the Terran R and Terran 1 launch vehicles.

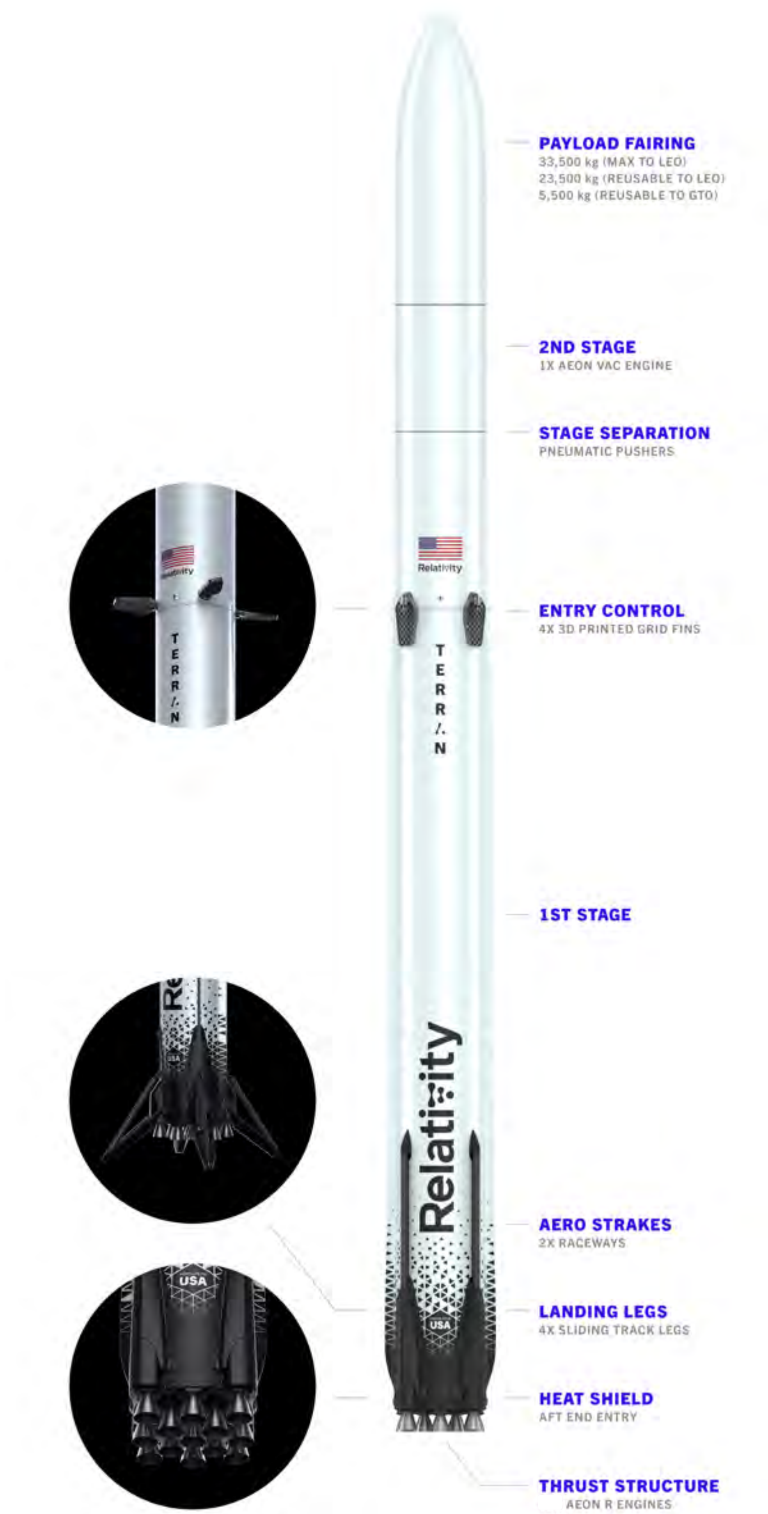


Figure 2. Terran R Launch Vehicle

Table 1. Terran R vs. Terran 1 Comparison

	Terran R *(Bounding Configuration)*	Terran 1
Stage 1 (ft):	175	66
Stage 2 (ft):	35	13.5
Payload (ft):	65	22
Interstage (ft):	45	9
Total Vehicle (ft):	320	110.5
Diameter of Stage 1 (ft):	18	7.5
Diameter of Payload (ft):	18	10
Stage 1, Number of Engines:	14	9
Max Thrust at Sea Level (single engine, lbf):	320,000	23,000
Stage 2, Number of Engines:	1	1

Table 2. Terran R vs. Terran 1 Propellant Comparison

	Terran R (*Bounding Configuration*)	Terran 1
Stage 1 LOX Mass (lbm):	1,709,651	93,083
Stage 2 LOX Mass (lbm):	340,474	18,265
Total LOX Mass (lbm):	2,050,126	111,348
Stage 1 LNG Mass (lbm):	615,249	33,050
Stage 2 LNG Mass (lbm):	122,526	6,631
Total LNG Mass (lbm):	737,774	39,681

lbm (pound-mass)

2.2 Selection Standards and Criteria

As part of the selection criteria process, Relativity considered and evaluated various Terran R launch sites. In accordance with Title 32 CFR 989.8, reasonable alternatives were evaluated using the following selection criteria:

1. Within the real property boundary of Relativity's current launch license;
2. SLC on the Eastern Range with existing infrastructure and Range Safety support capabilities;
3. SLC with opportunity for operational efficiencies in existing launch commodities and infrastructure to minimize capital expense;
4. Ability to safely support LEO and SSO launch trajectories; and
5. Launch site meeting the requirements for launches of the Terran R launch vehicle.

2.3 Alternatives Considered but Eliminated from Further Study

Other existing, no-longer operational CCSFS launch sites were evaluated, located as shown in ***Figure 3*** below. The following CCSFS and KSC sites were considered but eliminated as detailed below.

- ***SLC-20*** – The USSF has a real property license for SLC-20 with Space Florida. SLC-20 is currently sub-licensed to FireFly Aerospace, Inc. SLC-20 also did not provide efficiencies in launch commodities and infrastructure in order to minimize the extent of capital expenditures needed to build out the launch site. The extent of construction required at SLC-20 necessary to meet the requirements of the Terran R Launch Program would result in significant capital costs and extended buildout timelines that would not meet the projected launch schedule noted in ***Section 2.4.2.10***. SLC-20 is also not within Relativity's current real property boundary.
- ***SLC-46*** – The USSF has a real property license for SLC-46 with Space Florida. 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 could not be accommodated. Relativity was unable to come to terms with Space Florida during lease negotiations for SLC-46. No opportunities were present at SLC-46 for capitalizing on existing efficiencies in launch equipment or other commodities. Additionally, this launch complex is not within the current real property license boundary.
- ***SLC-15*** – SLC-15 was considered at the same time as SLC-16 as they are similar in layout. However, this launch complex was allocated to another launch service provider and the existing infrastructure at SLC-15 requires larger expenditures of time and construction scope. SLC-15's current allocation and additional construction requirements and lack of existing launch commodities does not allow site development to meet the Terran R launch requirement for minimized capital expenditures. SLC-15 is also not within the current Relativity real property boundary.
- ***SLC-34*** **–** SLC-34 was considered but is outside of the license area and has no existing usable infrastructure or potential efficiencies. Furthermore, this location is not ideal due to the extremely close proximity to SLC-37. Explosive safety quantity-distance criteria are used to establish safe distances from SLCs and associated support facilities to non-related facilities and roadways (through Department of Defense (DoD) and Air Force Explosive Safety Standards). Based on the explosive equivalent of propellant associated with the Terran R Program and considering related QD's, SLC-34 is not ideal to support Terran R due to the ongoing missions at SLC-37. Additionally, SLC-34 would not allow the Terran R Program to minimize capital expenses nor is SLC-34 within the real property boundary.
- ***SLC-48*** – SLC-48 was considered but is outside of the license area and has no existing usable infrastructure or potential efficiencies that would allow the Terran R Program to minimize capital expenses.
- ***SLC-49*** – SLC-49 was considered but is outside of Relativity's current license boundary area. SLC-49 is a greenfield site with no existing infrastructure to meet Relativity's requirement of minimal capital expense and existing launch infrastructure. Additionally, the timeline to bring SLC-49 to a functional state does not meet the timeline to support earlier Terran R launches.

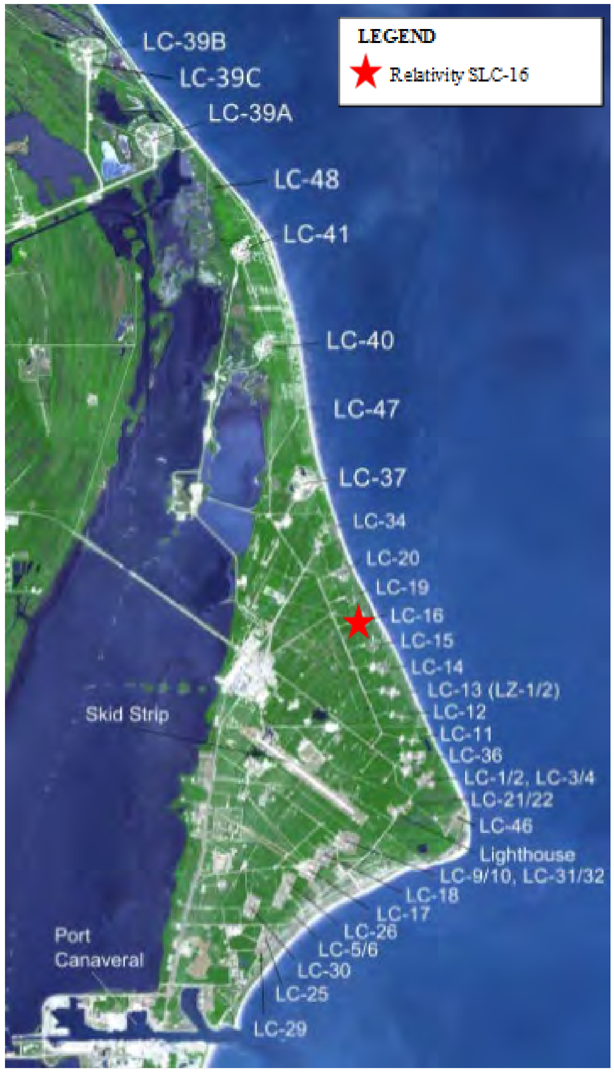


Figure 3. CCSFS Space Launch Complexes

No existing CCSFS space launch facilities outside of SLC-16 were found to meet all selection criteria mentioned in ***Section 2.2***. Additionally, SLCs are limited in availability and SLD 45 is not able to allocate another SLC to Relativity for Terran R; therefore, due to limited asset availability Terran R would need to stay within Relativity's current licensed boundary that was previously issued for Terran 1. Therefore, further evaluation of alternative launch site locations was eliminated from this analysis.

2.4 Alternatives Carried Forward for Analysis

2.4.1 No Action Alternative

The CEQ regulations, 40 CFR 1502.14, require agencies to consider a No Action alternative in their NEPA analyses. The No Action alternative serves as the baseline to compare the impacts of the Proposed Action and is analyzed in this SEA.

Under the No Action Alternative, the Terran R Program would not be implemented, and a new license would not be issued by the FAA. Under the No Action Alternative, no launch services would be provided by Relativity at SLC-16. The No Action alternative would not allow the DAF to capitalize on Relativity's technology and capabilities in order to support the purposes of the National Space Policy by actively promoting the purchase and use of US commercial space goods and services, nor would it reduce space transportation costs.

2.4.2 Space Launch Complex-16

SLC-16 (see ***Figure 4***) is the only existing SLC that meets all selection criteria described in ***Section 2.2*** and satisfies the purpose and need for the Proposed Action described in ***Section 1.3***. This location provides the ability for Relativity to build from the operations and infrastructure evaluated in the 2020 Terran 1 EA. This alternative provides the opportunity to modify the discontinued Terran 1 Program infrastructure and minimize construction of new infrastructure to support the Terran R Launch Program. Construction includes the expansion of the existing propellant farms and high-pressure gas storage area, upgrades to the existing Instrumentation Bay and renovations to the existing launch pad and flume. Existing personnel vehicle parking areas, roadways, stormwater systems and other utilities infrastructure would also be expanded to support the new Terran R Program. This selection avoids duplications in equipment and infrastructure that would be required at alternative locations outside of SLC-16, thus allowing Relativity to meet its 2026 milestones for the first Terran R launch. Additional details on SLC-16 modifications and upgrades are provided below.

Figure 4. SLC-16 Google Earth Aerial Imagery, 2022

2.4.2.1 SLC-16 Terran R Construction and Facility Modifications

The Proposed Action requires modifications to existing facilities and construction of new systems and facilities at SLC-16. Reference ***Figure 5*** for an overview of existing and proposed infrastructure at SLC-16. Modifications to the site include construction of a new launch pad and flume, HIF, ECS Facility, instrumentation bay, tech workshop, office, lightning protection towers, two (2) flare stacks, vehicle lighting, LNG and LOX storage tanks. Site upgrades may also include up to a 1,000,000-gallon water tower, with additional smaller ground storage vessels to support longer duration stage mission duty cycle (MDC) and static fire testing on site. Modifications to the recently renovated SLC-16 are required to support the larger Terran R launch vehicle and anticipated payloads. Construction of Terran R support infrastructure is expected to take 24 months.

2.4.2.1.1 New Launch Pad and Flame Trench

A new launch pad and concrete flame trench would be constructed to support the Terran R launch vehicle. Terran R upgrades would also include a newly designed and constructed deluge/sound suppression system to support new program requirements. A new lightning protection system, to protect the launch vehicle, would consist of new deep foundations, two (2) structural steel framed towers and a catenary down conductor system.

Figure 5. Terran R Program Proposed Action Modifications

2.4.2.1.2 New Horizontal Integration Facility

A new prefabricated HIF would be constructed for Terran R component integration prior to rollout to the pad for testing and launch. The facility would contain overhead cranes for use in vehicle and payload integration. Terran R payloads would be mated to the launch vehicle in the HIF, following processing in the annex with a Class 100,000 cleanroom. Class 100,000 cleanrooms have a maximum particle count of 100,000 particles (≥0.5 micrometers) per cubic foot of interior air. They are required to have HEPA filtration coverage over 4-5% of the area and provide a minimum of 20 air exchanges per hour with air flow rates of 4-8 cubic feet per minute (CFM) per square foot. Payloads would not be fueled on-site and no on-site storage for payload propellants would be provided. Fueled payloads containing up to 2,000 kilograms of monomethyl hydrazine (MMH), hydrazine, green propellants, and/or nitrogen tetroxide (N_2O_4) would be transported from external payload processing facilities to the SLC-16 HIF, where the payload would be mated to the launch vehicle and readied for launch.

The new HIF would be located directly east of the existing Terran 1 Shop Building with a new pad approach roadway for Transporter Erector (TE) roll-out of the Terran R to the pad. A new PPF, located on Azusa Road is being evaluated under a separate NEPA process as part of the Range of the Future (ROTF) assessment titled *Environmental Assessment for Eastern Range Planning and Infrastructure Development at Cape Canaveral Space Force Station, Florida*. Payload processing and integration facility air systems would be designed so they are resilient to smoke from potential prescribed or wildland fires.

2.4.2.1.3 New Instrumentation Bay and Environmental Control System Facility

A new Instrumentation Bay and ECS Facility would be constructed south of the new Terran R launch pad. ECS Facility would contain equipment to condition air to meet launch vehicle and payload temperature and humidity requirements while at the pad. Electrical and data communications systems in the Instrumentation Bay would be installed to support Terran R launch operation requirements.

2.4.2.1.4 SLC-16 Entrance and Security Modifications

Relativity would use the existing SLC-16 entrance from ICBM Road. An expanded paved parking are would be constructed near the existing security staging area and Badge Exchange shelter, located on the north side of the entrance road.

2.4.2.1.5 Propellant Farms and High-Pressure Gas Storage Area Modifications

The existing three (3) 13,000-gallon LOX storage tanks and dump basin would be expanded to support the Terran R launch vehicle. Modifications include the installation of 660,000 gallons of LOX storage tanks to support Terran R.

The existing 28,000-gallon LNG Storage Farm and LNG impoundment basin would be expanded and relocated to include 838,000 gallons of LNG storage tanks. Two (2) new LNG flare stacks would be constructed for additional burn-off.

2.4.2.2 Terran R Launch Vehicle Components

Terran R vehicle stages and payloads would be transported from either the factory in Los Angeles County, CA or Relativity's test site at Stennis Space Center, MS via vessel/barge to a commercially available port or CCSFS-located wharf. Terran R vehicle stages and payloads would then be loaded on standard over-the-road tractor-trailers fitted with specialized cradles and transportation hardware for transport to SCL-16. Axle loading is anticipated to be less than American Association of State Highway Transportation Officials (AASHTO) HS-20 design criteria loading.

Terran R first stage vehicle components are fully reusable. However, during early program development, Terran R may be expended in the ocean. Following payload separation, jettisoned payload fairings would become debris, landing in the ocean.

2.4.2.3 Terran R Ground Support Operations

Terran R pre-launch ground support operations would consist of Stage Checkouts, Stage Mate and Integration into TE, Functional Checkouts, Fairing Mate, and Vehicle Fueling.

Arrival on-site - The Terran R S1, S2, fairing, and additional hardware such as spare components or nozzles would arrive separately, via truck or vessel/barge, from the Los Angeles County, CA manufacturing facility and delivered to the SLC-16 HIF.

Payload Preparation - Payload processing activities such as fueling and checkouts would be performed at the new PPF along Azusa Road. If additional checkouts are required before testing/launch, they can occur within the cleanroom attached to the HIF at SLC-16. Encapsulated payloads would be delivered by truck to the HIF, where the payload would be mated to the launch vehicle and readied for launch. Payloads may contain up to 2,000 kilograms of MMH, green propellants, hydrazine, and/or nitrogen. ***Table 3*** provides additional anticipated payload fuel types and quantities for the Terran R Program.

Table 3. Additional Anticipated Payload Fuel Types and Quantities

Fuel Type (Varying Spacecraft)	Loaded Quantity (per spacecraft)	Number of Spacecraft	Total Fuel Qty per Launch
Hydrazine (N_2H_4)	164 kg/362 lbs.	12	1640 kg/3620 lbs.
Monomethyl Hydrazine	20kg/44lbs	1	20kg/44 lbs.
Green prop – (e.g. AF-M315E, LMP-103S)	81 kg/180 lbs.	20	1620 kg/3600 lbs.
Isobutane	50 kg/110 lbs.	20	1000 kg/2200 lbs.
Xenon	15 kg/33 lbs.	15	225 kg/495 lbs.
Krypton	50 kg/110 lbs.	27	1350 kg/2970 lbs.
Kerosene	700 kg	1	700 kg/1540 lbs.
Hydrogen Peroxide (95% purity)	2400 kg	1	2400 kg/5280 lbs.
Hydrogen Peroxide (35% purity)	1200kg	1	1200kg/2640 lbs.
H_2O_2 (Unknown Purity)	50 kg/110 lbs.	20	1000 kg/2200 lbs.
De-ionized water	150 kg/330 lbs.	20	3000 kg/660 lbs.
Nitrous Oxide	46.4 kg/102 lbs.	1	46.4 kg/102 lbs.
Ethane	21.8 kg/48 lbs.	1	21.8 kg/48 lbs.

Vehicle Stage Integration – S1 and S2 would be placed on individual integration carts, allowing for checkouts, closeout, alignment, and mating. The Terran R vehicle will have an ordnance-based Flight Termination System that will be installed in the final stage of vehicle integration A small amount of DOT Hazard Classification System, Division 1.4 and Division 1.1 ordnance would be handled during launch vehicle preparation within the HIF. Small quantities (less than five (5) gallons) of lubricants, aerosols and cleaning agents needed for launch vehicle integration would be maintained in approved chemical lockers in the HIF.

Vehicle to TE Integration - The integrated launch vehicle would 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 HIF 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 Roll-out - The TE transports the Terran R 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 would be erected, and final checkouts completed. After final system checkouts, mission rehearsals (dry without propellants or wet with propellants) would typically occur to allow for team training and coordination with CCSFS.

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

2.4.2.4 Terran R Test Operations

Stage MDC Hot Fire Testing – The Stage MDC Hot Fire testing consists of fully fueling the vehicle and igniting the engines to provide a thorough test of all systems. Stage hot fire tests are anticipated to last 30 seconds with an estimated 14 tests occurring per year. Stage hot fire testing at SLC-16 would occur between several days to weeks before Static Fire Testing.

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 approximately eight (8) seconds, depending on the test being performed. Static test fires are required prior to every launch with up to 24 static test fire events expected per year. Static fire test events would occur between several days to weeks before each individual launch.

2.4.2.5 Terran R Launch Operations

Following static test fire, the Terran R launch vehicle would be lowered to the horizontal position and rolled back into the HIF. The encapsulated payload would be mated to the vehicle. The integrated payload and launch vehicle would roll out to the pad and be erected to the vertical orientation for launch.

All launch and reentry operations would comply with the necessary notification requirements, including issuance of local and international NOTAMs and NOTMARs, as defined in agreements required for a launch vehicle operator license issued by the FAA. Advance notice via NOTAMs assists general aviation pilots in scheduling around any temporary disruption of flight activities in the area of operation. A NOTAM provides notice of unanticipated or temporary changes to components of, or hazards in, the National Airspace System (FAA Order JO 7930.2S, Notices to Air Missions). The FAA issues a NOTAM at least 72-hours prior to a launch or reentry activity in the airspace to notify pilots and other interested parties of temporary conditions. Advance notice via NOTAMs and the identification of Aircraft Hazard Areas would assist pilots in scheduling around any temporary disruption of flight activities in the area of operation. Launches and reentries would be infrequent, of short duration, and scheduled in advance to minimize interruption to air traffic.

To comply with the FAA's licensing requirements, Eastern Range operations follow the procedures stated in a LOA (dated October 28, 2022) between SLD 45 and the FAA. The LOA outlines procedures and responsibilities applicable to operations including notification of launch activity; communication procedures prior to, during, and after a launch; planning for contingencies/emergencies; NOTAM issuance; and any other measures necessary to protect public health and safety. The LOA establishes responsibilities and describes procedures for SLD 45, Eastern Range operations, within airspace common to the Miami Center, Jacksonville Center, New York Center, San Juan Center Radar Approach Control, Central Florida Terminal Radar Approach Control, NASA Shuttle Landing facility, Fleet Area Control and Surveillance Facility Jacksonville, Air Traffic Control System Command Center, and Central Altitude Reservation Function areas of jurisdiction. The LOA defines responsibilities and procedures applicable to operations, which require the use of Restricted Areas, Warning Areas, Air Traffic Controlled Assigned Airspace, and/or altitude reservations within Eastern Range airspace. The Proposed Action would not require the FAA to alter the dimensions (shape and altitude) of the airspace. However, temporary closures of existing airspace may be necessary to ensure public safety during the proposed operations.

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

Relativity would submit a Flight Safety Data Package to the FAA in advance of the launch or reentry. The package would include the launch/reentry trajectory and associated Aircraft Hazard Areas. These Aircraft Hazard Areas define the temporarily closed airspace that would be defined and published through a NOTAM prior to the launch/reentry. FAA Air Traffic Organization Space Operations Office uses the Aircraft Hazard Area information to produce an Airspace Management

Plan, which describes the launch/reentry information and any associated impacts to the National Airspace System. Airspace controlled by the FAA may be restricted through the activation of airspace closures. The most common type of airspace closures are Temporary Flight Restrictions (TFR) and altitude reservations. The FAA generally uses TFR to protect airspace over land up to 12 nautical miles offshore and altitude reservations to protect oceanic airspace beyond 12 nautical miles offshore. The NOTAM would establish a closure window that is intended to warn aircraft to keep out of a specific region throughout the time that a hazard may exist. The length of the window is primarily intended to account for the time needed for the operator to meet its mission objectives. The location and size of the closure area is defined to protect the public. For a launch or reentry, typically the keep-out must begin at the time of launch and ends when the mission has been completed, terminated, or cancelled. Airspace closures are immediately released once the mission has successfully cleared the area and no longer imposes a risk to the public. The actual duration of airspace closure is normally much less than the original planned closure, especially if the launch or reentry window is relatively long and the launch or reentry occurs at the beginning of the window. The FAA typically begins to clear airspace and reroute aircraft in advance of a launch or reentry and directs aircraft back into the released airspace after the mission to recover to normal flow and volume.

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

All launch and reentry operations would comply with necessary notification requirements, including issuance of NOTMARs, as defined in agreements required for a launch license issued by the FAA. The USCG would be responsible for issuing NOTMARs that provide hazard area locations prior to each mission event with ocean impacts. A NOTMAR provides a notification regarding a temporary hazard within a defined area (a Ship Hazard Area [SHA]) to ensure public safety during proposed operations. A NOTMAR itself does not alter or close shipping lanes; rather, the NOTMAR provides a notification regarding a temporary hazard within a defined area to ensure public safety during the proposed operations. This tool provides both an established and reliable line of communication with the maritime public. The NOTMAR would include the dates and times of the operations and coordinates of the hazardous operation area.

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

The USCG publishes NOTMARs weekly and as needed, informing the maritime community of temporary changes in conditions or hazards in navigable waterways. Notices in international areas are published by the National Geospatial Intelligence Agency (NGA). Advance notice via

NOTMAR and the identification of SHAs would assist mariners in scheduling around any temporary disruption of shipping activities in the area of operation. The Proposed Action would not require shipping lanes to be altered or closed.

The Terran R Program includes temporary closures of existing airspace and navigable waterways only. No changes to airspace dimensions, such as shape and altitude, are proposed. Advanced notice via NOTAMs and NOTMARs would allow general aviation pilots and mariners to anticipate temporary disruption to flight and shipping activities during launch operations. Launch operations would be of short duration, up to four (4) hours, and scheduled in advance to minimize interruption to airspace and waterways.

If Relativity anticipates international impacts, Relativity has an LOA with the FAA to conduct international NOTAMs. Relativity would lead any international coordination and the US Department of State would provide assistance upon request.

2.4.2.6 Terran R Booster Landing Operations

The Proposed Action also includes landing of the Terran R launch vehicle booster on a Relativity ocean-going barge in the Atlantic Ocean. Reentry activities occurring in the marine environment would occur in deep waters at least five (5) nautical miles off the coast of the CCSFS, with most activities occurring hundreds of miles offshore. The only component of the launch and reentry operations that occurs near (less than 5 NM offshore) the coast are the vessels (watercraft) transiting to and from Port Canaveral during pre-launch surveillance or when recovering and transporting spacecraft or launch vehicle components in the ocean. NOTAM and NOTMARs, discussed in ***Section 2.4.2.5*** above, would apply to all booster landing operations for the Terran R launch vehicle, resulting in temporary closures of airways and navigable waterways. The USCG would notify maritime stakeholders of events impacting navigation safety. The FAA would notify aviation pilots of temporary closures to airspace.

The landing platform would be a USCG classed vessel, likely a barge hull platform with self-propulsion. The barge would be towed into the landing location and disconnected from its tow wire. The barge would have an onboard propulsion system controlled via a commercial-off-the-shelf dynamic positioning system with a minimum of DP-1 requirements. No anchoring would be required to maintain the position of the ocean-going barge. A maximum of 24 ocean-based barge booster landings per year are anticipated as part of the Terran R Program. However, during launches still early in the program development, Relativity may require expending Terran R in the ocean.

During a Terran R launch, S1 will continue travelling downrange after jettison and perform entry and landing burns to target a precise landing location and associated target velocity and attitude. The maximum error on the S1 landing location relative to the target will be less than 10 meters for a nominal mission. This landing location will be within the proposed Region of Influence (ROI), see ***Figure 6*** and discussion in ***Section 3.2.2.2***, and is defined for a particular mission trajectory. The S1 landing location's azimuth relative to the launch site is determined by the mission trajectory's launch azimuth. The landing location's downrange distance is determined by the trajectory's insertion orbit, atmospheric constraints, and S1 reentry constraints.

Following fairing separation, two jettisoned payload fairing halves are uncontrolled and would become debris, landing in the ocean. The fairing debris footprint for any Terran R mission will be bounded by the proposed ROI, with the debris footprint of a particular mission trajectory being much smaller. Like S1, the fairing's landing location varies with the mission trajectory's launch azimuth, insertion orbit, atmospheric conditions, and S1 reentry constraints.

For all Terran R Program missions, S2 would be placed in a disposal orbit. Disposal orbits are orbits that, because 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 R S2 would also be passivated to preclude debris creation resulting from explosive overpressure or electric discharge. These techniques are in accordance with the National Security Space Launch program System Performance Document and international agreements on space debris minimization.

The Terran R landing operations include a controlled S1 entry, descent, and landing, including up to two (2) burn phases with a subset of S1 engines. Following stage separation, the first stage would be maneuvered into position for a retrograde entry burn. The entry burn performs a restart of three engines to reduce velocity and lower atmospheric heating and loads on the stage. After entry burn cutoff, the stage performs a controlled atmospheric flight to guide the stage towards a designated landing site up to approximately 300-500 nautical miles offshore. Once the first stage is in position and approaching the ocean-going barge, three of the engines would ignite to perform the landing burn. The landing burn is performed to reduce velocity and maintain attitude control. Partway through the landing burn, two of the engines are shut down and the burn is completed using a single engine. The landing burn is cutoff after the vehicle touches down on the landing platform. A sonic boom is anticipated during return, see ***Section 3.7.3.3*** for details and figures. Landing legs would deploy prior to final single engine burn that would slow the stage and enable a landing.

An ocean-going barge landing in the Atlantic Ocean would require three (3) vessels: an unmanned ocean-going barge, a support vessel, and an ocean tug. The support vessel is a research vessel that may house the crew, instrumentation, and communication equipment, as well as assist with debris collection, if possible. The tug is a commercial ocean vessel that operates in open waters. Relativity would work with both the USCG and the American Bureau of Shipping (ABS) on the classification of the recovery platform. This effort would begin with plan reviews involving ABS, local USCG Marine Safety Detachment (MSD), and USCG Marine Safety Center (MSC) for platform development approval. Relativity plans on utilizing Subchapter I vessels.

The tug tows the ocean-going barge into position at the landing spot and then returns to Port Canaveral, or NASA/USSF docks with the ocean-going barge and rocket. Once offloaded at a Port wharf or NASA/USSF dock, the rocket would be transported to SLC-16 within CCSFS by standard over-the-road tractor-trailers. Hazardous materials would be off-loaded after the ocean-going barge is docked. Any hazardous materials would be handled in accordance with federal, state, and local laws and regulations. CCSFS has established plans and procedures to handle and dispose of hazardous materials and solid wastes. Relativity has an established emergency response team, and any unexpected spills would be contained and cleaned up per the procedures identified in Relativity's Emergency Action Plan and Spill Prevention, Control, and Countermeasures Plan (SPCC).

Landing operations will include both landings onto an ocean-going barge and soft-water landings in the Atlantic for missions early in the program development. The nominal velocity for both landing on an ocean-going barge and soft-water landings is approximately 10 feet per second. For planned expendable missions, S1 will nominally perform a controlled, vertical landing at low velocities for a soft-water landing with only residual propellant remaining in the tanks at the time of impact. Residual propellant values result in LOx and LNG tank concentrations of less than 0.3% and 2.1%, respectively, assuming tank volumes of at least 500 cubic meters and standard propellant densities. The preliminary S1 conditions at water impact provided in the Terran R Preliminary Jettison and Breakup report (see ***Appendix C***) represent a conservative outlook. Relativity does not reasonably foresee a potential for explosion at such low levels of propellant concentration. Maximum expected propellant values reported assume unburned residual propellant mass after performing a landing burn. Similarly, given the lack of potential ignition mechanisms, Relativity does not consider a mixed combustion event as reasonably foreseeable. Relativity's analysis of the behavior of the Terran R vehicle after jettison during separation event and upon potential impact with a marine environment is discussed in ***Section 3.5.3.2.***

When a Terran R booster reaches the end of its useful life, it will either carry out an expendable/soft water landing final flight or would be deconstructed at a Relativity facility. The deconstructed booster parts with remaining service life could be reused on other boosters. Any end-of-life parts or other scrap material would be handled by an approved third party with experience disposing of proprietary material. There are no plans to dispose of Stage 1 with an uncontrolled, fast water landing.

2.4.2.7 Launch Operations Personnel

On average, a full-time staff of approximately 25 persons would be onsite for ground support operations, ramping up to approximately 50 essential personnel during peak launch operations at SLC-16, not including customer payload support personnel or launch control center personnel.

2.4.2.8 Operations Safety Plan

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

- Space Systems Command Manual (SSCMAN) 91-710V1 – V5, Range Safety Requirements, as tailored for the Terran R 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
- 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

2.4.2.9 Launch Trajectories

The Terran R Program launch vehicle trajectories would be specific to each particular mission. Flight trajectories vary based on mission parameters such as payload and desired orbit. The Terran

R launch azimuths would range from 41° to 105° for block 1 of the Terran R vehicle, as shown in ***Figure 6*** and would be specified for a given mission based on the desired inclination at orbit insertion. The altitude and downrange distance profiles are also mission specific and are based on desired insertion orbit and atmospheric constraints on the vehicle.

2.4.2.10 Projected Launch Schedule

The first Terran R Program launch from SLC-16 is anticipated in 2026, ramping up to 24 anticipated maximum annual launches per year. This is an increase in launch cadence compared to the 12 launches per year analyzed in the 2020 Terran 1 EA. For purposes of this SEA, a maximum launch rate of 24 Terran R launches per year from CCSFS will be analyzed. One (1) launch of the Terran R orbital launch vehicle would occur in 2026, ramping up to eight (8) launches in 2027 and up to 24 launches per year beginning in 2028.

First stage landing on an ocean-based barge would occur following each launch. However, during early launches in the program development, Relativity may require expending Terran R in the ocean. For the first two (2) launches, Relativity plans to conduct a controlled S1 entry, descent, and soft-landing into the ocean, resulting in Terran R's intact impact with the ocean's surface. If a flight anomaly is experienced during these two (2) Terran R missions, Relativity may choose to expand the number of missions that have an expendable S1 with a soft-landing into the ocean. For subsequent launches, S1 will be recovered after performing a controlled entry, descent, and landing onto an ocean-based barge.

Depending on mission requirements, launches could occur during daylight or nighttime hours. The anticipated lifespan for the Terran R Program is beyond 10 years. As mentioned previously, the Terran 1 Program has been suspended, therefore, the 12 Terran 1 launches evaluated in the Terran 1 EA would be replaced by the 24 launches per year under the Terran R Program.

2.4.2.11 Payloads

The Terran R mission payloads would be similar to current commercial and government payloads expected over the next 10 years. The Terran R can deliver payloads up to 33,500 kg. No payloads with nuclear material are anticipated. Payloads would be processed offsite at the Azusa Road PPF or at an off-base customer site. Following processing, the payload would be transported to the HIF and PPF in accordance with DOT requirements.

In November 2011, NASA prepared an EA, with USAF as a cooperating agency for *Launch of NASA Routine Payloads (NRP) on Expendable Launch Vehicles* (NASA, 2011) which was adopted by USAF. This document verified that no new or substantial environmental impacts or hazards were identified for NASA routine payloads.

An initial assessment of potential Terran R payloads determined that anticipated payloads fit within the scope of the 2011 NASA Routine Payload EA using ***Table 4***, shown below.

Table 4. Summary of Envelope Payload Characteristics by Spacecraft Subsystems

Characteristic	Description
Structure	• Unlimited: aluminum, beryllium, carbon resin composites, magnesium, titanium, and other materials unless specified as limited.
Propulsion[a]	• Liquid propellant(s); 3,200 kilograms (7,055 pounds) combined hydrazine, monomethyl hydrazine 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.).
Communications	• Various 10–100-Watt (RF) transmitters.
Power	• 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 (NiCad), or Nickel-hydrogen (Ni-H2) battery.
Science Instruments	• 10-kilowatt radar. • American National Standards Institute safe lasers.
Other	• U. S. Department of Transportation Class 1.4 Electro-Explosive Devices 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.

[a] Propellant limits are subject to range safety requirements.
Source – NASA Routine Payload EA, 2011

3 Affected Environment and Environmental Consequences

In compliance with NEPA and CEQ guidelines, this Section describes the existing environment and environmental consequences for the Proposed Action and No Action Alternative. For each resource area, an ROI is established that defines an area where the federal action, program or activity may cause an impact. The ROI for this assessment is SLC-16, Port Canaveral and the Atlantic Ocean booster landing location which is within the Atlantic Ocean Action Area defined in the NMFS Programmatic Consultation for Launch and Reentry Vehicle Operations in the Marine Environment.

As stated in ***Section 1***, this SEA complies with FAA Order 1050.1F (the FAA's NEPA-implementing policies and procedures), so the FAA can easily adopt this SEA 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.

Section 1 of this SEA contains an introduction to the Terran R Program and the scope of the proposed action. ***Section 2*** of this SEA describes the Proposed Action and Alternatives. ***Section 3*** describes the 12 affected resources identified for analysis and the environmental consequences associated with each resource: Air Quality, Water Resources, Soil and Geological Resources, Cultural Resources, Biological Resources, Land Use/Coastal Resources, Noise, Infrastructure, Public Health and Safety, Hazardous Materials and Wastes, Socioeconomics, Environmental Justice, and the impacts in each environmental aspect area. ***Section 4*** describes cumulative environmental impacts. ***Section 5*** provides a summary of applicable environmental regulations. ***Section 6*** list references, ***Section 7*** provides a list of preparers.

The following resources were considered but not analyzed in detail in this SEA:

- **Farmlands.** The Proposed Action would not convert prime agricultural land to other uses or result in a decrease in the land's productivity. No farmland is present within the Proposed Action area.
- **Natural Resources and Energy Supply.** The Proposed Action would not have a measurable effect on natural resources, such as water, asphalt, aggregate, or wood. The action does not have the potential to cause demand to exceed available or future supply of these resources.
- **Children's Environmental Health and Safety Risks.** The USSF controls public access to CCSFS and therefore no member of the public would be present around the launch site during launch operations. Therefore, the Proposed Action does not have the potential to lead to a disproportionate health or safety risk to children.

3.1 Air Quality and Climate

This section describes air quality resources at CCSFS for the atmosphere at altitudes below 3,000 feet above ground level, which contains the atmospheric boundary layer for CCSFS. Air quality impacts are determined by the type and number of pollutants emitted in the atmosphere, the topography of the air basin, and meteorological conditions. 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 within Brevard County and 12 miles offshore to include US territorial seas.

3.1.1 Regulatory Setting

National Ambient Air Quality Standards (NAAQS) 40 CFR Part 50-51, Title V of the Clean Air Act (CAA) Part 70, 40 CFR Part 61 and 63 (National Emission Standards for Hazardous Air Pollutants [NESHAPs]), 40 CFR Part 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. Pollutants regulated under the CAA that have established NAAQS include six (6) common air pollutants also known as "criteria" air pollutants. These include Particulate Matter (PM) (further segregated to particulate matter equal to or less than 10 microns [PM10] and particulate matter equal to or less than 2.5 microns [PM2.5]), Ozone (O3), Carbon Monoxide (CO), Sulfur Dioxide (SO2), Nitrogen Dioxide (NO2), and Lead (Pb).

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. The regulated substances and threshold quantities are provided in 40 CFR 68.130. Both methane and ethane are regulated substances listed under 40 CFR 68.130 ***Table 3*** (Regulated Flammable Substances), with a threshold quantity of 10,000 pounds. However, US EPA has an exclusion under RMP requirements, which is outlined in 40 CFR 68.126. This states, *A flammable substance listed in **Tables 3 and 4** of § 68.130 is nevertheless excluded from all provisions of this part when the substance is used as a fuel or held for sale as a fuel at a retail facility.*

Since methane and ethane, components of LNG fuel, are used as a fuel at SLC-16, they meet the criteria of the exemption under 40 CFR 68.126 and are therefore not subject to the provisions of RMP.

FAA Order 1050.1F provides guidance for Greenhouse Gasses (GHGs) and climate considerations under NEPA. To assess GHGs, incremental changes in CO_2 emissions during the Proposed Action should be considered to accomplish an FAA NEPA review. Analysis of GHG emissions may be qualitative or quantitative to identify impacts to the overall climate.

3.1.2 Affected Environment

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°F 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 influence the state's weather, which is punctuated by thunderstorms, lightning, and hurricanes.

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 USSF 45TH Weather Squadron (45 WS). The 45 WS provides weather support to the space program at CCSFS and KSC. They provide technical and climatological consultations to SLD 45 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 CCSFS launch vehicles. Extensive forecasting is conducted to minimize possible negative short-term effects in air quality in the event of a launch failure or anomaly.

In Florida, regional air quality is assessed at the county level. If the air quality in a geographic area meets or is cleaner than the national standard, it is called an attainment area; areas that don't meet the national standard are called nonattainment areas. CCSFS is located within Brevard County which has been designated by both EPA and Florida Department of Environmental Protection (FDEP) to be in attainment for all NAAQS Criteria Pollutants. 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 monitoring stations in Melbourne and Cocoa Beach. The only monitoring at these stations was for ozone and PM as shown in ***Table 5***.

Table 5. Measured Ambient Air Concentrations of Criteria Pollutants Brevard County

Pollutant	Average Time	Nearest Monitoring Station	Maximum Measured Concentration (ppm, except PM in μm/m^3)				
			2017	2018	2019	2020	2021
Ozone	1 Hour	Cocoa Beach	75	84	71	73	65
Ozone	8 Hour	Cocoa Beach	69	79	67	64	60
Ozone	1 Hour	Melbourne	69	64	97	69	68
Ozone	8 Hour	Melbourne	66	60	55	63	62
$PM_{2.5}$	24 Hour	Melbourne	26.8	no monitoring	19.7	27.6	27
PM_{10}	24 Hour	Melbourne	53.9	27.3	67.1	93.7	73.3
Source - https://fldep.dep.state.fl.us/air/flaqs/HighReport.asp?HighestYear=2021&SiteId=120090007							

GHGs are gas emissions from natural processes and human activities that trap heat in the atmosphere. 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 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 6 summarizes the latest CCSFS GHGs Emissions data. CCSFS emissions are small compared to global emissions, so the cumulative impact would not be significant. CO2-equivalent emissions in this report are—if not stated otherwise—aggregated using global warming potentials (GWPs) over a 100-year time horizon.

Table 6. Summary of Greenhouse Gases Emissions for CCSFS (2020-2022)

GHG	2020 GHG Emissions		
	Ton (Short)	**Ton (Metric)**	**MTCO2e**
Carbon Dioxide (CO_2)	8,470	7,684	7,684
Nitrous Oxide (N_2O)	0.0307	0.0278	8.3
Methane (CH_4)	0.2109	0.1914	4.8
Total Reportable GHG for 2020			**7,697.1**
GHG	**2021 GHG Emissions**		
	Ton (Short)	**Ton (Metric)**	**MTCO₂e**
CO_2	6,641	6,025	6,025
N_2O	0.022490	0.0204	6.1
CH_4	0.160416	0.1455	3.6
Total Reportable GHG for 2021			**6,034.7**
GHG	**2022 GHG Emissions**		
	Ton (Short)	**Ton (Metric)**	**$MTCO_2e$**
CO_2	6,518	5,913	5,913
N_2O	0.02767	0.0251	7.5
CH_4	0.17682	0.1604	4
Total Reportable GHG for 2022			**5,924.5**
Source: APIMS Greenhouse Gas Emissions Summary, Andrew Phillips 45 CES/CEIE Note: MTCO2e: Metric Ton Carbon Dioxide Equivalent			

Because SLC-16 is near the Atlantic Ocean (1,000 feet east of pad centerline) 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 Intergovernmental Panel on Climate Change (IPCC), global mean sea level (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.

At CCSFS, MSL is approximately 0.587 feet North American Vertical Datum of 1988 (NAVD88). Mean water level of the Indian River Lagoon (including 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 CCSFS fluctuate cyclically, with maximum heights generally in October and minimal elevations in February and March (NASA, 2013).

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 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 ROI for air quality and climate includes all CCSFS and Brevard County, including both lower and upper atmospheres. An action is considered insignificant if the annual net change in emissions for each pollutant of concern is below the general insignificance indicator for an air quality NEPA assessment.

3.1.3 Environmental Consequences

Air emissions from the Proposed Action include emissions associated with construction, ground support operations and launches. Although listed chemicals may be used in excess of RMP thresholds, fuels are exempt from CAA RMP requirements as discussed in ***Section 3.1.1***. Therefore, preparation of an RMP will not be required as part of the Terran R Program.

3.1.3.1 Construction

Air emissions, including generation of GHGs, from construction activities at SLC-16 would be consistent with those evaluated in the Terran 1 Program EA. Vehicles would emit exhaust CO, NO_x, and SO_2 during project construction operations. PMs would be generated during construction activities from equipment exhaust used to grade, dig, and perform other construction related activities. The two (2) main pollutants of concern in diesel exhaust that affect human health are NO_x and PM. NO_x and PM emissions during construction were estimated using the Air Conformity Applicability Model (ACAM) (***Appendix F***). During the first year of construction, 3.59 tons of NO_x and 47.02 tons of PM are estimated to be emitted, followed by 2.60 tons of NO_x and 12.85 tons of PM the second and final year of construction. The remaining criteria air pollutant emissions during the first year of construction are shown in ***Table 7*** below. Based on these estimates within the ACAM modeling software, the action would not cause an exceedance on one or more NAAQSs.

Table 7. ACAM Construction Emissions Output

Pollutant	Emissions		Insignificance Indicator	
	2024	2025	Indicator (ton/year)	Exceedance (Yes or No)
VOC	0.652	0.520	250	No
NO_x	3.588	2.596	250	No
CO	4.247	3.691	250	No
SO_x	0.059	0.055	250	No
PM10	47.016	12.847	250	No
PM2.5	0.178	0.152	250	No
Pb	0.000	0.000	25	No
NH_3	0.011	0.007	250	No
$CO2_e$	1250.4	801.5	--	--

Based on the EPA 2021 National-Level US GHG Inventory, approximately 6,347 million metric tons of CO_2 equivalents were emitted (EPA, 2023). Based on calculations within ACAM, emissions during the first year of construction operations are estimated to be 1,250.4 metric tons of CO_2 equivalents and 801.5 metric tons of CO_2 equivalents the second and final year of construction (***Appendix F***). As previously shown in ***Table 6***, the 2022 GHG emissions from CCSFS totaled 5,924.5 metric tons of CO_2 equivalents. Although construction for the Terran R Program would increase the emissions of CO_2 equivalents from CCSFS, this impact would be short-term and localized.

Construction activities are not expected to significantly change regional (Brevard County) or local (CCSFS) air pollutant or GHG emissions. No NAAQS exceedances are expected during construction. Therefore, construction of the Proposed Action would not have significant impacts to air quality and climate.

3.1.3.2 Ground Support Operations and Maintenance

Ground support operations air emissions would also be similar to those evaluated in the Terran 1 Program EA. Emissions would include PM, VOC, NO_x, SO_x, HAPs and CO_2/CO from intermittent sources noted below:

- Fugitive emissions due to road dust or modification of existing facilities
- Vehicle, mobile equipment emissions
- Lead-acid 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 stacks
- LNG, LN_2, LOX storage and supply fugitive emissions
- Isopropyl Alcohol (IPA) flush carts
- Fugitive emissions from hand-wipe cleaning, application of adhesives, and other maintenance activities

Potential air emissions from the proposed testing campaigns and launches would include activities related to liquid fuel loading (LOX and LNG) and the projected number of maximum launches. Air permits are not required for emissions from the launches, as these are mobile sources, are temporary in nature, and not considered to be major emissions of criteria pollutants or HAPs (FAC Rule 62-210.300(3)(a)). Title V air permitting with FDEP is anticipated from emissions generated from stage MDC hot fire and static fire testing.

Relativity ground support operations use no ozone depleting substances. The Terran R launch preparation and ground support operations emissions are expected to be below CCSFS criteria pollutant and HAP emissions.

Emissions during ground support operations and maintenance were also estimated using ACAM (***Appendix F***). Criteria air pollutant emissions following construction activities at SLC-16 are shown in ***Table 8*** below.

Table 8. ACAM Ground Support Operations and Maintenance Emissions Output

Pollutant	Emissions	Insignificance Indicator	
	2027	Indicator (ton/year)	Exceedance (Yes or No)
VOC	0.056	250	No
NO_x	0.045	250	No
CO	0.642	250	No
SO_x	0.000	250	No
PM10	0.001	250	No
PM2.5	0.001	250	No
Pb	0.000	25	No
NH_3	0.003	250	No
$CO2_e$	57.6	--	--

Based on these estimates within the ACAM modeling software, no NAAQS exceedances during ground support operations would occur. Therefore, ground support operations would not have significant impacts to the existing air emissions within CCSFS and Brevard County, including both lower and upper atmospheres.

3.1.3.3 Stage MDC Testing, Static Fire, Launch and Landing

Relativity contracted with BRRC to develop the technical report titled *Emissions Study for Relativity Space Terran R Operations at CCSFS* (***Appendix F***) to quantify emissions associated with the Terran R launch vehicle. Project-related annual emissions from construction and operational activity are compared against a 250 tons per year significance threshold as shown in ***Table 9.*** BRRC used their Rocket Propulsion Noise and Emissions Simulation Model (RUMBLE 4.1) to predict the annual emissions associated with the proposed 24 static fire tests at eight (8) seconds, 14 stage MDC hot fire tests at 30 seconds, 24 launches, and 24 S1 ocean-based barge landings (see ***Table 10***). It should be noted, RUMBLE 4.1 does not analyze SO_2 and VOC emissions. SO_2 emissions are negligible due to the extremely low concentrations of sulfur impurities in LNG. VOCs are not typically emitted by launch vehicles. Based on BRRC's analysis, Terran R launch operations emissions are not considered to be a significant impact as detailed below.

Emissions from stage MDC testing, static fire, launch and landing operations would be similar in composition to the Terran 1 Program, but at a larger scale, due to increased number of engines and the additional engine burns during stage MDC hot fire tests and ocean-based barge landing operations. The Terran R vehicle is equipped with up to 14 S1 Aeon R engines and one (1) S2 Aeon Vac LNG/LOX engine. All Aeon engines use LOX and LNG as propellant. Water vapor (H_2O) and CO_2 are the main pollutants emitted because they are the products of complete combustion between oxygen and LNG. However, the combustion process in a rocket engine is typically incomplete. Small amounts of black carbon (BC), CO and NOx are also emitted. BC is the only significant source of PM emitted by the Terran R launch vehicle. The pollutant masses in metric tons (103 kg) per year are presented by atmospheric layer: troposphere below the mixing height (3,000 feet above ground level), troposphere above the mixing height, stratosphere, and mesosphere. ***Table 9*** provides the expected annual mass of pollutants, in US tons, emitted for both construction and launch operations combined, along with the significance threshold for each pollutant. ***Table 10*** summarizes the annual mass of pollutants, in metric tons, emitted during stage MDC hot fire tests, static fire, launch and landing. ***Table 11*** summarizes the annual mass of pollutants, in metric tons, emitted during stage MDC hot fire tests. ***Table 12*** summarizes the annual mass of pollutants, in metric tons, emitted during static fire events.

Table 13 summarizes the annual mass of pollutants, in metric tons, emitted during launch events, and ***Table 14*** summarizes the annual mass of pollutants, in metric tons, emitted during ocean-based barge landing events.

Table 9. Total Annual Pollutant Mass in US Tons Emitted – Construction and Launch Operations

Atmospheric Layer	CO_2	H_2O	CO	NO_x	BC	SO_x	VOC	O_3	PM_{10} $PM_{2.5}$	Pb
Troposphere Below 3,000 feet (Construction)	1,250	-	4.2	3.6	-	0.1	0.7	-	47.02 0.18	-
Troposphere Below 3,000 feet (Test/Launch/Landing)	4,974	4,086	10	217	1.3	-	-	-	-	-
Total	6,224	4,086	14.2	220.6	1.3	0.1	0.7	-	47.2	-
Insignificance Indicator	-	-	250	250	-	250	250	-	250	25
Threshold Exceeded?	-	-	No	No	-	No	No	-	No	No

Note: Construction emissions were estimated with Air Conformity Applicability Model v5.0. Values from 2024 projections, during maximum construction activity.

BRRC emissions values shown in US tons.

Table 10. Annual Pollutant Mass in Metric Tons Emitted (14 Stage MDC Hot Fire Tests, 24 Static Fire Tests, 24 Launches, 24 S1 Landings)

Atmospheric Layer	CO_2	H_2O	CO	NO_x	BC	SOx	VOC	O_3	PM	Pb
Troposphere Below 3,000 feet	4,513	3,707	9.2	197	1.2	-	-	-	-	-
Troposphere Above 3,000 feet	3,906	3,212	11	67	1.1	-	-	-	-	-
Stratosphere	6,846	5,767	127	3.0	17	-	-	-	-	-
Mesosphere	2,199	2,279	372	<0.01	19	-	-	-	-	-
Total	17,464	14,965	519	267	38	-	-	-	-	-

Table 11. Annual Pollutant Mass in Metric Tons Emitted by Stage MDC Hot Fire Test

Atmospheric Layer	CO_2	H_2O	CO	NO_x	BC	SOx	VOC	O_3	PM	Pb
Troposphere Below 3,000 feet	1,686	1,384	3.4	76	0.46	-	-	-	-	-

Table 12. Annual Pollutant Mass in Metric Tons Emitted by Static Fire Testing

Atmospheric Layer	CO_2	H_2O	CO	NO_x	BC	SOx	VOC	O_3	PM	Pb
Troposphere Below 3,000 feet	771	633	1.6	35	0.21	-	-	-	-	-

Table 13. Annual Pollutant Mass in Metric Tons Emitted by Launch

Atmospheric Layer	CO_2	H_2O	CO	NO_x	BC	SOx	VOC	O_3	PM	Pb
Troposphere Below 3,000 feet	1,911	1,569	3.9	80	0.52	-	-	-	-	-
Troposphere Above 3,000 feet	3,887	3,196	11	66	1.1	-	-	-	-	-
Stratosphere	6,537	5,500	115	3.0	16	-	-	-	-	-
Mesosphere	1,990	2,079	350	<0.01	17	-	-	-	-	-
Total	14,325	12,344	480	149	35	-	-	-	-	-

Table 14. Annual Pollutant Mass in Metric Tons Emitted by Landing

Atmospheric Layer	CO_2	H_2O	CO	NO_x	BC	SOx	VOC	O_3	PM	Pb
Troposphere Below 3,000 feet	147	120	0.30	6.1	0.040	-	-	-	-	-
Troposphere Above 3,000 feet	19	15	0.040	0.65	<0.01	-	-	-	-	-
Stratosphere	308	267	11	<0.01	1.8	-	-	-	-	-
Mesosphere	209	200	23	<0.01	1.7	-	-	-	-	-
Total	683	402	34	6.8	3.5	-	-	-	-	-

General conformity determinations are not required for launch operations in Florida since launch facilities are located within a NAAQS attainment area for all regulated criteria pollutants. The ambient air quality in proposed action areas is predominantly influenced by daily operations such as vehicle traffic, utilities, fuel combustion, and standard refurbishment and maintenance operations. Other operations occurring infrequently throughout the year, including launches, stage MDC/static fire testing, and prescribed burnings, also play a role in the quality of air as episodic events.

Based on the BRRC emissions modeling, the total potential emissions of any criteria pollutants from the Terran R stage MDC/static fire test, launch and ocean-based barge landing would not exceed thresholds of significance and would not be expected to cause exceedances of the NAAQS. Based on the infrequency and limited scale of activities, Terran R operations are a small percentage of the Brevard County emissions and would not cause an exceedance of any NAAQS. Therefore, impacts to air quality from these launch activities are expected to be insignificant.

The Terran R stage MDC testing, static fire, launches, and landings emit GHGs, CO_2 and water vapor. Emissions of GHGs from the Proposed Action would not cause any appreciable global warming leading to climate change. However, these emissions would slightly increase the atmospheric concentration of GHGs. At present, no methodology exists for estimating impacts of incremental GHG emissions and their local or global warming effects. The impact on the climate would still be insignificant.

Conservative climate models project the seas off KSC and CCSFS 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 (NASA, 2015). 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 SLC-16 by 2100 using the predictions. Relativity's design of SLC-16 takes sea level rise and climate change into account by constructing new roads higher than surrounding elevations and finished floor elevations of new facilities above the 100-year flood stage.

Generation of dust during the Terran R testing and launch operations is not expected to have a significant impact on air quality. Although small amounts of particulate matter would be generated due to the use of LNG and LOX rocket fuel, dust generation would be minimized based on the design of the Terran R launch pad. The deluge water system, concrete flume, and diverter would prevent generation of dust during launch and test operations. The deluge water system would use 75,000 – 100,000 gallons during launch. This would eject water vapor and steam preventing large amounts of dust dispersal. The concrete flume and diverter would direct the heat plume vertically into the atmosphere, above the tree line, without dispersal of large amounts of sand or other debris exhaust into the wooded area north of the launch pad, towards the Atlantic Ocean.

Therefore, the Terran R testing, launch and landing operations would not have a significant impact on air quality and climate within CCSFS and Brevard County.

3.1.4 No Action Alternative

Under the No Action Alternative, the Terran R Program would not be implemented, and no additional air emissions or GHGs would be produced at SLC-16.

3.2 Water Resources

Water resources located at CCSFS include surface water (inland and ocean), groundwater, floodplains, and wetlands. The ROI for groundwater includes the local aquifers directly or indirectly used by CCSFS. The ROI for inland surface water is the drainage system/watershed in which SLC-16 is located. The ocean waters ROI includes the Atlantic Ocean within the proposed launch azimuth ranges and ocean-based barge landing locations. The ROI for wetlands and floodplains includes the limits of improvement for direct and indirect impacts from SLC-16 construction.

3.2.1 Regulatory Setting

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. 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. Permitting through the United States Army Corps of Engineers (USACE) or FDEP is required where waters are regulated under Section 404 of the CWA (33 U.S.C. 1344). On December 22, 2020, the US EPA signed an agreement delegating the FDEP the authority to issue wetland permits in Florida under Section 404 of the CWA. The agreement allows the FDEP to regulate Florida "assumed" waters only. USACE retained authority for certain waters referred to as "retained" waters. The USACE will retain responsibility for permitting for the discharge of dredged or fill material in those waters identified in the Retained Waters List, as well as all waters subject to the ebb and flow of the tide shoreward to their mean high-water mark that are not specifically listed in the Retained Waters List, including wetlands adjacent thereto landward to the administrative boundary. Because no Retained Waters or Assumed Waters are being proposed for impact or exists within the Project Area, no USACE or FDEP State 404 permits will be required for the Proposed Action. St. Johns River Water Management District (SJRWMD) regulates stormwater construction and operation permits. An Environmental Resource Permit (ERP) will be acquired from this State agency for the Proposed Action. The FDEP regulates NPDES stormwater construction permits for land disturbing activities greater than one (1) acre and has authority to regulate wastewater discharges, both surface water and groundwater discharges, related to state water quality. An NPDES permit will be acquired from FDEP for the Proposed Action.

3.2.2 Affected Environment

3.2.2.1 Surface Water (Inland)

SLC-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 (3) major bodies of water; the Banana River to the immediate west, Mosquito Lagoon to the north, and the Indian River to the west. Many constructed canals and ditches facilitate surface water runoff from CCSFS developed areas. All three (3) water bodies are estuarine lagoons, with circulation provided mainly by wind-induced currents (DAF, 1998). CCSFS areas designated as Outstanding Florida Waters (OFW) per FAC 62-320 include most of Mosquito Lagoon, 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. Mosquito Lagoon and Indian River have been designated as Class II surface waters, as described by the FDEP within FAC 63-320. The Banana River has been designated as a Class III (Outstanding Florida Water, Impaired Water) surface water within the vicinity of CCSFS and KSC.

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. There are no rivers protected under the Wild and Scenic Rivers Act located on or near CCSFS. Therefore, this resource was considered but not analyzed in this SEA.

On SLC-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.

3.2.2.2 Surface Water (Ocean)

The ROI for ocean waters is the Terran R launch azimuths (41°-105°), booster recovery/landing areas (300-500 nautical miles offshore), and fairing jettison areas (less than 1,350 km downrange) within the Atlantic Ocean (see ***Figure 6***). This area is within the Action Area identified in the NMFS programmatic consultation (blue polygon) as provided in ***Appendix B*** and within ***Figure 6***. The ROI for ocean waters covers all suborbital jettisoned items during a Terran R launch, including the booster recovery and landing areas and fairing jettison areas. The specifics of the trajectory and mission plan for the first flight of the Terran R and beyond are not presently defined, so this ROI is intended to cover a variety of mission types that will be flown on Terran R.

Ocean waters within the ROI include offshore, deep, high salinity waters defined by prevailing currents. Water quality in ocean waters may be characterized by temperature, salinity, dissolved oxygen, and nutrient levels. US territorial seas extend 12 nautical miles from the coast. Booster recovery and landing would occur in international waters; however, all the Terran R support vessels would navigate to and from Port Canaveral.

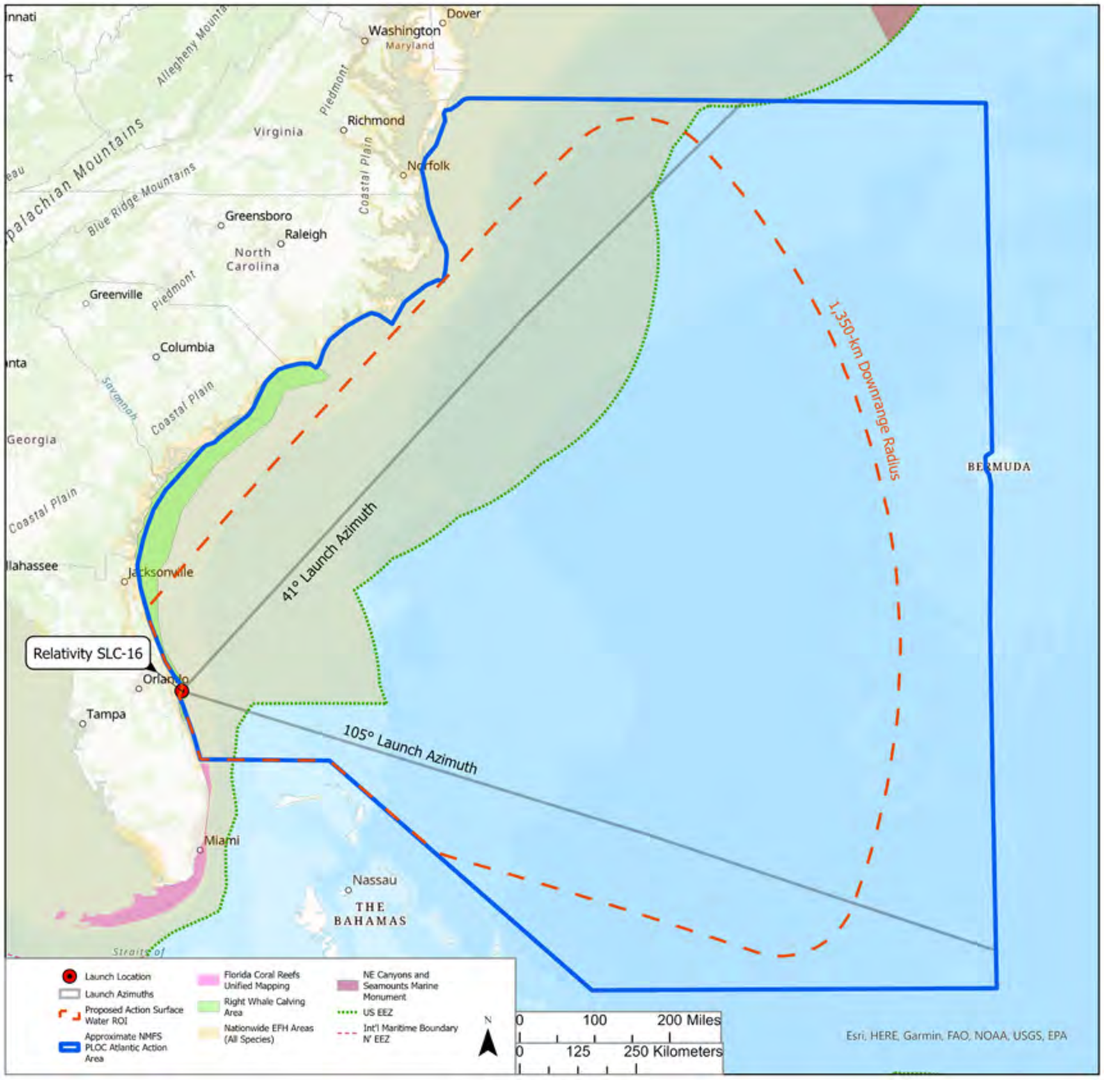


Figure 6. Terran R Surface Water (Ocean) ROI

3.2.2.3 Ground Water

Groundwater at CCSFS 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 CCSFS groundwater flow in the surficial aquifer is westward, toward the Banana River. However, groundwater at SLC-16 flows south /southeast towards a large canal. 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 SLC-16 consists of groundwater that occurs at depths of two (2) to three (3) 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 supply wells on or near CCSFS or Cocoa Beach. Due to historical operations involving mismanagement of hazardous materials, groundwater contamination is present at SLC-16 consisting of industrial solvents such as trichloroethene and its daughter products in both dissolved phases at the majority of the complex and at high concentrations in a large source area just west of the launch complex. SLC-16 is managed by CCSFS Installation Restoration Program (IRP) through Solid Waste Management Unit (SWMU) C040. The SWMU C040 contamination map is shown in ***Figure** 7* below. Land Use Controls (LUCs) have been implemented to restrict groundwater use and to ensure that contaminant residuals do not cause any adverse impacts to human health or the environment. A long-term monitoring plan was enacted in the 1990s to track degradation of contaminants. A large-scale remediation effort within the source area is scheduled to begin in FY24 (HGL, 2023). Construction efforts would require extensive coordination to ensure goals for both projects align appropriately.

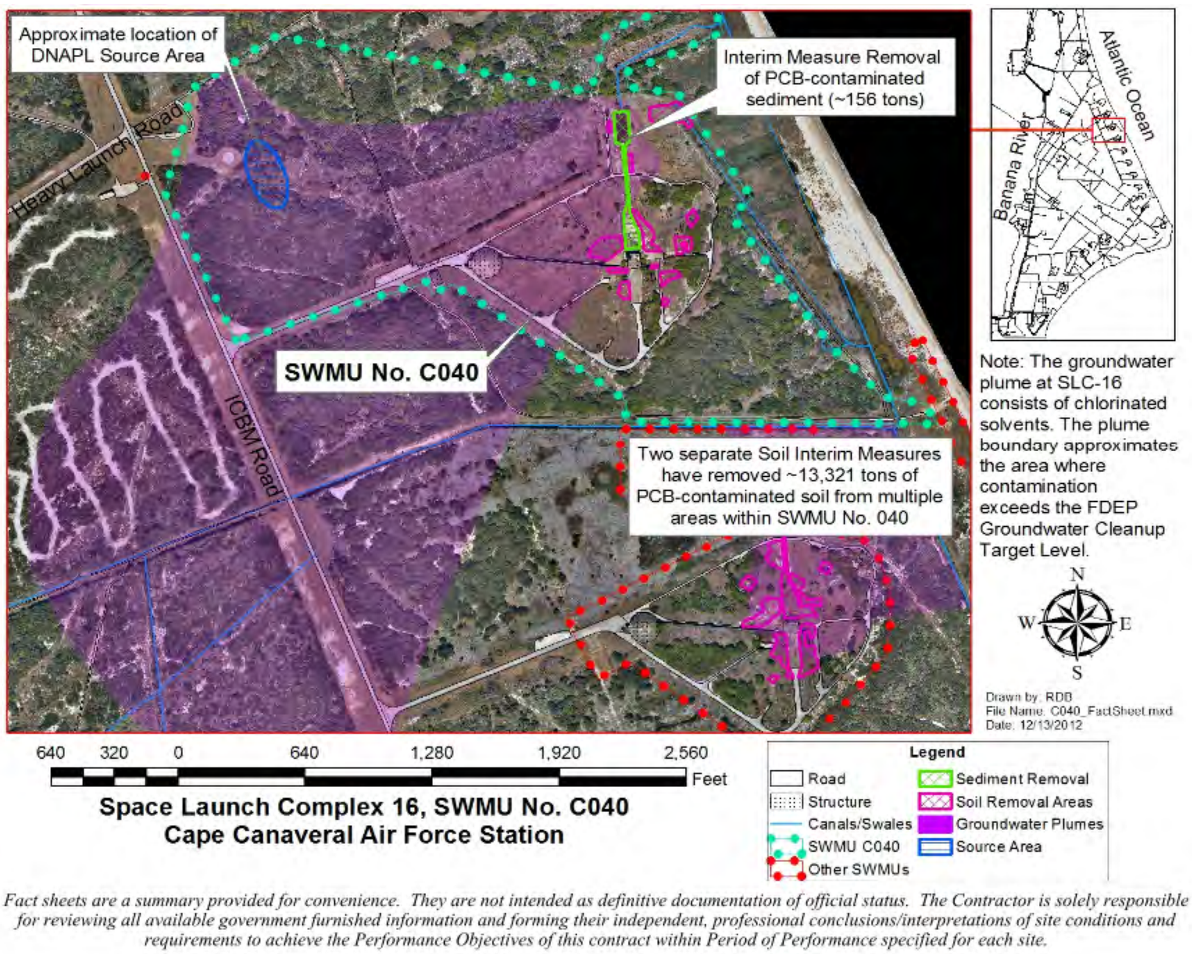


Figure 7. SWMU C040 Contamination Map SLC-16

3.2.2.4 Floodplains

Floodplains are lowland and relatively flat areas adjoining inland and coastal waters subject to flooding. Since CCSFS does not have a significant change in topography, the floodplains include the coastal dunes, wetlands, and all areas of CCSFS. 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 CCSFS and six (6) feet above MSL along the Banana River (USSF, 2015). ***Figure 8*** depicts 100-year and 500-year floodplain limits and acreages within SLC-16.

3.2.2.5 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 in Florida are delineated using the 1987 Corps of Engineers Wetlands Delineation Manual and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (Version 2.0) (ERDC/EL TR-10-20, November 2010). Florida wetlands are legally defined as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils. 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, 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 (***Appendix G***) conducted by Atlantic Environmental and are shown in green polygons in ***Figure 9*** below**.**

Approximately 1.63 acres of the Proposed Action fall directly within the mapped wetlands as shown in

Figure 10 below. These are herbaceous wetlands consisting of sand cordgrass, sawgrass, semaphore thoroughwort, St. Augustine grass, Brazilian pepper saltbush, and swamp flatsedge (see ***Appendix G***). Initial consultation has occurred with the SJRWMD. As no Retained Waters exist within the Project Area, no engagement with USACE is necessary for the Proposed Action. Furthermore, as the on-site wetlands are isolated from Waters of the United States, no State 404 Permit is required to be obtained for the Proposed Action. With this having been said, a No Permit Required determination is being sought from FDEP for the State 404 Permit.

Figure 8. SLC-16 FEMA Flood Map

Figure 9. SLC-16 Existing Wetlands

1

2 **Figure 10. Wetland Impact Map**

3.2.3 Environmental Consequences

3.2.3.1 Construction

3.2.3.1.1 Surface Water (Inland and Ocean)

Surface water impacts during construction of new facilities would be prevented using spill prevention and stormwater pollution prevention best management practices (BMPs). Modifications to the existing SLC-16 SJRWD ERP No. 162674 would be required prior to Terran R Program site modifications. Relativity would coordinate with SLD 45 CES and SJRWMD for modification of the existing permit to ensure all stormwater and flood storage volumes are treated and attenuated on site. Stormwater Pollution Prevention Plans (SWPPPs) would be generated and adhered to during construction as part of the NPDES permits to provide erosion and sediment control BMPs. SLC-16 is approximately 1,000 feet west of the Atlantic Ocean and is therefore a far enough distance such that there is no potential for impacts from construction.

Therefore, construction for the Proposed Action would have no significant impacts to inland and ocean surface waters.

3.2.3.1.2 Groundwater

The Proposed Action does not use groundwater for any purpose. During construction however, dewatering may be required for excavation of utilities and deep pile foundations since groundwater levels occur only two (2) to three (3) feet BLS. Authorization through the CCSFS IRP would be required along with the submission and approval of a dewatering plan by IRP, CEIE and FDEP to ensure groundwater handling and disposal requirements are met. The approval of the dewatering plan and implementation of BMPs during dewatering operations would ensure protection of adjacent surface waters and wetlands. A project-specific health and safety advisor would be appointed in accordance with the site LUCs. The health and safety advisor would provide consultation regarding proper selection of personal protective equipment during construction.

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 CCSFS and Relativity spill response plans and would address prevention of groundwater contamination. Although impacts to groundwater may occur during construction excavations, Relativity would follow all state and federal requirements to minimize impacts.

Therefore, no significant impacts to groundwater are expected as a result of the construction during the Proposed Action.

3.2.3.1.3 Floodplains and Wetlands

Based on the National Flood Hazard Layer FIRMette Map for SLC-16 (***Figure 8***) the 100-year (1%) and 500-year (0.2%) annual flood hazard contours are within SLC-16. Construction for the Terran R modifications to SLC-16 would impact these floodplains, meeting the significance threshold per FAA Order 1050.1F. However, during the stormwater ERP permitting process with SJRWMD, floodplain analysis and mitigation actions would offset this localized impact on surface waters through the purchase of credits from the Neo Verde Mitigation Bank such that no net loss of wetland functions is expected. With mitigation measures and BMPs in place, the impacts due to the Proposed Action would be below threshold values. Relativity would design stormwater systems as shown in ***Figure 5*** to treat and attenuate volumes associated with the impacted floodplains. Reference ***Section 3.9.2.4*** for additional information on stormwater permitting as part of the Proposed Action.

Locations of the pad, flame trench, and roadways have been designed to accommodate transport of the Terran R vehicle throughout the Site. Numerous Terran R site layouts were reviewed considering the minimization of floodplain and wetland impacts, utilization of existing infrastructure facilities and utilities, compliance with applicable regulatory requirements, and overall Terran R programmatic needs. The proposed site layout minimizes wetland impacts considering all requirements in constructing the SLC-16 improvements. Approximately 1.63 acres of SJRWMD jurisdictional wetlands are proposed for impact in association with the Proposed Action as shown in ***Figure 10***. Of these proposed impacts, impacts to Wetland B (±0.93 acres) and Wetland C (±0.16 acres) will require mitigation. Wetland C requires mitigation due to its connectivity via manmade swale to Wetland B. Mitigation for impacts to Wetland 1 (±0.07 acres) and Wetland A (±0.47 acres) will not be required as these wetlands are isolated and under 0.50 acres. A functional loss of up to 1.10 herbaceous units is generated from the proposed impacts to Wetland B and Wetland C. Credits to offset this impact have been reserved through Neo Verde Mitigation Bank. It is expected that 100% of all impacts would be permanent, with approximately 75% of the affected wetlands being filled with impervious surface and the remaining 25% being filled with pervious surface.

Figure 9 identifies the location of wetlands to be impacted and mitigated. Permitting through SJRWMD's ERP Program, as well as the acquisition of a No Permit Required through FDEP's State 404 permitting with FDEP would be completed prior to construction to determine compensatory mitigation requirements to offset wetland impacts. This would include a final assessment by SJRWMD to confirm the acreage of impacted wetlands and the required amount of mitigation credits. Mitigation credits required for wetland impacts would be determined using the FDEP's Uniform Mitigation Assessment Method (UMAM). Pursuant to 32 CFR 989.14, a FONPA is provided as part of this SEA.

Therefore, construction associated with the Proposed Action would have no significant impacts to floodplains and wetlands.

3.2.3.2 Ground Support Operations and Maintenance

3.2.3.2.1 Surface Water (Inland and Ocean)

Surface water impacts during ground support operations and maintenance activities would be similar to those evaluated within the Terran 1 Program EA. Relativity would implement an SPCC Plan to prevent impacts to adjacent surface waters. Proper storage and handling of hazardous materials used during ground support operations and maintenance would also be accomplished. More information on hazardous materials is provided in ***Section 3.11.***

Ground support operations would have no significant impacts to inland and ocean surface waters.

3.2.3.2.2 Groundwater

No drilling, excavations or other potential groundwater disturbance would take place during ground support operations and maintenance.

Ground support operations and maintenance would not impact groundwater.

3.2.3.2.3 Floodplains and Wetlands

No impacts to floodplains and wetlands are expected during ground support operations and maintenance during the Terran R Program.

3.2.3.3 Stage MDC Testing, Static Fire, Launch and Landing Operations

3.2.3.3.1 Surface Water (Inland and Ocean)

Surface Water (Inland)

Similar to the Terran 1 Program, stage MDC testing, static fire and launch deluge water associated with the Terran R Program would be contained in the impermeable concrete flame trench, sampled, and pumped to a percolation pond in accordance with FDEP Industrial Wastewater requirements (see ***Section 3.9.3.3.2*** for industrial wastewater permitting details). Any increase in surface water runoff due to the Proposed Action would be attenuated through a properly sized percolation pond in accordance with UFC 3-210-10, Low Impact Development and the Energy Independence and Security Act (42 USC 17001 et seq). Site planning design, construction, and maintenance strategies would be implemented to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of any property where the project exceeds 5,000 SF. Terran R's combined deluge and sound suppression water is expected to be approximately 75,000 gallons during each individual stage MDC and static fire test and 100,000 gallons during each launch.

As mentioned previously, due to the use of deluge water during test and launch operations, the concrete flume and diverter, the Terran R launch exhaust would not generate large amounts of dust or particulate matter dispersal that would impact inland water resources. Significant impacts to water quality turbidity due to dust and other particulate matter is not expected.

No impacts on inland surface water would occur from the stage MDC testing, static fire, or launch.

Surface Water (Ocean)

Booster landing and recovery operations for the Terran R Program would include the mobilization of an unmanned ocean-going barge, support vessel and an ocean tug from Port Canaveral. As noted in ***Section 3.11*** support vessel and recovery operations have the potential to release small amounts of oil and gas into the water. However, vessel operations would be conducted in accordance with the International Convention for Prevention of Pollution from Ships (MARPOL 73/78), prohibiting certain discharges of oil, garbage, and other substances from vessels.

It is Relativity's goal to recover and reuse Terran R boosters. However, during launches early in the program development, Relativity may require expending Terran R in the ocean. Relativity expects most of the Terran R debris to sink because the launch vehicle is constructed primarily of aluminum. Unlike other vehicles, Terran R is not planned to utilize large carbon fiber segments which yield a majority of surface debris. Expendable stage landings would not result in permanent changes to physical parameters (temperature, salinity, oxygen concentration, etc.) of the water column. The amount of propellant, metals, or other substances that could leach or dissolve into the water column or substrate after the vehicle sinks to the ocean floor would be minimal and would not result in detectable changes to water or sediment quality. Additionally, the probability of an expended vehicle impacting essential fish habitat would be considered negligible given the small number of soft-water landings per year in the study area. Due to the depth of water in the splashdown locations, attempts at subsea recovery are nearly impossible and efforts would not be made.

Per 14 CFR Part 450, Relativity would submit a Post Jettison Operation Memo (***Appendix C***) as part of the 14 CFR Part 450 licensing process that would describe S1 re-entry behavior and behavior during water impact when not landing on a barge. Relativity would use engineering analysis to determine potential for explosion, break-up and possible impacts for a nominal launch/re-entry. A vehicle that makes an impact with the ocean surface would have minimal LOX and LNG onboard resulting in no release of toxics or hydrocarbons. In an anomalous condition, the risks could include a detonation event of remaining propellant or a release of high-pressure gas stored inside the vehicle's composite overwrapped pressure vessel, presenting 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 temporary and localized. Ocean water impacts due to launch failure scenarios would be minimized due to the negligible amount of residual propellant during an anomaly and the design of the Terran R propellant storage vessel.

No impacts on ocean surface water would occur from the stage MDC testing, static fire or launch.

3.2.3.3.2 Groundwater

Collection of all deluge water from stage MDC, static fire and launch would prevent spills that may reach groundwater.

No impacts to groundwater would occur from the stage MDC testing, static fire or launch.

3.2.3.3.3 Floodplain and Wetlands

Stage MDC testing, static fire, launch, and landing operations have the potential to impact floodplains and wetlands. Potential impacts to floodplains and wetlands due to these operations would be minimized with the implementation of FDEP Industrial Wastewater Permitting (if deemed applicable by FDEP) or through FDEP approval for Industrial Wastewater exemptions for stage MDC, static fire, and launch deluge water, preventing the discharge of contaminated water to nearby water resources.

Existing wetlands could be affected by the exhaust cloud that would form near the launch pad at liftoff as a result of the exhaust plume, evaporation and subsequent condensation of deluge water. Because the Terran R first stage booster consumes LOX and LNG propellants, the exhaust cloud would consist of primarily of steam with no quantifiable amounts of hazardous constituents. The volume of water condensing from the exhaust cloud is expected to be minimal and temporary, thus the exhaust cloud would generate no significant impacts on surface water quality or wetlands at or near SLC-16.

No impacts to groundwater would occur from the stage MDC testing, static fire or launch.

3.2.4 No Action Alternative

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

3.3 Soils and Geological Resources

3.3.1 Regulatory Setting

Sites at CCSFS with known historical contamination are managed by the Air Force Civil Engineer Center's (AFCEC) IRP. LUCs for site soils and geology resources at SLC-16 are administered under SWMU C040. Disturbance of site soils within SWMU C040 is prohibited without prior approval and coordination with IRP and SLD 45 to ensure personnel safety and environmental protection.

3.3.2 Affected Environment

The geology underlying CCSFS can be generally defined by four (4) 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 CCSFS (USDA, 1974).

Bedrock at CCSFS 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, coquinoid limestone and unconsolidated, well-graded quartz sand (USSF, 2015).

3.3.2.1 Topography and Soils

CCSFS 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 CCSFS, with a gentle slope to lower elevations toward the marshlands along the Banana River. Land surfaces are level to gently sloping along the SLCs with elevations that range from sea level to approximately 20 feet above MSL (DAF, 1998).

CCSFS has 11 different soil types. The three (3) 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.

SLC-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. SLC-16 disturbed areas are considered Urban Land, zero (0) to two (2) percent slopes (USDA, 1974). See ***Figure 11*** and ***Table 15*** below for the SLC-16 USDA Soil Map and legend.

Figure 11. USDA Soil Classification Map, SLC-16

Table 15. USDA Soil Map Unit Legend, SLC-16

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
9	Canaveral-Anclote complex, gently undulating	80.3	68.5%
10	Canaveral-Urban land complex	19.7	16.8%
14	Beaches	2.4	2.1%
52	Quartzipsamments, smoothed	0.6	0.5%
69	Urban land, 0 to 2 percent slopes	14.2	12.1%
	Totals for Area of Interest	**117.3**	**100.0%**

3.3.3 Environmental Consequences

3.3.3.1 Construction

No unique geologic features of exceptional interest or mineral resources occur within SLC-16; thus, no impacts would occur to these resources (USDA, 1974). Proposed Action construction would impact contaminated soils at SLC-16 however, the proposed facility locations, utility routing and deep excavations were strategically located to minimize impacts to highly contaminated soils areas to the greatest extent feasible. Throughout construction, site LUCs would be followed in accordance with SMU C040 requirements. LUCs include a prohibition on soil removal from the site without SLD 45 approval and required engineering controls and personnel protection. The development and implementation of a SWPPP in accordance with the NPDES Construction Stormwater permit would specify methods to control erosion.

Therefore, the Proposed Action construction would have no significant impacts to geology or soils.

3.3.3.2 Ground Support Operations and Maintenance

Soil impacts due to ground support operations and maintenance would be similar to those identified within the Terran 1 Program EA. Potential impacts would be associated with spills and is covered in ***Section 3.11***.

3.3.3.3 Stage MDC Testing, Static Fire, Launch and Landing

Terran R LOX and LNG propellants would create an exhaust cloud consisting primarily of steam with no quantifiable amounts of hazardous constituents. The volume of water condensing from the exhaust cloud is expected to be minimal and temporary.

Therefore, stage MDC testing, static fire, launch and ocean-based barge landing of the Terran R launch vehicle would have no significant impacts on soils at or near SLC-16.

3.3.4 No Action Alternative

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

3.4 Historical and Cultural Resources

Cultural resources include resources with pre-contact, post-contact, historic, and cultural associations. These include resources that represent physical evidence of human presence considered important to a culture, subculture, or community for scientific, traditional, religious, or other reasons. Cultural resources also include historic properties, which are defined in Section 106 of the NHPA of 1966 (Section 106) as properties that are listed in or are eligible for listing in the NRHP. Historic properties meet the listing criteria specified in the Department of the Interior Regulations Title 36 CFR 60.4 and National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation. Historic properties include archaeological resources, sites, buildings, structures, objects, landscapes, and sites of religious and cultural significance to Native American Tribes. For the Proposed Action, impacts on cultural resources were considered within the project area and in accordance with Section 106.

3.4.1 Regulatory Setting

In addition to the NEPA, the primary laws that pertain to the treatment of cultural resources during environmental analysis are the NHPA (1996) (especially Sections 106 and 110), the Archaeological Resources Protection Act (ARPA) (1979), the American Indian Religious Freedom Act (AIRFA) (1978) and the Native American Graves Protection and Repatriation Act (NAGPRA, 1990).

Section 106 of the NHPA of 1966 (as amended) requires federal agencies to consider the effects of their actions on historic properties. *AFMAN 32-7003, Environmental Conservation*, provides guidelines for the protection and management of cultural resources on USSF-managed lands.

Federal cultural resource preservation statutes, including the NAGPRA mandate that if prehistoric or historic artifacts are inadvertently 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. Under the ARPA, regulation 32 CFR Part 229, *Protection of Archaeological Resources* and 43 CFR Part 10, *Native American Graves Protection and Repatriation Regulations,* detailed notification and protection requirements must be met in accordance with the SLD 45 ICRMP. Based on the results of such notifications and subsequent evaluations of potential human remains or cultural artifacts, the provision of NAGPRA may apply. Procedures within 43 CFR Part 10 would be followed, as required. The SLD 45 Cultural Resource Manager and archaeologist will work with the SHPO should inadvertent discoveries occur, and project re-commencement would only be authorized with SHPO approval.

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 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.

3.4.2 Affected Environment

Under Section 106, the Area of Potential Effects (APE) is defined “the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist” (36 CFR 800.16(d)). Areas potentially impacted include properties, structures, landscapes, or traditional cultural sites that qualify for listing in the NRHP. A cultural resources assessment survey was conducted at SLC-16 in 2015 resulting in the determination by the Florida SHPO that SLC-16 did not have sufficient integrity to possess historical significance and only Facility 13122, Blockhouse was eligible for listing on the National Register.

For the Proposed Action, the APE for archaeological resources is defined as the Project's Area of Direct Impact where ground disturbance would occur. 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) as provided in ***Appendix I***.

The APE for aboveground resources includes areas potentially affected by rocket engine noise/vibration. The stage MDC testing, static fire and launch areas within the $\geq$130 dB contour (see ***Figure 12*** and ***Figure 13***) define the Proposed Action APE. The Maximum Unweighted Sound Level (Lmax) value of 130 dB is used to assess the ROI and potential impacts to structures. Based on a report from the National Research Council, one may conservatively consider all sound lasting more than one second with levels exceeding 130 dB as potentially damaging to structures. The 130 dB Lmax ROI contours do not include any land area outside of CCSFS boundaries as shown in ***Figure 12*** and ***Figure 13***. The contours associated with 1:1,000 damage claims (111 dB) and 1:100 damage claims (120 dB) are also presented in ***Figure 12*** and ***Figure 13***. The 1:100 damage claims contours do not encompass any land area outside of CCSFS and KSC boundaries. The 1:1,000 damage claims contours include areas on Merritt Island and Cape Canaveral from launch events, and a small area south of the KSC boundary near the Pine Island Conservation area and south of Titusville along the shore from static fire and stage hot fire tests.

In September 2019, the Florida Department of State Division of Historic Resources and SHPO performed a Section 106 and 110 NHPA of 1966 review of the Relativity Space Terran 1 Program at SLC-16. They determined that Facility 13122, SLC-16 Blockhouse (8BR2322) appears to meet the criteria for listing on the National Register. Their conclusion also concurred with SLD 45 the Terran 1 Program would have no effect on the historic character of the blockhouse (CCSFS, 2019). As a result, SHPO has concurred that no historic properties are affected as a result of the proposed project as provided in ***Appendix I***.

On April 27, 2023, STOF-THPO indicated they did not have any objections to the Proposed Action. ***Appendix I*** provides a copy of the correspondence from STOF-THPO.

Figure 12. Historic and Cultural APE – Test Operations

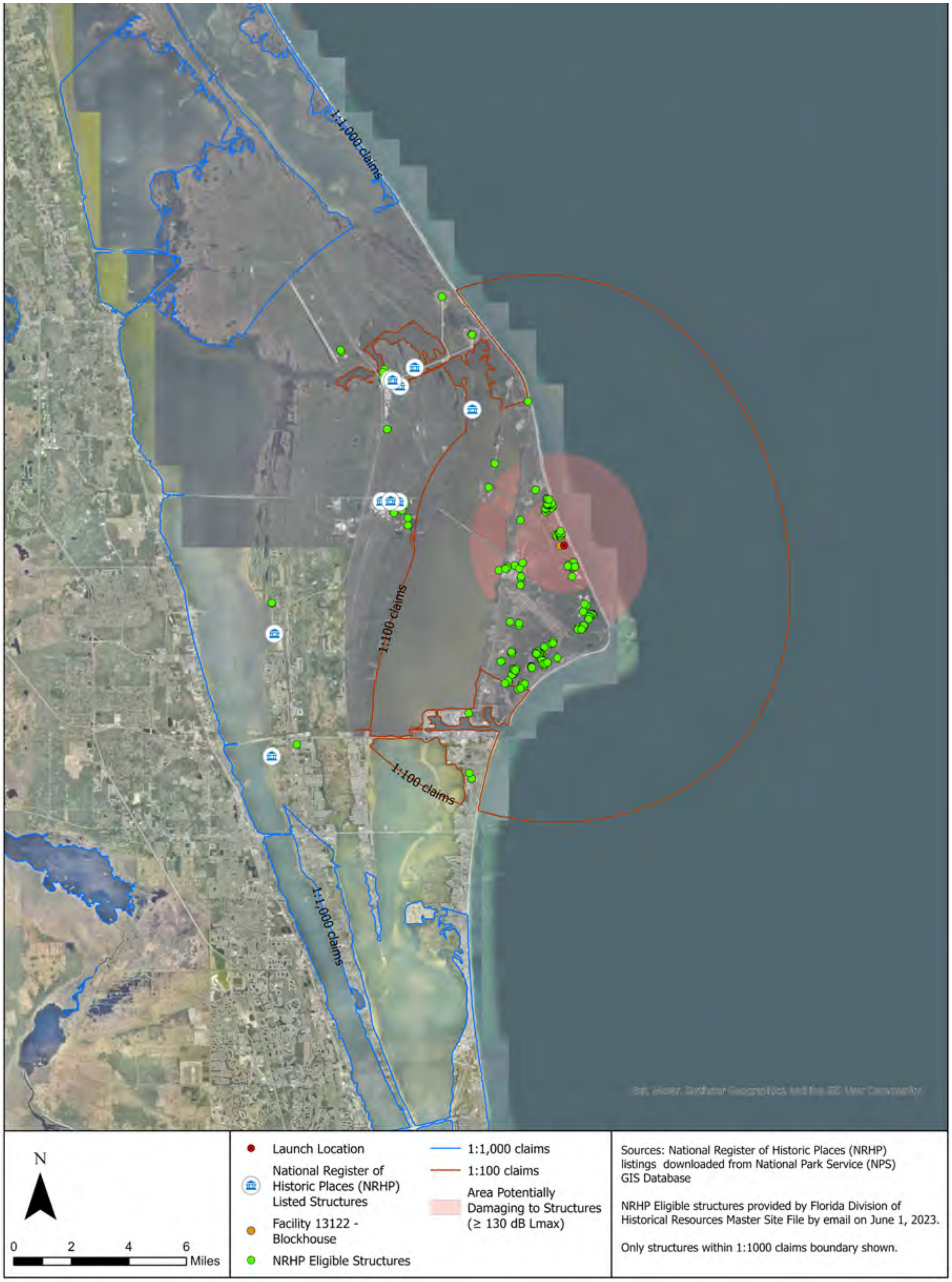


Figure 13. Historic and Cultural APE - Launch Operations

3.4.3 Environmental Consequences

3.4.3.1 Construction

No renovations or modifications to Blockhouse, Facility 13122 are planned as part of the Proposed Action. Based on the Section 106 consultation completed as part of the Terran 1 Program EA, the Proposed Action would not impact on cultural resources at SLC-16 due to construction activities.

Additionally, no traditional cultural properties are on CCSFS inclusive of the project area as a result of consultation with the Seminole Tribe of Florida, the Seminole Nation of Oklahoma, and the Miccosukee Tribe of Indians of Florida (CCSFS, 2020). These three (3) consulting Tribes notified CCSFS they will not consult on projects unless the project could potentially affect Native American archaeological sites as documented in the SLD 45 ICRMP.

As stated above, no traditional cultural properties were identified within the APE. Therefore, ground support operations would have no impact on traditional cultural properties.

3.4.3.2 Ground Support Operations and Maintenance

Ground support operations and maintenance activities would not impact historical or cultural resources. Blockhouse, Facility 13122 would be used to support Terran R SLC-16 operations in the same manner as the Terran 1 Program. Relativity intends to use the Blockhouse for temporary storage, instrument bays, local pad controls and pad office space.

Therefore, ground support operations would have no significant impact to traditional cultural properties.

3.4.3.3 Stage MDC Testing, Static Fire, Launch and Landing

In general, structural damage to buildings due to launch noise is rare. This is due to the fact that sound pressure levels would have to be very high to excite building structural elements vibrationally to the point of damage. In addition, residential buildings are usually located at certain distances away from launch facilities which further reduce launch noise levels.

Structures within the APE include Blockhouse, Facility 13122 within SLC-16 and abandoned structures within SLC-19, to the north. SLC-19 is identified within the CCAFS National Historic Landmark Nomination Form due to its historic Gemini operations. These facilities are the only known historic structures identified that fall within the ≥130 dB noise contour evaluated as part of the BRRC Noise Report (***Figure 12*** and ***Figure 13***). According to the BRRC Noise Report, households within the ≥130 dB contour have the potential for structures to be damaged, with windows as the most sensitive structural component to launch noise. Infrequently, plastered walls and ceilings may also be affected. Based on the original purpose of construction for the Blockhouse and abandoned structures within SLC-19 to withstand concussive forces and the absence of windows susceptible to damage, no significant impacts due to rocket engine noise/vibration are expected. These structures have been previously evaluated as not eligible for the NRHP. Consequently, no historic properties have the potential to be affected by rocket engine noise/vibration.

Thus, Proposed Action testing, launch and landing operations would have no significant impacts on historic properties or cultural resources.

3.4.4 No Action Alternative

Under the No Action Alternative, no impact to historical or cultural resources would occur.

3.5 Biological Resources

Much of the detailed Biological Resource information included was extracted from the Terran 1 Program Environmental Assessment, the *SLD 45 Integrated Natural Resources Management Plan (INRMP)* and the *Revised Biological Assessment for the Relativity Space Launch Complex-16 Terran R Project Site Construction and Operation at CCSFS, Florida* by Atlantic Environmental of Florida, LLC dated February 2023. 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). These resources occur or could potentially occur in the ROI, defined as areas surrounding SLC-16, that could be affected by construction activities and the effect of launch operations as well as the Atlantic Ocean within planned launch trajectories azimuths (41° and 105°) and booster landing locations. Sensitive and protected biological resources include plant and animal species listed as threatened or endangered by the USFWS, NMFS, and the Florida Fish and Wildlife Conservation Commission (FWCC). Natural areas around SLC-16 are managed by the USSF.

3.5.1 Regulatory Setting

3.5.1.1 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.

In 1988, in compliance with Section 7 of the ESA, the USSF developed *45th SWI 32-7001, Exterior Lighting Management* for various areas and facilities on CCSFS to protect sea turtles. A BO issued by the USFWS requires development of Light Management Plans (LMPs) for all new facilities in close proximity to the beach as well as existing facilities with significant light pollution or sky glow from the beach. USSF biologists conduct nighttime inspections to ensure all exterior lighting is operated in accordance with policies. The BO authorizes no more than 3% incidental take of turtles as the result of disorientation.

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.

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 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 CCSFS 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.

AFMAN 32-7003, Environmental Conservation, commits the USSF to the long-term management of all natural areas on the installation. Long-term management objectives are identified in the SLD 45 INRMP, with specific land management objectives such as wetland protection, conservation of T&E species and habitat restoration.

3.5.2 Affected Environment

3.5.2.1 Threatened and Endangered (T&E) Species

CCSFS 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 CCSFS. ***Table 16*** contains a complete list of federal and state listed birds, sea turtles, reptiles, amphibians, and mammals in the ROI.

Table 16. ROI Federal and State Listed Species

Common Name	Scientific Name	Federal	State
Birds			
American Oystercatcher	*Haematopus palliatus*	--	T
Black Skimmer	*Rynchops niger*	--	T
Crested Caracara	*Caracara cheriway*	T	--
Florida Scrub-Jay	*Aphelocoma coerulescens*	T	--
Least Tern	*Sternula antillarum*	--	T
Little Blue Heron	*Egretta caerulea*	--	T
Piping Plover	*Charadrius melodus*	T	--
Red Knot	*Calidris canutus rufa*	T	--
Reddish Egret	*Egretta rufescens*	--	T
Roseate Spoonbill	*Platalea ajaja*	--	T
Roseate Tern	*Sterna dougallii*	T	
Snowy Plover	*Charadrius nivosus*	--	T
Southeastern-American Kestrel	*Falco sparverius paulus*	--	T
Tricolored Heron	*Egretta tricolor*	--	T
Wood Stork	*Mycteria americana*	T	--
Sea Turtles			
Loggerhead Turtle	*Caretta caretta*	T	--
Green Sea Turtle	*Chelonia mydas*	T	--
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	E	--
Leatherback Turtle	*Dermocheyls coriacea*	E	--
Hawksbill Turtle	*Eretmochelys imbricata*	E	
Other Reptiles/Amphibians			
American Alligator	*Alligator mississippiensis*	T	--
Gopher Tortoise	*Gopherus polyphemus*	--	T
Eastern Indigo Snake	*Drymarchon couperi*	T	--
Florida Pine Snake	*Pituophis melanoleucus*	T	--
Fish			
Smalltooth Sawfish	*Pristis pectinata*	E	--
Oceanic Whitetip Shark	*Carcharhinus longimanus*	T	--
Giant Manta Ray	*Manta birostris*	T	--
Atlantic Sturgeon	*Acipenser oxyrhynchus*	E	--
Nassau Grouper	*Epinephelus striatus*	T	--
Shortnose Sturgeon	*Acipenser brevirostrum*	E	-
Insect			
Monarch Butterfly	*Danaus plexippus*	C	--
Mammals			
TriColored Bat	*Perimyotis subflavus*	E	-
North Atlantic Right Whale	*Eubalaena glacialis*	E	--
Humpback Whale	*Megaptera novaeangliae*	E	--
Florida Manatee	*Trichechus manatus*	T	--

Table 16. ROI Federal and State Listed Species

Common Name	Scientific Name	Federal	State
Southeastern Beach Mouse	*Peromyscus polionotus niveiventris*	T	--
Blue Whale	*Balaenoptera musculus*	E	-
Fin Whale	*Balaenoptera physalus*	E	-
Sei Whale	*Balaenoptera borealis*	E	-
Sperm Whale	*Physeter macrocephalus*	E	-
T: Threatened E: Endangered C: Candidate			

3.5.3 Environmental Consequences

Consultation on potential impacts due to the Proposed Action are required for protected species on land as well as those in the marine environment. Any operation that may affect federally listed species or their critical habitats involves consultation with the USFW and NMFS under Section 7 of the ESA of 1973 (as amended). The USFWS consults on species found on land but also includes nesting sea turtles and manatees. The MMPA of 1972 prohibits the taking of marine mammals, including tormenting them, and may require consultation with the NMFS to evaluate impacts due to the Proposed Action. The NMFS is also responsible for evaluating potential impacts to EFH and enforcing the provisions of the 1996 amendments to the MSFCMA.

The Section 7 Consultation with the USFWS for the Terran R Program was completed to assess the Proposed Action's effects on federally listed species.

A review of the latest NMFS consultation for launch activities was completed and determined that Relativity's Terran R Program is consistent with the USSF launch operations evaluated in the NMFS Programmatic Consultation for Launch and Reentry Vehicle Operations in the Marine Environment with FAA, NASA, and the USSF (Refer to NMFS No: OPR-2021-02908). Relativity confirmed the proposed actions within the Terran R Program align with those analyzed in the NMFS Programmatic Letter of Concurrence (see ***Appendix B***). Relativity's Terran R Program consistency analysis within the NMFS programmatic consultation is provided in ***Appendix C***. Based on this consistency, it is concluded the Terran R Program may affect, but is not likely to adversely affect marine ESA-listed species and designated critical habitat within NMFS' jurisdiction. A summary of consultations, permits, and actions to protect biological resources is provided in ***Table 17*** below.

Table 17. 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 effects on T&E species. Determine if species under USFWS (land species) and NMFS (marine species) 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 NMFS
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 would not adversely impact EFH, otherwise mitigation would be required.	NMFS
EO 11988	Directs each Federal agency to provide leadership in reducing flood losses and losses to environmental values served by floodplains.	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 (USSF).	DoD
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 (USSF).	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
AFMAN 32-7003	Long-term management of all-natural areas on the Installation.	Protect listed species, biodiversity, wetlands.	DoD
MMPA	Protection of all marine mammals.	Prohibits unauthorized take of marine mammals, including harassment, capturing, collecting or killing in US waters.	NMFS

3.5.3.1 T&E Species Impacts - Construction, Ground Support and Launch Operations

Potential impacts to Biological Resources due to the Proposed Action include construction, ground support operations, stage MDC testing, static fire, launch and landing. The Proposed Action includes the expansion of new construction activities outside of the previously analyzed construction areas covered under the March 20, 2020 Terran 1 BO. Based on conclusions presented in the June 2023 revised Biological Assessment, no state or federally listed T&E plant species have been documented in the Proposed Action construction area. Southeastern beach mice and Scrub-Jay have historically been within or in the vicinity of SLC-16. Four (4) species of endangered sea turtles' nest on the beaches in the SLC-16 vicinity. ***Table 18*** summarizes the potential impacts to listed wildlife species potentially present within SLC-16.

Table 18. Potential Impacts to Federal and State Protected Wildlife Species within the Proposed Action Area

Common Name ***Scientific Name***	**USFWS; NMFS**	**Occurrence**	**Potential Impacts**	**Effect Determination**
Florida Scrub-Jay *Aphelocoma coerulescens*	T	Not Present	Loss of breeding habitat. Disruption due to noise and heat.	NLAA
Audobon's crested caracara *Caracara cheriway*	T	Not Present	Disruption due to noise.	NLAA
Eastern Indigo Snake *Drymarchon corais couperi*	T	Potential	Crushing by equipment. Loss of habitat. Disruption due to noise and heat.	NLAA
Monarch butterfly *Danaus plexippus*	C	Potential	Crushing by equipment. Disruption due to noise and heat.	NLAA
Southeastern Beach Mouse *Peromyscus polionotus niveiventris*	T	Documented	Crushing by equipment. Disruption due to noise and heat.	LAA
Sea Turtles: Leatherback *(Dermocheyls coriacea);* Green *(Chelona mydas);* Loggerhead *(Caretta caretta);* Kemps Ridley *(Lepidochelys kempii);* Hawksbill Sea Turtle (*Eretmochelys imbricate)*	E/T/T/E/E	Documented	Disruption and disorientation due to light. Disruption due to noise. Potential falling debris.	NLAA
Manatee *Trichechus manatus latirostris*	T	Documented	Disruption due to noise. Potential falling debris.	NLAA
Blue Whale *Balaenoptera musculus*	E	Documented	Disruption due to noise. Potential falling debris.	NLAA
Fin Whale *Balaenoptera physalus*	E	Documented	Disruption due to noise. Potential falling debris.	NLAA
North Atlantic Right Whale *Eubalaena glacialis*	E	Documented	Disruption due to noise. Potential falling debris.	NLAA

Table 18. Potential Impacts to Federal and State Protected Wildlife Species within the Proposed Action Area

Common Name *Scientific Name*	USFWS; NMFS	Occurrence	Potential Impacts	Effect Determination
Sei Whale *Balaenoptera borealis*	E	Documented	Disruption due to noise. Potential falling debris.	NLAA
Sperm Whale *Physeter macrocephalus*	E	Documented	Disruption due to noise. Potential falling debris.	NLAA
Giant Manta Ray *Manta birostris*	T	Documented	Disruption due to noise. Potential falling debris.	NLAA
Nassau Grouper *Epinephelus striatus*	T	Documented	Disruption due to noise. Potential falling debris.	NLAA
Oceanic Whitetip Shark *Carcharhinus longimanus*	T	Documented	Disruption due to noise. Potential falling debris.	NLAA
Smalltooth Sawfish *Pristis pectinata*	E	Documented	Disruption due to noise. Potential falling debris.	NLAA
Shortnose Sturgeon *Acipenser brevirostrum*	E	Documented	Disruption due to noise. Potential falling debris.	NLAA
Wood Stork *Mycteria americana*	T	Potential	Disruption due to noise and heat.	NLAA
Piping Plover *Charadrius melodus*	T	Documented	Disruption due to noise.	NLAA
Red Knot *Calidris canutus*	T	Documented	Disruption due to noise.	NLAA
Tricolored Bat *Perimyotis subflavus*	PE	Potential	Crushing by equipment. Disruption due to noise and heat.	NLAA
Legend: (T) Threatened; (E) Endangered; (C) Candidate; (PE) Propose for Listing as Endangered; (LAA) May Affect, Likely to Adversely Affect, (NLAA) May Affect, Not Likely to Adversely Affect				

Although Terran R is a larger vehicle when compared to Terran 1, potential impacts to biological resources in and around SLC-16 would be similar to those evaluated in the Terran 1 Program EA. With this having been said, the noise disruption contours and heat plume will be larger in scope, have been accounted for, and are discussed below. Potential impacts to biological resources during construction would be minor. All construction would occur within the SLC-16 perimeter boundary or on the road leading to SLC-16, which has been previously disturbed. The Proposed Action ROI would encompass +/-33.68 acres, as well as an additional 1.83 acres of proposed heat plume influenced area. The proposed expanded Areas of Construction and range of heat plume influenced area (together making up the Proposed Action Area) encompasses approximately 35.51 acres as shown in ***Figure 14***. Of this ±35.51 acres, ±33.01 acres supports a combination of native scrub, open grassed areas, scattered invasive forested species, portion of the original launch complex, as well as areas that support a monoculture of Brazilian pepper. The remaining ±2.50 acres of the Proposed Action Area supports ditches (±0.40 acres), wetlands (±1.63 acres), and reservoirs (±0.41 acres). 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.

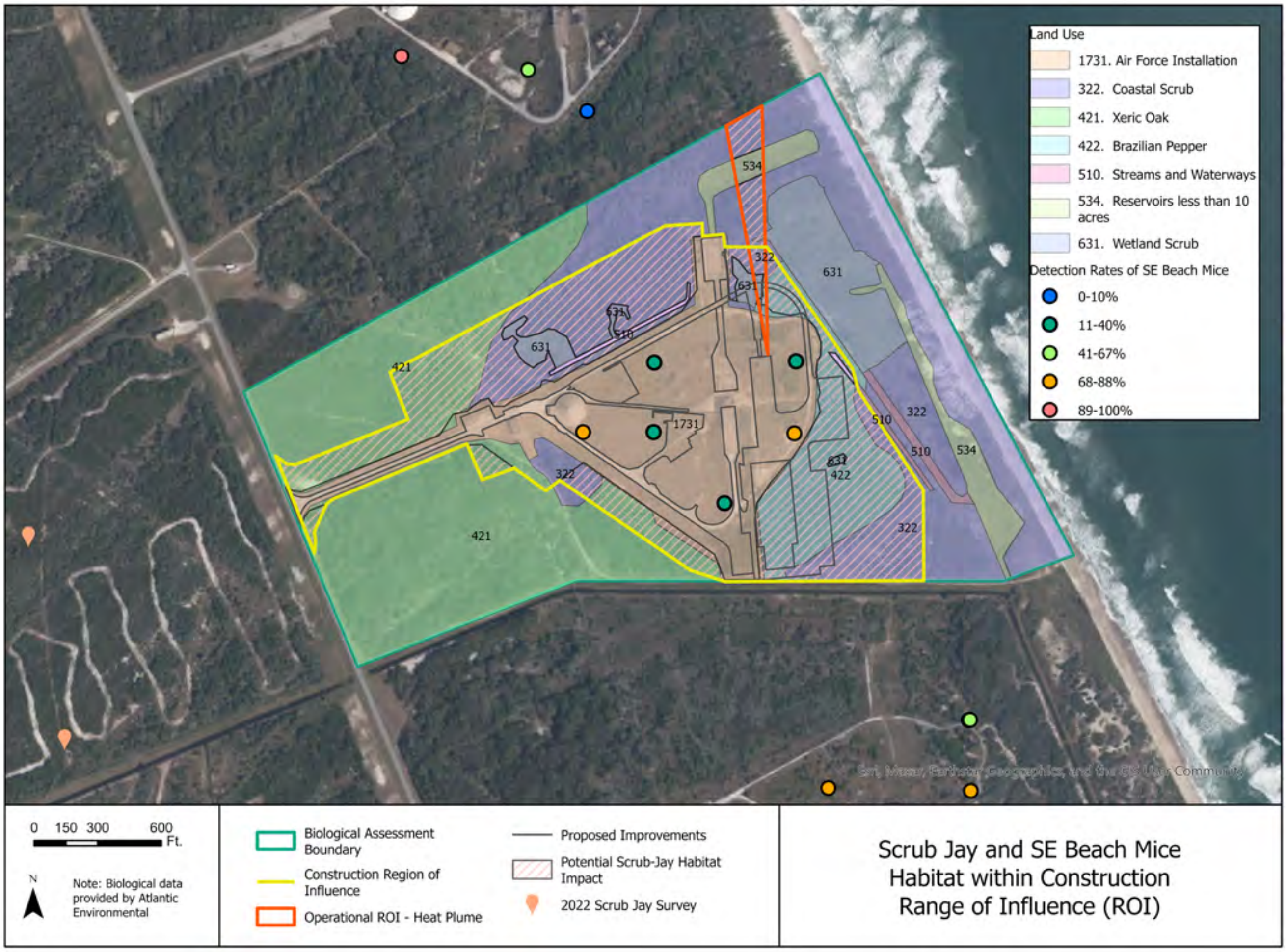


Figure 14. Scrub-Jay and Beach Mice Habitat within Construction ROI

Florida Scrub-Jay

The clearing for the Proposed Action would result in the loss of approximately 33.01 acres of potential Scrub-Jay habitat that is currently both unoccupied and unsuitable for Scrub-Jay occupation. The 2022 Florida Scrub-Jay census did not reveal the presence of any Scrub-Jay groups or individuals within the Proposed Action area as shown in ***Figure 15*** and therefore direct impacts are not expected. The site does contain suboptimal habitat in the form of coastal scrub, wetlands, and other natural areas that are not considered capable of being managed and occupied by the Florida Scrub-Jay.

Current and past launch programs on CCSFS, including the Atlas, Titan, and Delta launches, have been documented to not cause any animal mortality or significant impact to wildlife on CCSFS (USAF 1998a). With this being said, launch noise and the anticipated launch heat plume appear to possess the greatest impact risk to the Florida Scrub-Jay. Launch noise would extend into jay habitat and could temporarily displace this species. These potential effects would be short-term and happen on a limited basis.

The heat plume generated by Terran R (depicted on ***Figure 17***) during launch events could impact Florida Scrub-Jays that may be within the heat plume range of influence. With this being said, the heat plume is not expected to affect Scrub-Jays because suitable occupied habitat is not present within the plume's reach and the heat plume should be diverted over the tree line (see ***Figure 18***).

The Proposed Action would result in the taking of unoccupied and unsuitable Florida Scrub-Jay habitat, and therefore this species should fall under a May Affect, Not Likely to Adversely Affect (NLAA) determination.

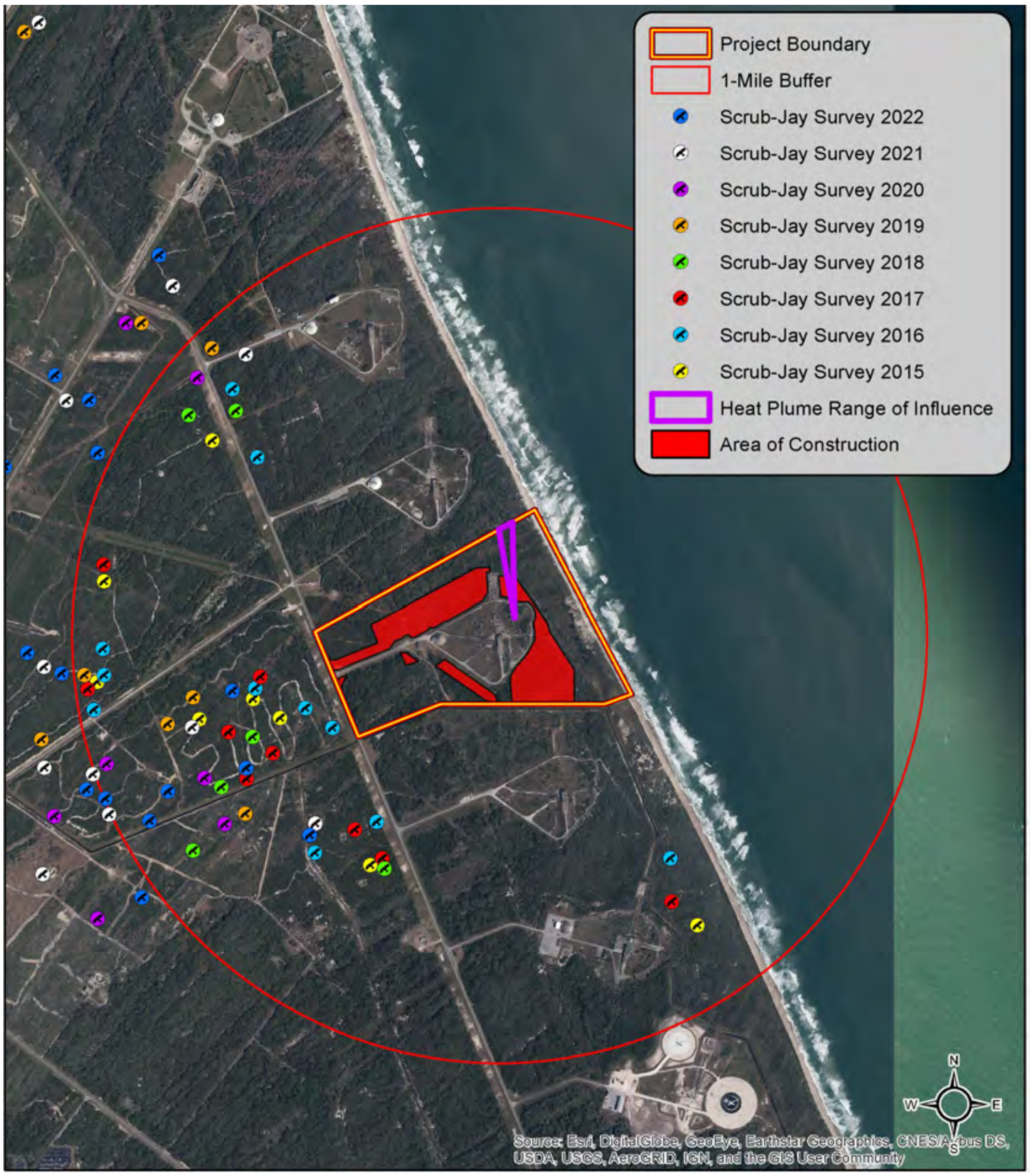


Figure 15. Florida Scrub-Jay Survey Map

Potential effects to the Florida Scrub-Jay during construction activities would include disruption of normal activities due to noise and ground disturbances. These impacts would be short-term and would elicit a "startle response" to avoid the noise. This would help the birds to avoid the threat and therefore, would not cause a negative impact to populations near the project area. Noise associated with stage MDC testing, static fire, and launch may startle many species within the CCSFS area. The 105 decibel (dB) maximum A-weighted instantaneous noise level (L_{Amax}) defines the operational ROI and is considered the reasonable noise level at which wildlife might exhibit a response (e.g., startle response) to the short-term noise associated with operations (FRA 2005; Manci et al. 1988; Dufour 1980; McKechnie and Gladwin 1993; Bradley et al. 1990; Lee and Fleming 2002). See ***Figure 16*** for the 105 dB L_{Amax} sound level contours during testing and launch.

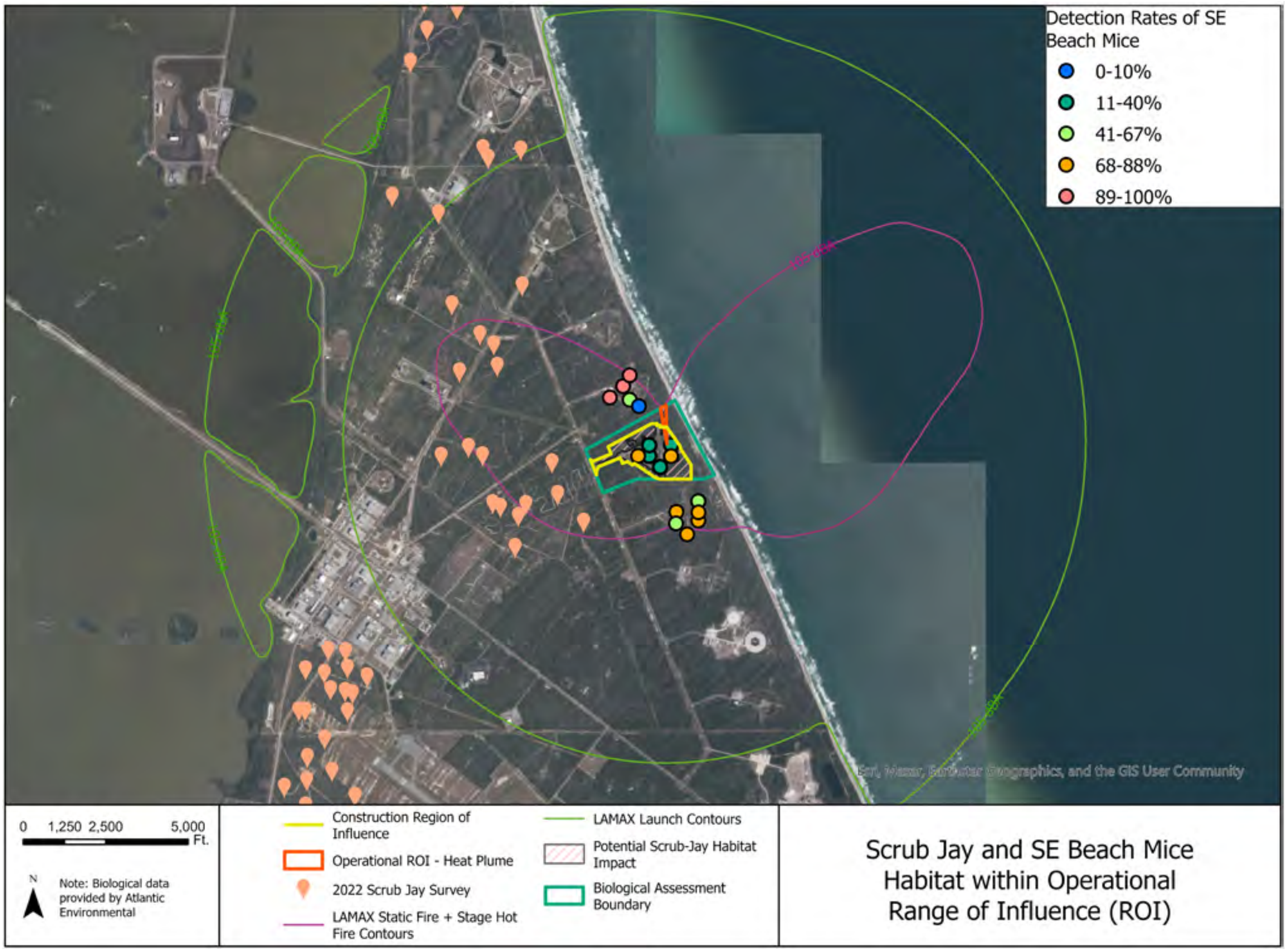


Figure 16. Scrub Jay and Beach Mice Habitat within Operational ROI

Mitigation for impacts to the Scrub-Jay would compensate for impacts caused by the Proposed Action. Provided the following compensation measures are implemented, this species should fall under a NLAA determination.

In lieu of habitat restoration as mitigation for loss of unoccupied potential FL Scrub-Jay habitat, Relativity Space proposes to provide funding to enhance unoccupied Scrub-Jay habitat adjacent to occupied jay habitat in Land Management Unit (LMU) 22 or another LMU to be designated by the USSF. Impacts proposed include 7.60 acres in LMU 22, 6.94 acres in LMU 27, and 18.47 acres in LMU 28. LMU is to be mitigated for at a 2:1 ratio while LMUs 27 and 28 are to be mitigated for at a 1:1 ratio. Funding for the improvement of a total of 40.61 acres in LMU 22 (or another LMU to be designated by the USSF) would be provided. Brazilian pepper infestation continues to be a problem on CCSFS, and the amount of funding received annually is not enough to completely eradicate this species from habitat that is currently occupied. This funding would assist the USSF in continuing efforts to eradicate invasive floral species in habitat that is currently occupied by jays or in areas adjacent to occupied habitat.

The presence of new launch operations at SLC-16 has the potential to negatively affect the SLD 45's prescribed burning program in adjacent LMUs due to launches, payload processing, and other operation activities. As a result, this could have negative indirect impacts on the Florida Scrub-Jay because of the reduced restoration of suitable habitat for this species. SLD 45 intends to conduct controlled burns and mechanical vegetation management to improve the Scrub-Jay habitat on CCSFS, including up to the Proposed Action Boundary. Relativity Space must ensure that proposed processing facilities can accommodate smoke that may occur as a result of a nearby prescribed fire.

Lastly, if a dead Scrub-Jay is found at the project site, it would be collected and frozen, and notification would be made to the USFWS office in Jacksonville.

Audubon's Crested Caracara

The Proposed Action would not directly impact critical Audubon's crested caracara habitat. However, launch noise possesses the greatest impact risk to this species, should it be present at the time of launch. Launch noise would extend into habitat surrounding SLC-16 resulting in potential temporary displacement of this species. This potential effect would be short-term and occur on a limited basis.

Based on these observations, this species should fall under a NLAA determination.

Indigo Snake

The Proposed Action would result in the loss of approximately 35.51 acres of potential eastern indigo snake habitat (includes all lands within the Proposed Action Area). Habitat loss may occur but adjacent habitat is available. Eastern indigo snakes would also be vulnerable to mortality as a result of injuries sustained during construction activities.

Reptiles and amphibians are sensitive to vibrations, which provide information about approaching predators and prey. Vibration and noise associated with construction activities would elicit a "startle response" to avoid the noise. These impacts would be considered short-term and would not cause a negative impact to the eastern indigo snake within the vicinity of the project area (USAF, 2010).

Noise associated with stage MDC testing, static fire and launch may startle many species within the CCSFS area. The heat plume generated by the Terran R launch vehicle could impact eastern indigo snake habitat, however it is expected that noise associated with pre-launch operations would cause individuals to disperse or hide in underground refugia prior to be exposed to the heat plume.

The SLD 45 Indigo Snake Protection/Education Plan would be presented to the project manager, construction manager and personnel. Education signs would 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 would be allowed to safely move out of the project area. Any observations of live or dead indigo snakes would be reported to the USSF immediately, who would then report it to USFWS if appropriate. With these measures in place, this species should fall under a NLAA determination.

Monarch Butterfly

The Proposed Action would not directly impact critical Monarch butterfly habitat. However, launch noise and the anticipated launch vehicle heat plume possess the greatest impact risk to this species, should it be present at the time of launch. Launch noise would extend into habitat surrounding SLC-16 resulting in potential temporary displacement of this species. These potential effects would be short-term and occur on a limited basis.

The heat plume generated by the Terran R launch vehicle could impact Monarch butterfly habitat, however no recent sightings exist for monarch butterflies at SLC-16.

Although this species is currently a candidate species, this species should ultimately fall under a NLAA determination.

Southeastern Beach Mouse

Construction and operations would occur at least 425 feet west of the beach dune area; typical habitat of the beach mouse. However, 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. Based on plans for construction, approximately 33.01 acres of clearing to a combination of native scrub, open grassed areas, scattered invasive forested species, as well as areas supporting monoculture of Brazilian pepper would occur. This area of clearing appears to be the only land within the Project Area with potential to contain habitat supporting the southeastern beach mouse; leaving substantial area for apparent expanding beach mouse habitat.

Potential noise related effects to the Southeastern Beach Mouse during construction activities would include disruption of normal activities due to noise and ground disturbances. These impacts would be short-term and would elicit a “startle response” to avoid the noise. This would help the mice to avoid the threat and therefore, would not cause an impact to the Beach Mouse within the vicinity of the project area.

In addition to habitat impacts, launch noise and the anticipated launch heat plume possess the greatest impact risk to the southeastern beach mouse as previously shown in ***Figure 16***. Launch noise would extend in the species’ habitat and could temporarily displace this species. These potential effects would be short-term and limited.

The heat plume generated by the Terran R launch vehicle (see ***Figure 17***) could impact southeastern beach mouse habitat or individuals present at the time of launch. However, due to the diverter and concrete flume design, the heat plume is directed vertically into the atmosphere, above the tree line (see ***Figure 18***). Therefore, heat plume impacts to beach mice and their habitat are anticipated to be minimal, approximately 1.87 acres, and fall within the SLC-16 boundary. Considering the southeastern beach mice have been documented inside facilities throughout CCSFS, the USSF has a Programmatic BO that covers pest management activities within and around such facilities. The Relativity Space facilities would be required to live trap and release the southeastern beach mouse within and around its facilities on SLC-16 per the existing BO.

While there could be a take of a southeastern beach mouse, the proposed habitat enhancement within scrub habitat in LMU 22 or some other LMU to be designated would offset impacts to the occupied southeastern beach mouse habitat. The USSF has a Programmatic BO that addresses impacts to beach mice associated with certain activities, which includes restoration and enhancement actions. Based on past studies completed for CCSFS, beach mice benefit from the same land management activities being conducted for Scrub-Jays, and the population is expanding into inland locations. Therefore, the potential exists to improve approximately 33.01 acres of additional habitat for beach mice. Proposed Action acreage that may support beach mice is contiguous with adjacent beach mouse habitat to the east and therefore would allow movement of individuals. With these measures and BO in place, this species should fall within a May Affect, Likely to Adversely Affect (LAA) determination.

Sea Turtle

The proposed clearing and construction of new facilities would not directly impact the nesting beach. While current exterior lighting for Relativity's facilities has the potential to be visible from the beach and could result in adult and/or hatchling disorientation adjacent to SLC-16, lighting impact has been and is proposed to continue to be limited by an approved Light Management Plan.

Sea turtles are not expected to be affected by vibration and noise associated with construction activities since the project area would be beyond the beach and dune area. However, noise associated with stage MDC testing, static fire, launch and ocean-based barge landing may startle many species. Launch noise would extend into habitat surrounding SLC-16 and could temporarily startle this species. These potential effects would be short-term and limited.

To minimize potential impacts to sea turtles from new or temporary facility lighting, the majority of exterior lighting proposed for this project would be in accordance with the 45th SW Instruction 32-7001, *Exterior Lighting Management* dated April 23, 2018. It is expected that some "non-turtle friendly" lighting may be required during actual "day" of S1 MDC testing, static fire, or launch, and if any of these activities were to occur at night. A Light Management Plan has been completed by Relativity Space and will be amended, if needed, once the design is completed and this Plan will be forwarded to USFWS for approval prior to new or temporary lighting construction. Clearing of vegetation could increase the amount of light visible to sea turtles on the beach, increasing potential disorientations of nesting and hatching sea turtles. With light management in place, sea turtles on CCSFS should fall under a NLAA determination.

Manatee

The Proposed Action is not likely to have a negative impact on manatees in the area. Manatees are not expected to be affected by vibration and noise associated with construction activities since they are not in the area continuously and the project area would be west of and beyond the beach and dune area. Noise associated with launch operations and ocean-based barge landings would be temporary in nature and are expected to elicit a "startle response".

The Proposed Action is not likely to have a negative impact on manatees in the area and therefore a NLAA determination is recommended.

Wood Stork

Nearby wetlands and surface waters present within SLC-16 are made up of poor-quality wood stork foraging habitat, therefore, impact to this species' habitat is expected to be negligible. Launch noise, however, would extend into wood stork foraging habitat and could temporarily displace this species. These potential effects would be short-term and limited.

The heat plume generated by the Terran R launch vehicle (as shown on ***Figure 17***) during launch events could impact wood storks that may be within the heat plume ROI. However, it is expected that noise associated with pre-launch operations would cause individuals to flee the area, avoiding the heat plume. For this reason, this species should fall under a NLAA determination.

Piping Plover

Impacts to Piping Plover habitat is expected to be negligible since no work takes place within their beach habitat. However, during launch operations, any Plovers on the beach adjacent to SLC-16 could be startled. This would be expected to be a short-term impact. Based on these observations, this species should fall under a NLAA determination.

Red Knot

Red Knot habitat is expected to be negligible due to construction, since no work takes place within their beach habitat. However, during launch operations, any red knots on the beach adjacent to SLC-16 could be startled. This would be expected to be a short-term impact. Based on these observations, this species should fall under a NLAA determination.

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

Tricolored Bat

On September 13, 2022, USFWS announced a proposal to list the tricolored bat as endangered under the ESA. The bat faces extinction due to the impacts of white-nose syndrome, a deadly disease affecting cave-dwelling bats across North America. The tricolored bat is one of the smallest bats native to North America. This once common species is wide ranging across the eastern and central US and portions of southern Canada, Mexico, and Central America. During the winter, tricolored bats are found in caves and mines, although in the southern US, where caves are sparse, tricolored bats may be found roosting in man-made structures (e.g., buildings, culverts, and bridges). During the spring, summer, and fall, tricolored bats are found in forested habitats where they roost in trees, primarily among leaves. As its name suggests, the tricolored bat is distinguished by its unique tricolored fur that appears dark at the base, lighter in the middle and dark at the tip. Tricolored bats have been documented on CCSFS and may be present within the proposed project area.

The proposed rule to list the tricolored bat as endangered currently does not specify activities that would violate the ESA because the bat occurs in a variety of habitat conditions across its range. With the implementation of site-specific surveys prior to vegetation clearing, adverse impacts to the tricolored bat are not anticipated. If tricolored bats are observed or detected during these surveys, additional coordination with USFWS will be initiated. The Proposed Action has an NLAA determination with respect to the tricolored bat.

Proposed Action impacts to T&E species due to dust generation and dispersal are not expected. Based on the conclusion of insignificant impacts to air quality and water resources due to dust generation, (See ***Section 3.1.3.3*** and ***3.2.3.3.1***) resulting impacts to biological resources are also not anticipated.

3.5.3.2 Other Wildlife and Marine Life Impacts FA

No animal mortality has been observed at CCSFS that could be attributed to Delta, Atlas or Titan launches (Schmalzer 1998). No other data has been published at the time of issuance of this SEA. Similar results are expected for Terran R Program launches. Scrub-Jays, gopher tortoise, southeastern beach mice, indigo snakes and sea turtle nesting occur in the vicinity of SLC-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 (USSF, 1998).

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. Following stage separation, the first stage would be maneuvered into position for retrograde burn, reentry and landing on the ocean-going barge. 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.

Launch debris from expended boosters, payload fairings, launch abort tests, or any launch failure anomalies have the potential to affect MMPA and ESA-listed marine species. The primary concern is a direct impact from an object landing on a marine mammal, sea turtle or fish. Based on the relatively low water impact velocity of Terran R after a controlled landing burn, Relativity expects S1 to remain intact and not explode. Relativity would perform water impact and buoyancy analyses similar to those approved for Terran 1 to confirm this expectation. This analysis would also consider the unique 'slapdown' impact cases that are possible with a low-velocity water landing, where the booster falls over sideways and impacts the water along its longitudinal axis. The nominal flight plan for S1 soft-water landings without a barge would result in S1 impacting the water intact vertically. Terran R would sink at an angle (similar to a sinking ship), during which sea water would flood the tanks through the fill drain valves near the bottom. As the tanks flood, the vehicle would become waterlogged and sink to the ocean floor. If in an off- nominal event, Terran R did not sink, Relativity would attempt to scuttle Terran R.

The Proposed Action ROI extends to 1,350 km downrange within the Action Area defined in the 2023 NMFS Programmatic Consultation. Marine mammals and ESA-listed species are sparsely distributed across these ocean expanses, resulting in very low densities of species overall. The probability of a direct impact to protected marine mammal, sea turtle or fish is thus extremely unlikely. Materials have been expended from rocket launches for decades with no known interactions with any of the ESA-listed species considered in the 2023 NMFS Programmatic Consultation. Relativity's analysis of the behavior of the Terran R vehicle after jettison upon potential impact with a marine environment is discussed in ***Appendix C.*** Because it would be extremely unlikely for a MMPA or ESA-listed species to be directly struck by launch vehicle components, spacecraft, and any launching or landing-related debris, the potential for effects to marine life from a direct impact by those fallen objects are discountable. Therefore, direct impacts from fallen objects to MMPA protected marine mammals, ESA-listed marine mammals, sea turtles, and fish in the action area due to launch activities may affect but are not likely to adversely affect these animals (NMFS, 2023).

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. Impacts from residual liquid propellant within the launch vehicle is considered a negligible hazard because virtually all hazardous materials are consumed in the destruct action or dispersed in the air and only structural debris would strike the water. In a destruct action, the Terran R vehicle may survive to impact the water essentially intact. The Terran R propellant storage is designed to retain residual propellant however, in the unlikely event the propellant tank ruptures on impact, the propellant would evaporate or be quickly diluted and buffered by seawater. Relativity's recovery operations team would implement their Hazardous Emergency Response Plan to contain spills and minimize the duration and impact of spilled hazardous materials following a launch failure scenario. Due to the unlikely scenario of liquid propellants leaking from the launch vehicle and the quick dilution or evaporation of liquid propellants, hazardous material exposure to MMPA and ESA-listed marine mammals, sea turtles, and fish in the action area may affect, but are not likely to adversely affect these animals.

Relativity will use last state vectors and range assets to approximate a primary debris field. Using local weather and current drift analysis, Relativity will estimate the location of debris and make best efforts to redirect recovery vessels or charter third party vessel to perform debris recovery operations. Relativity would have a vessel in the area of highest likelihood of debris that would identify large debris for salvage. Relativity would use the vessel to survey the debris field for approximately of 24 to 48 hours (using visual survey in the day and onboard vessel radar at night) depending on the outcome of the breakup. The initial survey area would be determined based on last known data location point received from the telemetry on the vehicle upon splashdown. Weather and ocean current data would be used to further characterize the debris field as the operation is conducted. Methods to physically remove debris could include using a net or a boat hook. Relativity would report debris findings to the USCG to determine the most appropriate method of recovery or sinking as described above and would be on a case-by-case basis depending on personnel safety, vessel safety, and capability. Relativity would act to mitigate the debris in coordination with USCG to verify the debris sinks within 10 days as noted in the NMFS Letter of Concurrence. If debris is still identified after the 24-48 hours survey and recovery efforts, Relativity would use another method including, an additional vessel or satellite imaging to confirm and characterize any debris and take appropriate action to retrieve or sink it.

In the event of an anomalous landing where the vehicle misses the landing platform and remains intact, the recovery team will assess safely scuttling the stage via valve commands to open the vehicle to flooding or using a firearm and other onboard tools such as hooks and chain to compromise the structural integrity of the tank leading to sinking.

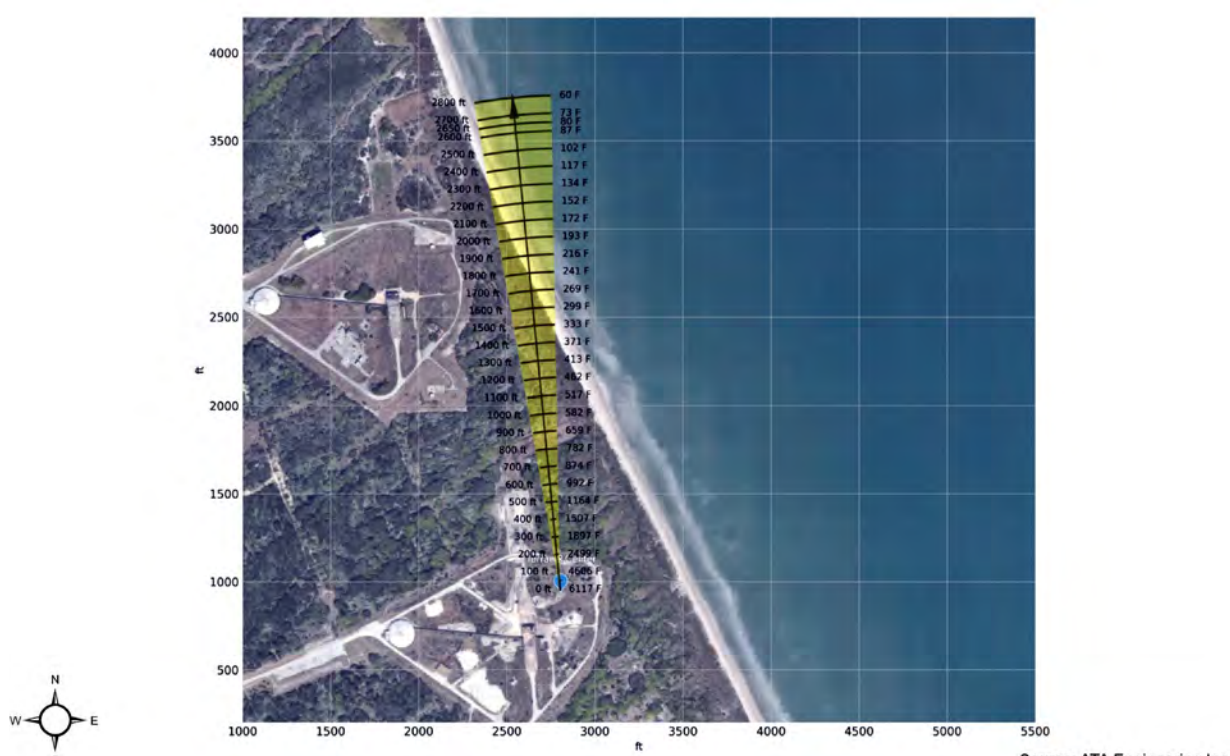
Other potential impacts on marine habitats and wildlife from Terran R vehicle launches and ocean-based barge landings are associated with the resulting sonic booms. These potential impacts are fully described by NMFS as part of FAA's 2023 ESA Section 7 consultation (NMFS, 2023). This consultation addressed comparable commercial space vehicle launch, reentry, landing, and recovery operations in the Atlantic Ocean. The consultation resulted in NMFS concurring that commercial vehicle launch and reentry operations may affect but are not likely to adversely affect ESA-listed species and designated critical habitat (***Appendix C***). The same impact mechanisms and effects described and assessed as part of the 2023 NMFS consultation are directly applicable to the proposed project.

Previous research conducted by the USAF supports this conclusion with respect to sonic booms, indicating the lack of harassment risk for protected marine species in water (USAF Research Laboratory, 2000). The researchers were using a threshold for harassment of marine mammals and sea turtles by impulsive noise of 12 pounds per square inch (psi) peak pressure and/or 182 dB referenced (re) to the standard unit of acoustic pressure underwater, 1 micro-Pascal (μPa), which is an older threshold used by NMFS and DoD at the time. The researchers pointed out that, to produce the 12 psi in the water, there needs to be nearly 900 pounds per square foot (psf) at the water surface, assuming excellent coupling conditions. As noted in the *Noise Study for Terran R Operations at CCSFS* (***Appendix D***), the maximum modeled peak overpressures reach 11 psf for SLC-16 northeasterly launches and 47 psf for ocean-based barge landings. The impacts resulting from the sonic booms generated by Terran R launch operations are therefore not expected to affect marine species underwater.

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

3.5.3.3 Vegetation Impacts

Heat plume at the rocket's center point reaches 6,117°F and decreases to 4,606°F 100 feet to the northeast, 2,499°F at 200 feet, 1,897°F at 300 feet, 1,507°F at 400 feet, and <600°F at the property boundary. ***Figure 17*** depicts the ROI of the heat plume associated with Terran R launches as determined by ATA Engineering, Inc. Terran R launches would 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 CCSFS. Vegetation scorching was limited to small areas (less than 2.67 acres) within 492 feet of the launch pad. Past vegetation scorching has not permanently affected the vegetation near other launch complexes and this same impact is expected to apply to Terran R launches.



Source: ATA Engineering Inc.

Figure 17. Heat Plume Range of Influence

It is important to note that the potential heat plume impact is conservatively estimated at a 1.83-acre swath of land. ***Figure 18*** depicts an elevation view of Terran R and its associated heat plume. As shown on this figure, due to the diverter and concrete flume angle, it is anticipated that the heat plume would have minimal impacts to the north at ground level. Instead, the heat plume would be realized above the tree line in this area.

Relativity would perform monitoring within the heat plume region of influence to better understand any potential impacts. Monitoring would include temperature sensors, as well as visual review of the potentially affected area after both static and launch events. Results from this monitoring would be reviewed with SLD 45 and if additional heat related impacts are realized from this monitoring, these impacts would be addressed with the appropriate agencies.

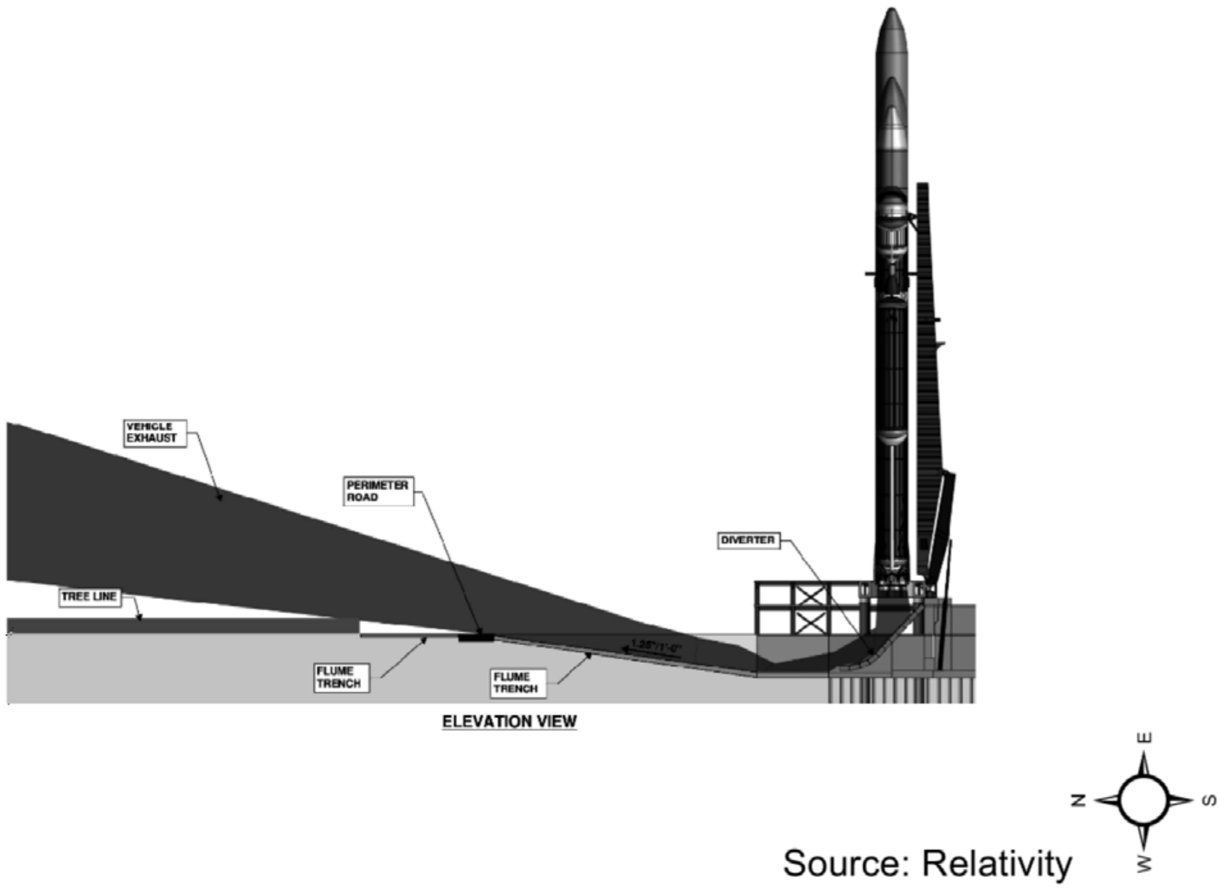


Figure 18. Heat Plume Elevation View

Acid deposition on vegetation, following Terran R launches, is not a concern. Relativity's Terran R engines consume LOX and LNG with negligible to no particulate depositions produced.

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 (USAF, 2000). Similar results are expected for Terran R's Program launch anomalies. Terran R launches would have no significant impact on vegetation resources.

3.5.4 No Action Alternative

Under the No Action Alternative, the Terran R Program would not be implemented and a new license by FAA would not be issued. Under the No Action Alternative, no launches would take place with no construction or changes made to SLC-16. Listed species habitats would not be impacted and habitat restoration would not be required. Nearby ESA-listed species would not be disturbed by noise impacts of the Terran R Program. The No Action Alternative would not have the potential to impact protected wildlife species within CCSFS and the Atlantic Ocean.

3.6 Land Use, Visual Effects and Coastal Resources

3.6.1 Regulatory Setting

Land use is defined as the human usage of land resources for use 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, Visual Effects and Coastal Resources ROI includes SLC-16 and surrounding areas, including adjacent shorelines as applicable on CCSFS.

3.6.2 Affected Environment

3.6.2.1 Regional Land Use and Zoning

Brevard County and the City of Cape Canaveral are the local planning authorities for incorporated and unincorporated areas near CCSFS and designate compatible land uses and zoning around CCSFS. CCSFS 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, the USSF, the US Coast Guard and commercial space launch companies to support space launches, shipping, vessel maintenance and other related activities.

Use of the river and ocean water areas surrounding CCSFS include commercial fishing, marine recreation, and marine transportation. KSC is northwest of CCSFS 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 (NPS).

3.6.2.2 Land Use and Zoning

CCSFS encompasses approximately 16,200 acres (25 square miles), representing approximately two (2) percent of Brevard County’s total land area. Land uses at CCSFS include an airfield, port operations, launch operations, launch, and range support, commercial aerospace ventures, station support, 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 (2) sections by the Skid Strip (airfield). Port operations are within the southern region of CCSFS and includes facilities for government, commercial and industrial shipping activities. The CCSFS industrial area is centrally located in the western portion of CCSFS, near the Banana River, and is identified as a CCSFS support area category. Land use at CCSFS also includes administrative, recreational, historic lighthouse, monuments and museum and range support functions. Open space is dispersed throughout CCSFS. CCSFS has no public beaches.

LUCs are implemented within SLC-16 and the CCSFS industrial area due to RCRA Facility Investigations (RFIs) identifying hazardous waste spills and contamination. Additional information on SWMUs is included in ***Section 3.11.2.4.***

Undeveloped land west, south and north of SLC-16 is subject to Wildland Fire Operations. *AFMAN 32-7003, Environmental Conservation*, outlines the USSF Wildland Fire Management requirements.

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 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 19.*** Summary of Land Use and Zoning Requirements

Table 19. 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), USSF

Table 19. Summary of Land Use and Zoning Requirements

Law or Rule	Permit/Action(s)	Requirement	Agency or Organization
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
FAC 62B-33.004 (2) (b)	Exemptions from Permit Requirements	(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.

CCSFS has additional siting and facility design standards for construction that require new facilities to be set back at least 150 feet from the coast. SLC-16 pad centerline is approximately 1,000 feet west of the Atlantic shoreline. Land uses are addressed by the CCSFS General Plan, 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 USSF is responsible for making the final coastal zone consistency determinations for its activities within the state and the FDEP along with FCMP member agencies would review the Florida CZMA plan to ensure the proposed action is consistent with the coastal zone consistency determination through submittal of this SEA to the Florida Clearinghouse.

3.6.2.3 Visual Effects

The ROI for light emission effects includes people, wildlife and land uses in the SLC-16 area. Light emissions from the proposed Terran R Launch Program would be within 2,000 feet of the Atlantic Ocean.

The ROI for light emissions includes most of CCSFS Atlantic coastline due to sensitivity of nesting adult and emerging hatchling sea turtles to artificial lighting. ***Section 3.5.3*** provides additional details on compliance with Section 7 of the Endangered Species Act (ESA). The USSF has developed exterior lighting requirements, for various areas and facilities on CCSFS to protect sea turtles. A Light Management Plan would be developed and implemented based on SWI 32-7001.

3.6.2.3.1 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 SLC-16 facilities consists mainly of the indigenous Florida coastal scrub (including oak and rosemary scrub) and also includes the Atlantic Ocean coastline, the Banana River and surrounding wetlands.

3.6.3 Environmental Consequences

3.6.3.1 Construction

SLC-16 is designated for space launch activities and operations, consistent with both the Base General Plan and the USSF mission at CCSFS. 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. A Light Management Plan would be implemented during construction to minimize impacts to nesting sea turtles on the nearby coastline.

LUCs are in place at SWMU C040, within SLC-16, to protect against exposure from contaminated paint residue, soil, and shallow groundwater. The LUCs applicable to this project include:

- Soils will not be disturbed or moved during property development, maintenance or construction without USSF review, coordination, and approval.
- Consumptive use of surficial aquifer groundwater is prohibited. Consumption and dermal exposure to groundwater will be prevented.
- Groundwater will not be contacted, pumped, or discharged during property development, maintenance, or construction, without USSF review, coordination, and approval.

Therefore, Proposed Action construction would have no significant impacts on land use, visual effects, or coastal resources within SLC-16 or the surrounding CCSFS area.

3.6.3.2 Ground Support Operations and Maintenance

Offloading operations at Port Canaveral, or a commercially available port, for Terran R first stage boosters from following ocean-based barge landing is also consistent with current land use and would have no significant impacts. Existing loading docks and infrastructure would be used to accommodate the Terran R Program.

Relativity's facilities would 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 R Program construction, refurbishment and operation activities are within and adjacent to the existing launch complex footprint, and at heights similar to or lower than other active launch sites at CCSFS.

Therefore, the ground support operations would have no significant impacts on land use, visual effects, and coastal resources within the ROI.

3.6.3.3 Stage MDC Testing, Static Fire, Launch and Landing

Terran R Program S1 MDC testing, static fire, launch, and landing operations are similar in scope to previous and current launch activities occurring at CCSFS. Stage MDC testing, static fire and launch operations at SLC-16 would be similar to space launch activities currently approved as part of the Terran 1 Program. Landing operations on an ocean-based barge would be consistent with current booster landing operations within the Atlantic. Relativity would have mobile equipment to accomplish post booster landing operations. Booster offloading at Port Canaveral would also be consistent with current port operations.

All Terran R Program construction, refurbishment, ground support operations and launch activities would be coordinated with CCSFS, as required. Coordination with KSC, FAA, FDEP and FCMP member agencies would 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 would determine whether the Proposed Action is consistent with the FCMP.

Therefore, stage MDC testing, static fire, launch and landing would have no significant impacts to land use, visual effects, or coastal resources.

3.6.4 No Action Alternative

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

3.7 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. $L_{A,max}$ is a single-event metric that describes the highest A-weighted sound level during an event in which the sound changes with time.

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 20*** contains common sound examples.

Table 20. 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	
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 – FEIS, 1998.		

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 21.***

Table 21. 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.

Table 21. Sound Level Descriptors

Descriptor	Description
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 psf. Peak overpressure is often used to measure the magnitude of sonic booms, particularly with respect to evaluating the potential for structural damage.

3.7.1 Regulatory Setting

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 two (2) psf, below which damage is unlikely (Haber, 1989).

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 would be exposed at or above the DNL 65 dB level due to a DNL 1.5 dB or greater increase, when compared to the No Action Alternative for the same timeframe. 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 70 dBA and 95 dBA at 50 feet (FHWA, 2020).

Temporary noise sources associated with construction would be considered significant to equipment operators and those within five feet if they resulted in noise levels equal to or greater than 85 dB, a noise threshold limit value for construction workers in an eight-hour day (NIOSH, 1998).

In accordance with 29 CFR Part 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 moderate or lower levels presented in ***Table 20***, 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. Noise impacts on wildlife are discussed in ***Section 3.5.3.2***.

3.7.2 Affected Environment

The ROI for noise includes the area around SLC-16, CCSFS and the closest populated areas, which are Cape Canaveral and Cocoa Beach to the south and Merritt Island to the southwest. Two (2) noise areas associated with the Proposed Action are evaluated, Construction Noise and Launch Operations Noise.

Noise levels around industrial facilities at CCSFS 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 CCSFS Skid Strip. Other less frequent but more intense sources of noise in the region are launches from CCSFS. The closest residential areas to CCSFS are in Merritt Island and Cape Canaveral, approximately eight (8) miles and 12 miles respectively, from SLC-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 flyovers and rocket launches from CCSFS 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.

3.7.3 Launch Operations Noise

Operation-related noise refers to noise generated from activities such as stage MDC testing, static fire, launches and ocean-based barge landing. The highest recorded levels at the spaceport were produced by the Space Shuttle and could exceed 160 dBA. The November 2022 launch of NASA's Artemis 1 Space Launch System (SLS) reached noise levels of 109 dBA at the KSC Press Site approximately three (3) miles from the launch pad. The Artemis 1 SLS provided 8.8 million pounds of thrust at liftoff (NASA, 2023). Terran R is expected to have a total thrust of 3.6 million pounds at liftoff.

Launch is the major source of all operational noise. Three (3) distinct noise events are associated with launch, ascent and return of a launch vehicle: on-pad engine noise (including stage MDC testing/static fire) in-flight engine noise, and sonic booms. Operations-related noise from the actual launches are summarized below.

3.7.3.1 On-pad Noise

On-pad engine noise occurs when engines are firing during a stage/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. The technical report titled *Noise Study for Relativity Space Terran R Operations at CCSFS* is included in ***Appendix D***.

3.7.3.2 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).

3.7.3.3 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.

3.7.4 Construction Noise

Construction noise includes temporary noise during construction, maintenance or refurbishment activities and ongoing noise generated from worker traffic to and from the selected site. 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 70 and 95 dBA at a distance of 50 feet (FHWA, 2006). In addition, noise diminishes at a rate about six (6) dBA for each doubling of distance from the source. CCSFS has no sensitive receptors (e.g., schools, hospitals) in its vicinity. All construction work would be conducted as normal activities on CCSFS.

3.7.5 Environmental Consequences

Noise generated during the Proposed Action is categorized as stage testing/static fire engine noise, stage hot fire engine noise, launch engine noise, sonic boom (launch and ocean-based barge landing) and construction noise. Relativity contracted with BRRC to develop the technical report titled *Noise Study for Relativity Space Terran R Operations at CCSFS* to quantify noise associated with the Terran R launch vehicle (***Appendix D***). BRRC used their Rocket Propulsion Noise and Emissions Simulation Model (RUMBLE 4.1) to predict the noise associated with the proposed Terran R launch operations. Nominal launch vehicle configurations were included in BRRC’s modeling. Based on BRRC’s analysis, Terran R launch noise is not considered to be a significant impact as detailed below.

The FAA completed a technical noise modeling methodology review for BRRC's RUMBLE 4.1 model. Concluding the review, FAA approved of BRRC's modeling methodology. A copy of the memorandum to record FAA's decision is provided in ***Appendix E***.

3.7.5.1 Construction and Ground Support Operations

A temporary increase in ambient noise levels would occur at SLC-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 typically limited to 1,000 feet or less. No residential areas or other sensitive receptors occur at, or near, SLC-16; therefore, refurbishment noise would not impact the public or sensitive receptors.

When employees are subject to sound exceeding OSHA limits during construction or ground support operations, engineering or administrative controls would be used and/or personal protective equipment, such as approved hearing protection, would be provided. OSHA noise level standards and protections would be followed to protect worker safety and health. Monitoring of worker exposure to noise would be conducted as required by OSHA.

Similar construction activities and heavy equipment use take place within CCSFS on a regular basis. Therefore, noise effects during construction and ground support operations would have no significant impact under the Proposed Action.

3.7.5.1.1 Stage MDC Testing, Static Fire, Launch Operations

A single nominal Terran R launch event may generate levels at or above a maximum A-weighted sound level ($L_{A,max}$) of 115 dBA within 0.83 miles of the launch pad, as shown by the orange contour in ***Figure 19***. $L_{A,max}$ is a single-event metric that describes the highest A-weighted sound level during an event in which the sound changes with time.

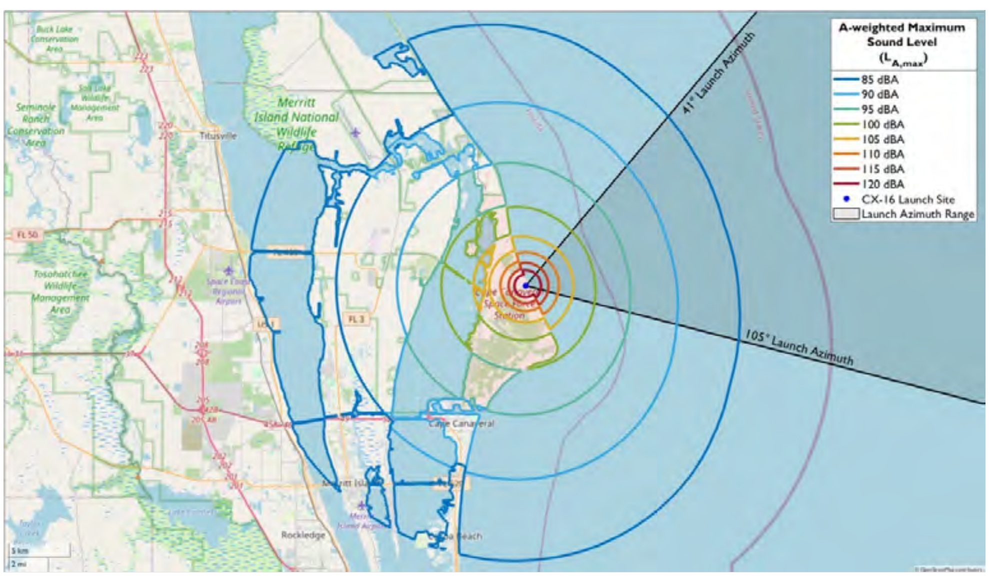


Figure 19. A-Weighted Maximum Sound Level Contours for Northeasterly Launch Operations

The entire land area encompassed by the 115 dB noise contours resulting from Terran R launches lies within CCSFS.

Terran R stage MDC testing/static fire noise contours are more directive than launches because the plume is redirected in-line with the deflector heading during testing. A receptor located within the peak directivity angle may experience a $L_{A,max}$ of 115 dBA at approximately 0.63 miles from SLC-16, shown in ***Figure 20*** below. The entire land area encompassed by the 115 dB noise contours is within the boundaries of CCSFS. It is important to note that levels produced by stage MDC and static fire operations would remain constant over the duration of the test, while noise levels produced by launch operations would decrease as the rocket moves further away from the receptor.

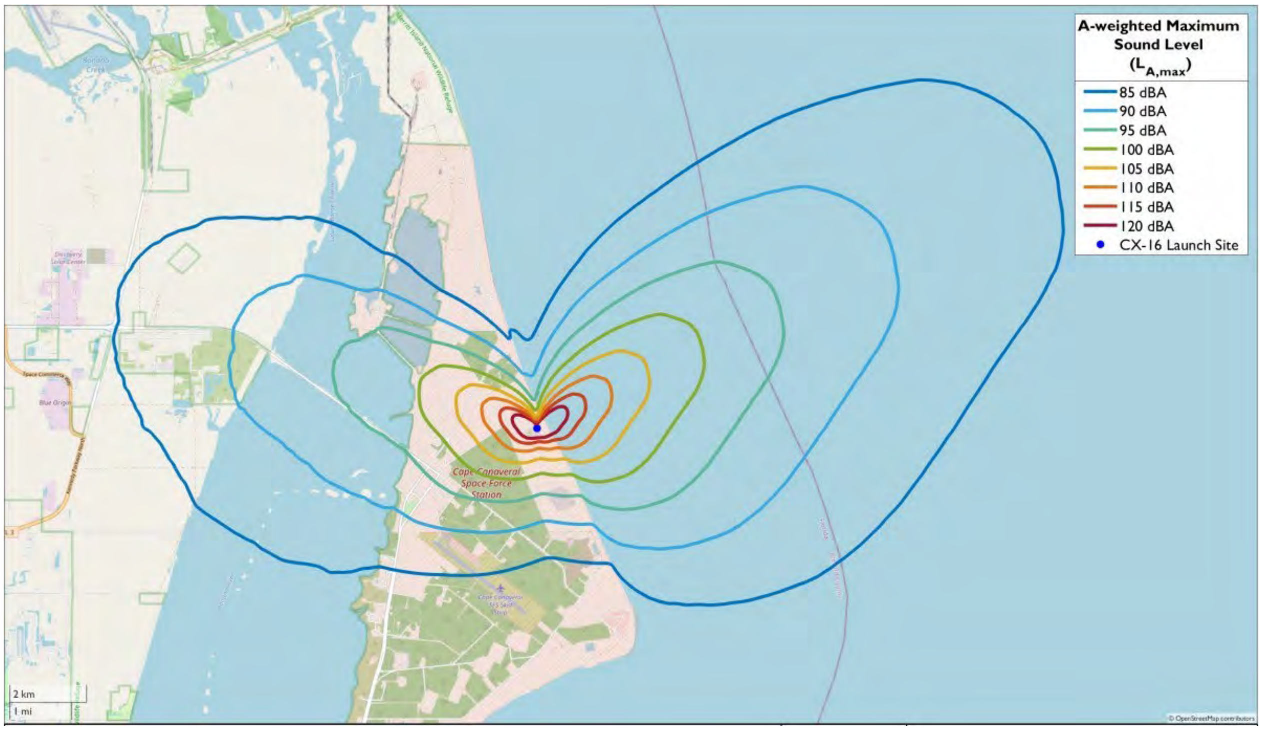


Figure 20. A-Weighted Maximum Sound Level Contours for Stage MDC/Static Fire Operations

Structural damages were assessed by analyzing the 111 dB and 120 dB L_{max} contours generated by a Terran R launch and stage MDC/static fire operations. The potential for structural damage claims is approximately one (1) damage claim per 100 households exposed at 120 dB and one (1) in 1,000 households at 111 dB. For Terran R launch and stage MDC/static fire events, L_{max} in excess of 120 dB would be limited to land within CCSFS and KSC, as shown in ***Figure 21***. L_{max} in excess of 111 dB includes areas on Merritt Island and Cape Canaveral from launch events, and a small area south of the KSC boundary near the Pine Island Conservation area from stage MDC/static fire events, as shown in ***Figure 22*** The L_{max} value of 130 dB is used to further assess potential noise impacts to structures considering all sound lasting more than one (1) second with levels exceeding 130 dB (unweighted) as potentially damaging to structures. Based on the modeling analysis, the 130 dB L_{max} contours do not include any land areas outside CCSFS boundaries.

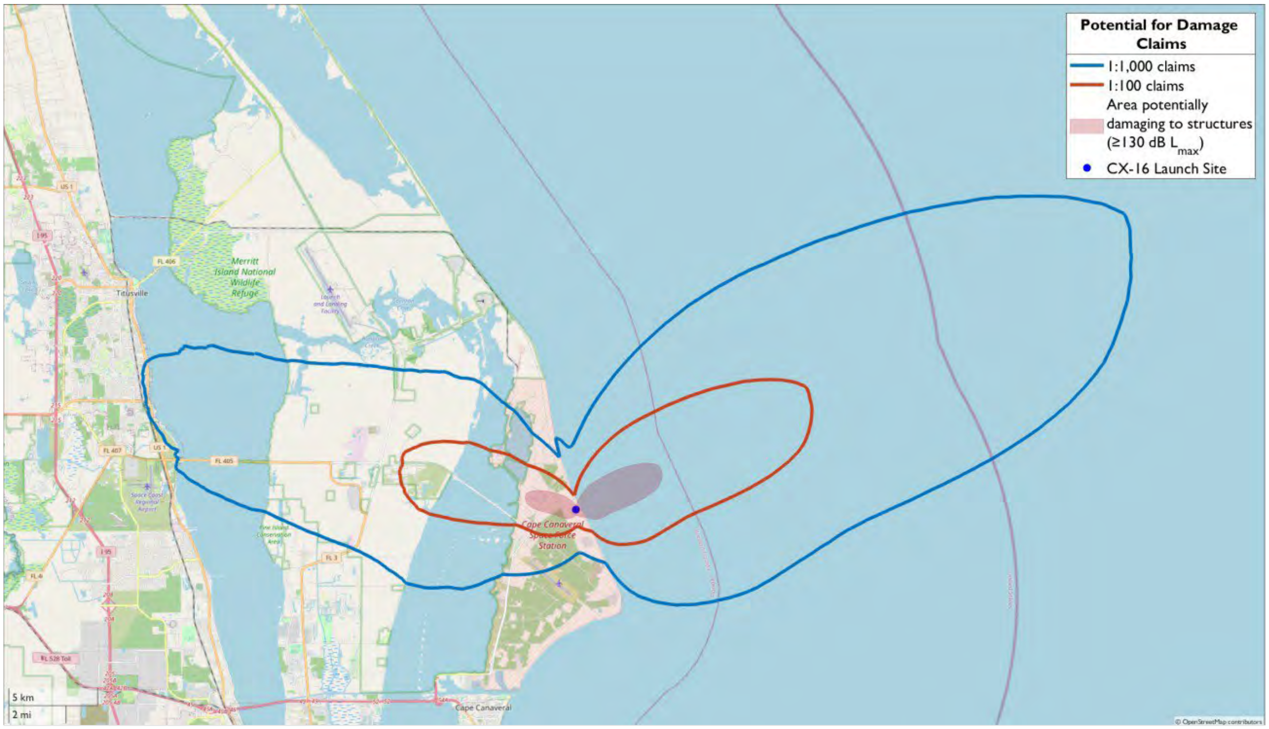


Figure 21. Potential for Damage Claims Contours for Stage Hot Fire and Static Fire Tests

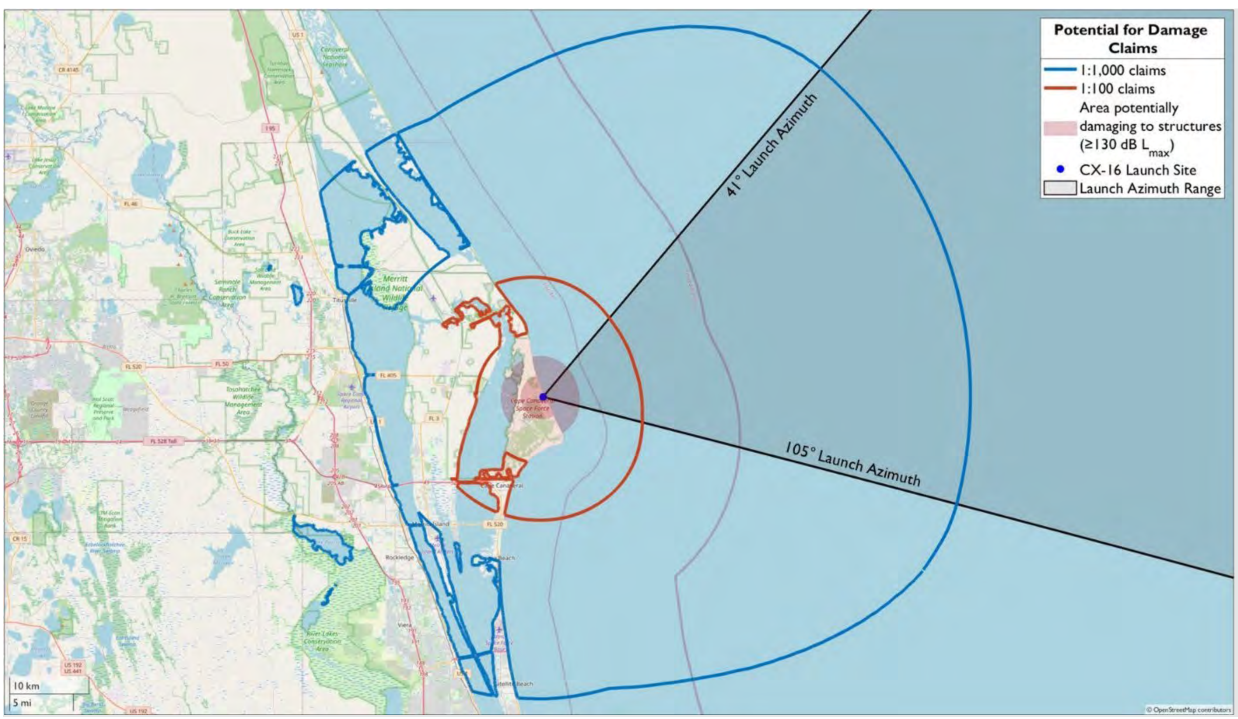


Figure 22. Potential for Damage Claims Contours for Launch Operations Over the Proposed Azimuth Range (41° - 105°)

As shown in ***Figure 23,*** the DNL 65 and 60 dBA contours extend approximately 2.8 and 3.2 miles from the launch pad, respectively. This area does not encompass land outside the boundaries of CCSFS and KSC, and thus no residences are impacted. When compared to the existing noise levels described in ***Section 3.7.2***, there is no significant increase in noise levels due to Terran R launch operations. Industrial areas around CCSFS experience noise levels from 60-80 dBA. Other launch and reentry events with less frequent, but more intense, sources of noise are typical of the noise environment at CCSFS and not a significant increase from existing conditions.

Therefore, Terran R stage MDC/static fire tests and launches would not result in significant noise impacts to the surrounding areas.

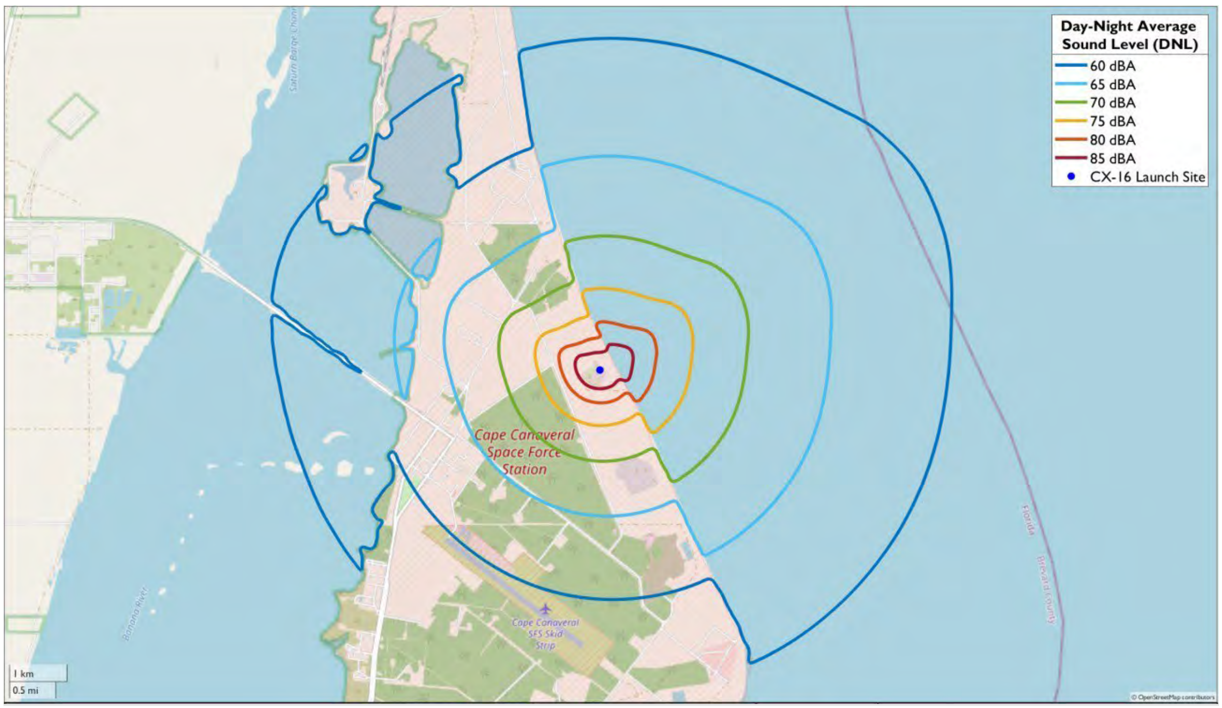


Figure 23. DNL Contours for Terran R Operations at CCSFS

3.7.5.1.2 Sonic Boom

The modeled nominal Terran R launch generates a sonic boom over a narrow, forward facing crescent shaped focus boom region as shown in ***Figure 24***. The focus boom region is created due to continuous acceleration and downward pitch as the launch vehicle ascends. As the launch vehicle ascends, the sonic boom levels decrease, resulting in the crescent shape becoming slightly longer and wider. The focus boom region begins approximately 35 miles downrange from the launch pad. The maximum modeled sonic boom peak overpressure along the focus boom region is 11 psf. However, the focus boom region is entirely over water, and these high levels would only occur in small areas along the focus boom region.

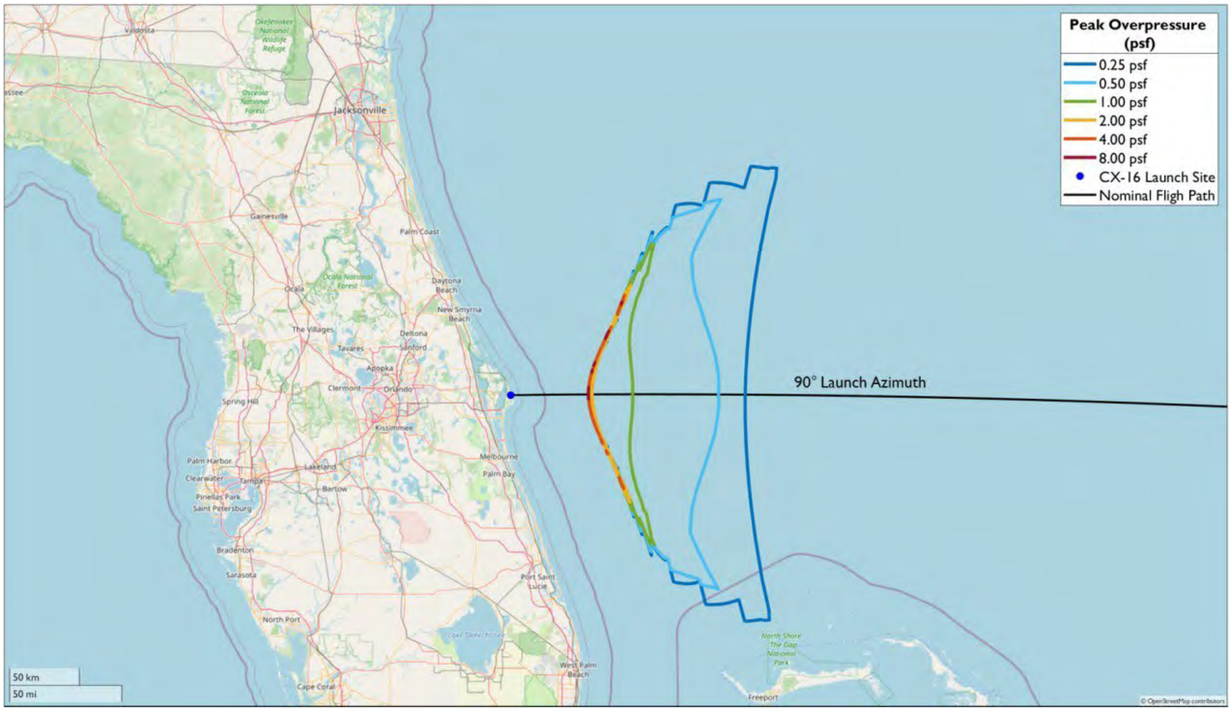


Figure 24. Sonic Boom Peak Overpressure Contours for a Nominal Launch

The modeled Terran R ocean-based barge landing also generates a sonic boom, as shown in ***Figure 25***. The maximum modeled sonic boom peak overpressure along this focus boom region is 47 psf (BRRC, 2023). Sonic booms for ocean-based barge landings would occur more than 250 nautical miles offshore.

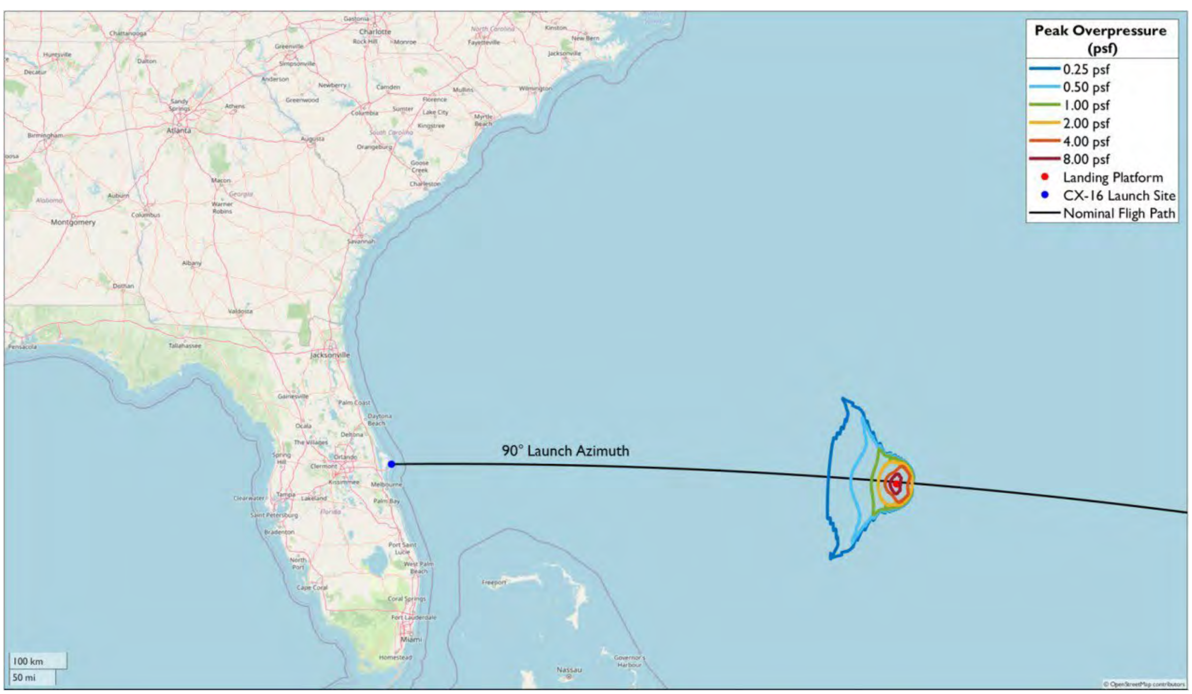


Figure 25. Sonic Boom Peak Overpressure Contours for a Nominal First Stage Landing

Since the entire boom footprint for nominal launches is over water, the only potential impacts would be to wildlife (refer to ***Section 3.5.3.2***). However, no current or past launch programs on CCSFS, including Atlas, Titan, or Delta launches, have been documented as causing any animal mortality or significant impact to wildlife habitat on CCSFS.

Therefore, sonic boom noise effects during testing, launch, and landing operations would have no significant impact under the Proposed Action.

3.7.6 No Action Alternative

Under the No Action Alternative, no Terran R launch operation and construction noise would occur. With the retirement of the Terran 1 Program in May 2023, the No Action Alternative would not result in any new or additional impacts on the existing noise environment.

3.8 Transportation Infrastructure

3.8.1 Regulatory Setting

A transportation network of roadways, railroads and marine transportation provides access to CCSFS. The ROI for the Terran R Program focuses on the roadways, railroads, and ports to access SLC-16 and the regional area immediately surrounding CCSFS.

3.8.2 Affected Environment

3.8.2.1 On-Site Roadways

The major on-site roadway on CCSFS is Samuel C. Phillips Parkway, a four (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 (1) way northbound arterial, with Hangar Road serving as the southbound arterial. East-west roadways provide additional internal access. To the north and south of CCSFS, Samuel C. Phillips Parkway becomes SR 401. The general work force using these roadways is increasing because of new commercial development at CCSFS.

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

3.8.2.2 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. CCSFS has limited rail service to the Integrate, Transfer, Launch area through KSC. No other areas on CCSFS have rail service and Relativity has no plans to use railways to support the Terran R Program.

3.8.2.3 Wharfs

The CCSFS Wharfs are 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 CCSFS wharfs and Port Canaveral, including commercial shipping and cruise lines and commercial and private fishing and pleasure boats. Relativity plans to use waterways to support the Terran R Program booster offloading and ocean-based barge landing operations and is aware of the planning and logistics into locating operations at a home port. Agreements for the exact pier location for Terran R Program operations are ongoing and would include coordination with local port government bodies and local USCG units/sectors. Potential use of CCSFS wharfs would be for receiving Terran R Program vehicle stages and payloads from Relativity facilities/ocean-going landing barges and customer sites, respectively. Potential locations include the Army Wharf (south side), Delta Mariner Dock (south side), Pegasus Barge Dock, and Wharf AF/Hangar AF.

3.8.3 Environmental Consequences

3.8.3.1 Construction

During the Proposed Action construction activities at SLC-16, 100 people, on average, would be working on site. The current construction schedule is approximately 24 months. Seventy (70) of the 100 people would be directly involved in construction. Assuming the worst-case scenario, an additional 70 people (or 70 daily vehicle trips) traveling on key roadways within CCSFS 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 SLC-16 area via the CCSFS roadways, however, the increase in construction vehicle traffic would not significantly accelerate the normal wear and tear of the roadways on CCSFS.

Therefore, Proposed Action construction would not have a significant impact on transportation assets.

3.8.3.2 Ground Support Operations and Maintenance

The Terran R Program vehicle stages and payloads would arrive at CCSFS 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 proposed primary route for the transport of launch vehicle stages and launch vehicle components within CCSFS would be through CCSFS South Gate near Port Canaveral, then northeast on Samuel C. Phillips Parkway, right onto Central Control Road heading southeast, left onto ICBM Road heading northwest, and right onto the entrance road to SLC-16. The launch vehicle stages and components would then be delivered to the integration facility for final integration and checkouts prior to launch operations.

Following the Terran R booster ocean-based barge landing, the support vessel, ocean tug and ocean-based barge would travel from approximately 300-500 nautical miles offshore to Port Canaveral for offloading and transfer for truck transportation. Terran R would nominally make entrance to port with no residual propellant onboard and would be inerted prior to entry.

Relativity would be responsible for coordinating local approvals with the relevant state, local agencies and port authorities to ensure timely offload and impacts to vessel traffic are prevented. Relativity would also schedule oversized vehicle transport to avoid peak traffic periods, generally from 6:00 A.M to 9:00 A.M. and from 3:30 P.M. to 5:30 P.M. Following offload at Port Canaveral, first stage boosters would be transported to SLC-16 on standard over-the road tractor-trailers fitted with specialized cradles and transportation hardware. Relativity would ensure all pressurized tanks are vented to the DOT-mandated maximum pressure prior to transport. The three (3) transport route options for recovery operations are shown in ***Figure 26, Figure 27, and Figure 28*** below. ***Figure 26*** shows a potential transportation route from CCSFS wharf***, Figure 27*** illustrates transportation from Hangar AF Wharf, and ***Figure 28*** shows the transportation route from Pegasus Barge Dock.

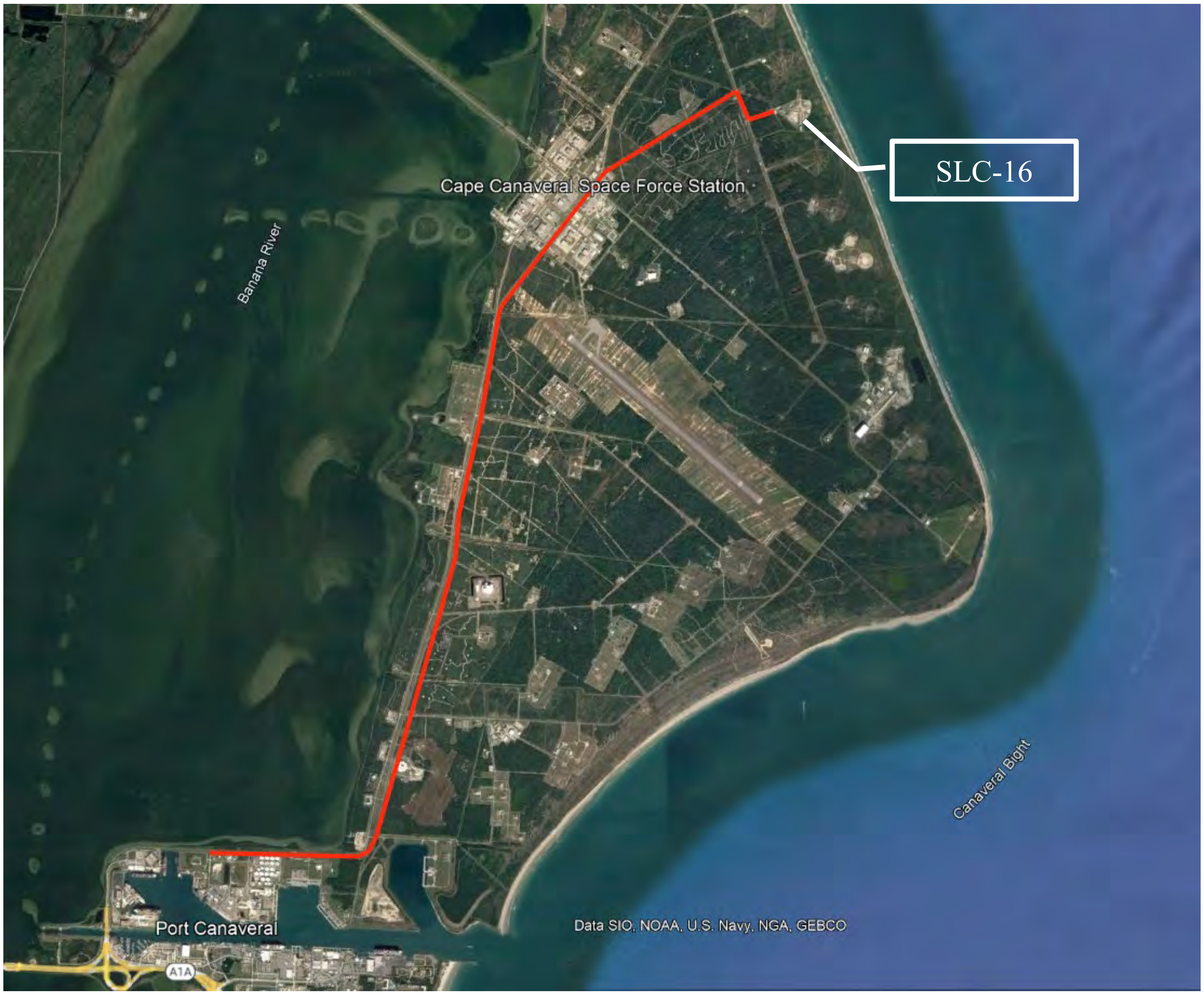


Figure 26. Terran R Booster Recovery Transport Route, CCSFS Wharf

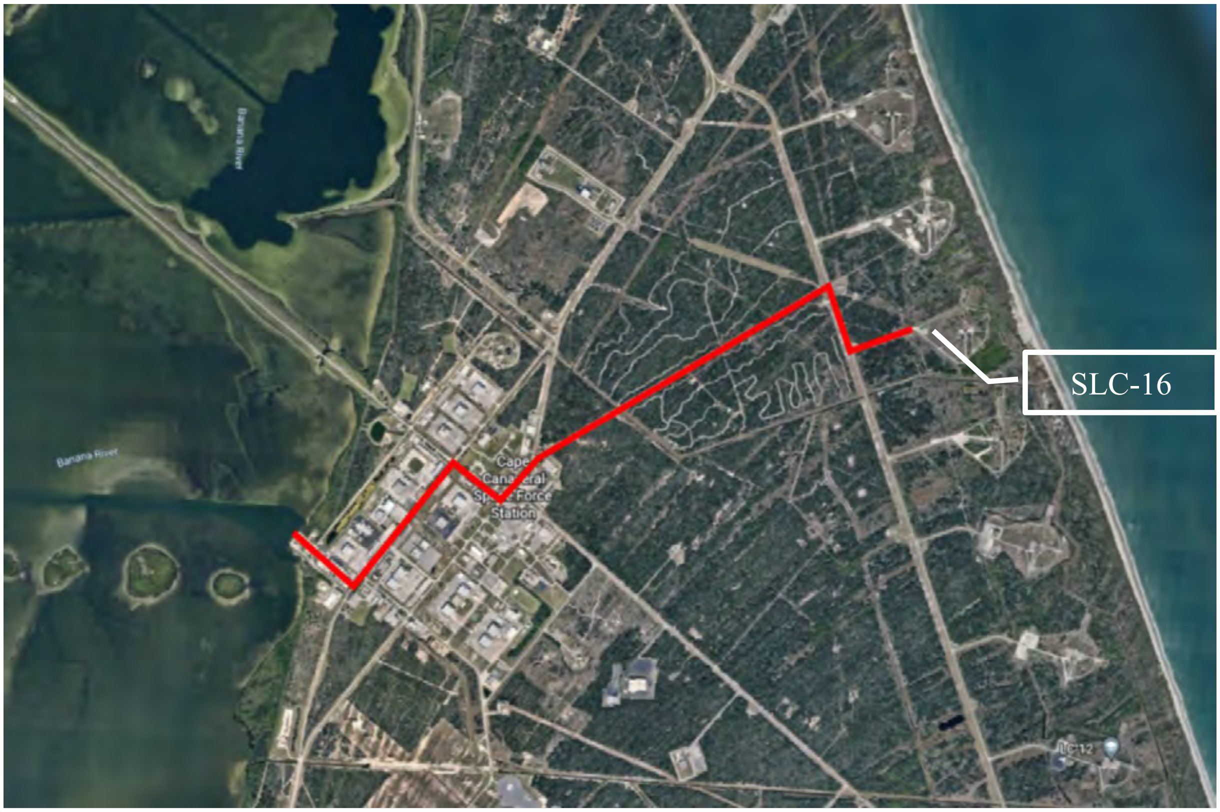


Figure 27. Terran R Booster Recovery Transport Route, Hangar AF Wharf

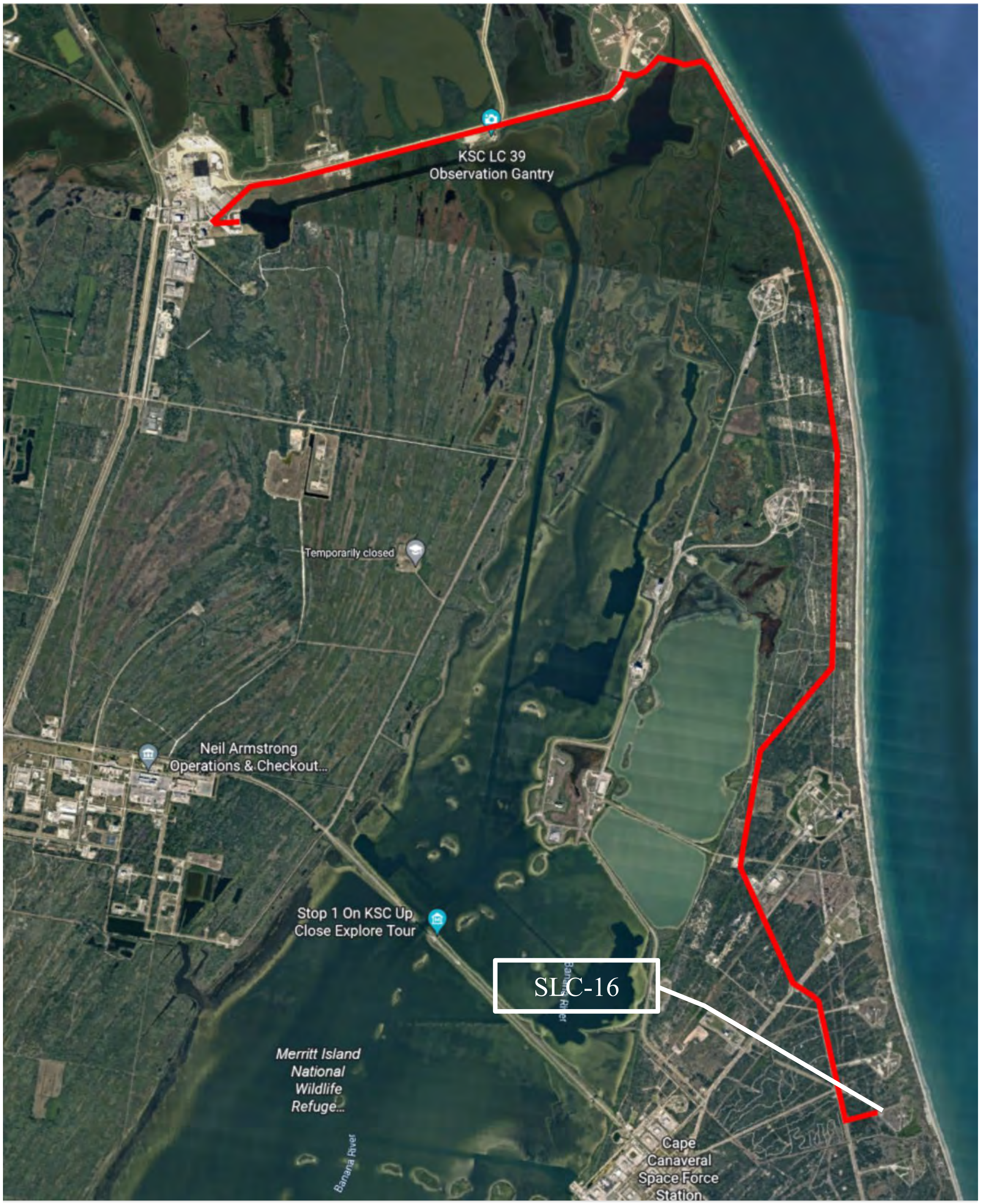


Figure 28. Terran R Booster Recovery Transport Route, Pegasus Barge Dock

Based on Relativity's coordination with relevant local agencies for transportation at Port Canaveral and within CCSFS roadways, the Proposed Action launch vehicle component transportation would not have a significant impact on transportation assets.

Therefore, Terran R ground support operations would not have a significant impact on transportation infrastructure, including local and regional traffic patterns.

3.8.3.3 Stage MDC Testing, Static Fire, Launch, and Landing – Launch Viewing Related Traffic Impacts

Approximately 25-30 people are required on-site at SLC-16 to support Terran R's vehicle launches. Roadway access restrictions within CCSFS would occur during stage MDC testing, static fire and launch events. This would prevent vehicle access to certain portions of the base until launch operations were complete and CCSFS security restrictions lifted. During these closures, access routes to emergency vehicles would be maintained. Terran R stage MDC testing, static fire, and launches would be scheduled outside of peak traffic flow periods to the greatest extent feasible. Fourteen stage MDC tests at 30 seconds each, 24 static fires at eight (8) seconds each, and 24 launch windows ranging from one (1) to four (4) hours would be completed per year. Based on these durations, prolonged access restrictions would be limited to the two (2) launches per month at eight (8) hours per month maximum. Based on the limited number of prolonged access restrictions, no significant impact to CCSFS transportation routes during stage MDC testing, static fire or launch are expected.

Therefore, stage MDC testing, static fire, launch, and landing would not have significant impacts to transportation infrastructure.

3.8.4 No Action Alternative

Under the No Action Alternative, the Terran R Program would not be implemented; therefore, no impacts to roadways or transportation routes would occur. Implementation of the No Action Alternative would not result in any new or additional impacts on the transportation environment.

3.9 Utilities Infrastructure

3.9.1 Regulatory Setting

Potable water utilities within CCSFS must adhere to FAC water quality regulations for safe drinking water.

SJRWMD regulates stormwater discharges through SJRWMD Rule 40C-4, FAC. SJRWMD issues ERPs for all proposed work in, on or over wetlands or other surface waters. The FDEP grants NPDES construction stormwater permits for sites that disturb one (1) or more acres. SLC-16 construction would require this permit.

Section 438 of the Energy Independence and Security Act (EISA) (2007), requires all federal development that exceeds 5,000 square feet to maintain or restore pre-development hydrology. Federal agencies can comply using a variety of stormwater management practices often referred to as "green infrastructure" or "low impact development" practices, including reducing impervious surfaces and using vegetative practices, porous pavements, cisterns and green roofs.

FDEP regulates the permitting and construction of Onsite Sewage Treatment and Disposal Systems (OSTDS) under FAC 62-6. Nonetheless, there is no FDEP or Department of Health permitting requirement for installation of an OSTDS on Federal properties. Although permitting is not required for the proposed project, the OSTDS would meet all the requirements as if it were.

3.9.2 Affected Environment

3.9.2.1 Water Supply

CCSFS operates under its own Public Water System (PWS), PWS ID# 3054140. Water is used at CCSFS 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 SLC-16 and no service is planned. An eight (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 SLC-14, approximately 3,700 linear feet south and SLC-20, approximately 4,000 linear feet north.

3.9.2.2 Wastewater

No CCSFS sanitary sewer services are available at SLC-16 or in the immediate vicinity along ICBM Road. 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 SLC-16.

An FDEP Industrial Wastewater Permit Exemption exists as part of the Terran 1 Program at SLC-16 (Permit Exemption Number FLAB07245-001-IWB/MR). Coordination with FDEP would be required to modify the permit exemption for the Terran R Program, however, changes to industrial wastewater chemistry is not expected to be significant due to the same propellants used for Terran 1 and Terran R launch vehicles. Sound suppression and deluge water volumes would be the same as the Terran 1 launch vehicle.

3.9.2.3 Electric Power

CCSFS 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 CCSFS-owned distribution system. Individual unit substations convert the distributed 13.2kV or 23.2kV power to user level 480V or 208V power. Electrical service is available at SLC-16.

3.9.2.4 Stormwater

Stormwater retention ponds are present within SLC-16 as part of the Terran 1 Program. SJRWMD ERP 162674 – 2 was issued in 2020 for the construction and operation of this stormwater management system. See ***Section 3.2*** for more details on existing stormwater management features at SLC-16.

3.9.3 Environmental Consequences

3.9.3.1 Construction

3.9.3.1.1 Electric Power

The Proposed Action would require upgrades and additions to the existing electrical infrastructure at SLC-16. Medium voltage electrical feeders were installed as part of the Terran 1 Program to provide electrical service to the site. New feeders would be installed along ICBM Road to support facilities and operations for the Terran R program. No electrical upgrades are required at Port Canaveral to support the Terran R Program. Relativity Space would coordinate with the electric utility provider to ensure there is enough service capacity for the Terran R Program prior to activation of additional infrastructure.

As a result, the Proposed Action would have no significant impact on available electrical power supply.

3.9.3.1.2 Wastewater

An OSTDS would be installed to manage sanitary sewage from new Terran R facilities at SLC-16. Relativity would submit a permit for construction approval of the OSTDS with FDEP to meet applicable requirements.

Therefore, the Proposed Action would have no significant impact on wastewater due to construction.

3.9.3.1.3 Stormwater

SLC-16 disturbed areas is greater than one (1) acre, therefore 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 modifications for stormwater management and compliance at SLC-16. Compliance with SJRWMD and NPDES stormwater regulations ensure mitigation measures are in place during construction.

Therefore, construction associate with the Proposed Action would not have a significant impact on storm or surface water resources at CCSFS.

3.9.3.2 Ground Support Operations and Maintenance

3.9.3.2.1 Water Supply

No potable water service is available within or immediately adjacent to SLC-16. CCSFS does not have immediate plans to provide potable water service to SLC-16. Relativity does not intend to extend potable water service to SLC-16 for ground support operations and maintenance. Bottled drinking water would be provided, safety showers and eyewashes would be self-contained, and restrooms would have independent handwash stations.

Therefore, ground support operations would not have significant impacts to water supply.

3.9.3.2.2 Wastewater

Ground support operations would not impact wastewater. No generation of industrial wastewater is anticipated during ground support operations.

3.9.3.2.3 Electrical Supply

After electrical upgrades have been completed, sufficient electrical power capacity is available at SLC-16 as noted in ***Section 3.9.3.1.1***, therefore no impacts to electrical power supply would occur during ground support operations.

3.9.3.3 Stage MDC Testing, Static Fire, Launch and Landing

3.9.3.3.1 Water Supply

Relativity proposes to use the existing fire main service for deluge/sound suppression water and fire suppression as needed. Relativity plans to construct a new 1,000,000-gallon water tower and pump house to store deluge water for the Terran R launch vehicle. It is estimated that 75,000 gallons of water would be required for each individual stage MDC and static fire test and 100,000 gallons of water for each launch. ***Section 2.4.2.4*** contains the proposed test rates of Terran R. ***Section 2.4.2.10*** contains the proposed launch rates for Terran R launches. At the peak yearly rate of 14 Terran R stage MDC test campaigns, 24 static fires, and 24 launches, the proposed project would require approximately 5.25 million gallons per year of water for deluge/sound suppression. This is in comparison to the 3.7 MGD historic average consumption for CCSFS, KSC and PSFB combined. After launch, samples of the deluge water would be collected and analyzed and the results would be reported to FDEP. Water containing prohibited chemical levels would be removed and hauled to an approved industrial wastewater treatment facility. With these measures in place, there would be less than significant impacts on water resources.

Therefore, testing, launch, and landing operations would not have significant impacts on the CCSFS water supply.

3.9.3.3.2 Wastewater

Under the Proposed Action, deluge and sound suppression industrial wastewater would be captured within a containment and disposal system, identical to existing Terran 1 operations. 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 CCSFS. CCSFS Wastewater Treatment Plant (WWTP) does not have the capacity to treat additional industrial wastewater and no connections to the CCSFS sanitary sewer at SLC-16 would be made.

Given approximately 75,000 gallons of deluge water for each individual stage MDC and static fire test and 100,000 gallons for each launch and assuming approximately half is vaporized during test/launch, at the peak yearly rate of 24 launches per year, the Terran R Program would generate approximately three (3) million gallons of industrial wastewater.

With the satisfaction of Industrial Wastewater Permitting exemption approvals or completion of Industrial Wastewater Permitting through FDEP, the Terran R testing, launch, and landing would have no significant impacts at SLC-16.

3.9.4 No Action Alternative

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

3.10 Public Health and Safety

3.10.1 Regulatory Setting

Range safety organizations review, approve, monitor, and impose safety holds, when necessary, on all pre-launch and launch operations in accordance with *SSCMAN 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.

3.10.2 Affected Environment

3.10.2.1 Operations Safety

Relativity would comply with OSHA Standards 29 CFR Part 1910, *Occupational, Safety, and Health Standards* requirements for the protection of health and safety and 29 CFR Part 1926, *Safety and Health Regulations for Construction* during project construction. Fire protection systems would comply with NFPA requirements as applied by the CCSFS Authority Having Jurisdiction, Unified Facilities Criteria and DoD Engineering Technical Letter (ETL) guidance and direction. Fire protection alarms would be monitored by the CCSFS Fire Department. Hazardous materials such as propellants, ordnance, chemicals, and other payload components must be transported to CCSFS in accordance with DOT regulations for interstate shipment of hazardous substances (Title 49 CFR Part 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 CCSFS have occurred.

3.10.2.2 CCSFS 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 SLD 45 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 CCSFS 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 CCSFS Emergency Response Team as directed in the Air Force Emergency Management Program, AFI 10-2501.

3.10.2.3 Range Safety Procedures

SSCMAN 91-710, Range Safety Requirements directs overall safety regulations for CCSFS. It outlines the process for reviews, approvals and operation safety including monitors and safety holds on all launch operations. Per 14 CFR Part 450, Relativity is required to issue NOTMARs/NOTAMs for local and international hazard areas. SLD 45 would issue local NOTMARs/NOTAMs. Per FAA ATO LOA, FAA ATO would issue international NOTAMs. Relativity would issue international NOTMARs. Local and international hazard areas are determined by the SLD 45 Launch Safety (SLD 45/SEL) team. An approved sea surveillance plan, which is approved by SLD 45/SEL, would be in place for each launch which would bound both ascent, reentry/landing, and anomalous scenarios. Sea surveillance efforts could include the use of aerial and seaborne assets for eyes on detection of targets of interest within the hazard contour. For far downrange tracking of hazard areas, automatic identification system (AIS) based surveillance would be conducted. For the landing zone, Relativity would have waterborne assets in the area capable of surveilling the area visually and with radar/AIS. Targets of interest within these contours are reported to the Space Force Risk Assessment Center for risk analysis inputs in compliance with risk thresholds per 14 CFR Part 450 and SPFCMAN 91-710.

The SLD 45 Flight Analysis notifies the 1st Range Operations Squadron of areas that are hazardous to aircraft (i.e., impact debris corridors) for all normally jettisoned and impacting stages by 10 calendar days prior to launch. The 1st Range Operations Squadron notifies the FAA so that the appropriate Altitude Reservation (ALTRV) or NOTAM can be disseminated. Restricted and Warning Areas would be active and controlled according to *SSCMAN* 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 *SSCMAN* 91- 710, Range Safety Requirements is required.

3.10.2.4 SLD 45 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 SLD 45 Flight Analysis notifies the 1st Range Operations 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 Local Notice to Mariners. Broadcasts by US Coast Guard Sector Jacksonville provide the latest available hazard information to offshore surface vessels. CCSFS in conjunction with PSFB 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 CCSFS, the on-scene emergency response team from CCSFS 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.

3.10.2.5 Quantity Distance Criteria Requirements

Explosive safety quantity-distance criteria are used to establish safe distances from SLCs 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 SSCMAN 91-710, all SLC-16 facilities would be properly sited and approved in accordance with DoD quantity distance criteria and explosives safety standards. A preliminary explosive site plan detailing explosive safety quantity-distance radiuses during testing activities is provided in ***Figure 29.*** Closure areas during launch and reentry will be coordinated with SLD 45 and FAA based on the Flight Safety Analysis results. Closures due to launch safety hazards are dependent upon the Flight Safety Analysis (risk assessment) performed by the USSF Range Safety Office based on the specific launch and reentry trajectories and fuel loads on the rocket. Typically, these closure areas include road closures at multiple points, evacuation of all personnel, and ceasing all operations within the Blast Danger Area, Flight Caution Area, and Flight Hazard Area. These restricted areas are determined from the Flight Safety Analysis. Closures remain in place until the all clear is determined by the provider in conjunction with SLD 45.

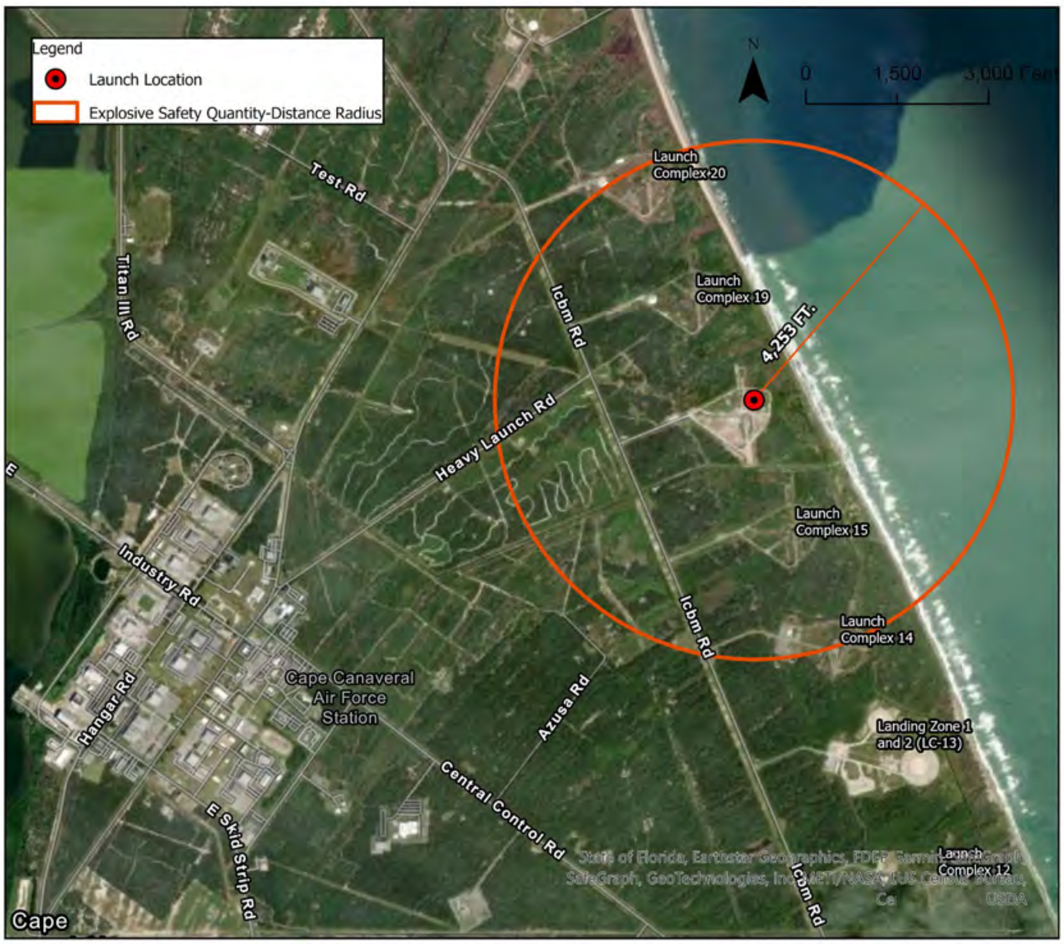


Figure 29 Closure Areas/Access Restrictions During Test Operations

3.10.2.6 Security Requirements

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

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

3.10.3 Environmental Consequences

3.10.3.1 Construction, Ground Support Operations

The Terran R Program would adhere to OSHA regulation 29 CFR Part 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 Part 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 3.10.1***, CCSFS 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 SLD 45. 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 (49 CFR Part 100-199). Hazardous materials such as liquid rocket propellant are transported in specially designed containers to reduce the potential of a mishap should an accident occur. The Terran R Program would adhere to all Relativity, USSF, CCSFS, state and federal safety and health regulations and requirements.

Therefore, the Terran R Program construction and ground support operations would have no significant impacts on on-site personnel health and safety.

3.10.3.2 Stage MDC Testing, Static Fire, Launch and Landing

CCSFS 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 CCSFS allowable collective public risk limit is less than or equal to 30×10^{-6} with an individual risk of 1×10^{-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 R uses only LNG/LOX engines and payloads may contain up to 2,000 kilograms of monomethyl hydrazine, hydrazine, and/or nitrogen tetroxide. Terran R Vehicle failure would release fewer and less hazardous materials and thus generally fits within the EIS and SIES 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 would be covered under a separate NEPA action specific to each payload customer.

USSF has a rigorous launch safety certification process which would require a launch license from the FAA prior to the start of launch operations. This would ensure that the public would not be exposed to greater risk than the launches currently at approved at CCSFS.

Thus, the Terran R testing, launch and landing operations would not have a significant impact to the health and safety of the public.

3.10.4 No Action Alternative

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

3.11 Hazardous Materials, Solid Waste and Hazardous Waste

3.11.1 Regulatory Setting

Hazardous waste management at CCSFS is regulated under RCRA (40 CFR Part 260-280) and FDEP (Rule 62-730, FAC). 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. In addition, certain types of waste are “listed” or identified as hazardous in 40 CFR Part 263. In regulatory terms, a RCRA hazardous waste is a waste that appears on one of the four (4) 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. 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 Comprehensive Environmental Response, Compensation, and Liability Act (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 IRP is a USAF program that identifies, characterizes, and remediates past environmental contamination on USAF and USSF 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 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 CCSFS in 1984.

The SARA of 1986, Title III: Emergency Planning and Community Right-to-Know Act (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.

Pollution prevention is defined as the process of 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 *AFMAN 32-7002, Environmental Compliance and Pollution Prevention* provide guidance on pollution prevention objectives.

3.11.2 Affected Environment

3.11.2.1 Hazardous Materials Management

Hazardous materials include all chemicals identified and regulated under the EPCRA, OSHA, Hazardous Communication (HAZCOM) Standard, Hazardous Materials Transportation Act (HMTA), CERCLA, Toxic Substance Control Act (TSCA) and the CAA. Relativity would purchase and manage all hazardous materials proposed for use at SLC-16 through its internal supply system.

In the event of a spill of hazardous materials, Relativity would determine if the situation were an emergency. If it is an emergency, Relativity would notify the USSF. The USSF SLD 45 has the primary responsibility for Emergency Response at CCSFS. 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 would be conducted in accordance with the SLD 45 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 USSF, 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 SLD 45 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 would modify the existing spill response plan to cover Terran R operations. This plan would 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.

3.11.2.2 Solid Waste Management

Solid waste from SLC-16 operations would be managed by a contracted waste management company. Proper management and disposal of solid waste from construction at SLC-16 would be the responsibility of the construction contractor. Solid waste would be disposed of off base at disposal facilities in Florida.

3.11.2.3 Hazardous Waste Management

If required, Relativity would obtain an EPA hazardous waste generator identification number and would be responsible for managing and disposing of all hazardous waste generated. Hazardous waste anticipated to be generated as part of Terran R operations would include flammable debris (epoxy and isopropyl alcohol wipes). Relativity would manage all Terran R hazardous waste generated from its operations in accordance with all local, state, and federal regulations. All organizations that generate hazardous waste at CCSFS are responsible for complying with applicable hazardous waste regulations. Waste generation from the Terran R Program is expected to be similar to existing Terran 1 operations.

Nearby hazardous waste transfer and disposal facilities include US Ecology of Tampa, Florida and Clean Harbors of Bartow, Florida. According to the EPA, the Clean Harbors Bartow facility alone received and transferred for treatment or disposal more than 5.0 million pounds of hazardous waste during the most recent biennial reporting period (EPA Envirofacts, 2023). The quantity of hazardous waste expected to be generated by the Proposed Action is orders of magnitude below the total capacity of the transfer and disposal facilities.

3.11.2.4 Installation Restoration Program

One (1) IRP SWMU is associated with the Proposed Action. ***Figure 7*** (previously provided) shows all of SLC-16 is contained within SWMU C040. A Land Use Implementation Plan (LUCIP) is in place due to polychlorinated biphenyl (PCB) and polycyclic aromatic hydrocarbons (PAH)-contaminated soils and chlorinated solvents in groundwater. Several interim measures (IMs) were conducted to remove contaminated soil and sediment to levels that are safe for industrial re-use. The IMs included the removal of approximately 13,321 tons of PCB-contaminated soil from multiple areas within SWMU C040. Residual PCB and PAH-contaminated soil remains on-site in excess of residential cleanup standards (BEM, 2006 and O'Brien and Gere, 2001). Due to the extensive soil investigation and removal activities associated with the IMs, residually contaminated soil is expected to be localized and of small quantities. Additionally, no TSCA PCB Remediation Waste (soil with PCB concentrations equal to or above 50 ppm) is expected to be encountered during implementation of the Proposed Action based on the PCB concentrations detected in soil following the 2006 IM (BEM, 2006). No soil export from the site is anticipated as part of construction activities.

The chlorinated solvent groundwater plume in the shallow aquifer reportedly extends from the intersection of Heavy Launch Road and ICBM Road to the south through the central portion of the site, passing just to the west of the existing launch stand. The groundwater plume source area is located upgradient from the site to the northwest, and the Proposed Action is located on the eastern edge of the groundwater plume where concentrations of chlorinated solvents are relatively low (HGL, 2021). The plume extents and source area locations are shown on ***Figure* 7**. Periodic groundwater monitoring is ongoing throughout SWMU C040 (HGL, 2023).

LUCs include prohibiting the removal of contaminated soils from the site, developing residential properties on-site, and groundwater use. The LUCs remain in effect until the contamination is removed or is naturally attenuated to acceptable regulatory levels (IRP, 2005). The following conditions must be coordinated with the IRP and USSF prior to disturbance of contaminated media in order to protect on-site workers and the surrounding environment:

- USSF 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 to prevent unauthorized release or disposal of the affected media. 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.

3.11.3 Environmental Consequences

3.11.3.1 Construction

3.11.3.1.1 Solid Waste

Construction and demolition solid waste, including concrete and scrap metal, would be generated during construction at SLC-16. 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. Limited amounts of construction and demolition waste would be generated during construction due to minimal demolition and expansion of existing infrastructure. Current landfill capacity information is not readily available. However, significant impacts due to the Terran R Program are not expected when compared to the cumulative waste generation throughout Brevard County. Brevard County landfills potentially used by the Terran R Program include the Brevard County Central Disposal Facility in Cocoa and the Sarno Landfill in Melbourne.

Therefore, construction associated with the Proposed Action would not have significant impacts to solid waste.

3.11.3.1.2 Hazardous Materials

Construction activities require the use of hazardous materials such as diesel fuel, gasoline and propane; hydraulic fluids, oils, and lubricants; welding gases; paints and solvents; adhesives and batteries. Hazardous materials associated with construction activities would be delivered and properly stored to prevent leaks and spills to soil, groundwater, and surface waters. Hazardous materials management would be conducted 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 49 CFR regulations.

Construction associated with the Proposed Action would have no significant impacts to hazardous materials.

3.11.3.1.3 Hazardous Waste

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. Construction contractors would be responsible for safely removing construction-generated wastes and for arranging for recycling or disposal in accordance with applicable regulations. No heavy metal, asbestos or PCB waste would be generated during the Proposed Action. Construction has been designed to result in a net import of soil to the site, therefore, off-site disposal of PCB-contaminated soil is not expected to be required. Existing buildings identified with hazardous materials within the Terran 1 EA include the Blockhouse, Ready Building and Pad Support Building. These facilities would not be impacted as part of this Proposed Action. All other facilities within SLC-16 were constructed as part of the Terran 1 Program in 2020 and are not a concern for existing hazardous waste generation due to construction age.

The total monthly generation of hazardous waste during construction is anticipated to be less than 100 kilograms. 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. As discussed in ***Section 3.11.2.3***, hazardous waste generated during construction and operation would be orders of magnitude below receiving facility capacities.

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

3.11.3.1.4 Installation Restoration Program

Construction at SLC-16 would require soil disturbance within SWMU C040. LUCs have been enacted at SWMU C040 for soil and groundwater contamination in excess of regulatory criteria. All soils must be retained onsite or coordinated with IRP for proper disposal. SLC-16 construction has been designed with a net import of soil, such that off-site export is not expected. Groundwater use/consumption is prohibited at SLC-16 due to chlorinated solvent concentrations in excess of regulatory criteria. Any contact with groundwater (i.e. dewatering) requires further coordination with IRP. To ensure protection of human health and the environment, LUCs would be adhered to during earthwork and groundwater management throughout the construction process. Coordination with IRP would be conducted in order to minimize impacts on groundwater monitoring during construction and operations.

With proper coordination and compliance with LUCs, the Proposed Action construction have no significant impact on ongoing IRP investigations and activities.

3.11.3.2 Ground Support Operations

3.11.3.2.1 Solid Waste

The EPA estimates that one (1) person generates 4.90 pounds of waste per day. Based on an average of 25 full-time Terran R Program employees, it is expected that approximately 123 pounds of solid waste would be generated per day, resulting in approximately 16 tons of solid waste generated per year (assuming 260 workdays) due to the Terran R Program. Relativity would use a contracted waste service for solid waste collection and disposal.

Solid waste generated from Terran R launch support activities would be in small quantities and disposed off-site by construction contractors or independent waste disposal services.

Therefore, ground support operations would have no significant impact to CCSFS solid waste management.

3.11.3.2.2 Hazardous Materials

Terran R ground support operations and maintenance activities at SLC-16, LZ-1/LZ-2 and Port Canaveral would require the use and storage of hazardous materials. Hazardous materials used include cryogenic propellants (LNG and LOX), flight batteries and compressed gases such as propane, helium, and nitrogen. Typical operations and maintenance activities would require 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 manufacturer recommendations and applicable federal and state regulations to prevent environmental impacts. Propellants, chemicals, and other hazardous material payload components would be transported in accordance with 49 CFR regulations (e.g., 49 CFR Part 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 sufficient space would be provided for spill cleanup and emergency response access. Storage units would meet building and fire code requirements 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.

The storage and transport of hazardous materials or waste have the potential to result in accidental spills adversely impacting soil, surface water, and groundwater adjacent to transportation routes or down-gradient from construction and operations areas. Potential impacts to water resources with regards to spills are discussed in ***Section 3.2.3***. 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 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.

Department of Transportation Hazard Class 1.4 and Class 1.1 ordnance would not be stored within Relativity facilities as part of the Terran R Program. The Terran R vehicle will have an ordnance-based Flight Termination System that will be installed in the final stage of vehicle integration. A small amount of Division 1.4 and 1.1 ordnance would be handled during launch vehicle preparation within the HIF.

Therefore, hazardous materials used during ground support operations would have no significant impact to the environment.

3.11.3.2.3 Hazardous Waste

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 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 storage, handling and management procedures, hazardous materials and waste during the Proposed Action ground support operations would have no significant impacts on the environment.

3.11.3.3 Stage MDC Testing, Static Fire, Launch and Landing

3.11.3.3.1 Solid Waste Management

The Proposed Action testing and launch operations are not expected to generate non-hazardous solid waste. Solid waste associated with the Terran R Program would occur during construction and ground support operations as mentioned above.

3.11.3.3.2 Hazardous Materials

Similar to the ground support operations, stage MDC testing, static fire, launch and landing would require the use of cryogenic propellants (LNG and LOX), flight batteries and compressed gases such as propane, helium and nitrogen. The Terran R Program would result in additional propellant and fuels usage as mentioned in ***Section 2.4.2.1.5***. 660,000 gallons of LOX storage tanks and 838,000 gallons of LNG storage tanks would be installed to support the Terran R launch vehicle.

Relativity launch programs consider pollution prevention in the design of launch infrastructure systems and vehicles. Environmental aspects of design decisions are considered during all design phases. Pollution Prevention BMPs would be implemented in accordance with the Pollution Prevention Act of 1990. Relativity would prevent pollution via source reduction to the greatest extent feasible. Polluting substances whose use cannot be avoided would be recycled and/or treated and disposed of in accordance with applicable laws. All accidental releases of polluting substances would be responded to quickly and appropriate clean up measures implemented in accordance with applicable laws to minimize impacts to the environment.

Therefore, Terran R testing, launch and landing operations are not expected to have significant impact to the environment from hazardous materials.

3.11.4 No Action Alternative

Under the No Action Alternative, the Terran R Program would not be implemented, thus no hazardous materials and hazardous and solid waste impacts at CCSFS would occur.

3.12 Socioeconomics

3.12.1 Regulatory Setting

Considerations in socioeconomic impacts from the Proposed Action include the potential to: induce substantial economic growth in an area, either directly or indirectly (e.g., through establishing projects in an undeveloped area); disrupt or divide the physical arrangement of an established community; cause extensive relocation when sufficient replacement housing is unavailable; cause extensive relocation of community businesses that would cause severe economic hardship for affected communities; disrupt local traffic patterns and substantially reduce the levels of service of roads serving an airport and its surrounding communities; or produce a substantial change in the community tax base.

Florida commercial fishermen are subject to a complex regulatory system. In state waters, commercial fishing is regulated by the Florida FWCC. Fisheries in federal waters off the coast of Florida are managed by regional councils. Federal fisheries off the coast of East Florida are managed by the SAFMC and NOAA Fisheries under multiple fishery management plans.

3.12.2 Affected Environment

The influence of launch programs at CCSFS on population and employment varies widely within several counties. CCSFS generally influences eastern Brevard County, which includes the cities of Melbourne (27 miles to the southwest), Cocoa Beach (11 miles to the south), Titusville (17 miles to the northwest), Rockledge (14 miles to the southwest) and Cocoa (12 miles to the southwest) and unincorporated areas in Brevard County including Merritt Island (12 miles to the southwest), Port St. John (13 miles to the west) and Viera (17 miles to the southwest) in addition to the Maritime Waterways off Cape Canaveral and Port Canaveral. CCSFS also draws commuters from Orange County (Orlando) and Volusia County (Daytona Beach). Based on the 2022 Census of Population and Housing, Brevard County had a population of 616,628 persons (USCB, 2022). Brevard County boasts the largest share of science, technology, engineering, and mathematics jobs in Florida. Additionally, the area includes one of the nation’s largest concentrations of employment in the communications sector and the most concentrated manufacturing workforce in the state of Florida.

Statewide, the Aerospace Industry employs over 106,000 workers as of 2021 (Enterprise, 2021). Most of the employees are based out of Brevard County, making CCSFS/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 (2) 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 (KSC, 2010).

In addition to the aerospace industry, commercial fishing is a common business out of Port Canaveral. Private commercial vessels fish for species such as red snapper, grouper, king mackerel, swordfish, and dolphin fish (Mahi Mahi). Other important species for East Florida commercial fishermen include shrimp and spiny lobster. In inshore waters, fishermen harvest blue crabs, stone crabs, quahog clams, and oysters. Temporary closures of navigable waterways during a Terran R launch may impact commercial fishing. The fishing industry had recently voiced concerns that the increased launch cadence at CCSFS would bring difficulties for the King and Spanish mackerel fleets in the region.

The commercial fishing year for the king mackerel in the Southern Zone is split into hook-and-line and gillnet components. The fishing year for the hook-and-line component is July 1 through June 30 with a trip limit of 1,250 pounds. The fishing year for the gillnet component is the Tuesday after the Martin Luther King, Jr. holiday through June 30 with a trip limit of 45,000 pounds. The five (5) year historical commercial landings for king mackerel are shown in ***Table 22*** below.

Table 22. King Mackerel Historical Commercial Landings for the South Atlantic

Year	Total Landings in Southern Zone	% of Annual Catch Limit Quota
2019-2020	2,304,794	63.7%
2018-2019	2,377,127	59.4%
2017-2018	2,145,289	47.2%
2016-2017	1,075,206	41.5%
2015-2016	931,003	36.0%

*Source:**https://www.fisheries.noaa.gov/southeast/commercial-fishing/2023-preliminary-south-atlantic-commercial-landings***
Historical Commercial Landings for the South Atlantic (NOAA Fisheries)

The commercial fishing year for the Atlantic Spanish mackerel is March 1 through the end of February. For the southern zone, which extends from the North Carolina/South Carolina state line to the Miami-Dade/Monroe Florida county line, the trip limit begins at 3,500 pounds. After 75% of the Southern Zone adjusted quota (total quota minus 250,000 lbs.) is met or projected to be met, the trip limit is reduced to 1,500 pounds. When 100% of the Southern Zone adjusted quota is met or projected to be met, the trip limit is reduced to 500 pounds until the end of the fishing year or until the Southern Zone total commercial quota is met or projected to be met, at which time the commercial sector in the Southern Zone would be closed to harvest of Spanish mackerel. The 5-year historical commercial landings for Spanish mackerel is shown in ***Table 23*** below.

Table 23. Atlantic Spanish Mackerel Historical Commercial Landings for the South Atlantic

Year	Total Landings in Southern Zone	% of Annual Catch Limit Quota
2019-2020	2,745,302	113.6%
2018-2019	3,297,801	124.9%
2017-2018	2,487,557	123.6%
2016-2017	2,551,274	102.9%
2015-2016	2,103,221	98.7%

Source: ***https://www.fisheries.noaa.gov/southeast/commercial-fishing/2023-preliminary-south-atlantic-commercial-landings***
Historical Commercial Landings for the South Atlantic (NOAA Fisheries)

3.12.3 Environmental Consequences

Socioeconomics impacts would be considered significant if SLC-16 Terran R 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.

For approximately one (1) week during launch preparations, a maximum of 50 people, not including payload support and LCC personnel, support the Terran R Program launches at SLC-16. Between launch campaigns, 25 employees are present at the site on average. The Terran R launch preparation timeframe and personnel requirements are anticipated to be far less than other launch operations currently at CCSFS. The Terran R Program would 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 negligible socioeconomic impacts on the region.

Construction for the Proposed Action would result in a temporary and minor increase in the number of personnel on CCSFS. 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 negligible socioeconomic impacts on the region.

Visitor traffic volume increases outside within Brevard County for Terran R launches are expected to be similar to current Atlas, Delta or SpaceX launches. Impacts from increased visitor or public observers are routinely managed and would cause no significant impacts on local traffic patterns.

Based on current SLD 45 risk analysis assessments, access restrictions relative to Terran R pre-launch nominal operations such as S1 Hot Fire, Wet Dress Rehearsal, and Static Fire to support 24 Terran R missions that have the potential to impact land and sea is estimated to be less than 300 hours per year. Access restrictions impacting land, air, and sea for nominal Terran R launch operations are estimated to be less than 100 hours per year. Assuming an average of one (1) scrub per mission (two total launch attempts), access restrictions from launch operations would increase to 200 hours per year. If an anomalous event occurs, Relativity anticipates debris cleanup could require less than 50 hours of access restrictions per anomaly.

On launch days, there is a possibility of temporary restricted access due to visitor volume on sections of KSC managed by USFWS and NPS, specifically the MINWR and Canaveral National Seashore. These temporary closures have occurred for other space programs and are typically related to crowd control and access for emergency services. They are related to the volume of visitor traffic in an area and are not related to a public safety hazard from a launch. Any potential closures due to visitor volume would be coordinated between CCSFS security, USFWS, and NPS by monitoring to ensure parking lot thresholds are not exceeded, and that roadways allow for emergency egress for any form of emergency associated with large crowds. Such closures would not be expected to cause more than a minimal disturbance to the enjoyment of the resources of MINWR and Canaveral National Seashore and would be determined by the land managing agencies. Spaceport Integration and Services has had several quarterly tag-ups since implementation of the closure procedure process. All parties have agreed that the closure process is effective at adequately managing the issue. All closures, whether dictated by public safety concerns or due to visitor volumes exceeding capacity, would be temporary, lasting approximately three (3) to six (6)hours each time (estimated at 24 to 30 occurrences each year).

Temporary closures of airspace and navigable waterways have the potential to impact private businesses who operate in the closure areas such as airlines, cruise ships, and commercial fishermen. Advanced notice via NOTAMs and NOTMARs would allow general aviation pilots and mariners to anticipate temporary disruption to flight and shipping activities during launch operations. Launch operations would be of short duration and scheduled in advance to minimize interruption to airspace and waterways. Temporary closures from pre-launch test activities and launch operations result in restrictive access to fishing grounds within the affected areas. To assess the specific impacts of temporary closures on the socioeconomics of the fishing industry in the South Atlantic, it would be necessary to analyze detailed historical fishing data, including catch numbers, and stakeholder perspectives. Based on a review of dealer trip tickets reported to the Southeast Fisheries Science Center, the regional commercial fishing industry within the South Atlantic has had a relative increase in the annual percentage of fish caught over the past five (5)-years in relation to the annual allowable catch limit as shown in ***Table 22.*** Notwithstanding, the region of influence from booster landing on an ocean-going barge and vehicle recovery operations are 300-500 nautical miles offshore or less than 1,350 km downrange from the launch site when considering fairing jettison areas. Landing and recovery operations would occur within the action area assessed as part of the 2023 NMFS consultation. As shown in ***Figure 30***, this action area includes limited vessel traffic activity and would therefore not result in significant disruptions to the maritime industry. Although more recent vessel traffic data was available, pre-COVID-19 pandemic vessel counts were used to avoid underrepresenting vessel traffic volumes by using data collected during reduced economic activity due to the pandemic.

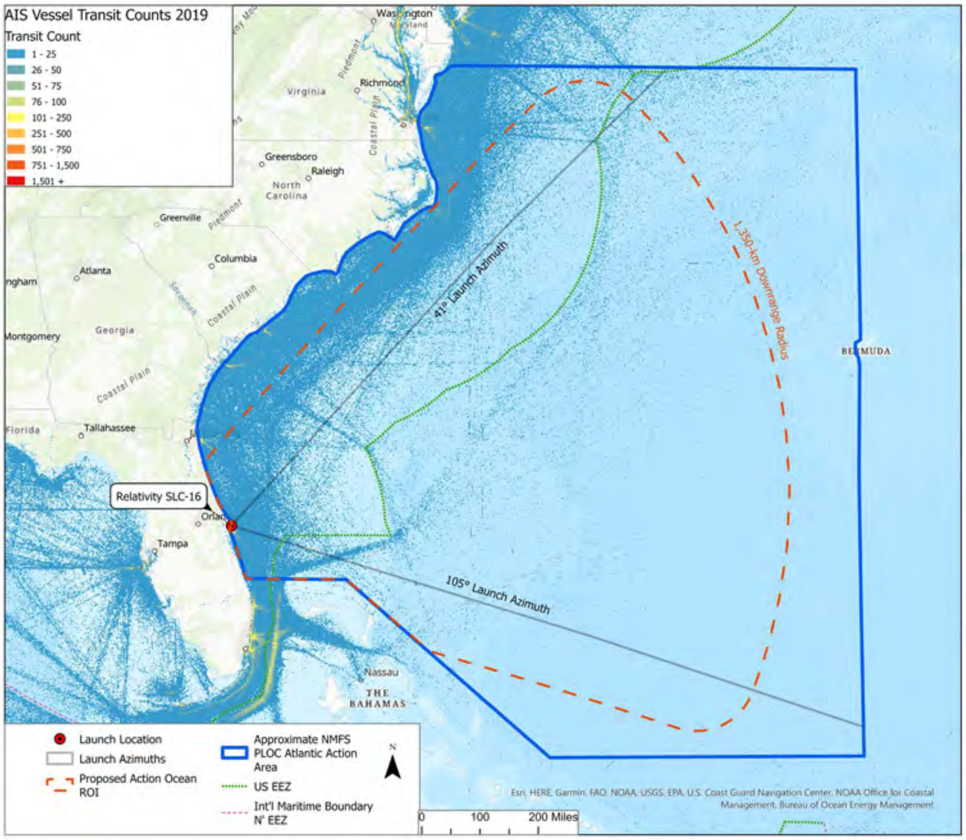


Figure 30 Terran R Action Area from Landing Operations

Taking into account the maximum of 24 launches per year (less than 500 hours of access restrictions per year), short duration of airspace and waterway closures, and the advanced notification for pilots and mariners to anticipate such closures, significant impacts to socioeconomic conditions due to launch activities within Brevard County would not be anticipated.

3.12.4 No Action Alternative

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

3.13 Environmental Justice

3.13.1 Regulatory Setting

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."

32 CFR 989.33, Environmental Justice and *AFI 32-1015, Integrated Installation Planning* 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.

3.13.2 Affected Environment

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. The Proposed Action is located within Brevard County and roughly 20 miles from Orange County. Based upon the 2022 Census of Population and Housing, Brevard County had a population of 616,628 persons. Of this total, 178,205 persons, or 28.9 %, were a minority. Orange County had a population of 1,429,190 persons of this total, 936,119 persons or 65.5% were minority. The largest segment of the minority population is Hispanic at 33.1%. The local economy of Brevard County is primarily driven by healthcare, retail trade, accommodation and food services, and manufacturing. Approximately 11.3% of persons in Brevard County were in poverty at the time of the 2020 census (USCB, 2022).

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.

3.13.3 Environmental Consequences

The construction of Relativity facilities and operations of Terran R would occur in the same area as the existing SLC-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 (8) miles south of Proposed Action activities. The proposed construction activities would not produce excessive pollution or create a hazardous situation impacting 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.

Therefore, the Terran R Program would not have significant impacts on Environmental Justice within Brevard County.

3.13.4 No Action Alternative

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

3.14 Department of Transportation Act Section 4(f) Properties

3.14.1 Regulatory Setting

Section 4(f) of the US Department of Transportation Act of 1966 (now codified at 49 U.S.C. Part 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 SEA 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 a 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.

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.

3.14.2 Affected Environment

The study area of 4(f) affected resources includes CCSFS and the area surrounding SLC-16 that would be affected by the Proposed Action as shown in ***Figure 31***. Areas affected include potential closures and noise impacts from testing and launch operations. There are multiple NRHP-eligible structures and National Historic Landmarks within the vicinity (1,000-foot radius) of the site. These properties include SLC-19 to the north and SLC-15 to the south of the site. Additionally, the Blockhouse at SLC-16 is an NRHP-eligible property. The nearest listed NRHP properties are located approximately five (5) miles from SLC-16 at KSC.

Multiple public parks and recreation areas are within Brevard County, adjacent to CCSFS and KSC. The nearest public park, Jetty Park, is located about six (6) miles south of SLC-16 in the City of Cape Canaveral. Other public parks within an approximate 15-mile (24.1 km) radius of SLC-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. Tosohatchee State Game Preserve is located west of Interstate 95 in Orange County, approximately 20 miles from SLC-16. MINWR is located approximately two (2) miles west of SLC-16, outside of the boundaries of CCSFS and the Cape Canaveral National Seashore is located approximately ten miles to the north of SLC-16.

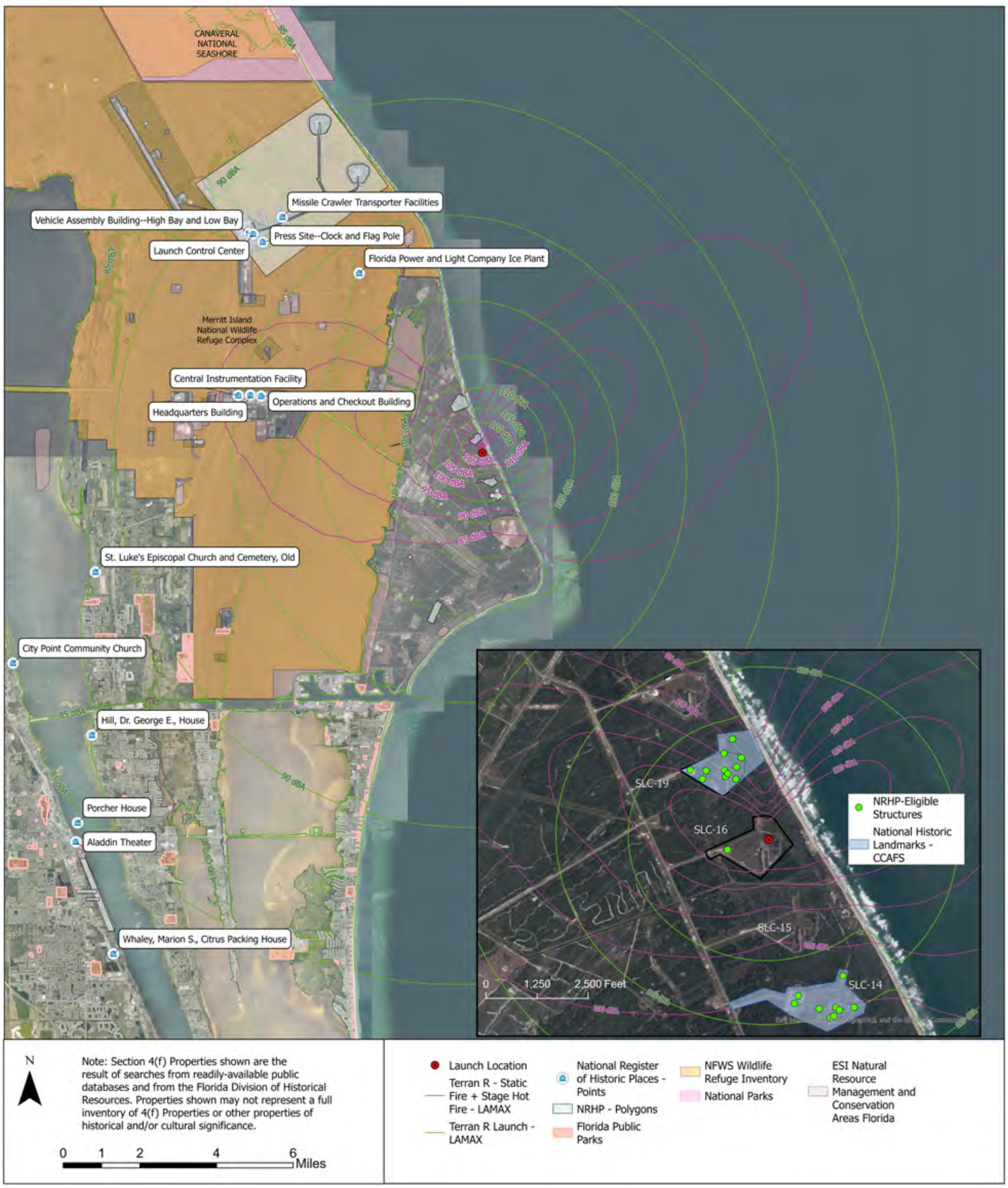


Figure 31 Study Area of 4(f) Affected Resources

3.14.3 Environmental Consequences

For decades, these properties have been experiencing increased noise levels during launches taking place at KSC and CCSFS. Due to the proximity of the potential Section 4(f) properties to SLC-16, these properties may experience temporary increases in noise from proposed Terran R launches. The DNL 60 dBA contour is used to conservatively identify the potential for significant noise impacts resulting from the propulsion noise generated by Terran R operations at 4(f) properties. The area identified within the 60 dBA contour for cumulative noise does not encompass land outside of the boundary of CCSFS. This low magnitude of annoyance at only occasional times should not diminish the significance and enjoyment of 4(f) properties. The noise levels expected to be experienced at these locations during launch and hot fire activities are shown in ***Figure 31.***

4(f) properties and visitors to unrestricted 4(f) locations would have negligible impacts from noise levels including sonic booms during Terran R MDC, static fire, and launch and landing operations as the sonic booms for these events are entirely over water. Due to the long history of these properties experiencing noise and temporary closures associated with launches at CCSFS and KSC, 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.

3.14.4 No Action Alternative

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

3.15 Airspace

3.15.1 Regulatory Setting

Airspace management considers how airspace may be designated, used, and administered to meet military, commercial and general aviation needs. 49 USC, Subtitle VII, Part A regulates the minimum navigable airspace altitudes and necessary airspace needed for safe takeoff and landing of aircraft. The FAA administers this limited natural resource as necessary to ensure aircraft safety and efficient use. FAA considers competing priorities and demands for airspace in relation to airport operations, federal airways, jet routes, military training activities, commercial space operations and other needs to best structure the National Airspace System (NAS) and address all user requirements.

Based on 14 CFR Part 71, the FAA has designated four (4) types of airspace within the US: controlled, special use, other and uncontrolled. Controlled airspace is a generic term that covers different classifications of airspace and their defined dimensions. Controlled airspace consists of Classes: A, B, C, D, and E. Special use airspace is the designation of airspace in which certain activities must be confined or limitations may be imposed on aircraft operations not part of those activities. Special use airspace consists of prohibited areas, restricted areas, warning areas, military operations areas, alert areas, and controlled firing areas. Other airspace is a general term referring to the majority of remaining airspace. This includes, but is not limited to, local airport advisory areas, military training routes, temporary restriction areas, parachute jump aircraft operation areas, and national security areas.

3.15.2 Affected Environment

The airfield within CCSFS is referred to as the Skid Strip. The operational constraints at the Skid Strip include accident potential zones (APZs), FAA height and lighting restrictions, tactical air navigation systems approach restriction, and airport imaginary surfaces. The airspace ROI includes the airspace associated with the Skid Strip, controlled by the Department of the Air Force. The airspace surrounding launch trajectories and hazard areas is controlled primarily by the Miami Air Route Traffic Control Center (ARTCC), Jacksonville ARTCC, and New York ARTCC.

In alignment with the 2023 Federal Aviation Administration Notice of Updated Factors for Optimizing Use of the NAS, in effort to minimize frequent NAS disruptions, the FAA will consider the following in order to minimize the disruption to the NAS. Relativity will do due diligence when submitting for launch dates and windows in alignment with these considerations.

- The location and timing of the proposed commercial space operation
- The number of flights and/or passengers that will be affected by the operation
- Holidays or significant events that result in more NAS congestion generally or in specific areas of the country
- Launch window duration
- Nighttime v. daytime launches
- Mission purpose: The FAA generally will prioritize commercial space operations that (1) have a national security purpose or are in the national interest and/or (2) commercial space launches carrying payloads.

Significant impacts to airspace would affect the structure, use, or management of the airspace environment. Impacts would be significant if they imposed major restrictions on air commerce opportunities, substantially limited airspace access to a large number of users or required modifications to existing air traffic control systems.

3.15.3 Environmental Consequences

Airspace impacts could occur due to Terran R Program launch operations. However, FAA’s TFR have been redesigned to prevent commercial and private airspace rerouting and delays during launches. Joint research with the USSF, NASA and launch operators concluded the old temporary TFR area was too large and could be reduced with no impact on operational safety. The new TFR extends to the east and southeast, with no changes in altitude. This new TFR does not occupy the AR6 and AR15 airspace corridors, typically used by transatlantic flights from Orlando International Airport. Based on these updated TFR corridors, impacts to airspace by the Terran R Program would be minimized.

Therefore, the Terran R Program launch operations would not have a significant impact on local airspace.

3.15.4 No Action Alternative

Under the No Action Alternative, the Terran R Program would not be implemented. No impacts to airspace would occur.

4 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." The effects of the Proposed Action in combination with the effects of other relevant past, present, and reasonably foreseeable future projects are evaluated in this cumulative effects analysis. The depth of this analysis is commensurate with the potential for significant impacts and present those impacts to the decision-makers.

4.1 Past, Present, and Reasonably Foreseeable Future Actions

The ROI for cumulative impacts generally includes CCSFS, KSC, Port Canaveral, and surrounding municipalities (i.e. Cape Canaveral, Titusville, Cocoa, Merritt Island, Canaveral National Seashore, MINWR, and Brevard County, where appropriate) and the Atlantic Ocean.

The past, present, and reasonably foreseeable launch actions at CCSFS and KSC are listed in ***Table 24*** and ***Table 25*** below. Future projects with relevance to the Proposed Action are summarized in ***Table 26*** below. Projects are assumed to be accurate and applicable to the Cumulative Impacts analysis in this SEA.

There was coordination with local governments and municipalities when developing this analysis. The following references were reviewed for past, present, and reasonably foreseeable actions that could impact the ROI:

- SLD 45 installation planning documents, including *CCSFS District Development Plan* (USSF 2022a), *PSFB District Development Plan* (USSF 2022b), and *PSFB Installation Development EA* (USSF 2023).
- 2045 Long Range Transportation Plan for Space Coast Transportation Planning Organization (2020).
- Space Coast Transportation Planning Organization Transportation Improvement Program Fiscal Years 2022-2026) (2021).
- Brevard County Budget Office Capital Improvement Plan from 2020-2025 (2020).
- City of Cocoa Bead Adopted Annual Budget for Fiscal Year 2023 (2022).
- FDOT District 5-year Work Program (2021).
- Space Florida Cape Canaveral Spaceport Complex Master Plan, January 2017.
- KSC Master Plan, 2012-2032 (2014).
- Port of Canaveral 30-Year Strategic Vision Plan 2017-2047 (2018).
- Environmental Assessment for Exploration Park North at the John F. Kennedy Space Center, Kennedy Space Center, Florida, August 2021.
- Resilient Cape Canaveral: Storm Surge, Flooding, and Sea Level Rise, Sea Level Rise + Surge (2019).
- Draft Environmental Assessment for Eastern Range Planning and Infrastructure Development, March 2023.
- EIS EELV Program, April 1998.
- Supplemental EIS for the EELV Program, March 2000.
- EA Blue Origin Orbital Launch Site at CCSFS Florida, November 2016.

- 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.
- EA for SpaceX Falcon Launches at Kennedy Space Center and CCAFS, February 2020.
- Environmental Assessment for the Relativity Terran 1 Program Launch Complex 16, Cape Canaveral Space Force Station, FL, dated June 2020.

Table 24. Past Vehicle Launches at KSC and CCSFS

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	0	3	5	2	10
2013	0	2	6	2	10
2014	0	4	6	6	16
2015	0	2	8	7	17
2016	0	3	7	7	17
2017	0	1	4	13	18
2018	0	1	4	15	20
2019	0	2	2	11	15
2020	0	1	5	25	31
2021	0	0	3	28	31
2022	1	0	6	48	55
Total Launches	7	25	63	166	261
Note: * One Delta Launch in 2011 was a Delta II 7000					

The forecast for CCSFS launches during the next four (4) years is presented in ***Table 25***.

Table 25. Future Planned and Projected Vehicle Launches CCSFS

Year	Total
2023	68
2024	85
2025	99
2026	83
2027	71
Notes: SLD 45 provided these numbers as projections based on scheduling, the launch manifest, and other known information, therefore these numbers are subject to change.	

Table 26. Past, Present, and Reasonably Foreseeable Future Actions

Project	Description	Relevance to Proposed Action
	Past Actions	
Implement Falcon Program from SLC-39A and SLC-40 (SpaceX)	Construction and launch operations at SLCs 39A (KSC) and 40 (CCSFS): *EA and FONSI for SpaceX Falcon Launches at Kennedy Space Center and Cape Canaveral Air Force Station*, July 2020	Existing conditions/activity would be in proximity to the Proposed Action
Refurbish SLC-39B to launch multiple vehicle types (NASA)	Construction and launch operations at SLC 39B, which supports NASA's Space Launch System	Existing conditions/activity would be in proximity to the Proposed Action
Construct Cruise Terminal Three (Canaveral Port Authority)	Construction and operation of the largest terminal (185,000 SF) at Port Canaveral with parking garage, completed in 2021	Existing conditions/activity would be in proximity to the Proposed Action
Repair Cruise Terminals Five, Eight, & Ten (Canaveral Port Authority)	Repairs/upgrades moorings and facilities to accommodate larger cruise ships	Existing conditions/activity would be in proximity to the Proposed Action
Reconstruct Port Canaveral North Cargo Berth 3 Reconstruction (Canaveral Port Authority)	Reconstruction of berthing space to support cargo and space mission requirements	Existing conditions/activity would be in proximity to the Proposed Action
Construct FPL solar farm (NASA)	Construction of a 500-acre solar farm north of the KSC Visitor Center	Activity would be in proximity to the Proposed Action Construction would overlap with Proposed Action implementation
	Present Actions	
Construct SLC-48 (NASA)	Construction and launch operations at SLC 48 for small-lift vehicles	Existing conditions/activity would be in proximity to the Proposed Action
Develop NOTU campus (U.S. NAVY)	Development of the NOTU campus on CCSFS	Existing conditions/activity would be in proximity to the Proposed Action. Construction would overlap with Proposed Action implementation
Refurbish and reuse SLC-11 and SLC-36 (Blue Origin)	Construction and launch operations at SLCs 11 and 36: EA *for the Blue Origin Orbital Launch Site Construction at Launch Complex 11 and 36 Cape Canaveral Air Force Station (CCAFS)*, FL December 2016	Existing conditions/activity would be in proximity to the Proposed Action

Table 26. Past, Present, and Reasonably Foreseeable Future Actions

Project	Description	Relevance to Proposed Action
Upgrade SLC-41 and nearby facilities for the Vulcan Centaur launch program (ULA)	Construction and launch operations at SLC 41: *EA for the United Launch Alliance Vulcan Centaur Program Space Launch Complex (SLC) 41 Cape Canaveral Air Force Station (CCAFS), FL*, June 2019	Existing conditions/activity would be in proximity to the Proposed Action
Develop Exploration Park (Space Florida)	Construction of facilities at Exploration Park	Existing conditions/activity would be in proximity to the Proposed Action. Construction would overlap with Proposed Action implementation
Refurbish SLC-39A (NASA)	Construction and launch Operations of Starship Superheavy at SLC-39A (NASA 2019)	Activity would be in proximity to the Proposed Action Construction is on-going and could overlap with Proposed Action implementation
Improve SLC-20 (Space Florida)	Construction of multi-user launch pad at SLC-20 and the associated improvements (roadways and utilities) needed to support future customers	Close in proximity to the Proposed Action, operations would overlap on ICBM Road Construction is on-going and could overlap with Proposed Action implementation
Future Actions		
Repair/construct airfield infrastructure (USSF)	Repairs and new construction at Skid Strip, including paved overruns, administrative facility, hangar, and apron for future DoD mission	Activity would be in proximity to the Proposed Action Construction would overlap with Proposed Action implementation
Range of the Future Infrastructure Improvements	Proposed future development and infrastructure improvement met the current and anticipated launch cadence, Major Range and Test Facility Base requirements, and SLD 45 and tenant missions, while promoting sustainable and resilient development within the installation. Goals identified within the ROTF Plan include: provide reliable infrastructure capable of supporting mission requirements; reduce impacts to personnel and equipment from launch operations; eliminate critical periods on the Easter Range; improve base logistics capacity; and expand developable areas in support of mission requirements.	Construction would overlap with Proposed Action implementation

Table 26. Past, Present, and Reasonably Foreseeable Future Actions

Project	Description	Relevance to Proposed Action
Reactivation of SLC-13 (Phantom/Vaya Space)	Refurbishment of existing inactive SLC for Phantom and Vaya Space Launch operations	Close in proximity to the Proposed Action, operations would overlap on ICBM Road Construction would overlap with Proposed Action implementation.
Reactivation of SLC-14 (STOKE Space)	Refurbishment of existing inactive SLC for STOKE Space Launch operations	Close in proximity to the Proposed Action, operations would overlap on ICBM Road Construction would overlap with Proposed Action implementation.
Reactivation of SLC-15 (ABL Space Systems)	Refurbishment of existing inactive SLC for ABL Space Systems launch operations	Close in proximity to the Proposed Action, operations would overlap on ICBM Road Construction would overlap with Proposed Action implementation.
Construct new SLC on CCSFS (USSF)	Construction of new SLC-50 to support future launch operations	Close in proximity to the Proposed Action, operations would overlap on ICBM Road Construction would overlap with Proposed Action implementation
Construct new SLC on KSC (NASA)	Construction of new SLC-49 to support future launch operations	Activity would be in proximity to the Proposed Action Construction would overlap with Proposed Action implementation
Improve shuttle landing facility (NASA/Space Florida)	Construction at the shuttle landing facility to support commercial spaceflight and, aviation testing, research, development, and training	Activity would be in proximity to the Proposed Action Construction would overlap with Proposed Action implementation
Replace SR 401 Drawbridge (FDOT)	Evaluate alternatives to replace the drawbridge on SR 401 over the Canaveral Barge Canal	Activity would be in proximity to the Proposed Action Construction may overlap with Proposed Action implementation

Source – Environmental Assessment for Eastern Range Planning and Infrastructure Development at Cape Canaveral Space Force Station, Florida (Range of the Future)

4.2 Cumulative Impact Analysis on Resource Areas

For the scenarios under consideration to have a cumulatively significant impact on an environmental resource, two (2) conditions must be met. First, the combined impacts of all identified past, present, and reasonably foreseeable actions, including the Proposed Action, must be significant. Second, the Proposed Action must make a substantial contribution to that significant cumulative impact. It is anticipated that the reasonably foreseeable actions would proceed whether or not the Proposed Action was implemented. Under the No-Action Alternative, the Proposed Action would not occur and there would be no contribution to cumulative impacts within the ROI.

The launch actions and projects listed in ***Table 25*** and projects in ***Table 26*** 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 4.1*** and evaluates the potential cumulative impacts resulting from these interactions. As described in ***Section 3***, no direct or indirect 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.

4.2.1 Air Quality and Climate

CCSFS and Brevard County are in an "Attainment" area and the operational emissions for the proposed Terran R Program operations 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 CCSFS and Brevard County, including both lower and upper atmospheres. The Proposed Action includes air and GHG emissions for construction, ground support operations, testing and launch.

Air emissions from other projects summarized above would be localized and short term in nature except for launch operations at KSC and CCSFS, and shipping activity at Port Canaveral which are anticipated to continue. Long-term emissions from the projects are not expected to increase regional air quality impacts or global GHG emissions.

The small quantity of GHG emissions from the Proposed Action alone would not cause appreciable global warming that would lead to climate changes. However, these emissions would increase GHG concentration in the atmosphere, and, in combination with past, present, and reasonably foreseeable future emissions from all other sources, contribute incrementally to climate change.

Increased air and GHG emissions are expected due to the overall increased activity with cruise lines, cargo shipping and local traffic within and surrounding CCSFS. However, these increases are not expected to change the attainment status of Brevard County. The Department of the Air Force and local communities are developing sustainability and climate change support initiatives to reduce GHG emissions.

Therefore, when considered with other past, present, and foreseeable future actions, the Proposed Action would not result in significant cumulative impacts to air quality and climate change.

4.2.2 Water Resources

The Proposed Action would have no significant impact on surface water (inland and ocean), groundwater, floodplains, or wetlands. It is expected that permanent impacts to a functional loss of up to 1.10 acres of wetlands would occur. However, mitigation actions would offset this localized impact on wetlands through the purchase of credits from the Neo Verde mitigation bank such that no net loss of wetland functions is expected. Contaminated groundwater dewatering may be required for excavation of utilities and deep pile foundations since groundwater levels occur only two (2) to three (3) feet BLS. However, authorization through the CCSFS IRP would be required along with the submission and approval of a dewatering plan by IRP, CEIE and FDEP to ensure groundwater handling and disposal requirements are met. These minor impacts to groundwater would not present an incremental cumulative impact to groundwater flow or quality within CCSFS.

With the increases in construction and launch activities at CCSFS and KSC, incremental impacts to water resources are expected. Impacts to wetlands, floodplains, surface water or groundwater would depend on the specific construction requirements and launch vehicle fuels. Alternatives to prevent future development within the 100-year floodplain would be challenging since much of CCSFS is within the 100-year floodplain. SLD 45 would continue to consider alternative locations for construction outside of the floodplains unless no practical alternative exists. To minimize impacts, mitigation measures and BMPs would be implemented. Impacts outside of CCSFS would also be minimized through state and local building code requirements.

Incremental increases in impervious surface are also expected with the foreseeable future construction projects within CCSF and Brevard County. Increased stormwater treatment, water control, and retention would be required throughout the county. The USSF’s on-going efforts and commitment to reducing total maximum daily loads and improving water quality regionally would minimize the impacts of future launch and construction activity.

Cumulative impacts to water resources at CCSFS would occur if future projects inadequately address water resource issues in their respective ROIs. Compliance with state, federal and local requirements for proper management of materials would minimize impacts to water resources. Implementing mitigation measures and BMPs in coordination with federal, state, and local agencies in conjunction with other past, present, or reasonably foreseeable projects would not have significant impacts on water resources.

4.2.3 Biological Resources

The Proposed Action would not have a significant impact on terrestrial vegetation and wildlife, marine species, or protected species. The Terran R Program construction activities would have minimal impact on Biological Resources since construction activities would be within or adjacent to the previously developed SLC-16 area.

Relativity’s Terran R engines consume LOX and LNG with negligible 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 R launch failures has a small potential to adversely affect managed fish species and their habitats in the vicinity of the project area. During the April 2023 *Programmatic Concurrence Letter for Launch and Reentry Vehicle Operations in the Marine Environment and Starship/Super Heavy Launch Vehicle Operations at SpaceX's Boca Chica Launch Site, Cameron County, TX* , a consultation with NMFS determined that launch and vehicle reentry operations may affect, but are not likely to adversely affect ESA-listed species or designated critical habitat under the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et seq.). This SEA also determines the Terran R Program launch and vehicle reentry operations may affect but are not likely to adversely affect ESA-listed species or designated critical habitat.

Future habitat removal and disturbances to biological resources from future actions on CCSFS is likely. Future actions would comply with section 7 of the ESA and consultations with the USFWS would be required. Mitigation measures would be developed based on USFWS consultation to minimize potential future impacts. As a result, the overall cumulative effect of the Proposed Action with other past, present, and reasonably foreseeable future actions on Biological Resources are considered minor and not significant. 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.

4.2.4 Land Use, Visual and Coastal Resources

The proposed action would not result in any additional impacts to land use compatibility since CCSFS'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 R Vehicle.

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

The ROTF Plan for CCSFS considers land use compatibility, consolidation of facilities, mission sustainability, safety, and security. All future projects must comply with Light Management Plans to minimize the amount of sky glow and impacts to nesting sea turtles. When considered with other past, present, and foreseeable future actions, the Proposed Action would not contribute to adverse cumulative impacts on land use or visual and coastal resources.

4.2.5 Noise

DNL is used to estimate the potential long-term community noise impacts from the proposed Terran R 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 would be exposed at or above this level due to the increase. The DNL contours from 60 dBA to 85 dBA are presented in ***Figure 23***. The DNL 65 and 60 dBA contours extend approximately 2.8 and 3.2 miles from the launch pad, respectively. This area does not encompass land outside of the boundaries of CCSFS and no residences are impacted (BRRC, 2023). The BRRC report concluded that noise impacts would not be significant based on the DNL 65 dB noise contour for the Proposed Action.

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 R Vehicle launches are not expected to generate significant propulsion noise or sonic boom impacts in the community.

Future projects and launches are not expected to substantially change noise levels and contours currently experienced within the region of CCSFS and surrounding cities. An increase in launch cadence is expected to reach 321 total launches from 2023 through 2026. This increase in launch cadence may result in increased annoyance to surrounding public areas. Although an increase in launch cadence would result in increased occurrences of noise exposure, the DNL 60 dBA noise contours would not reach residences or other sensitive populated communities outside CCSFS. Therefore, when considered with other past, present, and reasonably foreseeable future actions, the Proposed Action would not contribute to adverse cumulative impacts from noise.

4.2.6 Transportation Infrastructure

Transportation impacts may be attributable to construction, ground support, and launch operations. A slight increase in the traffic during the approximate 18-month period of construction is anticipated but would not significantly impact CCSFS roadways. Terran R's Program vehicle stages and payloads would arrive at CCSFS loaded on vessels or standard over-the road tractor-trailers fitted with specialized cradles and transportation hardware. The transportation routes used for Terran R's vehicle components are illustrated in ***Figure 25*** through ***Figure 27.*** Proposed Action vehicle component transportation would not have a significant impact on transportation assets. During launches, the increase in traffic for viewing should be similar to existing launches and would not be significant.

Other construction projects and launch activities would provide incremental impacts on traffic patterns within CCSFS, CCSFS wharfs, and surrounding areas such as the replacement of SR 401 drawbridge over the Canaveral Barge Canal. Large load transport would also degrade aged roadways leading to decreased transportation infrastructure reliability. However, the ROTF Plan notes a main goal for improvement and includes improving base logistics capacity. Infrastructure improvements would support more efficient operations at CCSFS with a focus on optimizing haul routes and traffic flow. Optimized haul routes include connecting NASA Causeway with Central Control Road, widening of Phillips Parkway, as well as other strategic roadway connections for ease of oversized vehicle movement.

Minimizing day to day impacts to CCSFS personnel due to launch missions is another goal of the ROTF Plan. Roadways and access gates are closed during launch and testing operations, resulting in rerouted traffic and personnel inconvenience. Infrastructure improvement would relocate non-essential personnel and functions outside of launch exclusionary safety zones to minimize these impacts.

Based on the planned transportation infrastructure improvements identified within the ROTF Plan, the cumulative effect of other past, present, and reasonably foreseeable future actions would not be significant to CCSFS roadways. When considered with other past, present, and foreseeable future actions, the Proposed Action would not contribute a noticeable incremental impact to regional or local transportation assets.

4.2.7 Utilities Infrastructure

4.2.7.1 Water Supply

Neither CCSFS nor Relativity plan to extend potable water services to SLC-16. Bottled drinking water would be provided, safety showers and eyewashes would be self-contained, and restrooms would 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. Relativity is also planning to provide on-site water storage. No impacts to the industrial water supply are expected from the Proposed Action.

Future water uses for construction and launch operations would cause an incremental increase in potable water demand at CCSFS. The amount of water demand for future launch providers is unknown and would be unique to each provider. SLD 45 plans to construct a 750,000-gallon and 400,000-gallon potable water storage tank to increase potable water resiliency. Two (2) and a half miles of new ductile iron water main would also be constructed to decrease pressure variations within the distribution system. These upgrades would minimize impacts to water supply at CCSFS. Therefore, when considered with other past, present, and foreseeable future actions, the Proposed Action would not contribute to cumulative impacts to the water supply.

4.2.7.2 Wastewater

Relativity plans to install a new septic system at SLC-16 to manage sanitary sewage for Terran R facilities. 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 would be disposed of in accordance with FDEP Industrial Wastewater requirements. No connections to the CCSFS sanitary sewer at SLC-16 would be made. No impacts to wastewater systems are expected from the Proposed Action.

Similar to water supply demand, wastewater supply would also incrementally increase due to increased activity within CCSFS. Aged piping infrastructure and existing limited capacity of the Regional Wastewater Treatment Plant (RWWTP) could result in impacts to wastewater treatment capabilities. Proposed improvement to wastewater infrastructure as part of the ROTF Plan include construction of a new 100,000-gallon equalization basin at the RWWTP, 2.8 miles of new wastewater main line, and a two (2) acre percolation pond for deluge washdown water. These proposed improvements would increase wastewater resiliency and capacity within CCSFS. Additionally, Space Florida is currently working to extend the wastewater line down ICBM Road to support SLC-20C and perhaps additional customers farther down ICBM Road in the future. Therefore, when considered with other past, present, and foreseeable future actions, the Proposed Action would not contribute to cumulative impacts to wastewater.

4.2.7.3 Electrical

The Proposed Action would require upgrades of existing Terran 1 electrical infrastructure to support SLC-16. The Proposed Action would have no significant impact on available electrical power supply. Future projects to upgrade electrical systems and utility infrastructure would be a positive impact to CCSFS power grid and support capabilities. Future projects include construction of approximately 2.5 miles of new concrete encased duct bank with 500-kcmil, 15-kilovolt power conductors along ICBM Road, new 1.5-megawatt emergency generator, and other miscellaneous electrical support equipment upgrades. The improvements would increase power distribution resiliency and redundancy throughout CCSFS. Therefore, when considered with other past, present, and foreseeable future actions, the Proposed Action would not contribute to cumulative impacts to electrical utilities and supply.

4.2.7.4 Stormwater

The Proposed Action requires ERP stormwater permitting at SLC-16. Since the construction area exceeds one (1) 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.

Foreseeable future actions would have a positive impact on CCSFS utilities infrastructure through improvement and upgrades to support current and future mission requirements. Improvements to supply and capacity for existing stormwater treatment facilities would provide a long-term benefit to CCSFS.

As a result, the overall cumulative effect of other past, present, and reasonably foreseeable future actions on utilities are considered a positive impact and would increase CCSFS capabilities. When considered with other past, present, and foreseeable future actions, it is not anticipated that the Proposed Action would contribute a significant impact on stormwater.

4.2.8 Hazardous Materials and Solid and Hazardous Waste

Terran R operations would use products containing hazardous materials, including paints, solvents, oils, lubricants, acids, batteries, surface coating, cleaning compounds, propellants, chemicals, and other hazardous material payload components. 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 would be applied during to the Terran R Program, limiting the potential for impacts.

The Proposed Action could have short-term, minor adverse impacts associated with hazardous materials/waste and solid waste. Construction activities would increase the use and storage of hazardous materials at CCSFS during the 24 months of construction. Operations related to hazardous waste generation would continue to be managed in accordance with the SLD 45 Hazardous Waste Management Plan and applicable federal, state, and local requirements.

Management of hazardous materials is the responsibility of each private organization and is regulated under RCRA and Rule 62-730. A substantial cumulative impact due to hazardous materials spills and contamination are not expected. Safeguards, management plans, and emergency response plans would be in place for all launch operators to minimize any significant impacts due to hazardous materials. When considered with other past, present, and foreseeable future actions, the Proposed Action would have a negligible contribution to impacts from hazardous materials and solid and hazardous waste.

4.2.9 Socioeconomics

The Terran R launch preparation timeframe and personnel requirements are anticipated to be negligible and would 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 CCSFS. 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. Temporary closures from planned vehicle launches at CCSFS result in restrictive access to fishing grounds within the affected areas. Commercial fishermen may be required to halt their fishing activities or relocate to alternative areas during the closure period. Notwithstanding, historical commercial landing numbers for key commercially fished species within the Atlantic (as shown in ***Table 22*** and ***Table 23*** indicate an increase in the percentage of allowable fish caught within the commercial fishing industry. This occurred concurrent with an increase in space vehicle launches from KSC and CCSFS as presented in ***Table 24***. Therefore, the cumulative impact from temporary closures to navigable waterways has not resulted in a significant displacement of commercial fishing vessels within usual fishing grounds. The Proposed Action would generate negligible socioeconomic impacts on the region.

The Proposed Action would have a slightly positive influence on socioeconomics, through contributions to the local economy. Cumulatively, with other foreseeable future actions, increases in construction jobs and tourism to Brevard County are expected as more launch programs start operations. 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 have a less than significant, beneficial impact on socioeconomics.

4.2.10 Airspace

Airspace impacts due to the Proposed Action are anticipated to be insignificant due to the updated TFR with limited interruption to other airspace users during Terran R launch operations.

Cumulatively, with other foreseeable future actions, increases in launches from CCSFS are expected within the airspace ROI. Based on ***Table 26***, approximately 321 launches are expected at CCSFS within the next four (4) years. As mentioned previously, the FAA has reestablished highly used travel corridor TFR’s to minimize impacts to transatlantic flights to Orlando, Tampa, St. Petersburg and other airports within Central Florida. Foreseeable future launches from CCSFS would abide by the same TFR requirements and would not impact the highly used AR6 and AR15 airspace travel corridors, north of CCSFS. An increase in future launch activity is not expected to result in a larger TFR area within the CCSFS airspace. Future launch and reentries would be infrequent, of short duration, and scheduled in advance to minimize interruption to air traffic.

With the new TFR corridors, advanced notice via NOTAMs and the identification of Aircraft Hazard Areas, commercial and private flights would have the necessary information to avoid flight activity disruptions in the area of operation. No flight path reroutes, delays or extra miles flown are expected due to future launch activities.

As a result, the overall cumulative effect of other past, present, and reasonably foreseeable future actions on airspace is not significant. When considered with other past, present, and foreseeable future actions, it is anticipated that the Proposed Action would have a less than significant, impact on airspace.

5 Summary of Potential Environmental Effects

Table 27 summarizes the potential environmental effects in the 15 categories for the Proposed Action and No Action Alternative.

Table 27. 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	Launches would not result in significant impacts to land use compatibility at CCSFS. SLC-16 is designated for space launch activities consistent with the CCSFS General Plan. The Proposed Action would not impact or require changes to land use. Facilities built for the Terran R Program would be within or directly adjacent the existing launch complex footprint. The Proposed Action has no change to coastal zone impacts and would be consistent in meeting Florida CZMA plan objectives. The Proposed Action would generate no significant impacts on visual resources.	No change to existing SLC-16 land use or visual resource impacts.

Aspect Area	Proposed Action Environmental Impacts	No Action Alternative
2. Noise	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 SLC-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. 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. The modeled nominal Terran R launch generates a sonic boom over a narrow, forward facing crescent shaped focus boom region. The focus boom region is created due to continuous acceleration and downward pitch as the launch vehicle ascends. As the launch vehicle ascends, the sonic boom levels decrease, resulting in the crescent shape becoming slightly longer and wider. The focus boom region begins approximately 35 miles downrange from the launch pad. The maximum modeled sonic boom peak overpressure along the focus boom region is 11 psf. However, the focus boom region is entirely over water, and these high levels would only occur in small areas along the focus boom region. The modeled Terran R ocean-based barge landing also generates a sonic boom. The maximum modeled sonic boom peak overpressure along this focus boom region is 47 psf. Sonic booms for ocean-based barges would occur more than 250 nautical miles offshore. The Proposed Action would generate no significant noise impacts.	No SLC-16 noise impacts.

3. Biological Resources	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 CCSFS. Exterior construction would occur within the SLC-16 previously disturbed area and adjacent areas. Other than the common "startle response", no impacts to wildlife due to construction noise are anticipated. The clearing for the Proposed Action would result in the loss of approximately 33.01-acres of potential Scrub-Jay habitat. The 2022 Florida Scrub-Jay census did not reveal the presence of any Scrub-Jay groups or individuals within the Proposed Action area and therefore direct impacts are not expected. The site does contain suboptimal habitat in the form of coastal scrub, wetlands, and other natural areas that are not considered capable of being managed and occupied by the Florida Scrub-Jay. The Proposed Action would result in the taking of unoccupied Florida Scrub-Jay habitat. The clearing for the Proposed Action would result in the loss of approximately 33.01 acres of potential southeastern beach mouse habitat and direct impacts are possible. 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 clearing within the Proposed Action Area. The ±33.68 acres contained within the Proposed Action Area will be cleared using heavy machinery while the area (±1.83 acres) within the range of the proposed heat plume influence will remain naturally vegetated and only be affected for short durations during launch operations. Potential negative impacts of lighting on sea turtle survivability are reduced and managed by 45 SWI 32-7001 which addresses exterior Lighting Management. 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. Post launch monitoring conducted on previous launches and previous environmental analyses concluded that launch impacts to T&E species are minimal and insignificant.	No biological resource impacts.

Aspect Area	Proposed Action Environmental Impacts	No Action Alternative
	Overall impacts on Biological Resources are anticipated to be insignificant.	
4. Historical and Cultural Resources	The SLD 45 Cultural Resources Manager evaluated the Proposed Action affected areas and no historical or cultural resource issues were found. The Proposed Action would have no effect on Historical or Cultural Resources.	No cultural resources impacts.
5. Air Quality	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, NO_x and CO_2. Emissions are expected to be minor from these sources over the expected 24 months of construction. Construction activities are not expected to significantly change regional (Brevard County) or local (CCSFS) air emissions. Operations and Launch**:** Relativity operations at SLC-16 would result in a major source of air pollutants would require a Title V air operating permit to cover S1 MDC and Static Fire Testing. As documented in previous EAs and EISs performed for launch vehicles at CCSFS, emissions from nominal launches, catastrophic launch failures, or spills of liquid propellants would not substantially impact ambient air quality. Air emissions from Terran R launches with LNG/LOX engines are expected to be lower than launches with solids. LNG is a cleaner burning fuel than Rocket Propellant-1, with anticipated reductions in PM. Terran R operations at CCSFS would not be expected to have a significant impact on air quality. 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 warning 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. The Proposed Action GHG emissions would be essentially unmeasurable and not have a climate change impact.	No air quality or climate impacts.

Aspect Area	Proposed Action Environmental Impacts	No Action Alternative
6. Hazardous Materials/Solid and Hazardous Waste	Construction: The construction activities at SLC-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. Ground support operations, stage MDC testing, static fire, launch and ocean-based barge landing: Operations 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 similar to other EELV-class launch programs. The Proposed Action poses no significant impact on hazardous material use or solid or hazardous waste generated.	No hazardous material or solid/hazardous waste impacts would occur.
7. Water Resources	The Proposed Action would have no significant impact on surface water, groundwater and floodplains and wetlands. Approximately 1.63 acres of wetlands along the northern portion of SLC-16 would be impacted for roadway rerouting and the new flame trench. ***Figure 10*** identifies the location of wetlands to be impacted and mitigated (WB and WC). Permitting through SJRWMD's ERP Program as well as a Section 404 No Permit Required determination with FDEP would be completed prior to construction to determine compensatory mitigation requirements to offset wetland impacts. Mitigation credits required for wetland impacts would be determined using the FDEP's Uniform Mitigation Assessment Method (UMAM). Contaminated groundwater dewatering may be required as part of the Proposed Action. Impacts would be minimized however, through the coordination with CCSFS IRP and approval of a dewatering plan by IRP, CEIE and FDEP to ensure groundwater handling and disposal requirements are met. The Proposed Action would collect and treat all deluge water in accordance with FDEP Industrial Wastewater requirements and therefore no significant impacts on surface waters are expected. 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 CCSFS launches. 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. No significant water resource impacts are expected to result from the Proposed Action.	No SLC-16 water resources impacts would occur.

Aspect Area	Proposed Action Environmental Impacts	No Action Alternative
8. Geology and Soils	No unique geologic features of exceptional interest or mineral resources occur in the project area; therefore, no impacts would occur to these resources. The Proposed Action would have no direct impacts on geology or soils.	No geology or soil impacts would occur.
9. Transportation	A slight increase in the traffic during the approximate 24-month period of construction is anticipated but it would not significantly impact CCSFS roadways. Transportation of the Terran R Program components to assembly areas is not expected to have a significant impact on CCSFS transportation routes. During launches, the increase in traffic should be similar to existing launches and would not be significant. No significant transportation impacts are expected to result from the Proposed Action.	No transportation impacts.
10. Utilities	Construction personnel do not add appreciably to utility loads. Proposed Action impacts on electrical power requirements would not result in significant impacts compared to existing availability and capacity. Potable water and wastewater service are not connected to SLC-16. No potable water or wastewater impacts due to the Proposed Action are expected. Relativity would use industrial water provided by CCSFS for fire protection and exhaust deluge and sound suppression. No significant impact to CCSFS industrial water supply is anticipated. Stormwater permitting at SLC-16 would 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.	No utility impacts.
11. Health and Safety	Relativity requires all employees and contractors to follow all USSF and OSHA regulations during construction activities. No significant impacts to health and safety of workers during construction is anticipated. The Terran R Program would adhere to all Relativity, USSF, CCSFS, state and federal safety and health regulations and requirements. The Terran R Program construction and launch operations would have no significant impacts on on-site personnel health and safety.	No health and safety impacts.

Aspect Area	Proposed Action Environmental Impacts	No Action Alternative
12. Socioeconomics	The Terran R Launch Program 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 CCSFS. 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. Temporary closures of airspace and navigable waterways have the potential to impact private businesses who operate in the closure areas such as airlines, cruise ships, and commercial fishermen. Taking into account the maximum of 24 launches per year (<500 hours of access restrictions per year), short duration of airspace and waterway closures, and the advanced notification for pilots and mariners to anticipate such closures, significant impacts to socioeconomic conditions due to launch activities within Brevard County would not be anticipated. The Proposed Action would generate negligible socioeconomic impacts on the region.	No socioeconomic impacts would occur.
13. Environmental Justice	No significant impacts have been identified. The construction of Relativity facilities and operations of Terran R are not located adjacent to or near minority populations or low-income population centers. Therefore, environmental impacts generated by construction, ground support operations, and 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. Use of the SLC-16 site would also not have an impact on any Environmental Justice subject groups.	No impacts to minority or low-income populations would occur.
14. Section 4(f) Properties	No designated 4(f) properties, including public parks, recreation areas, or wildlife refuges, exist within the boundaries of CCSFS. No Section 4(f) properties would be significantly impacted by noise levels from Terran R launches. The Proposed Action would generate no negative Section 4(f) publicly owned land impacts on the region.	No impacts would occur to publicly owned land.
15. Airspace	Due to the redesigned airspace temporary flight restriction areas, a limited amount of commercial and private flights would be impacted during launches from CCSFS. The 24 annual Terran R Program launches would not require a significant number of airspace closures. The Proposed Action would not have a significant impact on airspace.	No impacts to airspace.

6 List of Agencies, Organizations, and Persons Contacted

Tribal Contacts

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

Agency Contacts

Agency	Address	City	State	Zip Code
Brevard County	Viera Government Center 2725 Judge Fran Jamieson Way Building A	Viera	FL	32940
City of Cape Canaveral	100 Polk Avenue	Cape Canaveral	FL	32920
City of Cocoa	65 Stone Street	Cocoa	FL	32922
City of Titusville	PO Box 2806	Titusville	FL	32781
East Central Florida Regional Planning Council	455 N. Garland Avenue Fourth Floor	Orlando	FL	32801
Federal Aviation Administration	800 Independence Avenue SW Suite 325	Washington	DC	20591
Florida Department of Environmental Protection	3319 Maguire Boulevard	Orlando	FL	32803
FDEP Florida State Clearinghouse	2600 Blair Stone Road, MS 47	Tallahassee	FL	32399
Florida Department of Transportation	719 South Woodland Boulevard	DeLand	FL	32720
Florida Division of Historical Resources	Bureau of Historic Preservation R.A. Gray Building 500 South Bronough Street	Tallahassee	FL	32399
Merritt Island National Wildlife Refuge	PO Box 2683	Titusville	FL	32781
National Aeronautics and Space Administration	Email correspondence			
National Marine Fisheries Service	Southeast Regional Office Habitat Conservation Division 263 13th Avenue South	St. Petersburg	FL	33701

Agency	Address	City	State	Zip Code
National Parks Service	Interior Region 2 (Legacy Southeast Region) Cultural Resources Division100 Alabama Street SW, 1924 Building	Atlanta	GA	30303
National Parks Service Canaveral National Seashore	Canaveral National Seashore 212 S. Washington Avenue	Titusville	FL	32796
Space Coast Transportation Planning Organization	2725 Judge Fran Jamieson Way Building B; Room 105 MS #82	Melbourne	FL	32940
Space Florida	505 Odyssey Way, Suite 300	Exploration Park	FL	32953
St. Johns River Water Management District	525 Community College Parkway, SE	Palm Bay	FL	32909
US Army Corps of Engineers	Cocoa Permits Section 400 High Point Drive Suite 600	Cocoa	FL	32926
US Coast Guard	Email correspondence			
U.S. Environmental Protection Agency Region 4	Sam Nunn Atlanta Federal Center	Atlanta	GA	30303
US Fish and Wildlife Service	North Florida Ecological Services 7915 Bay Meadows Way, Suite 200	Jacksonville	FL	32256
US Navy	Email correspondence			

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8 List of Preparers

Table 28. Preparer Details

Name / Company	Title / Responsibility
Steven Henderson Salas O'Brien	Environmental Engineer
Jeff Longshore, P.E. Salas O'Brien	Director, Civil/Environmental Engineering
James Strickland Salas O'Brien	Project Manager
Jon M. Shepard Atlantic Environmental Services	Ecologist
Brian Wemple, P.E. Relativity Space	Director, Launch Infrastructure
Stephen Abille Relativity Space	Manager, Environmental Engineering
Matthew Mazzone, P.E. Relativity Space	Chemical Engineer

Appendix A
Florida Clearinghouse Review

Appendix B

NMFS Programmatic Concurrence Letter for Launch and Reentry Vehicle Operations in the Marine Environment

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1315 East-West Highway
Silver Spring, Maryland 20910

4/14/23

Refer to NMFS No: OPR-2021-02908

Michelle Murray
Manager, Operations Support Branch (A), ASA-140
FAA Office of Commercial Space Transportation
800 Independence Ave SW, Suite 325
Washington, DC 20591

RE: Amended Programmatic Concurrence Letter for Launch and Reentry Vehicle Operations in the Marine Environment and Starship-Super Heavy Launch Vehicle Operations at SpaceX's Boca Chica Launch Site, Cameron County, TX

Dear Ms. Murray:

On August 25, 2021, the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) Endangered Species Act (ESA) Interagency Cooperation Division received a request for concurrence with the Federal Aviation Administration's (FAA) determination that launch and reentry vehicle operations in the marine environment may affect, but are not likely to adversely affect ESA-listed species or designated critical habitat under the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et seq.). On August 11, 2021, the FAA submitted a consultation request letter to the ESA Interagency Cooperation Division seeking concurrence on their determination that issuing experimental permits and/or a Vehicle Operator License that would allow SpaceX to launch the Starship-Super Heavy from the Boca Chica (Cameron County, TX) Launch Site may affect, but are not likely to adversely affect ESA-listed species or designated critical habitat. Because of the similarities in the two proposed actions, NMFS decided to batch the two consultations into a single programmatic letter of concurrence (PLOC). The response to your consultation requests was prepared by NMFS pursuant to section 7(a)(2) of the ESA, implementing regulations at (50 CFR §402), and agency guidance for preparation of letters of concurrence. A PLOC was provided to the action agencies on January 31, 2022.

The ESA Interagency Cooperation Division received a letter on October 7, 2022 from the FAA regarding the PLOC, that stated after reviewing the PLOC and coordinating with the other action agencies, specifically the U.S. Space Force (USSF) and National Aeronautics and Space Administration (NASA), the FAA, USSF, and NASA would like to reinitiate the informal consultation to expand upon and clarify portions of the PLOC. The changes requested in the letter clarify information submitted and provide additional information for this programmatic consultation. The requested revisions did not change the scope of activities, the effects previously analyzed, or our effects conclusions; therefore, reinitiating the PLOC was not necessary. The PLOC was amended as a result of the requested changes and this amended PLOC now supersedes the previous version.

This letter underwent pre-dissemination review using standards for utility, integrity, and objectivity in compliance with agency guidelines issued under section 515 of the Treasury and General Government Appropriations Act of 2001 (Data Quality Act; 44 U.S.C. 3504(d)(1) and 3516). A complete record of this informal consultation is on file at NMFS Office of Protected Resources in Silver Spring, Maryland.

CONSULTATION HISTORY

Because of the history of the FAA requesting individual consultations for different components of space launches and reentries, NMFS proposed a programmatic consultation focused on commercial space launches and reentries to the FAA in March 2018. The FAA agreed to a programmatic approach to combine space launches and reentries into a single consultation. The National Aeronautics and Space Administration (NASA) and the U.S. Space Force (USSF) are included as federal action agencies in this programmatic consultation due to their involvement with commercial space launch operations that are part of the proposed action, such as leasing launch complexes and launch-related infrastructure to commercial launch operators, as well as their involvement in conducting launch operations by and for the federal government as long as these operations fall within the scope of the proposed action.

The FAA submitted a consultation request letter to the ESA Interagency Cooperation Division on August 11, 2021, seeking concurrence on their effects determination for the proposed issuance of experimental permits and/or a Vehicle Operator License that would allow SpaceX to launch the Starship-Super Heavy from the Boca Chica (Cameron County, TX) Launch Site. NMFS ESA Interagency Cooperation Division decided to combine the two consultations into a single PLOC. Programmatic ESA section 7 consultations allow the Services to consult on the effects of programmatic actions such as: (1) multiple similar, frequently occurring or routine actions expected to be implemented in particular geographic areas; and (2) a proposed program, plan, policy, or regulation providing a framework for future actions (50 C.F.R. §402.02).

The action agencies submitted a letter to the ESA Interagency Cooperation Division on October 7, 2022, requesting changes to the PLOC to clarify information submitted and provide additional information for this programmatic consultation. The PLOC was amended as a result of the requested changes and the amended PLOC now supersedes the previous version.

The history of this consultation is as follows:

- During early coordination and technical assistance, the FAA submitted a draft Programmatic Biological Evaluation (BE) to NMFS on February 25, 2021, to solicit review and comments. The ESA Interagency Cooperation Division subsequently distributed the draft BE to NMFS regional offices for review. NMFS comments on the BE were combined and provided to the FAA on June 4, 2021.
- The FAA provided a revised BE to NMFS on August 25, 2021. The revised BE was reviewed by ESA Interagency Cooperation Division staff and sent to the NMFS regional offices. NMFS provided the FAA with questions following review of the revised BE on September 13, 2021. FAA provided responses on October 13, 2021. NMFS had additional questions regarding these responses, which were sent to the FAA on October 18, 2021, and the FAA responded on October 22, 2021.

- The SpaceX concurrence request letter was subsequently distributed to NMFS regional offices for review by the ESA Interagency Cooperation Division. NMFS comments on the letter were combined and provided to the FAA on September 15, 2021. The FAA provided responses on November 4, 2021, that included a revised letter and an expanded action area in the Gulf of Mexico for the consultation.
- On October 15, 2021, the ESA Interagency Cooperation Division staff requested a meeting with the FAA to discuss combing the Starship-Super Heavy proposed activities with the programmatic launch and reentry vehicle operations consultation. The meeting occurred on November 5, 2021, and, due to the significant overlap of proposed activities, action areas and effects analysis, NMFS and the FAA agreed to incorporate the Starship-Super Heavy consultation into the programmatic launch and reentry vehicle operations consultation.
- The ESA Interagency Cooperation Division received a letter on October 7, 2022 from the FAA that stated after reviewing the PLOC and coordinating with the other action agencies, specifically the USSF and NASA, the FAA, USSF, and NASA would like to reinitiate the informal consultation to expand upon and clarify portions of the PLOC. The requested revisions did not change the scope of activities, the effects previously analyzed, or our effects conclusions; therefore, reinitiating the PLOC was not necessary. The PLOC was amended as a result of the requested changes.

The FAA, NASA, the USSF, and the U.S. Air Force (USAF) prior to the creation of USSF, have completed informal consultations with NMFS for the types of activities included in this programmatic consultation.

Previous consultations for the activities included in this programmatic consultation include:

- **SER-2016-17894:** On April 11, 2016, the FAA, USAF and NASA submitted a request for concurrence under ESA section 7 to NMFS's Southeast Regional Office (SERO) for SpaceX launch operations occurring from Cape Canaveral, Kennedy Space Center, and the SpaceX Texas Launch Site (now referred to as the SpaceX Boca Chica Launch Site), and launch recovery operations occurring in open waters in the Atlantic Ocean and Gulf of Mexico. On August 8, 2016, NMFS issued a Letter of Concurrence for those proposed activities.
- **FPR-2017-9231:** After concluding the 2016 consultation, SpaceX informed the FAA that parafoils and parachutes associated with the payload fairings that descend through the Earth's atmosphere and land in the Atlantic Ocean after a launch might not be fully recovered by SpaceX. The FAA also learned the parachutes associated with other spacecraft (e.g., Dragon) reentry were not always recovered. These aspects of the project were not considered in the 2016 consultation because it was assumed all parachutes and parafoils would be fully recovered. SpaceX also proposed to conduct Falcon 9 launch vehicle and Dragon spacecraft recovery operations in the Pacific Ocean, which were not addressed in the 2016 consultation. Actions in the Pacific Ocean include recovery of parafoils and parachutes associated with payload fairings and the Dragon spacecraft. On June 7, 2017, via conference call, staff from the FAA, USAF, NASA, and NMFS Protected Resources staff (from Headquarters and SERO) discussed ongoing operations and ESA coverage needs for future operations. The parties mutually agreed that NMFS ESA Interagency Cooperation Division would complete the ESA section 7 consultation

for the expanded operations. On October 2, 2017, NMFS issued a Letter of Concurrence for SpaceX's proposed launch and recovery operations in the Atlantic Ocean, Gulf of Mexico, and Pacific Ocean.

- **SER-2018-19649 and FPR-2018-9287:** On October 15, 2018, the FAA reinitiated ESA consultation with NMFS (Headquarters and SERO) to consider the effects to the giant manta ray (*Manta birostris*) and the oceanic whitetip shark (*Carcharhinus lonigmanus*) because these species were federally listed subsequent to the 2016 and 2017 consultations. On November 21, 2018 and November 30, 2018, NMFS SERO and NMFS Headquarters, respectively, issued Letters of Concurrence.
- **OPR-2020-00268:** On October 7, 2019, the FAA reinitiated ESA consultation with NMFS (Headquarters) because SpaceX expanded their proposed launch trajectories to include a southern trajectory for payloads requiring polar orbits. The change expanded the action area for which Falcon first stage booster return and recovery operations in the Atlantic Ocean could occur. On February 26, 2020, NMFS Headquarters issued a Letter of Concurrence.

The purpose of this programmatic consultation is to streamline the FAA's, USSF's, and NASA's compliance with ESA section 7 for the actions as described in the *Proposed Action* section of this letter. This programmatic consultation includes all the project-specific activities evaluated in the above-mentioned consultations (including the environmental protection measures) and expands upon them to enable application to future launch projects or operations. Thus, this programmatic consultation supersedes the above-mentioned consultations. Proposed actions occurring under consultations that are not cited above, are not included in this programmatic consultation.

Office of National Marine Sanctuaries

If a federal agency finds that a proposed action is likely to injure National Marine Sanctuary resources, the agency is required to consult with the NOAA Office of National Marine Sanctuaries (ONMS). The ESA Interagency Cooperation Division provided the Programmatic BE and the Starship-Super Heavy concurrence request letter to ONMS on October 1, 2021, to determine if consultations would be needed for the proposed activities. The ONMS responded on October 12, 2021, stating that a permit might be needed if any material is expected to make its way into a sanctuary. The FAA determined none of the proposed activities are expected to occur within sanctuaries.

Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) requires that an incidental take authorization be obtained for the unintentional "take" of marine mammals (e.g., by harassment) incidental to otherwise lawful activities. The action agencies and/or their commercial space partners are required to apply for an MMPA authorization from the NMFS Office of Protected Resources, Permits and Conservation Division, if their activities could subject marine mammals to "take" as defined by the MMPA.

PROPOSED ACTION AND ACTION AREA

Agency Action Overview

The FAA, USSF, and NASA prepared the Programmatic BE to address the potential effects of the following federal actions on ESA-listed species and designated critical habitat:

1) FAA's action of issuing licenses or permits to commercial space applicants in general practice, and specifically for SpaceX Starship-Super Heavy operations launched from Boca Chica;
2) USSF's (Space Launch Delta [SLD] 30 and 45) action of conducting launch operations from Cape Canaveral Space Force Station (CCSFS) and Vandenberg Space Force Base (VSFB)[1], including the action of leasing launch complexes to commercial launch operators; and
3) NASA's action of conducting launch, landing, and recovery operations from Kennedy Space Center (KSC) and Wallops Flight Facility (WFF), including the action of leasing launch complexes and launch-related infrastructure to commercial launch operators.

The following subsections provide an overview of the FAA's, USSF's, and NASA's missions pertaining to this consultation.

Federal Aviation Administration

The FAA Office of Commercial Space Transportation oversees, licenses, and regulates U.S. commercial launch and reentry activity, as well as the operation of non-federal launch and reentry sites, as authorized by the Commercial Space Launch Act of 1984, as amended and codified at 51 U.S.C. 50901–50923. An FAA license or permit is required for any commercial launch or reentry, or the operation of any commercial launch or reentry site, by U.S. citizens anywhere in the world, or by any individual or entity within the United States. An FAA license or permit is not required for launch or reentry activities carried out by the federal government, such as NASA or Department of Defense (DoD) launches. The FAA licensing and permitting evaluation consists of five major components: 1) a policy review, 2) a payload review, 3) a safety review, 4) a determination of maximum probable loss for establishing financial responsibility requirements, and 5) an environmental review.

The FAA defines a 'launch vehicle' as a vehicle built to operate in, or place a payload in, outer space, or a suborbital rocket. The FAA defines a 'reentry vehicle' as a vehicle designed to return from Earth orbit or outer space to Earth substantially intact. The FAA issues licenses or permits to commercial launch vehicle operators (referred to as vehicle operators or launch operators) for operation of launch and reentry vehicles. The same vehicle operators may also conduct operations for NASA or DoD. Additionally, NASA and DoD may conduct launches and/or reentries of launch and reentry vehicles that were built by the federal government.

The FAA Office of Commercial Space Transportation issues the following types of licenses and permits, in accordance with Title 14, Code of Federal Regulations (CFR) parts 420, 437, and 450:

- **Launch Site Operator License** (14 CFR Part 420): A license to operate a launch site authorizes a licensee to offer its launch site to a launch operator (i.e., a person or

[1] With the creation of the USSF, Cape Canaveral Air Force Station and Vandenberg Air Force Base were renamed Cape Canaveral Space Force Station and Vandenberg Space Force Base. The 30th and 45th Space Wings were renamed Space Launch Delta (SLD) 30 and 45.

company conducting the launch of a launch vehicle and any payload) for each launch point, launch vehicle type, and weight class identified in the license application and upon which the licensing determination is based. Examples of launch site operators include airports and state or local governments. Examples of launch operators include companies such as SpaceX, Blue Origin, Firefly, Rocket Lab, Northrop Grumman, Virgin Orbit, and United Launch Alliance. Issuance of a launch site operator license does not relieve a licensee of its obligation to comply with any other laws or regulations, nor does it confer any proprietary, property, or exclusive rights in the use of airspace or outer space. A launch site operator license remains in effect for 5 years from the date of issuance unless surrendered, suspended, or revoked before the expiration of the term and is renewable upon application by the licensee. Actual launches cannot occur from a launch site until a launch operator receives a vehicle operator license for the site.

- **Vehicle Operator License** (14 CFR Part 450):A vehicle operator license authorizes a licensee to conduct one or more launches or reentries using the same vehicle or family of vehicles. Launch includes the flight of a launch vehicle and pre- and post-flight ground operations. Reentry includes activities conducted in Earth orbit or outer space to determine reentry readiness and that are critical to ensuring public health and safety and the safety of property during reentry flight. Reentry also includes activities necessary to return the reentry vehicle, or vehicle component, to a safe condition on the ground after impact or landing.
- **Experimental Permits** (14 CFR Part 437): An experimental permit authorizes launch or reentry of a reusable suborbital rocket. The authorization includes pre- and post-flight ground operations. A suborbital rocket is a vehicle, rocket-propelled in whole or in part, intended for flight on a *suborbital* trajectory. A permit is an alternative to licensing and is valid for a one-year renewable term.
- **SpaceX Starship-Super Heavy, Boca Chica:** SpaceX must obtain an experimental permit or launch vehicle operator license from the FAA for Starship (spacecraft)-Super Heavy (rocket booster) launch and reentry operations that originate from the Boca Chica Launch Site. SpaceX proposed launch operations include suborbital and orbital launches.

U.S. Space Force

The USSF is the lease or license holder for the real property and ranges where launches occur from CCSFS and VSFB. The USSF uses its own launch and reentry vehicles, as well as those of commercial launch operators, to launch USSF payloads into space.

- **Space Launch Delta 45:** SLD 45 is responsible for overseeing the preparation and launching of U.S. government, civil, and commercial satellites from CCSFS, Florida, and operates the Eastern Range for the USSF. SLD 45 also provides launch facilities and services to support NASA and commercial space operations. A directive of the USSF is to provide efficient means of executing national security and military policy goals. The Eastern Range operations provide the resources and activities for safe flight, range instrumentation, infrastructure, and schedule to support space and ballistic launches. The Eastern Range consists of tracking stations at CCSFS, mainland annexes, and downrange tracking stations on islands located in the Caribbean Sea and South Atlantic Ocean. SLD 45 is the primary missile and rocket launch organization for the USSF on the east coast of the United States.

- **Space Launch Delta 30:** SLD 30 at VSFB is the Air Force Space Command organization responsible for DoD space and missile launch activities on the west coast of the United States. The primary mission of VSFB is to launch and track satellites destined for polar or near-polar orbit, test and evaluate America's Intercontinental Ballistic Missile systems, and support aircraft operations. SLD 30 supports West Coast launch activities for the DoD (including USAF and Missile Defense Agency), NASA, foreign nations, and various private contractors.

National Aeronautics and Space Administration

The National Aeronautics and Space Act is the U.S. federal statute that created NASA. The Space Act gives NASA the responsibility for planning, directing, and conducting the nation's civilian space program, aeronautics and aerospace research activities. It also gives NASA the authorization to enter into cooperative agreements, leases, and contracts with public and private entities in the use of NASA's services, equipment, and facilities in support of scientific research and discovery.

- **Kennedy Space Center:** Established in 1962 as the NASA Launch Operations Center, KSC has carried out launch operations for the Apollo, Skylab, Space Shuttle, and cargo and crewed launches to the International Space Station. KSC is NASA's only launch site for human spaceflight. KSC's mission is to function as a multi-user spaceport for launch operations operated by NASA and a growing number of private partners. In addition to providing all aspects of launch, landing, and recover operations for both government and commercial launch providers, KSC also provides payload processing, testing, and integration for government and commercial partners at facilities across KSC. KSC is located adjacent to CCSFS and the two entities work closely together to execute their missions, sharing resources, facilities, and infrastructure.
  KSC's launch complexes consist of Launch Complex 39A and 39B, Launch Complex 48, and the Shuttle Landing Facility. KSC also has land identified for up to two additional launch complexes for potential future development. In anticipation of missions to the moon and Mars, KSC will facilitate further research, development, and diverse partnerships to develop, integrate, and sustain space systems. Launch Complex 39A is designated as a multi-use complex that will support the NASA Space Launch System launch vehicle and the Orion crew capsule for manned missions beyond low Earth orbit. Launch Complex 39A is operated by SpaceX and supports Falcon vehicle launch operations with potential plans to support future SpaceX launch vehicle operations. Launch Complex 48 is a small class vehicle pad that is being developed to support commercial launches.
- **Wallops Flight Facility:** NASA Goddard Space Flight Center manages WFF, the oldest active launch range in the continental United States and the only rocket testing and launch range owned and operated by NASA. For over 70 years, WFF has flown thousands of research vehicles in the quest for information on the flight characteristics of launch vehicles and spacecraft, and to increase the knowledge of the Earth's upper atmosphere and the near space environment. The primary purpose of the WFF launch range is to provide the infrastructure, data services, logistics, and safety services necessary for flight projects supporting NASA science, technology, and exploration programs; DoD research and other government agency needs; and academic and commercial industry needs. WFF regularly provides launch support, range safety, and

downrange tracking for the emerging commercial launch industry, either directly or through the Mid-Atlantic Regional Spaceport, which is a commercial launch site on Wallops Island licensed by the FAA and operated by the Virginia Commercial Space Flight Authority (Virginia Space). The Spaceport provides facilities and services for NASA, DoD, and commercial launches of payloads into space.

Launch Sites

USSF launches occur at CCSFS and VSFB. NASA launches occur at KSC and WFF. Commercial space launches are currently authorized to occur at several launch sites, including sites at CCSFS, VSFB, KSC, and WFF.[2] Existing launch sites that involve operations in the marine environment are listed in Table 1. The FAA, USSF, and/or NASA might receive proposals in the future for launch operations involving operations in the marine environment at other existing launch sites or new launch sites. Upon receipt of a new proposal that involves operations in the marine environment, the lead action agency will review the proposal and coordinate with NMFS to determine if the proposed launch operations fall within the scope of this consultation (see *Project-Specific Review* for details).

Table 1. Launch Sites with Operations in the Marine Environment

Launch Site	FAA Launch Site OperatorLicense	Location	Site Operator	Type of Launch (Vertical or Horizontal)[a]
Cecil Airport	Yes	Jacksonville, FL	Jacksonville Aviation Authority	Horizontal
CCSFS (multiple launch and landing complexes)	No	Cape Canaveral, FL	U.S. Space Force	Vertical
CCSFS Skid Strip	No	Cape Canaveral, FL	U.S. Space Force	Horizontal
CCSFS LC-46	Yes	Cape Canaveral, FL	Space Florida	Vertical
Ellington Airport	Yes	Houston, TX	Houston Airport System	Horizontal
Mojave Air and Space Port	Yes	Mojave, CA	Mojave Air & Space Port	Horizontal
NASA KSC (except SLF)	No	Merritt Island, FL	NASA	Vertical
NASA KSC SLF	Yes	Merritt Island, FL	Space Florida	Horizontal
NASA WFF (except LC-0)	No	Wallops Island, VA	NASA	Both
NASA WFF LC-0 (referred to as MARS)	Yes	Wallops Island, VA	Virginia Commercial Space Flight Authority	Vertical

[2] See the FAA's website for a current list of active licenses: https://www.faa.gov/data_research/commercial_space_data/licenses/.

Launch Site	FAA Launch Site OperatorLicense	Location	Site Operator	Type of Launch (Vertical or Horizontal)[a]
NASA WFF Main Base	Yes	Wallops Island, VA	NASA	Horizontal
Pacific Spaceport Complex Alaska	Yes	Kodiak Island, AK	Alaska Aerospace Development Corporation	Vertical
Space Coast Regional Airport	Yes	Titusville, FL	Titusville-Cocoa Airport Authority	Horizontal
SpaceX Boca Chica Launch Site	No[b]	Brownsville, TX	SpaceX	Vertical
VSFB (multiple launch and landing complexes)	No	Vandenberg, CA	U.S. Space Force	Both

[a] Vertical = the launch vehicle takes off vertically from a launch pad (i.e., a traditional rocket launch); Horizontal = the launch vehicle takes off horizontally from a runway like an aircraft.
[b] SpaceX is the exclusive user of the Boca Chica Launch Site and therefore only need a vehicle operator license to launch.
AK = Alaska; CA = California; CCSFS = Cape Canaveral Space Force Station; FL = Florida; KSC = Kennedy Space Center; LC = Launch Complex; MARS = Mid-Atlantic Regional Spaceport; NASA = National Aeronautics and Space Administration; SLF = Shuttle Landing Facility; TX = Texas; VA = Virginia; VSFB = Vandenberg Space Force Base; WFF = Wallops Flight Facility

Launch Vehicles

A launch vehicle is a vehicle built to operate in, or place a payload in, outer space, or it is a suborbital rocket. Launch vehicles are commonly termed rockets. Launch vehicles take off either vertically from a launch pad or horizontally from a runway.

Currently, all of the vertical launch vehicles included in this consultation are expendable (i.e., individual stages are either disposed of in the ocean or in outer space), except for the first stages of SpaceX's Falcon 9 and Falcon Heavy, and the first and second stages of Starship-Super Heavy rockets, which are reusable (i.e., SpaceX recovers the stages by either landing them at a launch site or on a barge in the ocean). In the future, the FAA, USSF, and/or NASA expect to receive proposals from other operators (e.g., Blue Origin) for first stage booster landings at a launch site or on a barge in the ocean, similar to SpaceX.

In addition to vertically launched rockets, there are three main types (or concepts) of horizontal launch vehicles: Concepts X, Y, and Z (Table 2). Concepts X and Y vehicles are reusable (i.e., they are not expended during a launch mission). Concept Y vehicles are similar to Concept X vehicles, except they are powered solely by rocket engines. Propellants include liquid oxygen and either kerosene or alcohol. The Concept Y vehicle takes off from the runway under rocket power and flies a suborbital trajectory. Upon atmospheric reentry, the vehicle conducts an unpowered descent and landing at the spaceport. The Concept Z vehicle is a two-part launch system consisting of a carrier aircraft (reusable) and a rocket (expendable or reusable). The turbojet engines of the carrier aircraft use Jet-A fuel (kerosene) and the hybrid rocket engine uses nitrous oxide and hydroxyl-terminated polybutadiene. During a launch, the carrier aircraft takes off from the spaceport runway with the rocket attached and ascends to an altitude of approximately 50,000 feet (ft), where the rocket is released from the carrier aircraft. The rocket ignites its engines and flies a suborbital trajectory. Upon atmospheric reentry, a reusable rocket makes an unpowered descent and landing at the spaceport. Meanwhile, the carrier aircraft makes a normal powered landing after releasing the rocket. Use of an expendable rocket for the Concept Z launch vehicle involves expending a booster stage into the ocean.

Table 2. Types of Horizontal Launch Vehicles

Type	Takeoff Propulsion	Propulsion to Reach Orbit	Landing Propulsion	Reusable or Expendable
Concept X	Jet	Rocket	Jet	Reusable
Concept Y	Rocket	Rocket	Unpowered (glide)	Reusable
Concept Z[a]	Jet	Rocket	Jet (carrier aircraft); Unpowered (rocket)	Both

Notes:
[a] The Concept Z vehicle is a two-part launch system consisting of a carrier aircraft (reusable) and a rocket (expendable or reusable).

Examples of launch vehicles (vertical and horizontal) for which operations could affect ESA-listed species under NMFS jurisdiction are listed in Table 3.

Table 3. Examples of Launch Vehicles that could affect the Marine Environment

Launch Vehicle	Type	Operator(s)	Launch Site(s)
Alpha	Vertical	Firefly	VSFB
Antares Family	Vertical	Northrop Grumman	WFF
Astra Rocket 3	Vertical	Astra Space, Inc.	PSCA
Atlas V	Vertical	ULA, Lockheed Martin	CCSFS, VSFB
Delta IV	Vertical	ULA	CCSFS, VSFB
Electron	Vertical	Rocket Lab	WFF
Falcon 9	Vertical	SpaceX	CCSFS, KSC, VSFB
Falcon Heavy	Vertical	SpaceX	KSC
Minotaur Family	Vertical	Northrop Grumman	CCSFS, WFF, VSFB
New Glenn	Vertical	Blue Origin	CCSFS, VSFB
Pegasus	Horizontal – Concept Z (expendable)	Northrop Grumman	CCSFS, WFF, VSFB
LauncherOne	Horizontal – Concept Z (expendable)	Virgin Orbit	MASP
RS1	Vertical	ABL Space Systems	CCSFS, VSFB

Launch Vehicle	Type	Operator(s)	Launch Site(s)
Starship-Super Heavy	Vertical	SpaceX	KSC, SpaceX Boca Chica Launch Site
Terran 1	Vertical	Relativity Space, Inc.	CCSFS, VSFB
Vector-H, Vector-R	Vertical	Vector	CCSFS, WFF
Vulcan	Vertical	ULA	CCSFS, VSFB
X-60	Horizontal	Generation Orbit	Cecil Airport, WFF

AFB = Air Force Base; CCSFS = Cape Canaveral Space Force Station; KSC = Kennedy Space Center; MASP = Mojave Air & Space Port; PSCA = Pacific Spaceport Complex-Alaska; ULA = United Launch Alliance; VSFB = Vandenberg Space Force Base; WFF = Wallops Flight Facility

Starship-Super Heavy Launch Vehicle

The fully integrated launch vehicle is approximately 400 ft tall by 30 ft diameter and comprised of two stages: Super Heavy is the first stage (or booster) and Starship is the second stage. Both stages are designed to be reusable. Unlike the SpaceX Falcon launch vehicle, Starship-Super Heavy will not have separable fairings or parachutes. The Super Heavy is expected to be equipped with up to 37 Raptor engines, and the Starship will employ up to six Raptor engines. The Raptor engine is powered by liquid oxygen (LOX) and liquid methane (LCH_4). Super Heavy is expected to hold up to 3,700 metric tons (MT) of propellant and Starship will hold up to 1,500 MT of propellant.

Reentry Vehicles

Reentry means to return or attempt to return, purposefully, a vehicle and its payload or human being, if any, from Earth orbit or from outer space to Earth. A reentry vehicle is a vehicle designed to return from Earth orbit or outer space to Earth intact. Examples of reentry vehicles are SpaceX's Dragon and Starship spacecrafts, NASA's Orion spacecraft, Boeing's Starliner spacecraft, Inversion Space Company's capsule, Sierra Space's UPSTAR recoverable landing system, and Sierra Space's Dream Chaser spacecraft. SpaceX's Dragon spacecraft has reentered Earth and landed in the Pacific Ocean and the Gulf of Mexico. SpaceX is proposing to have Starship landings occur in the Gulf of Mexico and a location in the Pacific Ocean (offshore Kauai Island, Hawaii; see Figure 5 in the *Action Area*).

SpaceX is able to conduct landings of the first stage of the launch vehicle shortly after launch (takeoff). These first stage operations are suborbital and are not considered by the FAA to be a reentry vehicle because they have not completed one orbit around the Earth. These first stage landings are considered part of a launch and it is expected that additional launch operators will utilize this strategy in the future.

Vertical Launches

Vertical launches occur from launch pads located at a launch site. After liftoff, the rocket quickly gains altitude and flies over the ocean. At some point downrange, the rocket reaches supersonic speeds (which generates a sonic boom) and pitches over to attain its intended orbital trajectory. Depending on the rocket's orientation, it is possible for the sonic boom to intercept the Earth's surface. Given the altitude at which the rocket reaches supersonic speeds, most of the sonic boom footprint that reaches the Earth's surface is usually of small magnitude (1–2 pounds per square foot [psf]), but there could be areas that experience a sonic boom up to 8 psf. The area exposed to the higher overpressure (up to 8 psf) is much smaller than the areas that experience lower overpressures. Sonic boom intensity, in terms of psf, is greatest under the flight path and progressively weakens with greater horizontal distance away from the flight track.

Vertical rocket launches may involve expending one or more stages (or boosters) and skirt rings in the ocean. After stage separation during the rocket's flight, the booster(s) and skirt rings fall into the ocean and sink to the ocean floor. This has been the normal practice for decades. The commercial aerospace company SpaceX has developed the ability to recover first stage boosters for subsequent reuse instead of expending boosters in the ocean. For missions involving booster recovery, the booster conducts fly back and landing on a platform barge in the ocean or on a pad at a launch site. The platform barge[3] has its own azimuth thrusters to maintain position needed for landings. After securing the vehicle, the barge is towed (by an approximately 80 ft long tugboat) with the booster to a port or wharf (e.g., Port of Cape Canaveral, a CCSFS-located wharf, Port of Long Beach, or Port of Los Angeles). During booster landing in the ocean, a sonic boom is produced, up to 8 psf directly underneath and directed towards the landing barge platform. Other launch companies will likely develop technology to recover boosters in the future.

In addition to expended boosters falling into the ocean, payload fairings also fall into the ocean and sink. The fairing consists of two halves that separate to facilitate the deployment of the payload. Like booster recovery, SpaceX has developed the ability to conduct fairing recovery. SpaceX's fairing recovery operations use a parachute system hundreds of miles offshore in deep water. The parachute system consists of one drogue parachute and one parafoil (see Appendix A for characteristics of parachutes and parafoils). Drogue parachutes are thinner and smaller (65-113 foot square[ft^2]) than the parafoils (1,782-3,000 ft^2), deployed to gain control of the fairing at speeds that would destroy the larger parafoil, and therefore deployed before the parafoil. Following re-entry of the fairing into Earth's atmosphere, the drogue parachute is deployed at a high altitude (approximately 50,000 ft) to begin the initial slow down and to extract the parafoil. The drogue parachute is then cut away following the successful deployment of the parafoil. A salvage ship (approximately 170 ft long, offshore supply vessel) that is stationed in a designated safety zone near the anticipated splashdown area facilitates the fairing and parafoil recovery operation. Upon locating the fairing, rigid-hulled inflatable boats (RHIBs; approximately 12 ft long) recover the fairing. If sea or weather conditions are poor, recovery of the fairing and parafoil may be unsuccessful. The salvage ship transports the fairing to a port, wharf, (e.g., Port of Cape Canaveral, Port of Long Beach or Port of Los Angeles). The drogue parachute assembly is deployed at a high altitude, so it can be difficult to locate, but if the recovery team can get a visual fix, recovery of the drogue parachute is attempted. The drogue parachute becomes saturated with seawater quickly and begins to sink (see Appendix A for approximate sink rates), which also makes recovery of the drogue parachute difficult.

[3] A converted Marmac freight barge (~300 ft x 100 ft) that SpaceX refers to as an autonomous drone ship. *https://www.americaspace.com/2015/01/04/spacex-autonomous-spaceport-drone-ship-sets-sail-for-tuesdays-crs-5-rocket-landing-attempt/*

Boosters, skirt rings, and fairings that are expended in the ocean are made of materials that sink, strong metal with heavy duty components designed to stand up to the stressful forces of launch, reentry, and extreme temperatures. A few internal parts that are lighter items (e.g., carbon composite-wrapped aluminum containers) could be released upon impact and may float, but are expected to become waterlogged and sink within a few days (10 days maximum).

SpaceX Starship-Super Heavy Launches

During the program's development, SpaceX is proposing to conduct up to 20 Starship suborbital launches annually (Table 4). As the program progresses, SpaceX is proposing to conduct up to five Starship suborbital launches annually (operational phase). During a Starship suborbital launch, the Starship would ascend to high altitudes and then its engines would throttle down or shut off to descend, landing back at the Boca Chica Launch Site or downrange (no closer than 19 miles from shore) either directly in the Gulf of Mexico or on a platform barge (as described above for the Falcon booster landings) in the Gulf of Mexico. A Super Heavy launch could be orbital or suborbital and could occur by itself or with Starship integrated as the second stage of the launch vehicle.

Table 4. Proposed SpaceX Starship-Super Heavy Annual Operations

Operation	Program Development Phase	Operational Phase
Starship Suborbital Launch	20	5
Super Heavy Launch	3	5

Each Starship-Super Heavy orbital launch would include an immediate boost-back and landing of the Super Heavy. During flight, the Super Heavy's engines would cut off at an altitude of approximately 40 miles and the booster would separate from Starship. Shortly thereafter, Starship's engines would start and burn to the desired orbit location. After separation, Super Heavy would rotate and ignite engines to place it in the correct angle to land. Once Super Heavy is in the correct position, the engines would be shut off. Super Heavy would then perform a controlled descent using atmospheric resistance to slow it down and guide it to the landing location (like current Falcon 9 booster landings at Cape Canaveral Space Force Station). Once near the landing location, Super Heavy would ignite its engines to conduct a controlled landing. Super Heavy could have approximately up to 5 metric tons of LCH_4 onboard following an orbital flight.

When Super Heavy landings occur on a platform barge downrange in the Gulf of Mexico, the Super Heavy would then be delivered on the towed barge to the Port of Brownsville and transported the remaining distance to the Boca Chica Launch Site over roadways. Super Heavy landings would generate a sonic boom(s). The maximum overpressure from a sonic boom generated by a Super Heavy landing is predicted to be 15 psf. A maximum of five Super Heavy landings in the Gulf of Mexico could occur each year during the operational phase (Table 4).

It is SpaceX's goal to recover and reuse the Starship and Super Heavy boosters. However, during launches that are still early in the program development, SpaceX may require expending Super Heavy or Starship in the ocean (Gulf of Mexico or Pacific Ocean). When this occurs, SpaceX would not recover the Super Heavy or the Starship and expects they would breakup on impact with the ocean surface. Impact debris is expected to be contained within approximately one kilometer of the landing point. SpaceX expects debris to sink because the launch vehicle is made of steel, and if some lighter internal parts (e.g., carbon composite-wrapped aluminum containers as stated for other vertical launches) are released, they are expected to become waterlogged and sink within 10 days.

Horizontal Launches

Horizontal launches, including takeoff and landing, occur from a runway at the launch site. Concept X, Concept Y, and reusable Concept Z launch vehicle operations do not involve expending launch vehicle components in the marine environment. Horizontal launch vehicle operations can produce a sonic boom during flight over the marine environment that may affect the ocean's surface. The expendable Concept Z launch vehicle operations (e.g., Pegasus launches) involve expending a stage(s) into the ocean. The stage(s) is not recovered and rapidly sinks to the ocean floor.

Launch Failure Anomaly

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

Spacecraft Reentry and Recovery Operations

Some launch companies launch spacecraft as their payload into space (e.g., SpaceX Dragon spacecraft and Boeing Starliner spacecraft). After completing its mission in space, the spacecraft returns to Earth. Spacecraft reentry, splashdown, and recovery are the three elements of a spacecraft landing operation. After completing its mission in space, the spacecraft travels back to Earth where it completes a deorbit burn and reenters the atmosphere. During reentry, the spacecraft creates a sonic boom that may impact the ocean's surface. Spacecraft reentry would not be conducted in any type of stormy weather (i.e., weather that would compromise the success of the mission; e.g., a severe thunderstorm or hurricane) unless deemed necessary in an emergency (e.g., a medical emergency with an astronaut).

Spacecraft typically deploy two drogue parachutes and three to four main parachutes to assist in landing. The smaller drogue parachutes (19 ft^2 each) are deployed first to gain control of the spacecraft and then are released (and expected to land in the ocean within 0.5–1 mile from the spacecraft) before the larger main parachutes (116 ft^2 each) are deployed. The main parachutes slow the spacecraft enough to allow for a soft splashdown in the water (or on land). Drogue and main parachutes are typically made of Kevlar and nylon (see Appendix A).

During reentry, the spacecraft reenters Earth's atmosphere on a pre-planned trajectory and is tracked to a splashdown area in the ocean. Following splashdown, an electronic locator beacon on the spacecraft assists in locating and recovering the spacecraft by a pre-positioned 160 ft long recovery vessel equipped with up to six RHIBs.

Hypergolic fuels (e.g., nitrogen tetroxide [NTO] and monomethylhydrazine [MMH]) may be on the spacecraft during splashdown. A spacecraft's propellant storage is designed to retain residual propellant, so any propellant remaining in the spacecraft is not expected to be released into the ocean. In an unlikely event the propellant tank ruptures on impact, the propellant would evaporate or be quickly diluted and buffered by seawater.

The vehicle operator's personnel attempt to recover all parachutes deployed and load the spacecraft onto the recovery vessel. It is possible some or all the parachutes may not be recovered due to sea or weather conditions, and the drogue parachute may land well beyond sight of the spacecraft recovery area. For missions involving space crew (humans), the crew and any time-critical cargo may be transported via helicopter to the nearest airport. The recovery vessel transports the spacecraft to whatever port the launch operator uses (e.g., Port of Cape Canaveral, a CCSFS-located wharf, commercially available port or wharf on the Gulf Coast, Port of Long Beach, or Port of Los Angeles).

SpaceX Starship-Super Heavy Reentry and Recovery Operations

Each Starship-Super Heavy orbital launch would include a Starship reentry and landing after Starship completes its orbital mission. Starship landing could occur at the vertical launch area, downrange in the Gulf of Mexico (either on a floating platform or expended in the Gulf of Mexico), or expended in the Pacific Ocean approximately 62 nautical miles (NM) north of Kauai, Hawaiian Islands (Figure 5). Starship may have between 1 to 10 metric tons of LCH_4 onboard following an orbital flight. As Starship slows down during its landing approach, a sonic boom(s) with a maximum predicted overpressure of 2.2 psf will be generated. If a Starship landing occurs downrange in the Gulf of Mexico on a floating platform barge, it will be delivered on the barge to the Port of Brownsville, and transported the remaining distance to the Boca Chica Launch Site over roadways.

For missions involving the Starship landing in the Pacific Ocean, SpaceX will arrange an overflight to confirm that debris from the impact has sunk and attempt to locate the launch vehicle mission recording device (aka the 'black box') which has a global positioning system (GPS) tracking signal. If the tracking signal from the recording device is found, locally contracted scuba divers may be deployed to facilitate device retrieval. If there is floating debris found, a local contractor may be utilized to recover any floating debris that could drift into the Papahanaumokuakea Marine National Monument.

Launch Abort Tests

As part of research and development, launch operators may conduct launch abort tests that include waterborne landings. Abort tests may include pad abort tests and launch ascent abort tests. For both types of tests, operations may involve launching spacecraft on a low-altitude, non-orbit trajectory resulting in a waterborne landing in the Atlantic Ocean (see Atlantic Ocean in *Action Area*). Abort test operations typically involve a non-propulsive spacecraft landing using drogue and main parachutes. Recovery of the spacecraft will be similar to recovering a reentry vehicle (i.e., use of a recovery vessel and RHIBs). During an abort test, the launch vehicle could break apart (explode) and land in the ocean. In such a case, the launch operator will be responsible for retrieving as many pieces of debris as feasible. SpaceX's January 19, 2020 in-flight abort test is an example of a launch abort test. During that test, the Falcon 9 launch vehicle exploded and landed in the Atlantic Ocean. SpaceX personnel retrieved as many pieces of debris as they could locate.

Weather Balloon Deployment

Launch operators and federal government personnel (e.g., the Weather Squadron at VSFB) release weather balloons, typically 5 but up to 15 if there are any launch delays, to measure wind speed prior to launches. The data are used to create wind profiles that help determine if it is safe to launch and land the vehicle. A radiosonde, typically the size of a half-gallon milk carton, is attached to the weather balloon to measure and transmit atmospheric data to the launch operator. The latex balloon rises to approximately 20-30 kilometers (km) above Earth's surface and bursts. The radiosonde and shredded balloon pieces fall back to Earth and are not recovered. The radiosonde does not have a parachute and is expected to sink to the ocean floor.

Spotter Aircraft and Surveillance Vessels

A number of spotter aircraft and surveillance vessels (watercraft) are used during launch activities to ensure that designated hazard areas are clear of non-participating crafts. Combinations of radar and visual spotter aircraft, and surface surveillance and law enforcement vessels (watercraft), may be deployed prior to launch. Most fixed wing aircraft operate at altitudes of 15,000 ft but may drop to 1,500 ft to visually obtain a call sign from a non-participating vessel.

Project Design Criteria

Project design criteria (PDCs) are identified as part of a programmatic consultation and are applicable to future projects implemented under the program. In the case of this consultation, PDCs include environmental protection measures developed by the FAA to limit the effects of launch operations. These environmental protection measures will lead to avoidance and minimization of effects to ESA-listed species and designated critical habitat in the action area to assist in the conservation of these resources.

General PDCs applicable to this consultation:

- Launch and reentry operations will be conducted by the USSF, NASA, or an FAA-licensed (or permitted) commercial operator from a launch site identified in Table 1. Launch preparations will occur in compliance with standard operating procedures and best management practices currently implemented at these existing launch vehicle facilities.
- Launch operations will utilize launch vehicles identified in Table 3.
- Launch activities, including suborbital landings and splashdowns, and orbital reentry activities will occur in the proposed action area at least 5 NM offshore the coast of the United States or islands. The only operations component that will occur near shore will be watercraft transiting to and from a port when recovering spacecraft or launch vehicle components, or possibly for surveillance.
  - No launch operator will site a landing area in coral reef areas.
  - No activities will occur in or affect a National Marine Sanctuary unless the appropriate authorization has been obtained from the Sanctuary.
- Landing operations will not occur in the aquatic zone extending 20 NM (37 km) seaward from the baseline or basepoint of each major rookery and major haul-out of the Western Distinct Population Segment (DPS) Steller sea lion located west of 144° W.
- Launch abort testing will only occur in the Atlantic Ocean from CCAFS or KSC as previously analyzed (SER-2016-17894, FPR-2017-9231). In addition:
  - It will not occur in designated critical habitat for the North Atlantic right whale.

- It will not occur during the North Atlantic right whale winter calving season from November to mid-March.

- Utilize all feasible alternatives and avoid landing in Rice's whale core habitat distribution area as much as possible. No more than one splashdown, reentry and recovery of the Dragon capsule, will occur in Rice's whale core habitat distribution area per year. No other operations, spacecraft, launch or reentry vehicle landings, or expended components will occur in Rice's whale core habitat distribution area. The Rice's whale core habitat distribution area map (Figure 1) and GIS boundary can be accessed here: https://www.fisheries.noaa.gov/resource/map/rices-whale-core-distribution-area-map-gis-data.

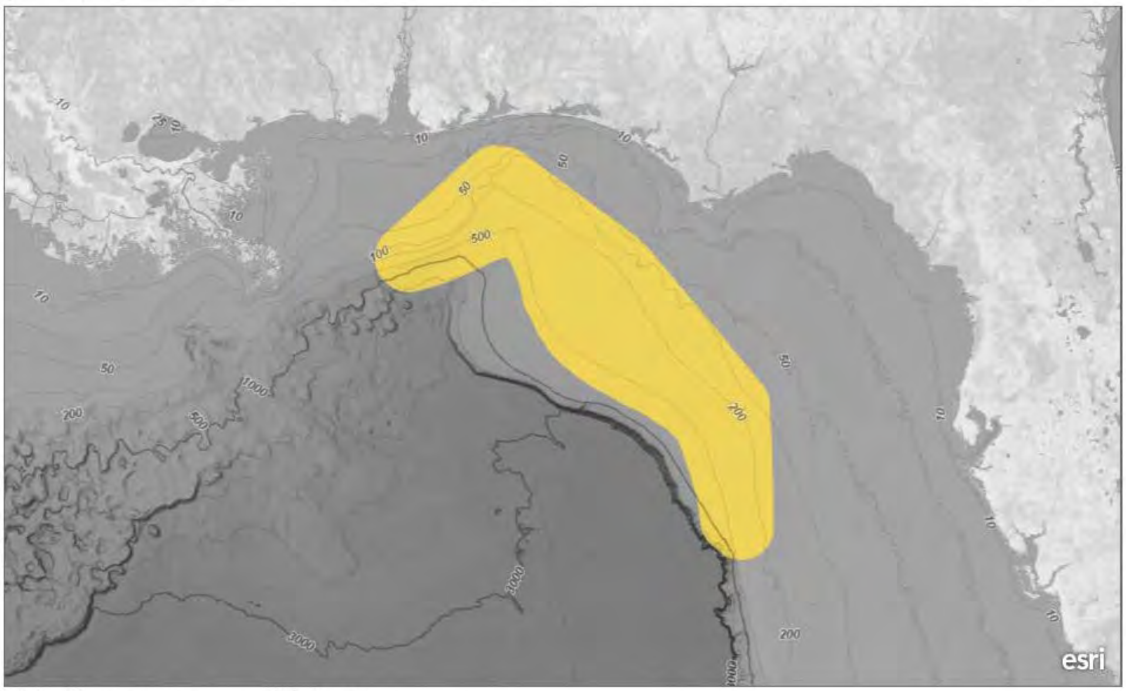

Figure 1. Rice's Whale Core Distribution Area in the Gulf of Mexico.

Education and Observation

- Each launch operator will instruct all personnel associated with launch operations about marine species and any critical habitat protected under the ESA, and species protected under the MMPA that could be present in the operations area.[4] The launch operator will advise personnel of the civil and criminal penalties for harming, harassing, or killing ESA-listed and MMPA-protected species.
- Each launch operator will provide a dedicated observer(s) (e.g., biologist or person other than the watercraft operator that can recognize ESA-listed and MMPA-protected species) that is responsible for monitoring for ESA-listed and MMPA-protected species with the

[4] The FAA is responsible for ensuring ESA compliance. The launch operator is responsible for MMPA compliance. Measures to protect all marine mammals are included here for animal conservation purposes.

aid of binoculars during all in-water activities, including transiting marine waters for surveillance or to retrieve boosters, spacecraft, other launch-related equipment or debris.

  - When an ESA-listed or MMPA-protected species is sighted, the observer will alert vessel operators to apply the Vessel Operations protective measures.
  - Dedicated observers will record the date, time, location, species, number of animals, distance and bearing from the vessel, direction of travel, and other relevant information, for all sightings of ESA-listed or MMPA-protected species.
  - Dedicated observers will survey the launch recovery area for any injured or killed ESA-listed or MMPA-protected species and any discoveries will be reported as noted below.

Reporting Stranded, Injured, or Dead Animals

- Each launch operator will immediately report any collision(s), injuries or mortalities to, and any strandings of ESA-listed or MMPA-protected species to the appropriate NMFS contact listed below, and to the Office of Protected Resources ESA Interagency Cooperation Division by e-mail at nmfs.hq.esa.consultations@noaa.gov.
  - For operations in the Gulf of Mexico and Atlantic Ocean: 727-824-5312 or via email to takereport.nmfsser@noaa.gov, and a hotline 1-877-WHALE HELP (942-5343).
  - For operations on the west coast/Pacific Ocean: 562-506-4315 or via email to Justin.Viezbicke@noaa.gov, and a hotline for whales in distress 877-767-9245.
  - For operations near Alaska, statewide hotline: 877-925-7773.
  - Additional regionally organized contact information is here: https://www.fisheries.noaa.gov/report.
- In the Gulf of Mexico and Atlantic Ocean waters near Florida, each launch operator will report any smalltooth sawfish sightings to 941-255-7403 or via email Sawfish@MyFWC.com.
- Each launch operator will report any giant manta ray sightings via email to manta.ray@noaa.gov.
- In the Atlantic Ocean, each launch operator will report any injured, dead, or entangled North Atlantic right whales to the U.S. Coast Guard via VHF Channel 16.

Vessel Operations

All watercraft operators will be on the lookout for and attempt to avoid collision with ESA-listed and MMPA-protected species. A collision with an ESA-listed species will require reinitiation of consultation. Watercraft operators will ensure the vessel strike avoidance measures and reporting are implemented and will maintain a safe distance by following these protective measures:

- Maintain a minimum distance of 150 ft from sea turtles.
- In the Atlantic Ocean, slow to 10 knots or less and maintain a minimum distance of 1,500 ft (500 yards) from North Atlantic right whales.
- In the Gulf of Mexico, slow to 10 knots or less and maintain a minimum distance of 1,500 ft (500 yards) from Rice's whale [formerly Gulf of Mexico Bryde's whale]. If a whale is observed but cannot be confirmed as a species other than a Rice's whale, the vessel operator must assume that it is a Rice's whale.
- Maintain a minimum distance of 300 ft (100 yards) from all other ESA-listed and MMPA-protected species. If the distance ever becomes less than 300 ft, reduce speed and

shift the engine to neutral. Do not engage the engines until the animals are clear of the area.

- Watercraft operators will reduce speed to 10 knots or less when mother/calf pairs or groups of marine mammals are observed.
- Watercraft 65 ft long or longer will comply with the Right Whale Ship Strike Reduction Rule (50 CFR §224.105)[5] including reducing speeds to 10 knots or less in Seasonal Management Areas or in Right Whale Slow Zones, which are dynamic management areas established where right whales have been recently seen or heard.
    - The Whale Alert app automatically notifies when entering one of these areas.
- Check various communication media for general information regarding avoiding ship strikes and specific information regarding North Atlantic right whale sightings in the area. These include NOAA weather radio, U.S. Coast Guard NAVTEX broadcasts, and Notices to Mariners.
    - There is also an online right whale sightings map available at https://apps-nefsc.fisheries.noaa.gov/psb/surveys/MapperiframeWithText.html.
- Attempt to remain parallel to an ESA-listed or MMPA-protected species' course when sighted while the watercraft is underway (e.g., bow-riding) and avoid excessive speed or abrupt changes in direction until the animal(s) has left the area.
- Avoid vessel transit in the Rice's whale core distribution area. If vessel transit in the area is unavoidable, stay out of the depth range of 100 m to 425 m (where the Rice's whale has been observed; Rosel et al. 2021) as much as possible and go as slow as practical, limiting vessel speed to 10 knots or less.
- No operations or transit will occur at night in Rice's whale core distribution area.

Aircraft Procedures

Spotter aircraft will maintain a minimum of 1,000 ft over ESA-listed or MMPA-protected species and 1,500 ft over North Atlantic right whales. Additionally, aircraft will avoid flying in circles if marine mammals or sea turtles are spotted to avoid any type of harassing behavior.

Hazardous Materials Emergency Response

In the event of a failed launch operation, launch operators will follow the emergency response and cleanup procedures outlined in their Hazardous Material Emergency Response Plan (or similar plan). Procedures may include containing the spill using disposable containment materials and cleaning the area with absorbents or other materials to reduce the magnitude and duration of any impacts. In most launch failure scenarios, at least a portion (if not most) of the propellant will be consumed by the launch/failure, and any remaining propellant will evaporate or be diluted by seawater and biodegrade over time (timeframes are variable based on the type of propellant and environmental conditions, but generally hours to a few days).

Project-Specific Review

Project-specific reviews for this programmatic consultation for launch and reentry vehicle operations in the marine environment are not required as long as the activities are within the scope of the *Proposed Action*, within the action area for this consultation, and comply with the PDCs. When projects do not fully meet those requirements, a project-specific review is required.

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[5] See: http://www.fisheries.noaa.gov/pr/shipstrike/.

The project lead action agency will coordinate with NMFS to determine if the scope of the project is within the scope of this programmatic concurrence, or if an individual consultation is required. Examples of when an action agency should coordinate a project-specific review include: operations using a new launch site, a new launch vehicle, other substantial changes in technology and operations, or cannot fully comply with the applicable PDC protective measures (e.g., Rice's whale avoidance).

If an action agency has any uncertainty that an activity is within this programmatic consultation or needs a project-specific review, they should contact the NMFS Office of Protected Resources ESA Interagency Cooperation Division. Project-specific review requests should be sent by email to nmfs.hq.esa.consultations@noaa.gov with the subject line "Project Specific Review Request, OPR-2021-02908, Programmatic Concurrence for Launch Vehicle and Reentry Operations" and include the following information: a project description that details the operations, including where and when they will occur, any criteria or measures that may not be fully implemented and any proposed changes to these measures or additional measures, and determination of effects to ESA-listed species and critical habitat that could result from the project. Requests for a project-specific review should be submitted at least six months in advance of the proposed activity to allow time for completion of a formal ESA section 7 consultation if one is required.

Annual Reporting to NMFS

The FAA, USSF, and NASA, in collaboration with launch operators, propose to prepare and submit reports to NMFS by April 1 beginning the calendar year after this consultation completed and continuing each year activities covered under this consultation occur. The reports will document the outcome of each launch mission that may affect the marine environment. The FAA will report on FAA-licensed launches (i.e., commercial launches) and USSF and NASA will report on their respective launches (i.e., government launches), including those involving commercial space vehicle operations.

Annual reports will include the following for all activities covered under this programmatic:

1) The dates and locations of all missions, including launch site, launch and reentry vehicles and any relevant license or permit that authorized the activities;
2) Contact information for the agencies and commercial entities involved in the events;
3) Details of launch and reentry operations that may affect the marine environment, such as booster stage landings at sea, and particularly those that involve entry of materials into the marine environment, such as payload fairing recovery missions, spacecraft reentries, and abort tests;
4) Dates of reentry and recovery operations if different from launch date;
5) Approximate locations with GPS coordinates when available of all landing and splashdown areas, including fairing recoveries (and drogue parachute recoveries, if applicable) and spacecraft recoveries (including abort tests). Information should also be provided regarding support vessels used during operations and transit routes, as well as aircraft activity associated with an event;
6) Any available information on the location and fate of unrecovered parachutes, parafoils, expended components and debris;
7) Information regarding the implementation of the *Environmental Protection Measures* described above, including any issues identified by an observer or other crew member, divers or other personnel engaged in in-water activities;

8) Any information regarding effects to ESA-listed species due to the activities; and
9) Sighting logs with observations of ESA-listed species with date, time, location, species (if possible to identify), number of animals, distance and bearing from the vessel, direction of travel, and other relevant information.

Annual reports should be submitted electronically to nmfs.hq.esa.consultations@noaa.gov with the subject line "Annual Review, OPR-2021-02908, Programmatic Concurrence for Launch Vehicle and Reentry Operations Starship-Super Heavy Launch Vehicle Operations at SpaceX's Boca Chica Launch Site."

Basic information regarding events conducted in a given year can be provided in tabular form accompanied by a narrative summary organized by geography: Pacific, Atlantic, and Gulf of Mexico. Copies of the annual reports should also be submitted electronically to the appropriate NMFS regional offices for their review and comment dependent on where launch and reentry activities occur in a given year: SERO (nmfs.ser.esa.consultations@noaa.gov), PIRO (EFHESAconsult@noaa.gov), and WCR (see https://www.fisheries.noaa.gov/west-coast/consultations/esa-section-7-consultations-west-coast for information on contacts based on geographic area).

The summary of annual aggregate activities and associated effects will allow NMFS to evaluate, among other things, whether the scope of the activities are consistent with the description of the proposed action and action area, and whether the nature and scale of the effects predicted continue to be valid. Annual reviews help monitor development of the industry and the potential for increased frequency of activities that may indicate the effects to ESA resources could change, requiring new analysis and/or adjustments to implementing requirements under the programmatic.

Landing Failure Anomaly

It is possible that a stage booster landing could have a failure. The FAA indicated that, for the past several years, SpaceX has been successfully landing boosters on land and offshore on a barge. A failure on the barge would be very rare. SpaceX has adjusted mission operations to avoid explosions on the barge. During reentry/descent, if the launch vehicle indicates any failures, SpaceX would expend it into the open ocean, rather than attempt a barge landing to avoid an explosion on the barge. Therefore, this consultation does not include stage booster landing failure. If a failure were to occur in the marine environment, reinitiation of this consultation may be required.

Action Area

The action area is defined in 50 CFR §402.02 as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action." In general, the action area includes portions of the Atlantic Ocean and Caribbean Sea, Gulf of Mexico, and the Pacific Ocean where launch and reentry activities are anticipated (see Figures 2a, 2b, 3 and 4). SpaceX is proposing to land the Starship after an orbital mission in the Pacific Ocean, approximately 62 NM north of Kauai, Hawaii, as shown in Figure 5.

The launch and reentry activities occurring in the marine environment would occur in deep waters at least 5 NM offshore the coast of the United States or islands, with most activities occurring hundreds of miles offshore. The only component of the launch and reentry operations that occurs near (less than 5 NM offshore) the coast of the United States are the vessels (watercraft) transiting to and from a port during pre-launch surveillance or when recovering and transporting spacecraft or launch vehicle components in the ocean. These nearshore vessel transit areas in the action area include marine waters that lead to the Port of Brownsville, Texas; Port Canaveral, Florida; Port of Los Angeles, California; Port of Longview, California; Port of Kodiak, Alaska; and a port facility at Vandenberg Space Force Base, California.

Figure 2a. Atlantic Ocean Action Area (without Bahamas and Caribbean areas)

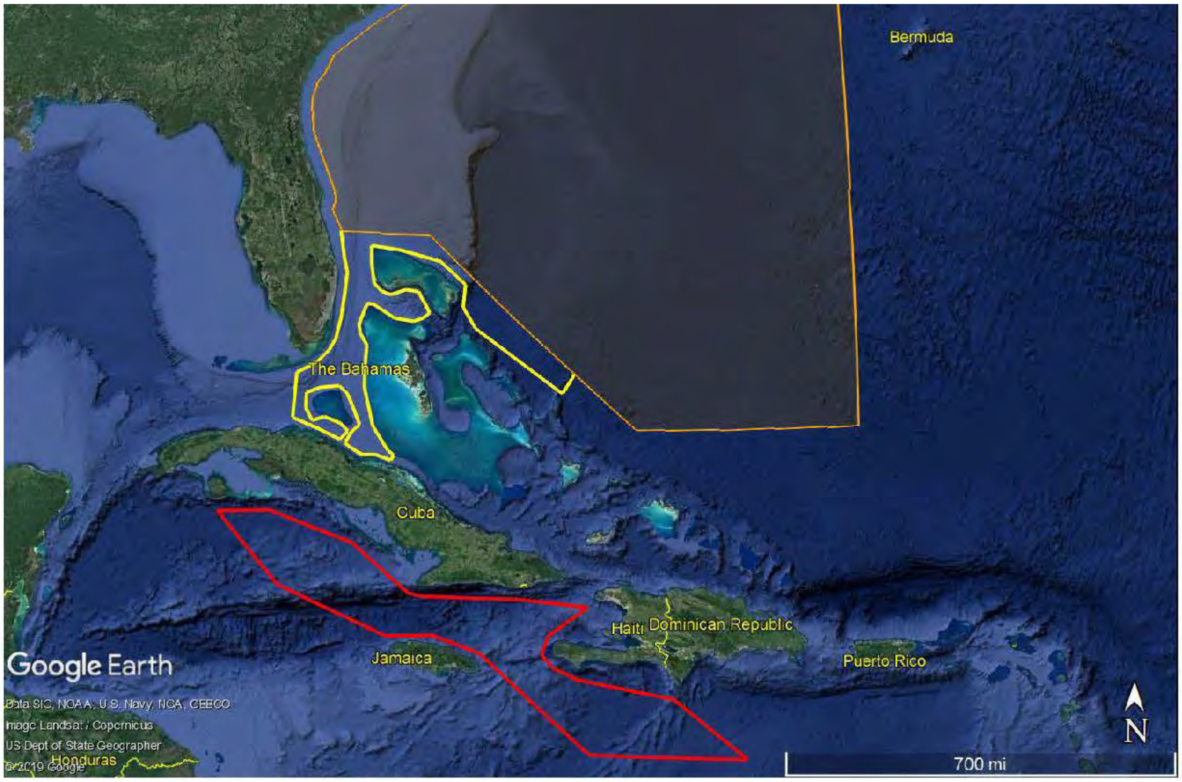

Figure 3b. Bahamas (yellow) and Caribbean (red) portions of Atlantic Ocean Action Area

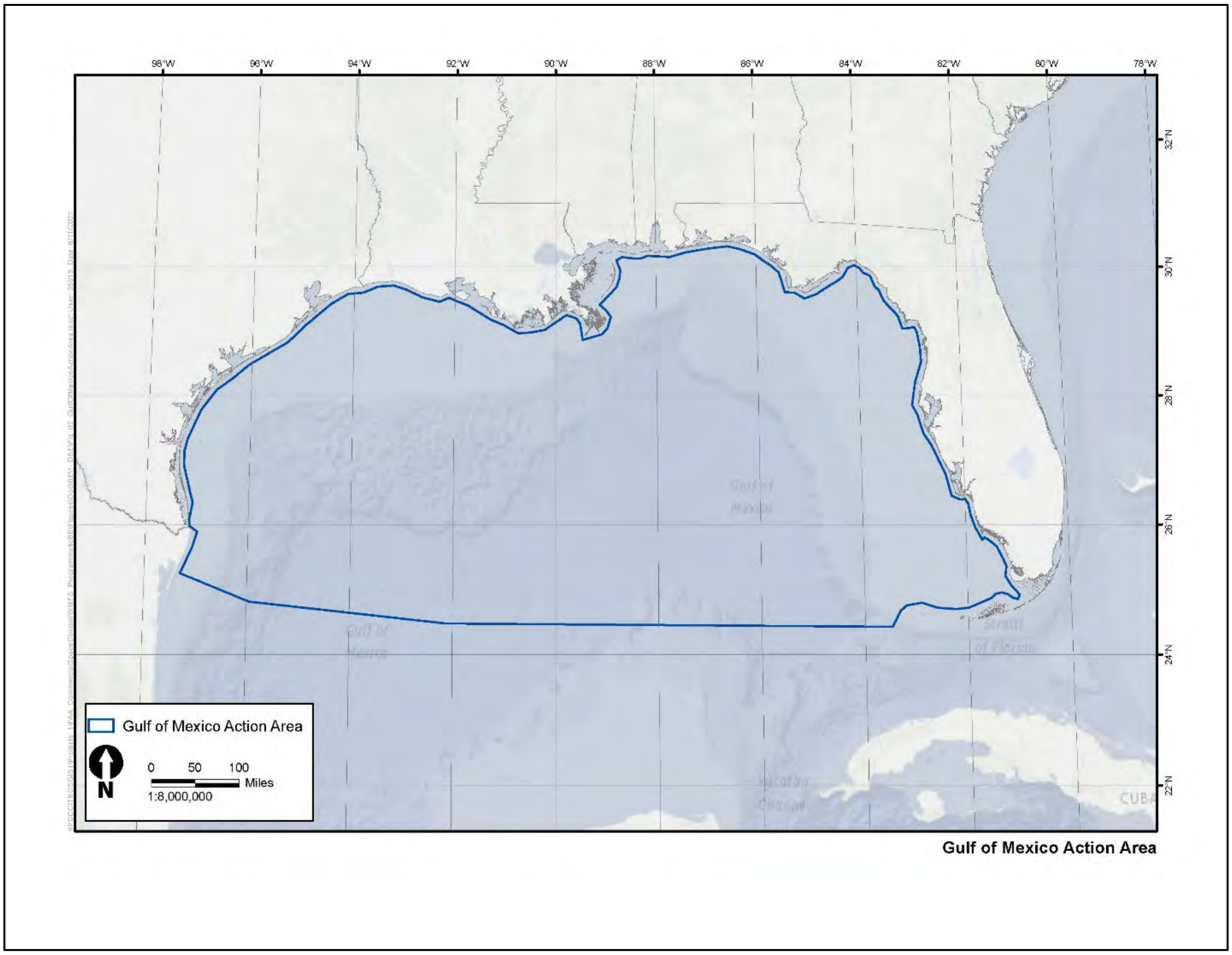

Figure 4. Gulf of Mexico Action Area

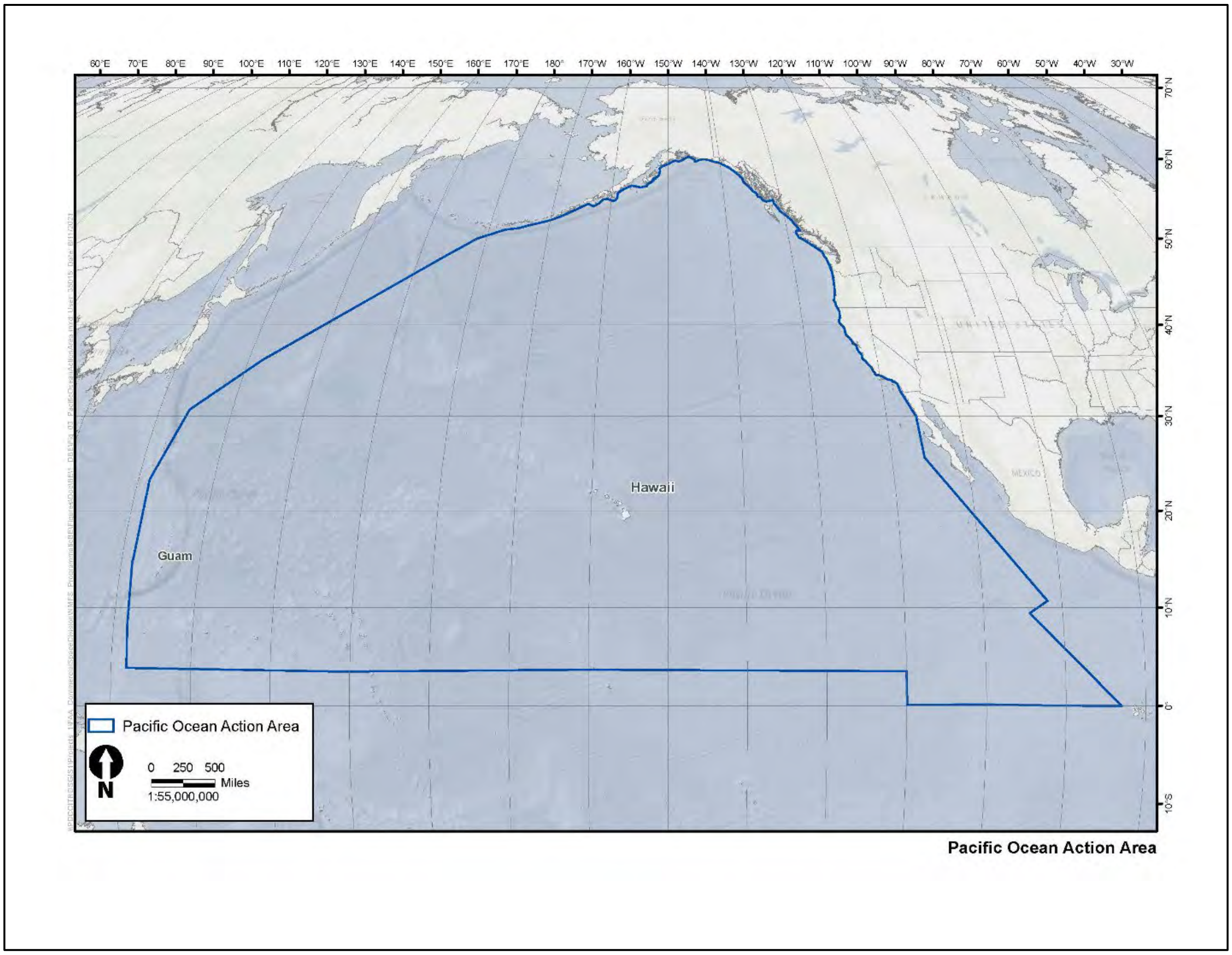

Figure 5. Pacific Ocean Action Area

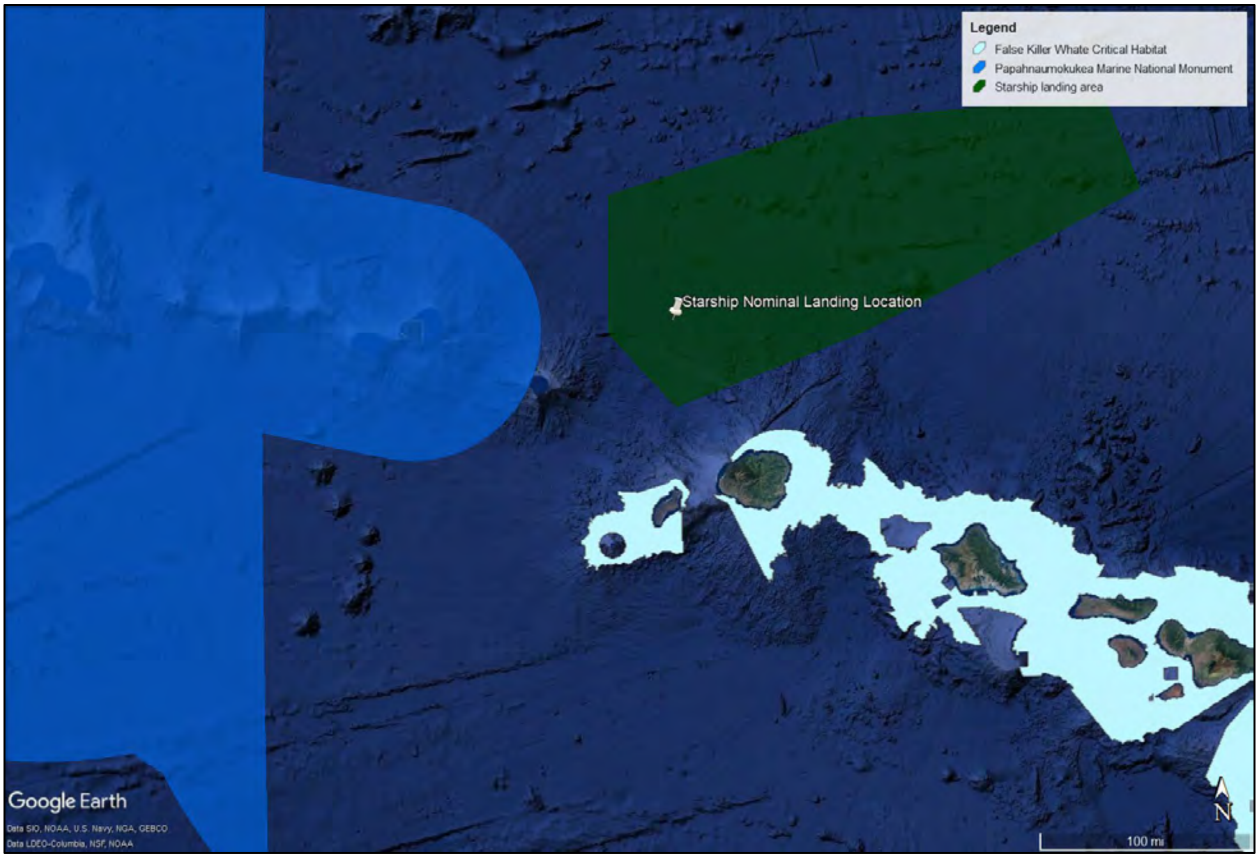

Figure 6. Proposed Landing Area in the Pacific Ocean for SpaceX Starship Orbital Missions.

Annual Operations per Ocean Area

Dependent on mission needs, the amount of annual launch and recovery operations can be variable. The table below outlines the maximum annual operations expected by the action agencies in the marine environment over the next five years (2022 through 2026) for the activities included in this consultation.

Table 5. Maximum Annual Operations

Type of Operation	Maximum # of Annual Operations
Atlantic Ocean Action Area	
Launches involving stages and fairings that are expended in the ocean (not recovered)	30
Launches involving attempted recovery of stages and fairings in the ocean	70
Spacecraft reentry and landing in the ocean	10
Launch abort test	1
Pacific Ocean Action Area	
Launches involving stages and fairings that are expended in the ocean (not recovered)	30
Launches involving attempted recovery of stages and fairings in the ocean	20
Spacecraft reentry and landing in the ocean	3
Gulf of Mexico Action Area	
Launches involving stages that are expended in the ocean (not recovered)	5

Type of Operation	Maximum # of Annual Operations
Launches involving attempted recovery of stages in the ocean	5
Spacecraft reentry and landing in the ocean	10

ESA-Listed Species and Critical Habitat in the Action Area

Several ESA-listed marine mammals (cetaceans and pinnipeds), sea turtles, fishes and designated critical habitats are known to occur or have the potential to occur in the action area (Table 6). The FAA, USSF, and NASA have determined that launch and reentry vehicle operations in the marine environment may affect, but are not likely to adversely affect any ESA-listed species or designated critical habitat.

The action area does not include nearshore areas where most ESA-listed coral species occur. There is proposed critical habitat for three coral species in the Gulf of Mexico farther offshore (i.e., > 5 NM). However, no launch operator would site a landing area in coral reef areas, and the location of the proposed critical habitat in the Gulf of Mexico is too far north of the launch trajectories from the Boca Chica Launch Site to be affected. Therefore, the FAA determined launch and reentry operations will have no effect on ESA-listed coral species or their proposed critical habitat in the action area.

Table 6. ESA-listed Species and Designated Critical Habitat Potentially Present in the Action Area

Species	ESA Status	Critical Habitat	Recovery Plan
Marine Mammals - Cetaceans			
Blue Whale (*Balaenoptera musculus*)	E – 35 FR 18319	-- --	07/1998 11/2020
False Killer Whale (*Pseudorca crassidens*) – Main Hawaiian Islands Insular DPS	E – 77 FR 70915	83 FR 35062	Draft – 85 FR 65791 9/2020
Fin Whale (*Balaenoptera physalus*)	E – 35 FR 18319	-- --	75 FR 47538 07/2010
Gray Whale (*Eschrichtius robustus*) – Western North Pacific Population	E – 35 FR 18319	-- --	-- --
Humpback Whale (*Megaptera novaeangliae*) – Central America DPS	E – 81 FR 62259	86 FR 21082	11/1991
Humpback Whale (*Megaptera novaeangliae*) – Mexico DPS	T – 81 FR 62259	86 FR 21082	11/1991

Humpback Whale (*Megaptera novaeangliae*) – Western North Pacific DPS	E – 81 FR 62259	86 FR 21082	11/1991
Killer Whale (*Orcinus orca*) – Southern Resident DPS	E – 70 FR 69903 Amendment 80 FR 7380	71 FR 69054 86 FR 41668	73 FR 4176 01/2008
North Atlantic Right Whale (*Eubalaena glacialis*)	E – 73 FR 12024	81 FR 4837	70 FR 32293 08/2004
North Pacific Right Whale (*Eubalaena japonica*)	E – 73 FR 12024	73 FR 19000	78 FR 34347 06/2013
Rice's Whale (*Balaenoptera ricei*)	E – 84 FR 15446 E – 86 FR 47022	-- --	-- --
Sei Whale (*Balaenoptera borealis*)	E – 35 FR 18319	-- --	12/2011
Sperm Whale (*Physeter macrocephalus*)	E – 35 FR 18319	-- --	75 FR 81584 12/2010
Marine Mammals - Pinnipeds			
Guadalupe Fur Seal (*Arctocephalus townsendi*)	T – 50 FR 51252	-- --	-- --
Hawaiian Monk Seal (*Neomonachaus schauinslandi*)	E – 41 FR 51611	80 FR 50925	72 FR 46966 2007
Steller Sea Lion (*Eumetopias jubatus*) – Western DPS	E – 55 FR 49204	58 FR 45269	73 FR 11872 2008
Marine Reptiles			
Green Turtle (*Chelonia mydas*) – North Atlantic DPS	T – 81 FR 20057	63 FR 46693	10/1991
Green Turtle (*Chelonia mydas*) – South Atlantic DPS	T – 81 FR 20057	-- --	-- --
Green Turtle (*Chelonia mydas*) – Central North Pacific DPS	T – 81 FR 20057	-- --	63 FR 28359 01/1998
Green Turtle (*Chelonia mydas*) – Central West Pacific DPS	E – 81 FR 20057	-- --	63 FR 28359 01/1998

Green Turtle (*Chelonia mydas*) – Central South Pacific DPS	E – 81 FR 20057	-- --	63 FR 28359 01/1998
Green Turtle (*Chelonia mydas*) – East Pacific DPS	T – 81 FR 20057	-- --	63 FR 28359 01/1998
Hawksbill Turtle (*Eretmochelys imbricata*)	E – 35 FR 8491	63 FR 46693	57 FR 38818 08/1992 – U.S. Caribbean, Atlantic, and Gulf of Mexico 63 FR 28359 05/1998 – U.S. Pacific
Kemp's Ridley Turtle (*Lepidochelys kempii*)	E – 35 FR 18319	-- --	09/2011
Leatherback Turtle (*Dermochelys coriacea*)	E – 35 FR 8491	44 FR 17710 and 77 FR 4170	10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 63 FR 28359 05/1998 – U.S. Pacific
Loggerhead Turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS	T – 76 FR 58868	79 FR 39855	74 FR 2995 10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 05/1998 – U.S. Pacific 01/2009 – Northwest Atlantic
Loggerhead Turtle (*Caretta caretta*) – North Pacific Ocean DPS	E – 76 FR 58868	-- --	63 FR 28359
Olive Ridley Turtle (*Lepidochelys olivacea*) – All Other Areas/Not Mexico's Pacific Coast Breeding Colonies	T – 43 FR 32800	-- --	-- --
Olive Ridley Turtle (*Lepidochelys olivacea*) – Mexico's Pacific Coast Breeding Colonies	E – 43 FR 32800	-- --	63 FR 28359
Fishes			
Atlantic Sturgeon (*Acipensar oxyrinchus oxyrinchus*) – Carolina DPS	E – 77 FR 5913	82 FR 39160	-- --
Atlantic Sturgeon (*Acipensar oxyrinchus oxyrinchus*) – Chesapeake DPS	E – 77 FR 5879	82 FR 39160	-- --

Atlantic Sturgeon (*Acipensar oxyrinchus oxyrinchus*) – Gulf of Maine DPS	T – 77 FR 5879	82 FR 39160	-- --
Atlantic Sturgeon (*Acipensar oxyrinchus oxyrinchus*) – New York Bight DPS	E – 77 FR 5879	82 FR 39160	-- --
Atlantic Sturgeon (*Acipensar oxyrinchus oxyrinchus*) – South Atlantic DPS	E – 77 FR 5913	82 FR 39160	-- --
Chinook Salmon (*Oncorhynchus tshawytscha)* – California Coastal ESU	T – 70 FR 37160	70 FR 52488	81 FR 70666
Chinook Salmon (*Oncorhynchus tshawytscha)* – Central Valley Spring-Run ESU	T – 70 FR 37160	70 FR 52488	79 FR 42504
Chinook Salmon (*Oncorhynchus tshawytscha)* – Lower Columbia River ESU	T – 70 FR 37160	70 FR 52629	78 FR 41911
Chinook Salmon (*Oncorhynchus tshawytscha)* – Puget Sound ESU	T – 70 FR 37160	70 FR 52629	72 FR 2493
Chinook Salmon (*Oncorhynchus tshawytscha)* – Sacramento River Winter-Run ESU	E – 70 FR 37160	58 FR 33212	79 FR 42504
Chinook Salmon (*Oncorhynchus tshawytscha)* – Snake River Fall-Run ESU	T – 70 FR 37160	58 FR 68543	80 FR 67386 (Draft)
Chinook Salmon (*Oncorhynchus tshawytscha)* – Snake River Spring/Summer Run ESU	T – 70 FR 37160	64 FR 57399	81 FR 74770 (Draft) 11-2017-Final
Chinook Salmon (*Oncorhynchus tshawytscha)* – Upper Columbia River Spring-Run ESU	E – 70 FR 37160	70 FR 52629	72 FR 57303
Chinook Salmon (*Oncorhynchus*	T – 70 FR 37160	70 FR 52629	76 FR 52317

tshawytscha) – Upper Willamette River ESU			
Chum Salmon (*Oncorhynchus keta*) – Columbia River ESU	T – 70 FR 37160	70 FR 52629	78 FR 41911
Chum Salmon (*Oncorhynchus keta*) – Hood Canal Summer-Run ESU	T – 70 FR 37160	70 FR 52629	72 FR 29121
Coho Salmon (*Oncorhynchus kisutch*) – Central California Coast ESU	E – 70 FR 37160	64 FR 24049	77 FR 54565
Coho Salmon (*Oncorhynchus kisutch*) – Lower Columbia River ESU	T – 70 FR 37160	81 FR 9251	78 FR 41911
Coho Salmon (*Oncorhynchus kisutch*) – Oregon Coast ESU	T – 73 FR 7816	73 FR 7816	81 FR 90780
Coho Salmon (*Oncorhynchus kisutch*) – Southern Oregon and Northern California Coasts ESU	T – 70 FR 37160	64 FR 24049	79 FR 58750
Eulachon (*Thaleichthys pacificus*) –Southern DPS	T – 75 FR 13012	76 FR 65323	9/2017
Giant Manta Ray (*Manta birostris*)	T – 83 FR 2916	-- --	-- --
Green Sturgeon (*Acipenser medirostris*) – Southern DPS	T – 71 FR 17757	74 FR 52300	2010 (Outline) 8/2018- Final
Gulf Sturgeon (*Acipenser oxyrinchus desotoi*)	T – 56 FR 49653	68 FR 13370	09/1995
Nassau Grouper (*Epinephelus striatus*)	T – 81 FR 42268	Proposed Rule (87 FR 62930)	8/2018- Outline
Oceanic Whitetip Shark (*Carcharhinus longimanus*)	T – 83 FR 4153	-- --	9/2018- Outline
Smalltooth Sawfish (*Pristis pectinata*) – U.S. portion of range DPS	E – 68 FR 15674	74 FR 45353	74 FR 3566 01/2009
Scalloped Hammerhead Shark (*Sphyrna lewini*) – Central and Southwest Atlantic DPS	T – 79 FR 38213	-- --	-- --

Scalloped Hammerhead Shark (*Sphyrna lewini*) – Eastern Pacific DPS	E – 79 FR 38213	-- --	-- --
Scalloped Hammerhead Shark (*Sphyrna lewini*) – Indo-West Pacific DPS	T – 79 FR 38213	-- --	-- --
Shortnose Sturgeon (*Acipenser brevirostrum*)	E – 32 FR 4001	-- --	63 FR 69613 12/1998
Sockeye Salmon (*Oncorhynchus nerka*) – Ozette Lake ESU	T – 70 FR 37160	70 FR 52630	74 FR 25706
Sockeye Salmon (*Oncorhynchus nerka*) – Snake River ESU	E – 70 FR 37160	58 FR 68543	80 FR 32365
Steelhead Trout (*Oncorhynchus mykiss*) – California Central Valley DPS	T – 71 FR 834	70 FR 52487	79 FR 42504
Steelhead Trout (*Oncorhynchus mykiss*) – Central California Coast DPS	T – 71 FR 834	70 FR 52487	81 FR 70666
Steelhead Trout (*Oncorhynchus mykiss*) – Lower Columbia River DPS	T – 71 FR 834	70 FR 52629	78 FR 41911
Steelhead Trout (*Oncorhynchus mykiss*) – Middle Columbia River DPS	T – 71 FR 834	70 FR 52629	74 FR 50165
Steelhead Trout (*Oncorhynchus mykiss*) – Northern California DPS	T – 71 FR 834	70 FR 52487	81 FR 70666
Steelhead Trout (*Oncorhynchus mykiss*) – Puget Sound DPS	T – 72 FR 26722	81 FR 9251	84 FR 71379
Steelhead Trout (*Oncorhynchus mykiss*) – Snake River Basin DPS	T – 71 FR 834	70 FR 52629	81 FR 74770 (Draft) 11-2017-Final
Steelhead Trout (*Oncorhynchus mykiss*) – South-Central California Coast DPS	T – 71 FR 834	70 FR 52487	78 FR 77430

Steelhead Trout (*Oncorhynchus mykiss*) – Southern California Coast DPS	E – 71 FR 834	70 FR 52487	77 FR 1669
Steelhead Trout (*Oncorhynchus mykiss*) – Upper Columbia River DPS	T – 71 FR 834	70 FR 52629	72 FR 57303
Steelhead Trout (*Oncorhynchus mykiss*) – Upper Willamette River DPS	T – 71 FR 834	70 FR 52629	76 FR 52317

DPS=distinct population segment; ESU=evolutionarily significant unit; E=endangered; T=threatened; FR=*Federal Register*

ESA-Listed Marine Mammals in the Action Area

Blue whales, fin whales, and sei whales are widely distributed across the globe in all major oceans. All of these species typically winter at low latitudes, where they mate, calve and nurse, and summer at high latitudes, where they feed. They are most common in offshore continental shelf and slope waters that support productive zooplankton blooms.

Humpback whales are also widely distributed and winter at low latitudes, where they calve and nurse, and summer at high latitudes, where they feed. The Western North Pacific DPS of humpback whales breeds/winters in the area of Okinawa and the Philippines, which are not in the action area, and migrates to feeding grounds in the northern Pacific Ocean, primarily off the Russian coast outside of the action area, but also feeds near the Aleutian Islands and the Gulf of Alaska (81 FR 62259). The Mexico DPS of humpback whales breeds along the Pacific coast of mainland Mexico and the Revillagigedos Islands, and feeds in the action area across a broad geographic range from California to the Aleutian Islands (81 FR 62259). The Central America DPS of humpback whales breeds along the Pacific coast of Central America and feeds in the action area almost exclusively offshore of California and Oregon (81 FR 62259).

The Southern Resident DPS killer whale is found along the Pacific Coast of the United States and Canada. Southern Resident killer whales occur in the inland waterways (not in the action area) of Puget Sound, the Strait of Juan de Fuca, and the Southern Georgia Strait during the spring, summer and fall. During the winter, they move out into coastal waters primarily off Oregon, Washington, California, and British Columbia.

The Western North Pacific gray whales tend to feed near the bottom in productive waters closer to shore. Some Western North Pacific of gray whales winter in the action area on the west coast of North America, while most others migrate south to winter in waters off Japan and China and summer in the Okhotsk Sea off northeast Sakhalin Island, Russia, and off southeastern Kamchatka in the Bering Sea (Burdin et al. 2013).

The North Atlantic right whale is primarily found in the western North Atlantic Ocean from shallow coastal water breeding grounds in temperate latitudes off the coast of the southeastern

U.S. during the winter, and feeding in summer outside the action area on large concentrations of zooplankton in the sub-polar latitudes (Colligan et al. 2012) off the coast of Nova Scotia (Waring et al. 2016).

North Pacific right whales mostly inhabit coastal and continental shelf waters in the North Pacific Ocean. They have been observed in temperate latitudes during winter off Japan (outside the action area), California, and Mexico where they likely calve and nurse. In the summer, they feed on large concentrations of zooplankton in sub-polar waters around Alaska.

The range of Rice's whale is primarily in a relatively small biologically important area in the northeastern Gulf of Mexico near De Soto Canyon, in waters 100 to 400 meters (m) deep along the continental shelf break. It inhabits the Gulf of Mexico year round, but its distribution outside of this biologically important area is unknown. It should be noted that population estimates for Rice's whale are very low, in 2009 estimated at 33 individuals (Rosel et al. 2016). An estimate by Roberts et al. (2016) utilizing habitat-based density models that incorporate visual survey data from 1992 to 2009 is 44 individuals.

The sperm whale is widely distributed globally, found in all major oceans. Sperm whales mostly inhabit areas with a water depth of 600 m (1,968 ft) or more, and are uncommon in waters less than 300 m (984 ft) deep. They winter at low latitudes, where they calve and nurse, and summer at high latitudes, where they feed primarily on squid and demersal fish.

False killer whales prefer waters more than 1,000 m (3,280.8 ft) deep, feeding on fishes and cephalopods. The Main Hawaiian Islands Insular DPS of false killer whale is considered resident within 40 km (21.6 NM) of the Main Hawaiian Islands.

Guadalupe fur seals breed mainly on Guadalupe Island with another smaller breeding colony in the San Benito Archipelago, Baja California, Mexico (Belcher and T.E. Lee 2002). Guadalupe fur seals feed mainly on squid species (Esperon-Rodriguez and Gallo-Reynoso 2013) with foraging trips that can last between four to 24 days (average of 14 days) and cover great distances, with sightings occurring thousands of kilometers away from the main breeding colonies (Aurioles-Gamboa et al. 1999). Guadalupe fur seals are infrequently observed in U.S. waters but they can be found on California's Channel Islands.

The entire range of the Hawaiian monk seal is located within U.S. waters. The main breeding subpopulations are in the Northwestern Hawaiian Islands, but there is also a small growing population found on the Main Hawaiian Islands. Hawaiian monk seals are considered foraging generalist that feed primarily on benthic and demersal prey such as fish, cephalopods, and crustaceans in subphotic zones (Parrish et al. 2000).

The Western DPS Steller sea lions reside in the central and western Gulf of Alaska, the Aleutian Islands, as well as coastal portions of Japan and Russia that are not in the action area. Western DPS Steller sea lions typically forage in coastal waters on the continental shelf, but they sometimes forage in deeper continental slope and pelagic waters, especially in the non-breeding season.

ESA-Listed Sea Turtles in the Action Area

The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, subtropical and, to a lesser extent, temperate waters. After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage believed to last several years. Adult green turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Green turtles from the North Atlantic DPS range from south of the action area, from the boundary of South and Central America, throughout the Caribbean Sea (a portion of which is in the action area), into the Gulf of Mexico and the U.S. Atlantic coast (in the action area), and range north of the action area toward Canada (outside the action area). The range of the North Atlantic DPS of green turtle also extends east beyond the action area to the western coasts of Europe and Africa. The North Atlantic DPS of green turtle nesting occurs primarily outside the action area in Costa Rica, Mexico, and Cuba, but also in Florida. The South Atlantic DPS green turtles are found in the Atlantic Ocean from the Caribbean to South America and across the Atlantic to the west coast of Africa. Nesting for the green turtle South Atlantic DPS occurs on both sides of the Atlantic Ocean, along the western coast of Africa, Ascension Island, the U.S. Virgin Islands in the Caribbean and eastern South America, from Brazil north to the Caribbean. On the western side of the Atlantic, juveniles and adults can be found on feeding grounds in the Caribbean, a portion of which is in the action area, and the nearshore waters of Brazil, Uruguay and Argentina; which are not in the action area. The Central North Pacific DPS of green turtle is found in the Pacific Ocean near the Hawaiian Archipelago and Johnston Atoll. The major nesting site for the Central North Pacific DPS of green turtle is at East Island, French Frigate Shoals, in the Northwestern Hawaiian Islands; lesser nesting sites are found throughout the Northwestern Hawaiian Islands and the Main Hawaiian Islands. Green turtles in the Central West Pacific DPS are found throughout the western Pacific Ocean, in Indonesia, the Philippines, the Marshall Islands, and Papua New Guinea. In the action area, Central West Pacific DPS green turtle nesting assemblages occur in the Federated States of Micronesia, and the Marshall Islands. Green turtles in the East Pacific DPS are found in the action area from the California/Oregon border to south of the action area, to central Chile. Nesting occurs outside the action area at major sites in Michoacán, Mexico, and the Galapagos Islands, Ecuador. Smaller nesting sites are found in the Revillagigedos Archipelago, Mexico, and along the Pacific Coast of Costa Rica, Columbia, Ecuador, Guatemala and Peru (Seminoff et al. 2015). The Central South Pacific DPS green turtle is found in the South Pacific Ocean extending north from northern New Zealand to Tuvalu and extending east over to Easter Island, Chile. The Central South Pacific DPS encompasses several island groups including American Samoa, French Polynesia, Cook Islands, Fiji, Kiribati, Tokelau, Tonga, and Tuvalu. Those island groups are south of the action area, except Kiribati breaches into the action area, the most northern island group. Central South Pacific DPS nesting occurs sporadically throughout the geographic distribution of the population, with isolated locations having relatively low to moderate nesting activity.

The hawksbill turtle has a circumglobal distribution throughout tropical and, to a lesser extent, subtropical waters of the Atlantic, Indian, and Pacific Oceans. In their oceanic phase, juvenile hawksbill turtles can be found in *Sargassum* mats; post-oceanic hawksbills may occupy a range of habitats that include coral reefs or other hard-bottom habitats, seagrass, algal beds, mangrove bays and creeks (Bjorndal and Bolten 2010; Musick and Limpus 1997).

The Kemp's ridley turtle occurs from the Gulf of Mexico and up along the Atlantic coast of the U.S. (TEWG 2000). The majority of Kemp's ridley turtles nest at coastal Mexican beaches in the Gulf of Mexico. During spring and summer, juvenile Kemp’s ridleys occur in the shallow coastal waters of the northern Gulf of Mexico from south Texas to north Florida. In the fall, most Kemp’s ridleys migrate to deeper or more southern, warmer waters and remain there through the winter (Schmid 1998). As adults, many Kemp’s ridley turtles remain in the Gulf of Mexico, with only occasional occurrence in the Atlantic Ocean (NMFS et al. 2010).

Globally, olive ridley sea turtles can be found in tropical and subtropical waters in the Atlantic, Indian, and Pacific Oceans. Major nesting beaches are found outside the action area in Nicaragua, Costa Rica, Panama, India and Suriname. Olive ridleys may forage across ocean basins, primarily in pelagic habitats, on crustaceans, fish, mollusks, and tunicates. The range of the endangered Pacific coast breeding population extends as far south as Peru and up to California. Olive ridley turtles of the Pacific coast breeding colonies nest outside the action area on arribada beaches at Mismaloya, Ixtapilla and La Escobilla, Mexico. Solitary nesting takes place all along the Pacific coast of Mexico.

Loggerhead turtles are circumglobal, and are found in the temperate and tropical regions of the Atlantic, Indian, and Pacific Oceans. The post-hatchling stage is in pelagic waters and juveniles are first in the oceanic zone and later in the neritic zone (i.e., coastal waters). While in their oceanic phase, loggerhead turtles undertake long migrations using ocean currents. Adults and sub-adults occupy nearshore habitat important for foraging and inter-nesting migration. The Northwest Atlantic Ocean DPS of loggerhead turtle hatchlings disperse widely, most likely using the Gulf Stream to drift throughout the Atlantic Ocean. Genetic evidence demonstrates that juvenile loggerheads from southern Florida nesting beaches comprise the vast majority (71 to 88 percent) of individuals found in foraging grounds throughout the western and eastern Atlantic (Masuda 2010). North Pacific Ocean DPS of loggerhead turtles are found throughout the Pacific Ocean, north of the equator. Their range extends from the West Coast of North America to eastern Asia. Two major juvenile foraging areas have been identified in the North Pacific Basin: Central North Pacific and off Mexico’s Baja California Peninsula. Hatchlings from Japanese nesting beaches outside the action area use the North Pacific Subtropical Gyre and the Kurishio Extension to migrate to those foraging grounds (Abecassis et al. 2013; Seminoff et al. 2014).
The leatherback sea turtle is unique among sea turtles for its large size and ability to maintain internal warmth (due to thermoregulatory systems), which allows it to range worldwide from tropical into subpolar latitudes. Leatherbacks occur throughout marine waters, from nearshore habitats to oceanic environments (Shoop and Kenney 1992). Leatherback sea turtles migrate long, transoceanic distances between their tropical nesting beaches and the highly productive temperate waters where they forage, primarily on jellyfish and tunicates. Detailed population structure is unknown, but the leatherback distribution is assumed dependent upon nesting beach locations in the Pacific, Atlantic, and Indian Oceans. Movements are largely dependent upon reproductive and feeding cycles and the oceanographic features that concentrate prey, such as frontal systems, eddy features, current boundaries, and coastal retention areas (Benson et al. 2011).

ESA-Listed Fishes in the Action Area

Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Atlantic sturgeon occupy ocean waters and associated bays, estuaries, and coastal river systems from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida (ASMFC 2006; Stein et al. 2004). Five DPS's of Atlantic sturgeon are listed under the ESA: Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic. Juveniles typically spend two to five years in freshwater before eventually becoming coastal residents as sub-adults (Boreman 1997; Schueller and Peterson 2010; Smith 1985). Atlantic sturgeon exhibit high fidelity to their natal rivers but can undergo extensive mixing in coastal waters (Grunwald et al. 2008; King et al. 2001; Waldman et al. 2002).

The Pacific salmon (chinook, coho, chum and sockeye) and steelhead trout are anadromous fishes and the ESA-listed DPSs and ESUs spawn in their natal rivers in Washington, Oregon and California. Juvenile Chinook may reside in freshwater for 12 to 16 months, but some migrate to the ocean as young-of-the-year within eight months of hatching. Chinook salmon spend a few years feeding in the ocean, and sexually mature between the ages of two and seven but are typically three or four years old when they return to spawn, generally in summer or early fall. Coho salmon spend a year in freshwater and then migrate out to the ocean to spend about 1.5 years feeding before returning to spawn, generally in fall or early winter. Sockeye salmon rear in freshwater for one to three years, after which they reach the smolt stage and migrate to the ocean to feed and grow. They typically mature and return to freshwater to spawn in the summer or fall after two to three years at sea, but some return earlier or stay at sea longer, between four and five years. Steelhead trout typically migrate to open marine waters after spending two years in freshwater. They reside in marine waters for typically two or three years prior to returning to their natal stream as four- or five-year-olds to spawn shortly after river entry from December through April. Young chum salmon (fry) typically migrate directly to estuarine and marine waters soon after they are born and do not reside in freshwater for an extended period. As chum salmon grow larger, they migrate offshore and as they approach maturity, typically between the ages of three and six, they migrate back to spawn in late summer through March.
The eulachon is an anadromous fish, smaller than salmonids (8.5 inches, 21.5 centimeters), that can be found in the continental shelf waters of the eastern Pacific Ocean. Adult and juvenile Southern DPS eulachon typically occupy waters 50 to 200 m deep (Gustafson 2016), and up to depths of about 300 m, from California to the Bering Sea. Southern DPS eulachon are those that return to spawn in rivers south of the Nass River in British Columbia to the Mad River in California.

The giant manta ray occupies tropical, subtropical, and temperate oceanic waters and productive coastlines where they feed on zooplankton. Giant manta rays are commonly offshore in oceanic waters, but are sometimes found feeding in shallow waters (less than 10 m [32.8 ft]) during the day. Giant manta rays can dive to depths of over 1,000 m (3,280.8 ft), and also conduct night descents to between 200 and 450 m (656.2 to 1,476.4 ft) deep.

The green sturgeon is an anadromous fish that occurs in the nearshore coastal waters to a depth of 110 m from Baja California, Mexico to the Bering Sea, Alaska (Hightower 2007). Adult Southern DPS green sturgeon enter San Francisco Bay and migrate up the Sacramento River to spawn (Heublin et al. 2009).

The current range of the Gulf sturgeon extends from Lake Pontchartrain in Louisiana east to the Suwannee river system in Florida. Young-of-the-year slowly work their way downstream from where they hatched and arrive in estuaries and river mouths where they will spend their next six years developing (Sulak and Clugston 1999). After six years, Gulf sturgeon enter the marine environment to forage on benthic (bottom dwelling) invertebrates along the shallow nearshore (2-4 m depth), barrier island passes, and in unknown offshore locations in the Gulf of Mexico (Huff 1975, Carr et al. 1996, Fox et al. 2002, Ross et al. 2009).

The Nassau grouper is distributed from south Florida throughout the Caribbean, and Bermuda. Juveniles inhabit macroalgae, coral clumps, and seagrass beds, and are relatively solitary. As they grow, they occupy progressively deeper areas and offshore reefs, and can be in schools of up to forty individuals. When not spawning, adults are most common in waters less than 100 m deep.

The oceanic whitetip shark is a large pelagic shark distributed globally throughout open ocean waters, outer continental shelves, and around oceanic islands, primarily from 10 degrees North to 10 degrees South, but up to 30 degrees North and 35 degrees South (Young 2016). They occur from the surface to at least 152 m (498.7 ft) deep, and display a preference for water temperatures above 20 degrees Celsius (°C).

Shortnose sturgeon occur in estuaries, rivers, and the sea along the east coast of North America (Vladykov and Greeley 1963). Their northerly distribution extends north of the action area to the Saint John River, New Brunswick, Canada, and their southerly distribution historically extended to the Indian River, Florida (Evermann and Bean 1898, Scott and Scott 1988). Some populations rarely leave freshwater while others are known to migrate along the coast between river systems (Quattro et al. 2002, Wirgin et al. 2005, Dionne et al. 2013, Altenritter et al. 2015).

The scalloped hammerhead shark is found throughout the world and the Central and Southwest Atlantic DPS, Eastern Pacific DPS, and Indo-West Pacific DPSs live in coastal warm temperate and tropical seas. The species occurs over continental shelves and the shelves surrounding islands, as well as adjacent deep waters, but is seldom found in waters cooler than 22 (°C) (Compagno 1984; Schulze-Haugen and Kohler 2003). It ranges from the intertidal and surface to depths of up to 450 to 512 m (1,476.4 to 1,679.8 ft), with occasional dives to even deeper waters. It has also been documented entering enclosed bays and estuaries. The Central and Southwest Atlantic DPS of scalloped hammerhead shark’s range extends from the southeast coast of Florida to outside the action area, down to Brazil, including the Caribbean Sea, but not the Gulf of Mexico. The Eastern Pacific DPS of scalloped hammerhead shark’s range extends from the coast of southern California, down south past the action area, to Ecuador and possibly Peru, and waters off Tahiti. The Indo-West Pacific DPS of scalloped hammerhead shark ranges from Japan down to Australia, including tropical Pacific islands in the action area. The central Pacific Ocean waters near Hawaii are not included within the range of listed DPSs.

Historically within the United States, smalltooth sawfish have been captured in estuarine and coastal waters from New York southward through Texas, with the largest number of recorded captures in Florida (NMFS 2010). Recent capture and encounter data suggest that the current distribution is primarily south and southwest Florida from Charlotte Harbor through the Dry Tortugas (Seitz and Poulakis 2002, Poulakis and Seitz 2004). Water temperatures (no lower than 16-18°C) and the availability of appropriate coastal habitat (shallow, euryhaline waters and red mangroves) are the major environmental constraints limiting the distribution of smalltooth sawfish (Bigalow and Schroeder 1953). Juvenile sawfish spend the first 2-3 years of their lives in am not sure what you mean, there is a statement regarding them a few paragraphs down.the shallow waters provided in the lower reaches of rivers, estuaries, and coastal bays (Simpfendorfer et al. 2008 and 2011). As smalltooth sawfish approach 250 centimeters (cm), they become less sensitive to salinity changes and begin to move out of the protected shallow water embayments and into the shorelines of barrier islands (Poulakis et al. 2011). Adult sawfish typically occur in more open water, marine habitats (Poulakis and Seitz 2004).

Critical Habitat in the Action Area

This section discusses designated critical habitat that is either completely encompassed by the action area or is partially within the action area.

Green Sturgeon

The action area includes critical habitat for Southern DPS green sturgeon (Figure 6). In marine waters, the designated critical habitat is up to the 110 m depth isobath from Monterey Bay to the U.S.-Canada border.

The physical and biological features (PBFs) essential for the conservation of the Southern DPS green sturgeon are:

1. **Migratory corridor:** A migratory pathway necessary for the safe and timely passage within marine and between estuarine and marine habitats.
2. **Water quality:** Nearshore marine waters with adequate dissolved oxygen levels and acceptably low levels of contaminants (e.g., pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal behavior, growth, and viability of subadults and adults.
3. **Food resources:** Abundant prey items for subadults and adults, which may include benthic invertebrates and fishes.

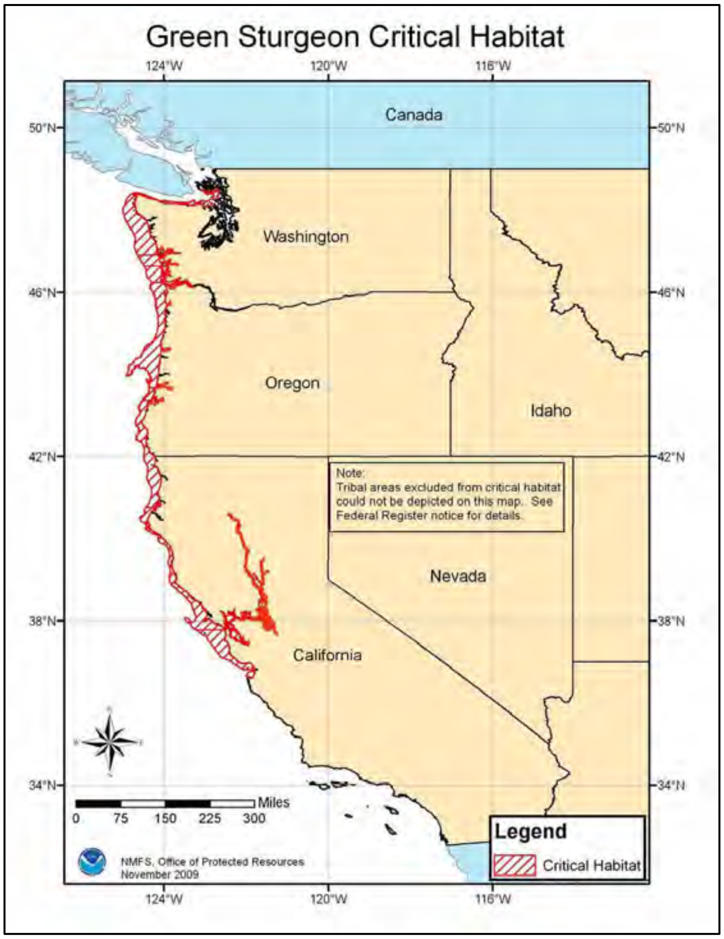

Figure 7. Green Sturgeon Critical Habitat

Gulf Sturgeon

Most of the Gulf sturgeon critical habitat is outside the action area, except for a boundary portion near Cedar Key, Florida, in the Gulf of Mexico (Figure 7). Most subadult and adult Gulf sturgeon spend cool months (October or November through March or April) in estuarine areas, bays, or in the Gulf of Mexico.

The PBFs relevant to the conservation of gulf sturgeon in estuarine and marine areas are:

1. Abundant prey items within estuarine and marine habitats and substrates for juvenile, subadult, and adult life stages;
2. Water quality, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages;
3. Sediment quality, including texture and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages; and
4. Safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats (e.g., a river unobstructed by any permanent structure, or a dammed river that still allows for passage).

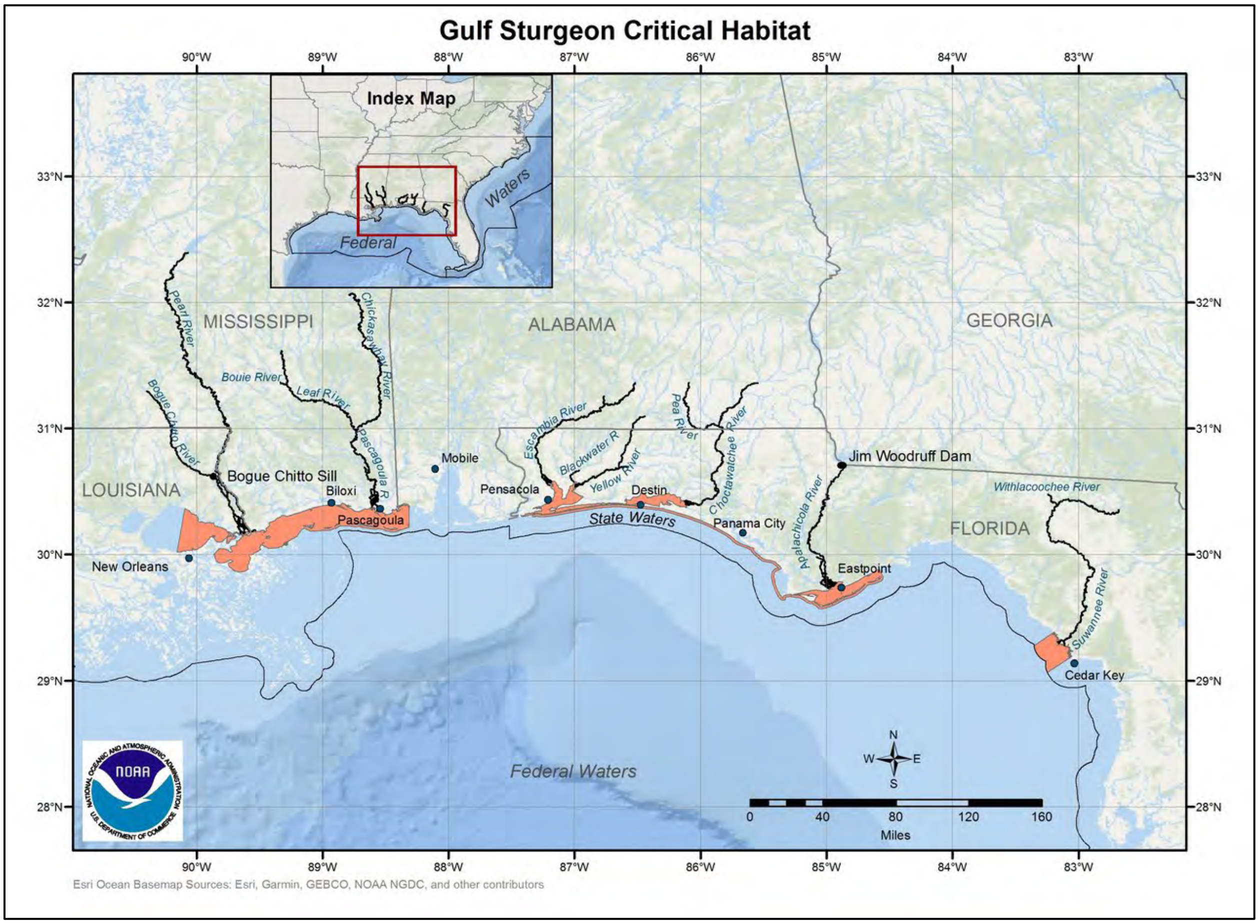

Figure 8. Gulf Sturgeon Critical Habitat

Pacific Leatherback Sea Turtle

The action area includes leatherback sea turtle critical habitat along the U.S. West Coast (Figure 8). This designation includes approximately 43,798 square kilometers stretching along the California coast from Point Arena to Point Arguello east of the 3000 m depth contour; and 64,760 square kilometers stretching from Cape Flattery, Washington to Cape Blanco, Oregon east of the 2,000 m depth contour. The designation includes waters from the ocean surface down to a maximum depth of 80 m. These waters were designated specifically because of the occurrence of prey species, primarily Scyphomedusae of the order Semaeostomeae (i.e., jellyfish), of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks.

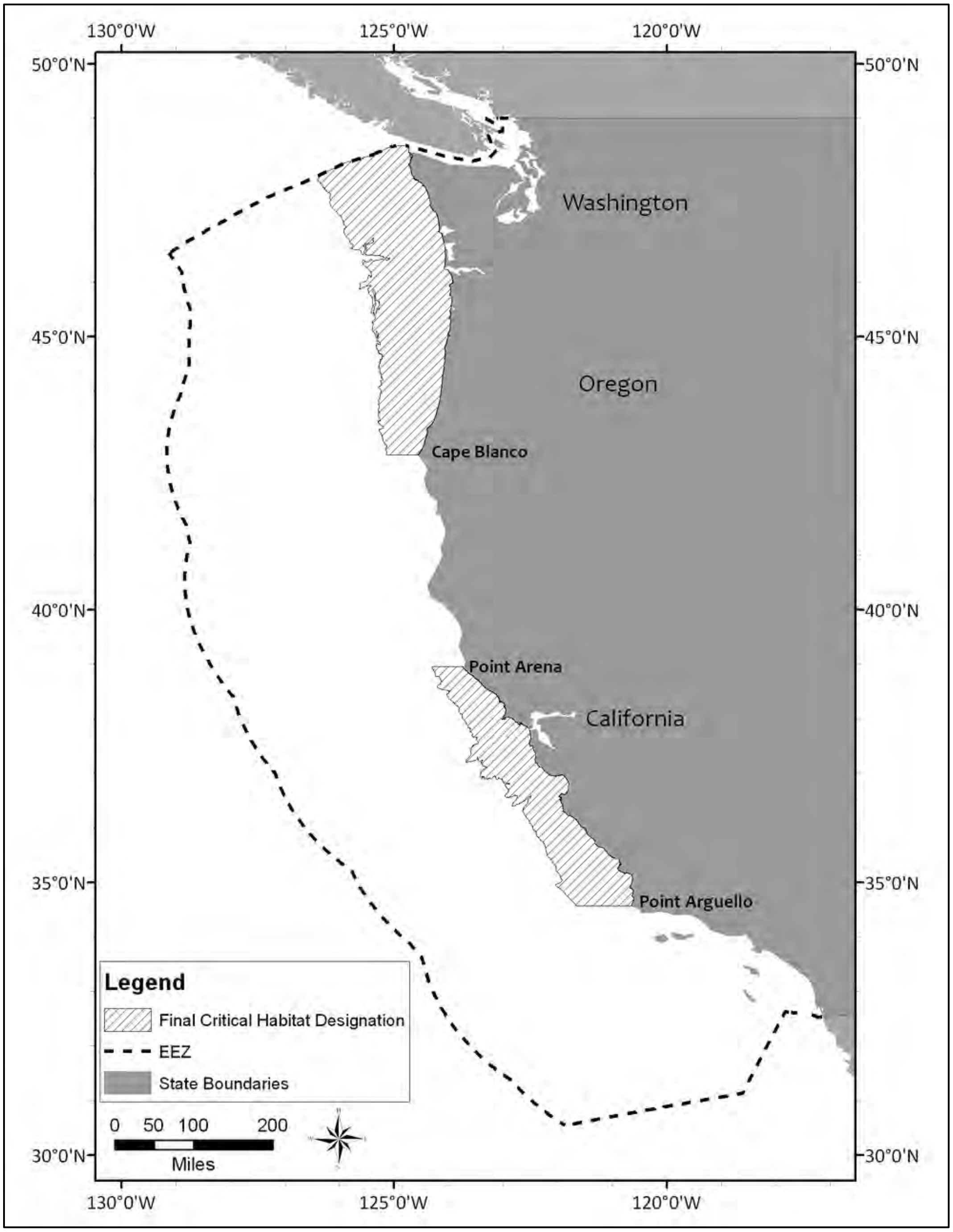

Figure 9. Pacific Leatherback Sea Turtle Critical Habitat

Loggerhead Sea Turtle

The action area includes Northwest Atlantic Ocean DPS loggerhead sea turtle critical habitat in the Gulf of Mexico and Atlantic Ocean (Figure 9). The designated critical habitat includes overlapping areas of nearshore reproductive habitat, constricted migratory habitat, breeding habitat, and *Sargassum* habitat (descriptions below). The FAA determined that approximately 13 miles of nearshore reproductive habitat is within the action area around Cape Canaveral and Port

Canaveral, but the remaining nearshore reproductive habitat areas are outside the action area because the landing/splashdown area begins 5 NM offshore.

- **Nearshore reproductive habitat:** The PBFs of nearshore reproductive habitat as a portion of the nearshore waters adjacent to nesting beaches that are used by hatchlings to egress to the open-water environment as well as by nesting females to transit between beach and open water during the nesting season. The following primary constituent elements support this habitat: (i) nearshore waters directly off the highest density nesting beaches and their adjacent beaches, as identified in 50 CFR § 17.95(c), to 1.6 kilometers offshore; (ii) waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water; and (iii) waters with minimal manmade structures that could promote predators (i.e., nearshore predator concentration caused by submerged and emergent offshore structures), disrupt wave patterns necessary for orientation, and/or create excessive longshore currents.
- **Constricted migratory habitat:** The PBFs of constricted migratory habitat as high use migratory corridors that are constricted (limited in width) by land on one side and the edge of the continental shelf and Gulf Stream on the other side. Primary constituent elements that support this habitat are the following: (i) constricted continental shelf area relative to nearby continental shelf waters that concentrate migratory pathways; and (ii) passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas.
- **Breeding habitat:** The PBFs of concentrated breeding habitat as those sites with high densities of both male and female adult individuals during the breeding season. Primary constituent elements that support this habitat are the following: (i) high densities of reproductive male and female loggerheads; (ii) proximity to primary Florida migratory corridor; and (iii) proximity to Florida nesting grounds.
- ***Sargassum* habitat:** The PBFs of loggerhead *Sargassum* habitat as developmental and foraging habitat for young loggerheads where surface waters form accumulations of floating material, especially *Sargassum*. Primary constituent elements that support this habitat are the following: (i) convergence zones, surface-water downwelling areas, the margins of major boundary currents (Gulf Stream), and other locations where there are concentrated components of the *Sargassum* community in water temperatures suitable for the optimal growth of *Sargassum* and inhabitance of loggerheads; (ii) *Sargassum* in concentrations that support adequate prey abundance and cover; (iii) available prey and other material associated with *Sargassum* habitat including, but not limited to, plants and cyanobacteria and animals native to the *Sargassum* community such as hydroids and copepods; and (iv) sufficient water depth and proximity to available currents to ensure offshore transport (out of the surf zone), and foraging and cover requirements by *Sargassum* for post-hatchling loggerheads, i.e., >10 m in depth.

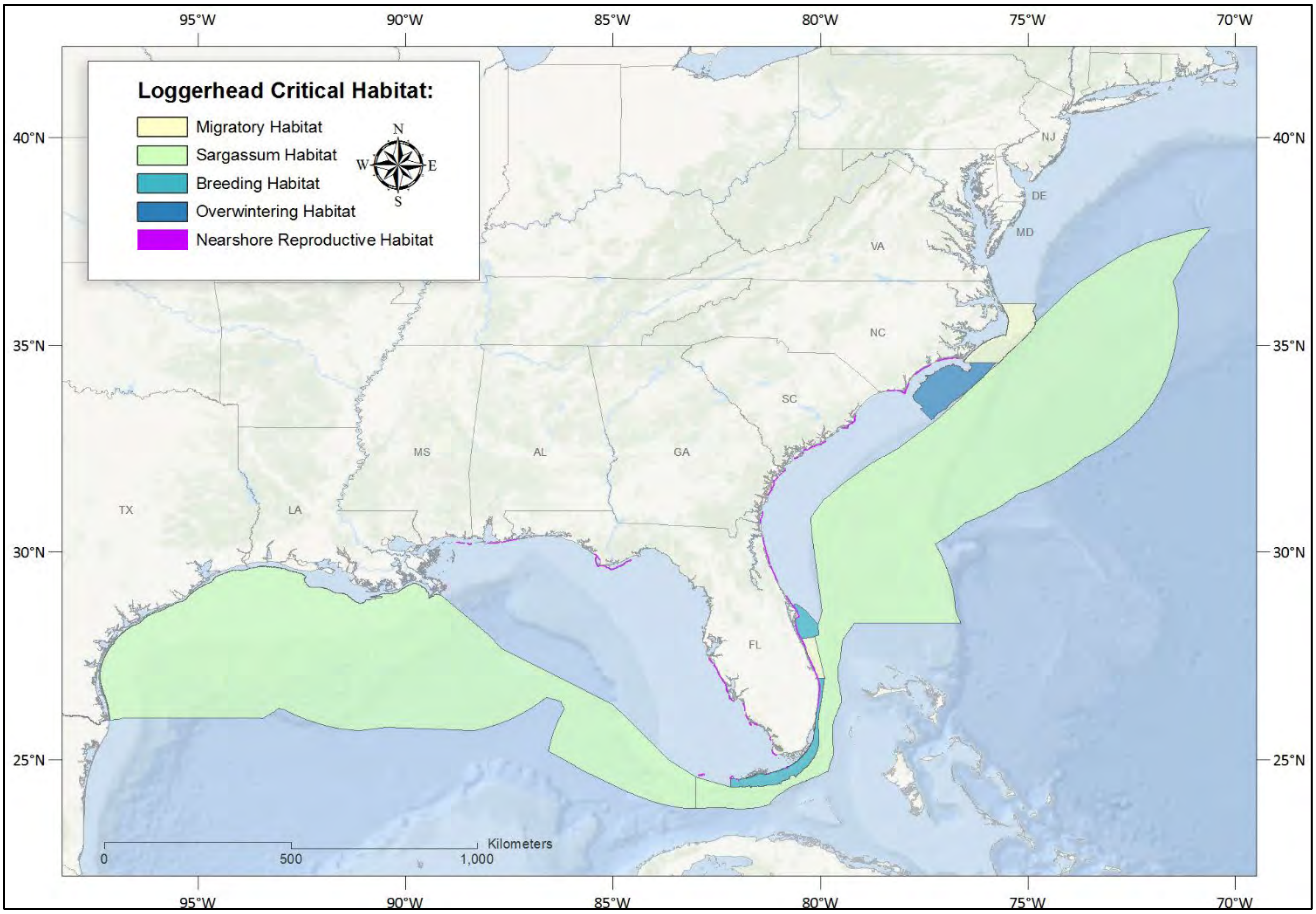

Figure 10. Loggerhead Sea Turtle Critical Habitat

North Atlantic Right Whale

NMFS designated two units of critical habitat for the North Atlantic right whale. Unit 1 is for foraging habitat in the Gulf of Maine and Georges Bank region, and is not in the action area. Unit 2 is for calving and is in the action area, consisting of all marine waters from Cape Fear, North Carolina, southward to approximately 27 NM below Cape Canaveral, Florida (Figure 10). Unit 2 occurs off the coast of CCSFS and extends seaward approximately 5 NM off the coast north of CCSFS. The following PBFs are present in Unit 2:

- Sea surface conditions associated with Force 4 or less on the Beaufort Scale.
- Sea surface temperatures of 7°C to 17°C.
- Water depths of 6-28 m, where these features simultaneously co-occur over contiguous areas of at least 231 square NM of ocean waters during the months of November through April. When these features are available, they are selected by right whale cows and calves in dynamic combinations that are suitable for calving, nursing, and rearing, and which vary, within the ranges specified, depending on factors such as weather and age of the calves.

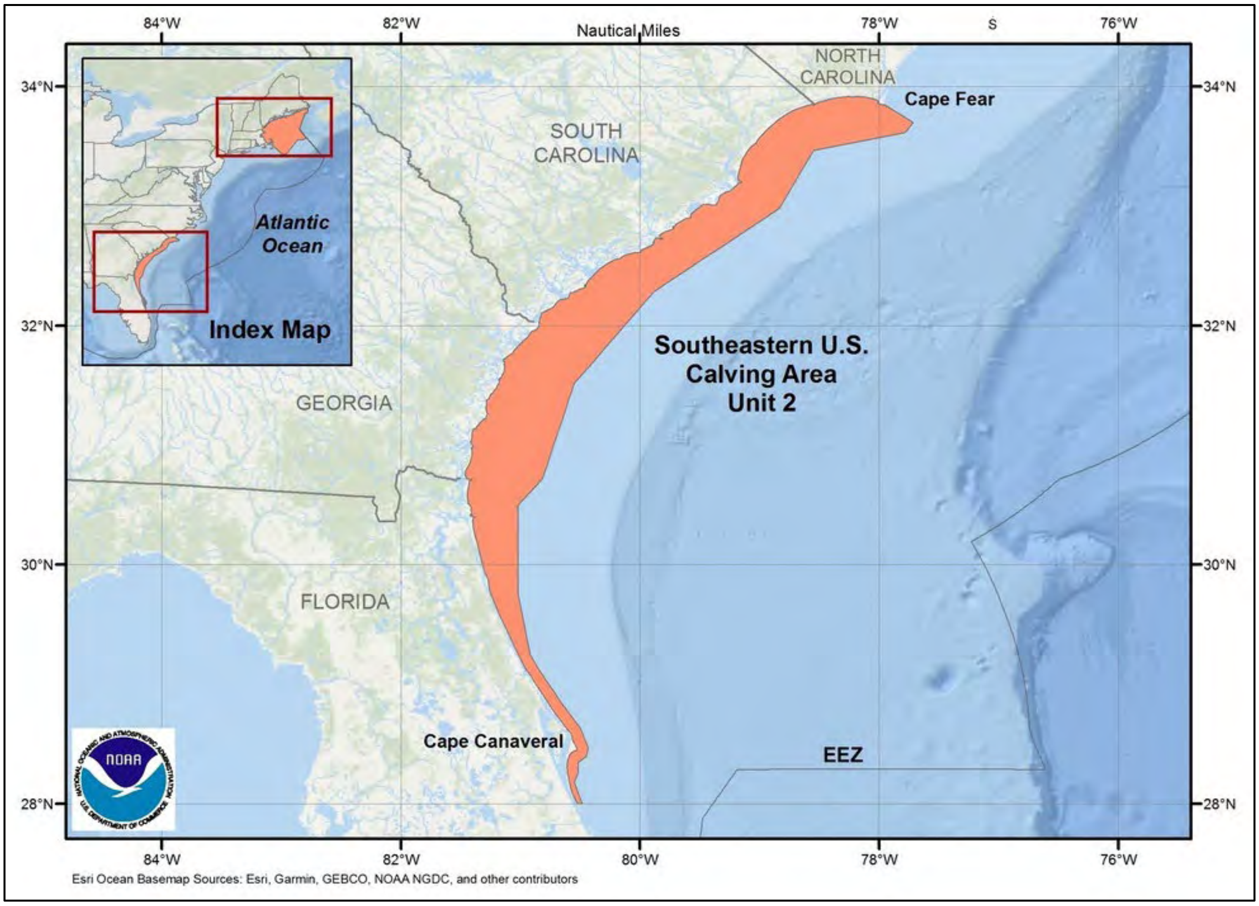

Figure 11. North Atlantic Right Whale Critical Habitat Unit 2

North Pacific Right Whale

Designated critical habitat for the North Pacific right whale includes an area in the Southeast Bering Sea, which is not in the action area, and an area south of Kodiak Island in the Gulf of Alaska (Figure 11), which is in the northern boundary of the action area in the Pacific. Both critical habitat areas support feeding by North Pacific right whales because they contain the designated PBFs, which include: nutrients, physical oceanographic processes, certain species of zooplankton (e.g. copepods *Calanus marshallae*, *Neocalanus cristatus*, and *N. plumchris*, and the euphausiid *Thysanoëssa raschii*), and a long photoperiod due to the high latitude (73 FR 19000).

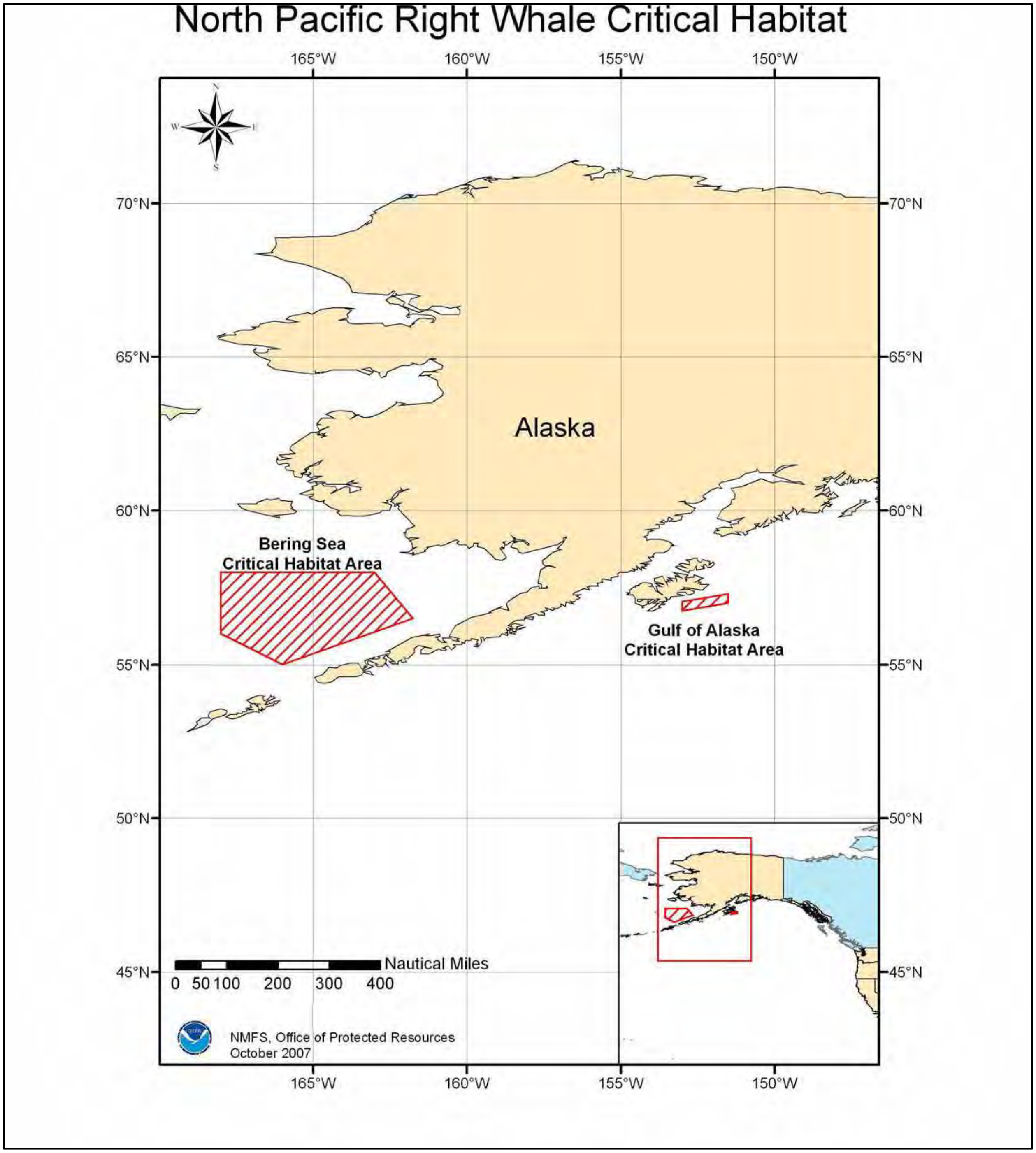

Figure 12. North Pacific Right Whale Critical Habitat

Humpback Whale

NOAA Fisheries designated critical habitat for the endangered Western North Pacific DPS, the endangered Central America DPS, and the threatened Mexico DPS of humpback whales on May 21, 2021 (86 FR 21082; Figures 12-14). The area designated as critical habitat for the Central America DPS contain approximately 48,521 square NM of marine habitat in the Pacific Ocean within the portions of the California Current Ecosystem off the coasts of Washington, Oregon, and California (Figure 12). Areas designated as critical habitat for the Mexico DPS contain approximately 116,098 square NM of marine habitat in the North Pacific Ocean, including areas within portions of the eastern Bering Sea, Gulf of Alaska, and California Current Ecosystem (Figure 13). Areas designated as critical habitat for Western North Pacific DPS contain approximately 59, 411 square NM of marine habitat in the North Pacific Ocean, including areas within the eastern Bering Sea and Gulf of Alaska (Figure 14).

The following PBFs were identified as essential to the conservation of the DPSs as follows:

1. **Central American DPS:** prey species, primarily euphausiids and small pelagic schooling fishes, such as Pacific sardine, northern anchovy, and Pacific herring, of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth.
2. **Mexico DPS:** prey species, primarily euphausiids and small pelagic schooling fishes, such as Pacific sardine, northern anchovy, Pacific herring, capelin, juvenile walleye pollock, and Pacific sand lance of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth.
3. **Western North Pacific DPS:** prey species, primarily euphausiids and small pelagic schooling fishes, such as Pacific herring, capelin, juvenile walleye pollock, and Pacific sand lance of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth.

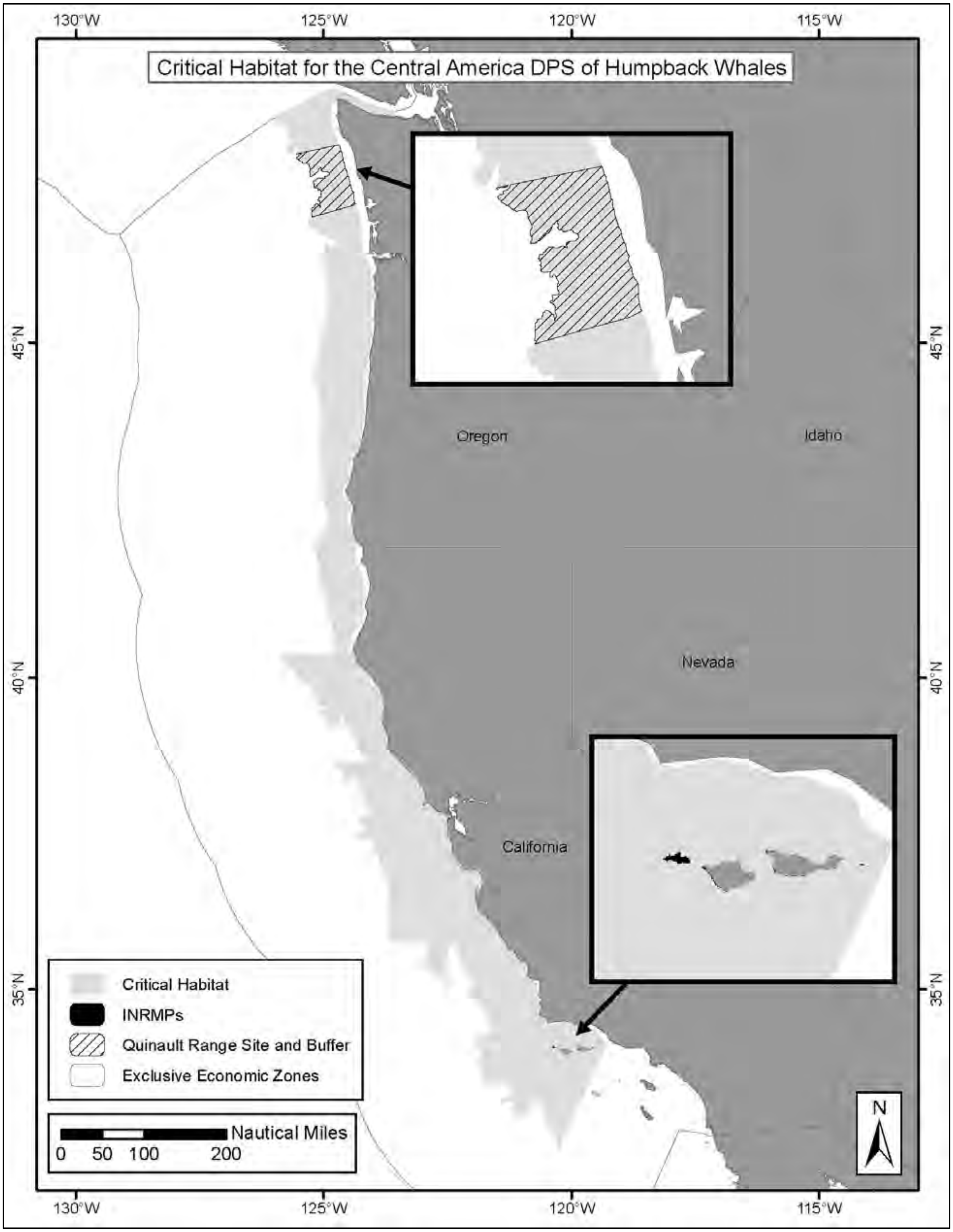

Figure 13. Critical Habitat for Central America DPS humpback whales

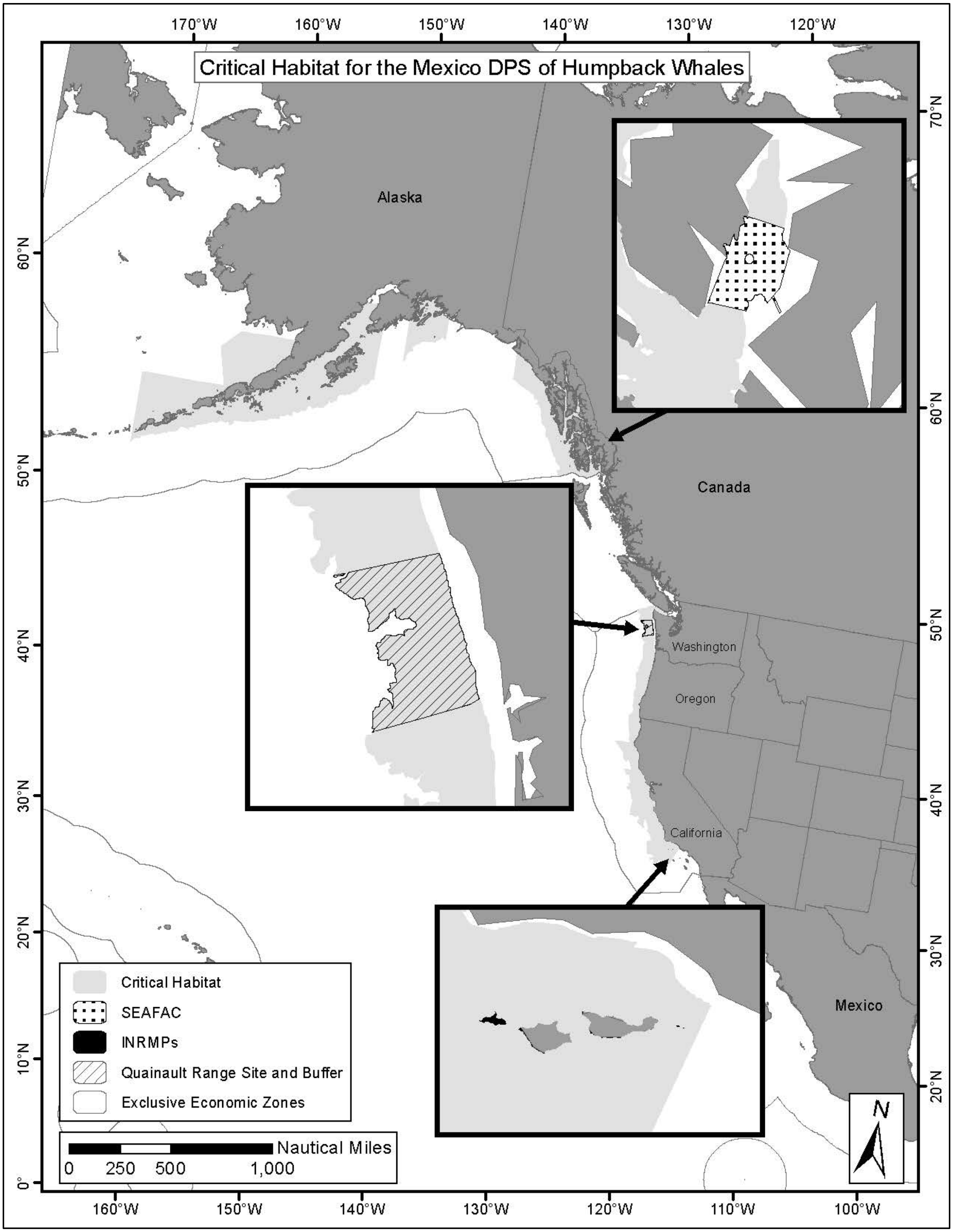

Figure 14. Critical Habitat for Mexico DPS humpback whales

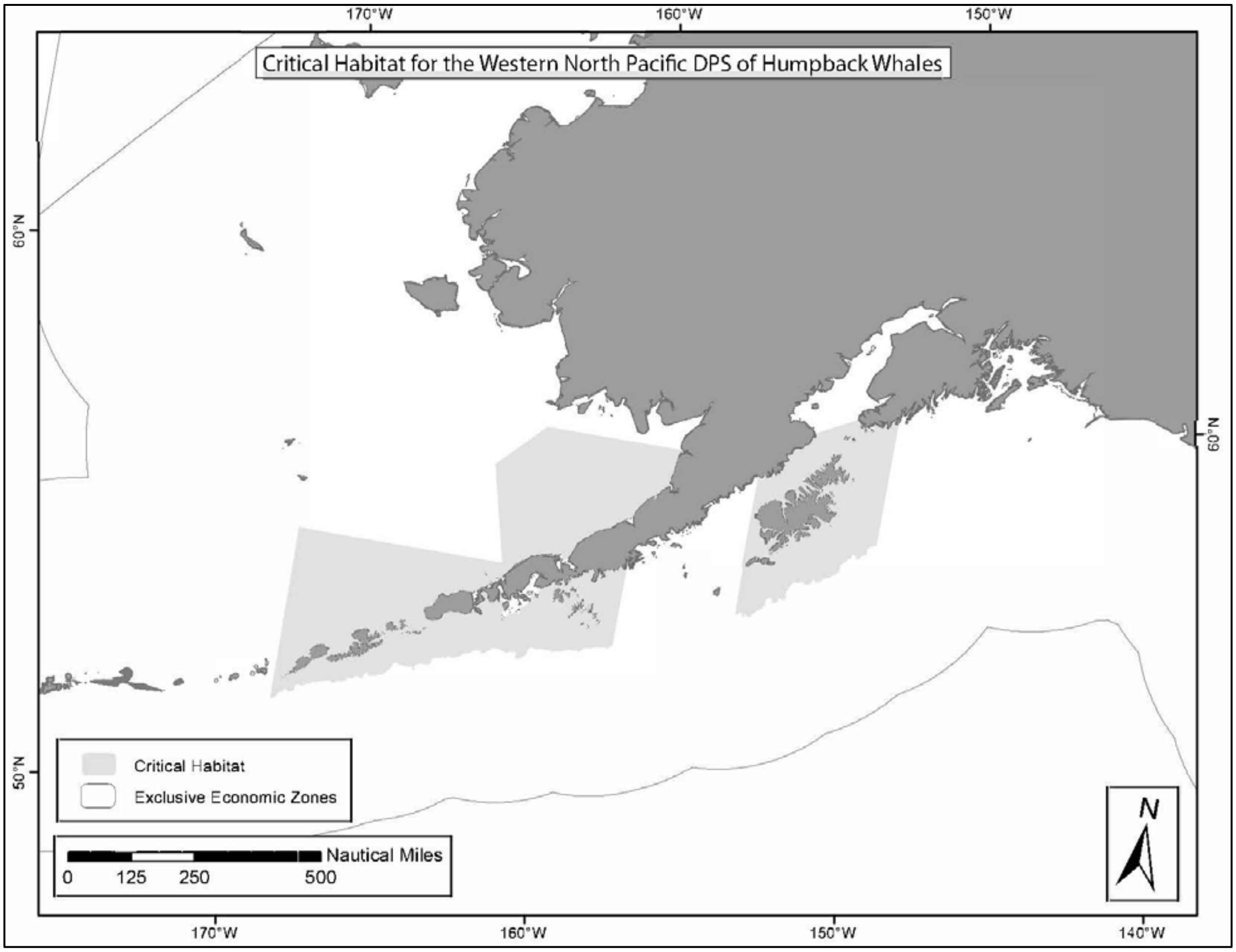

Figure 15. Critical Habitat for Western North Pacific DPS humpback whales

Killer Whale

In 2006, NMFS issued a final rule designating approximately 2,560 square miles of inland waters of Washington State as critical habitat for the Southern Resident DPS killer whale. In August of 2021, NMFS issued a revised rule to the critical habitat designation by expanding it to include six new areas along the U.S. West Coast, while maintaining the whales' currently designated critical habitat in inland waters of Washington (Figure 15). The expanded critical habitat includes marine waters between the 6.1 m depth contour and the 200 m depth contour from the U.S. international border with Canada south to Point Sur, California. Critical habitat within the action area contains PBFs associated with water quality to support growth and development, prey availability for growth, reproduction and development, and overall population growth; and passage conditions to allow for migration, resting, and foraging.

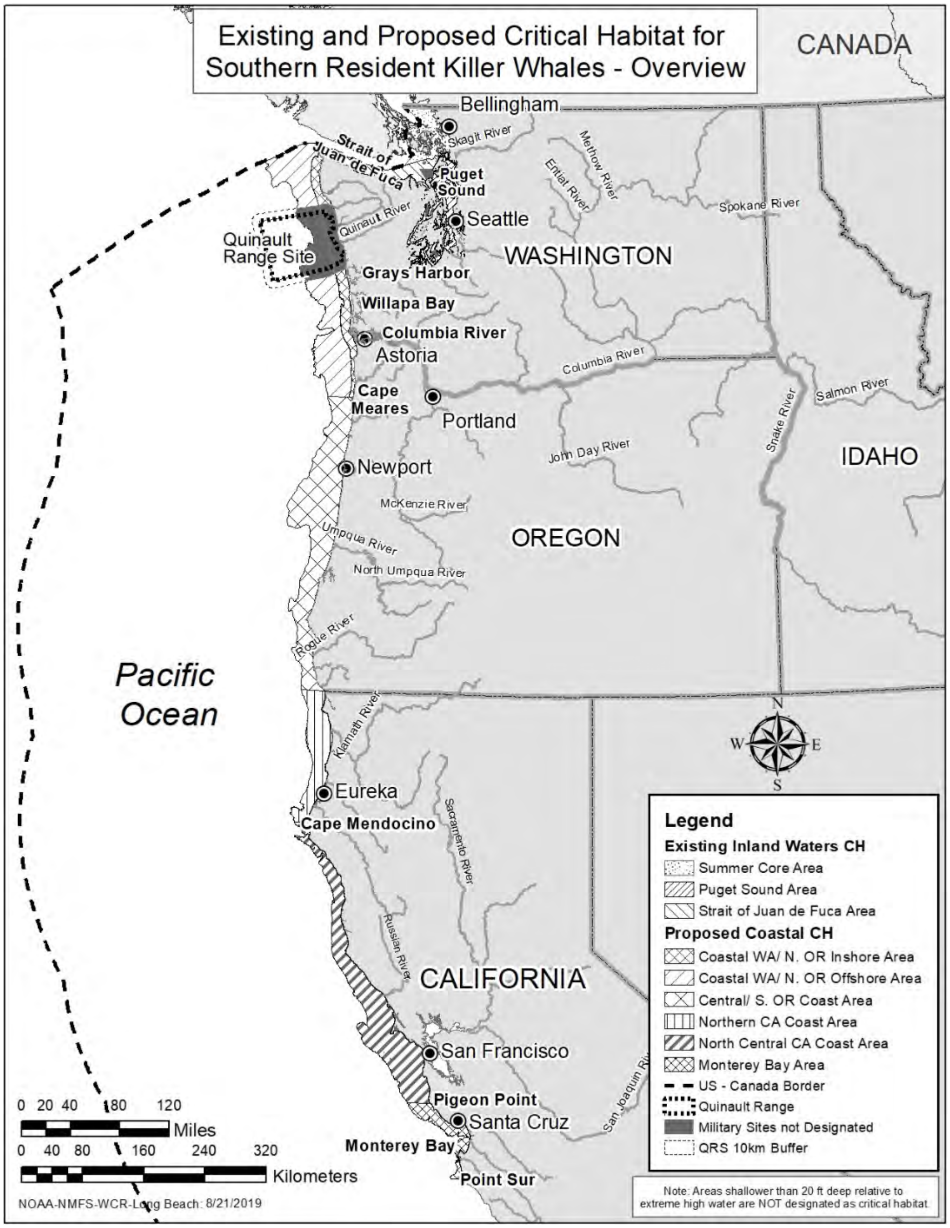

Figure 16. Southern Resident Killer Whale Critical Habitat

False Killer Whale

On July 24 2018, NOAA Fisheries designated critical habitat for the main Hawaiian Islands insular false killer whale DPS by designating waters from the 45-m depth contour to the 3,200-m depth contour around the main Hawaiian Islands from Ni'ihau east to Hawai'i (Figure 16). Island-associated marine habitat is an essential feature for the conservation of the main Hawaiian Islands insular false killer whale. Main Hawaiian Islands insular false killer whales are island-associated whales that rely entirely on the productive submerged habitat of the main Hawaiian Islands to support all of their life-history stages. The following characteristics of this habitat support insular false killer whales' ability to travel, forage, communicate, and move freely around and among the waters surrounding the main Hawaiian Islands:

1. Adequate space for movement and use within shelf and slope habitat;
2. Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth;
3. Waters free of pollutants of a type and amount harmful to main Hawaiian Islands insular false killer whales; and
4. Sound levels that would not significantly impair false killer whales' use or occupancy.

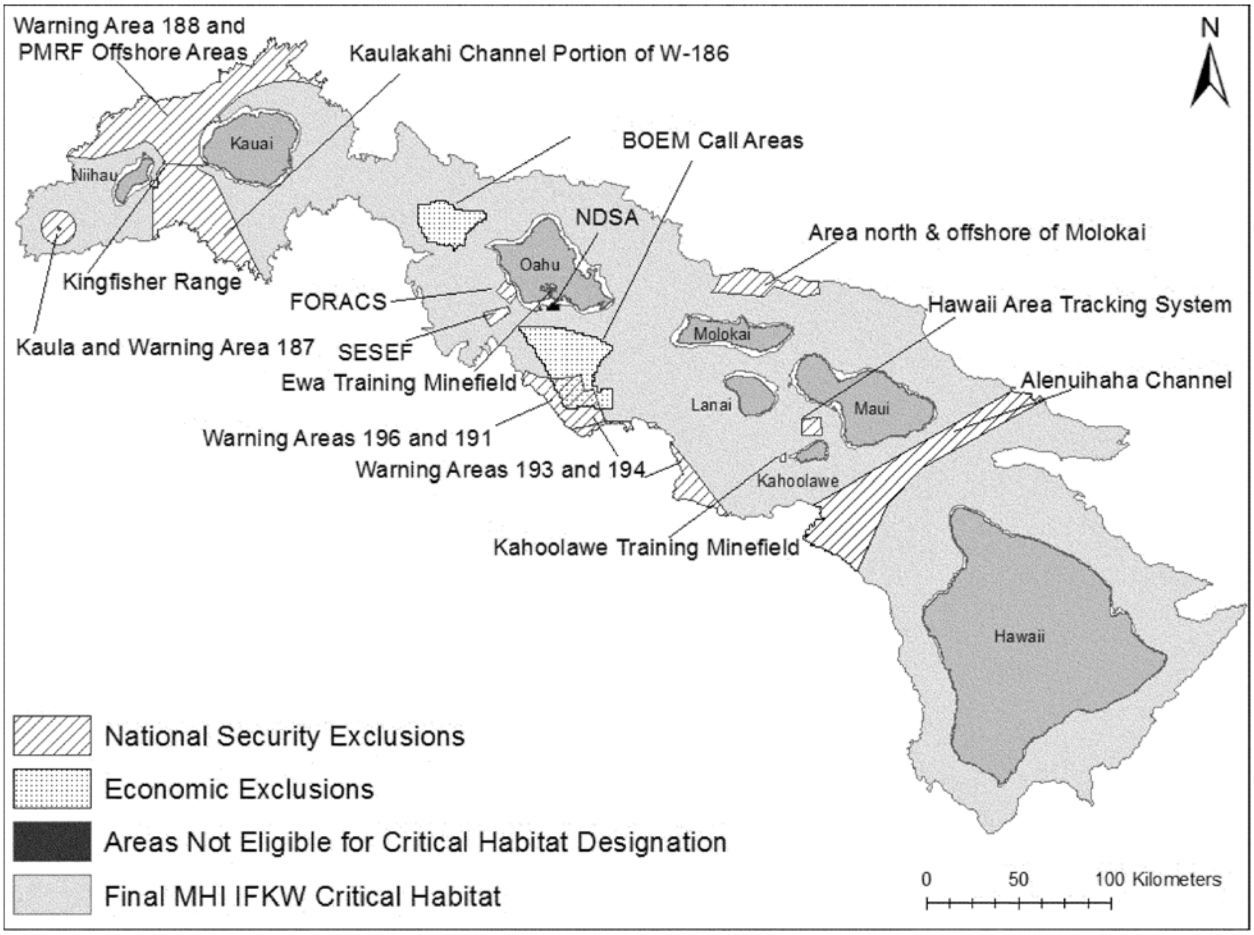

Figure 17. Main Hawaiian Islands insular DPS false killer whale critical habitat.

Hawaiian Monk Seal

NOAA Fisheries designated Critical Habitat for the Hawaiian monk seal in sixteen occupied areas within the range of the species (See series of Critical Habitat maps at: https://www.fisheries.noaa.gov/resource/map/hawaiian-monk-seal-critical-habitat-map), These areas contain one or more PBFs essential to Hawaiian monk seal conservation, including: preferred pupping and nursing areas, significant haul-out areas, and/or marine foraging areas out to 200 m in depth.

Northwestern Hawaiian Islands (Hawaiian names in parenthesis)

There are ten designated Hawaiian monk seal critical habitat areas in the Northwestern Hawaiian Islands that include all beach areas, sand spits, and islets, including all beach crest vegetation to its deepest extent inland, as well as the seafloor and marine habitat 10 m in height above the seafloor from the shoreline out to the 200 m depth contour around:

- Kure Atoll (Hōlanikū)
- Midway Atoll (Kuaihelani)
- Pearl and Hermes Reef (Manawai)
- Lisianski Island (Kapou)
- Laysan Island (Kamole)
- Maro Reef (Kamokuokamohoaliʻi)
- Gardner Pinnacles (ʻŌnūnui)
- French Frigate Shoals (Lalo)
- Necker Island (Mokumanamana)
- Nihoa Island

Main Hawaiian Islands

There are six designated Hawaiian monk seal critical habitat areas in the main Hawaiian Islands that include the seafloor and marine habitat to 10 m above the seafloor from the 200-m depth contour through the shoreline and extending into terrestrial habitat 5 m inland from the shoreline between identified boundary points around the following islands:

- Kaula Island (includes marine habitat only)
- Niʻihau (includes marine habitat from 10 to 200 m in depth)
- Kauaʻi
- Oʻahu
- Maui Nui (including Kahoʻolawe, Lānaʻi, Maui, and Molokaʻi)
- Hawaiʻi Island

Steller Sea Lion

Critical habitat for designated for the Steller sea lion includes specific rookeries, haul-outs, and associated areas, as well as three foraging areas that are considered to be essential for the health, continued survival, and recovery of the species. Critical habitat includes terrestrial, air and aquatic areas that support reproduction, foraging, resting, and refuge.
Critical habitat in Alaska includes a terrestrial zone extending 3,000 ft (0.9 km) landward from each major rookery and haul-out; it also includes air zones extending 3,000 ft (0.9 km) above these terrestrial zones and aquatic zones. Aquatic zones extend 3,000 ft (0.9 km) seaward from the major rookeries and haul-outs east of 144°W (Figure 17). West of 144° W, where the Western DPS is located, the aquatic zone extends 20 NM (37 km) seaward from the baseline or basepoint of each major rookery and major haul-out (Figure 18). In addition, NMFS designated special aquatic foraging areas as critical habitat for the Steller sea lion. These areas include the Shelikof Strait (in the Gulf of Alaska), Bogoslof Island, and Seguam Pass (the latter two are in the Aleutians). These sites are located near Steller sea lion abundance centers and include important foraging areas with large concentrations of prey.

Although within the range of the now delisted Eastern DPS, the designated critical habitat in California and Oregon remains in effect (Figure 19). In California and Oregon, major Steller sea lion rookeries and associated air and aquatic zones are designated as critical habitat. Critical habitat includes an air zone extending 3,000 ft (0.9 km) above rookery areas historically occupied by sea lions. Critical habitat also includes an aquatic zone extending 3,000 ft (0.9 km) seaward.

Figure 18. Steller Sea Lion Critical Habitat – Southeast Alaska

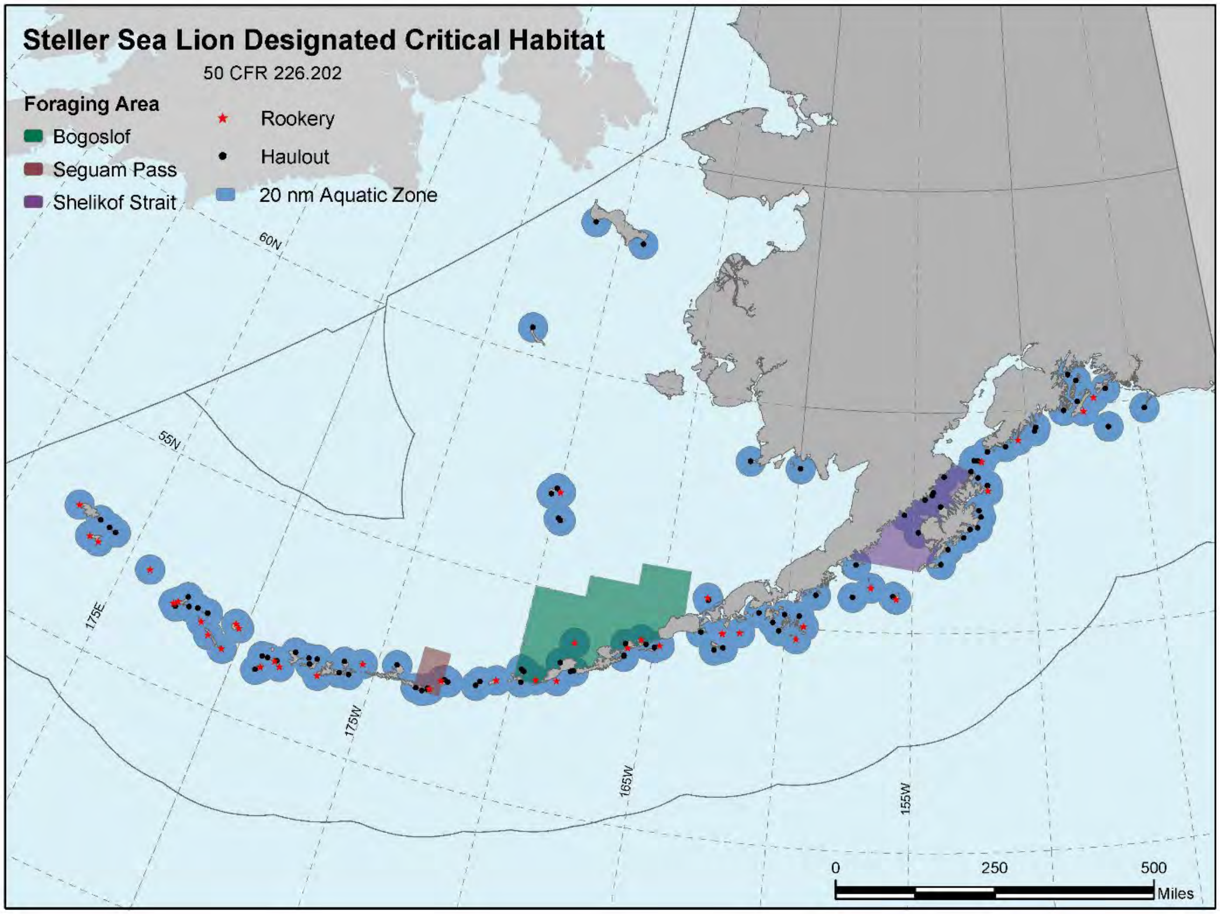

Figure 19. Steller Sea Lion Critical Habitat – Western Alaska

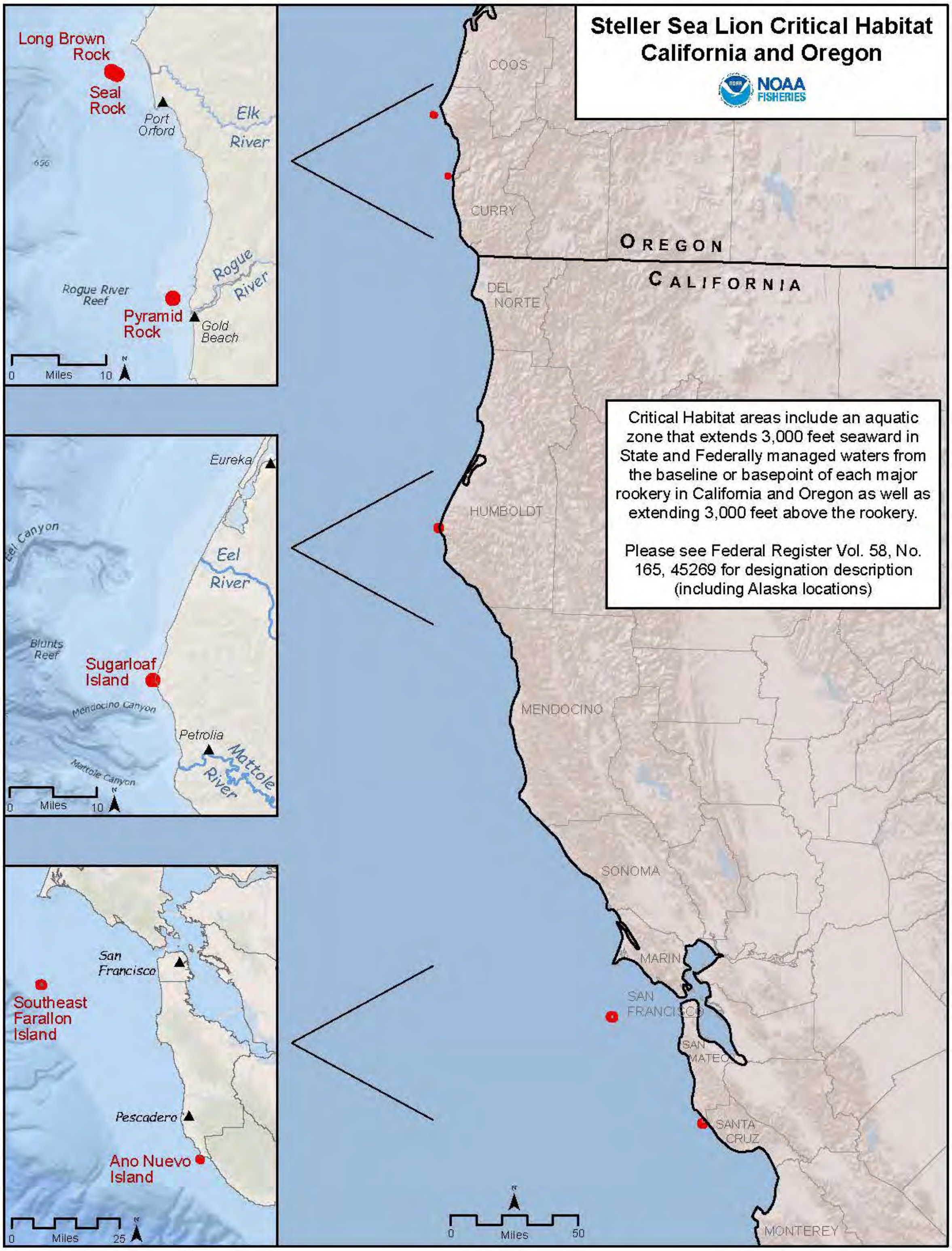

Figure 20. Steller Sea Lion Critical Habitat – Oregon and California

EFFECTS ANALYSIS

"Effects of the action" means all consequences to ESA-listed species or designated critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 C.F.R. §402.2).

The applicable standard to find that a proposed action is not likely to adversely affect ESA-listed species or designated critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or wholly beneficial. Beneficial effects have an immediate positive effect without any adverse effects to the species or habitat. Insignificant effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when plausible effects are going to happen, but will not rise to the level of constituting an adverse effect. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action that would be an adverse effect if it did affect an ESA-listed species), but it is very unlikely to occur.
The following subsections identify the potential stressors and analyze the potential effects of the proposed launch and reentry vehicle operations on the ESA-listed species and critical habitat in the action area.

Potential Stressors to ESA-Listed Species

Stressors are any physical, chemical, or biological agent, environmental condition, external stimulus, or event that may induce an adverse response in either an ESA-listed species or its designated critical habitat. Potential stressors to ESA-listed species from the proposed activities include the following:

- Impact by fallen objects: spacecraft, rocket parts, radiosonde;
- Entanglement in unrecovered parachutes and parafoils;
- Ingestion of material from unrecovered parachutes, parafoils, and weather balloon fragments;
- Exposure to hazardous materials;
- Exposure to sonic booms (overpressure) and impulse noise generated during spacecraft reentry or stage landings in the ocean;
- Ship strike; and
- Harassment by aircraft overflight.

Fallen objects, unrecovered parachutes/parafoils, and hazardous materials could also impact designated critical habitat. Potential effects to the ESA-listed species from these stressors are discussed in the following sections, followed by potential effects to the PBFs of designated critical habitat.

Impact by Fallen Objects

Boosters, fairings, spacecraft, and radiosondes from weather balloons falling through the atmosphere to Earth's surface have the potential to affect ESA-listed species marine species. Debris from a launch abort test or any launch failure anomalies could also have an effect. The primary concern is a direct impact from an object landing on an ESA-listed marine mammal, sea turtle or fish.

The action area where objects could splashdown encompasses vast expanses of ocean. ESA-listed species are sparsely distributed across these ocean expanses, resulting in very low densities of species overall. The probability of a direct impact to an ESA-listed species is thus extremely unlikely.

The same conclusion was reached when analyzing the Joint Flight Campaign missile testing from some of the same launch sites and overlapping areas of the Atlantic and Pacific Oceans (OPR-2021-02470). The BE for the Joint Flight Campaign utilized the best available density data for ESA-listed marine mammals and sea turtles, which is from the U.S. Navy's Marine Species Density Databases for training and testing areas in the Pacific and Atlantic (U.S. Navy 2017a and b, U.S. Navy 2018). Species densities were averaged across study areas within a proposed drop zone and the highest estimated densities across seasons were used to represent animal densities in the entire drop zone. For a flight test from VSFB, the maximum number of estimated animal exposures for any ESA-listed species in the broad ocean area is for fin whales at 0.00002 individuals, corresponding to a one in 50,000 chance of contacting a fin whale during a single test from VSFB. For a flight test from WFF, the maximum number of estimated animal exposures for any ESA-listed species in the broad ocean area is 0.000008 individuals for marine mammals (fin whales) and 0.00005 for sea turtles (loggerheads). This corresponds to a one in 121,000 chance of contacting a fin whale and a one in 22,000 chance of contacting a loggerhead turtle during a single test from WFF.

The very low probabilities of direct contact further illustrate the likelihood of ESA-listed mammals or sea turtles being in the same spot where these materials happen to land in vast open ocean areas is very low. Similar density data for ESA-listed fish species is not available, but most of the fish species that may be present in the action area do not spend much time near the surface where direct strikes could occur and often prefer deeper waters (e.g., eulachon, grouper, sawfish, sturgeons, salmonids). Additionally, a physical strike affecting a fish depends on the relative size of the object potentially striking the fish and the location of the fish in the water column. Because fish are likely able to detect an object descending in the water column (e.g., sensing the pressure wave or displacement of water) and are highly mobile, fish would likely swim away from an oncoming object. The oceanic whitetip shark, scalloped hammerheads and giant manta ray are known to spend time near the surface, likely to utilize sunlight-warmed waters, but are also known to dive to greater depths. However, the chance of any ESA-listed fish species being in the same spot where launch materials happen to land is highly unlikely, and therefore, the risk of being directly hit by any falling objects from launch operations is extremely low.

It is worth noting that materials have been expended from rocket launches for decades with no known interactions with any of the ESA-listed species considered in this programmatic. In summary, because it would be extremely unlikely for an ESA-listed species to be directly struck by launch vehicle components, spacecraft, radiosondes, and any launching or landing-related debris, the potential for effects to ESA-listed species from a direct impact by those fallen objects are discountable. Therefore, we conclude that direct impacts from fallen objects to ESA-listed marine mammals, sea turtles, and fish in the action area because of activities covered under this programmatic may affect, but are not likely to adversely affect these animals.

Entanglement

Spacecraft reentry and recovery operations and fairing recovery involve the use of parachutes and/or parafoils, which introduces the possibility of marine species becoming entangled in the parachute/parafoil material and attached lines, particularly if the material is not recovered by the launch operator. Entanglement can impact a marine animal by limiting its ability to move through the water for feeding, reproductive, or migratory purposes (Laist 1997). Materials entangled tightly around a body part may cut into tissues, enable infection, and severely compromise an individual's health, and may lead to death. A compromised individual is also less likely to be able to escape predation.

Drogue parachutes are the smallest and are cut away at altitude, which separates it from the spacecraft or fairing before the point of splashdown and so are more likely not to be recovered than the other parachutes and parafoils. The drogue parachute's primary material (nylon) is in the family of high molecular weight polymers, which are not easily degraded by abiotic (physical or chemical) or biotic processes (Haines and Alexander 1974). Photooxidative degradation, the process of decomposition of the material by light (most effectively by near-ultraviolet [UV] and UV wavelengths) would be the most effective source of damage exerted on the nylon parachute. However, the drogue parachute assembly becomes saturated within approximately one minute of splashing down and begins to sink. The drogue parachutes are expected to sink at a rate of approximately 1,000 ft in 46 minutes (or approximately 22 ft per minute; see Appendix A), rapidly sinking below the depths to which UV radiation penetrates in the oceans, eventually resting on the ocean floor where exposure to UV light would not occur, making photo-oxidation improbable. Once on the ocean floor, the relatively constant temperatures and lower oxygen concentration (as compared to the atmosphere) would slow the degradation process (Andrady 1990).

If the larger main parachutes or parafoils are not recovered, they will take longer than the drogue parachutes to become saturated and will sink more slowly, but even the largest parafoil is expected to sink at a rate of approximately 1,000 ft in 145.5 minutes (or approximately 7 ft per minute; see Appendix A). This still is a relatively short amount of time to pass through the water column, likely reaching the ocean floor within a matter of hours.

All parachutes and parafoils are meant to be recovered and they have been recovered during the majority of operations. Even if the parachutes or a parafoil are not recovered, they sink rather quickly and spend a short time passing through the water column. Fairing recovery typically takes place between 300-500 NM offshore and if any drogue parachutes or parafoils are not recovered, they are expected to settle (> 3,000 m [9,800 ft]). None of the ESA-listed species considered in this programmatic forage that deep, and therefore are not expected to encounter the settled parachutes or parafoils. SpaceX's Dragon spacecraft parachutes (drogue and main) are the only spacecraft parachutes that have been deployed to date for spacecraft re-entries. Missions use the Dragon spacecraft during contract support for NASA, delivering cargo to the International Space Station. Recovery of Dragon spacecraft reentering from resupply missions occurs offshore over deep waters (> 3,000 m [9,800 ft]), similar to the fairings. SpaceX has typically recovered the Dragon spacecraft within one hour of splashdown and subsequently recover parachutes.

However, there have two instances where sea and weather conditions during Dragon cargo spacecraft recovery created complications and SpaceX did not recover the parachutes. In 2020, a crewed test flight of Dragon-2 was conducted and the recovery operation was not as far offshore (approximately 27 NM), for human crew safety logistics, and therefore occurred over shallower water. The crewed Dragon test flight recovered both drogue parachutes and 3 of the 4 main parachutes. As the crewed Dragon flights become operational, procedures should become more efficient, including parachute retrieval. Crewed Dragon spacecraft missions will be less frequent than cargo missions and only expected to happen once or twice a year.

Considering the low occurrence of parachutes or parafoils not being recovered, the limited time they would spend in the water column and settling typically in the deep ocean, exposure of ESA-listed mammals, sea turtles, or fishes to the parachutes or parafoils is extremely unlikely and therefore the risk of entanglement is discountable.

Ingestion

Foraging individuals of ESA-listed species could be exposed and therefore risk ingesting, pieces of weather balloons, parachutes or parafoils.

Latex weather balloons typically have a diameter at launch of approximately 4 ft, but then rise to approximately 20–30 km where the volume increases to the point where the elastic limit is reached and the balloon bursts. The temperature at this altitude range can reach negative 40 degrees Fahrenheit (°F) and even colder. Under these conditions of extreme elongation and low temperature, the balloon undergoes "brittle fracture" where the rubber actually shatters along grain boundaries of crystallized segments. The resultant pieces of rubber are small strands comparable to the size of a quarter (Burchette 1989). This was confirmed by researchers at the University of Colorado and NOAA (University of Colorado and NOAA 2017). The small shreds then make their way back to the surface of the Earth and are expected to land in the ocean. Along the way, the pieces can be subject to movements in atmospheric pressure and wind as they sink through the air. This can cause the fragments to become scattered and disperse before landing on the surface of the ocean where they are subject to movement of surface currents, which can cause additional dispersion.

The balloon fragments would be positively buoyant, float on the surface, and begin to photo-oxidize due to UV light exposure. Studies have shown latex in water will degrade, losing tensile strength and integrity, though this process can require multiple months of exposure time (Pegram and Andrady 1989; Andrady 1990; Irwin 2012). Field tests conducted by Burchette (1989) showed latex rubber balloons are very degradable in the environment under a broad range of exposure conditions, including exposure to sunlight and weathering and exposure to water. The balloon samples showed significant degradation after six weeks of exposure (Burchette 1989).

The floating latex balloon fragments would provide substrate for algae and eventually be weighed down with growth of heavier epifauna, such as tunicates (Foley 1990). The degree to which such colonization may occur will correspond to the amount of time the balloon remains at or near the ocean's surface. Additionally, an area's geographic latitude (and corresponding climatic conditions) has a marked effect on the degree of biofouling on marine debris. Fouling of the latex shreds could be confused with organic matter while ESA-listed species are foraging. Green sea turtles are herbivorous and a large study of green sea turtles that stranded in Texas between 1987 and 2019, discovered 48% had ingested plastic, although there was no evidence of mortality related to the ingestion of the plastics (Choi et al. 2021). A study of latex balloon fragment ingestion by freshwater turtles and catfish found no significant impact on survival or blood measured indicators of stress response (Irwin 2012).

In addition to further degradation of the latex material, the embedded fouling organisms would cause the material to become negatively buoyant, making it slowly sink to the ocean floor. Studies in temperate waters have shown that fouling can result in positively buoyant materials (e.g., plastics) becoming neutrally buoyant, sinking below the surface into the water column after only several weeks of exposure (Ye and Andrady 1991; Lobelle and Cunliffe 2011), or descending farther to rest on the seafloor (Thompson et al. 2004).

Given the small balloon shreds are likely to be scattered and not concentrated, and they should only be available in the upper portions of the water column on the order of weeks, the potential for exposure of ESA-listed marine species to these shreds is extremely low and therefore discountable.

As stated previously, operators expect to recover parachutes/parafoils soon after splashdown and in the rare occasion they are not recovered (a few each year, see Appendix A), the parachutes/parafoils will sink to the seafloor within a matter of hours. As discussed previously, the degradation of parachute and parafoil materials will be a slow process that takes place after the materials have settled on the sea floor. It is possible that small fragments could temporarily resuspend in the water column, but the potential for this depends on local ocean floor conditions and the fragments are not expected to resuspend high in the water column where they would likely be encountered by ESA-listed species. As previously discussed recovery operations typically take place far offshore (e.g. 300-500 NM) and any drogue parachutes or parafoils not recovered are expected to settle (> 3,000 m [9,800 ft]). None of the ESA-listed species considered in this programmatic forage that deep, therefore, the likelihood of them encountering ingestible material once it has settled over the long-term is expected to be extremely unlikely to occur and thus discountable.

We conclude that the risk of ingesting pieces of weather balloons, parachutes or parafoils to ESA-listed marine mammals, sea turtles, and fish in the action area because of activities covered under this programmatic may affect, but are not likely to adversely affect these animals.

Exposure to Hazardous Materials

Hypergolic fuels (e.g., NTO and MMH) may be on the spacecraft during a splashdown. A spacecraft's propellant storage is designed to retain residual propellant, so any propellant remaining in the spacecraft is not expected to be released into the ocean. In an event the propellant tank actually ruptures on impact, the propellant would evaporate or be quickly diluted.

In the event of a failed launch operation, launch operators will follow the emergency response and cleanup procedures outlined in their Hazardous Material Emergency Response Plan (or similar plan). Procedures may include containing the spill using disposable containment materials and cleaning the area with absorbents or other materials to reduce the magnitude and duration of any impacts. In most launch failure scenarios, at least a portion of the propellant will be consumed by the launch/failure, and any remaining propellant will evaporate within hours or be diluted by seawater and degrade over time (timeframes are variable based on environmental conditions, but generally hours to days).

Launch vehicles and spacecraft are designed to retain propellants and even if there is a rare launch failure (> 93% success rate over 30 years), propellants will evaporate and be diluted within hours. The chance for ESA-listed marine species to be exposed to the residual propellants from a splashdown or launch failure is extremely low and therefore discountable. Therefore, we conclude that hazardous material exposure to ESA-listed marine mammals, sea turtles, and fish in the action area because of activities covered under this programmatic may affect, but are not likely to adversely affect these animals.

Exposure to Sonic Booms and Impulse Noise

A sonic boom will be generated during spacecraft reentry and stage landings in the ocean. Due to the shape and size of existing spacecraft and spacecraft in development, as well as the altitude at which reentering spacecraft generate a sonic boom, the FAA, USSF, and NASA do not expect the overpressure from reentering spacecraft to exceed 1 psf. An overpressure of 1 psf is similar to a thunderclap. For boosters that can currently land on a barge in the ocean (e.g., SpaceX Falcon series), overpressures at the ocean's surface could be up to 8 psf. For the Super Heavy, which is currently in developmental stages and expected to be operational soon, overpressures at the ocean's surface could be up to 15 psf from ocean barge landings. Boom intensity, in terms of psf, is greatest under the flight path and progressively weakens with horizontal distance away from the flight track. Based on modeling for landings at the Boca Chica Launch Site, the area beneath the stage receiving the maximum overpressure (up to 15 psf) as it is landing could be up to 1.28 km in diameter.

Overpressure from sonic booms are not expected to affect marine species underwater. Acoustic energy in the air does not effectively cross the air/water interface and most of the noise is reflected off the water surface (Richardson et al. 1995). The landing platform barge will also act as a barrier to the most intense portion of overpressure from landings. In addition, underwater sound pressure levels from in-air noise are not expected to reach or exceed threshold levels for injury or harassment to ESA-listed species.

Previous research conducted by the USAF supports this conclusion with respect to sonic booms, indicating the lack of harassment risk for protected marine species in water (U.S. Air Force Research Laboratory 2000). The researchers were using a threshold for harassment of marine mammals and sea turtles by impulsive noise of 12 pound per square inch (psi) peak pressure and/or 182 decibels (dB) referenced (re) to the standard unit of acoustic pressure underwater, 1 micro Pascal (μPa), which is an older threshold used by NMFS and DoD at the time. The researchers pointed out that, to produce the 12 psi in the water, there needs to be nearly 900 psf at the water surface, assuming excellent coupling conditions. They also noted that it is very difficult to create sonic booms that even approach 50 psf. Current thresholds utilized by NMFS for behavioral disturbance from impulsive acoustic sources are lower (in water, re 1 μPa: 175 dB sea turtles, 160 dB marine mammals, 150 dB fishes) but these are root mean square (rms) values and not peak pressure values.. The rms is a square root of the average of sound signal pressures that have been squared over a given duration. Due to the squaring and averaging of sound pressure values (which tends to level out large values), the rms, results in a more conservative value than just a peak value. Still, what the USAF research report illustrates is that it would take a tremendously greater sonic boom than what is generated by the booster stage landings to create an acoustic impact underwater that could approach disturbing ESA-listed marine mammals, sea turtles or fish. Therefore, any effect from the sonic booms on ESA-listed species while under water would be insignificant.

ESA-listed marine mammals and sea turtles could be exposed to the overpressures from sonic booms in the air when they are surfacing for air; however, the chances of both events happening at same time (i.e., species surfacing and a sonic boom occurring) is extremely unlikely, especially considering the length of a sonic boom is less than one second. The Guadalupe fur seal, Hawaiian monk seal, and Steller sea lion can spend time hauled out of the water and therefore may be affected by an in-air sonic boom. The potential for effect would only be present during spacecraft reentry missions occurring in the Pacific Ocean and rocket booster landing are not planned near areas where these species haul out. Spacecraft reentry in the Pacific Ocean would generate sonic booms at high altitudes (approximately 50,000 ft). The magnitude of the high altitude sonic boom overpressure that has the potential to impact land areas where Guadalupe fur seals, Hawaiian monk seals, and Steller sea lions may be present is low (1 psf or lower). Therefore, the effect of these sonic booms is unlikely to create any meaningful disturbance for these ESA-listed pinnipeds when they are out of the water.

The 2019 MMPA Letter of Authority for VSFB launch operations arrived at a similar conclusion (84 FR 14314). Over 20 years of monitoring data for species including harbor seals (*Phoca vitulina*), elephant seals (*Mirounga angustirostris*), and California sea lions (*Zalophus californianus*) at VSFB and the North Channel Islands (CA), show reactions to sonic booms tend to be insignificant when not above 1.0 psf. Observational data do not include the ESA-listed pinnipeds considered in this programmatic, but the long time series data for other species serve as a proxy indicating this category of sonic booms for marine mammals that haul out of water do not result in disturbance at low overpressures.

In summary, it is extremely unlikely that an ESA-listed sea turtle or marine mammal would surface close to a landing booster at the exact moment to be exposed to a sonic boom (greater than 1 psf) in the air, therefore the effects are discountable. Any ESA-listed sea turtles, marine mammals or fishes underwater are not expected to be exposed to measurable acoustic effects from a sonic boom therefore, the effects are insignificant. The low level sonic boom (not above 1 psf) resulting from spacecraft reentry at high altitude in the Pacific, is not expected to create any significant disturbance to hauled out ESA-listed pinnipeds and the effects are therefore insignificant.

Ship Strike

Ships and other watercraft vessels are used to recover launch vehicle stages that land on a platform in the ocean, as well as to recover spacecraft and payload fairings. Vessels may also be used for surveillance to ensure that designated hazard areas are clear of non-participating crafts. These watercraft operations have potential to result in a ship strike of ESA-listed species that spend time at or near the surface of the water (e.g., marine mammals, sea turtles, giant manta ray, oceanic whitetip shark, and scalloped hammerhead). ESA-listed marine mammals and sea turtles can spend time at the surface, but most of their time is spent submerged. Giant manta ray, oceanic whitetip and scalloped hammerhead sharks can also spend time at or near the ocean surface and be subject to potential ship strikes, but they also dive to great depths. All vessels would be required to comply with the *Environmental Protection Measures* for vessel operations. All watercraft would have a dedicated observer on board, adhere to maintaining minimum safety distances between ESA-listed species and vessels, and reduce speed as required.

During the portion of time that ESA-listed marine mammals, sea turtles, and some elasmobranch fish species may spend near the ocean surface, ship strikes are considered extremely unlikely to occur and therefore discountable, due to the use of dedicated observation personnel and safety procedures for avoidance. Based on previous operation reports provided as part of ESA section 7 consultations for similar operations, there have not been reported vessel collisions with ESA-listed marine species.

Rice's whale requires additional consideration due to its very low population size (likely < 50) and its ecology. The Rice's whale dives deep during the day to forage but at night tends to stay just below the surface, increasing the chance of the animal being struck at night. The *Vessel Operations* measures in the PDCs for this programmatic consultation include the condition that recovery and vessel transit will not occur at night in the Rice's whale core distribution area. The PDCs for this programmatic consultation stipulate only one splashdown, a reentry and recovery of the Dragon capsule, may occur in Rice's whale core habitat distribution area per year. These restrictions will ensure the effects of vessel strike due to recovery vessel operations are discountable.

We conclude that the risk of ship strike to ESA-listed marine mammals, sea turtles, and fish in the action area because of activities covered under this programmatic may affect, but are not likely to adversely affect these animals.

Aircraft Overflight

Noise from aircraft overflight may enter the water, but, as stated in relation to sonic booms, very little of that sound is transmitted into water. Sound intensity produced at high altitudes is reduced when it reaches the water's surface. At lower altitudes, the perceived noise will be louder, but it will decrease rapidly as the aircraft moves away. Individual ESA-listed species that occur at or very near the surface (e.g., marine mammals, sea turtles, giant manta ray and sharks) at the time of an overflight could be exposed to some level of elevated sound. There could also be a visual stimulus from overflight that could potentially lead to a change in behavior. Both noise and visual stimulus impacts would be temporary and only occur if an individual is surfacing or very close to the surface and an aircraft happens to be flying over at the same time.

Studies in the Gulf of Mexico found that most sperm whales dive when overflown by fixed wing aircraft (Wursig et al. 1998). Richter et al. (2006) documented only minor behavioral effects (i.e., both longer surface time and time to first vocalization) of whale-watching aircraft on New Zealand sperm whales. However, details on flight altitude were not provided. Smultea et al. (2008) studied sperm whales in Hawai‘i, documenting that diving responses to fixed winged overflights occurred at approximately 820 ft above ground level (AGL).

Patenaude et al. (2002) observed bowhead whales, which are not a species considered in this consultation but serve as an example for mysticetes, during spring migration in Alaska and recorded short-term responses to fixed-wing aircraft activity. Few (approximately 2%) of the observed bowheads reacted to overflights (between 200 and 1,500 AGL), with the most common behavioral responses being abrupt dives, short surfacing episodes, breaching, and tail slaps (Patenaude et al. 2002). Most of these responses occurred when the aircraft was below altitudes of 600 ft (Patenaude et al. 2002), which is below the altitude expected to be flown by fixed wing aircraft during project-related surveillance for the activities considered in this consultation.

Species-specific studies on the reaction of sea turtles to fixed wing aircraft overflight are lacking. Based on sea turtle sensory biology (Bartol and Musick 2003), sound from low-flying aircraft could likely be heard by a sea turtle at or near the ocean surface. Sea turtles might be able to detect low-flying aircraft via visual cues such as the aircraft's shadow, similar to the findings of Hazel et al. (2007) regarding watercraft, potentially eliciting a brief reaction such as a dive or lateral movement. However, considering that sea turtles spend a significant portion of their time below the sea surface (Lutcavage and Lutz 1997) and the low frequency and short duration of surveillance flights, the probability of exposing an individual to an acoustically or visually-induced stressor from aircraft momentarily flying overhead would be very low. The same is relevant for giant manta rays and the ESA-listed shark species in the action area, considering their limited time near the surface and brief aircraft overflight.

As stated in the *Environmental Protection Measures*, spotter aircraft will maintain a minimum of 1,000 ft over ESA-listed or MMPA-protected species and 1,500 ft over North Atlantic right whales. Additionally, aircraft will avoid flying in circles if marine mammals or sea turtles are spotted to avoid any type of harassing behavior. The chances of an individual ESA-listed species being exposed to the proposed aircraft overflights are extremely low. Given the limited and temporary behavioral responses documented in available research, it is expected that potential effects on ESA-listed species, should they even occur, would be insignificant. We conclude that effects from aircraft overflight to ESA-listed marine mammals, sea turtles, and fish in the action area because of activities covered under this programmatic may affect, but are not likely to adversely affect these animals.

Critical Habitat

A common element across several of the designated critical habitats in the action area that may be affected by the proposed action is water quality: green sturgeon, Gulf sturgeon, Southern Resident DPS killer whale, and Main Hawaiian Islands Insular DPS false killer whale critical habitat include PBFs for water quality. Water quality may be temporarily degraded as a result of a launch failure. Potential effects to water quality could result from debris and propellants. Recovery activities and any emergency response and cleanup procedures would reduce the magnitude and duration of any impacts. As previously discussed, propellants are expected to evaporate and quickly become diluted, limiting any impacts to a temporary duration. Given the unlikely scenario of a launch failure and the brief exposure of residual propellants from splashdowns, it is highly unlikely that water quality features would become degraded to the extent the conservation value of the critical habitats are impacted.

Most of the proposed operations would occur well offshore in deep waters. Landing and recovery operations would not occur within 5 NM of the coast where most of the critical habitat for green sturgeon is located. The same is true for Gulf sturgeon, except for Cedar Key, Florida, but it is far away from flight trajectories from the Boca Chica Launch Site. It is very unlikely that any launch or reentry operations would occur within that portion of Gulf sturgeon critical habitat. Unit 2 of the North Atlantic right whale critical habitat occurs off the coast of CCSFS and extends seaward approximately 5 NM off the coast. Keeping operations out of the first 5 NM from shore helps avoid this critical calving area. Operations are not expected to have any impact on the oceanic features near the Unit 2 calving area such as sea temperature, sea state or depth. PBFs for Hawaiian monk seal conservation include significant haul-outs and preferred pupping/nursing areas. Operations will not occur in or near those areas. Critical habitat for Steller sea lions includes major rookeries, haul-outs, and associated zones extending 3,000 ft (0.9 km) landward, in the air above, or into the water from those major rookeries and haul-outs, that support reproduction, foraging, resting, and refuge. Operations will not occur in those zones. West of 144° W, where the Western DPS Steller sea lion is located, the critical habitat aquatic zone extends 20 NM (37 km) seaward from the baseline or basepoint of each major rookery and major haul-out. If operations cannot comply with the PDC that landings will not occur in those 20 NM aquatic zones, they will require a project-specific review.

Migratory passage and adequate space for movement are features common to Southern Resident DPS killer whale, Main Hawaiian Islands Insular DPS false killer whale, and Northwest Atlantic Ocean DPS loggerhead sea turtle critical habitats. As stated previously, no operations will occur in the immediate nearshore environment (< 5 NM), resulting in a considerable amount of those critical habitats not being affected by the proposed action. Landing and reentry operations will typically be much farther out but, even if they were to occur close to the 5 NM limit, they are temporary with no long-term occupation or structures creating obstructions to movement, thus any potential effects are likely to be insignificant.

Prey and foraging areas are other common elements across several of the designated critical habitats in this consultation: leatherback, Southern Resident DPS killer whale, Main Hawaiian Islands Insular DPS false killer whale, North Pacific right whale; Western North Pacific, Central America, and Mexico DPSs of humpback whales; and Hawaiian monk seal and Steller sea lion foraging areas. As previously stated, sound from sonic booms is not expected to enter the water with enough intensity to create any significant disturbances to ESA-listed species and the effects of this sound is also expected to be insignificant for zooplankton or small pelagic schooling fishes that are the important prey species for these critical habitats. Pieces of weather balloons or parachutes/parafoils are not expected to be available to prey species in sufficient concentrations to measurably affect prey populations. Considering the rare occurrence of not recovering parachutes/parafoils, as the parachutes/parafoils begin to become saturated with seawater and begin to sink, prey fish species should be able to detect the object and move out of the way (as previously discussed for fishes) and the chance of entanglement is extremely unlikely to occur and thus discountable. Prey zooplankton species may have less of an ability to move out of the way and therefore some could get entrapped in the parachute/parafoil. The removal of a small amount of zooplankton is not expected to reduce the conservation value of that PBF in any designated critical habitats and therefore the effect will be insignificant.

A unique PBF for Main Hawaiian Islands Insular DPS false killer whale critical habitat is sound levels that would not significantly impair false killer whales' use or occupancy. As previously stated, sound of any intensity that would create meaningful disturbance underwater is not an expected effect from proposed operations.

Oceanographic conditions supporting *Sargassum* habitat having adequate abundance and cover for post hatchlings and prey is a PBF for Northwest Atlantic Ocean DPS loggerhead sea turtle critical habitat. The scale of operations are not large enough to affect boundary currents or areas of convergence that promote the aggregation of *Sargassum*. Any potential impacts to these features are expected to be very small and temporary, and therefore insignificant.

In summary, the effects associated with stressors from launch and reentry operations that are part of the proposed action may affect, but are not expected to adversely affect any of the designated critical habitats in the action area.

Additive Effects

We have concluded the proposed launch and reentry vehicle operations in the marine environment, when in compliance with the requirements of this programmatic, are not likely to adversely affect ESA-listed marine mammals, sea turtles, and fishes or designated critical habitat for green sturgeon, Gulf sturgeon, leatherback sea turtle, Northwest Atlantic Ocean DPS loggerhead sea turtle, North Atlantic right whale, North Pacific right whale; Western North Pacific DPS, Central America DPS, and Mexico DPS of humpback whales; Southern Resident DPS killer whale, Main Hawaiian Islands Insular DPS false killer whale, Hawaiian monk seal, and the Western DPS Steller sea lion. Programmatic consultations often involve actions that may occur with some frequency over many years and possibly continue for an indefinite time. As a result, we evaluate the potential for the effects of the stressors to ESA-listed species and designated critical habitat over the lifetime of the proposed action to result in additive effects due to chronic stress or cumulative effects. Therefore, we determine if, when considered additively, the effects of stressors associated with the launch and reentry vehicle operations in the marine environment that are part of the proposed action are likely to adversely affect the aforementioned ESA-listed species and designated critical habitat.

The USSF (and previously USAF), NASA, and commercial space operations with authorization from the FAA have been conducting launch and reentry vehicle operations for decades with little documented impact to the marine environment as a whole, including a lack of reported incidences affecting ESA-listed species and designated critical habitats in the action area. The activities considered in this programmatic consultation will occur across large expanses of open water in the Atlantic and Pacific Oceans, and the Gulf of Mexico. Each of the stressor categories (see *Effects of the Action*) were determined to have effects that are extremely unlikely to occur and therefore discountable, or to result in effects that are so small as to be insignificant. The possibility of the discountable effects overlapping in time and space and having a cumulative effect to ESA-listed species and designated critical habitat in the action area does not seem plausible considering the limited time operations occur in a small portion of the vast action areas. Within the same reasoning, chronic stress from activities whose effects are considered insignificant also does not seem plausible. Therefore, additive effects from the activities considered in this consultation are extremely unlikely and thus discountable.

CONCLUSION

Based on this analysis, NMFS ESA Interagency Cooperation Division concurs with the FAA, NASA and the USSF, that the proposed action may affect, but is not likely to adversely affect ESA-listed species and designated critical habitat.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on ESA-listed species or critical habitat, to help implement recovery plans or develop information (50 C.F.R. §402.02).

As previously stated, the Rice's whale population is likely less than 50 individuals and therefore at high risk from threats that could reduce their numbers. Vessel strike is one of those threats. As discussed in the *Effects Analysis*, spacecraft recovery vessel activities are not likely to adversely affect ESA-listed marine mammals such as the Rice's whale. Even though one Dragon capsule splashdown and recovery per year in the Rice's whale core distribution area is not considered a significant threat, we are using this opportunity within this programmatic consultation to emphasize the conservation priority of avoiding the area, especially depths greater than 100 m deep. We also want to take this opportunity to address debris that originates from space launch and reentry operations, even though it is mostly expected to sink and settle in deep water, any reduction of debris in the marine environment could benefit all marine wildlife, including ESA-listed species.

The following conservation recommendations are discretionary measures that NMFS believes are consistent with the Federal action agencies' obligation under section 7(a)(1) and therefore should be carried out where applicable:

- Every effort should be made to move spacecraft capsule splashdowns closer to shallow edges of the Rice's whale core distribution area boundaries. Moving out of the area altogether is preferred.
- No vessel transit should take place in the Rice's whale core distribution area unless to specifically to pick up the capsule and then immediately exit at the nearest boundary edge while staying out of the core habitat area with depths of 100 m to 425 m, where the Rice's whale has been observed (Rosel et al. 2021).
- The action agencies should coordinate with NMFS ESA Interagency Cooperation Division to foster collaboration with the NOAA Marine Debris Program (MDP), in order to evaluate how activities of the MDP may apply to debris that originates from space launch and reentry operations (e.g., expended vehicle components).

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects on, or benefiting, ESA-listed species or their critical habitat, the FAA, NASA, and/or USSF (as applicable) should notify the ESA Interagency Cooperation Division and SERO of any conservation recommendations implemented as part of activities included in this programmatic consultation. This information can be included in annual reports.

REINITIATION OF CONSULTATION

Reinitiation of consultation is required and shall be requested by the federal agency, where discretionary federal involvement or control over the action has been retained or is authorized by law and:

1. New information reveals effects of the action that may affect an ESA-listed species or designated critical habitat in a manner or to an extent not previously considered;
2. The identified action is subsequently modified in a manner that causes an effect to the ESA-listed species or designated critical habitat that was not considered in this concurrence letter;
3. Take of an ESA-listed species occurs; or
4. A new species is listed or critical habitat designated that may be affected by the identified action (50 C.F.R. §402.16).

Please direct questions regarding this letter to Dr. Soren Dahl, Consulting Biologist, at (301) 427-8495 or soren.dahl@noaa.gov, or me at (301) 427-8493 or lisamarie.carrubba@noaa.gov.

Sincerely,

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Cc: USSF, NASA

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APPENDIX A – PARACHUTE INFORMATION PROVIDED TO NMFS BY THE FAA

A.1 Spacecraft Parachutes

Two sets of parachutes are typically used during spacecraft re-entry: drogue and main parachutes. The drogue parachutes are thin parachutes deployed during reentry to gain control of the spacecraft at speeds that would destroy larger parachutes and therefore are deployed before the larger and thicker main parachutes (see Figure A-1). Spacecraft can be rigged with two drogue parachutes. Each drogue parachute has a diameter of approximately 19 feet with 72 feet of risers/suspension and are made of variable porosity conical ribbon. The drogues typically land within 0.5–1 mile from the spacecraft.

Shortly after the drogue parachutes are deployed, they are released, and the main parachutes are deployed (see Figure A-1). The main parachutes slow the spacecraft to a speed of approximately 13 miles per hour allowing for a "soft" splashdown in the water. The main parachutes are made of Kevlar and nylon and have a diameter of approximately 116 feet with 147 feet of risers/suspension. Spacecraft may be rigged with up four main parachutes.

Figure A-1. Main Parachutes with Released Drogue Parachutes in the Background (SpaceX Dragon)

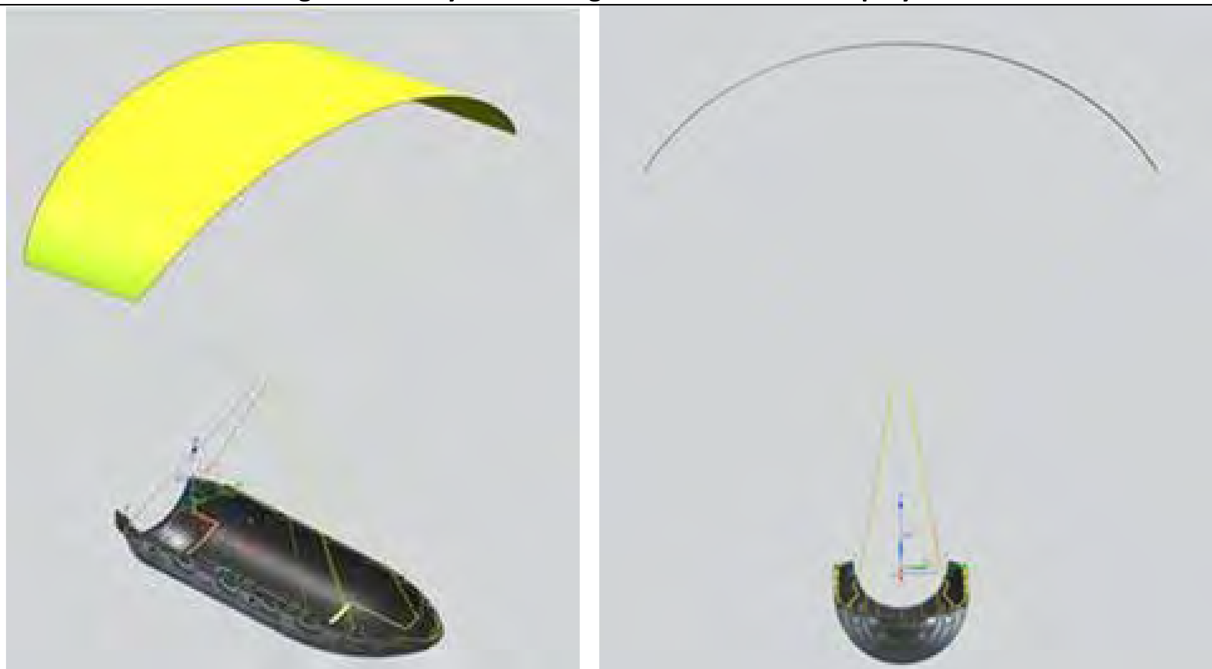
SpaceX's Dragon parachutes (drogue and main) are the only spacecraft parachutes that have been deployed to date for spacecraft re-entries. The parachutes remain floating on the surface enabling the recovery operations. However, due to sea and weather conditions, there have been two instances where SpaceX did not recover Dragon's main parachutes. Similarly, there have been four instances where SpaceX did not recover Dragon's drogue parachutes. Refer to the FAA's 2018–2020 annual reports sent to NMFS regarding SpaceX launch recovery efforts.

A.2 Payload Fairing Parachutes

SpaceX has designed a parachute system to enable recovering of payload fairings. Other launch operators may do the same in the future. SpaceX's parachute system consists of one drogue parachute and one parafoil (see Figures A-2 and A-3).

Figure A-2. Fairing Parafoil

Figure A-3. Payload Fairing Half with Parafoil Deployed



The parachute system slows the decent of the fairing to enable a soft splashdown such that the fairing remains intact. Following re-entry of the fairing into Earth's atmosphere, the drogue parachute is deployed at a high altitude (approximately 50,000 feet) to begin the initial slow down and to extract the parafoil. The drogue parachute is then cut away following the successful deployment of the parafoil. Refer to the FAA's 2018–2020 annual reports sent to NMFS regarding SpaceX launch recovery efforts.

Two parachute systems for the fairing may be used (Type 1 and Type 2). The specifications of each system are noted below (Tables A-1 and A-2). The Type 2 system has a similar drogue parachute as the Type 1 system but a larger and lighter parafoil than Type 1. Type 1 drogue parachute risers are made of Kevlar with nylon overwrap. Type 1 parafoil risers, for which there are four, are made of nylon with Kevlar overwrap. Type 2 drogue parachute risers are made of Kevlar. Type 2 parafoil risers, for which there are four, are made of nylon.

Table A-1. Specifications of Type 1 and Type 2 Fairing Drogue Parachutes

Drogue Type	Canopy Material	Area (ft^2)	Suspension Line Material	Deployment Bag (ft^2)[a]
Type 1	Nylon	63.59	Kevlar	28[b]
Type 2	Nylon	113	Kevlar	28[c]

[a] The deployment bag is part of the drogue parachute assembly; the two components are connected.

[b] Spectra cloth with Kevlar webbing.

[c] Nylon cloth.

ft^2 = square feet

Table A-2. Specifications of Type 1 and Type 2 Fairing Parafoils

Parafoil Type	Canopy Material	Area (ft^2)	Suspension Line Length (ft)
Type 1	Nylon	1,782	42.6
Type 2	Nylon	3,000	50

ft = feet; ft^2 = square feet

The projected sink rates for both types of drogue parachutes and parafoils are shown below (Tables A-3 to A-6 and Figures A-4 to A-7). As indicated in the figures, both types of drogue parachutes are expected to sink at a rate of approximately 1,000 feet in 46 minutes (or approximately 22 feet per minute). The Type 1 parafoil is expected to sink at a rate of approximately 1,000 feet in 63 minutes (or approximately 16 feet per minute). The Type 2 parafoil is expected to sink at a rate of approximately 1,000 feet in 145.5 minutes (or approximately 7 feet per minute). These estimated sink rates were calculated using a NASA method/spreadsheet for estimating sink rates of parachutes and balloons. The spreadsheet provides steady-state sink rates in water for parameters inputted by the user. There are conservative assumptions built in the spreadsheet, such as assuming the parachute remains open during the entire in-water descent, slowing the descent velocity, when, in actuality, the parachute could either collapse or become entangled in the other flight train components. The calculations present the most conservative (slowest) sink rates.

Table A-3. Projected Sink Rate for Type 1 Drogue Parachute

Properties	
Sum of masses:	18.2 pounds
Sum of buoyancy forces:	8.73 pounds
Sum of drag areas:	73 square feet
Sink Rate	
Terminal velocity of system in water:	0.36 feet/second
Sink time per 1,000 ft of depth:	46.2 minutes
Sink time per 100 m of depth:	15.17 minutes

Figure A-4. Sink Rate Chart for Type 1 Drogue Parachute

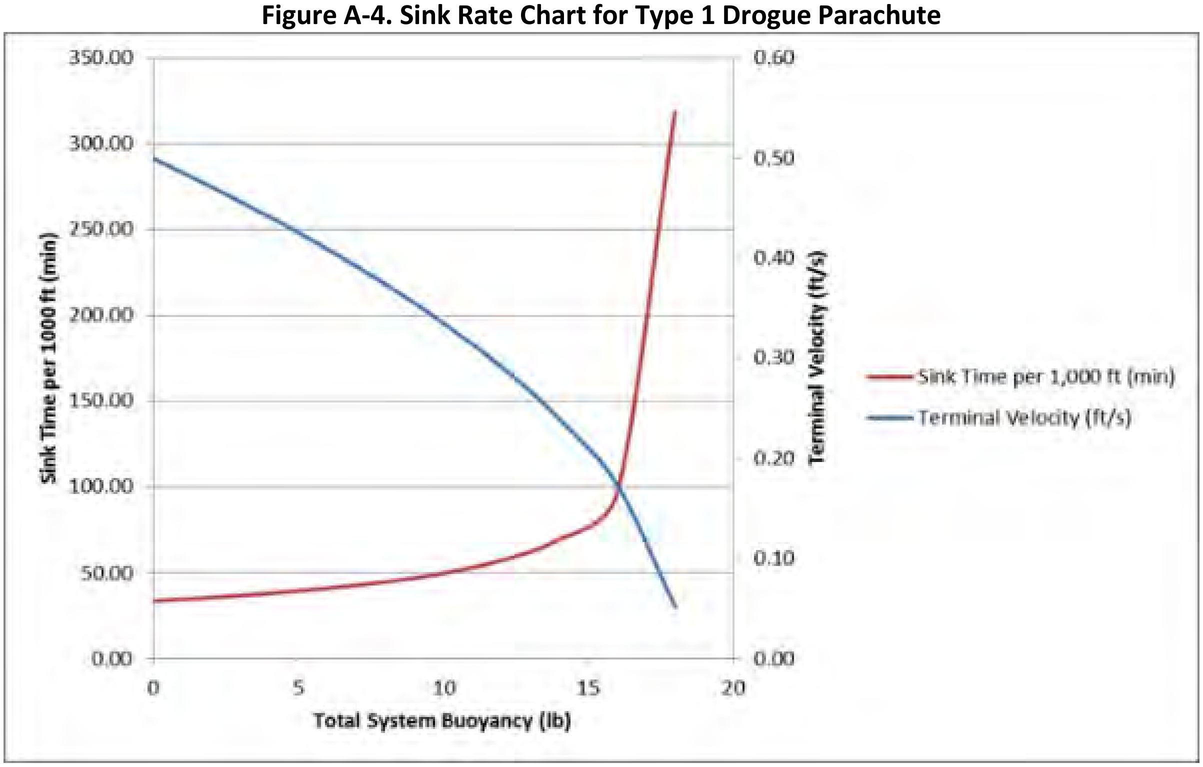


Table A-4. Projected Sink Rate for Type 1 Parafoil

Properties	
Sum of masses:	181 pounds
Sum of buoyancy forces:	84 pounds
Sum of drag areas:	1,426 square feet
Sink Rate	
Terminal velocity of system in water:	0.26 feet/second
Sink time per 1,000 ft of depth:	63.7 minutes
Sink time per 100 m of depth:	20.91 minutes

Figure A-5. Sink Rate Chart for Type 1 Parafoil

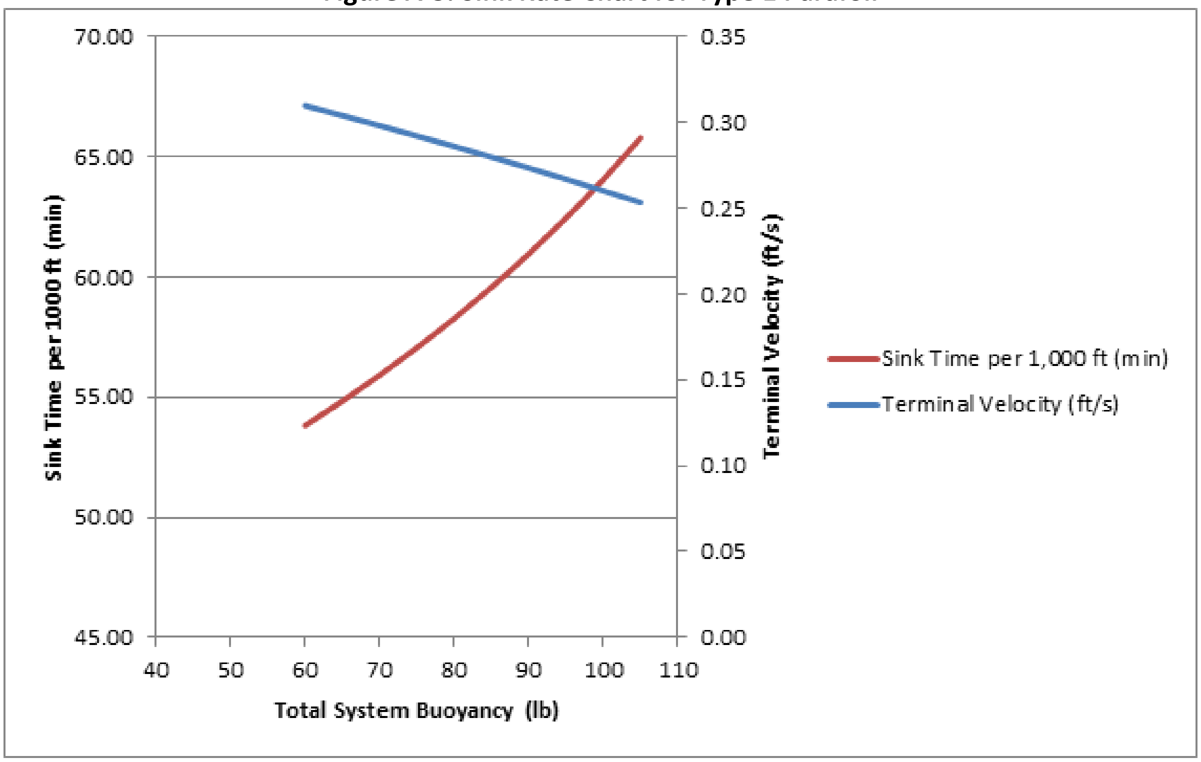


Table A-5. Projected Sink Rate for Type 2 Drogue Parachute

Properties	
Sum of masses:	18.2 pounds
Sum of buoyancy forces:	6.36 pounds
Sum of drag areas:	90 square feet
Sink Rate	
Terminal velocity of system in water:	0.36 feet/second
Sink time per 1,000 ft of depth:	45.9 minutes
Sink time per 100 m of depth:	15.07 minutes

Figure A-6. Sink Rate Chart for Type 2 Drogue Parachute

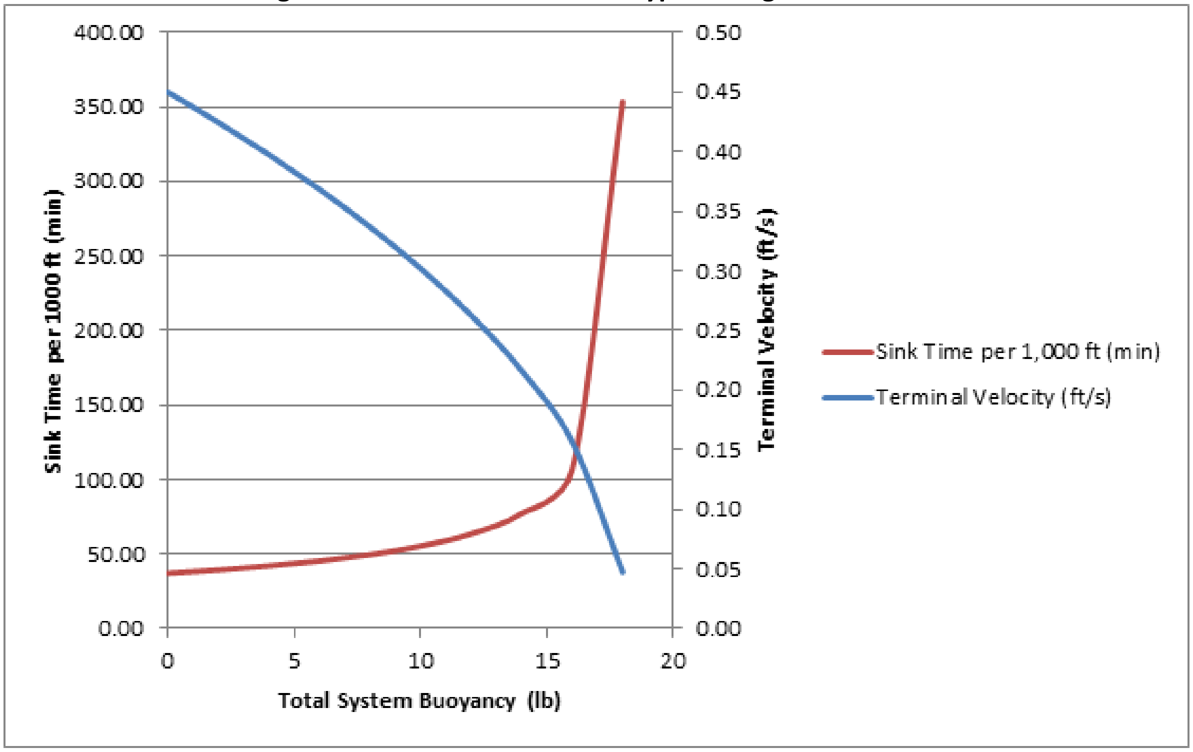
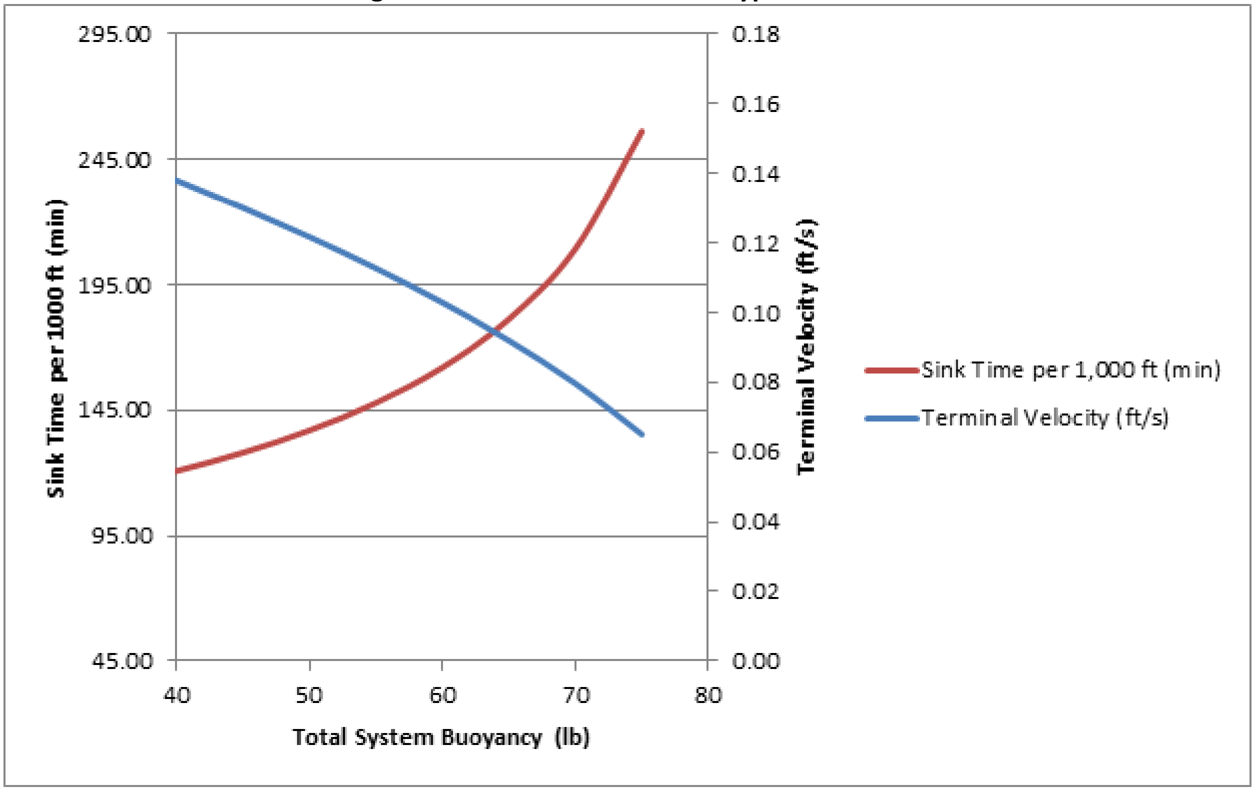


Table A-6. Projected Sink Rate for Type 2 Parafoil

Properties	
Sum of masses:	70 pounds
Sum of buoyancy forces:	39.01 pounds
Sum of drag areas:	2,376 square feet
Sink Rate	
Terminal velocity of system in water:	0.11 feet/second
Sink time per 1,000 ft of depth:	145.5 minutes
Sink time per 100 m of depth:	47.75 minutes

Figure A-7. Sink Rate Chart for Type 2 Parafoil



Appendix C
Terran R Programmatic Concurrence for Launch Vehicle & Reentry Operations

August 04, 2023

National Marine Fisheries Service
NMFS Office of Protected Resources ESA Interagency
Cooperation Division320 West 4th Street, Suite 200
Los Angeles, CA 90013

Project Specific Review Request, OPR-2021-02908,
Programmatic Concurrence for Launch Vehicle & Reentry Operations

The Federal Aviation Administration (FAA) is requesting a project-specific review for Relativity Space's (Relativity's) Terran R Launch Program. As stated in the April 14, 2023 National Marine Fisheries Service (NMFS) Letter of Concurrence (2023 LOC), NMFS issued a single programmatic letter of concurrence to the FAA for launch and reentry vehicle operations in the marine environment, which included the Terran 1 launch vehicle. The Terran 1 launch vehicle was referenced within Table 3 of OPR-2021-02908 as a vertical launch vehicle for which operations could affect Endangered Species Act (ESA) listed species under the National Marine Fisheries Service (NMFS) jurisdiction. Nonetheless, the Terran 1 Program was retired in May 2023 and the Terran R Program would supersede all operations proposed under Terran 1.

Relativity is preparing a Supplemental Environmental Assessment (SEA) to evaluate the impacts associated with implementing Relativity's proposed Terran R Launch Program operations at Space Launch Complex (SLC) 16 at Cape Canaveral Space Force Station (CCSFS). This SEA is a supplement to the *Finding of No Significant Impact* (dated September 21, 2021) related to the *Environmental Assessment for the Relativity Terran 1 Program Launch Complex 16, Cape Canaveral Space Force Station, FL*, dated June 2020.

Relativity's Terran R Launch Program SEA was developed with the United States Space Force (USSF) as the lead agency and National Aeronautics and Space Administration (NASA), the Federal Aviation Administration (FAA), and United States Coast Guard (USCG) as cooperating agencies. As noted in OPR-2021-02908, "upon receipt of a new proposal that involves operations in the marine environment, the lead action agency (USSF) will review the proposal and coordinate with NMFS to determine if the proposed launch operations fall within the scope of this consultation." As a result, a project-specific review under OPR-2021-02908 is being requested since the Terran R Launch Program involves launch and reentry vehicle operations in the marine environment, a new reusable launch vehicle, and substantial changes in operations from the Terran 1 Launch Program.

In execution of the Terran R Launch Program, Relativity will comply with all requirements of OPR-2021-02908. *Appendix A* provides a summary of the Terran R Launch Program's adherence to the requirements set forth in OPR-2021-02908.

Terran R Launch Vehicle

The Terran R Launch Vehicle diagram is shown in *Figure 1* on the following page. The Terran R launch vehicle has an upper bound design that results in Stage 1 measuring up to 175 feet tall, 18 feet in diameter, powered by up to 14 engines fueled with Liquid Oxygen (LOX) and Liquid Natural Gas (LNG). The interstage is designed to measure up to 45 feet tall and 18 feet in diameter. Stage 2 is designed to measure up to 35 feet tall, 18 feet in diameter, powered by one (1) Aeon R vacuum re-startable engine. Lastly, the payload fairing is designed to measure up to 65 feet tall, 18 feet in diameter. This results in the fully integrated Terran R launch vehicle configurable to up to approximately 320 feet in length.

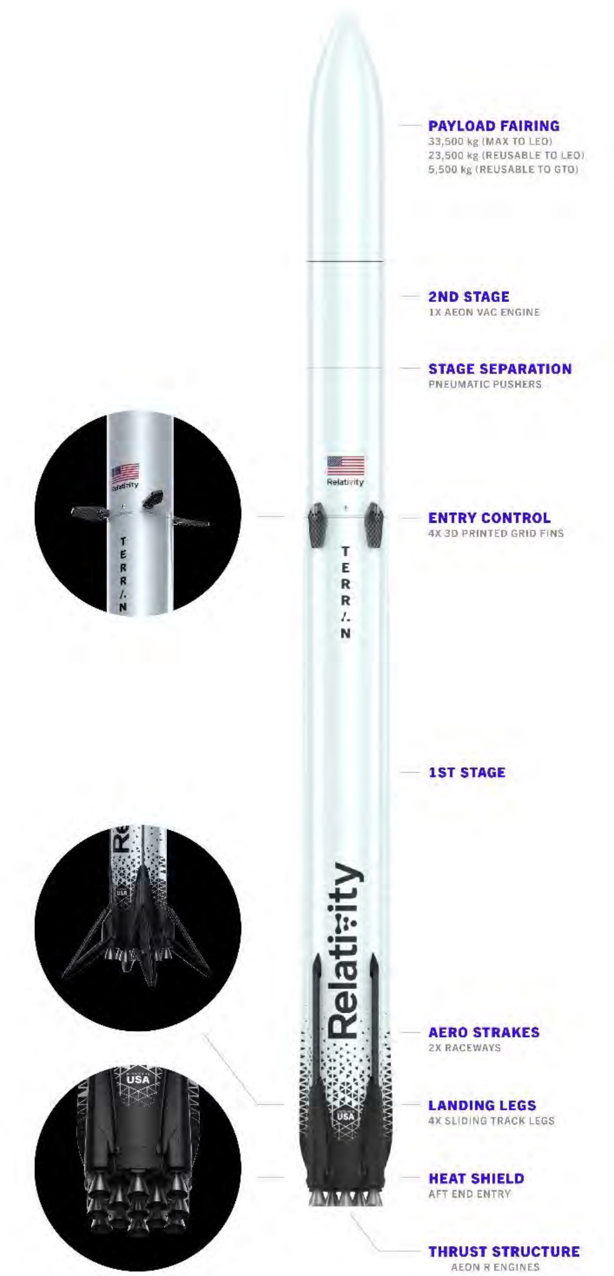


Figure 1. Terran R Launch Vehicle

The 14 Stage 1 Aeon R engines each produce 320,000 pounds of sea level thrust, for a total of up to 4,480,000 pounds of lift-off thrust. Stage 2 will use an updated Aeon R engine with a copper chamber. Terran R's payload delivery capability is up to 33,500 kg to 185 km Low Earth Orbit (LEO). The Terran R launch vehicle would fly in launch azimuths ranging from 41° to 105° for block 1 of the Terran R vehicle. *Table 1* provides size and engine comparisons between the Terran R and Terran 1 launch vehicles.
Table 2 provides a comparison between propellant requirements between the Terran R and Terran 1 launch vehicles. *Table 3* provides a comparison between Terran R and OPR-2021-02908 Listed

Vehicles. As noted, Terran R is similar in nature to those reusable vehicles analyzed within the programmatic consultation.

Table 1. Terran R vs. Terran 1 Comparison

	Terran R	Terran 1
Stage 1 (ft):	175	66
Stage 2 (ft):	35	13.5
Payload (ft):	65	22
Interstage (ft):	45	9
Total Vehicle (ft):	320	110.5
Diameter of Stage 1 (ft):	18	7.5
Diameter of Payload (ft):	18	10
Stage 1, Number of Engines:	14	9
Max Thrust at Sea Level (single engine, lbf):	320,000	23,000
Stage 2, Number of Engines:	1	1

Table 2. Terran R vs. Terran 1 Propellant Comparison

	Terran R	Terran 1
Stage 1 LOX Mass (lbm):	1,810,311	93,083
Stage 2 LOX Mass (lbm):	266,555	18,265
Total LOX Mass (lbm):	2,076,866	111,348
Stage 1 LNG Mass (lbm):	660,967	33,050
Stage 2 LNG Mass (lbm):	96,201	6,631
Total LNG Mass (lbm):	757,168	39,681

Table 3. Terran R vs. Terran 1 Propellant Comparison

	Terran R	Terran 1	Falcon 9	Falcon Heavy	Starship - Super Heavy
Total Thrust at sea level (lbf)	4,480,000	207,000	1,710,000	5,130,000	16,635,861
Total Length (feet)	320	111	229	229	400
Fuel	LNG	LNG	RP-1	RP-1	LNG
Reusable	Yes	No	Yes	Yes	Yes

Launch Vehicle Components

Terran R vehicle stages and payloads will arrive via vessel/barge at a commercially available port or CCSFS-located wharf. Potential use of CCSFS wharfs would be for receiving Terran R Program vehicle stages and payloads from Relativity facilities, ocean-going landing barges and customer sites. Potential wharfs under consideration within the proposed action include the Army Wharf (south side), Delta Mariner Dock (south side), Pegasus Barge Dock, and Wharf AF/Hangar AF.

The Terran R first stage vehicle components are fully reusable. Following payload separation, jettisoned payload fairings would become debris, landing in the ocean within 1,350 km downrange within the region of Influence detailed in *Figure 2*. During launches that are still early in the program development, Relativity may require expending Terran R in the ocean. When this occurs, Relativity would not recover Terran R and expects the vehicle to become waterlogged and sink to the ocean floor. The fate of vehicle components that are expended into the ocean is discussed in the *Stage Fate* section below. The expectation that vehicle components sink after impact is consistent with scenarios presented in OPR-2021-02908.

Proposed Action

The Proposed Action also includes landing of the Terran R launch vehicle booster on a Relativity ocean-going barge in the Atlantic Ocean. The landing platform will be a USCG classed vessel, likely a barge hull platform with self-propulsion. The barge will be towed into the landing location and disconnected from its tow wire. The barge will have an onboard propulsion system controlled via a commercial-off-the-shelf dynamic positioning system with a minimum of DP-1 requirements. No anchoring would be required to maintain the position of the ocean-going barge. A maximum of 24 ocean-based barge booster landings per year are anticipated as part of the Terran R Program. However, during launches that are still early in the program development, Relativity may require expending Terran R in the ocean. Notice to Air Missions (NOTAM) and Notice to Mariners (NOTMARs), would apply to all booster landing operations for the Terran R launch vehicle, resulting in temporary closures of airways and navigable waterways. The USCG would notify maritime stakeholders of events impacting navigation safety. The FAA would notify aviation pilots of temporary closures to airspace.

Proposed landing areas are within the boundaries of the Atlantic Ocean Action Area identified in 2023 NMFS programmatic letter of concurrence and are therefore consistent with the requirements of the OPR-2021-02908. The types of operations proposed for the Terran R Program in this area will also include attempted recovery of stages and expending of stages and fairings. These proposed operations are consistent with actions covered by OPR-2021-02908. Launch abort testing is not planned as part of the Terran R Launch Program.

Booster landing and recovery operations for the Terran R Program will include the mobilization of an unmanned ocean-going barge, support vessel and an ocean tug from Port Canaveral. Support vessel and recovery operations have the potential to release small amounts of oil and gas into the water. However, vessel operations would be conducted in accordance with the International Convention for Prevention of Pollution from Ships (MARPOL 73/78), prohibiting certain discharges of oil, garbage, and other substances from vessels. An ocean-going barge landing in the Atlantic Ocean would require three (3) vessels: an unmanned ocean-going barge, a support vessel, and an ocean tug. The support vessel is a research vessel that may house the crew, instrumentation, and communication equipment, as well as assist with debris collection, if possible. The tug is a commercial ocean vessel that operates in open waters. Relativity would work with both the USCG and the American Bureau of Shipping (ABS) on the classification of the recovery barge. This effort would begin with plan reviews involving ABS, local USCG Marine Safety Detachment (MSD), and USCG Marine Safety Center (MSC) for barge development approval. Relativity plans on utilizing subchapter i vessels. Vessel and spotter aircraft operations will comply with all requirements set forth in OPR-2021-02908, where applicable.

The tug tows the ocean-going barge into position at the landing spot and then returns to Port Canaveral, or NASA/USSF docks with the ocean-going barge and rocket. Once offloaded at a Port wharf or NASA/USSF dock, the rocket would be transported to SLC-16 within CCSFS by standard over-the-road tractor-trailers. Hazardous materials would be off-loaded after the ocean-going barge is docked. Any hazardous materials would be handled in accordance with federal, state, and local laws and regulations. CCSFS has established plans and procedures to handle and dispose of hazardous materials and solid wastes. Relativity has an established emergency response team, any unexpected spills would be contained and cleaned up per the procedures identified in Relativity's

Emergency Action Plan and Spill Prevention Control and Countermeasures Plan, as required by OPR-2021-02908.

Projected Launch Schedule
The first Terran R Program launch from SLC-16 is anticipated in 2026, ramping up to 24 anticipated maximum annual launches per year. For purposes of this SEA, a maximum launch rate of 24 Terran R launches per year from CCSFS will be analyzed. First stage controlled entry, descent, and landing would occur following each launch. However, during launches that are still early in the program development, Relativity will expend Terran R Stage 1 in the ocean after jettison. For the first two (2) launches, Relativity plans to conduct a controlled Stage 1 entry, descent, and soft-landing into the ocean, resulting in Terran R's intact impact with the ocean's surface. If a flight anomaly is experienced during these two Terran R missions, Relativity may choose to expand the number of missions that have an expendable Stage 1 with a controlled soft-landing into the ocean. For subsequent launches Stage 1 will be recovered after performing a controlled entry, descent, and landing on an ocean-based barge. Uncontrolled descents are not expected.

One (1) launch of the Terran R orbital launch vehicle will occur in 2026, ramping up to eight (8) launches in 2027 and up to 24 launches per year beginning in 2028. Depending on mission requirements, launches could occur during daylight or nighttime hours. The anticipated lifespan for the Terran R Program is beyond 10 years.

Payloads
Relativity plans to deploy and resupply satellite constellations for a variety of Government and commercial sector clients. Other missions may include deep space probes, ISS cargo resupply missions, and launch of commercial space station modules. Relativity Space is not anticipating payload reentry during cargo resupply missions. Terran R Program payloads would be similar to current commercial and government payloads expected over the next 10 years. Terran R can deliver payloads up to 23,500 kg. No payloads with nuclear material are anticipated.

Launch Trajectories
Terran R Program launch vehicle trajectories would be specific to each particular mission. Flight trajectories vary based on mission specifics such as payload and desired orbit. Terran R launch azimuths would range from 41° to 105° as shown in *Figure 2* and would be specified for a given mission based on the desired inclination at orbit insertion. The altitude and downrange distance profiles are also mission specific and are based on desired insertion orbit and atmospheric constraints on the vehicle.

<u>Region of Influence (ROI)</u>
The ROI for ocean waters covers all suborbital jettisoned items during a Terran R launch, including the booster recovery and landing areas (300-500 nautical miles offshore) and fairing jettison areas (less than 1,350 km downrange). The Terran R launch vehicle would fly in launch azimuths ranging from 41° to 105° for block 1 of the Terran R vehicle.

The Proposed Action ROI is illustrated in *Figure 2* and extends to 1,350 km downrange within the Action Area defined in the 2023 NMFS Programmatic Consultation. The specifics of the trajectory and mission plan for the first flight of Terran R and beyond are not presently defined, so this ROI is intended to cover a variety of mission types that will be flown on Terran R.

During a Terran R launch, Stage 1 will continue travelling downrange after jettison and perform entry and landing burns to target a precise landing location and associated target velocity and attitude.

The maximum error on the Stage 1 landing location relative to the target will be less than 10 meters for a nominal mission. This landing location will be within the proposed ROI (300-500 nautical miles offshore) and is defined for a particular mission trajectory. The Stage 1 landing location's azimuth relative to the launch site is determined by the mission trajectory's launch azimuth. The landing location's downrange distance is determined by the trajectory's insertion orbit, atmospheric constraints, and Stage 1 reentry constraints. Relativity will not site a landing area in coral reef areas or within National Marine Sanctuaries unless the appropriate authorization has been obtained from the Sanctuary.

Following fairing separation, two jettisoned payload fairing halves are uncontrolled and would become debris, landing in the ocean less than 1,350 km downrange. The fairing debris footprint for any Terran R mission will be bounded by the proposed ROI, with the debris footprint of a particular mission trajectory being much smaller. Like Stage 1, the fairing's landing location varies with the mission trajectory's launch azimuth, insertion orbit, atmospheric conditions, and Stage 1 reentry constraints.

The launch and reentry activities occurring in the marine environment would occur in deep waters at least 5 nautical miles offshore the coast of the United States or islands, with most activities occurring hundreds of miles offshore. The only component of the launch and reentry operations that occurs near (less than 5 NM offshore) the coast of the United States are the vessels (watercraft) transiting to and from a port during pre-launch surveillance or when recovering and transporting spacecraft or launch vehicle components in the ocean. Ocean waters within the ROI include offshore, deep, high salinity waters defined by prevailing currents. Water quality in ocean waters may be characterized by temperature, salinity, dissolved oxygen, and nutrient levels. US territorial seas extend 12 nautical miles from the coast. Booster recovery and landing may occur in international waters, however, all Terran R support vessels will navigate to and from Port Canaveral.

Sonic Booms

Following stage separation, the first stage would be maneuvered into position for a retrograde entry burn. The entry burn performs a restart of three engines to reduce velocity and lower atmospheric heating and loads on the stage. After entry burn cutoff, the stage performs a controlled atmospheric flight to guide the stage towards a designated landing site approximately 300-500 nautical miles offshore. Once the first stage is in position and approaching the ocean-going barge, three of the engines would ignite to perform the landing burn. The landing burn is performed to reduce velocity and maintain attitude control. Partway through the landing burn, two of the engines are shut down and the burn is completed using a single engine. The landing burn is cutoff after the vehicle touches down on the landing barge. A sonic boom is anticipated during return. Landing legs would deploy during the final single engine burn that would slow the stage and enable a landing. Following nominal launch operations, portions of the launch vehicle would be recovered by landing on an autonomous barge. *Figure 3* below depicts the nominal ocean landing areas and associated sonic booms across various launch azimuths. The maximum modeled peak overpressures reach 47 psf for ocean-based barge landings. The impacts resulting from the sonic booms generated by Terran R launch operations are therefore not expected to affect marine species underwater.

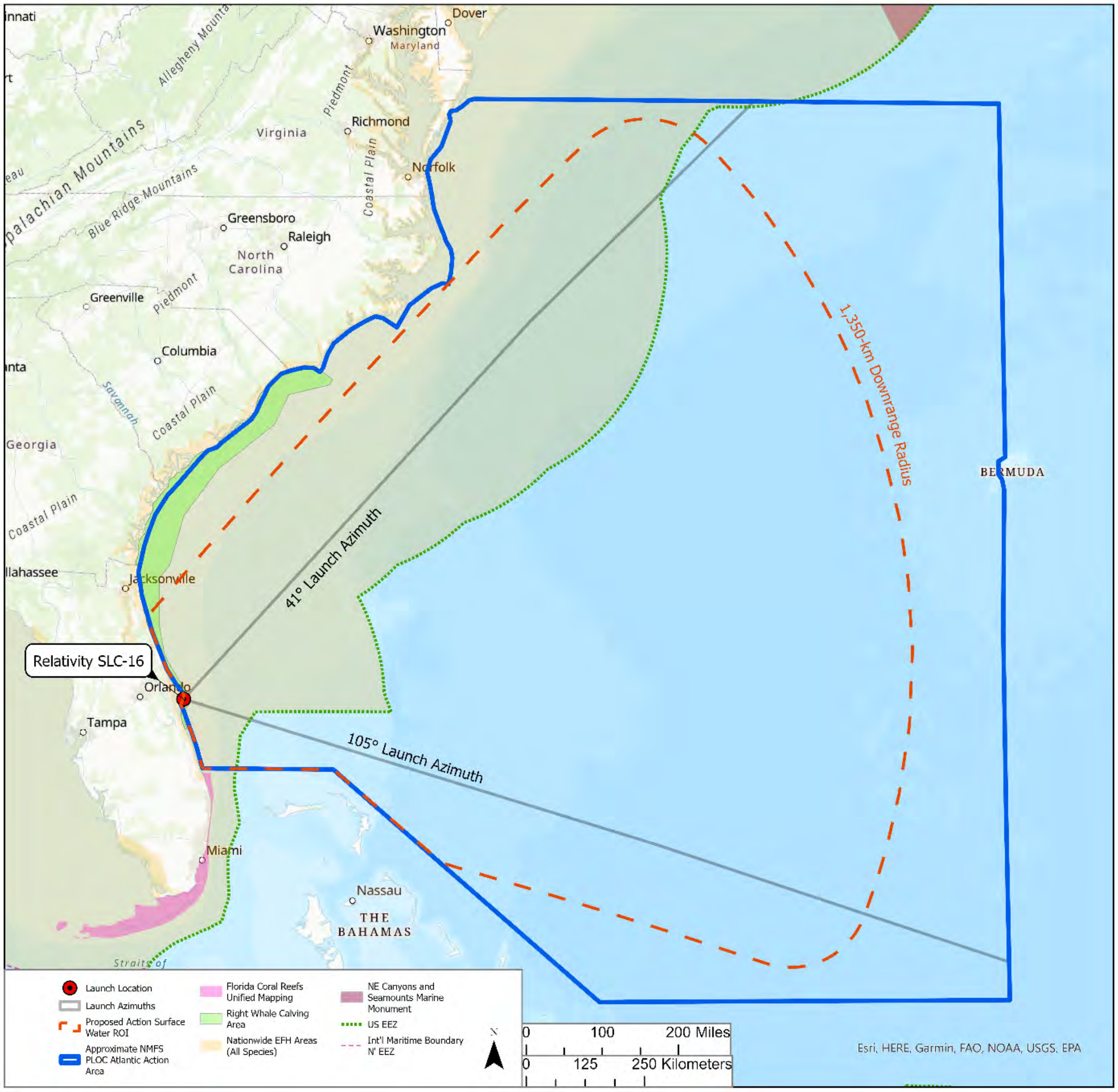


Figure 2: Proposed Action Region of Influence

Figure 3: Landing Locations and Associated Sonic Booms across various Launch Azimuths (BRRC Noise Report, 2023)

Essential Fish Habitat

Relativity expects Terran R debris to sink because it is made primarily of aluminum. Expendable stage landings would not result in permanent changes to physical parameters (temperature, salinity, oxygen concentration, etc.) of the water column. The amount of propellant, metals, or other substances that could leach or dissolve into the water column or substrate after the vehicle sinks to the ocean floor would be minimal and would not result in detectable changes to water or sediment quality. Additionally, the probability an expended vehicle impacting essential fish habitat (EFH) would be considered negligible given the small numbers of controlled soft-water landings per year in the study area; therefore, there would be no effects on EFH.

National Marine Monuments

No landings in national marine monuments are expected to occur as part of the Terran R launch program as shown in *Figure 2*.

<u>Stage Fate</u>

Terran R conops include a controlled Stage 1 entry, descent, and landing, including up to two burn phases with a subset of Stage 1 engines. Landing operations will include both controlled soft-water landings in water and landings onto an ocean-going barge. The nominal velocity for both water landings and onto an ocean-going barge is approximately 10 feet per second. For planned expendable missions, Stage 1 will nominally perform a controlled, vertical landing at low velocities for a soft-water landing with only residual propellant remaining in the tanks at the time of impact.

Residual propellant values result in LOx and LNG tank concentrations of less than 0.3% and 2.1%, respectively, assuming tank volumes of at least 500 cubic meters and standard propellant densities. The preliminary Stage 1 conditions at water impact provided in the Terran R Preliminary Jettison and Breakup report (see *Appendix B*) represent a conservative outlook. Relativity does not reasonably foresee a potential for explosion at such low levels of propellant concentration. Maximum expected propellant values reported assume unburned residual propellant mass after performing a landing burn. Similarly, given the lack of potential ignition mechanisms, Relativity does not consider a mixed combustion event as reasonably foreseeable.

The nominal flight plan for Stage 1 controlled soft-water landings without a barge would result in Stage 1 impacting the water intact vertically. Then, within several seconds, Stage 1 would tip over and impact the water horizontally Stage 1 would sink at an angle (similar to a sinking ship), during which sea water would flood the tanks through the fill drain valves near the bottom. As the tanks flood, the vehicle would become waterlogged and sink to the ocean floor. If in an off- nominal event, Stage 1 did not sink, Relativity would attempt to scuttle Terran R as detailed in the Vehicle Debris section below.

When a Terran R booster reaches the end of its useful life, it will either carry out an expendable/soft water landing final flight or would be deconstructed at a Relativity facility. The deconstructed booster parts with remaining service life could be reused on other boosters. Any end-of-life parts or other scrap material would be handled by an approved third party with experience disposing of proprietary material. There are no plans to dispose of Stage 1 with a fast water landing.

In general, Relativity designs end of mission to comply with federal regulations (FAA Part 450), and uses international standards (e.g. ISO 24113, ISO TR 18146, ISO 27852) to guide our mission design. For all Terran R Program missions, Stage 2 would be placed in a disposal orbit. Disposal orbits are orbits that, because 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 R Stage 2 would also be passivated to preclude debris creation resulting from explosive overpressure or electric discharge. Disposal orbits are uncontrolled and materials are succumbed to atmospheric demise during reentry. These techniques are in accordance with the National Security Space Launch Program System Performance Document and international agreements on space debris minimization.

Vehicle Debris

During expendable missions early in the Terran R Program's development, the nominal impact location of Terran R's Stage 1 will vary according to unique mission design parameters, such as target orbit inclination, trajectory lofting for high-energy orbits, and others. Notionally The debris footprint for Stage 1 and fairings would be bounded by the proposed ROI shown in *Figure 2*.

Relativity will use last state vectors and range assets to approximate a primary debris field. Using local weather and current drift analysis, Relativity will estimate the location of debris and make best efforts to redirect recovery vessels or charter third party vessel to perform debris recovery operations. Due to the nature of the vehicle's design, post anomaly debris will sink rapidly and there will be minimal surface level debris to recover. Unlike other vehicles, Terran R is not planned to utilize large carbon fiber segments which yield a majority of surface debris. Terran R components would sink when tanks are compromised. Due to the depth of water in the splashdown locations, attempts at subsea recovery are nearly impossible and efforts would not be made.

Relativity would have a vessel in the area of highest likelihood of debris that would identify large debris for salvage. Relativity would use the vessel to survey the debris field for approximately of 24 to 48 hours (using visual survey in the day and onboard vessel radar at night) depending on the outcome of the breakup. The initial survey area would be determined based on last known data location point received from the telemetry on the vehicle upon splashdown. Weather and ocean current data would be used to further characterize the debris field as the operation is conducted. Methods to physically remove debris could include using a net or a boat hook. Relativity would report debris findings to the USCG to determine the most appropriate method of recovery or sinking as described above and would be on a case-by-case basis depending on personnel safety, vessel safety, and capability. Relativity would act to mitigate the debris in coordination with USCG to verify the debris sinks within 10 days as noted in the National Marine Fisheries Service (NMFS) Letter of Concurrence. If debris is still identified after the 24-48 hours survey and recovery efforts, Relativity would use another method including, an additional vessel or satellite imaging to confirm and characterize any debris and take appropriate action to retrieve or sink it.

In the event of an anomalous landing where the vehicle misses the landing barge and remains intact, the recovery team will assess safely scuttling the stage via valve commands to open the vehicle to flooding or using a firearm and other onboard tools such as hooks and chain to compromise the structural integrity of the tank leading to sinking.

Impact by Fallen Objects

Launch debris from expended boosters, payload fairings, launch abort tests, or any launch failure anomalies have the potential to affect MMPA and ESA-listed marine species. The primary concern is a direct impact from an object landing on a marine mammal, sea turtle or fish. The Proposed Action ROI, where objects could splashdown, encompasses vast expanses of ocean as shown in *Figure 2*.

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. Impacts from residual liquid propellant within the launch vehicle is considered a negligible hazard because virtually all hazardous materials are consumed in the destruct action or dispersed in the air and only structural debris would strike the water. In a destruct action, the Terran R vehicle may survive to impact the water essentially intact. The Terran R propellant storage is designed to retain residual propellant however, in the unlikely event the propellant tank ruptures on impact, the propellant would evaporate or be quickly diluted and buffered by seawater. Relativity's recovery operations team would implement their Hazardous Emergency Response Plan to contain spills and minimize the duration and impact of spilled hazardous materials following a launch failure scenario. Due to the unlikely scenario of liquid propellants leaking from the launch vehicle and the quick dilution or evaporation of liquid propellants, hazardous material exposure to MMPA and ESA-listed marine mammals, sea turtles, and fish in the action area may affect, but are not likely to adversely affect these animals.

Marine mammals and ESA-listed species are sparsely distributed across these ocean expanses, resulting in very low densities of species overall. Direct strikes by debris from Terran R are extremely unlikely for all species of concern, fish, sea turtles, and marine mammals. This is due to the small size of the components as compared to the vast open ocean. If debris from the vehicle struck an animal near the water's surface, the animal would be injured or killed. Given the low frequency of the Terran R ocean descent and landing operations, and the fact that marine wildlife, marine mammals, and special status species spend the majority of their time submerged as opposed to on the surface, it is extremely unlikely they would be impacted. The relative availability of these animals at the ocean surface, spatially and temporally, combined with the low frequency of the Proposed Action, reduce the likelihood of impacts to extremely low. Spatial distribution data is not readily available for all ESA-listed species, however, the Marine Geospatial Ecology lab at Duke University (2022) modelled the population density of some ESA-listed species along the Atlantic Coast. The most abundant cetacean species identified in this study within the bounds of the PLOC was observed to be the Sperm Whale. The highest density of sperm whales observed during a single month in the study was 0.04 individuals per square kilometer. Using this value as a worst-case scenario estimate representative of the entirety of the potential impact area, the probability of impact with a sperm whale across the potential launch area was calculated to be approximately 7 in 1,000,000 as calculated in *Table 2* below. Impact probability for other ESA-listed species is expected to be lower due to lower densities and less frequent surfacing. Therefore, the cumulative probability of impacting an ESA-listed species is expected to be negligible. The probability of a direct impact to protected marine mammal, sea turtle or fish is thus extremely unlikely.

Table 2: Probability Estimate - Direct Strike to Sperm Whale

Description	Value	Units	Notes/Source
Maximum Observed Sperm Whale Population Density*	0.0256	individual/km2	Maximum observed density during month with highest observed sperm whale sightings.
Conversion ft2 to km2	9.29E-08	ft2/km2	Conversion Factor
100KM downrange area	567208	km2	Area between 41, 100 azimuths extending to 100km offshore. Measured from ArcGIS® Mapping Data.
Total assumed individuals within 100km downrange area	14515	individuals	Max observed density * total downrange area
Whale surface area - area of buffer around each individual	3014	ft2	Assumed 60 ft length by 8 ft width cylinder - Or approximate buffer of 62 ft diameter surrounding individual.
Total buffer area for all individuals	43,754,085	ft2	Max observed density * total downrange area
Total buffer area for all individuals	4.1	km2	Using conversion factor
Probability of impacting whale	7E-06		

**Source – Marine Geospatial Ecology Lab, Duke University. 2022*

- *Mapping and data obtained at https://seamap.env.duke.edu/models/Duke/EC/*
- *Note: 0.0256 individuals per square kilometer is a conservative estimate representing the maximum observed concentration of sperm whales within the study area.*
- *The mean sperm whale density throughout the entire study area during Month 9 (month with the highest observed mean density) was 0.005386 individuals/km2.*

Additionally, there are no known interactions with any of these species after decades of similar rocket launches and reentries. Further, the projected landing areas for Terran R are well offshore where density of marine species decreases compared to coastal environments and upwelling areas. Because it would be extremely unlikely for a Marine Mammal Protection Act (MMPA) or ESA-listed species to be directly struck by launch vehicle components, spacecraft, and any launching or landing-related debris, the potential for effects to marine life from a direct impact by those fallen objects are discountable. Therefore, direct impacts from fallen objects to MMPA protected marine mammals, ESA-listed marine mammals, sea turtles, and fish in the action area due to launch activities may affect but are not likely to adversely affect these animals (NMFS, 2023). *Table 3* summarizes the potential MMSA/ESA-listed marine species present within the ROI.

Table 3. ROI Federal and State Listed Species

Common Name	Scientific Name	Federal	State
Sea Turtles			
Loggerhead Turtle	*Caretta caretta*	T	--
Green Sea Turtle	*Chelonia mydas*	T	--
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	E	--

Table 3. ROI Federal and State Listed Species

Common Name	Scientific Name	Federal	State
Leatherback Turtle	*Dermocheyls coriacea*	E	--
Hawksbill Turtle	*Eretmochelys imbricata*	E	
Fish			
Smalltooth Sawfish	*Pristis pectinata*	E	--
Oceanic Whitetip Shark	*Carcharhinus longimanus*	T	--
Giant Manta Ray	*Manta birostris*	T	--
Atlantic Sturgeon	*Acipenser oxyrhynchus*	E	--
Nassau Grouper	*Epinephelus striatus*	T	--
Shortnose Sturgeon	*Acipenser brevirostrum*	E	-
Mammals			
North Atlantic Right Whale	*Eubalaena glacialis*	E	--
Humpback Whale	*Megaptera novaeangliae*	E	--
Florida Manatee	*Trichechus manatus*	T	--
Blue Whale	*Balaenoptera musculus*	E	-
Fin Whale	*Balaenoptera physalus*	E	-
Sei Whale	*Balaenoptera borealis*	E	-
Sperm Whale	*Physeter macrocephalus*	E	-
T: Threatened E: Endangered			

Entanglement

Launch programs that involve the use of parachutes and/or parafoils, introduce the possibility of marine species becoming entangled in the parachute/parafoil material and attached lines, particularly if the material is not recovered by the launch operator. The Terran R Program does not intend to use parachutes or parafoils as part of vehicle reentry procedures.

Exposure to Sonic Booms and Impulse Noise

Other potential impacts on marine habitats and wildlife from Terran R vehicle launches and ocean-based barge landings are associated with the resulting sonic booms. These potential impacts are fully described by NMFS as part of FAA's 2023 ESA Section 7 consultation (NMFS 2023). This consultation addressed comparable commercial space vehicle launch, reentry, landing, and recovery operations in the Atlantic Ocean. The consultation resulted in NMFS concurring that commercial vehicle launch and reentry operations may affect but are not likely to adversely affect ESA-listed species and designated critical habitat. The same impact mechanisms and effects described and assessed as part of the 2023 NMFS consultation are directly applicable to the proposed project.

Previous research conducted by the USAF supports this conclusion with respect to sonic booms, indicating the lack of harassment risk for protected marine species in water (U.S. Air Force Research Laboratory 2000). The researchers were using a threshold for harassment of marine mammals and sea turtles by impulsive noise of 12 pound per square inch (psi) peak pressure and/or 182 decibels (dB) referenced (re) to the standard unit of acoustic pressure underwater, 1 micro-Pascal (µPa), which is an older threshold used by NMFS and DoD at the time. The researchers pointed out that, to produce the 12 psi in the water, there needs to be nearly 900 psf at the water surface, assuming excellent coupling conditions. As noted in the Noise Study for Terran R Operations at CCSFS, the maximum modeled peak overpressures reach 11 psf for SLC-16 northeasterly launches and ~47 psf for ocean-based barge landings. The impacts resulting from the sonic booms generated by Terran R launch operations are therefore not expected to affect marine species underwater. Terran R launches would have no significant impact on wildlife and marine life resources.

Impacts to Special Status Species:

The proposed action may affect, but is not likely to adversely affect ESA-listed species and designated critical habitat. Reporting and monitoring requirements including reporting of coastal scrub acreage disturbance and reporting/handling of dead, injured, or sick threatened or endangered species are required by the USFWS Biological Opinion (BO). Relativity will follow all requirements of the BO. In addition to the requirements of the BO Relativity will adhere to all education and observation requirements set forth in OPR-2021-02908. Reporting of stranded, dead, or injured animals will be conducted in accordance with OPR-2021-02908.

During a nominal launch, the launch vehicle and spacecraft would be carried over the coastal waters of the Atlantic Ocean and through the Earth's atmosphere. Following stage separation, the first stage would be maneuvered into position for retrograde burn, reentry, and landing on the ocean-going barge. The payload fairings separate, re-enter the Earth's atmosphere and fall into the Atlantic Ocean within 1,350 km downrange. The second stage, powered by the Aeon VAC Engine, delivers the payload into orbit.

Per 14 CFR 450, Relativity will submit a Post Jettison Operation Memo as part of the 14 CFR 450 licensing process that will describe Stage 1 Re-entry Behavior and behavior during water impact when not landing on a barge. Relativity will use engineering analysis to determine potential for explosion, break-up, and possible impacts for a nominal launch/re-entry. A vehicle that makes an impact with the ocean surface will have minimal liquid oxygen and LNG onboard resulting in no release of toxics or hydrocarbons. In an anomalous condition, the risks could include a detonation event of remaining propellant or a release of high-pressure gas stored inside the vehicle's composite overwrapped pressure vessel, presenting 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 temporary and localized.

<u>References</u>

1. (14 Apr 2023) Amended Programmatic Concurrence Letter for Launch and Reentry Vehicle Operations in the Marine Environment and Starship-Super Heavy Launch Vehicle Operations at SpaceX's Boca Chica Launch Site, Cameron County, TX

2. (2022) Marine Geospatial Ecology Lab, Duke University. Mapping Tool for Marine Mammal Density for the U.S. Atlantic. OBIS-SEAMAP. https://seamap.env.duke.edu/models/mapper/EC

3. (2016) Roberts, J. J., B. D. Best, L. Mannocci, E. Fujioka, P. N. Halpin, D. L. Palka, L. P. Garrison, K. D. Mullin, T. V. Cole, C. B. Khan, W. A. McLellan, D. A. Pabst, and G. G. Lockhart. Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. Scientific Reports 6:22615.

4. (19 Jun 2023) Terran R Preliminary Jettison and Breakup

Appendix A
Project-Specific Design Criteria

General Project Design Criteria	*Terran R Launch Program Adherence?*	*Notes*
Launch and reentry operations will be conducted by the USSF, NASA, or an FAA-licensed (or permitted) commercial operator from a launch site identified in Table 1. Launch preparations will occur in compliance with standard operating procedures and best management practices currently implemented at these existing launch vehicle facilities.	YES	
Launch operations will utilize launch vehicles identified in Table 3	--	The 24 launches per year under the Terran R Launch Program will replace all future Terran 1 launches proposed in OPR-2021-02908,
Launch activities, including suborbital landings and splashdowns, and orbital reentry activities will occur in the proposed action area at least 5 NM offshore the coast of the United States or islands. The only operations component that will occur near shore will be watercraft transiting to and from a port when recovering spacecraft or launch vehicle components, or possibly for surveillance.	YES	
No launch operator will site a landing area in coral reef areas.	YES	
No activities will occur in or affect a National Marine Sanctuary unless the appropriate authorization has been obtained from the Sanctuary.	YES	
Landing operations will not occur in the aquatic zone extending 20 NM (37 km) seaward from the baseline or basepoint of each major rookery and major haul-out of the Western Distinct Population Segment (DPS) Steller sea lion located west of 144° W.	YES	
Launch abort testing will only occur in the Atlantic Ocean from CCAFS or KSC as previously analyzed (SER-2016-17894, FPR-2017-9231). In addition:	NOT APPLICABLE	Launch abort testing is not planned as part of the Terran R Launch Program
It will not occur in designated critical habitat for the North Atlantic right whale		
It will not occur during the North Atlantic right whale winter calving season from November to mid-March.		
Utilize all feasible alternatives and avoid landing in Rice's whale core habitat distribution area as much as possible. No more than one splashdown, reentry and recovery of the Dragon capsule, will occur in Rice's whale core habitat distribution area per year. No other operations, spacecraft, launch or reentry vehicle landings, or expended components will occur in Rice's whale core habitat distribution area. The Rice's whale core habitat distribution area map (Figure 1) and GIS boundary can be accessed here: https://www.fisheries.noaa.gov/resource/map/rices-whale-core-distribution-area-map-gis-data.	YES	
Education and Observation	*Terran R Launch Program Adherence?*	*Notes*
Each launch operator will instruct all personnel associated with launch operations about marine species and any critical habitat protected under the ESA, and species protected under the MMPA that could be present in the operations area. The launch operator will advise personnel of the civil and criminal penalties for harming, harassing, or killing ESA-listed and MMPA-protected species.	YES	
Each launch operator will provide a dedicated observer(s) (e.g., biologist or person other than the watercraft operator that can recognize ESA-listed and MMPA-protected species) that is responsible for monitoring for ESA-listed and MMPA-protected species with the aid of binoculars during all in-water activities, including transiting marine waters for surveillance or to retrieve boosters, spacecraft, other launch-related equipment or debris.	YES	
When an ESA-listed or MMPA-protected species is sighted, the observer will alert vessel operators to apply the Vessel Operations protective measures.	YES	
Dedicated observers will record the date, time, location, species, number of animals, distance and bearing from the vessel, direction of travel, and other relevant information, for all sightings of ESA-listed or MMPA-protected species.	YES	
Dedicated observers will survey the launch recovery area for any injured or killed ESA-listed or MMPA-protected species and any discoveries will be reported as noted below.	YES	
Reporting Stranded, Injured, or Dead Animals	*Terran R Launch Program Adherence?*	*Notes*
Each launch operator will immediately report any collision(s), injuries or mortalities to, and any strandings of ESA-listed or MMPA-protected species to the appropriate NMFS contact listed below, and to Cathy Tortorici, Chief, ESA Interagency Cooperation Division by e-mail at cathy.tortorici@noaa.gov	YES	
In the Gulf of Mexico and Atlantic Ocean waters near Florida, each launch operator will report any smalltooth sawfish sightings to 941-255-7403 or via email Sawfish@MyFWC.com.	YES	Vehicle recovery operations would only occur in the Atlantic Ocean
Each launch operator will report any giant manta ray sightings via email to manta.ray@noaa.gov.	YES	
In the Atlantic Ocean, each launch operator will report any injured, dead, or entangled North Atlantic right whales to the U.S. Coast Guard via VHF Channel 16.	YES	
Vessel Operations	*Terran R Launch Program Adherence?*	*Notes*
Maintain a minimum distance of 150 ft from sea turtles.	YES	
In the Atlantic Ocean, slow to 10 knots or less and maintain a minimum distance of 1,500 ft (500 yards) from North Atlantic right whales	YES	
In the Gulf of Mexico, slow to 10 knots or less and maintain a minimum distance of 1,500 ft (500 yards) from Rice's whale [formerly Gulf of Mexico Bryde's whale]. If a whale is observed but cannot be confirmed as a species other than a Rice's whale, the vessel operator must assume that it is a Rice's whale	NOT APPLICABLE	Vehicle recovery operations would only occur in the Atlantic Ocean
Maintain a minimum distance of 300 ft (100 yards) from all other ESA-listed and MMPA-protected species. If the distance ever becomes less than 300 ft, reduce speed and shift the engine to neutral. Do not engage the engines until the animals are clear of the area.	YES	
Watercraft operators will reduce speed to 10 knots or less when mother/calf pairs or groups of marine mammals are observed.	YES	
Watercraft 65 ft long or longer will comply with the Right Whale Ship Strike Reduction Rule (50 CFR §224.105)5 including reducing speeds to 10 knots or less in Seasonal Management Areas or in Right Whale Slow Zones, which are dynamic management areas established where right whales have been recently seen or heard.	YES	
Check various communication media for general information regarding avoiding ship strikes and specific information regarding North Atlantic right whale sightings in the area. These include NOAA weather radio, U.S. Coast Guard NAVTEX broadcasts, and Notices to Mariners	YES	
Attempt to remain parallel to an ESA-listed or MMPA-protected species' course when sighted while the watercraft is underway (e.g., bow-riding) and avoid excessive speed or abrupt changes in direction until the animal(s) has left the area.	YES	
Avoid vessel transit in the Rice's whale core distribution area. If vessel transit in the area is unavoidable, stay out of the depth range of 100 m to 425 m (where the Rice's whale has been observed; Rosel et al. 2021) as much as possible and go as slow as practical, limiting vessel speed to 10 knots or less.	YES	
No operations or transit will occur at night in Rice's whale core distribution area.	YES	
Aircraft Procedures	*Terran R Launch Program Adherence?*	*Notes*
Spotter aircraft will maintain a minimum of 1,000 ft over ESA-listed or MMPA-protected species and 1,500 ft over North Atlantic right whales. Additionally, aircraft will avoid flying in circles if marine mammals or sea turtles are spotted to avoid any type of harassing behavior	YES	
Hazardous Materials Emergency Response	*Terran R Launch Program Adherence?*	*Notes*
In the event of a failed launch operation, launch operators will follow the emergency response and cleanup procedures outlined in their Hazardous Material Emergency Response Plan (or similar plan). Procedures may include containing the spill using disposable containment materials and cleaning the area with absorbents or other materials to reduce the magnitude and duration of any impacts. In most launch failure scenarios, at least a portion (if not most) of the propellant will be consumed by the launch/failure, and any remaining propellant will evaporate or be diluted by seawater and biodegrade over time (timeframes are variable based on the type of propellant and environmental conditions, but generally hours to a few days).	YES	

Appendix B
Terran R Preliminary Jettison and Breakup

Terran R Preliminary Jettison and Breakup

Revision 2

19 July 2023

Authors: Ryan Kraft, Don Nguyen

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1 Document Change Log

Revision	Release Date	What Changed
1.0	2023/06/02	Initial Release
2.0	2023/07/19	Added clarity on nominal vs. expendable missions, explosion risks, revised residual propellant values

2 Introduction

This memo describes preliminary descriptions of concepts of operations and behavior of Relativity Space's Terran R vehicle after jettison during separation events in response to inquiries communicated in the email, "Relativity Terran R - NMFS Programmatic Consultation Coverage" dated 25 May 2023. The information in this memo applies to generic Terran R missions and is based on conceptual design and analysis that is likely to change as the program matures.

3 Heritage Information from Terran 1

Relativity received a vehicle operator license from the FAA for the Terran 1 launch vehicle and conducted operations from Launch Complex 16 (LC-16), Cape Canaveral Space Force Station, in early 2023. Terran 1 featured an expendable boost stage or Stage 1, used a thrust termination architecture for its Flight Termination System, and did not carry a payload or payload fairing. Terran 1 Stage 1's telemetry systems were not active after jettison, and as such no vehicle data could be recorded or broadcast during entry or water impact.

In compliance with prevailing regulation, Relativity performed various assessments according to FAA approved methodologies, including vehicle breakup and debris generation, water impact and buoyancy, and post-jettison operations [Refs. 1-3].

4 Terran R Vehicle Design & Concept of Operations

The Terran R launch vehicle expands upon the Terran 1 system architecture to support larger payloads, broader orbital insertion capability, and boost stage reusability. Like Terran 1, the Terran R vehicle uses aluminum primary structure with LOx/methane propellants in serial tanks with a common bulkhead. LOx tanks are positioned forward of methane tanks on both stages. In addition, the Terran R system architecture features an ordnance-based Flight Termination System, a separable payload fairing, and guidance and data systems on Stage 1 that remain active after jettison.

Unlike Terran 1, the Terran R conops comprise controlled Stage 1 entry, descent, and landing, including up to three burn phases with a subset of Stage 1 engines. Landing operations will include both direct landings in water and landings onto sea vessels.

5 Water Impact

5.1 Impact Location

The nominal impact location of Terran R's Stage 1 will vary according to unique mission design parameters, such as target orbit inclination, trajectory lofting for high-energy orbits, and others. In nominal re-usable operations, Stage 1 will continue traveling downrange after jettison and perform entry and landing burns to target a precise landing location and associated target velocity and attitude. An example Stage 1 flight trajectory at high inclination is shown below in Figure 1.

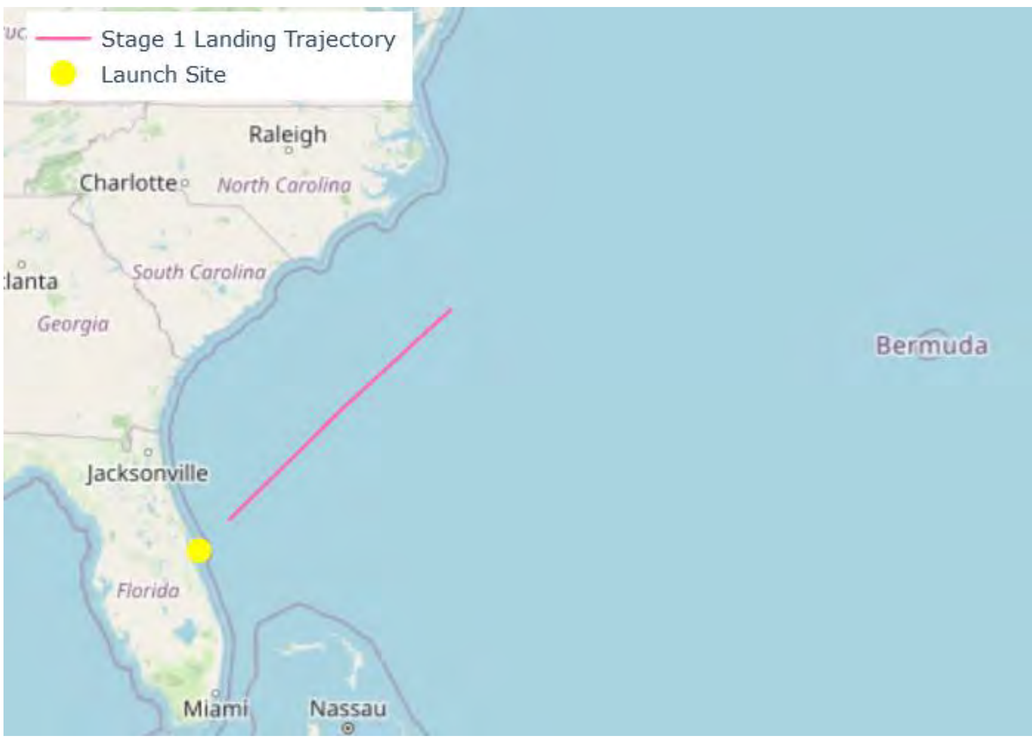

Figure 1: Example Stage 1 Flight Trajectory with Landing off the Shore of South Carolina

For expendable missions, Stage 1 will follow a similar entry and landing profile as a re-usable mission resulting in a soft-landing in the water. For both reusable and expendable missions, the expected water impact locations of all Terran R system elements fall within the areas described in the Programmatic Letter of Concurrence (PLOC), as described in Reference 4.

5.2 Condition at Impact

Stage 1 will nominally perform a controlled, vertical landing at low velocities for both water and barge landing conops, with only residual propellant remaining in the tanks at the time of impact. Preliminary data for nominal entry conditions is available in Table 1 below.

Table 1: Preliminary Stage 1 Conditions at Water Impact

Condition	**Attitude [deg]**	**Normal Velocity [ft/s]**	**Maximum LOx Mass [lbm]**	**Maximum Methane Mass [lbm]**
Nominal (Barge Landing)	0 +/- 30	~10	10,000	4,000
Expendable (Soft Water Landing)	0 +/- 30	~10	10,000	4,000

These residual propellant values result in LOx and Methane tank concentrations of less than 0.3% and 2.1%, respectively, assuming tank volumes of at least 500 m^3 and standard propellant densities. In accordance with previously accepted methodology discussed in Reference 3, Relativity does not reasonably foresee a potential for explosion at such low levels of propellant concentration. Similarly, given the lack of potential ignition mechanisms, Relativity does not consider a mixed combustion event as reasonably foreseeable.

5.3 Behavior Upon Impact

Based on the relatively low water impact velocity of Terran R after a controlled landing burn, Relativity expects Stage 1 to remain intact and not explode. Relativity shall perform water impact and buoyancy analyses similar those approved for Terran 1 to confirm this expectation. This analysis will also consider the unique ‘slapdown’ impact cases that are possible with a low-velocity water landing, where the booster falls over sideways and impacts the water along its longitudinal axis.

Booster structures and fairings that are expended in the ocean are made of strong metals and heavy-duty components designed to withstand the aggressive thermomechanical environments of launch and entry and should sink after breakup. Some internal parts of lower density, such as carbon overwrapped pressure vessels (COPVs), could be released upon impact and may float, but are expected to become waterlogged and sink within a few days (10 days maximum).

6 References

1. (03 Jan 2022) [Terran 1] Water Impact and Buoyancy Analysis
2. (28 Oct 2022) Terran 1 Debris Analysis Methodology, Revision 8
3. (27 Jan 2023) Terran 1 Stage 1 Post-Jettison Nominal Operation, Revision 1
4. (14 Apr 2023) Amended Programmatic Concurrence Letter for Launch and Reentry Vehicle Operations in the Marine Environment and Starship-Super Heavy Launch Vehicle Operations at SpaceX's Boca Chica Launch Site, Cameron County, TX

Appendix D

BRRC Noise Study
Terran R Operations

Blue Ridge Research and Consulting, LLC

BRRC Report 23-01 (Final)

Noise Study for Relativity Space Terran R Operations at CCSFS

18 May 2023 (Rev 6)

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ACRONYMS AND ABBREVIATIONS

The following acronyms and abbreviations are used in the report:

ASEL	A-weighted Sound Exposure Level
BRRC	Blue Ridge Research and Consulting, LLC
CCSFS	Cape Canaveral Space Force Station
CNEL	Community Noise Equivalent Level
dB	Decibel
dBA	A-weighted Decibel Level
dBC	C-weighted Decibel Level
DI	Directivity Indices
DNL	Day-Night Average Sound Level
CDNL	C-weighted Day-Night Average Sound Level
CX-16	Launch Complex 16
DoD	Department of Defense
DSM-1	Distributed Source Method 1
FAA	Federal Aviation Administration
ft	Foot/Feet
Hz	Hertz
KSC	Kennedy Space Center
lbf	Pound Force
lbs	Pound Mass
$L_{A,max}$	Maximum A-weighted Sound Level in Decibels
L_{max}	Maximum Unweighted Sound Level in Decibels
L_{pk}	Peak Sound Pressure Level in Decibels
NIHL	Noise-Induced Hearing Loss
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
Pa	Pascal
psf	Pounds per Square Foot
RUMBLE	The Rocket Propulsion Noise and Emissions Simulation Model
SEA	Supplemental Environmental Assessment
SEL	Sound Exposure Level
S.L.	Sea Level

1 INTRODUCTION

This report documents the noise study performed as part of Relativity Space's (Relativity's) efforts on the Supplemental Environmental Assessment (SEA) for proposed Terran R operations at Cape Canaveral Space Force Station (CCSFS). Relativity plans to conduct Terran R launches, static fire tests, and stage hot fire tests from CCSFS Launch Complex 16 (CX-16) and first stage landings on an ocean-going platform in the Atlantic Ocean. Figure 1 shows the locations of the Terran R CX-16 launch site at CCSFS.

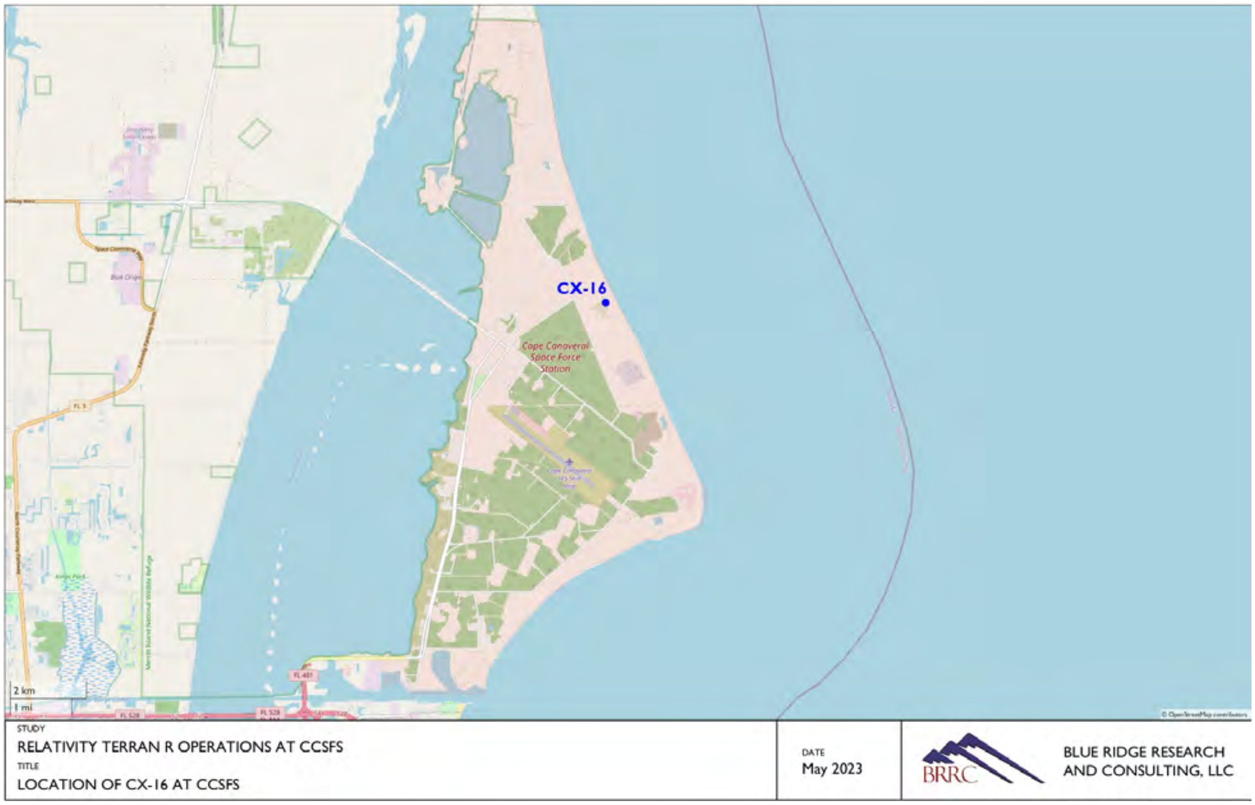

Figure 1. Location of the CX-16 launch site at CCSFS.

This noise study describes the environmental noise associated with the proposed Terran R operations. The potential impacts from propulsion noise and sonic booms are evaluated in relation to human annoyance, hearing conservation, and structural damage. The following sections of this report are outlined below.

- Section 2 defines the proposed Terran R operations.
- Section 3 reviews the noise metrics and effects discussed throughout this report.
- Section 4 presents the propulsion noise and sonic boom modeling results.
- Section 5 summarizes the notable findings of this noise study.
- Appendix A gives an overview of the basics of sound.
- Appendix B provides definitions of the noise metrics discussed throughout this report.
- Appendix C describes the propulsion noise and sonic boom modeling methods.

2 TERRAN R OPERATIONS

Relativity plans to launch the Terran R from CX-16 on an azimuth between 41° and 105° as shown in Figure 2. After stage separation, the Terran R's first stage will land on an ocean-going platform in the Atlantic Ocean over 500 miles downrange. The Terran R launch and landing trajectories will be unique to the vehicle configuration, mission, and environmental conditions. However, during launches that are still early in the program development, Relativity may require expending Terran R in the ocean. When this occurs, Relativity would not recover Terran R and expects the vehicle to break up on impact with the ocean surface. Relativity provided nominal launch and landing trajectories for the noise and sonic boom modeling.

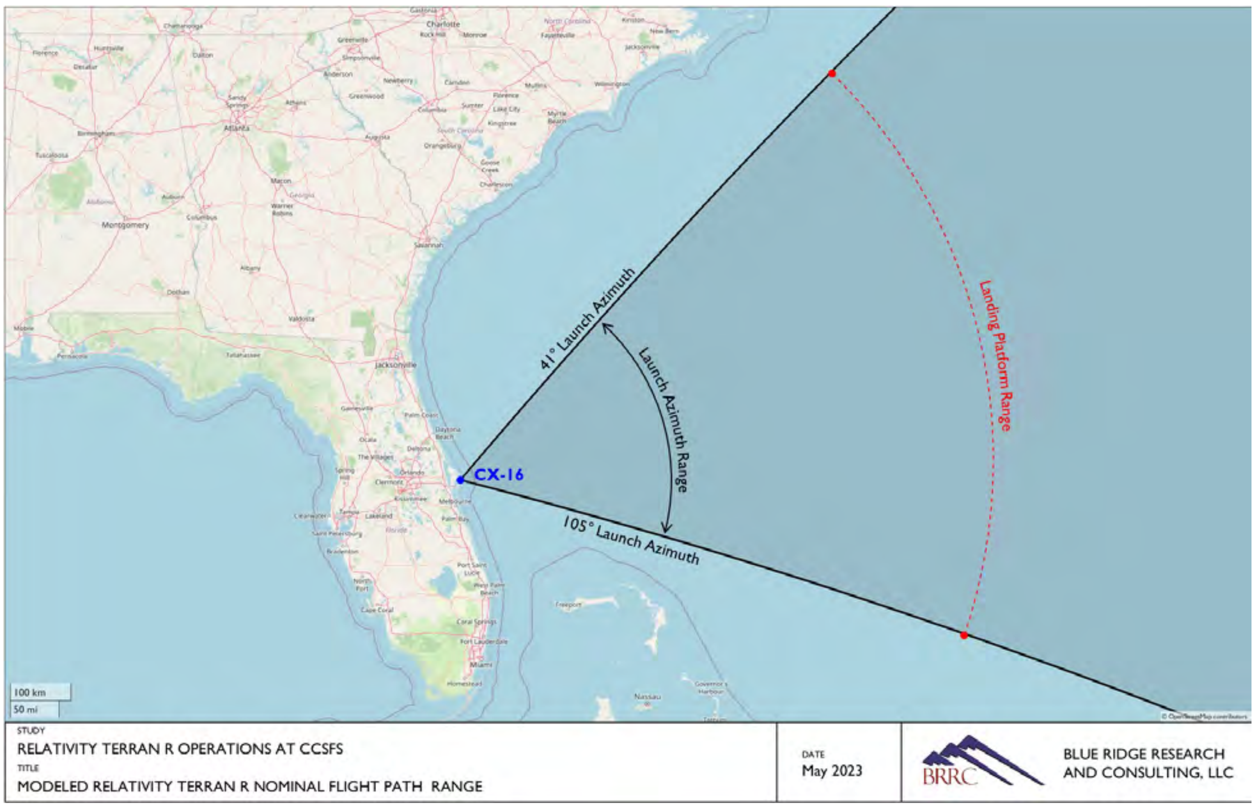

Figure 2. Range of Terran R launch azimuths and landing platform locations.

Table 1 presents the proposed Relativity Terran R operations at CCSFS. Relativity plans to conduct up to 24 launch and landing operations of the Terran R from CX-16 per year. Prior to launch, Relativity may conduct stage hot fire testing with a run-time up to 30 seconds and a pre-launch static fire test with a typical run-time of approximately eight (8) seconds. Table 1 also presents the distribution of the Terran R operations between acoustic day (0700 to 2200) and acoustic night (2200 – 0700). The acoustic time of day distribution is used to account for increased sensitivity to noise at night when computing the Day-Night Average Sound Level (DNL) metric, which applies an additional 10 dB adjustment to events during the acoustical nighttime period.

Table 1. Proposed Relativity Terran R operations at CCSFS.

		Annual Operations		
Event	Description	Daytime 0700 – 2200	Nighttime 2200 – 0700	Total
Stage Hot Fire	30 seconds hot fire	10	4	14
Static Fire	8 seconds static fire	18	6	24
Launch	Launch from CX-16	18	6	24
Stage 1 Landing	Landing on ocean-going platform	18	6	24

Table 2 presents the vehicle and engine modeling data for an upper bound configuration of the Terran R. The noise and sonic boom modeling of the launch and landing operations use the time varying weight and thrust profiles provided in the trajectories. A maximum thrust of approximately 4,480,000 lbf is reached during launch. The first stage landing burn initially ignites 3 engines, two of which shut down part way through the burn so that the vehicle lands on 1 engine.

Table 2. Vehicle and engine modeling parameters for an upper bound configuration of the Terran R.

Modeling Parameters	Values
Manufacturer	Relativity Space
Name	Terran R
Length	320 ft
Diameter	18 ft
Gross Weight	3,099,006 lbs
1st Stage Thrust (Max S.L)	4,480,000 lbf (320,000 lbf x Qty. 14 Aeon-R engines)
2nd Stage Thrust (Vacuum)	280,410 lbf (Qty. 1 Aeon-R-vac engines)

Figure 3. Conceptual rendering of the Terran R (Image Credit: Relativity)

3 NOISE METRICS AND EFFECTS

A variety of acoustic metrics can be used to describe how noise from commercial space operations affects communities and the environment. Metrics can describe the effect of an individual operation (single event) or the cumulative noise of multiple events over a long time. An overview of the basics of sound and definitions of the noise metrics discussed throughout this report are provided in Appendix A and Appendix B, respectively. Additionally, a comprehensive listing of acoustical terminology and definitions is available in the American National Standards Institute's (ANSI) "Acoustical Terminology" standard (ANSI S1.1-2013).

The Day Night Average Sound Level (DNL) is the FAA's primary noise metric to quantify the cumulative exposure of individuals to noise from aviation activities [1]. Despite the differences between aviation and commercial space vehicle noise, DNL is the required metric to quantify cumulative exposure to noise from commercial space transportation activities, too. However, the DNL metric may not fully describe the noise experienced during a commercial space noise event, and the use of supplemental noise metrics is recommended.

The metrics and effects relevant to propulsion noise and sonic booms from commercial space operations are presented in Sections 3.1 and 3.2, respectively. The noise effects described in the following sections are associated with the effects on people and structures.

3.1 Propulsion Noise Metrics and Effects

Table 3 presents metrics and associated effects relevant to the analysis of propulsion noise from commercial space operations. The associated effects referenced in Table 3 are discussed in more detail in Sections 3.1.1 through 3.1.3. For more detailed definitions of the metrics, beyond the descriptions provided in Table 3, see Appendix B.

In addition to the FAA's primary noise metric, DNL, Table 3 provides supplemental metrics that are used to evaluate potential impacts to people and structures. The maximum sound level metrics are particularly useful in improving the public's understanding of exceptionally loud commercial space event(s). Maximum sound level metrics are used to evaluate the potential for noise-induced hearing impairment and vibration effects on structures. Additionally, A-weighted Sound Exposure Level (SEL), and Percent Allowable Daily Noise Dose are used to describe the potential noise impact from rocket operations.

Table 3. Metrics for propulsion noise analysis.

Metric	Description	Effect	Level
Day-Night Average Sound Level (DNL)	A cumulative (A-weighted) metric that accounts for all noise events in a 24-hour period. (Appendix B)	Annoyance (Section 3.1.1)	65 dBA Ref. [1]
Maximum A-weighted Sound Level ($L_{A,max}$)	A single-event metric that describes the highest A-weighted sound level during an event in which the sound changes with time. (Appendix B)	Hearing Impairment (Section 3.1.2)	115 dBA Ref. [2]
Maximum Unweighted Sound Pressure Level (L_{max})	A single-event metric that describes the highest unweighted sound pressure level during an event in which the sound changes with time. (Appendix B)	Vibration on Structures (Section 3.1.3)	111 dB and 120 dB Ref. [3]
A-weighted Sound Exposure Level (SEL)	A single-event metric that accounts for the noise level and duration of the event, referenced to a standard duration of one second. (Appendix B)	--	--
Percent Allowable Daily Noise Dose	A single-event metric that describes the sound exposure normalized to an 8-hour working day, expressed as a percentage of the allowable daily noise dose. (Appendix B)	Hearing Impairment (Section 3.1.2)	--

3.1.1 Annoyance

DNL is based on long-term cumulative noise exposure and has been found to correlate with long-term community annoyance for regularly occurring events including aircraft, rail, and road noise [4, 5]. Noise studies used in the development of the DNL metric did not include rockets, which can have significant low-frequency noise energy and are historically irregularly occurring events. Thus, the suitability of DNL for rocket noise events is uncertain [6]. Additionally, the DNL "threshold does not adequately address the effects of noise on visitors to areas within a national park or national wildlife refuge where other noise is very low and a quiet setting is a generally recognized purpose and attribute" [1]. However, DNL is the most widely accepted metric to estimate the potential changes in long-term community annoyance.

DNL is the FAA's primary noise metric to quantify the cumulative exposure of individuals to noise from aviation activities. Exhibit 4-1 of FAA Order 1050.1F [1] defines the FAA's significance threshold for noise. An action is considered significant if it would increase noise in a noise-sensitive area by DNL 1.5 dBA or more and the resulting noise exposure level is at least DNL 65 dBA. For example, an increase from DNL 65.5 dBA to 67 dBA is considered a significant impact, as is an increase from DNL 63.5 dBA to 65 dBA.

3.1.2 Noise-Induced Hearing Impairment

U.S. government agencies provide guidelines on permissible noise exposure limits to unprotected human hearing. These guidelines are in place to protect human hearing from long-term continuous daily exposures to high noise levels and aid in the prevention of noise-induced hearing loss (NIHL). A number of federal agencies have set exposure limits on non-impulsive noise levels, including the Occupational Safety and Health Administration (OSHA) [2], National Institute for Occupational Safety and Health (NIOSH) [7], and the Department of Defense (DoD) Occupational Hearing Conservation Program [8]. The most conservative of these upper noise level limits is the OSHA standard, which specifies that exposure to continuous steady-state noise is limited to a maximum of 115 dBA. At 115 dBA, the allowable exposure duration is 15 minutes for OSHA and 28 seconds for NIOSH and DoD. $L_{A,max}$ can be used to identify potential locations where hearing protection should be considered for rocket operations.

In addition to the maximum exposure limits, OSHA standards also specify a daily noise dose based on the SEL which accounts for the energy over the duration of the event(s). Although the daily noise dose metric was established to protect workers against NIHL, the results can also help contextualize the noise exposure in the community. The level of exposure is typically calculated in terms of a daily noise dose, which is a function of the sound exposure normalized to an 8-hour workday. For example, a person will reach 100% of their daily noise dose after 15 minutes of exposure to 115 dBA. A person will also reach 100% of their daily noise dose after 8 hours of exposure to 90 dBA.

3.1.3 Noise-Induced Vibration Effects on Structures

Windows are typically the most sensitive components of a structure to launch vehicle noise. Infrequently, plastered walls and ceilings may also be affected. The potential for damage to a structure depends on the incident sound, the condition and material of the structural element, and installation of each element.

A National Aeronautics and Space Administration (NASA) technical memo [3] concluded that the probability of structural damage is proportional to the intensity of the low frequency sound. The conclusions were based on community responses to 45 ground tests of the first and second stages of the Saturn V rocket system conducted in Southern Mississippi over a period of five years. The memo found that the estimated number of damage claims is one in 100 households exposed to an average continuous sound level of 120 dB (unweighted) and one in 1,000 households exposed to 111 dB (unweighted).

It is important to highlight the difference between the static ground tests on which the rate of structural damage claims is based and the dynamic events modeled in this noise study. During ground tests, the rocket engine remains in one position, which results in a longer-duration exposure to continuous levels as opposed to the transient noise occurring from the moving vehicle during a launch event. Regardless of this difference, Guest and Slone's [3] damage claim criteria represent the best available dataset regarding the potential for structural damage resulting from rocket noise. Thus, L_{max} values of 120 dB (unweighted) and 111 dB (unweighted) are used in this report as conservative thresholds for potential risk of structural damage claims.

3.2 Sonic Boom Metrics and Effects

Table 4 presents metrics and associated effects relevant to the analysis of sonic booms from commercial space operations. The associated effects referenced in Table 4 are discussed in more detail in Sections 3.2.1 through 3.2.4. For more detailed metric definitions beyond the descriptions provided in Table 4, see Appendix B.

In addition to the FAA's primary noise metric for sonic booms, C-weighted DNL (CDNL), Table 4 provides supplemental metrics that can be used to evaluate potential impacts to people, and structures. The peak overpressure is particularly useful in improving the public's understanding of the impulsive sonic boom event(s). The peak overpressure is used to evaluate the potential for noise-induced hearing impairment and vibration effects on structures.

Table 4. Metrics for sonic boom analysis.

Metric	Description	Effect	Level
C-weighted Day-Night Average Sound Level (CDNL)	A cumulative (C-weighted) metric that accounts for all noise events in a 24-hour period. (Appendix B)	Annoyance (Section 3.2.1)	60 dBC [9]
Peak Overpressure	A single-event metric that describes the highest instantaneous sound pressure level, characterized for sonic booms by the front shock wave. (Appendix B)	Physiological Effects (Section 3.2.2)	
		Hearing Impairment (Section 3.2.3)	140 dB (4 psf) [7]
		Vibration on Structures (Section 3.2.4)	2 psf [10, 11]

3.2.1 Annoyance

Similar to propulsion noise (see Section 3.1.1), DNL is the FAA's primary noise metric to quantify the cumulative exposure of individuals to sonic booms. However, for impulsive noise sources with significant low frequency content such as sonic booms, C-weighted DNL (CDNL) is preferred over A-weighted DNL [12]. In terms of percentage of people who are highly annoyed, DNL 65 dBA is equivalent to CDNL 60 dBC [9].

3.2.2 Physiological Effects

The unexpected, loud impulsive noise of sonic booms tends to cause a startle effect in people. However, when people are exposed to impulsive noises with similar characteristics on a regular basis, they tend to become conditioned to the stimulus and no longer display the startle reaction. The physiological effects of single sonic booms on humans [13] can be grouped as presented in Table 5.

Table 5. Physiological effects of a single sonic booms on humans. [13]

Overpressure	Behavioral effects
< 0.3 psf	Orienting, but no startle response; eyeblink response in 10% of subjects; no arm/hand movement.
0.6–2.3 psf	Mixed pattern of orienting/startle responses; eyeblink in about half of subjects; arm/hand movements in about a fourth of subjects, but not gross bodily movements.
2.7–6.5 psf	Predominant pattern of startle responses; eyeblink response in 90 percent of subjects; arm/hand movements in more than 50 percent of subjects with gross body flexion in about a fourth of subjects.

3.2.3 Noise-Induced Hearing Impairment

Multiple U.S. government agencies provide guidelines on permissible noise exposure limits for impulsive noise such as sonic booms. NIOSH [7] and OSHA [2] state that impulsive or impact noise levels should not exceed 140 dB peak sound pressure level, which equates to a sonic boom peak overpressure level of approximately 4 psf.

3.2.4 Noise-Induced Vibration Effects on Structures

The potential for damage from sonic booms is generally confined to brittle objects, such as glass, plaster, roofs, and bric-a-brac. Table 6 provides a summary of potential damage to conventional structures at various overpressures. Additionally, Table 6 describes example impulsive events for each level range. A large degree of variability exists in damage types and amounts, and much of the potential for damage depends on the sonic boom overpressure and the pre-existing condition of a structure. Generally, the potential for damage to well-maintained structures from sonic boom overpressures less than 2 psf is unlikely [10, 11]. The probability of the potential for damage to well-maintained structures by overpressures less than 4 psf is low (see Table 6) and increases for levels greater than 4 psf. Ground motion resulting from sonic boom is rare and is considerably below structural damage thresholds accepted by the United States Bureau of Mines and other agencies.

Table 6. Possible damage to structures from sonic booms. [10]

Nominal level	Damage Type	Item Affected
0.5 – 2 psf *piledriver at construction site*	Glass	Extension of existing cracks; potential for failure for glass panes in bad repair; failure potential for existing good glass panes is less than 1 out of 10,000 at 2 psf.
	Ceiling Plaster	Fine cracks; extension of existing cracks; mostly from fragile areas.
	Wall Plaster	Fine cracks; extension of existing cracks (less than in ceilings); over doorframes; between some plasterboards; mostly fragile areas.
	Roof	Older roofs may have slippage of existing loose tiles/slates; sometimes new cracking of old slates at nail hole; New and modern roofs are rarely affected.
	Bric-a-brac	Those carefully balanced or on edges can fall; fine glass, such as large goblets, can fall and break.
2 – 4 psf *cap gun/ firecracker near ear*	Glass	Failures show that would have been difficult to forecast in terms of their existing localized condition. Nominally in good condition.
	Ceiling Plaster	Estimated rate of cracking ranges from less than 1 out of 5,000 (2 psf) to 1 out of 625 (4 psf).
	Wall Plaster	Estimated rate of cracking ranges from less than 1 out of 10,000 (2 psf) to 1 out of 1,000 (4 psf).
	Roof	Potential for nail-peg failure if eroded.
	Bric-a-brac	Increased risk of tipping or falling objects.
4 – 10 psf *handgun at shooter's ear*	Glass	Regular failures within a large population of well-installed glass (1 out 50 (10 psf) to 500 (4 psf)); Failure potential in industrial and greenhouses glass panes.
	Ceiling Plaster	Estimated rate of cracking ranges from 1 out of 625 (4 psf) to 1 out of 10 (10 psf). Potential for partial ceiling collapse of good plaster; complete collapse of very new, incompletely cured, or very old plaster.
	Wall Plaster	Estimated rate of cracking ranges from less than 1 out of 1,000 (4 psf) to 1 out of 50 (10 psf). Measurable movement of inside ("party") walls at 10 psf.
	Roof	Regular failures within a large population of nominally good slate, slurry-wash; some chance of failures in tiles on modern roofs; light roofs (bungalow) or large area can move bodily.
	Bric-a-brac	Increased risk of tipping of falling objects

Table 6. Possible damage to structures from sonic booms. [10] (continued)

Nominal level	Damage Type	Item Affected
> 10 psf *fireworks display from viewing stand*	Glass	Some good glass will fail regularly (great than 1 out of 10) to sonic booms and at an increase rate when the wavefront is normal to the glass panel. Glass with existing faults could shatter and fly. Large window frames move.
	Ceiling Plaster	Plasterboards displaced by nail popping.
	Wall Plaster	Most plaster affected. Internal party walls can move even if carrying fittings such as hand basins or taps; secondary damage due to water leakage.
	Roof	Most slate/slurry roofs affected, some badly; large roofs having good tile can be affected; some roofs bodily displaced causing gale-end and will-plate cracks; rarely domestic chimneys dislodged if not in good condition.
	Bric-a-brac	Some nominally secure items can fall, e.g., large pictures, especially if fixed to party walls.

4 RESULTS

The following section presents the propulsion noise and sonic boom modeling results with respect to the potential environmental impacts associated with Terran R operations at CCSFS.

4.1 Propulsion Noise Results

Rocket propulsion noise is created by the rocket plume interacting with the atmosphere and the combustion noise of the propellants. Propulsion noise generated by Terran R operations from CCSFS was modeled using RUMBLE 4.1, BRRC's Rocket Noise and Emissions Model (see Appendix C.1).

The propulsion noise results are presented in the form of noise contours, where a noise contour is a line drawn on a map that connects points of equal noise level. The noise contours are overlaid on map tiles from OpenStreetMap which contain helpful orienting features such as places, roads and boundaries, including the state and international water boundaries (shown parallel to the coastline).

The single-event noise contour maps are presented for each event type.

- The launch noise contours represent the maximum sound levels over the proposed range of launch azimuths between 41° and 105°.
- The landing noise contours represent a nominal launch azimuth, as the range of potential ocean-going platform locations between 41° and 105° is entirely over water.
- The stage hot fire (30 seconds) and static fire (8 seconds) noise contours are presented together when the metric is independent of duration and separately when the metric is a function of duration (i.e., Sound Exposure Level and OSHA Dose).

The noise contours extend further over water than over land because water surfaces reflect more sound energy than land. Thus, the sound levels over water are elevated relative to the sound levels over land at comparable distances.

The noise levels are presented in Section 4.1.1 to provide additional context regarding the intensity of the sound and its duration. The noise effects are discussed in Section 4.1.2 with respect to annoyance, hearing conservation, and structural damage.

4.1.1 Propulsion Noise Levels

The modeled noise levels generated by Terran R operations at CCSFS are presented for three noise metrics: Unweighted Maximum Sound Level, A-weighted Maximum Sound Level, and A-weighted Sound Exposure Level. Although the maximum sound level provides some measure of the event, L_{max} (or $L_{A,max}$) does not fully describe the sound because it does not account for how long the sound is heard. Thus, A-weighted SEL contours are provided in addition to the $L_{A,max}$ contours, as SEL represents both the intensity of a sound and its duration. SEL provides a measure of the net impact of the entire acoustic event, but it does not directly represent the sound level heard at any given time. The A-weighted SEL is also used in the calculation of DNL.

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

The modeled $L_{A,max}$ contours are presented in Figure 4 through Figure 6.

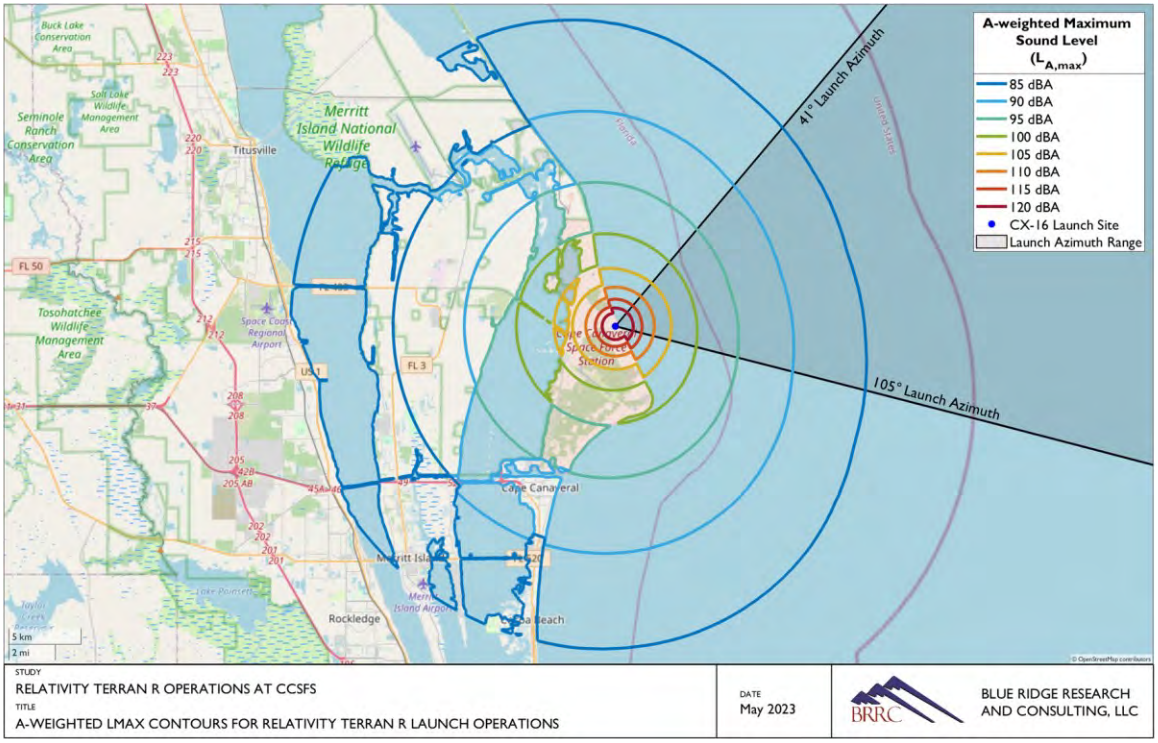

Figure 4. A-weighted maximum sound level contours for launch operations over the proposed azimuth range (41° - 105°).

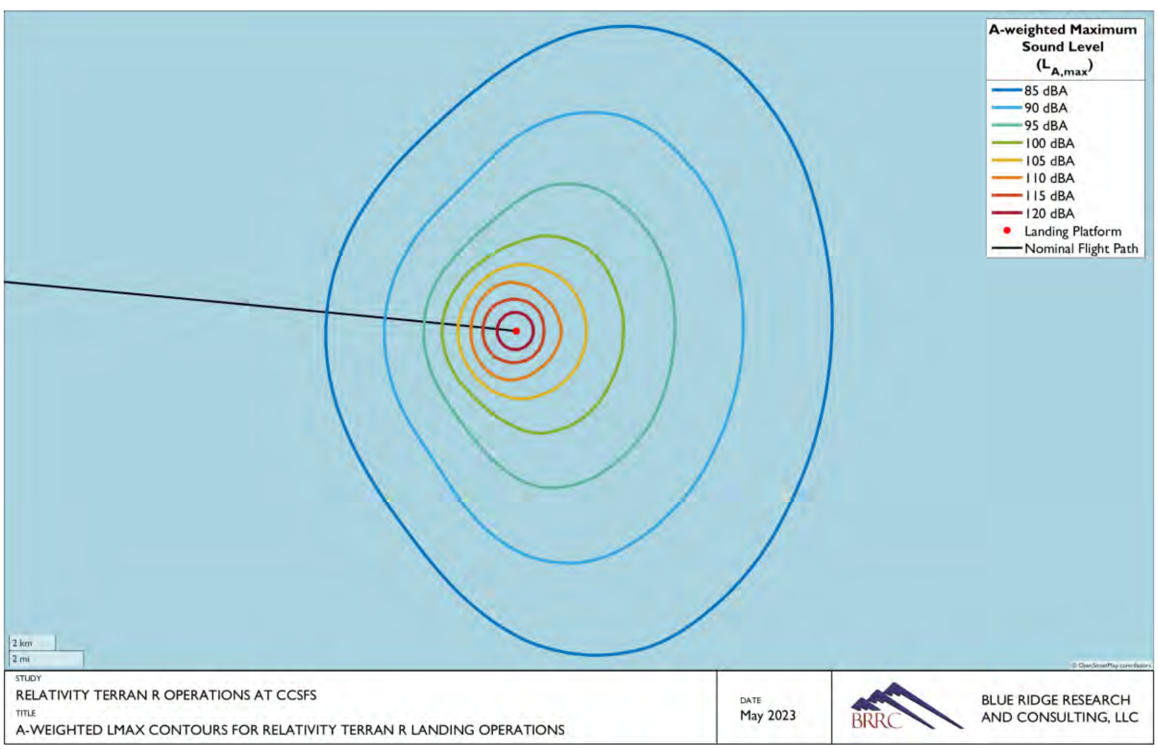

Figure 5. A-weighted maximum sound level contours for a nominal first stage landing.

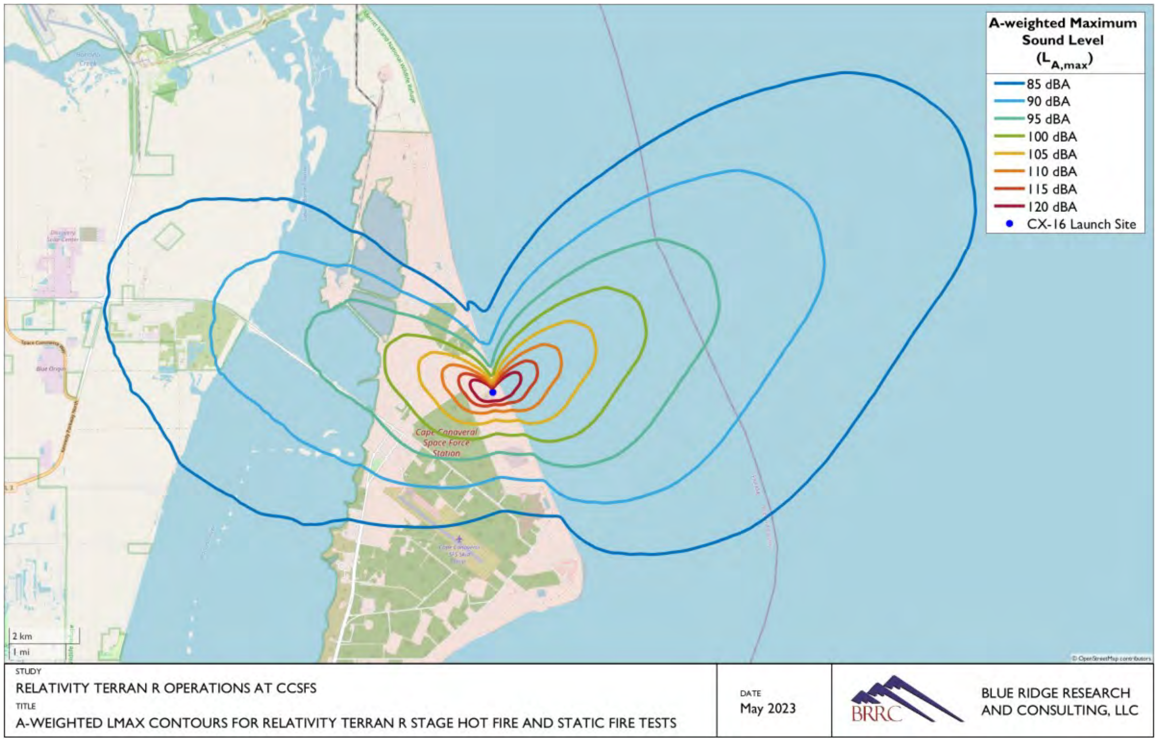

Figure 6. A-weighted maximum sound level contours for stage hot fire and static fire tests.

Unweighted Maximum Sound Level

The modeled L_{max} contours are presented in Figure 7 through Figure 9.

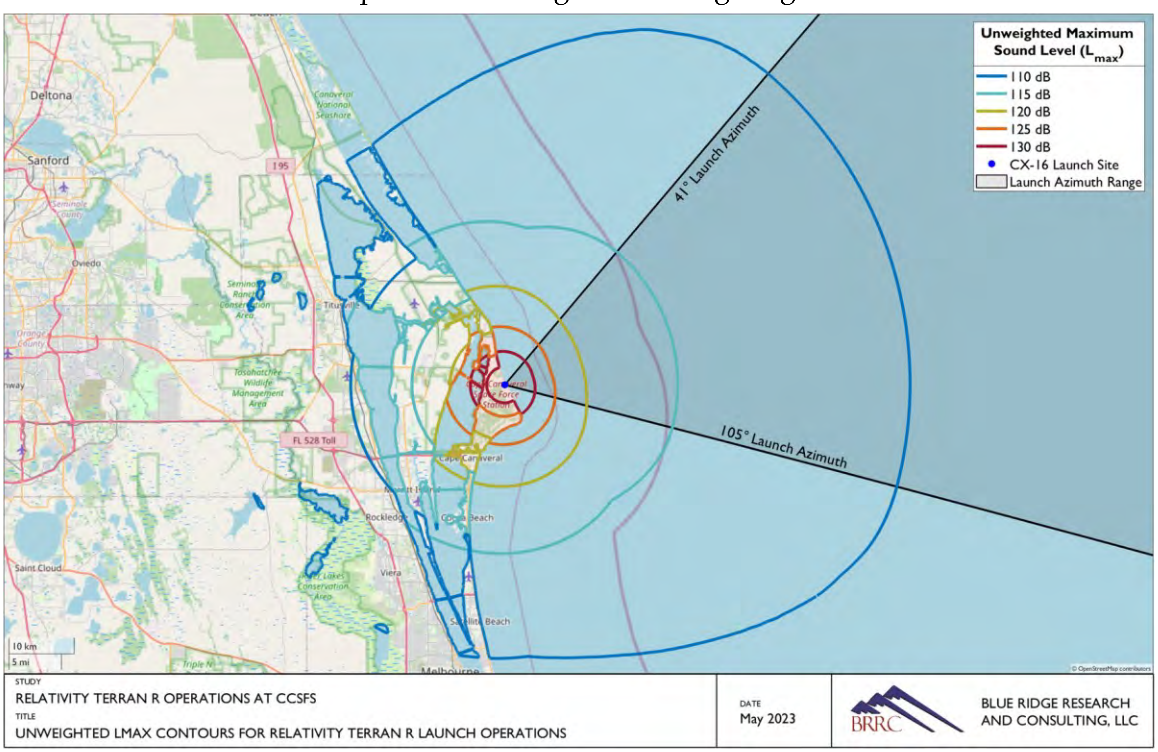

Figure 7. Unweighted maximum sound level contours for launch operations over the proposed azimuth range (41° - 105°).

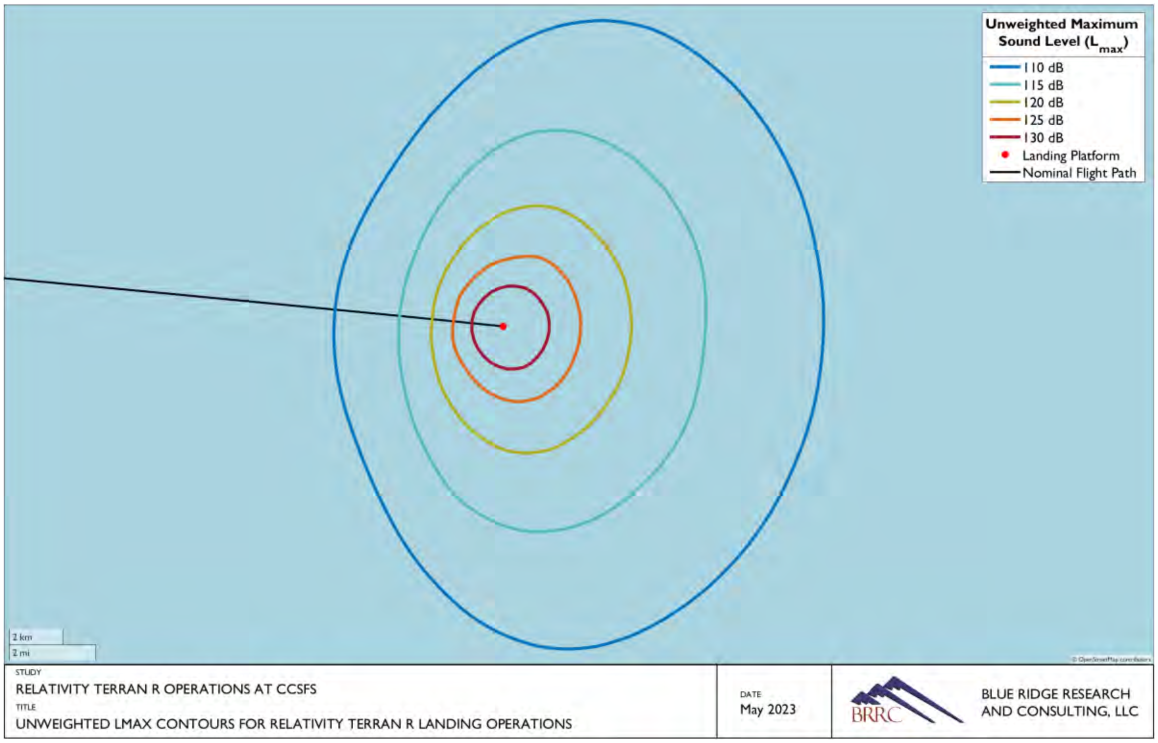

Figure 8. Unweighted maximum sound level contours for a nominal first stage landing.

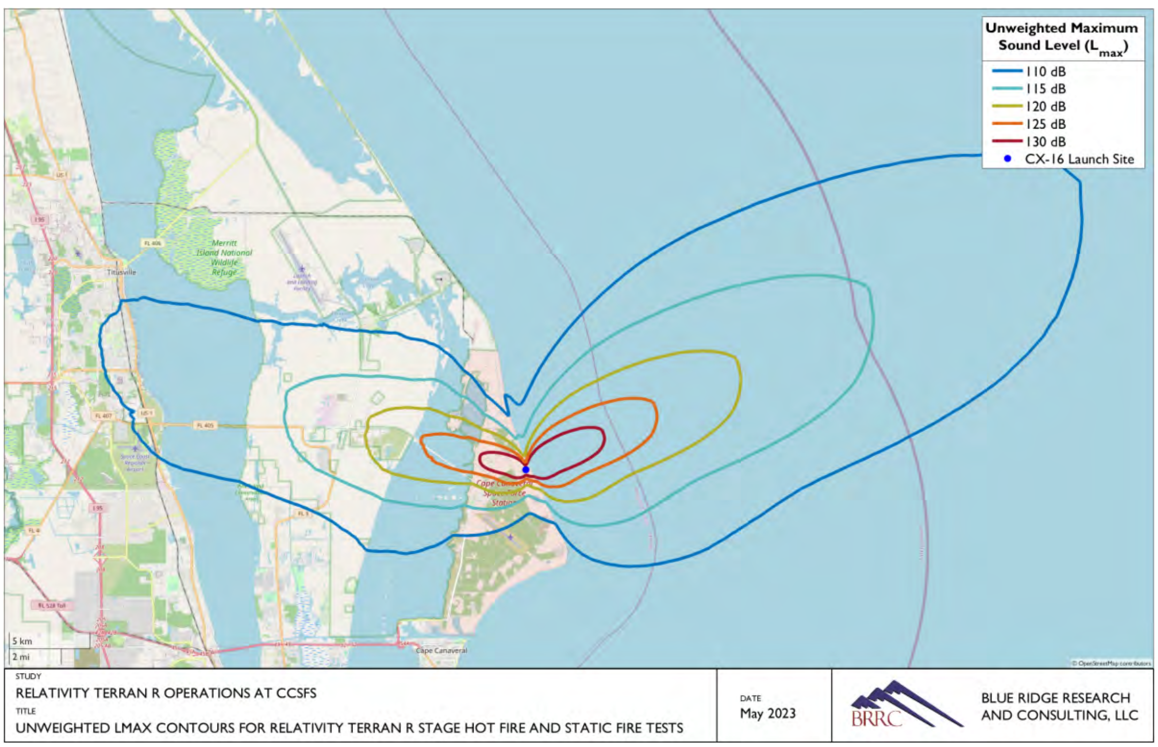

Figure 9. Unweighted maximum sound level contours for stage hot fire and static fire tests.

A-weighted Sound Exposure Level

The modeled A-weighted SEL contours are presented in Figure 10 through Figure 13.

Figure 10. Sound exposure level contours for launch operations over the proposed azimuth range (41° - 105°).

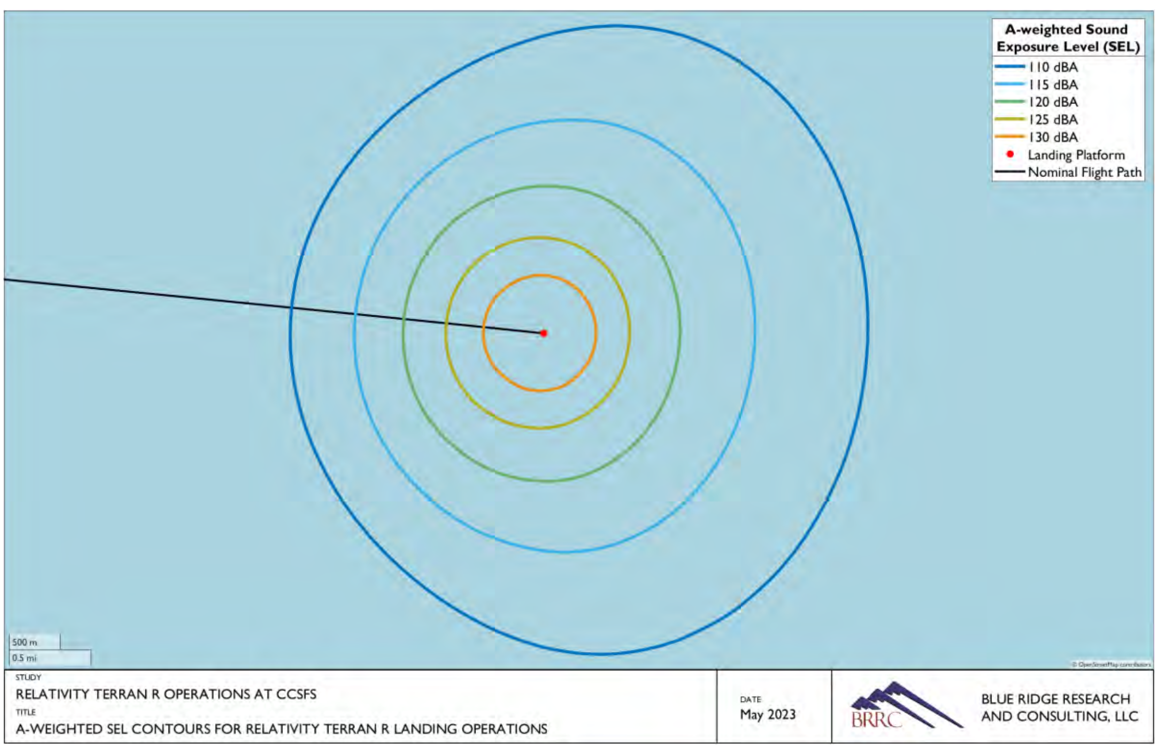

Figure 11. Sound exposure level contours for a nominal first stage landing.

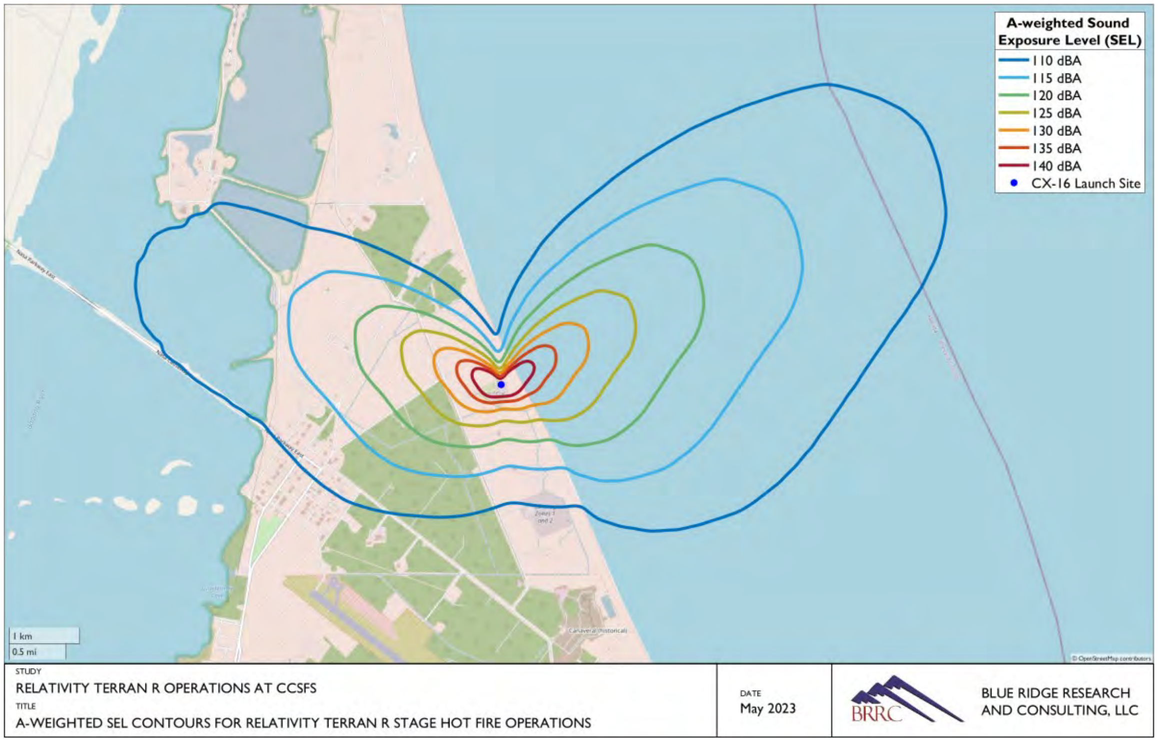

Figure 12. Sound exposure level contours for stage hot fire operations (30 seconds).

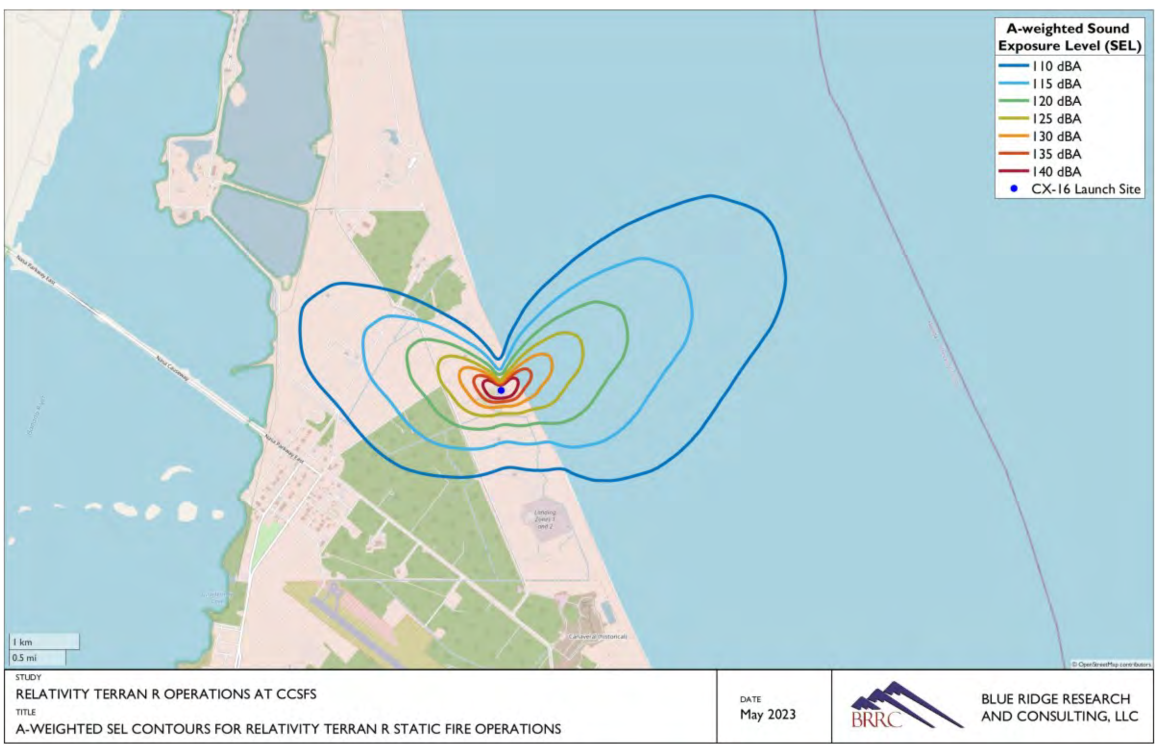

Figure 13. Sound exposure level contours for static fire operations (8 seconds).

4.1.2 Propulsion Noise Effects

The modeled noise generated by Terran R operations at CCSFS are presented with respect to three noise effects: annoyance, hearing conservation, and structural damage. The discussion of propulsion noise effects focuses on the launch, static fire, and stage hot fire operations. The noise contours from landing operations are entirely over water and thus the potential for noise effects with respect to annoyance, hearing conservation, and structural damage is not considered.

Annoyance

The potential for long-term community annoyance is assessed using DNL for propulsion noise. DNL accounts for the A-weighted SEL of all noise events in an average annual day; and accounts for increased sensitivity during the acoustical nighttime period. The DNL contours from 60 dBA to 85 dBA are presented in Figure 12. The circular shape of the DNL contours is typical of vertical launch operations, although the Terran R DNL contours are slightly wider in the east west direction because of the contribution of the more directive static fire and stage hot fire contours.

DNL contours representing the no action alternative at CCSFS are unavailable, thus, an alternative technique is used to identify the potential for significant noise impacts. The DNL 60 dBA contour is used to conservatively identify the potential for significant noise impacts, as 60 dBA is the smallest level that could increase noise by DNL 1.5 dBA or more for a noise sensitive area that is exposed to noise at or above the DNL 65 dBA noise exposure level, or that will be exposed at or above this level due to the increase. The DNL 65 and 60 dBA contours do not encompass any land area outside of CCSFS boundaries, and thus no residences are impacted.

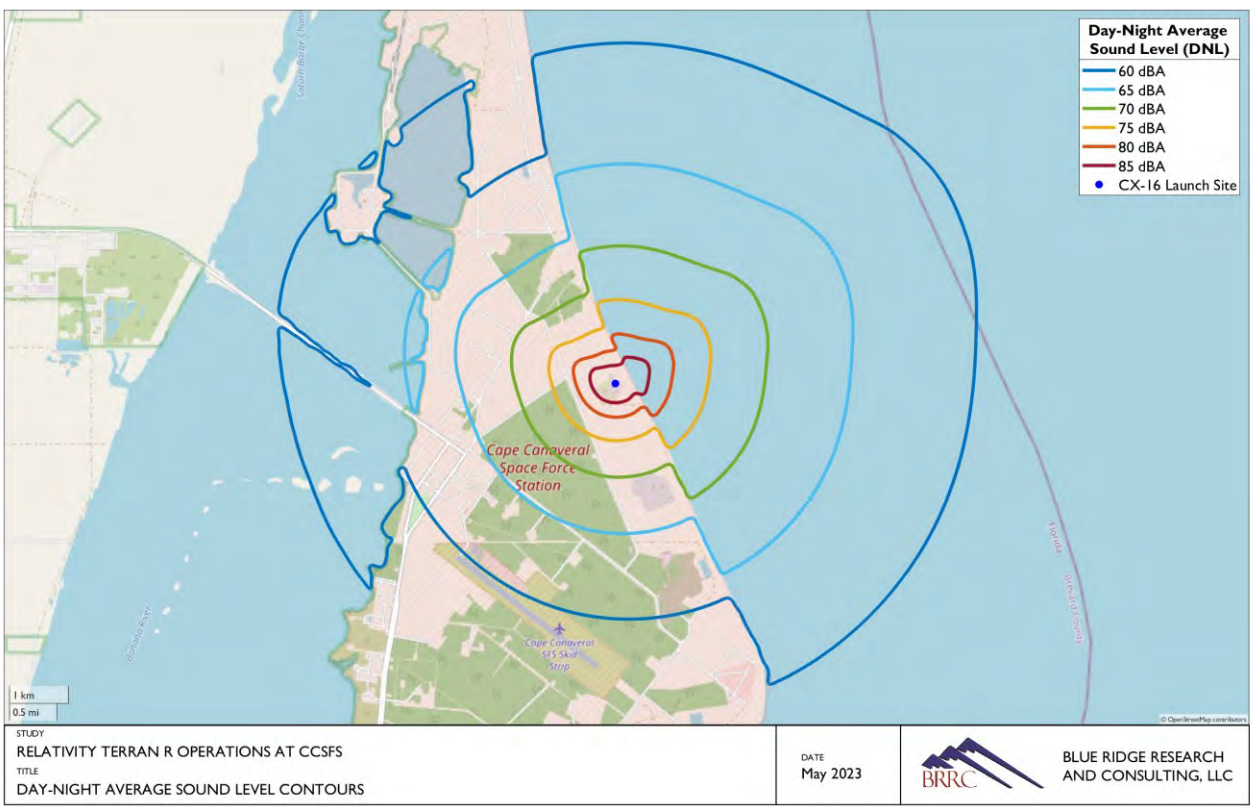

Figure 14. DNL contours for Terran R operations at CCSFS.

Noise-Induced Hearing Impairment

U.S. government agencies provide guidelines on permissible noise exposure limits to unprotected human hearing. The most conservative upper noise level limit is the OSHA standard, which specifies that exposure to continuous steady-state noise is limited to a maximum of 115 dBA. The $L_{A,max}$ 115 dBA contour can be used to identify potential locations where hearing protection should be considered for rocket operations. In addition to the maximum exposure limits, OSHA standards also specify a daily noise dose based on the SEL which accounts for the energy over the duration of the event(s). The modeled allowable daily noise dose contours and the $L_{A,max}$ 115 dBA contour associated with Terran R operations at CCSFS are presented in Figure 15 through Figure 18.

The modeled Terran R launch operations generate levels on land that are at or above an $L_{A,max}$ of 115 dBA within 0.87 miles of CX-16. The modeled Terran R static fire and MDC hot fire noise contours are more directive than the launch noise contours because the plume is redirected in-line with the deflector heading for the entire duration of the event. A receptor located along the peak directivity angle may experience an $L_{A,max}$ of 115 dBA at approximately 0.65 miles of CX-16 for static fire and stage hot fire tests. Note, the levels produced by static fire and stage hot fire tests will remain constant over the duration of the event, whereas the levels produced by launch operations will decrease as the rocket moves further away from the receptor. The entire land area encompassed by the 115 dBA noise contours is within the boundaries of CCSFS. Additionally, people in the community will reach less than 1% of their daily noise dose when exposed to noise from a single Terran R operation. Thus, the potential for impacts to people in the community with regards to hearing conservation is negligible.

Figure 15. Allowable daily noise dose contours for launch operations over the proposed azimuth range (41° - 105°).

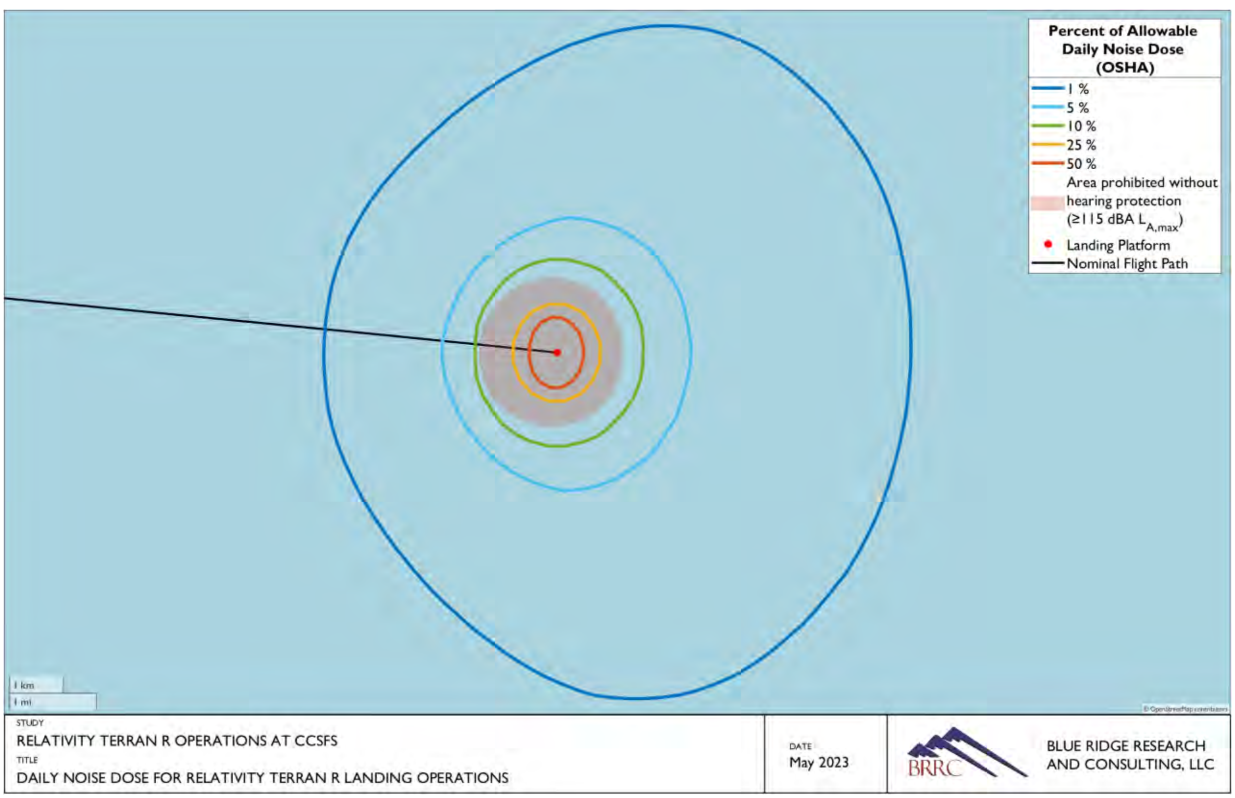

Figure 16. Allowable daily noise dose contours for a nominal first stage landing.

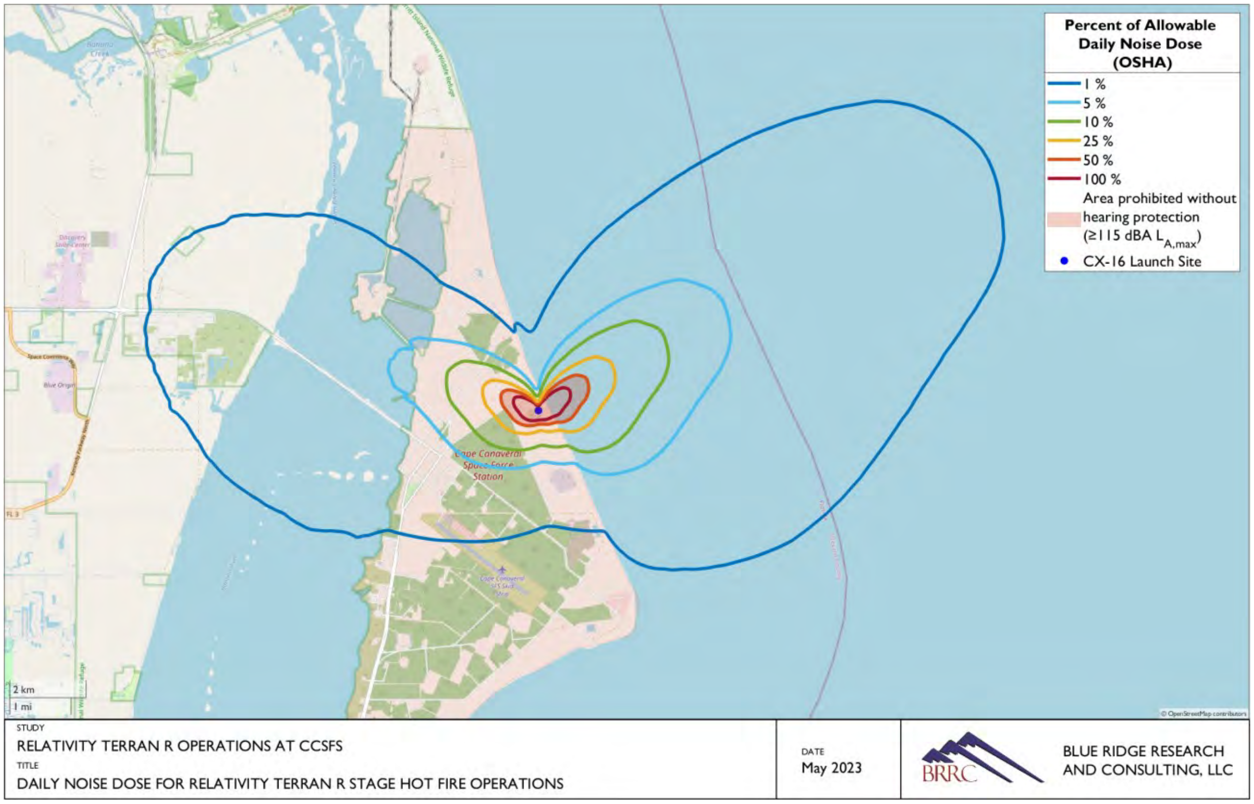

Figure 17. Allowable daily noise dose contours for stage hot fire operations (30 seconds).

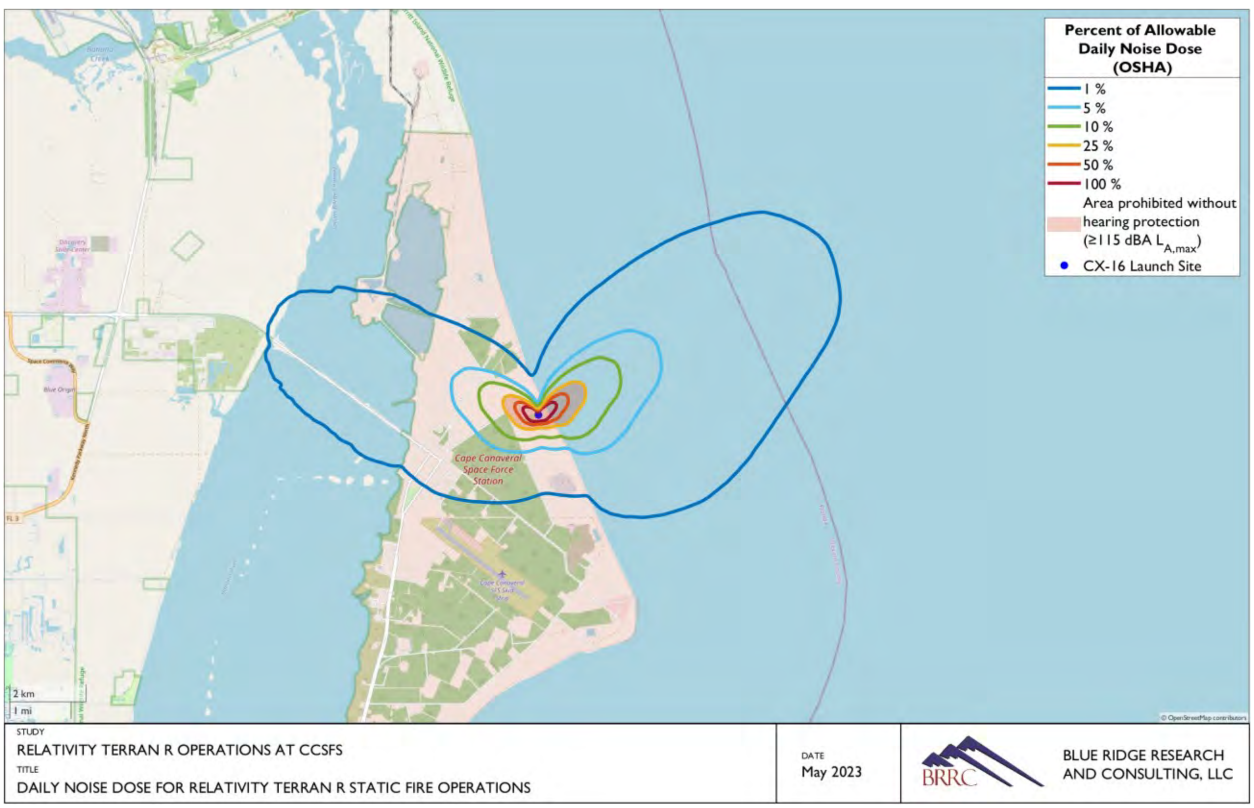

Figure 18. Allowable daily noise dose contours for static fire operations (8 seconds).

Noise-Induced Vibration Effects on Structures

Windows are typically the most sensitive components of a structure to launch vehicle noise. Infrequently, plastered walls and ceilings may also be affected. The potential for damage to a structure depends on the incident sound, the condition and material of the structural element, and installation of each element. A NASA technical memo [3] concluded that the probability of structural damage is proportional to the intensity of the low frequency sound. The memo found that the estimated number of damage claims is one in 100 households exposed to an average continuous sound level of 120 dB and one in 1,000 households exposed to 111 dB. L_{max} values of 120 dB and 111 dB are used in this report as conservative thresholds for potential risk of structural damage claims. The contours associated with 1:1,000 damage claims (111 dB) and 1:100 damage claims (120 dB) are presented in Figure 19 through Figure 21. The 1:100 damage claims contours do not encompass any land area outside of CCSFS and Kennedy Space Center (KSC) boundaries. The 1:1,000 damage claims contours include area on Merritt Island and Cape Canaveral from launch events, and a small area south of the KSC boundary near the Pine Island Conservation area and south of Titusville along the shore from static fire and stage hot fire tests.

The L_{max} value of 130 dB is used to further assess potential impacts to structures based on a report from the National Research Council which states that one may conservatively consider all sound lasting more than one second with levels exceeding 130 dB (unweighted) as potentially damaging to structures. The 130 dB L_{max} contours do not include any land area outside of CCSFS boundaries.

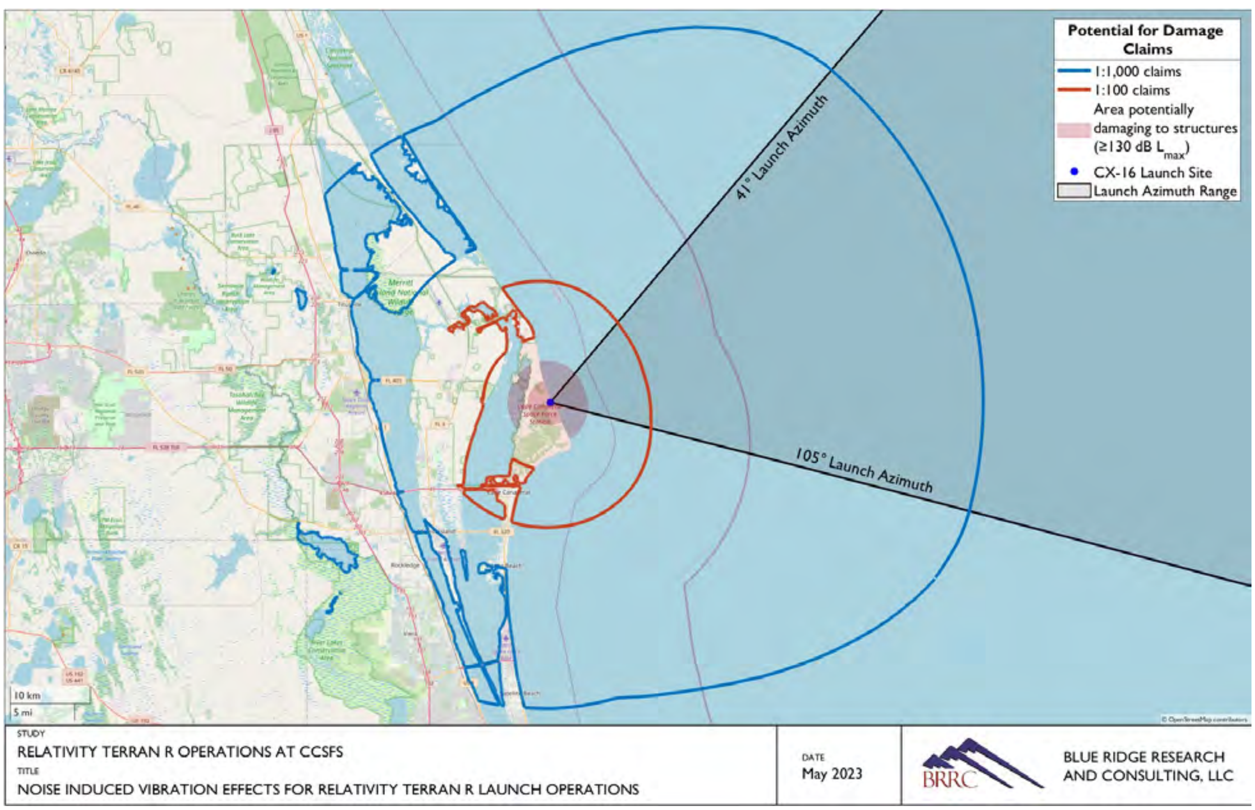

Figure 19. Potential for damage claims contours for launch operations over the proposed azimuth range (41° - 105°).

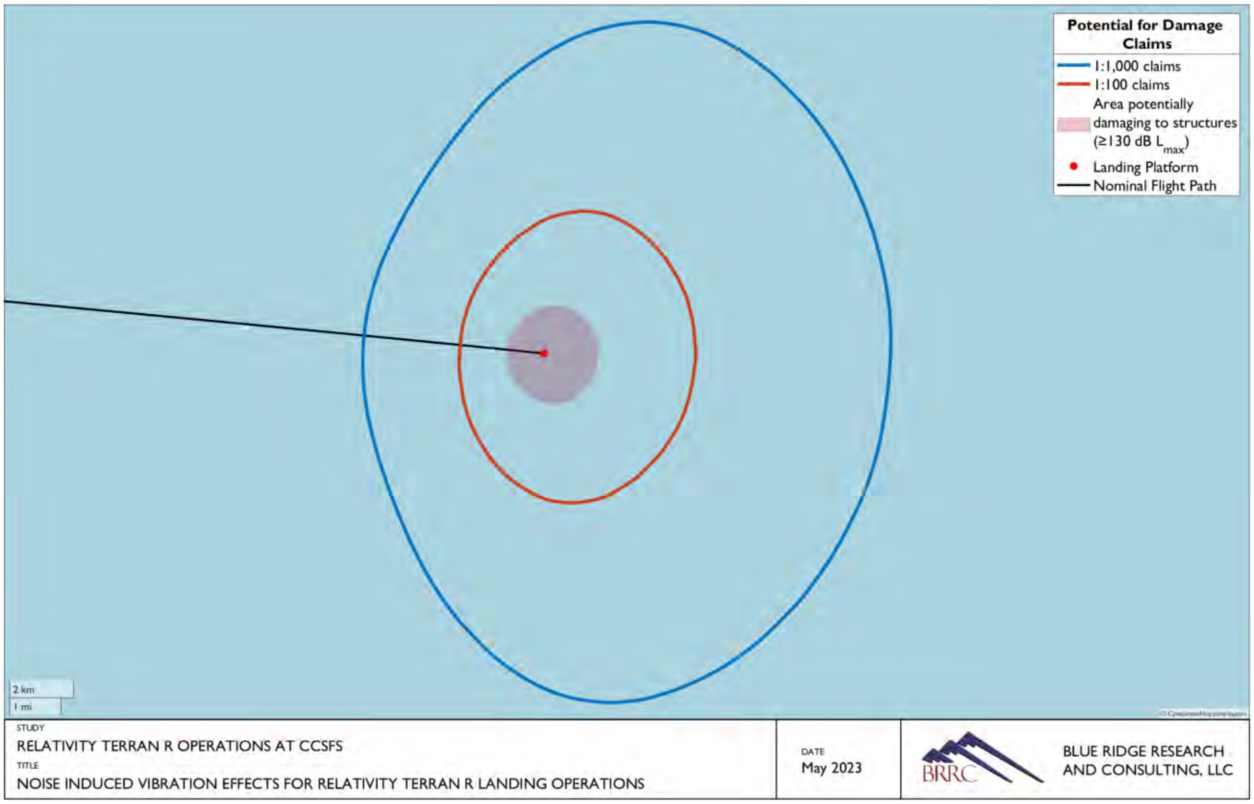

Figure 20. Potential for damage claims contours for a nominal first stage landing.

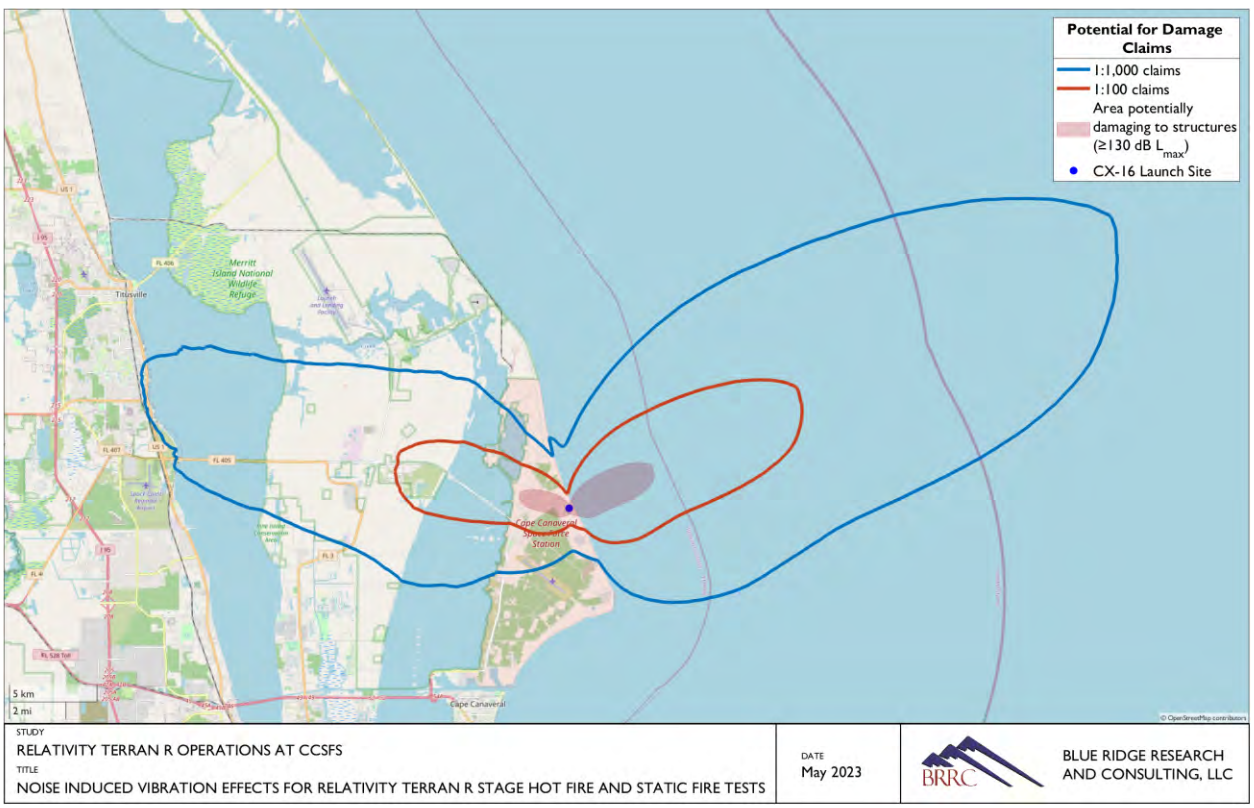

Figure 21. Potential for damage claims contours for stage hot fire and static fire tests.

4.2 Sonic Boom Results

Sonic booms generated by Terran R operations from CCSFS were modeled using PCBoom 6.7b (see Appendix C.2). The modeled peak overpressure levels of sonic booms from Terran R operations are described in Section 5.1. The potential sonic boom impacts from Terran R launch and landing operations are negligible as the sonic booms for these events are entirely over water and thus, will not affect any people or structures.

4.2.1 Sonic Boom Peak Overpressure Levels

The location and intensity of the sonic boom footprint produced by Terran R operations will be highly dependent on the vehicle configuration, trajectory, and atmospheric conditions at the time of flight. The modeled sonic boom peak overpressure contours for Terran R operations are presented in Figure 22 through Figure 25. A summary of the modeled results is detailed below for the launch and landing events.

Launch Sonic Boom

Figure 22 presents the Terran R launch sonic boom contours modeled for a nominal launch azimuth. The modeled sonic boom begins approximately 35 miles downrange of CX-16 with a narrow, forward-facing crescent shaped focus boom region. The maximum modeled peak overpressures occur within this focus boom region. Figure 22 presents peak overpressure contours up to 8 psf, although higher peak overpressure levels up to 11 psf are modeled to occur over smaller areas along the focus line. The focus boom region is generated when the vehicle continuously accelerates and pitches downward as it ascends. As the vehicle continues to ascend, the sonic boom levels decrease, and the crescent shape becomes slightly longer and wider. Figure 23 illustrates the sonic boom contours at the extents of the launch azimuth range (41° to 105°) and shows the area potentially exposed to peak overpressures greater than 0.25 psf from the range of launch azimuths. Sonic booms with peak overpressures greater than 0.25 psf from Terran R launch operations are modeled to occur entirely over the Atlantic Ocean.

Landing Sonic Boom

Figure 24 presents the Terran R landing sonic boom contours modeled for a nominal launch azimuth. The modeled sonic boom begins approximately 75 miles up range of the ocean-going landing platform with a wide low level sonic boom as the vehicle descends below 40 miles and ends when the vehicle's speed becomes subsonic. The sonic boom contours become narrower and increase in amplitude as the vehicle descends closer to the landing platform. The 4 psf contour begins approximately 12 miles up range from the landing platform and is approximately 40 miles wide. Figure 24 presents the peak overpressure contours up to 8 psf, although higher peak overpressure levels up to 47 psf are modeled to occur over smaller areas (within the 8 psf contour). The maximum peak overpressure level of 47 psf occurs when the vehicle's body is perpendicular to the direction of flight (at approximately 26,000 feet) during a flip maneuver to position the vehicle with engines forward for landing. Figure 25 illustrates the sonic boom contours at the extents of the launch azimuth range (41° to 105°) and shows the area potentially exposed to peak overpressures greater than 0.25 psf from the range of launch azimuths. Sonic booms with peak overpressures greater than 0.25 psf from Terran R landing operations are modeled to occur entirely over the Atlantic Ocean.

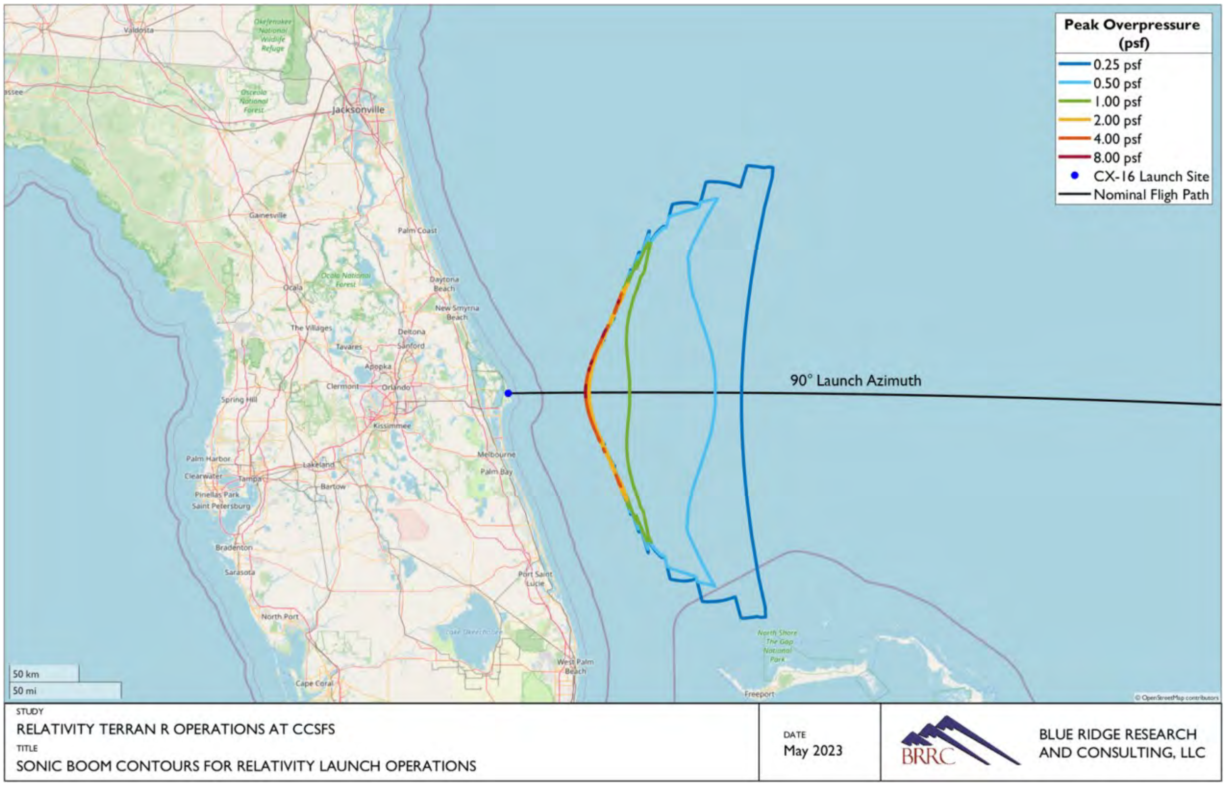

Figure 22. Sonic boom peak overpressure contours for a nominal launch.

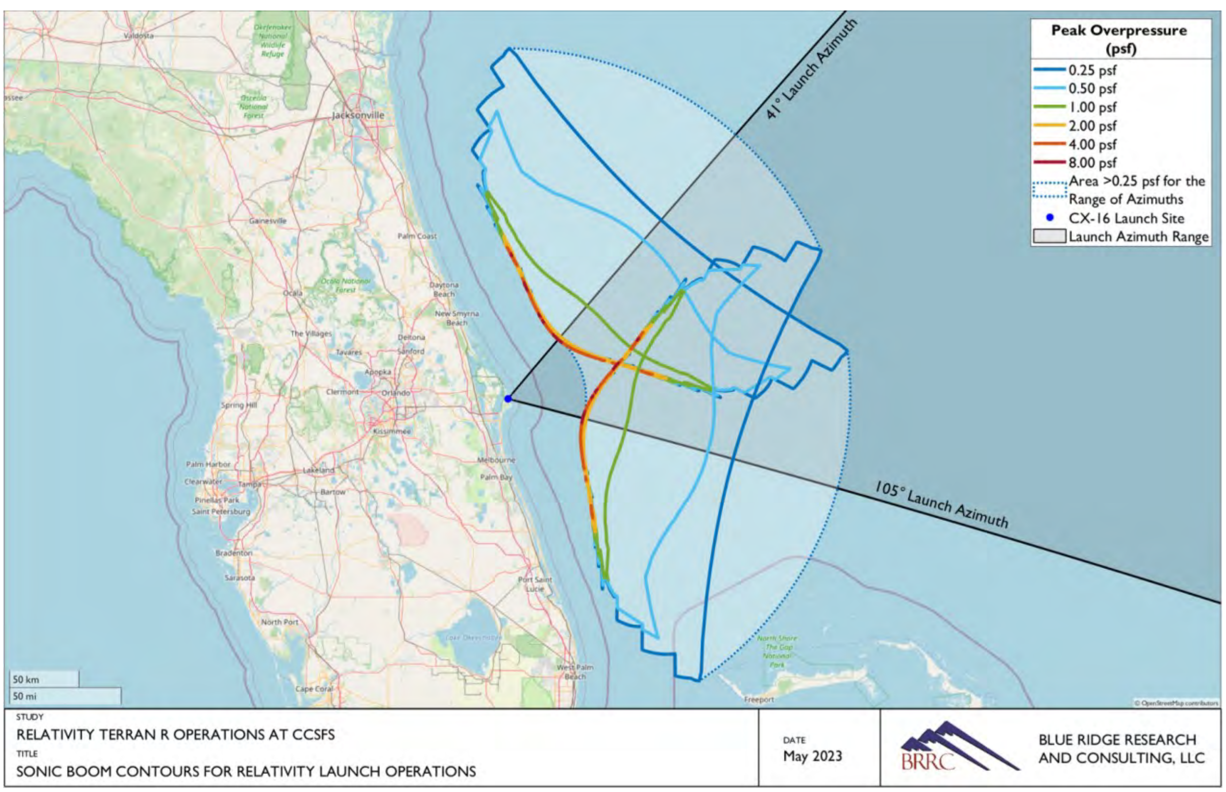

Figure 23. Sonic boom peak overpressure contours for launch operations over the proposed azimuth range (41° - 105°).

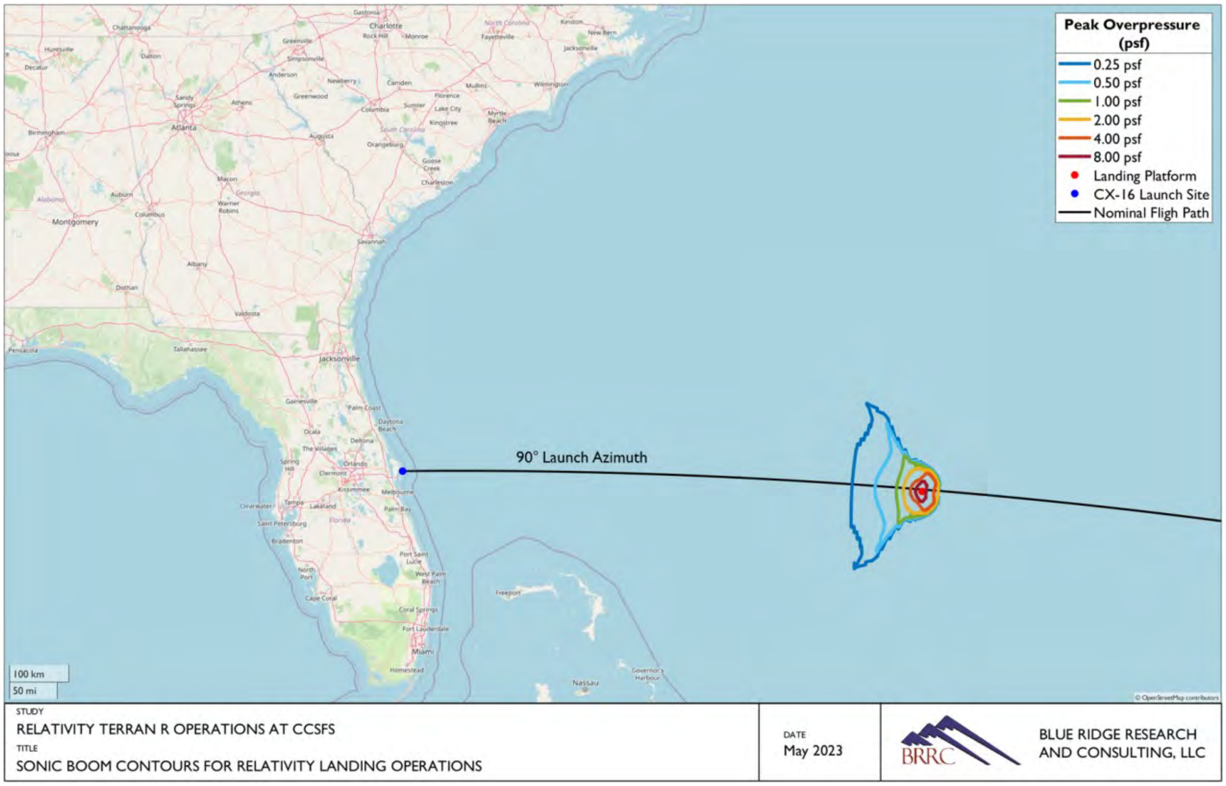

Figure 24. Sonic boom peak overpressure contours for a nominal first stage landing.

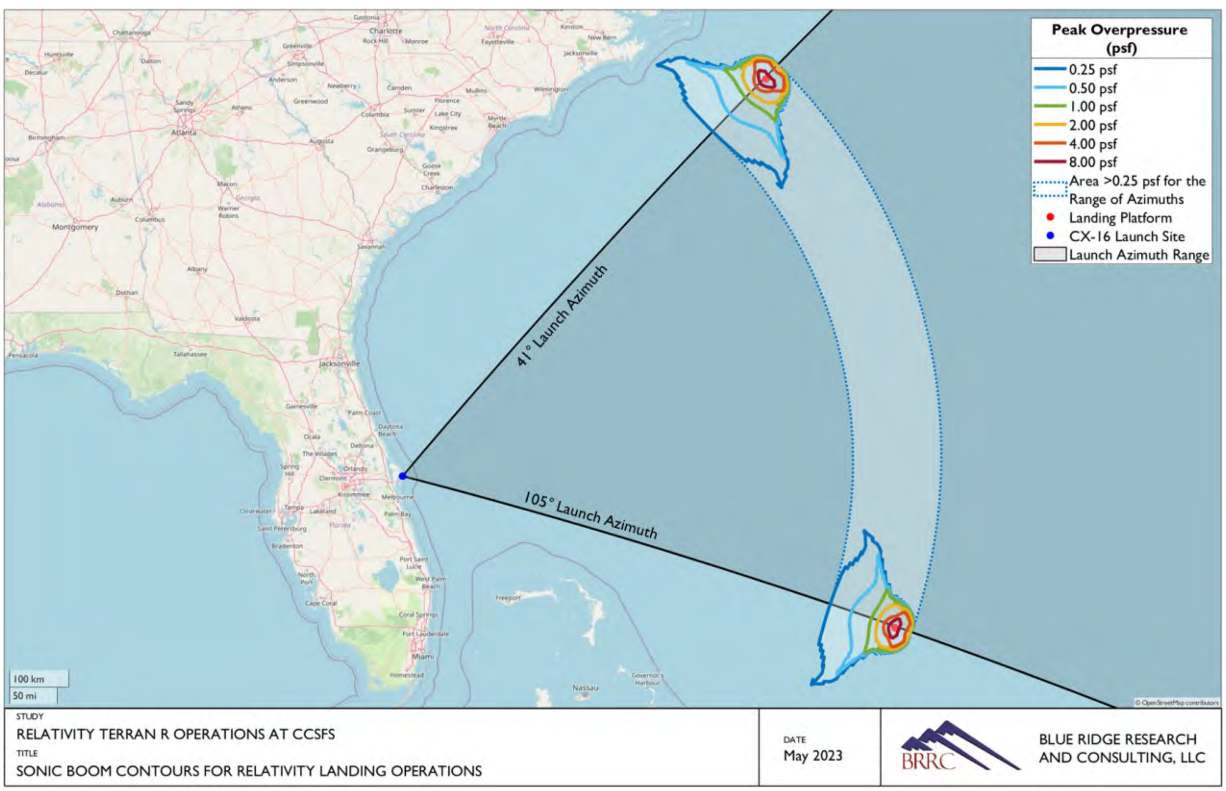

Figure 25. Sonic boom peak overpressure contours for first stage landing operations over the proposed azimuth range (41° - 105°).

5 SUMMARY

This report documents the noise and sonic boom study performed to support Relativity's environmental review of their launch, landing, and static operations at CCSFS. The potential impacts from propulsion noise and sonic booms are evaluated in relation to human annoyance, hearing conservation, and structural damage.

Propulsion Noise Results

The discussion of potential propulsion noise impacts from Terran R operations at CCSFS is summarized for the CX-16 launch, static fire, and stage hot fire operations. The propulsion noise generated by Terran R ocean-going platform landings is over water and thus, will not affect any people or structures.

- **Annoyance:** The DNL 60 dBA contour is used to conservatively identify the potential for significant noise impacts resulting from the propulsion noise generated by Terran R operations at CCSFS. The area identified within the 60 dBA contour for cumulative noise does not encompass land outside of the boundary of CCSFS, and, thus, no residences are impacted.
- **Hearing Conservation:** An upper limit noise level of $L_{A,max}$ 115 dBA is used as a guideline to protect human hearing from long-term continuous daily exposures to high noise levels and to aid in the prevention of NIHL. The entire land area encompassed by the 115 dBA Terran R noise contours is within CCSFS boundaries. Additionally, people in the community will reach less than 1% of their daily noise dose when exposed to noise from a Terran R launch or static fire operation. Thus, the potential for impacts to people in the community with regards to hearing conservation is negligible.
- **Structural Damage:** The potential for structural damage claims is approximately one damage claim per 100 households exposed at 120 dB and one in 1,000 households at 111 dB [3]. The 120 dB contours do not encompass any land outside of CCSFS and KSC boundaries. The land encompassed by the 111 dB Terran R noise contours include area on Merritt Island and Cape Canaveral from launch events, and a small area south of the KSC boundary near the Pine Island Conservation area and south of Titusville along the shore from static fire and stage hot fire tests.

Sonic Boom Results

The potential sonic boom impacts from Terran R launch and landing operations are negligible as the sonic booms for these events are entirely over water and thus, will not affect any people or structures.

APPENDIX A BASICS OF SOUND

Any unwanted sound that interferes with normal activities or the natural environment is defined as noise. Three principal physical characteristics are involved in the measurement and human perception of sound: intensity, frequency, and duration [48].

- **Intensity** is a measure of a sound's acoustic energy and is related to sound pressure. The greater the sound pressure, the more energy is carried by the sound and the louder the perception of that sound.
- **Frequency** determines how the pitch of the sound is perceived. Low-frequency sounds are characterized as rumbles or roars, while high-frequency sounds are typified by sirens or screeches.
- **Duration** is the length of time the sound can be detected.

Intensity

The loudest sounds that can be comfortably detected by the human ear have intensities a trillion times higher than those of sounds barely audible. Because of this vast range, using a linear scale to represent the intensity of sound can become cumbersome. As a result, a logarithmic unit known as the decibel (abbreviated dB) is used to represent sound levels. A sound level of 0 dB approximates the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level around 60 dB. Sound levels above 120 dB begin to be felt inside the human ear as discomfort. Sound levels between 130 and 140 dB are experienced as pain [49].

Because of the logarithmic nature of the decibel unit, sound levels cannot be simply added or subtracted and are somewhat cumbersome to handle mathematically. However, some useful rules help when dealing with sound levels. First, if a sound's intensity is doubled, the sound level increases by 3 dB, regardless of the initial sound level. For example:

$$50 \text{ dB} + 50 \text{ dB} = 53 \text{ dB, and } 70 \text{ dB} + 70 \text{ dB} = 73 \text{ dB.}$$

Second, the total sound level produced by two sounds with different levels is usually only slightly more than the higher of the two. For example:

$$50.0 \text{ dB} + 60.0 \text{ dB} = 60.4 \text{ dB.}$$

On average, a person perceives a change in sound level of about 10 dB as a doubling (or halving) of a sound's loudness. This relation holds true for both loud and quiet sounds. A decrease in sound level of 10 dB represents a 90% decrease in sound intensity but only a 50% decrease in perceived loudness because the human ear does not respond linearly [48]. In the community, "it is unlikely that the average listener would be able to correctly identify at a better than chance level the louder of two otherwise similar events which differed in maximum sound level by < 3 dB" [50].

The intensity of sonic booms is quantified with physical pressure units rather than levels. Intensities of sonic booms are traditionally described by the amplitude of the front shock wave, referred to as the peak overpressure. The peak overpressure is normally described in units of pounds per square foot (psf). The amplitude is particularly relevant when assessing structural effects as opposed to loudness or cumulative community response. In this study, sonic booms are quantified by either dB or psf, as appropriate for the particular impact being assessed [51].

Frequency

Sound frequency is measured in terms of cycles per second or hertz (Hz). Human hearing ranges in frequency from 20 Hz to 20,000 Hz, although perception of these frequencies is not equivalent across this range. Human hearing is most sensitive to frequencies in the 1,000 to 4,000 Hz range. Most sounds are not simple pure tones, but contain a mix, or spectrum, of many frequencies. Sounds with different spectra are perceived differently by humans even if the sound levels are the same. Weighting curves have been developed to correspond to the sensitivity and perception of different types of sound. A-weighting and C-weighting are the two most common weightings. These two curves, shown in Figure 26, 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.

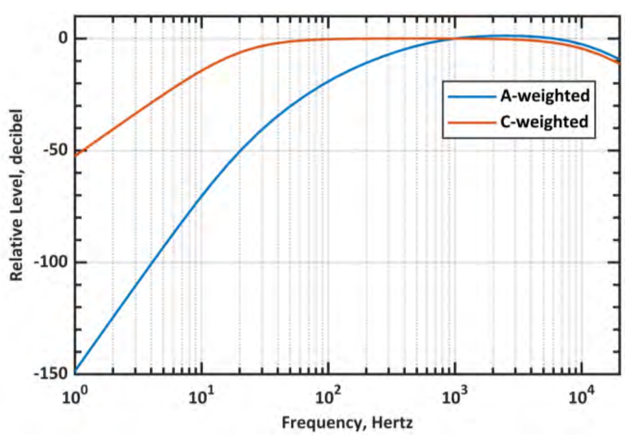

Figure 26. Frequency adjustments for A-weighting and C-weighting. [52]

Duration

The third principal physical characteristic involved in the measurement and human perception of sound is duration, which is the length of time the sound can be detected. Sound sources can vary from short durations to continuous, such as back-up alarms and ventilation systems, respectively. Sonic booms are considered low-frequency impulsive noise events with durations lasting a fraction of a second. A variety of noise metrics have been developed to describe noise over different time periods (See Appendix B).

Common Sounds

Common sources of noise and their associated levels are provided for comparison to the noise levels from the proposed action.

A chart of A-weighted sound levels from everyday sound sources [53] is shown in Figure 27. 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 27) are averages over extended periods [54]. Per the United States Environmental Protection Agency, "Ambient noise in urban areas typically varies from 60 to 70 dB but can be as high as 80 dB in the center of a large city. Quiet suburban neighborhoods experience ambient noise levels around 45-50 dB" [55].

A chart of typical impulsive events along with their corresponding peak overpressures in terms of psf and peak dB values are shown in Figure 28. For example, thunder overpressure resulting from lightning strikes at a distance of one kilometer (0.6 miles) is estimated to be near two psf, which is equivalent to 134 dB [56].

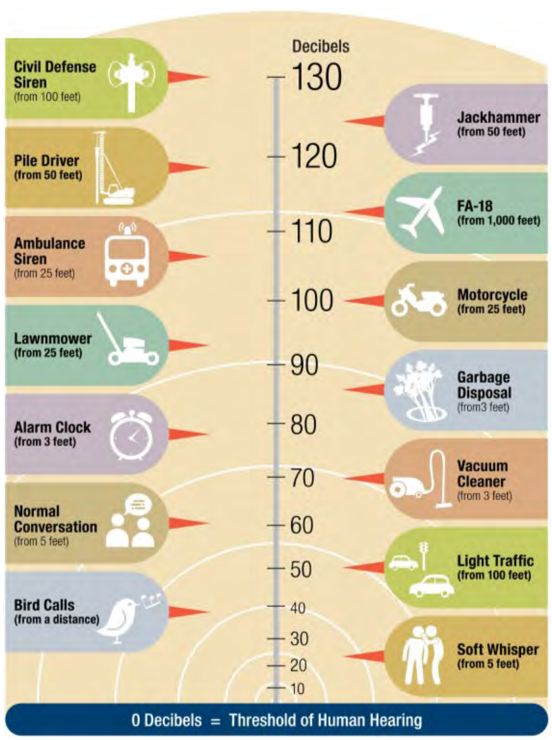

Figure 27. Typical A-weighted levels of common sounds. [57]

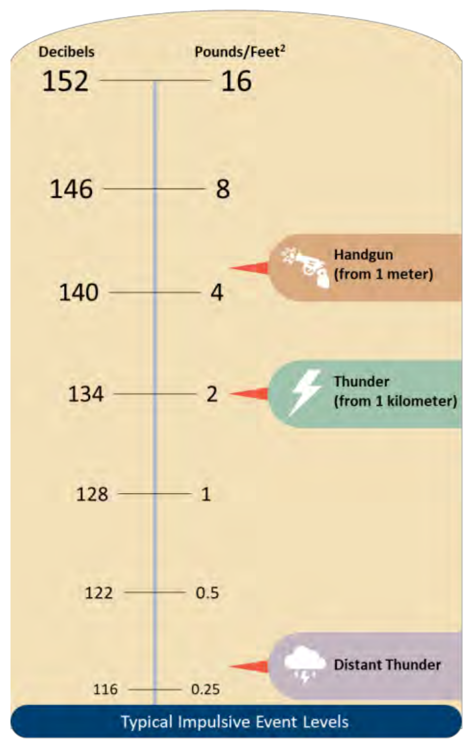

Figure 28. Typical impulsive event levels. [56]

APPENDIX B NOISE METRICS

A variety of acoustical metrics have been developed to describe sound events and to identify any potential impacts to receptors within the environment. These metrics are based on the nature of the event and who or what is affected by the sound. A brief description of the noise metrics used in this noise study are provided below.

Maximum Sound Level

The highest unweighted sound level measured during a single event, in which the sound changes with time, is called the Maximum Sound Level (abbreviated as L_{max}). The highest A-weighted sound level measured during a single event is called the Maximum A-weighted Sound Level (abbreviated as $L_{A,max}$). Although it provides some measure of the event, L_{max} (or $L_{A,max}$) does not fully describe the sound because it does not account for how long the sound is heard.

Sound Exposure Level

Sound exposure level (SEL) is a composite metric that represents both the intensity of a sound and its duration. Individual time-varying noise events have two main characteristics: a sound level that changes throughout the event and a period of time during which the event is heard. SEL provides a measure of the net impact of the entire acoustic event, but it does not directly represent the sound level heard at any given time. Mathematically, it represents the sound level of a constant sound that would generate the same acoustical energy in one second as the actual time-varying noise event. For sounds that typically last more than one second, the SEL is usually greater than the L_{max} because a single event takes seconds and the maximum sound level (L_{max}) occurs instantaneously. A-weighted sound exposure level is abbreviated as ASEL.

Day-Night Average Sound Level and Community Noise Equivalent Level

Day-Night Average Sound Level (DNL) is a cumulative metric that accounts for the SEL of all noise events in a 24-hour period. To account for increased sensitivity to noise at night, DNL applies an additional 10 dB adjustment to events during the acoustical nighttime period, defined as 10:00 PM to 7:00 AM. DNL represents the average sound level exposure for annual average daily events. Legislation in the state of California uses the Community Noise Equivalent Level (CNEL), a variant of the DNL. In addition to the 10 dB (i.e. 10 times weighting) adjustment during the acoustical nighttime period, the CNEL includes a ~4.8 dB adjustment (i.e. 3 times weighting) to events during the acoustical evening period (7:00 PM to 10:00 PM) to account for decreased community noise during this period. DNL and CNEL do not represent a level heard at any given time but represent long term exposure to noise.

Peak Overpressure

For impulsive sounds, the true instantaneous peak sound pressure level (L_{pk}), which lasts for only a fraction of a second, is important in determining impacts. The peak overpressure of the front shock wave is used to describe sonic booms, and it is usually presented in psf. Peak sound levels are not frequency weighted.

APPENDIX C MODELING METHODS

An overview of the propulsion noise and sonic boom modeling methodologies used in this noise study are presented in Section C.1 and C.2, respectively.

C.1 Propulsion Noise Modeling

Rocket propulsion systems, such as solid-propellant motors and liquid-propellant engines, generate high-amplitude broadband noise. Most of the noise is created by the rocket plume interacting with the atmosphere and the combustion noise of the propellants. Although rocket noise radiates in all directions, it is highly directive, meaning that a significant portion of the source's acoustic power is concentrated in specific directions.

RUMBLE 4.1, the Rocket Propulsion Noise and Emissions Simulation Model, developed by Blue Ridge Research and Consulting, LLC (BRRC), is the noise model used to predict the noise associated with the proposed operations. The core components of the model are visualized in Figure 29 and are described in the following subsections.

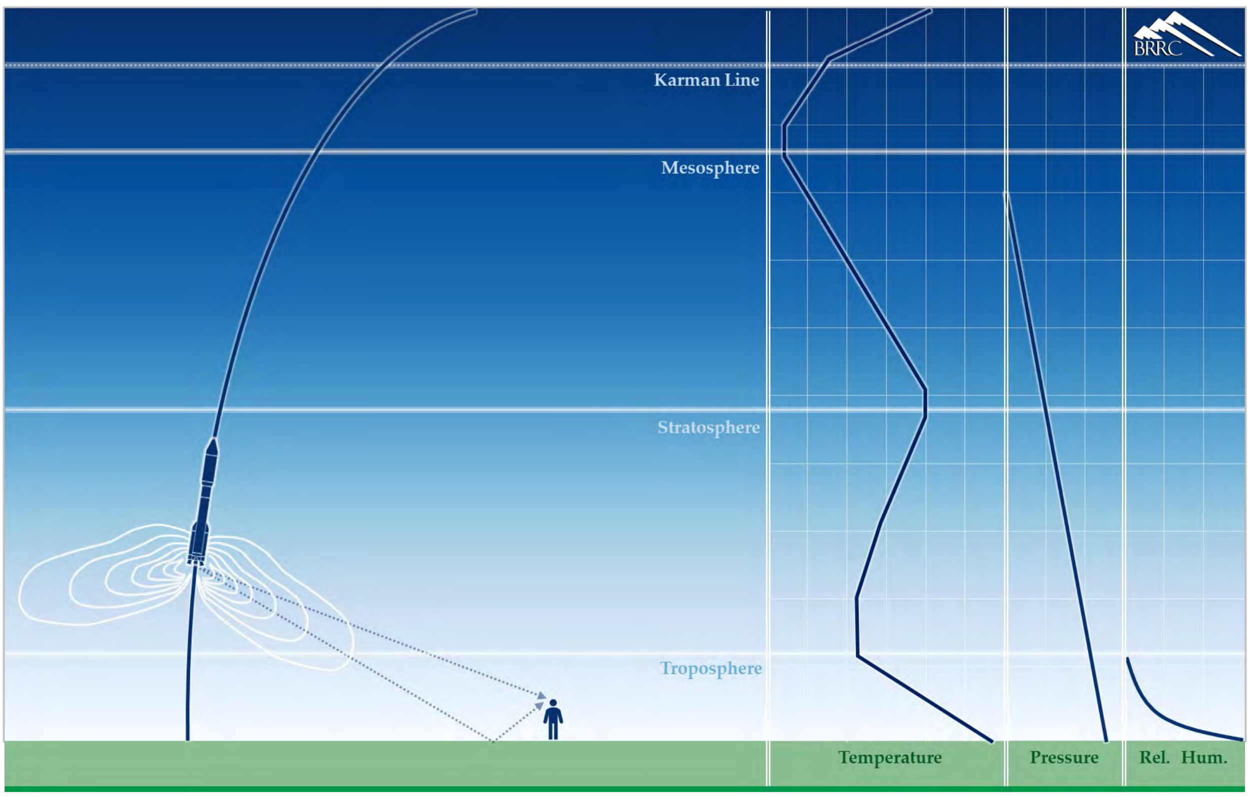

Figure 29. Conceptual overview of rocket noise prediction model methodology.

C.1.1 Source

The rocket noise source definition considers the acoustic power of the rocket, forward flight effects, directivity, and the Doppler effect.

Acoustic Power

Eldred's Distributed Source Method 1 (DSM-1) [14] is utilized for the source characterization. The DSM-1 model determines the vehicle's total sound power based on its total thrust, exhaust velocity, and the engine/motor's acoustic efficiency. BRRC's validation of the DSM-1 model showed very good agreement between full-scale rocket noise measurements and the empirical source curves [15]. The acoustic efficiency of the rocket engine/motor specifies the percentage of the mechanical power converted into acoustic power. The acoustic efficiency of the rocket engine/motor was modeled using Guest's variable acoustic efficiency [16]. Typical acoustic efficiency values range from 0.2% to 1.0% [14]. In the far-field, distributed sound sources are modeled as a single compact source located at the nozzle exit with an equivalent total sound power. Therefore, propulsion systems with multiple tightly clustered equivalent engines can be modeled as a single engine with an effective exit diameter and total thrust [14]. Additional boosters or cores (that are not considered to be tightly clustered) are handled by summing the noise contribution from each booster/core.

Forward Flight Effect

A rocket in forward flight radiates less noise than the same rocket in a static environment. A standard method to quantify this effect reduces overall sound levels as a function of the relative velocity between the jet plume and the outside airflow [17-20]. This outside airflow travels in the same direction as the rocket exhaust. At the onset of a launch, the rocket exhaust travels at far greater speeds than the ambient airflow. Conversely, for a vertical landing, the rocket exhaust and ambient airflow travel in opposing directions, yielding an increased relative velocity differential. As the differential between the forward flight velocity and exhaust velocity decreases, jet plume mixing is reduced, which reduces the corresponding noise emission. Notably, the maximum sound levels are normally generated before the vehicle reaches the speed of sound. Thus, the modeled noise reduction is capped at a forward flight velocity of Mach 1.

Directivity

Rocket noise is highly directive, meaning the acoustic power is concentrated in specific directions, and the observed sound pressure will depend on the angle from the source to the receiver. NASA's Constellation Program has made significant improvements in determining the directivity of rockets [21]. These directivity indices (DI) incorporate a larger range of frequencies and angles than previously available data. Subsequently, improvements were made to the formulation of the NASA DI [22] accounting for the spatial extent and downstream origin of the rocket noise source. These updated DI are used for this analysis.

Doppler Effect

The Doppler effect is the change in frequency of an emitted wave from a source moving relative to a receiver. The frequency at the receiver is related to the frequency generated by the moving sound source and by the speed of the source relative to the receiver. The received frequency is higher (compared to the emitted frequency) if the source is moving towards the receiver and is lower if the source is moving away from the receiver. During a rocket launch, an observer on the ground will hear a downward shift in the frequency of the sound as the distance from the source to receiver increases.

C.1.2 Propagation

The sound propagation from the source to receiver considers the ray path, atmospheric absorption, and ground interference.

Ray Path

The model assumes straight line propagation between the source and receiver to determine propagation effects. For straight rays, sound levels decrease as the sound wave propagates away from a source uniformly in all directions. The rocket propulsion noise model components are calculated based on the specific geometry between source (vehicle trajectory point) to receiver (grid point). The position of the vehicle, described by the trajectory, is provided in latitude and longitude, defined relative to a reference system (e.g. World Geodetic System 1984) that approximates the Earth's surface by an ellipsoid. The receiver grid is also described in geodetic latitude and longitude, referenced to the same reference system as the trajectory data, ensuring greater accuracy than traditional flat earth models.

Atmospheric Absorption

Atmospheric absorption is a measure of the sound attenuation from the excitation of vibration modes of air molecules. Atmospheric absorption is a function of temperature, pressure, and relative humidity of the air. The propulsion noise model utilizes an atmospheric profile, which describes the variation of temperature, pressure, and relative humidity with respect to the altitude. Standard atmospheric data sources [23-26] were used to create a composite atmospheric profile for altitudes up to 66 miles. The atmospheric absorption is calculated using formulas found in ANSI Standard S1.26-1995 (R2004). The result is a sound-attenuation coefficient, which is a function of frequency, atmospheric conditions, and distance from the source. The amount of absorption depends on the parameters of the atmospheric layer and the distance that the sound travels through the layer. The total sound attenuation is the sum of the absorption experienced from each atmospheric layer.

Nonlinear propagation effects can result in distortions of high-amplitude sound waves [27] as they travel through the medium. These nonlinear effects are counter to the effect of atmospheric absorption [28, 29]. However, recent research shows that nonlinear propagation effects change the perception of the received sound [30-36], but the standard acoustical metrics are not strongly influenced by nonlinear effects [37, 38]. The overall effects of nonlinear propagation on high-amplitude sound signatures and their perception is an ongoing area of research, and it is not currently included in the propagation model.

Ground Interference

The calculated results of the sound propagation using DSM-1 provide a free-field sound level (i.e. no reflecting surface) at the receiver. However, sound propagation near the ground is most accurately modeled as the combination of a direct wave (source to receiver) and a reflected wave (source to ground to receiver) as shown in Figure 29. The ground will reflect sound energy back toward the receiver and interfere both constructively and destructively with the direct wave. Additionally, the ground may attenuate the sound energy, causing the reflected wave to propagate a smaller portion of energy to the receiver. RUMBLE accounts for the attenuation of sound by the ground [39, 40] when estimating the received noise. The model assumes a five-foot receiver height and a variable ground impedance to account for grass (soft) or water (hard) ground surfaces. To account for the random fluctuations of wind and temperature on the direct and reflected wave, the effect of atmospheric turbulence is also included [39, 41].

C.1.3 Receiver

The received noise is estimated by combining the source and propagation components. The basic received noise is modeled as overall and spectral level time histories. This approach enables a range of noise metrics relevant to environmental noise analysis to be calculated and prepared as output. If a range of launch azimuths is being considered, the received noise represents the highest metric level generated from any launch azimuth within that range. For example, the noise metric level at a single receiver is modeled for every possible launch azimuth within the specified range, and the maximum of the range of levels is stored for the single receiver. This process is repeated for each receiver in the defined grid, and noise metric contours are developed from the grid of receivers.

C.2 Sonic Boom Modeling

A vehicle creates sonic booms during supersonic flight. The potential for the boom to intercept the ground depends on the trajectory and speed of the vehicle as well as the atmospheric profile. The sonic boom is shaped by the physical characteristics of the vehicle and the atmospheric conditions through which it propagates. These factors affect the perception of a sonic boom. The noise is perceived as a deep boom, with most of its energy concentrated in the low frequency range. Although sonic booms generally last less than one second, their potential for impact may be considerable.

A brief sonic boom generation and propagation modeling primer is provided in Section C.2.1 to describe relevant technical details that inform the sonic boom modeling. The primer also provides visualizations of the boom generation, propagation, and ground intercept geometry. An overview of the sonic boom modeling software used in the study, PCBoom, and a description of inputs are found in Section C.2.2.

C.2.1 Primer

When a vehicle moves through the air, it pushes the air out of its way. At subsonic speeds, the displaced air forms a pressure wave that disperses rapidly. At supersonic speeds, the vehicle is moving too quickly for the wave to disperse, so it remains as a coherent wave. This wave is a sonic boom. When heard at ground level, a sonic boom consists of two shock waves (one associated with the forward part of the vehicle, the other with the rear part) of approximately equal strength. When plotted, this pair of shock waves and the expanding flow between them has the appearance of a capital letter “N,” so a sonic boom pressure wave is usually called an “N-wave.” An N-wave has a characteristic "bang-bang" sound that can be startling. Figure 30 shows the generation and evolution of a sonic boom N-wave under the vehicle.

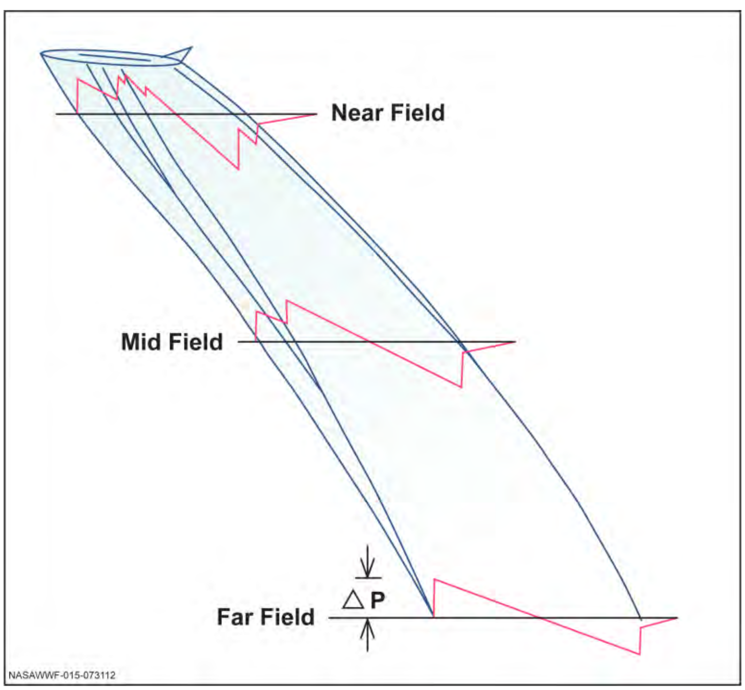

Figure 30. Sonic boom generation and evolution to N-wave. [42]

For aircraft, the front and rear shock are generally the same magnitude. However, for rockets, in addition to the two shock waves generated from the vehicle body, the plume itself acts as a large supersonic body, and it generates two additional shock waves (one associated with the forward part of the plume, the other with the rear part) and extends the waveform duration to as large as one second. If the plume volume is significantly larger than the vehicle, its shocks will be stronger than the shocks generated by the vehicle.

Figure 31 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."

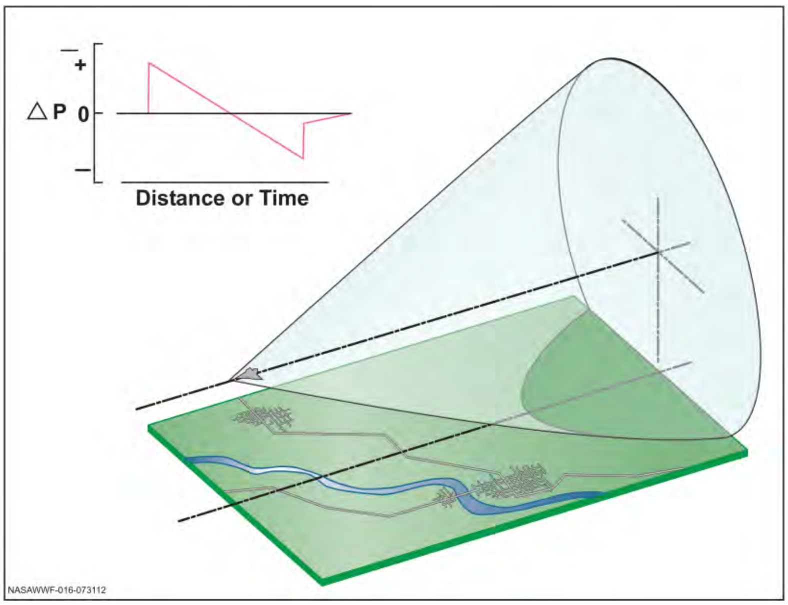

Figure 31. Sonic boom carpet for a vehicle in steady flight. [43]

Although the wave cone can be calculated from an aircraft-fixed reference frame, the ray perspective is more convenient when computing sonic boom metrics in a ground-fixed observer's reference frame [44]. Both perspectives are shown in Figure 32. The difference in wave versus ray perspectives is described for level, climbing, and diving flight, in the PCBoom Sonic Boom Model User Guide [44]:

> Sonic boom wave cones are not generated fully formed at a single point in time, instead resulting from the accumulation of all previous disturbance events that occurred during the vehicle's time history. […] Unlike wave cones, ray cones are fully determined at a single point in time and are independent of future maneuvers. They are orthogonal to wave cones and represent all paths that sonic boom energy will take from the point they are generated until a later point in time when they hit the ground. The ray perspective is particularly useful when considering refraction due to atmospheric gradients or the effect of aircraft maneuvers, where rays can coalesce into high amplitude focal zones.

When the ray cone hits the ground, the resulting intersection is called an "isopemp." The isopemp is forward-facing [as shown in Figure 32] 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."

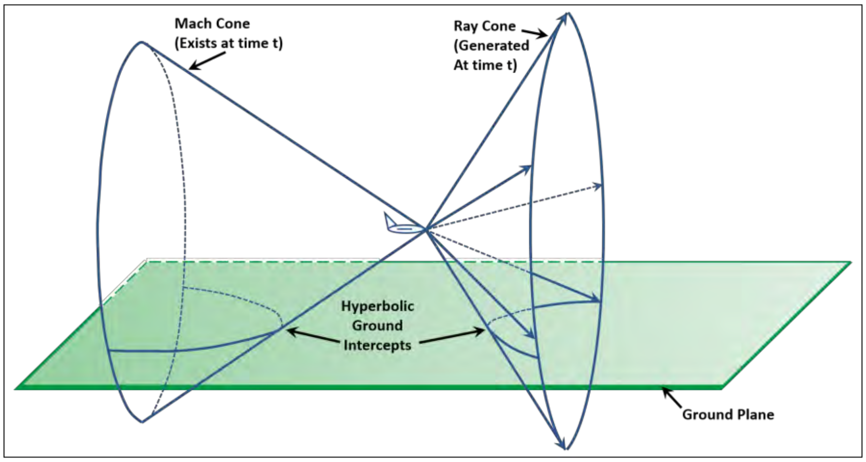

Figure 32. Mach cone vs ray cone viewpoints.

Figure 31 and Figure 32 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 32. For a vehicle climbing at an angle steeper than the ray cone half angle, such as in the left image of Figure 33, 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 33, 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.

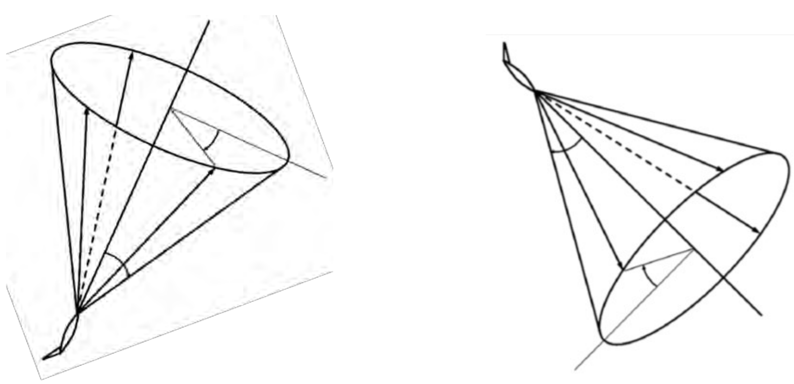

Figure 33. Ray cone in climbing (left) and diving (right) flight.

C.2.2 PCBoom

The single-event prediction model, PCBoom 6.7b [45-47], is a full ray trace sonic boom program that is used to calculate the magnitude, waveform, and location of sonic boom overpressures on the ground from supersonic flight operations. Additionally, BRRC uses a custom version of PCBoom 6.7b that implements proper plume physics.

Several inputs are required to calculate the sonic boom impact, including the geometry of the vehicle, the trajectory path, and the atmospheric conditions. These parameters along with time-varying thrust, drag, and weight are used to define the PCBoom starting signatures used in the modeling. The starting signatures are propagated through a site-specific atmospheric profile [26].

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Appendix E
FAA Noise Modeling Approval

Federal Aviation
Administration

Memorandum

Date: August 7, 2023

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

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

Subject: Noise Modeling Methodology for the Environmental Assessment of Relativity Inc.'s Terran R Operations at Cape Canaveral Space Force Station

The Office of Environment and Energy (AEE) has reviewed the proposed non-standard noise modeling methodology to be used in the Environmental Assessment of Relativity Space Inc.'s operations of the Terran R space launch vehicle at the Space Launch Complex (SLC) at Cape Canaveral Space Force Station (CCSFS) in Florida.

As the FAA does not currently have an approved propulsion noise model for launch vehicles, in accordance with FAA Order 1050.1F, all non-standard noise analysis in support of the noise impact analysis for the National Environmental Policy Act (NEPA) must be approved by AEE. This letter serves as AEE's response to the method proposed in the draft memorandum dated July 27, 2023 with subject 'Noise Methodology Approval Request – RUMBLE' from Leslie Grey of the Office of Commercial Space Transportation (AST) division. The memo proposes to use the Blue Ridge Research and Consulting (BRRC) software RUMBLE to model Terran R operations at CCSFS.

The noise levels generated from the Terran R operations will be predicted using the RUMBLE model, a full featured launch noise model developed by 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 F

Air Quality

Appendix F-1

BRRC Emissions Study
Terran R Operations

Blue Ridge Research and Consulting, LLC

BRRC Report 23-02 (Final)

Emissions Study for Relativity Space Terran R Operations at CCSFS

19 April 2023 (Rev 6)

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Table 5. Terran R primary emissions indices, in grams of pollutant emitted per kilogram of propellant consumed. 12

1 INTRODUCTION

This report documents the emissions study performed as part of Relativity Space's (Relativity's) efforts on the Supplemental Environmental Assessment (SEA) for proposed Terran R operations at Cape Canaveral Space Force Station (CCSFS). Relativity plans to conduct stage hot fire test, static fire test, and launch operations of the Terran R from CCSFS Launch Complex 16 (CX-16) and first stage landings on an ocean-going platform in the Atlantic Ocean.

This emissions study describes the mass of pollutants generated on an annual basis by Terran R operations at CCSFS. The emissions inventories were computed using BRRC's Rocket Noise and Emissions Simulation Model (RUMBLE) Version 4.1 [1]. RUMBLE's emissions modeling methods were developed under the Transportation Research Board (TRB) Airport Cooperative Research Program (ACRP) Project 02-85 and are summarized in Appendix A. For a more detailed description of RUMBLE's formulations, see the TRB ACRP Web-Only Document 51: Commercial Space Vehicle Emissions Modeling [2], published by the National Academies Press. In accordance with the Federal Aviation Administration (FAA) regulations [3], the emissions inventory results provide a quantitative, project-specific indication of the magnitude of the proposed operations' potential air quality impact.

The following sections of this report are outlined below.

- Section 2 describes the proposed Terran R operations;
- Section 3 presents the emissions modeling results;
- Appendix A describes the general methodology of the emissions modeling; and
- Appendix B provides the primary emissions indices of the Terran R vehicle's engines.

2 TERRAN R OPERATIONS

Relativity plans to conduct up to 24 launch operations of the Terran R per year from CX-16. Prior to each Terran R launch, Relativity will conduct a pre-launch static fire test with a typical run-time of approximately eight (8) seconds. Additionally, Relativity will conduct up to 14 stage hot fire tests per year each with a run-time up to 30 seconds. Stage hot fire testing at CX-16 will occur prior to static fire testing. The first stage of launches will land on an ocean-going platform in the Atlantic. However, during launches that are still early in the program development, Relativity may require expending Terran R in the ocean. When this occurs, Relativity would not recover Terran R and expects the vehicle to break up on impact with the ocean surface. Table 1 presents the modeled annual operations.

Table 1. Proposed Relativity Terran R operations at CCSFS.

Event	Description	Annual Operations
Stage Hot Fire	30 second hot fire	14
Static Fire	8 second static fire	24
Launch	Launch from CX-16	24
Stage 1 Landing	Landing on ocean-going platform	24

Table 2 presents the engine modeling data for a nominal configuration of the Terran R vehicle. The primary emissions indices of the Terran R vehicle's engines are provided in Appendix B.

Table 2. Engine modeling parameters for a nominal configuration of the Terran R vehicle.

Propellant	Stage	Name	Mass Flow Rate
Liquid Oxygen (LOX) + Liquid Natural Gas (LNG)	1st Stage	Aeon-R	5,502 kg/s (393 kg/s x Qty. 14)
	2nd Stage	Aeon-R-Vac	361 kg/s

Relativity provided nominal launch and first stage landing trajectories for the emissions modeling. The emissions modeling uses the time-varying mass flow rate from the trajectory. Note, the first stage landing burn initially ignites three engines, two of which shut down part way through the burn so that the vehicle lands on one engine.

3 RESULTS

The emissions results are presented in the form of emissions inventories, which enumerate the masses of the various pollutants emitted as a result of the proposed operations. The six most common air pollutants with known heath impacts that were regulated as criteria pollutants by the 1970 Clean Air Act are:

- Carbon Monoxide (CO),
- Oxides of Nitrogen (NOx),
- Sulfur Oxides (SOx),
- Volatile Organic Compounds (VOC), and
- Particulate Matter (PM) 2.5 and 10.

The pollutant masses emitted for these criteria pollutants and the greenhouse gases Carbon Dioxide (CO_2) and water (H_2O) are presented in Table 3 and Figure 1 for the proposed CCSFS Terran R annual operations: 14 stage hot fire tests, 24 static fire tests, 24 launches, and 24 first stage landings. The pollutant masses in metric tons (10^3 kg) per year are presented by atmospheric layer: troposphere below the mixing height (3,000 feet), troposphere above the mixing height, stratosphere, and mesosphere.

CO_2 and H_2O are the pollutants emitted in the greatest quantities because they are the products of complete combustion between oxygen and liquid natural gas (LNG). However, the combustion process in a rocket engine is typically incomplete. CO and a small amount of black carbon (BC) are emitted due to incomplete combustion inside the rocket engine. Black carbon, commonly known as soot, is the only significant source of PM emitted by the Terran R. Furthermore, NO_x are emitted due to afterburning between the extremely high-temperature exhaust plume and nitrogen from the surrounding air. No alumina (Al_2O_3) or chlorine species (Cl_x) are emitted because the propellant does not include aluminum or chlorine compounds. SO_2 emissions are negligible because sulfur impurities occur in extremely low concentrations in LNG. Additionally, VOCs are not typically emitted by launch vehicles.

The amount of each pollutant emitted into each atmospheric layer is directly related to the amount of propellant burned in each layer. Below 3,000 feet, the 14 stage hot fire tests (30 seconds) and 24 static fire tests (8 seconds) are the largest contributors to the pollutants emitted. While the pollutants emitted by stage hot fire and static fire tests is confined to the Troposphere below 3,000 feet, the launch and landing operations emit pollutants in all layers. Staging between the first and second stages of the Terran R occurs in the mesosphere. The mass of H_2O and CO_2 emitted into the mesosphere is less than the amount emitted into the stratosphere because the single Aeon-R-vac engine on the second stage burns less propellant than the fourteen Aeon-R engines on the first stage.

The amount of each pollutant emitted also varies with altitude due to altitude-dependent chemical processes. At low altitudes, CO is nearly completely oxidized to CO_2 by reactions with oxygen molecules from the surrounding air. However, the rate of oxidation decreases at higher altitudes because fewer oxygen molecules are present in the lower-density air. Thus, the amount of CO increases as altitude increases. Similarly, BC is nearly completely oxidized to CO and CO_2 at low altitudes, but the amount of BC also increases at higher altitudes due to decreasing oxidation. Conversely, since NO_x is formed by afterburning between the high-temperature exhaust plume and nitrogen from the surrounding air, NO_x production decreases with altitude because fewer nitrogen molecules are present in the lower-density air.

Table 3. Annual pollutant mass in metric tons emitted by 14 stage hot fire tests, 24 static fire tests, 24 launches, and 24 first stage landings.

Atmospheric Layer	CO_2	H_2O	CO	NO_x	BC	SO_x	VOC
Troposphere Below 3,000 feet	4,513	3,707	9.2	197	1.2	--	--
Troposphere Above 3,000 feet	3,906	3,212	11	67	1.1	--	--
Stratosphere	6,846	5,767	127	3.0	17	--	--
Mesosphere	2,199	2,279	372	<0.01	19	--	--
Total	17,464	14,965	519	267	38	--	--

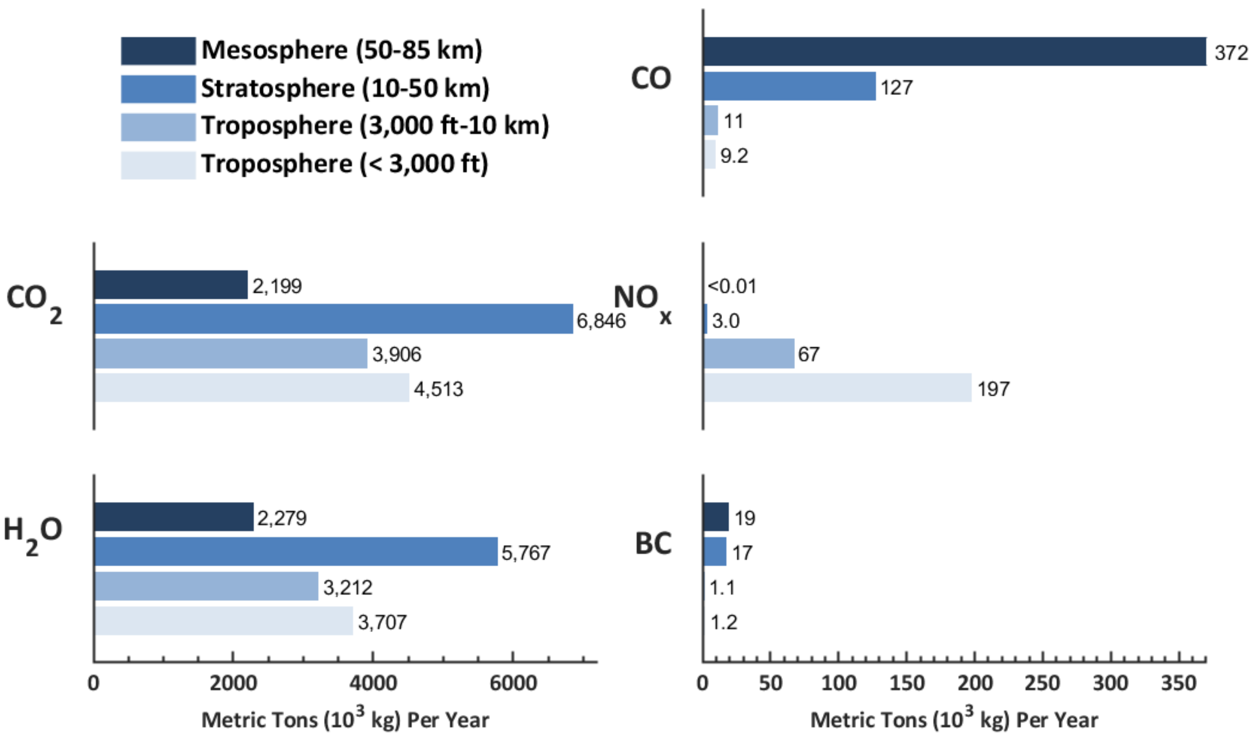

Figure 1. Annual pollutant mass in metric tons emitted by 14 stage hot fire tests, 24 static fire tests, 24 launches, and 24 first stage landings.

Table 4 presents the Terran R emissions inventories by operation group (event) and mode category (atmospheric layer). The duration, propellant burn, and pollutant mass values are reported on an annual basis (i.e., 30 second hot fire tests conducted 14 times per year equates to a total annual duration of 420). Figure 2 and Figure 3 display the annual pollutant mass emitted in each atmospheric layer by Terran R launches and first stage landings, respectively.

Table 4. Annual duration in seconds, propellant burn in metric tons, and pollutant mass emissions in metric tons grouped by operation type.

	Duration	Propellant	CO_2	H_2O	CO	NO_x	BC	SO_x	VOC
Stage Hot Fire									
Troposphere Below 3,000 feet	420	2,312	1,686	1,384	3.4	76	0.46	--	--
Troposphere Above 3,000 feet	--	--	--	--	--	--	--	--	--
Stratosphere	--	--	--	--	--	--	--	--	--
Mesosphere	--	--	--	--	--	--	--	--	--
Total	420	2,312	1,686	1,384	3.4	76	0.46	--	--
Static Fire									
Troposphere Below 3,000 feet	192	1,057	771	633	1.6	35	0.21	--	--
Troposphere Above 3,000 feet	--	--	--	--	--	--	--	--	--
Stratosphere	--	--	--	--	--	--	--	--	--
Mesosphere	--	--	--	--	--	--	--	--	--
Total	192	1,057	771	633	1.6	35	0.21	--	--
Launch									
Troposphere Below 3,000 feet	476	2,620	1,911	1,569	3.9	80	0.52	--	--
Troposphere Above 3,000 feet	970	5,337	3,887	3,196	11	66	1.1	--	--
Stratosphere	1,669	9,184	6,537	5,500	115	3.0	16	--	--
Mesosphere	888	3,471	1,990	2,079	350	<0.01	17	--	--
Total	4,003	20,612	14,325	12,344	480	149	35	--	--
Landing									
Troposphere Below 3,000 feet	170	201	147	120	0.30	6.1	0.040	--	--
Troposphere Above 3,000 feet	433	26	19	15	0.040	0.65	<0.01	--	--
Stratosphere	1,478	446	308	267	11	<0.01	1.8	--	--
Mesosphere	294	334	209	200	23	<0.01	1.7	--	--
	2,375	1,007	683	402	34	6.8	3.5	--	--

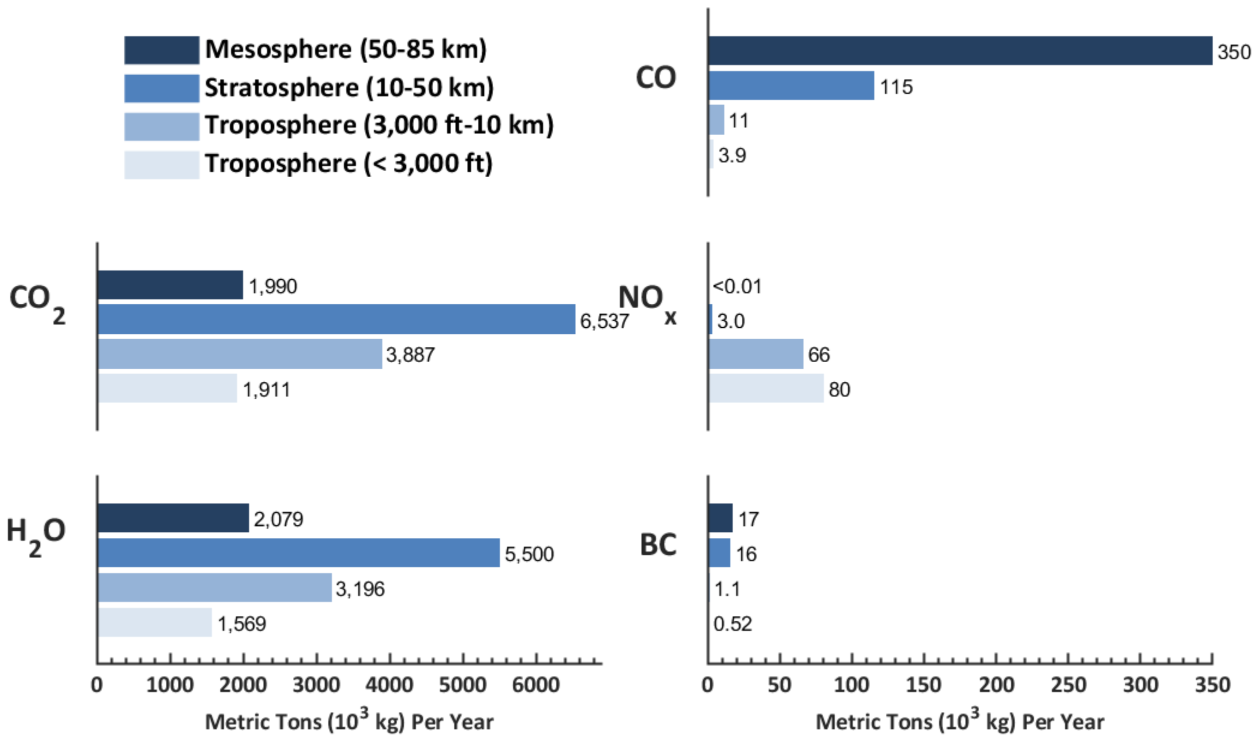

Figure 2. Annual pollutant mass in metric tons emitted by 24 launches.

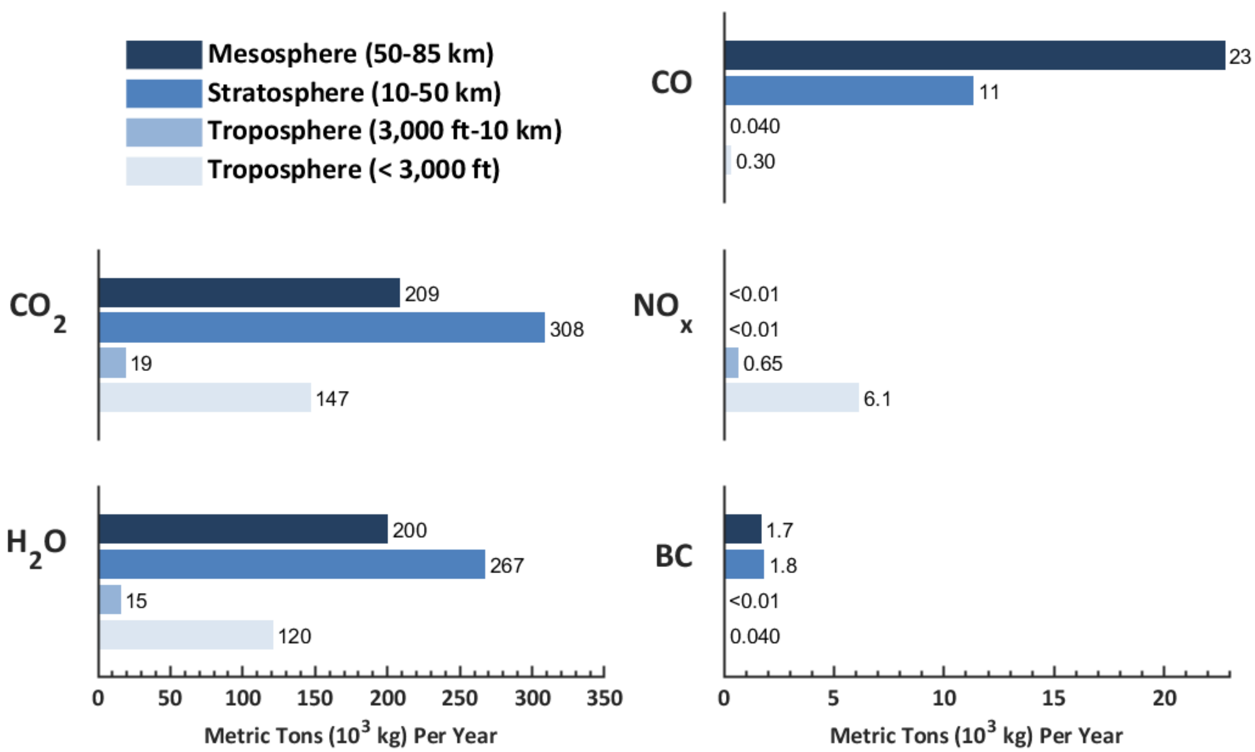

Figure 3. Annual pollutant mass in metric tons emitted by 24 first stage landings.

APPENDIX A EMISSIONS MODELING

RUMBLE 4.1, the Launch Vehicle Noise and Emissions Simulation Model developed by Blue Ridge Research and Consulting, LLC (BRRC), was the model used to predict the emissions associated with the proposed operations. Development of the RUMBLE emissions model was funded by FAA under Airport Cooperative Research Program (ACRP) Project 02-85 [2], administered by the Transportation Research Board (TRB), a unit of the National Academies of Sciences, Engineering, and Medicine. The RUMBLE emissions modeling methodology was developed to produce accurate emissions estimates relevant to environmental analysis of commercial space operations. The model is applicable to inflight and static operations of vertical and horizontal launch vehicles.

A.1 Emissions Background

Launch vehicle propulsion systems, such as liquid-propellant rocket engines and solid rocket motors, produce emissions through a series of chemical reactions, as shown in Figure 4. First, combustion occurs between the fuel and oxidizer inside the rocket engine. Next, the combustion products expand and accelerate through the nozzle, where additional chemical reactions may occur. Finally, the chemical species in the high-temperature exhaust plume may continue to react with each other and the surrounding air in a process called afterburning.

The combustion products present at the nozzle exit plane are called the *primary emissions* of the rocket engine. The products formed by afterburning and other reactions in the high-temperature exhaust plume are referred to as *secondary emissions*. The chemical species emitted into the atmosphere after the rocket has passed by and the exhaust plume has cooled to the ambient temperature include contributions from both the primary and secondary emissions. RUMBLE is designed to estimate these *final emissions* since they are the chemical species that the vehicle ultimately emits into the atmosphere.

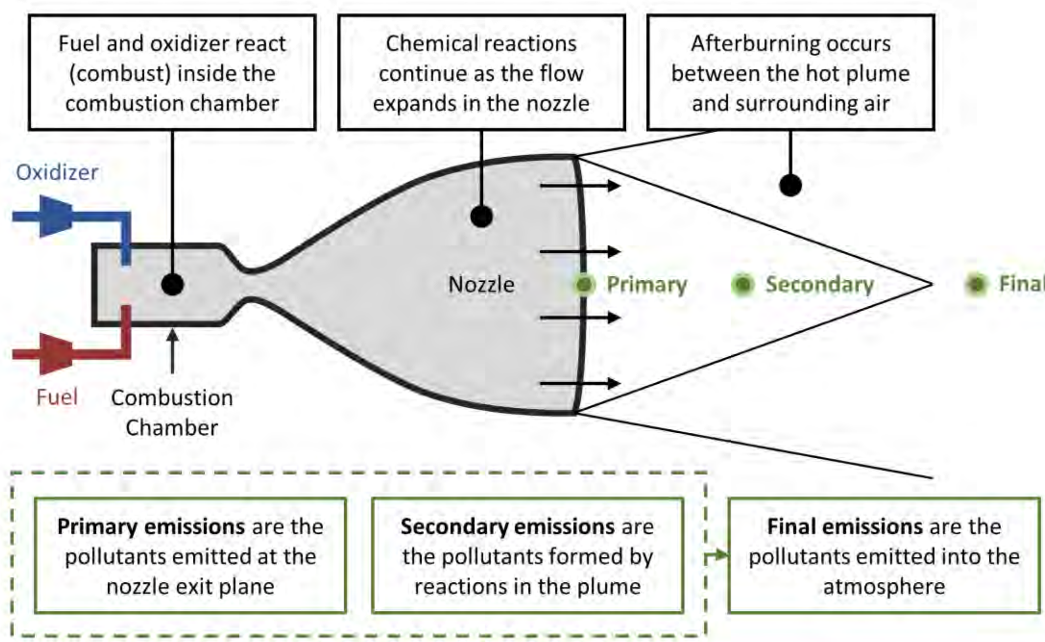

Figure 4. Diagram of the chemical processes in a rocket engine that produce the primary, secondary, and final emissions.

A.2 Emissions Modeling Methodology

The RUMBLE emissions model calculates the mass of each pollutant emitted by commercial space operations. The calculations are first performed at the most detailed level (i.e. individual trajectory segment), and the results are aggregated to produce the propellant burn report and emissions inventory.

First, the propellant mass burned by a single engine during an individual trajectory segment is calculated by

$$\begin{bmatrix}\text{Propellant}\\ \text{Mass}\end{bmatrix} = \begin{bmatrix}\text{Propellant}\\ \text{Mass Flow Rate}\end{bmatrix} \times \begin{bmatrix}\text{Segment}\\ \text{Duration}\end{bmatrix}$$

where the duration of the trajectory segment is the time between successive points in the trajectory.

Next, the mass of each pollutant emitted by a single engine during an individual trajectory segment is calculated by

$$\begin{bmatrix}\text{Pollutant}\\ \text{Mass}\end{bmatrix} = \begin{bmatrix}\text{Emissions}\\ \text{Index}\end{bmatrix} \times \begin{bmatrix}\text{Propellant}\\ \text{Mass}\end{bmatrix}$$

The emissions indices are the factors that relate the amount of propellant burned to the amount of each pollutant emitted by the engine. Emissions indices are discussed in more detail in Section A.3.

The main output of the RUMBLE emissions model is the emissions inventory. The emissions inventory enumerates the masses of the various pollutants emitted as a result of commercial space operations. RUMBLE aggregates the detailed pollutant mass calculations over the number of engines, trajectory segments, and operations to compute the total amount of each pollutant emitted. In accordance with FAA guidelines, RUMBLE reports the emissions inventory in the troposphere below and above the mixing height (3,000 feet), the stratosphere, and the mesosphere.

A.3 Emissions Indices

RUMBLE uses emissions indices to estimate the total amounts of the various pollutants emitted by space vehicles. Emissions indices are the factors that relate the amount of propellant burned to the amount of each pollutant emitted by a rocket engine. The emissions index for a specific pollutant reports the outcome of the complex series of chemical reactions that occur within the rocket engine and exhaust plume as a single number.

Primary Emissions Indices

The primary emissions are the chemical species present at the nozzle exit plane due to processes that occur inside the rocket engine. The primary emissions indices were predicted using the computer program Chemical Equilibrium with Applications (CEA) [4, 5]. CEA was developed at the NASA Glenn Research Center for the purpose of calculating the chemical equilibrium composition and thermodynamic properties of any chemical system.

A key application of CEA is the prediction of theoretical rocket engine performance and emissions. To predict rocket engine emissions, CEA requires the propellant (fuel and oxidizer) species, mixture ratio, combustion chamber pressure, and nozzle area ratio as input parameters.

Using these vehicle-specific input parameters, CEA performs calculations at several locations inside the rocket engine, including the combustion chamber, throat, and nozzle exit plane. The results at each location include the chemical composition, which is reported in terms of mole fractions or mass fractions of the combustion products. The mass fractions at the nozzle exit plane are directly proportional to the primary emissions indices.

Final Emissions Indices

However, the primary emissions indices at the nozzle exit plane are not the final emissions indices used in the emissions model. The chemical species in the high-temperature exhaust plume outside the rocket engine may continue to react with each other and with the surrounding air to produce secondary emissions. These secondary emissions modify and add to the final pollutant species that the rocket ultimately emits into the atmosphere. The formation of secondary emissions in the exhaust plume is a complex process involving finite-rate chemical kinetics, non-isentropic shocks and expansion waves, and turbulent dispersion. Prior studies have shown that the formation of secondary emissions depends most strongly on the chemical composition of the rocket exhaust plume and the altitude. Estimates for the secondary emissions from commercial space vehicles were developed under ACRP Project 02-85 [2]. RUMBLE implements these estimates to calculate the final emissions indices based on the primary emissions indices computed by CEA and the altitude from the nominal trajectory.

APPENDIX B TERRAN R PRIMARY EMISSIONS INDICES

The primary emissions indices for Relativity Terran R's Aeon-R and Aeon-R-Vac engines are presented in Table 5. The primary emissions indices listed were estimated using Chemical Equilibrium with Applications (CEA) [4, 5], with the exception of black carbon. CEA calculates the emissions indices based on the propellant species, mixture ratio, chamber pressure, and nozzle area ratio. The black carbon primary emissions index for LOX/methane engines (such as Relativity's Aeon engines) is estimated to be 20% of the value for LOX/RP-1 engines based on the reduction observed for internal combustion engines, where the primary emissions index of black carbon is estimated to be 25 g/kg for LOX/RP-1 propellants [2].

Table 5. Terran R primary emissions indices, in grams of pollutant emitted per kilogram of propellant consumed.

Model	Propellant	Al_2O_3	CO	CO_2	H_2O	H	H_2	OH	HCl	Cl	Cl_2	NOx	BC
Aeon-R	LOX + LNG	0	249.32	339.82	387.17	0	23.69	0	0	0	0	0	5
Aeon-R-Vac	LOX + LNG	0	144.87	503.91	320	0	31.21	0	0	0	0	0	5

Note, these primary emissions indices are used to calculate the altitude-dependent final emissions indices using first-order estimates [2].

REFERENCES

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

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

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

[4] S. Gordon and B. J. McBride, "Computer Program for Calculation of Complex Chemical Equilibrium Compositions and Applications: I. Analysis," NASA Reference Publication 1311, Cleveland, Ohio, 1994.

[5] B. J. McBride and S. Gordon, "Computer Program for Calculation of Complex Chemical Equilibrium Compositions and Applications: II. Users Manual and Program Description," NASA Reference Publication 1311, Cleveland, Ohio, 1996.

Appendix F-2

Air Conformity Applicability Model (ACAM) Report

AIR CONFORMITY APPLICABILITY MODEL REPORT
RECORD OF AIR ANALYSIS (ROAA)

1. General Information: The Air Force's Air Conformity Applicability Model (ACAM) was used to perform an analysis to assess the potential air quality impact/s associated with the action in accordance with the Air Force Manual 32-7002, Environmental Compliance and Pollution Prevention; the Environmental Impact Analysis Process (EIAP, 32 CFR 989); and the General Conformity Rule (GCR, 40 CFR 93 Subpart B). This report provides a summary of the ACAM analysis.

a. Action Location:
Base: CAPE CANAVERAL AFS
State: Florida
County(s): Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

b. Action Title: Terran R Program

c. Project Number/s (if applicable):

d. Projected Action Start Date: 1 / 2024

e. Action Description:

The Proposed Action to support Terran R Program operations requires modifications to existing facilities and construction of new systems and facilities at SLC-16. Modifications to the site include construction of a new Launch Pad and flume, Horizontal Integration Facility (HIF), Environmental Control System (ECS) Facility, Instrumentation Bay, Tech Workshop, office, lightning protection towers, two (2) flare stacks, vehicle lighting, LNG and LOX storage tanks, nitrogen and helium utilities with metering station and roadway infrastructure. Site upgrades may also include up to a 500,000-gallon water tower, with additional smaller ground storage vessels to support longer duration stage mission duty cycle (MDC) and static fire testing on site.

f. Point of Contact:
Name: Steven Henderson
Title: Civilian
Organization: Salas O'Brien/Nelson Engineering
Email: steven.henderson@salasobrien.com
Phone Number: 850-218-0769

2. Air Impact Analysis: Based on the attainment status at the action location, the requirements of the General Conformity Rule are:

_____ applicable
__X__ not applicable

Total net direct and indirect emissions associated with the action were estimated through ACAM on a calendar-year basis for the start of the action through achieving "steady state" (i.e., net gain/loss upon action fully implemented) emissions. The ACAM analysis used the latest and most accurate emission estimation techniques available; all algorithms, emission factors, and methodologies used are described in detail in the USAF Air Emissions Guide for Air Force Stationary Sources, the USAF Air Emissions Guide for Air Force Mobile Sources, and the USAF Air Emissions Guide for Air Force Transitory Sources.

"Insignificance Indicators" were used in the analysis to provide an indication of the significance of potential impacts to air quality based on current ambient air quality relative to the National Ambient Air Quality Standards (NAAQSs). These insignificance indicators are the 250 ton/yr Prevention of Significant Deterioration (PSD) major source threshold for actions occurring in areas that are "Clearly Attainment" (i.e., not within 5% of any NAAQS) and the GCR de minimis values (25 ton/yr for lead and 100 ton/yr for all other criteria pollutants) for actions occurring in areas that are “Near Nonattainment” (i.e., within 5% of any NAAQS). These indicators do not define a significant impact; however, they do provide a threshold to identify actions that are insignificant. Any action with net emissions below the insignificance indicators for all criteria pollutant is considered so insignificant that the action will not cause or contribute to an exceedance on one or more NAAQSs. For further detail on insignificance indicators see chapter 4 of the Air Force Air Quality Environmental Impact Analysis Process (EIAP) Guide, Volume II - Advanced Assessments.

The action’s net emissions for every year through achieving steady state were compared against the Insignificance Indicator and are summarized below.

Analysis Summary:

2024

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.652	250	No
NOx	3.588	250	No
CO	4.247	250	No
SOx	0.059	250	No
PM 10	47.016	250	No
PM 2.5	0.178	250	No
Pb	0.000	25	No
NH3	0.011	250	No
CO2e	1250.4		

2025

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.520	250	No
NOx	2.596	250	No
CO	3.691	250	No
SOx	0.055	250	No
PM 10	12.847	250	No
PM 2.5	0.152	250	No
Pb	0.000	25	No
NH3	0.007	250	No
CO2e	801.5		

2026

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.071	250	No
NOx	0.118	250	No
CO	0.742	250	No
SOx	0.005	250	No
PM 10	0.007	250	No
PM 2.5	0.007	250	No
Pb	0.000	25	No
NH3	0.004	250	No

CO2e	80.5		

2027 - (Steady State)

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.056	250	No
NOx	0.045	250	No
CO	0.642	250	No
SOx	0.000	250	No
PM 10	0.001	250	No
PM 2.5	0.001	250	No
Pb	0.000	25	No
NH3	0.003	250	No
CO2e	57.6		

None of estimated annual net emissions associated with this action are above the insignificance indicators, indicating no significant impact to air quality.Therefore, the action will not cause or contribute to an exceedance on one or more NAAQSs.No further air assessment is needed.

Steven Henderson , Civilian DATE

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

1. General Information

- Action Location
Base: CAPE CANAVERAL AFS
State: Florida
County(s): Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Action Title: Terran R Program

- Project Number/s (if applicable):

- Projected Action Start Date: 1 / 2024

- Action Purpose and Need:

The Proposed Action would allow Relativity Space to grow and upgrade the existing Terran 1 Program within the current SLC-16 boundary. Relativity's newest rocket, the Terran R, requires new infrastructure to support the rocket's larger size and payload capacities, when compared to the current Terran 1 launch vehicle.

The Proposed Action is needed to provide a more cost-competitive commercial space launch vehicle, to ensure US space launch capability is not reduced or limited and to ensure the US remains the leader in space launch technology. Relativity's program supports the U.S. Commercial Space Launch Competitiveness Act and allows for continued compliance with the National Space Policy to actively promote the purchase and use of US commercial space goods and services and reduce space transportation costs.

- Action Description:

The Proposed Action to support Terran R Program operations requires modifications to existing facilities and construction of new systems and facilities at SLC-16. Modifications to the site include construction of a new Launch Pad and flume, Horizontal Integration Facility (HIF), Environmental Control System (ECS) Facility, Instrumentation Bay, Tech Workshop, office, lightning protection towers, two (2) flare stacks, vehicle lighting, LNG and LOX storage tanks, nitrogen and helium utilities with metering station and roadway infrastructure. Site upgrades may also include up to a 500,000-gallon water tower, with additional smaller ground storage vessels to support longer duration stage mission duty cycle (MDC) and static fire testing on site.

- Point of Contact
Name: Steven Henderson
Title: Civilian
Organization: Salas O'Brien/Nelson Engineering
Email: steven.henderson@salasobrien.com
Phone Number: 850-218-0769

- Activity List:

Activity Type		Activity Title
2.	Construction / Demolition	Construction modifications to SLC-16 to support the Relativity Space Terran R Program.
3.	Emergency Generator	Emergency Generators
4.	Personnel	Launch Site Personnel

Emission factors and air emission estimating methods come from the United States Air Force's Air Emissions Guide for Air Force Stationary Sources, Air Emissions Guide for Air Force Mobile Sources, and Air Emissions Guide for Air Force Transitory Sources.

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

2. Construction / Demolition

2.1 General Information & Timeline Assumptions

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Construction modifications to SLC-16 to support the Relativity Space Terran R Program.

- Activity Description:

- Activity Start Date
Start Month: 1
Start Month: 2024

- Activity End Date
Indefinite: False
End Month: 1
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.957421
SO_x	0.018871
NO_x	5.682123
CO	6.429368
PM 10	59.761192

Pollutant	Total Emissions (TONs)
PM 2.5	0.228520
Pb	0.000000
NH_3	0.011399
CO_2e	1903.4

2.1 Site Grading Phase

2.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 10
Start Quarter: 1
Start Year: 2024

- Phase Duration
Number of Month: 4
Number of Days: 0

2.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 1275987
Amount of Material to be Hauled On-Site (yd^3): 275000
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Excavators Composite	1	8
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Scrapers Composite	3	8
Tractors/Loaders/Backhoes Composite	3	8

- Vehicle Exhaust

Average Hauling Truck Capacity (yd^3): 20 (default)

Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

2.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Excavators Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0584	0.0013	0.2523	0.5090	0.0100	0.0100	0.0052	119.71
Graders Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0714	0.0014	0.3708	0.5706	0.0167	0.0167	0.0064	132.90
Other Construction Equipment Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0461	0.0012	0.2243	0.3477	0.0079	0.0079	0.0041	122.61
Rubber Tired Dozers Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.1747	0.0024	1.1695	0.6834	0.0454	0.0454	0.0157	239.47
Scrapers Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.1564	0.0026	0.9241	0.7301	0.0368	0.0368	0.0141	262.83
Tractors/Loaders/Backhoes Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0348	0.0007	0.1980	0.3589	0.0068	0.0068	0.0031	66.875

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

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.282	000.002	000.207	003.392	000.006	000.005		000.023	00341.791
LDGT	000.376	000.003	000.373	004.889	000.007	000.006		000.024	00439.705
HDGV	000.832	000.005	000.964	016.217	000.016	000.014		000.046	00814.851
LDDV	000.084	000.003	000.127	002.822	000.004	000.004		000.008	00334.379
LDDT	000.227	000.004	000.365	004.850	000.007	000.006		000.008	00473.628

HDDV	000.423	000.014	004.175	001.653	000.176	000.162		000.028	01559.331
MC	003.040	000.003	000.626	013.017	000.026	000.023		000.052	00392.775

2.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase
$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase
CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
VMT_{VE} = (HA_{OnSite} + $HA_{OffSite}$) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

2.2 Trenching/Excavating Phase

2.2.1 Trenching / Excavating Phase Timeline Assumptions

- Phase Start Date
Start Month: 1
Start Quarter: 1
Start Year: 2024

- Phase Duration
Number of Month: 8
Number of Days: 0

2.2.2 Trenching / Excavating Phase Assumptions

- General Trenching/Excavating Information
Area of Site to be Trenched/Excavated (ft^2): 110000
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Trenching Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Excavators Composite	2	8
Other General Industrial Equipmen Composite	1	8
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

2.2.3 Trenching / Excavating Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Excavators Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0584	0.0013	0.2523	0.5090	0.0100	0.0100	0.0052	119.71
Graders Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0714	0.0014	0.3708	0.5706	0.0167	0.0167	0.0064	132.90
Other Construction Equipment Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0461	0.0012	0.2243	0.3477	0.0079	0.0079	0.0041	122.61
Rubber Tired Dozers Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.1747	0.0024	1.1695	0.6834	0.0454	0.0454	0.0157	239.47
Scrapers Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.1564	0.0026	0.9241	0.7301	0.0368	0.0368	0.0141	262.83
Tractors/Loaders/Backhoes Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0348	0.0007	0.1980	0.3589	0.0068	0.0068	0.0031	66.875

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

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.282	000.002	000.207	003.392	000.006	000.005		000.023	00341.791
LDGT	000.376	000.003	000.373	004.889	000.007	000.006		000.024	00439.705
HDGV	000.832	000.005	000.964	016.217	000.016	000.014		000.046	00814.851
LDDV	000.084	000.003	000.127	002.822	000.004	000.004		000.008	00334.379
LDDT	000.227	000.004	000.365	004.850	000.007	000.006		000.008	00473.628
HDDV	000.423	000.014	004.175	001.653	000.176	000.162		000.028	01559.331
MC	003.040	000.003	000.626	013.017	000.026	000.023		000.052	00392.775

2.2.4 Trenching / Excavating Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = (HA_{OnSite} + $HA_{OffSite}$) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)

HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

2.3 Building Construction Phase

2.3.1 Building Construction Phase Timeline Assumptions

- Phase Start Date
Start Month: 10
Start Quarter: 1
Start Year: 2024

- Phase Duration
Number of Month: 16
Number of Days: 0

2.3.2 Building Construction Phase Assumptions

- General Building Construction Information
Building Category: Office or Industrial
Area of Building (ft^2): 13984
Height of Building (ft): 50
Number of Units: N/A

- Building Construction Default Settings

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Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Cranes Composite	1	4
Forklifts Composite	2	6
Tractors/Loaders/Backhoes Composite	1	8

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

- Vendor Trips
Average Vendor Round Trip Commute (mile): 40 (default)

- Vendor Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

2.3.3 Building Construction Phase Emission Factor(s)

- Construction Exhaust Emission Factors (lb/hour) (default)

Cranes Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0715	0.0013	0.4600	0.3758	0.0161	0.0161	0.0064	128.78
Forklifts Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0246	0.0006	0.0973	0.2146	0.0029	0.0029	0.0022	54.451
Tractors/Loaders/Backhoes Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0348	0.0007	0.1980	0.3589	0.0068	0.0068	0.0031	66.875

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

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.282	000.002	000.207	003.392	000.006	000.005		000.023	00341.791
LDGT	000.376	000.003	000.373	004.889	000.007	000.006		000.024	00439.705
HDGV	000.832	000.005	000.964	016.217	000.016	000.014		000.046	00814.851
LDDV	000.084	000.003	000.127	002.822	000.004	000.004		000.008	00334.379
LDDT	000.227	000.004	000.365	004.850	000.007	000.006		000.008	00473.628
HDDV	000.423	000.014	004.175	001.653	000.176	000.162		000.028	01559.331
MC	003.040	000.003	000.626	013.017	000.026	000.023		000.052	00392.775

2.3.4 Building Construction Phase Formula(s)

- Construction Exhaust Emissions per Phase
$CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = BA * BH * (0.42 / 1000) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.42 / 1000): Conversion Factor ft^3 to trips (0.42 trip / 1000 ft^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Vender Trips Emissions per Phase
$VMT_{VT} = BA * BH * (0.38 / 1000) * HT$

VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
BA: Area of Building (ft^2)
BH: Height of Building (ft)
(0.38 / 1000): Conversion Factor ft^3 to trips (0.38 trip / 1000 ft^3)

HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VT}: Vender Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

2.4 Paving Phase

2.4.1 Paving Phase Timeline Assumptions

- Phase Start Date
Start Month: 3
Start Quarter: 1
Start Year: 2025

- Phase Duration
Number of Month: 8
Number of Days: 0

2.4.2 Paving Phase Assumptions

- General Paving Information
Paving Area (ft^2): 331089

- Paving Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Pavers Composite	1	8
Paving Equipment Composite	2	6
Rollers Composite	2	6

- Vehicle Exhaust
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

2.4.3 Paving Phase Emission Factor(s)

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- Construction Exhaust Emission Factors (lb/hour) (default)

Excavators Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0584	0.0013	0.2523	0.5090	0.0100	0.0100	0.0052	119.71
Graders Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0714	0.0014	0.3708	0.5706	0.0167	0.0167	0.0064	132.90
Other Construction Equipment Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0461	0.0012	0.2243	0.3477	0.0079	0.0079	0.0041	122.61
Rubber Tired Dozers Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.1747	0.0024	1.1695	0.6834	0.0454	0.0454	0.0157	239.47
Scrapers Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.1564	0.0026	0.9241	0.7301	0.0368	0.0368	0.0141	262.83
Tractors/Loaders/Backhoes Composite								
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	CH_4	CO_2e
Emission Factors	0.0348	0.0007	0.1980	0.3589	0.0068	0.0068	0.0031	66.875

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

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.282	000.002	000.207	003.392	000.006	000.005		000.023	00341.791
LDGT	000.376	000.003	000.373	004.889	000.007	000.006		000.024	00439.705
HDGV	000.832	000.005	000.964	016.217	000.016	000.014		000.046	00814.851
LDDV	000.084	000.003	000.127	002.822	000.004	000.004		000.008	00334.379
LDDT	000.227	000.004	000.365	004.850	000.007	000.006		000.008	00473.628
HDDV	000.423	000.014	004.175	001.653	000.176	000.162		000.028	01559.331
MC	003.040	000.003	000.626	013.017	000.026	000.023		000.052	00392.775

2.4.4 Paving Phase Formula(s)

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * EF_{POL}) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
EF_{POL}: Emission Factor for Pollutant (lb/hour)
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = PA * 0.25 * (1 / 27) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
PA: Paving Area (ft^2)
0.25: Thickness of Paving Area (ft)
(1 / 27): Conversion Factor cubic feet to cubic yards (1 yd^3 / 27 ft^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Off-Gassing Emissions per Phase
$VOC_P = (2.62 * PA) / 43560$

VOC_P: Paving VOC Emissions (TONs)
2.62: Emission Factor (lb/acre)
PA: Paving Area (ft^2)
43560: Conversion Factor square feet to acre (43560 ft2 / acre)^2 / acre)

3. Emergency Generator

3.1 General Information & Timeline Assumptions

- Add or Remove Activity from Baseline? Add

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Emergency Generators

- Activity Description:

- Activity Start Date
Start Month: 1
Start Year: 2024

- Activity End Date
Indefinite: No
End Month: 1
End Year: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.117703
SO_x	0.099141
NO_x	0.485156
CO	0.324000
PM 10	0.105891

Pollutant	Total Emissions (TONs)
PM 2.5	0.105891
Pb	0.000000
NH_3	0.000000
CO_2e	56.1

3.2 Emergency Generator Assumptions

- Emergency Generator
Type of Fuel used in Emergency Generator: Diesel
Number of Emergency Generators: 10

- Default Settings Used: Yes

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

3.3 Emergency Generator Emission Factor(s)

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

VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
0.00279	0.00235	0.0115	0.00768	0.00251	0.00251			1.33

3.4 Emergency Generator Formula(s)

- Emergency Generator Emissions per Year
AE_{POL}= (NGEN * HP * OT * EF_{POL}) / 2000

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

4. Personnel

4.1 General Information & Timeline Assumptions

- Add or Remove Activity from Baseline? Add

- Activity Location
County: Brevard
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Launch Site Personnel

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- Activity Description:

- Activity Start Date
Start Month: 1
Start Year: 2024

- Activity End Date
Indefinite: Yes
End Month: N/A
End Year: N/A

- Activity Emissions:

Pollutant	Emissions Per Year (TONs)
VOC	0.056031
SO_x	0.000376
NO_x	0.045202
CO	0.642183
PM 10	0.001001

Pollutant	Emissions Per Year (TONs)
PM 2.5	0.000852
Pb	0.000000
NH_3	0.003457
CO_2e	57.6

4.2 Personnel Assumptions

- Number of Personnel
Active Duty Personnel: 0
Civilian Personnel: 25
Support Contractor Personnel: 0
Air National Guard (ANG) Personnel: 0
Reserve Personnel: 0

- Default Settings Used: Yes

- Average Personnel Round Trip Commute (mile): 20 (default)

- Personnel Work Schedule
Active Duty Personnel: 5 Days Per Week (default)
Civilian Personnel: 5 Days Per Week (default)
Support Contractor Personnel: 5 Days Per Week (default)
Air National Guard (ANG) Personnel: 4 Days Per Week (default)
Reserve Personnel: 4 Days Per Month (default)

4.3 Personnel On Road Vehicle Mixture

- On Road Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	37.55	60.32	0	0.03	0.2	0	1.9
GOVs	54.49	37.73	4.67	0	0	3.11	0

4.4 Personnel Emission Factor(s)

- On Road Vehicle Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	Pb	NH_3	CO_2e
LDGV	000.282	000.002	000.207	003.392	000.006	000.005		000.023	00341.791
LDGT	000.376	000.003	000.373	004.889	000.007	000.006		000.024	00439.705
HDGV	000.832	000.005	000.964	016.217	000.016	000.014		000.046	00814.851

LDDV	000.084	000.003	000.127	002.822	000.004	000.004		000.008	00334.379
LDDT	000.227	000.004	000.365	004.850	000.007	000.006		000.008	00473.628
HDDV	000.423	000.014	004.175	001.653	000.176	000.162		000.028	01559.331
MC	003.040	000.003	000.626	013.017	000.026	000.023		000.052	00392.775

4.5 Personnel Formula(s)

- Personnel Vehicle Miles Travel for Work Days per Year

$VMT_P = NP * WD * AC$

VMT_P: Personnel Vehicle Miles Travel (miles/year)
NP: Number of Personnel
WD: Work Days per Year
AC: Average Commute (miles)

- Total Vehicle Miles Travel per Year

$VMT_{Total} = VMT_{AD} + VMT_C + VMT_{SC} + VMT_{ANG} + VMT_{AFRC}$

VMT_{Total}: Total Vehicle Miles Travel (miles)
VMT_{AD}: Active Duty Personnel Vehicle Miles Travel (miles)
VMT_C: Civilian Personnel Vehicle Miles Travel (miles)
VMT_{SC}: Support Contractor Personnel Vehicle Miles Travel (miles)
VMT_{ANG}: Air National Guard Personnel Vehicle Miles Travel (miles)
VMT_{AFRC}: Reserve Personnel Vehicle Miles Travel (miles)

- Vehicle Emissions per Year

$V_{POL} = (VMT_{Total} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{Total}: Total Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Personnel On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

Appendix G

Atlantic Environmental Revised Biological Assessment

Revised

Biological Assessment for the Relativity Launch Complex-16 Project Site Construction and Operation at Cape Canaveral Space Force Station, Florida

Prepared for Relativity Space in Cooperation with

Space Launch Delta 45
Patrick Space Force Base
Florida

Prepared By

Atlantic Environmental of Florida, LLC
657 Montreal Avenue
Melbourne, Florida 32935

June 2023

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SUMMARY

Relativity Space, in cooperation with the United States Space Force (USSF) as Lead Agency, and the Federal Aviation Administration (FAA), United States Coast Guard (USCG), and National Aeronautics and Space Administration (NASA) as Cooperating Agencies, has prepared this Biological Assessment (BA) in an effort to re-initiate the Section 7 Consultation process and to comply with National Environmental Policy Act (NEPA) requirements. This BA evaluates the potential environmental impacts resulting from activities associated with the increased footprint of redevelopment located at Space Launch Complex (SLC) 16 allowing for the horizontal vehicle integration, payload encapsulation, and orbital launch site development and operations for Relativity Space's Terran R launch vehicle program at Cape Canaveral Space Force Station (CCSFS), in Brevard County, Florida. In addition, this BA discusses the potential noise impacts resulting from launch activities and sonic boom over pressure level during ocean-going platform landings. This BA process has identified certain actions associated with the Proposed Action that may affect federally listed threatened and/or endangered species. In accordance with the Endangered Species Act, Formal Section 7 Consultation is required for any action that may affect listed species. As alluded to above, this BA provides the necessary information required to re-initiate Formal Section 7 Consultation.

CCSFS occupies approximately 15,800 acres (25 square miles) of land on Florida's Cape Canaveral barrier island as shown on **Figure 1.** Cape Canaveral is on the east coast of Brevard County, Florida and is approximately 155 miles south of Jacksonville, 210 miles north of Miami, and 60 miles east of Orlando. It is approximately 4.5 miles wide at its widest point. CCSFS has 81 miles of paved roads connecting various launch support facilities with the centralized Industrial Area. The northern boundary of CCSFS adjoins the Kennedy Space Center (KSC) boundary on the Merritt Island barrier island. The Banana River Lagoon separates CCSFS from KSC to the west. The Port of Cape Canaveral adjoins CCSFS to the south. CCSFS's eastern boundary is the Atlantic Ocean. The base is accessible primarily from U.S. Highway 528 to the south and from KSC to the west and north. Over 40 Launch Complexes have been constructed and used at CCSFS.

SLC-16 (**Figure 2)** on CCSFS experienced its first launch on December 12, 1959 and its most recent launch on March 22, 2023. A total of 142 launches have lifted off from this location, supporting launches of the Titan I, Titan II, Pershing 1 and 1a, Pershing II, and Terran 1 rockets. Relativity Space currently holds a 5-year license for Terran 1 operations and is currently pursing upgrades to support Terran R operations.

The purpose of the Proposed Action is to continue to provide Relativity Space the ability for horizontal vehicle integration, payload encapsulation, and construction of an orbital

launch site for its Terran R launch vehicle program. Table 1 below presents a summary of potential impacts to listed species that may arise from implementation of the Proposed Action. Note that these potential impacts were addressed within the Previous Area of Construction (see **Figure 3**) as outlined in U.S. Fish and Wildlife Service's (USFWS) March 20, 2020, Biological Opinion (BO) contained in **Appendix A**.

TABLE 1: Potential Impacts to Federal Protected Wildlife Species that Occur or Have Potential to Occur within the Proposed Action Area (area defined as direct or indirect impact by construction or operations)

Common Name *Scientific Name*	USFWS Status	Occurrence	Potential Impacts	Effect Determination
Florida Scrub-Jay (*Aphelocoma coerulescens*)	T	Not Present	Loss of breeding habitat. Disruption due to noise& heat	NLAA
Audubon's crested caracara (*Caracara cheriway*)	T	Not Present	Disruption due to noise.	NLAA
Eastern Indigo Snake (*Drymarchon corais couperi*)	T	Potential	Crushing by equipment. Loss of habitat. Disruption due to noise & heat.	NLAA
Monarch butterfly (*Danaus plexippus*)	C	Potential	Crushing by equipment. Disruption due to noise & heat.	NLAA
Southeastern Beach Mouse (*Peromyscus polionotus niveiventris*)	T	Documented	Crushing by equipment. Disruption due to noise & heat.	LAA
Marine Turtle: Leatherback (*Dermocheyls coriacea*, Green(*Chelona mydas)* Loggerhead(*Caretta caretta)*, Kemps Ridley (*Lepidochelys kempii*), Hawksbill Sea Turtle (*Eretmochelys imbricata*)	E/T/T/E/E	Documented	Disruption and disorientation due to light. Disruption due to noise.	NLAA
Manatee *(Trichechus manatus latirostris)*	T	Documented	Disruption due to noise. potential falling debris.	NLAA
Wood Stork (*Mycteria americana*)	T	Potential	Disruption due to noise & heat.	NLAA
Piping Plover (*Charadrius melodus*)	T	Documented	Disruption due to noise.	NLAA
Red Knot *(Calidris canutus*)	T	Documented	Disruption due to noise.	NLAA
Tricolored Bat (*Perimyotis subflavus*)	PE	Potential	Crushing by equipment. Disruption due to noise & heat.	NLAA

Legend: (T) Threatened; (E) Endangered; (C) Candidate;(PE) Proposed for Listing as Endangered; (LAA) May Affect, Likely to Adversely Affect; (NLAA) May Affect, Not Likely to Affect

1.0 Description of Proposed Action

1.1 Introduction and Description of the Proposed Action

The Proposed Action includes the expansion of new construction activities outside of the previously permitted areas covered under the March 20, 2020, BO, as well as some modifications to structures covered under that BO. Improvements include an instrumentation bay, an environmental control system building, a pad lightning protection system, a LNG farm area, a LOX farm area, a horizontal integration facility, a payload processing facility, a central chiller building, a engineering support building, and a LOX building. Site upgrades may also include up to a 500,000-gallon water tower, with additional smaller ground storage vessels to support longer duration static fire testing on site. Plans within **Appendix B** depict the proposed improvements.

1.2 Proposed Location and Site Construction Preparations

The Proposed Action location consists of an added ±33.68 acres of construction area, as well as an additional 1.83 acres of proposed heat plume influenced area (see **Appendix B** and **Figure 3**), that expands out from the ±33.91 acre Action Area covered under the March 20, 2020, BO of the approximately 138.50 acres within the Relativity Space's lease area on the eastern part of CCSFS that houses SLC-16. As can be seen on **Figure 4**, SLC-16 and its surrounding lands support previously developed land, densely vegetated areas, mowed and maintained grass areas, as well as wetlands and surface waters. A more detailed description, particularly of the area within the Proposed Action Area, can be found in Section 2 below.

Proposed construction activities as described above represent the layout of required facilities and infrastructure shown in **Appendix B.** The duration of proposed construction activities is expected to be approximately 15 months. Construction activities will not begin until after required consultation and permitting requirements are complete.

New construction includes all improvements described in Section 1.1. **Appendix B** depicts the proposed site improvements and **Figures 3 and 4** delineate the proposed expanded Areas of Construction and range of heat plume influenced area (together making up the Proposed Action Area) that encompasses approximately 35.51 acres. Of this ±35.51 acres, ±33.01 acres (see **Figure 5**) supports a combination of native scrub, open grassed areas, scattered invasive forested species, portion of the original launch complex, as well as areas that support a monoculture of Brazilian pepper. This acreage can be characterized as potential scrub-jay and/or beach mouse habitat. The remaining ±2.50 acres of the Proposed Action Area supports ditches (±0.40 acres), wetlands (±1.69

acres), and reservoirs (±0.41 acres).

The Area of Construction limits (±33.68 acres) contained within the Proposed Action Area will be cleared using heavy machinery while the area (±1.83 acres) within the range of heat plume influence will remain naturally vegetated and only be affected for short durations during launch operations. Cleared material would be placed in wheeled dump trucks for removal from within the construction area. Once vegetation is removed from this area using heavy machinery, much of it would be graded using large, heavy tracked bull dozers. Material will either be removed to a suitable off-site area, or burned on location in accordance with USSF regulations as schedule and burn conditions permit. It is anticipated that all excavated soil will remain onsite.

Any new or improved roadway will be constructed of compacted soil and appropriate impervious pavement material to support large equipment. Standard large-scale grass mowing equipment would be used on a periodic basis to maintain vegetation to about 3 to 5 inches in height in this area. It is not expected that a natural resource survey would be required prior to mowing events. As a result of the Proposed Action, it is anticipated that a short-term moderate level of noise would be generated from clearing and construction activities within the action area.

1.3 Relativity Space Launch Related Operations

Terran R provides both commercial and government customers affordable access to space, in low earth orbit (LEO) and beyond. Terran R accommodates the company's growing pipeline of commercial interest and will eventually offer a point-to-point space freighter capable of missions between Earth, Moon and Mars.

Relativity's Terran R launch vehicle will efficiently and cost-effectively serve government entities and commercial sectors whose payloads require LEO access of over 23,500 kg. Terran R is designed to compete with other rocket companies on cost, full reuse and rapid reusability. Relativity is targeting medium-class payload customers and providing schedule flexibility and mission customization made possible by Relativity's 3D printing technology. Relativity plans to deploy and resupply satellite constellations for a variety of Government and commercial sector clients. Other missions may include deep space probes, ISS cargo resupply missions, and launch of commercial space station modules. Capsules will be specialized depending on the mission.

<u>Main Engines</u>

The Terran R launch vehicle has an upper bound design that results in S1 measuring up to 175 feet tall, 18 feet in diameter, powered by up to 14 engines fueled with Liquid

Oxygen (LOX) and Liquified Natural Gas (LNG). The interstage is designed to measure up to 45 feet tall and 18 feet in diameter. S2 is designed to measure up to 35 feet tall, 18 feet in diameter, powered by one (1) Aeon VAC re-startable engine. Lastly, the payload fairing is designed to measure up to 65 feet tall, 18 feet in diameter. This results in the fully integrated Terran R launch vehicle configurable to up to approximately 320 feet in length. For the purposes of this analysis, the representative vehicle analyzed includes the upper bound parameters. Typically changes within 10-20% in the vehicle length are not enough to cause a significant change in associated impacts.

The majority of Terran R components are 3D printed using proprietary materials in Relativity's Stargate factory located in Los Angeles County, CA. The 13 S1 Aeon R engines (with configurations up to 14 engines) each produce 320,000 pounds of sea level thrust, for a total of up to 4,160,000 pounds of lift-off thrust (4,480,000 pounds in 14 engine configuration). S2 will use an updated Aeon 1 engine with a copper chamber. The heat plume generated from Terran R launches would travel away from launch pad, with temperatures < 600 °F reaching the edge of the property boundary at SLC-16, 400 °F approximately 0.25 mile from the launch pad, and temperatures reaching ambient temperature (86 °F) approximately 0.5 miles from the launch pad. The heat plumes and increased temperatures in this area would be temporary in nature and would only occur during engine ignition and dissipate within minutes. The maximum heat plume from Terran orbital launches would occur up to 24 times a year.

Terran R's payload delivery capability is over 23,500 kg to 185 km LEO. The Terran R launch vehicle would deliver payloads to inclinations up to azimuths ranging from 41° to 105°.

Payloads

All launch vehicles would be expected to have one or more satellite payloads per launch operation. Payload fuels and hazardous materials would be consistent with those currently being launched by multiple launch providers from CCSFS.

Operations

After receiving a launch site license from the Space Launch Delta 45 (SLD 45), Relativity will begin to construct the Terran R launch pad and related facilities. Following launch site construction, system activation, acceptance testing; integration testing can begin. Design, construction, and operations will be in accordance with tailored AFSPCMAN 91-710, AFMAN 91-201 and Complex Safety Plan requirements.

Vehicle and Engine Acceptance Testing

In support of launch 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 drive the need to establish procedural controls to ensure the safety of the general public and non-related personnel. Based upon a November 11, 2022, phone conversation with the USCG, once flight paths are identified, Relativity will request Aeronautical Information Services (AIS) data to track ship traffic patterns to assess impacts, if any. All hazards associated with the handling, integration, test, and operation of ground, launch vehicle, and payload systems will be analyzed, documented, and mitigated in accordance with AFSPCMAN 91-710 as tailored for the Terran R launch program.

Pre-Launch

Launch vehicle stages and payloads would arrive via vessel/barge at a commercially available port or CCSFS-located wharf. Terran R vehicle stages and payloads would arrive at CCSFS loaded on standard over-the-road tractor-trailers fitted with specialized cradles and transportation hardware. The proposed primary route for the transport of launch vehicle stages and launch vehicle components within CCSFS would be through CCSFS South Gate near Port Canaveral, then northeast on Samuel C. Phillips Parkway, a right onto Central Control Road heading southeast, a left onto ICBM Road heading northwest, and a right onto the entrance road to SLC-16. The launch vehicle stages and components would then be delivered to the integration facility for final integration and checkouts prior to launch operations.

Stage Hot Fire Testing Events

The Stage Hot Fire consists of fully fueling the vehicle and igniting the engines to provide a thorough test of all systems. Stage hot fire tests are anticipated to last 30 seconds with an estimated 14 tests occurring per year. Stage Hot Fire testing at SLC-16 would occur between several days to weeks before Static Fire Testing.

Static Fire Testing Events

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 approximately eight (8) seconds, depending on the test being performed. Static test fires are required prior to every launch with up to 24 static fire test fire events expected per year. Static fire test events would occur between several days to weeks before each individual launch.

Launch Events

The first Terran R Program launch from SLC-16 is anticipated in Q4 2026, ramping up to 24 anticipated maximum annual launches per year. For purposes of this SEA, a maximum launch rate of 24 Terran R launches per year from CCSFS will be analyzed. First stage boost back landing on an ocean-based platform would occur following each launch. However, during launches that are still early in the program development, Relativity may require expending Terran R in the ocean. One (1) launch of the Terran R orbital launch vehicle will occur in 2026, ramping up to eight (8) launches in 2027 and up to 24 launches per year beginning in 2028. Depending on mission requirements, launches could occur during daylight or nighttime hours. The anticipated lifespan for the Terran R Program is beyond 10 years.. As is similar with other launch programs from CCSFS, launches from SLC-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.

Noise Impacts

Noise impacts from sonic booms and propulsion noise are anticipated in association with Terran R operations. **Appendix C** contains Blue Ridge Research and Consulting, LLC's Noise Study for Relativity Space Terran R Operations at CCSFS completed in June 2023. This study demonstrates that the maximum modeled peak overpressure along the focus boom region associated with Northeasterly launch impacts is 11 pounds per square foot (psf). The focus boom region is over water and these high levels would only occur in extremely small areas along the focus boom region. With ocean-going platform landings, peak overpressures on the water's surface reach up to 47 psf when the vehicle's body is perpendicular to the direction of flight at approximately 26,000 feet. Even considering the above, Blue Ridge Research and Consulting, LLC concludes that the sonic boom for such events are entirely over water and will not affect people or structures.

The propulsion noise initiated at launch will cause a startle response in animals, causing these nearby species to temporarily move away from the perceived threat. The 105 decibel (dB) maximum A-weighted instantaneous noise level (LAmax) is considered the reasonable noise level at which wildlife might exhibit a response (e.g., startle response) to the short-term noise associated with operations (FRA 2005; Manci et al. 1988; Dufour 1980; McKechnie and Gladwin 1993; Bradley et al. 1990; Lee and Fleming 2002). See Appendix C for the 105 dB LAmax sound level contours during launch, testing, and landing.

Heat Plume

Heat plume at the rocket's center point reaches 6,117 °F and decreases to 4,606 °F 100 feet to the northeast, 2,499 °F at 200 feet, 1,897 °F at 300 feet, 1,507 °F at 400 feet, and <600 °F at the property boundary. **Figure 6** depicts the range of influence of the heat plume associated with Terran R launches as determined by ATA Engineering, Inc. Terran R 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 CCSFS. Vegetation scorching was limited to small areas (less than 2.67 acres) within 492 feet of the launch pad. Since Terran R is a relative sized vehicle, vegetation scorching is expected to be similar. Past vegetation scorching has not permanently affected the vegetation near other launch complexes and this same impact is expected to apply to Terran R launches.

It is important to note that the potential heat plume impact discussed above and previously described in this document as an approximately 1.83-acre swath of land is a conservative estimate of potential impacts. **Figure 7** depicts an elevation view of Terran R and its associated heat plume. As shown on this figure, due to the diverter and concrete flume angle, it is anticipated that the heat plume will have minimal impacts to the north at ground level. Instead, the heat plume will be realized above the tree line in this area. Relativity will be performing monitoring within the heat plume region of influence to better understand any potential impacts. Monitoring will include temperature sensors, as well as visual review of the potentially affected area after both static and launch events. Results from this monitoring will be reviewed with SLD 45 and if additional heat related impacts are realized from this monitoring, these impacts will be addressed with the appropriate agencies.

As stated above, the propulsion noise initiated at launch will cause a startle response in animals, causing these nearby species to temporarily move away from the perceived threat. While unlikely, those animals that do not move out of the heat plumes range of influence could be harmed or killed. However, the limited launch frequency, the lack of heat impacts at ground level or below the top of the tree line within the heat plume's region of influence, and relatively rapid dissipation of heat should not affect species at the population level.

2.0 Description of the Area Impacted by the Proposed Action

The Proposed Action area is located in and around the existing SLC-16, east of ICBM and Central Control Road, and west of the Atlantic Ocean, within Section 08, Township 23 South, Range 38 East, Brevard County, Florida (**Figures 1, 2 and 3**)**.** A broader area of potential impacts includes the beaches directly east of SLC-16, and the immediate areas off-shore within the Atlantic Ocean. In July 2018 and again in October 2022, a wildlife survey and environmental assessment was conducted of the approximately 138.50-acre lease area, as well as the additional surrounding lands north and south of SLC-16.

The Florida Land Use, Cover, and Forms Classification System (FLUCFCS) organizes most of the major categories of communities and land uses into particular descriptions, each corresponding to a different code number. Using our field observations and the FLUCFCS system as a guideline, the communities within SLC-16 and the immediate surrounding areas were determined. **Figure 4** depicts the location and associated code number of the FLUCFCS categories; specifically, Air Force Installation (FLUCFCS Code number 1731), Coastal Scrub (322), Xeric Oak (421), Brazilian Pepper (422), Streams and Waterways (510), Reservoirs less than 10 Acres (534), and Wetland Scrub (631).

Air Force Installation (1731)
Approximately 29.04-acres of SLC-16 supports the previously developed, and currently under construction portions, of this launch complex. This area houses paved roadways, bunkers, a space vehicle launch facility, and other manmade structures. The vegetated areas within this land use category support species including Brazilian pepper, bahiagrass, Bermuda grass, sandspur, semaphore thoroughwort, saltbush, sand cordgrass, and scattered cabbage palm.

Coastal Scrub (322)
A Coastal Scrub community (±41.41-acres) is located in the eastern portion of SLC-16. This community supports dense Brazilian pepper, saw palmetto, cabbage palm, scrub oaks, sand cordgrass, wax myrtle, and dune sunflower. The extreme eastern edge of this community is part of the beach and dune system, dominated by sea oats, that abuts the Atlantic Ocean.

Xeric Oak (421)
The Xeric Oak community supports approximately 44.10-acres of the western portion of SLC-16. This area is heavily dominated by dense scrub oaks that are intermixed with saw palmetto, coral bean, hog plum, Brazilian pepper, southern fox grape, winged sumac,

sand cordgrass, and shiny blueberry.

Brazilian Pepper (422)

An approximately 10.08-acre near monoculture of Brazilian pepper is located east of the developed portion of the launch complex.

Streams and Waterways (510)

Approximately 1.89-acres of linear manmade ditches have been created within the boundaries of SLC-16. These ditches house cattails and their banks are overrun with dense Brazilian pepper. To the immediate east of SLC-16 is the Atlantic Ocean.

Reservoirs less than 10 acres (534)

Two manmade lakes, totaling ±4.76-acres, are located within the eastern portion of SLC-16.

Wetland Scrub (631)

Approximately 6.81-acres of SLC-16 supports Wetland Scrub. Due to the density of the vegetation surrounding these areas, a combination of photointerpretation, historical aerial analysis, elevation data investigation, and limited ground truthing was used to determine the approximate community boundaries. These communities are dominated by sand cordgrass, sawgrass, semaphore thoroughwort, St. Augustine grass, Brazilian pepper, saltbush, and swamp flatsedge.

3.0 Description of Listed Species Within Impact Area

3.1 Florida Scrub-Jay

The Florida scrub-jay (*Aphelocoma coerulescens*) is a federally threatened bird endemic to open, oak-dominated scrub habitats of Florida. Widespread destruction and degradation of scrub habitat over the last century have resulted in dramatic declines in the distribution and abundance of this species. Because the scrub-jay is intimately tied to open, oak-dominated scrub, conservation of the species depends upon restoration of sufficient optimal habitat to support large populations. The jay population on CCSFS figures prominently in recovery plans for the species. Believed to be one of the largest remaining populations, the CCSFS population has been designated as belonging to one of three core populations for the species as described in the 2021 Florida scrub-jay Management Plan (USAF 2021a). **Figure 5** shows potential Florida scrub habitat that would be directly impacted by the proposed action (including within the heat plume range of influence). This area, encompassing approximately 33.01-acres of habitat, supports a combination of native scrub, open grassed areas, scattered invasive forested species, portion of the original launch complex, as well as areas that support a monoculture of Brazilian pepper. The majority of the proposed impact area is not considered highly suitable habitat because of the high percentage of invasive species and the overall vegetative density.

The USSF conducts a yearly census, as well as monitoring, of the Cape population of scrub-jays. All suitable accessible jay habitat is surveyed on a yearly basis. The 2022 census resulted in 142 groups with a total of 459 birds, which included 85 juveniles (USAF 2022a). Data from the 2022 census indicates the presence of groups northwest, west, and southwest of SLC-16 (see **Figure 8**), well removed from the proposed project area**.** The USSF has not been monitoring these groups; therefore territory information is not available.

Management actions for scrub-jays on CCSFS are primarily oriented toward habitat improvement and is guided by the scrub-jay Habitat Management Plan. Since a large portion of CCSFS is or could be scrub-jay habitat, many land clearing activities have the potential to adversely impact scrub-jays and their habitat. The USFWS has designated CCSFS as part of a core scrub-jay area, indicating that all scrub habitat on CCSFS is highly valuable to the recovery of the species. In the past, consultations between the USFWS and the USSF have resulted in a requirement to mitigate loss of scrub or potential scrub at a rate of 2:1. However, more recently, consultation between CCSFS and USFWS have resulted in prioritizing mitigation areas based on their location on CCSFS and that areas importance as a land management unit. Depending upon the importance of an area, the mitigation ratio typically ranges from 1:1 to 2:1.

The objective of scrub habitat restoration on CCSFS is to restore the over-mature scrub to a condition suitable to support the Florida scrub-jay (USAF 2021b). The main methods used for habitat restoration are mechanical treatment to reduce height of the scrub and prescribed burning of mechanically treated sites to provide open patches of sand and prevent accumulation of fuels.

Another form of scrub habitat improvement is via the removal of invasive and exotic vegetation species, particularly Brazilian pepper, that tend to form monocultures, outcompete native species, and degrade suitable scrub-jay habitat. Brazilian pepper infestation continues to be a problem on CCSFS, and additional funding would allow for added invasive species eradication improving scrub habitat on CCSFS.

3.2 Audubon’s Crested Caracara

Audubon’s crested caracara (*Caracara cheriway*) is a large, long legged, raptor with a distinct black cap and is a federally threatened species. The caracara prefers open areas of dry prairie and pasture with cabbage palm groupings as the preferred nest tree. Approximately ten observations of caracara on CCSFS property have been made over the past ten years, with observations increasing over the past three years (A. Chambers, personal communication, January 23, 2023). This species may use the project area or surrounding areas on an opportunistic basis.

3.3 Eastern Indigo Snake

The Eastern indigo snake (*Drymarchon corais couperi*) is a federally threatened species. It is the longest of North American snakes (up to 8.6 ft) and is locally abundant in parts of Florida but, as a top carnivore, population densities are typically low. The Eastern indigo snake has been observed on CCSFS and likely occurs throughout the installation; however, exact numbers are not known. A herpetological survey was completed in 2017-2018 (Kemcon 2018) with an emphasis on eastern indigos. No eastern indigos were observed or detected during that survey. The most recent observation of an eastern indigo occurred in 2018 just north of the CCSFS north boundary, on KSC property.

This primarily diurnal snake is known to occur in most types of habitat and is often associated with gopher tortoise burrows, although this has never been observed on CCSFS. The reproductive season encompasses copulation (November through April), egg-laying (May through June), and hatching (late July through October). Home ranges for male indigos range from 191 to 360 acres and female home ranges vary between 14 and 130 acres. Major threats to the indigo snake on CCSFS are habitat loss and vehicle traffic. There has not been an installation wide census completed for the eastern indigo snake; however, based on the different habitat types around SLC-16, it is possible that this species utilizes the areas to be cleared.

3.4 Monarch Butterfly

The monarch butterfly (*Danaus plexippus*) is a candidate species and not yet listed . Adult monarch butterflies are large and conspicuous, with bright orange wings surrounded by a black border and covered with black veins. The black border has a double row of white spots, present on the upper side of the wings. Adult monarchs are sexually dimorphic, with males having narrower wing venation and scent patches. The bright coloring of a monarch serves as a warning to predators that eating them can be toxic.

During the breeding season, monarchs lay their eggs on their obligate milkweed host plant (primarily Asclepias spp.), and larvae emerge after two to five days. Larvae develop through five larval instars (intervals between molts) over a period of 9 to 18 days, feeding on milkweed and sequestering toxic chemicals (cardenolides) as a defense against predators. The larva then pupates into a chrysalis before emerging 6 to 14 days later as an adult butterfly. There are multiple generations of monarchs produced during the breeding season, with most adult butterflies living approximately two to five weeks; overwintering adults enter into reproductive diapause (suspended reproduction) and live six to nine months.

In many regions where monarchs are present, monarchs breed year-round. Individual monarchs in temperate climates, such as eastern and western North America, undergo long-distance migration, and live for an extended period of time. In the fall, in both eastern and western North America, monarchs begin migrating to their respective overwintering sites. This migration can take monarchs distances of over 3,000 km and last for over two months. In early spring (February-March), surviving monarchs break diapause and mate at the overwintering sites before dispersing. The same individuals that undertook the initial southward migration begin flying back through the breeding grounds and their offspring start the cycle of generational migration over again.

It is possible that monarch butterflies utilize the project area as well as surrounding areas.

3.5 Southeastern Beach Mouse

The Southeastern Beach Mouse (*Peromyscus polionotus niveiventris)* is a federally threatened subspecies of the widely distributed oldfield mouse (*P. polionotus*). Originally occurring on coastal dunes and coastal strand communities along the Atlantic coast of Florida, this beach mouse generally occurs along the beach primary dune line and is presently known to exist in six sites in Brevard, Indian River, and St. Lucie Counties. Most breeding activity occurs November through January, and females can produce two or more litters per year, with litters averaging three to four offspring.

On CCSFS, the 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. While inland populations may be more stable, their abundance varies from site to site inland of the dune system. However, nearly every coastal scrub site surveyed on CCSFS supports the beach mouse. Furthermore, southeastern beach mice have been documented inside facilities throughout CCSFS.

FWC conducted beach mouse monitoring within and surrounding the SLC 16 area between February and December 2020 (FWC 2021). Results from this monitoring effort showed consistent presence of beach mice in these areas (see **Figure 9**). Additionally, track tube studies conducted between 2010 and 2018 just east of SLC 16 documented the presence of beach mice nearby (Oddy and Stolen 2018). As such, it is going be assumed that this species resides within the entire project area.

3.6 Marine Turtles

Four species of federally protected sea turtles have been documented as nesting on CCSFS: the loggerhead (*Caretta caretta*), green (*Chelona mydas*), leatherback *(Dermocheyls coriacea*), and the Kemps Ridley (*Lepidochelys kempii*). An additional federally protected sea turtle, the Hawksbill Sea Turtle (*Eretmochelys imbricata*), have been documented offshore in the abutting Atlantic Ocean. Based on nest surveys from 1986 to 2022, the average number of loggerhead and green nests deposited annually is 2,464 and 128, respectively. One hundred fifty-seven (157) leatherback nests have been documented since 1986. Two (2) Kemps Ridley nests were documented in 2015. Lastly, 2022 was a record year for loggerhead nesting on CCSFS, with 3,804 nests being documented (USAF 2022b).

On September 22, 2011 the Federal Register announced the determination of the NMFS and the USFWS that the Loggerhead sea turtle (*Caretta caretta*) is composed of nine distinct population segments (DPSs) that constitute ‘‘species’’ that may be listed as threatened or endangered under the ESA. In this final rule, they listed four DPSs as threatened and five as endangered under the ESA. They also designated critical habitat for the two loggerhead sea turtle DPSs occurring within the United States. CCSFS was exempt from the critical habitat designation because the 45 SW has an approved Integrated Natural Resources Management Plan that includes measures that provide a benefit to the conservation of loggerhead sea turtles.

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 Endangered Species Act, the USSF developed Light Management Plans (LMPs) for various areas and facilities on CCSFS (previously the Cape Canaveral Air Force Station) to protect sea turtles. A BO issued by the USFWS requires that LMPs be developed for all new facilities that are in close proximity to the beach, are not compliant with Wing lighting policies, have lighting directly visible from the beach and/or may cause significant sky glow. In addition, USSF biologists conduct nighttime inspections to ensure all exterior lighting is being operated in accordance with policies. The BO authorizes no more than 3% incidental take of sea turtles as the result of disorientation on CCSFS. In 2021, the incidental take reported to USFWS was 0.0%. The currently installed lighting at SLC-16 did produce minor amounts of disorientation, but still under the allowable 3 percent take. The disorientation events were observed during Relativity's hot fires, when both fixed white lighting and portable whit lighting were being utilized.

3.7 West Indian Manatee

The West Indian manatee is listed as "Endangered" by the USFWS. Manatees are protected under the Marine Mammal Protection Act, which prohibits the take (i.e., harass, hunt, capture, or kill) of all marine mammals. Manatees are found in marine, estuarine and freshwater environments. The West Indian manatee *(Trichechus manatus)*, includes two distinct subspecies; the Florida manatee *(Trichechus manatus latirostris)* and the Antillean manatee *(Trichechus manatus manatus)*. While morphologically distinctive, both subspecies have many common features. Manatees have large, seal-shaped bodies with paired flippers and a round, paddleshaped tail. They are typically grey in color (color can range from black to light brown) and occasionally spotted with barnacles or colored by patches of green or red algae. The muzzle is heavily whiskered and coarse, single hairs are sparsely distributed throughout the body. Adult manatees, on average, are about nine feet long (3 meters) and weigh about 1,000 pounds (200 kilograms). At birth, calves are between three and four feet long (1 meter) and weigh between 40 and 60 pounds (30 kilograms).

Although no habitat exists for the West Indian Manatee within the project boundaries, manatees have been documented to use littoral zones just offshore in the Atlantic Ocean. No West Indian Manatees were observed within the subject site during the wildlife survey.

3.8 Wood Stork

The wood stork (*Mycteria americana*) is a federally listed threatened species. It is a large, white and black wading bird, with a long ‘ibis-shaped’ beak. The wood stork is the only stork species which inhabits North America. Wood storks are often found in small pools, manmade ditches, and wetland areas which support minnows and other species of small fish. The species breeds in late winter once fish populations in small vernal pools have dried up sufficiently to support the raising of young.

SLC-16 and the surrounding areas contain several wetland areas and manmade open water features that may be used by the wood stork on an opportunistic basis. Although no wood storks have been observed on the Project Site, it is expected that they do occasionally utilize some habitat within and around the project area.

3.9 Piping Plover

The Piping Plover (*Charadrius melodus*), a federally listed threatened species, is a small sand-colored, sparrow-sized shorebird that nests and feeds along coastal sand and gravel beaches in North America. The adult has yellow-orange legs, a black band across the forehead from eye to eye, and a black ring around the neck. Their breeding habitat includes beaches or sand flats on the Atlantic coast, Great Lakes, and the mid- west. They forage for food on beaches moving across in short bursts around the high tide wrack zone eating insects, marine worms, and crustaceans.

The Piping Plover is not known to breed in Brevard County; however, it does have the potential to occur on Brevard beaches during the non-breeding season (July-March) and has been observed on CCSFS beaches in small numbers.

3.10 Red Knot

The Red Knot (*Calidris canutus*) is a federally listed threatened species and is a medium sized shorebird which breeds in tundra and the Arctic Cordillera in the far north of Canada, Europe, and Russia. The red knot has one of the longest migrations of any bird. The Red Knot is an occasional visitor along the Florida seashore during its annual migration. This species is not known to breed or nest in Brevard County, however, it has been observed on CCSFS beaches in small numbers.

3.11 Tricolored Bat

On September 13, 2022, USFWS announced a proposal to list the tricolored bat as endangered under the ESA. The bat faces extinction due to the impacts of white-nose syndrome, a deadly disease affecting cave-dwelling bats across North America. The tricolored bat is one of the smallest bats native to North America. This once common species is wide ranging across the eastern and central United States and portions of southern Canada, Mexico, and Central America. During the winter, tricolored bats are found in caves and mines, although in the southern U.S., where caves are sparse, tricolored bats may be found roosting in man-made structures (e.g., buildings, culverts, and bridges). During the spring, summer, and fall, tricolored bats are found in forested habitats where they roost in trees, primarily among leaves. As its name suggests, the tricolored bat is distinguished by its unique tricolored fur that appears dark at the base, lighter in the middle and dark at the tip. Tricolored bats have been documented on CCSFS and may be present within the proposed project area.

4.0 Effects of Action on Listed Species

The following sections discuss specific effects from the Proposed Action. Effects are caused by construction and operations activities which include impacts from construction and operation activities related to the launching of Relativity's Terran R launch vehicle. Potential impacts to listed species have been minimized by siting facilities/structures in and adjacent to previously disturbed areas to the maximum extent possible.

4.1 Florida Scrub-Jay

The clearing for the Proposed Action will result in the loss of approximately 33.01 acres of potential scrub-jay habitat. The 2022 Florida Scrub-Jay census did not reveal the presence of any scrub jay groups or individuals within the Proposed Action area as shown in **Figure 8** and therefore direct impacts are not expected. The site does contain suboptimal habitat in the form of coastal scrub, wetlands, and other natural areas that are not considered capable of being managed and occupied by the Florida Scrub-Jay.

Current and past launch programs on CCSFS, including the Atlas, Titan, and Delta launches, have been documented to not cause any animal mortality or significant impact to wildlife on CCSFS (USAF 1998a). With this being said, launch noise and the anticipated launch heat plume appear to possess the greatest impact risk to the Florida scrub-jay. Launch noise will extend into jay habitat and could temporarily displace this species. These potential effects would be short-term and happen on a limited basis.

The heat plume generated by Terran R (depicted on Figure 5) during launch events could impact Florida scrub-jays that may be within the heat plume range of influence. With this being said, the heat plume is not expected to affect scrub-jays because suitable occupied habitat is not present within the plume's reach and the heat plume should be diverted over the tree line (see **Figure 7**).

The Proposed Action will result in the taking of unoccupied Florida Scrub-Jay habitat and therefore this species should fall under a May Affect, Not Likely to Adversely Affect (**NLAA) determination**.

4.2 Audubon's Crested Caracara

The Proposed Action will not directly impact any habitat critical to Audubon's crested caracara. With this being said, launch noise appears to possess the greatest impact risk to this species, should it be in the area at the time of a launch. Launch noise will extend into habitat surrounding SLC-16 and could temporarily displace this species. These potential effects would be short-term and happen on a limited basis.

For this reason, we believe this species should fall under a **NLAA determination**.

4.3 Indigo Snake

The Proposed Action will result in the loss of approximately 35.51-acres of potential eastern indigo snake habitat (includes all lands within the Proposed Action Area). Habitat loss may occur but adjacent habitat is available. Eastern indigo snakes would also be vulnerable to mortality as a result of injuries sustained during construction activities.

Reptiles and amphibians are sensitive to vibrations, which provide information about approaching predators and prey. Vibration and noise associated with construction activities would elicit a "startle response" to avoid the noise. These impacts would be considered short-term and would not cause a negative impact to the eastern indigo snake within the vicinity of the project area (USAF 2010). Noise associated with rocket launches may startle many species within the CCSFS area. However actual noise impact to wildlife is expected to be minimal.

Although expected to be primarily over the tree line (see **Figure 7**), the heat plume generated by Terran R depicted on Figure 5 during launch events could impact indigo snakes that may be within the heat plume range of influence. However, one would expect that the noise associated with pre-launch operations would cause individuals to disperse from the area or hide in underground refugia prior to being exposed to the heat plume.

There is no recent indication of eastern indigos being on SLC-16 or within the nearby vicinity of the Project Area. We believe this species should fall under a **NLAA determination**.

4.4 Monarch Butterfly

The Proposed Action will not directly impact any habitat critical to monarch butterflies. With this being said, launch noise and the anticipated launch heat plume appear to possess the greatest impact risk to this species, should it be in the area at the time of a launch. Launch noise will extend into habitat surrounding SLC-16 and could temporarily displace this species. These potential effects would be short-term and happen on a limited basis.

There is no recent indication of monarch butterflies being on SLC-16 or within the vicinity of the Project Area. Although this species remains only a candidate species, we believe this species should ultimately fall under a **NLAA determination**.

4.5 Southeastern Beach Mouse

Construction and operations will occur at least 425 feet west of the beach dune area; typical habitat of the beach mouse. However, 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.

Based on plans for construction in combination with a conservative interpretation of the area that will be influenced by the heat plume associated with the launch of Terran R approximately 33.01-acres of native scrub, open grassed areas, scattered invasive forested species, portion of the original launch complex, as well as areas that support a monoculture of Brazilian pepper will be affected by the Proposed Action. This area of clearing and heat plume influenced area (see **Figure 5**) appears to be the land within the Project Area that may have potential to contain habitat that supports the southeastern beach mouse; leaving substantial area for apparent expanding beach mouse habitat.

In addition to habitat impacts, launch noise appears to possess the greatest impact risk to the southeastern beach mouse. Launch noise will extend into this species' habitat and could temporarily displace this species. These potential effects would be short-term and happen on a limited basis.

Lastly, considering that southeastern beach mice have been documented inside facilities throughout CCSFS, the USSF has a Programmatic BO that covers pest management activities within and around such facilities. The Relativity Space facility will be required to live trap and release the southeastern beach mouse within and around its facilities on SLC-16 per the existing BO.

Considering the above, we believe this species should fall within a May Affect, Likely to Adversely Affect **(LAA) determination**.

4.6 Marine Turtles

The proposed clearing and construction of new facilities would not directly impact the nesting beach. While current exterior lighting for Relativity's facilities has the potential to be visible from the beach and could result in adult and/or hatchling disorientation adjacent to SLC-16, lighting impact has been and is proposed to continue to be limited by an approved Light Management Plan.

Sea turtles are not expected to be affected by vibration and noise associated with construction activities since the project area would be beyond the beach and dune area. However, noise associated with rocket launches or ocean-going platform landings may startle many species within the CCSFS area. This launch noise will extend into habitat surrounding SLC-16 and could temporarily startle this species. These potential effects would be short-term and happen on a limited basis. As such, we believe this species should fall under a **NLAA determination**.

4.7 West Indian Manatee

Manatees are not expected to be affected by vibration and noise associated with construction activities since they are not in the area continuously and the project area would be west of and beyond the beach and dune area. The noise associated with launch operations and ocean-going platform landings will be very temporary in nature and are not expected to have more than a temporary startling effect on manatees.

The Proposed Action is not likely to have a negative impact on Manatees in the area and therefore a **NLAA determination** is recommended.

4.8 Wood Stork

The Proposed Action will not directly impact any wetlands or ditches supporting wood stork suitable foraging habitat. However, launch noise will extend into wood stork foraging habitat and could temporarily displace this species. These potential effects would be short-term and happen on a limited basis.

The heat plume generated by Terran R depicted on **Figure 5** during launch events could impact wood storks that may be within the heat plume range of influence. However, one would expect that the noise associated with pre-launch operations would cause individuals to disperse from the area prior to being exposed to the heat plume. For this reason, we believe this species should fall under a **NLAA determination**.

4.9 Piping Plover

The Proposed Action will not impact Piping Plover habitat. The Proposed Action does not anticipate any activities along the adjacent beach and there is no documented nesting of Piping Plover within Brevard County. Potential noise related effects from either construction or launch are not expected to impact the Piping Plover. For this reason, we believe this species should fall under a **NLAA determination**.

4.10 Red Knot

The Proposed Action will not impact the Red Knot habitat. The Proposed Action does not anticipate any activities along the adjacent beach and the Red Knot is only recognized as an occasional visitor during migration. Potential noise related effects from either construction or launch are not expected to impact the Piping Plover. For this reason, we believe this species should fall under a **NLAA determination**.

4.11 Tricolored Bat

The Proposed Action may affect but is not likely to adversely affect (**NLAA**) the tricolored bat. The proposed rule to list the tricolored bat as endangered currently does not specify activities that would violate the ESA because the bat occurs in a variety of habitat conditions across its range. With the implementation of site-specific surveys prior to vegetation clearing, adverse impacts to the tricolored bat are not anticipated. If tri-colored bats are observed or detected during these surveys, additional coordination with USFWS will be initiated.

5.0 Compensation for Affected Species

5.1 Florida Scrub-Jay

Mitigation for impacts to the scrub-jay would compensate for impacts caused by the Proposed Action. Provided the following compensation measures are implemented, the Proposed Action may affect, but is not likely to adversely affect Florida scrub-jays on CCSFS.

In lieu of habitat restoration as mitigation for loss of unoccupied potential Florida scrub-jay habitat (as well as southeastern beach mouse habitat, see Section 5.5), Relativity Space proposes to provide funding to enhance unoccupied scrub-jay habitat that is adjacent to occupied jay habitat in Land Management Units (LMU) 22. Impacts proposed include 7.60 acres in LMU 22, 6.94 acres in LMU 27, and 18.47 acres in LMU 28 (see **Figure 5**). Per recent consultation between CCSFS and USFWS, LMU 22 is to be mitigated for at a 2:1 ratio while LMUs 27 and 28 are to be mitigated for at a 1:1 ratio. As such, funding for the improvement of a total of 40.61 acres in LMU 22 will be provided.

Brazilian pepper infestation continues to be a problem on CCSFS and the amount of funding received annually is not enough to completely eradicate this species from habitat that is currently occupied. This funding will assist the USSF in continuing efforts to eradicate invasive floral species in habitat that is currently occupied by jays or in areas adjacent to occupied habitat.

The presence of new launch operations at SLC-16 has the potential to negatively affect the SLD 45’s prescribed burning program in adjacent LMUs due to launches, payload processing, and other operation activities. As a result, this could have negative indirect impacts on the Florida scrub-jay because of the reduced restoration of suitable habitat for this species. SLD 45 intends to conduct controlled burns and mechanical vegetation management to improve the scrub-jay habitat on CCSFS, including up to the Proposed Action Boundary. Relativity Space must ensure that proposed processing facilities can accommodate smoke that may occur as a result of a nearby prescribed fire.

Lastly, if a dead Scrub-Jay is found at the project site, it will be collected and frozen, and notification will be made to the USFWS office in Jacksonville.

5.2 Audubon’s Crested Caracara

Nesting habitat is not present within or around the project site and therefore the presence of an Audubon’s crested caracara in the vicinity of SLC-16 would be extremely rare.

During launch operations, it is expected that any caracara would be startled and therefore fly away from the perceived danger. Such a flight response would be expected be a short-term impact. As such, no mitigation measures are expected.

5.3 Eastern Indigo Snake

The SLD 45 Indigo Snake Protection/Education Plan will be presented to the project manager, construction manager and personnel. 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. Any observations of live or dead indigo snakes will be reported to the USSF immediately, who will then report it to USFWS if appropriate.

5.4 Monarch Butterfly

Monarch butterflies could be impacted by the temperature increase within the heat plume during launch operations. However, the heat plume will be generated for a very short duration and on an irregular basis. As such, no mitigation measures are expected.

5.5 Southeastern Beach Mouse

The Proposed Action would not significantly impact the southeastern beach mouse population at CCSFS since relatively little (i.e., $\pm$33.01 acres) clearing, construction, or heat plume impacts would occur in the Project Area where disturbance has not previously occurred. While there could be a take of a southeastern beach mouse, proposed habitat enhancement within scrub habitat in LMU 22 (see **Figure 10**) will offset impacts to the occupied southeastern beach mouse habitat as well as improve unoccupied scrub-jay habitat that is adjacent to occupied jay habitat as outlined in section 5.1. The USSF has a Programmatic Biological Opinion that addresses impacts to beach mice associated with certain activities, which includes restoration and enhancement actions. Based on past studies completed for CCSFS, beach mice benefit from the same land management activities being conducted for scrub-jays, and the population is expanding into inland locations. Therefore, the potential exists to improve approximately 33.01-acres of additional habitat for beach mice. Proposed Action acreage that may support beach mice is contiguous with adjacent beach mouse habitat to the east and therefore would allow movement of individuals.

5.6 Marine Turtles

To minimize potential impacts to sea turtles from new or temporary facility lighting, the majority of exterior lighting proposed for this project would be in accordance with the 45th SW Instruction 32-7001, *Exterior Lighting Management* dated April 23, 2018. It is expected that some “non-turtle friendly” lighting may be required during actual “day” of launch, and if any launches were to occur at night. A Light Management Plan has been completed by Relativity Space and will be amended, if needed, once the design is completed and this Plan will be forwarded to USFWS for approval prior to new or temporary lighting construction. Clearing of vegetation at the SLC-16 area would not have an impact to nesting or hatchling sea turtles; therefore, no mitigation is required for those activities.

5.7 West Indian 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. Furthermore, should an anomaly occur, and debris from such an event fall into the ocean, the likelihood of such debris coming into contact with this species is negligible. Therefore, mitigation measures are not needed.

5.8 Wood Stork

Because no nests have been observed within the SLC-16 project site, wood storks have not been observed foraging within the Proposed Action Area, and because the nearby wetlands and surface waters that do exist within SLC-16 are made up of poor quality wood stork foraging habitat, impact to this species’ habitat is expected to be negligible. Therefore, no mitigation measures are expected. During launch operations, any wood storks in the area could be startled. This would be expected to be a short-term impact.

5.9 Piping Plover

Because there would be no clearing on the beach itself, impacts to Piping Plover habitat is expected to be negligible. However, during launch operations, any Plovers on the beach adjacent to SLC-16 could be startled. This would be expected to be a short-term impact.

5.10 Red Knot

Because there would be no clearing on the beach itself, impacts to Red Knot habitat is expected to be negligible. However, during launch operations, any plovers on the beach adjacent to SLC-16 could be startled. This would be expected to be a short-term impact.

5.11 Tricolored Bat

The proposed rule to list the tricolored bat as endangered currently does not specify activities that would violate the ESA because the bat occurs in a variety of habitat conditions across its range. With the implementation of site-specific surveys prior to vegetation clearing, adverse impacts to the tricolored bat are not anticipated. Again, if tri-colored bats are observed or detected during these surveys, additional coordination with USFWS will be initiated.

6.0 Cumulative Impacts

Potential cumulative adverse impacts would occur for Florida scrub-jays, southeastern beach mice, and eastern indigo snakes. When evaluated with other projects occurring or proposed on CCSFS, the proposed removal of approximately 33.01-acres of potential scrub-jay habitat would result in a reduction of available breeding habitat, as well as a reduction in the availability of scrub habitat for restoration. However, the enhancement of approximately 40.61 acres of scrub habitat within LMU 22 (mitigation for the Proposed Action – see **Figure 10**) will result in an improvement of habitat that could be included in a scrub-jay territory and will also act to offset impacts to 33.01 acres of potentially occupied southeastern beach mouse habitat, while simultaneously improving habitat for eastern indigo snakes. The current INRMP (Integrated Natural Resources Management Plan) goal is for CCSFS to support 200 breeding pairs of jays. Because of the 2:1 mitigation requirement, the overall result will be a net increase in suitable habitat for scrub-jays, southeastern beach mice, and eastern indigo snakes.

The SLD 45 has a CCSFS habitat management goal of burning 500-acres annually to manage habitat for threatened and endangered species. This goal has been established through consultation with federal resource agencies pursuant to Section 7 of the Endangered Species Act. In order to achieve this goal, the SLD 45 typically needs 6-8 days of prescribed burning per year. Burn window opportunities for the SLD have been periodically reduced due to numerous factors such as weather, payload transport, payload processing, payload storage at a launch pad, launches, wet dress, and static test fires, among others. Historically, the SLD has been relatively successful at meeting this objective. However, due to the current military project needs and increasing number of commercial aerospace customers, prescribed burning has and will become more difficult.

Historically, the SLD has maintained a launch table from which burn windows are identified. The increase in aerospace activities has reduced the availability of these windows due to reasons listed above as well as secondary impacts such as launch delays or improper weather conditions when a prescribed burn window arises. As a result, the SLD plans to revise its approach with current and future users and Relativity to ensure adequate burn windows occur annually in an effort to prioritize this listed species management activity rather than it being secondary to launch operations. The SLD is currently working with senior CCAFS staff to develop operational controls that will block out a set number of days annually within which launches or other activities affected by prescribed burns cannot occur in order to allow SLD to meet its habitat management goals agreed to with the resource agencies. Operational controls will be implemented that will provide more assurance that CCSFS will meet its burning goals as part of its land management unit responsibilities. In addition, language will be incorporated into lease agreements that references the SLD prescribed burn goal, listed species management responsibilities, and resulting annual restrictions (1-2 weeks) during a SLD predefined period. As part of the lease agreement, Relativity will have a contractual obligation to comply with the specified prescribed burn days schedule by providing adequate protection for their equipment (via containment or filtration systems) or moving sensitive equipment to another location while the prescribed burn days are in force. Relativity Space will ensure that proposed processing facilities can accommodate smoke that may occur as a result of a nearby prescribed fire.

Cumulative impacts on sea turtles have the potential to occur. The new facilities may result in more exterior lighting than is currently present at SLC-16. Adherence to the Light Management Plan and Air Force lighting policies will help reduce these impacts. Amber LED lighting will be used to the maximum extent possible to minimize potential adverse impacts on nesting turtles and/or their young.

Cumulative impacts on the Manatee, Piping Plover, and the Red Knot are not expected to occur with the Proposed Action. There are no activities currently proposed within any on-site federally jurisdictional wetlands, ditches, the shoreline, or within the Atlantic Ocean.

Lastly, from a cumulative standpoint, heat plume impacts and noise impacts from proposed launch operations and sonic booms are not expected to significantly impact protected wildlife or these species' habitats. No negative population-level effects are expected on any of the above-listed species and the.

7.0 List of Preparers

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USAF, 2021b. Scrub Habitat Restoration Plan 45th Space Wing, CCAFS, 2021

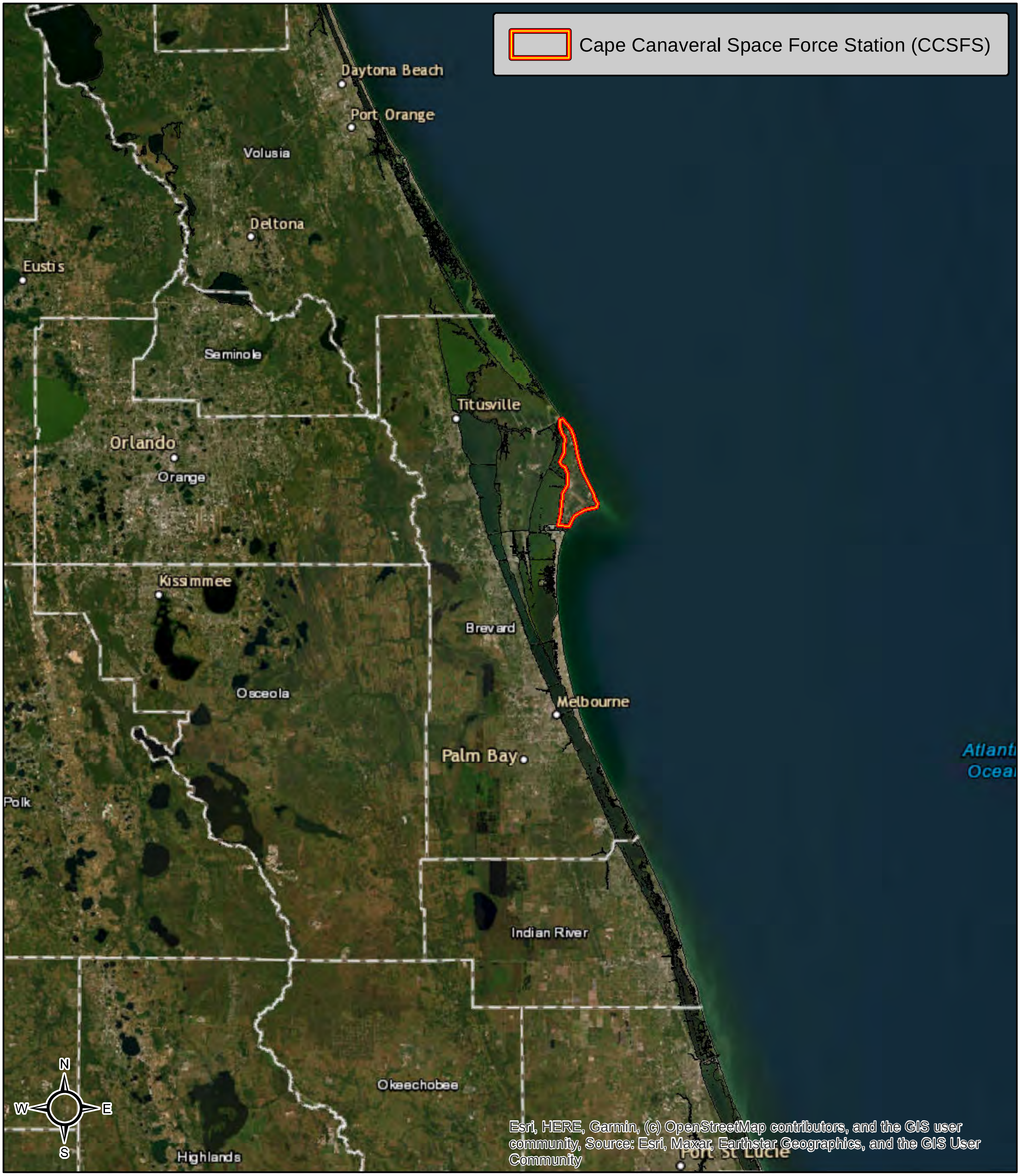
USAF, 2010. Environmental Assessment for the Skid Strip Area Development Plan at CCFS, Florida, 2010

USAF, 1998. U. S. Air Force, Final Environmental Impact Statement Evolved Expendable Launch Vehicle, April 1998.

USAF, 2022a. United States Air Force 45th Space Wing, CCAFS 2013-2022 Scrub Jay Survey Results

USAF, 2022b. United States Air Force 45th Space Wing, CCAFS 2009-2022 Sea Turtle Nesting Survey Results

USAF, 1998a. Monitoring Direct Effects of Delta, Atlas, and Titan Launches from Cape Canaveral Air Station



Project: Relativity Launch Complex

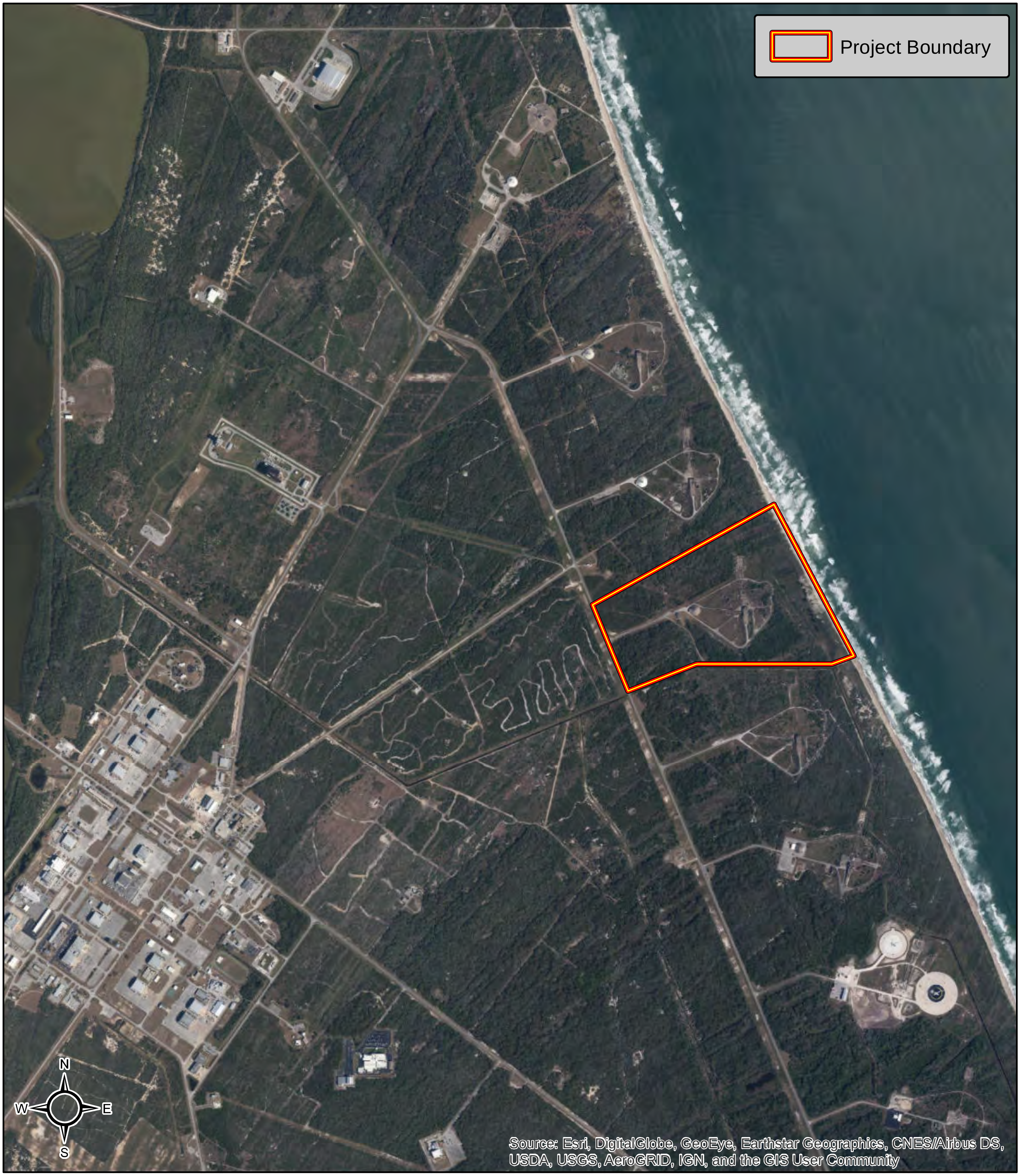
Figure 1: CCSFS Location Map

0 10 20 40 Miles

2018 Aerial, Brevard County, Florida

ATLANTIC ENVIRONMENTAL
ENVIRONMENTAL PERMITTING & MITIGATION

AE Proj #: 19352



Project: Relativity Launch Complex

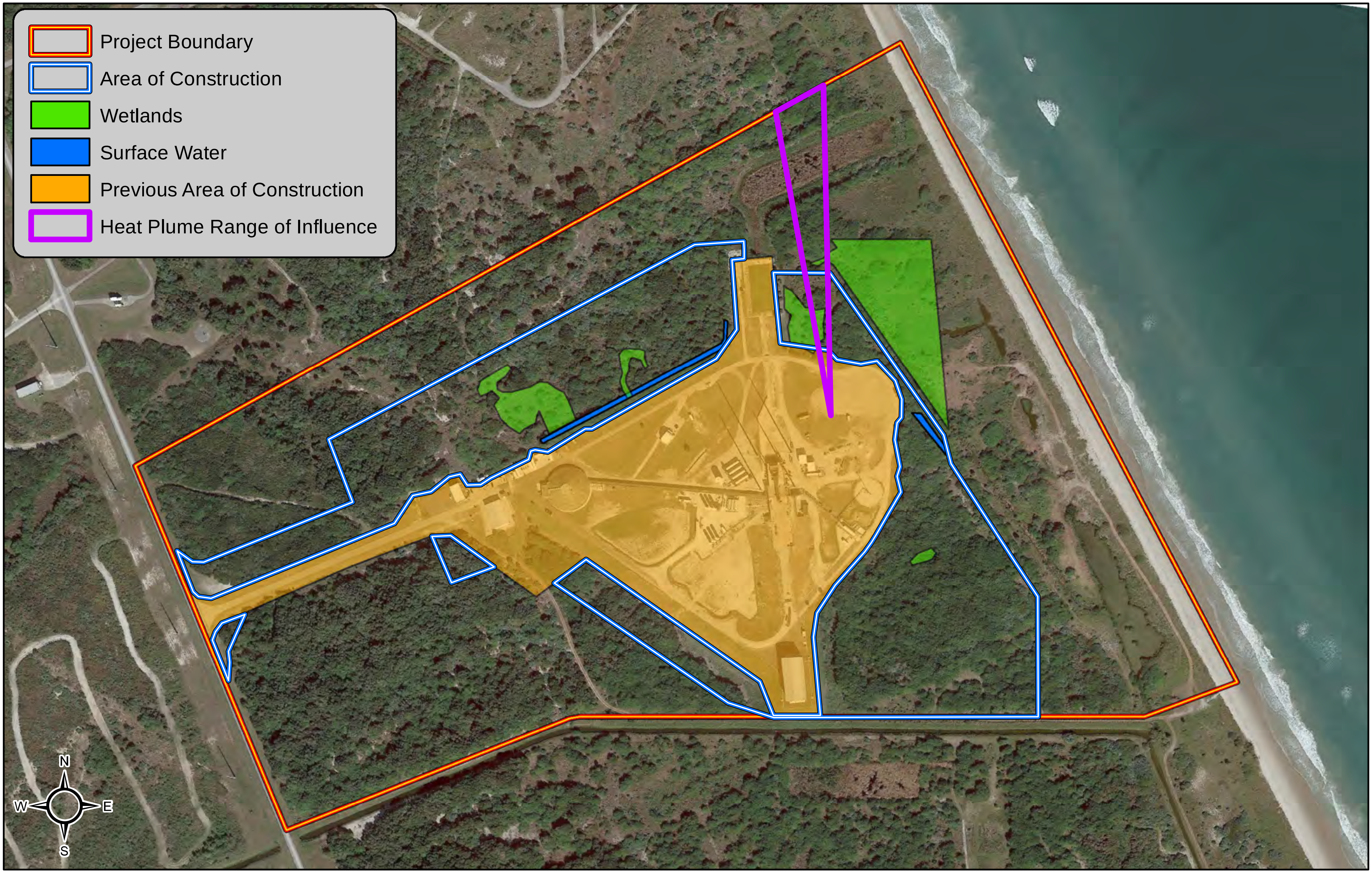
Figure 2: Location Map - Launch Complex 16

0 0.25 0.5 1 Miles

2018 Aerial, Brevard County, Florida

ATLANTIC ENVIRONMENTAL
ENVIRONMENTAL PERMITTING & MITIGATION

AE Proj #: 19352



Project: Relativity Launch Complex

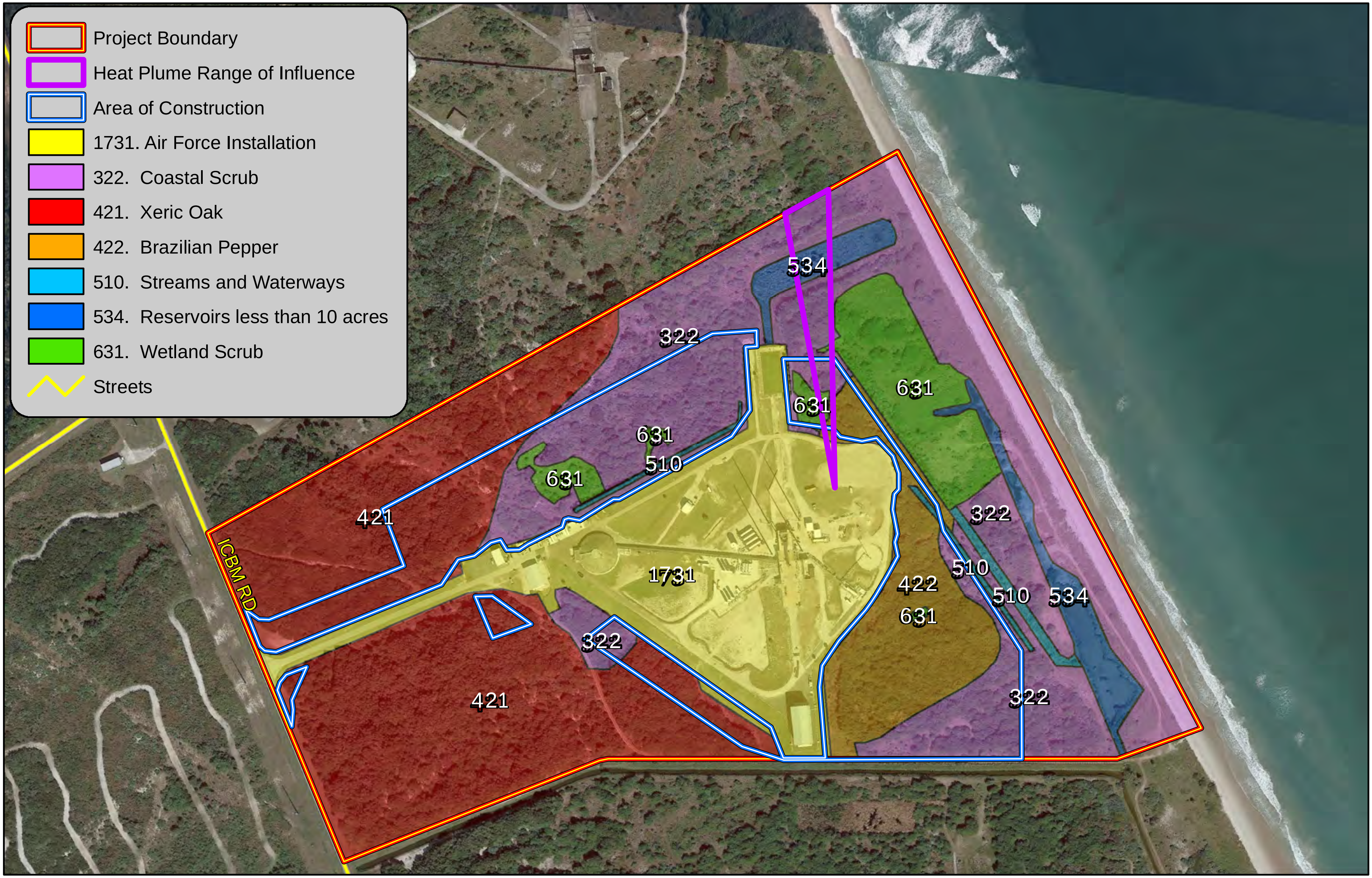
Figure 3: Wetland Map

0 250 500 1,000 Feet

2022 Aerial, Brevard County, Florida

ATLANTIC ENVIRONMENTAL
ENVIRONMENTAL PERMITTING & MITIGATION

AES Proj #: 19352



Project: Relativity Launch Complex

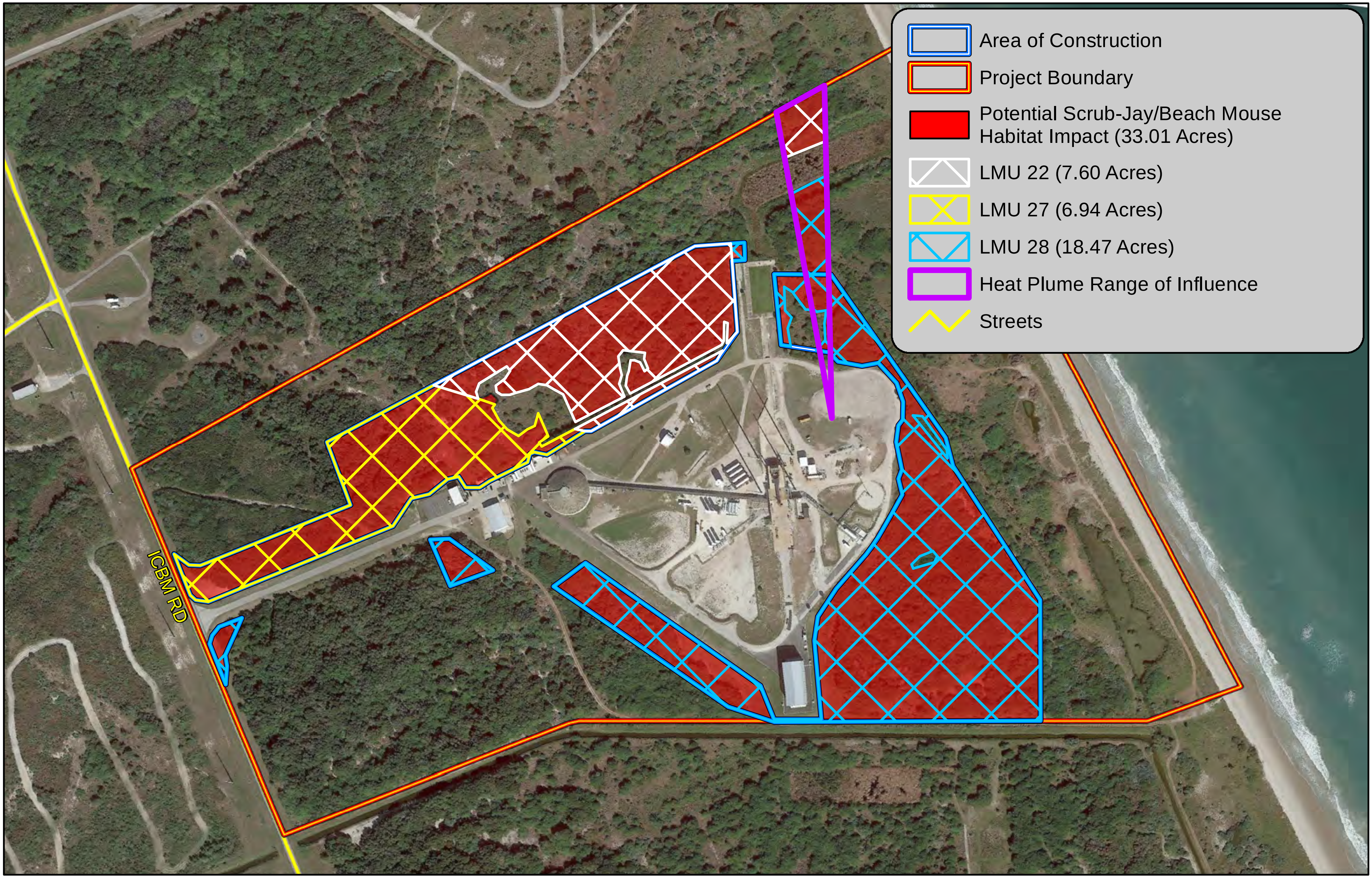
Figure 4: Land Use (FLUCFCS) Map

0 250 500 1,000 Feet

2022 Aerial, Brevard County, Florida

ATLANTIC ENVIRONMENTAL
ENVIRONMENTAL PERMITTING & MITIGATION

AES Proj #: 19352



Project: Relativity Launch Complex

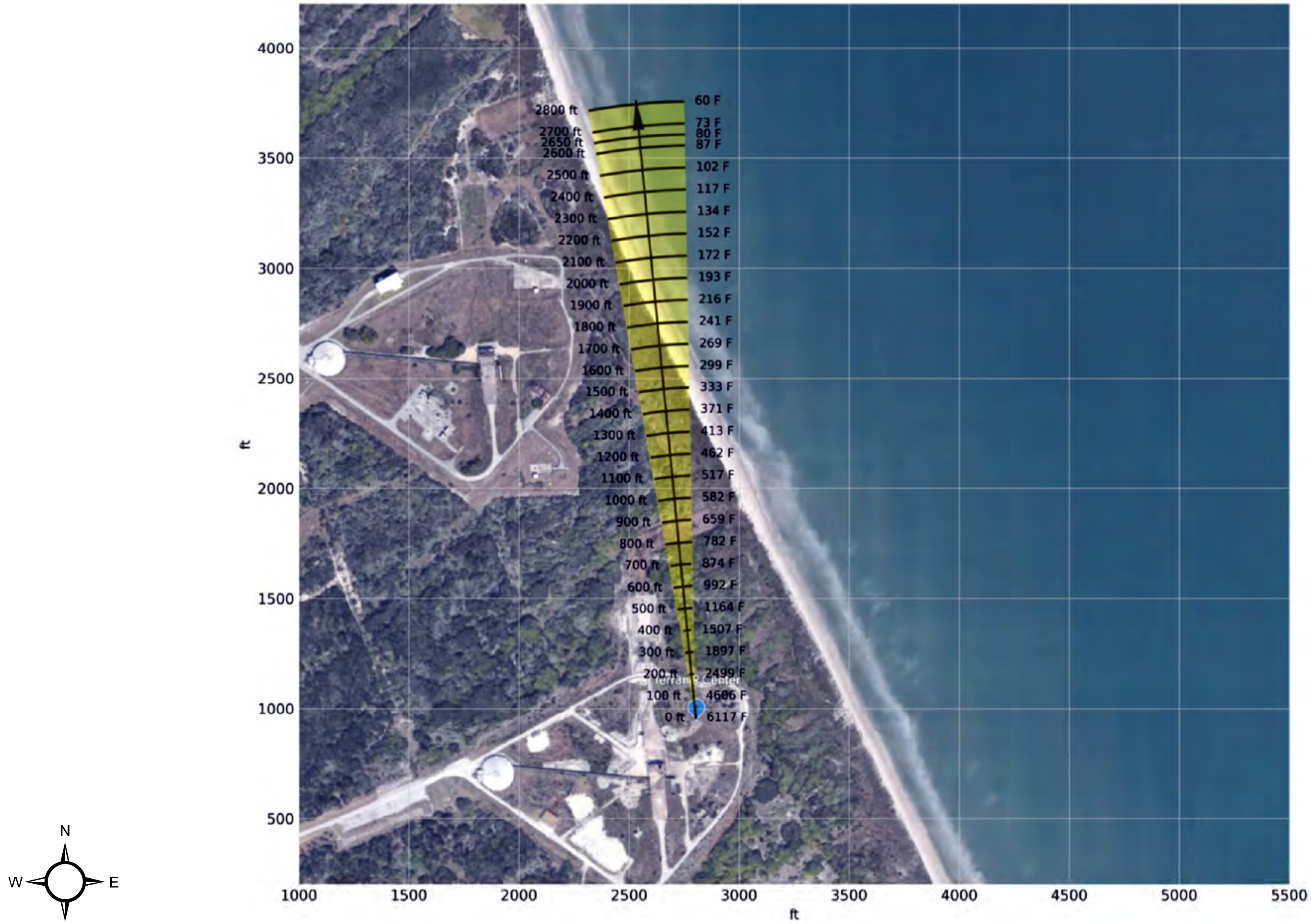
Figure 5: Potential Scrub-Jay/Beach Mouse Habitat Impact Map

0 250 500 1,000 Feet

2022 Aerial, Brevard County, Florida

ATLANTIC ENVIRONMENTAL
ENVIRONMENTAL PERMITTING & MITIGATION

AES Proj #: 19352



Source: ATA Engineering Inc.

Project: Relativity Launch Complex

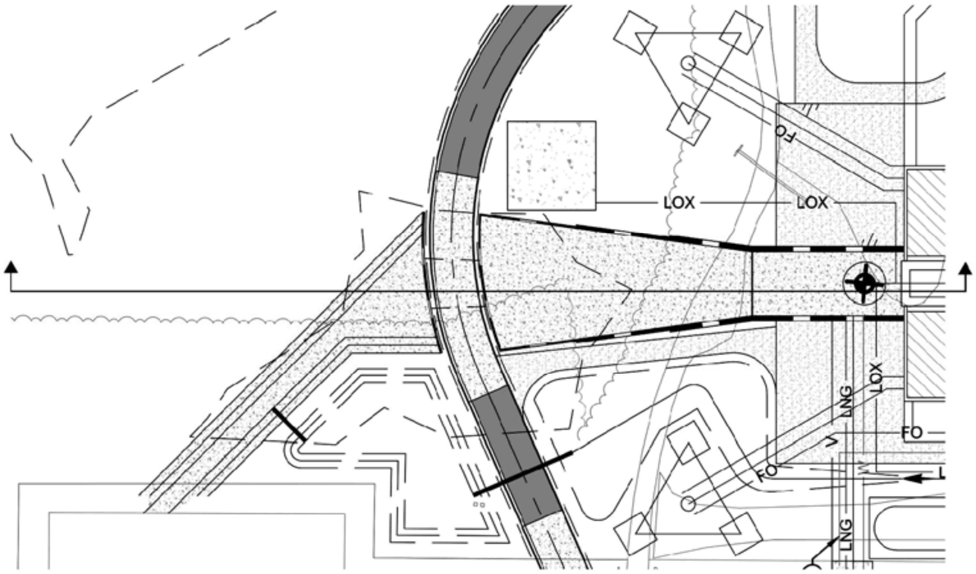
Figure 6: Heat Plume Range of Influence Map

0 125 250 500 Feet

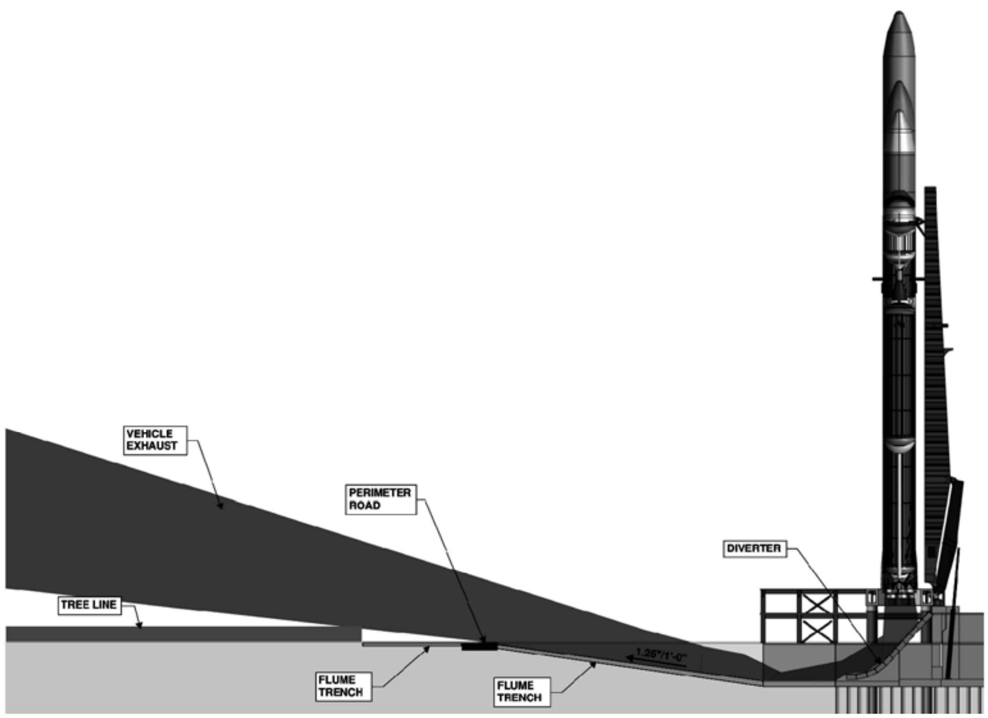
Brevard County, Florida

ATLANTIC ENVIRONMENTAL
ENVIRONMENTAL PERMITTING & MITIGATION

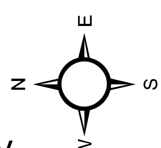
AES Proj #: 19352



PLAN VIEW



ELEVATION VIEW



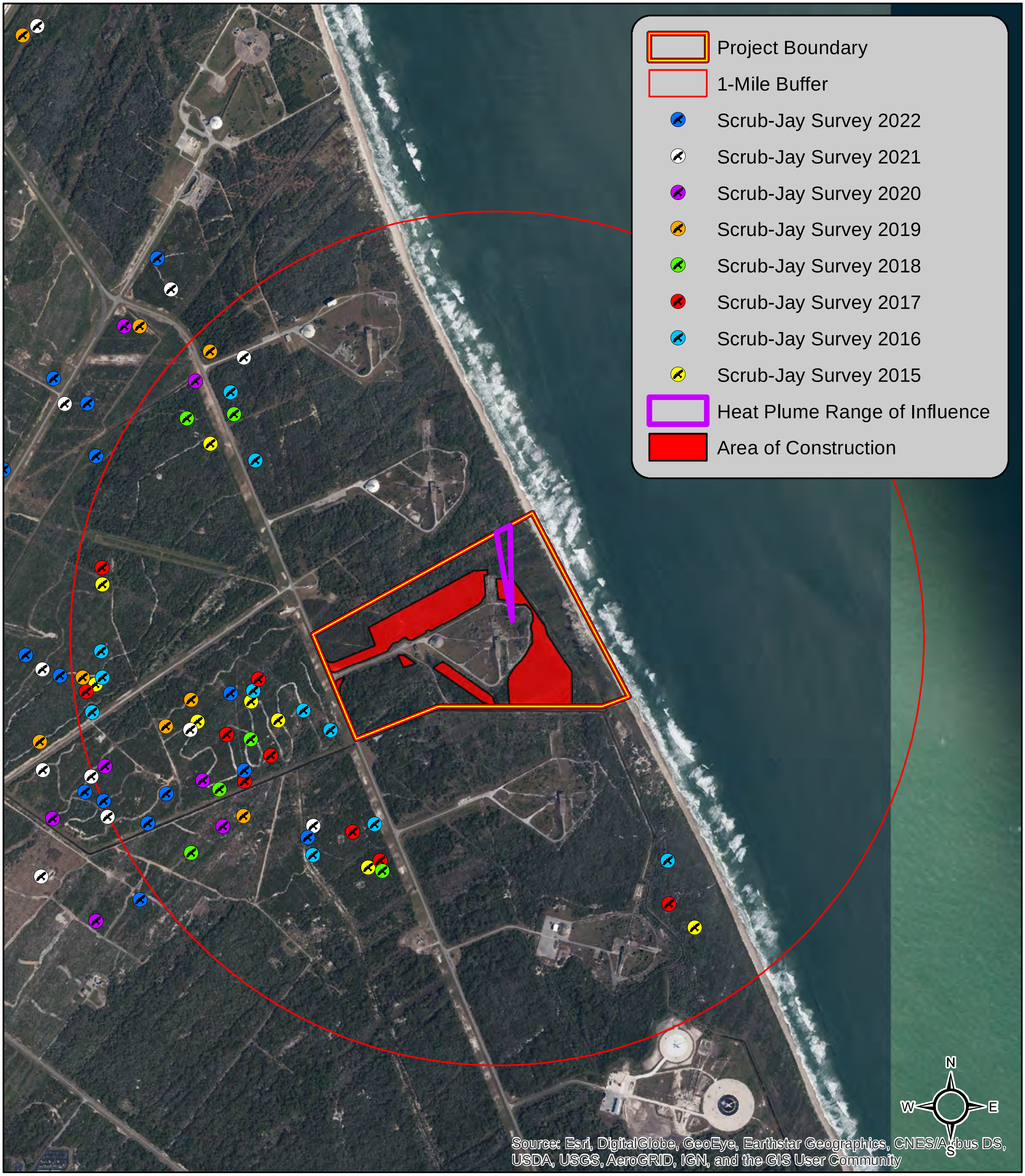
Source: Relativity

Project: Relativity Launch Complex

Figure 7: Heat Plume Plan & Elevation View

Brevard County, Florida

AES Proj #: 19352



Project: Relativity Launch Complex

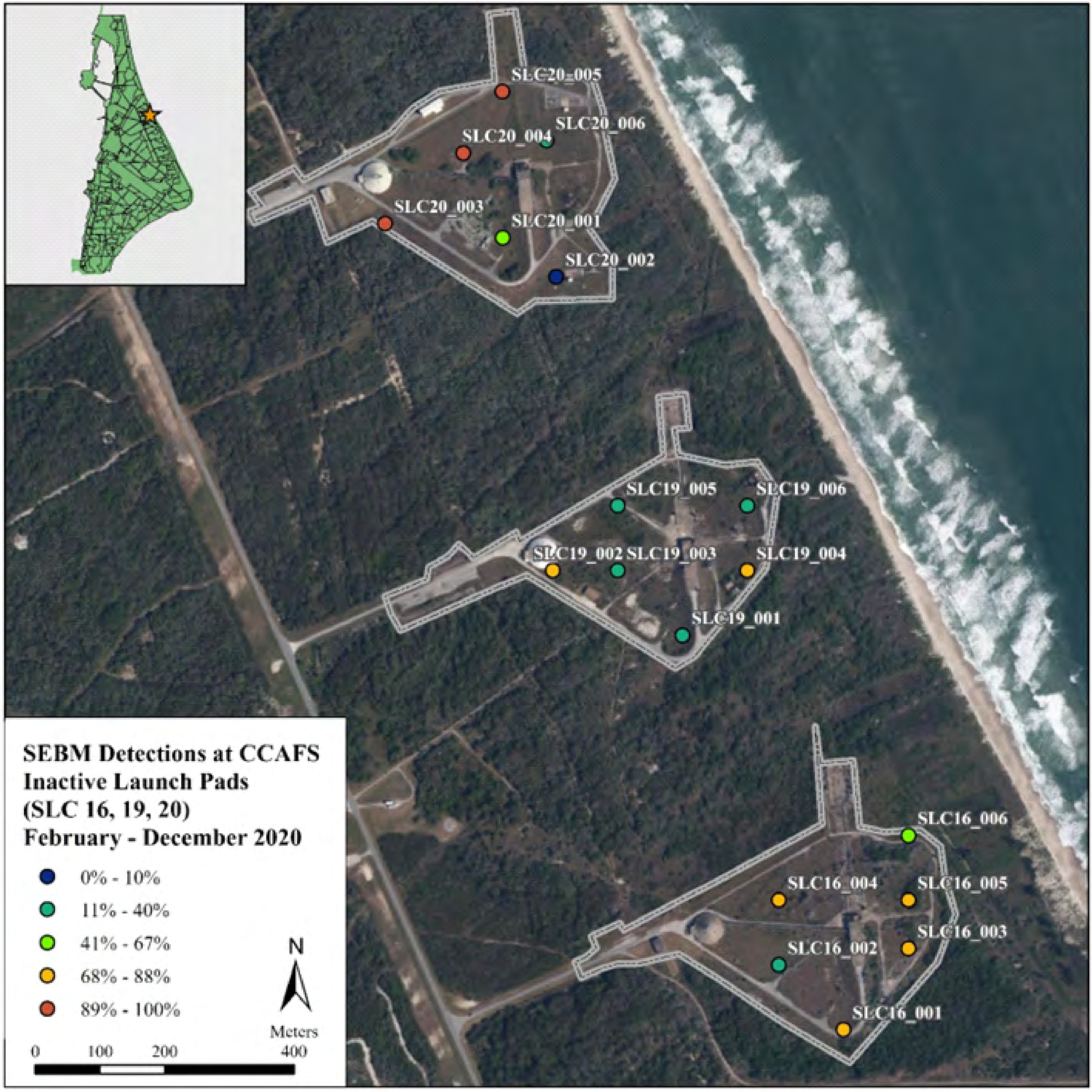
Figure 8: Florida Scrub-Jay Survey Map

0 0.25 0.5 1 Miles

2021 Aerial, Brevard County, Florida

ATLANTIC ENVIRONMENTAL
ENVIRONMENTAL PERMITTING & MITIGATION

AES Proj #: 19352



Gillikin, M., and T. Doonan. 2021. Assessing habitat restoration and management activities and benefits for Atlantic Coast beach mouse recovery through long-term monitoring. Annual Progress Report. U.S. Fish and Wildlife Service, Coastal Program.

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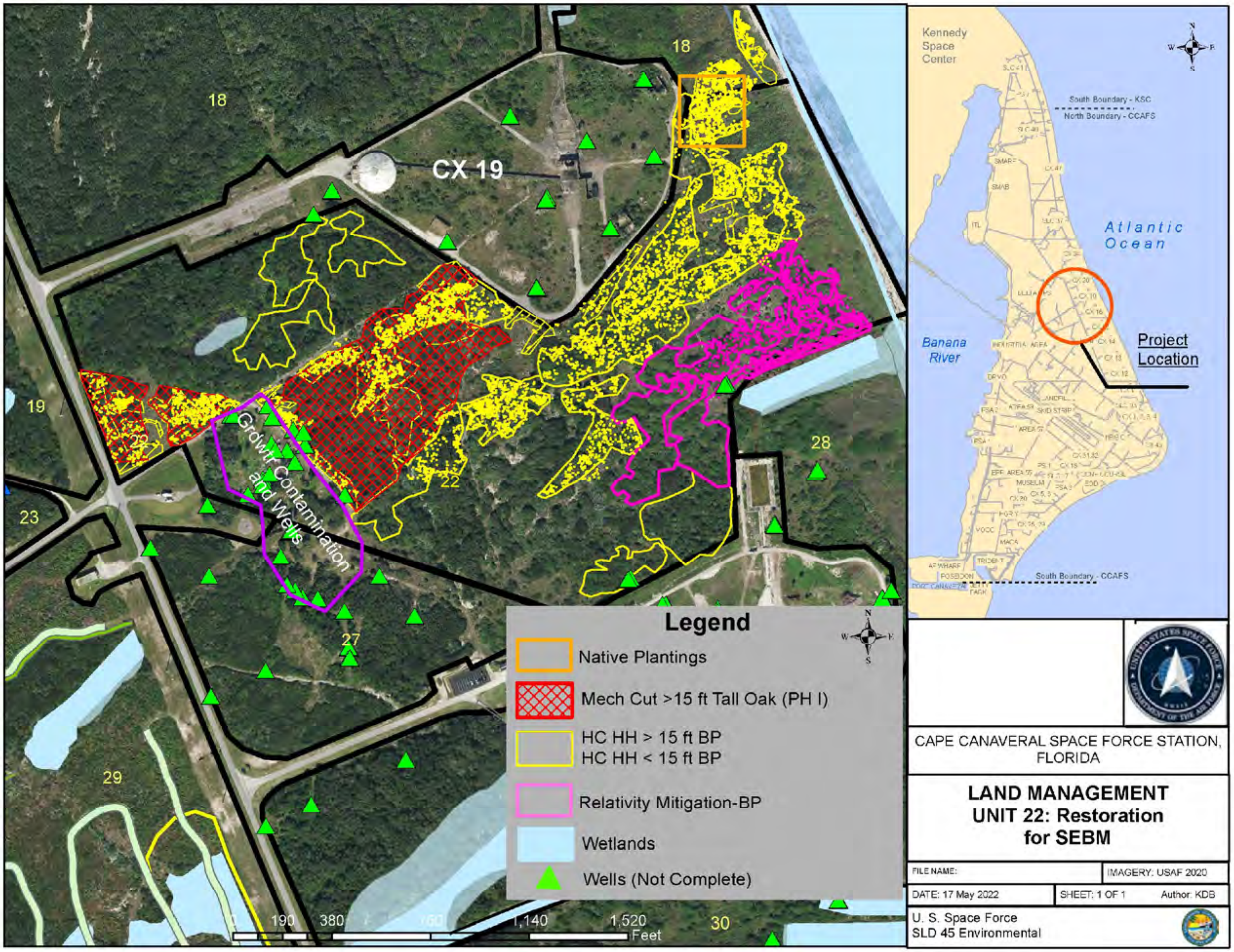
Project: Relativity Launch Complex

Figure 9: SLC 16 Detection Rates of Southeastern Beach Mice

Brevard County, Florida

ATLANTIC ENVIRONMENTAL
ENVIRONMENTAL PERMITTING & MITIGATION

AES Proj #: 19352



Project: Relativity Launch Complex

Figure 10: LMU 22 - Scrub-Jay/Beach Mouse Mitigation Area Map

2022 Aerial, Brevard County, Florida

ATLANTIC ENVIRONMENTAL
ENVIRONMENTAL PERMITTING & MITIGATION

AES Proj #: 19352

Appendix A

SLC-16 FWS Biological Opinion dated March 20, 2020

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
7915 Baymeadows Way, Suite 200
Jacksonville, FL 32256

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 – 45th 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 (*Dermocheuls coriacea*), green (*Chelona mydas*), loggerhead (*Caretta caretta*), Kemps Ridley (*Lepidochelys kempii*), and hawksbill (*Eretmochelys imbricata*), West Indian manatee (*Trichechus manatus latirostris*), Wood stork (*Myteria 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 45th 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 (*Myteria 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 (*Dermocheuls 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.

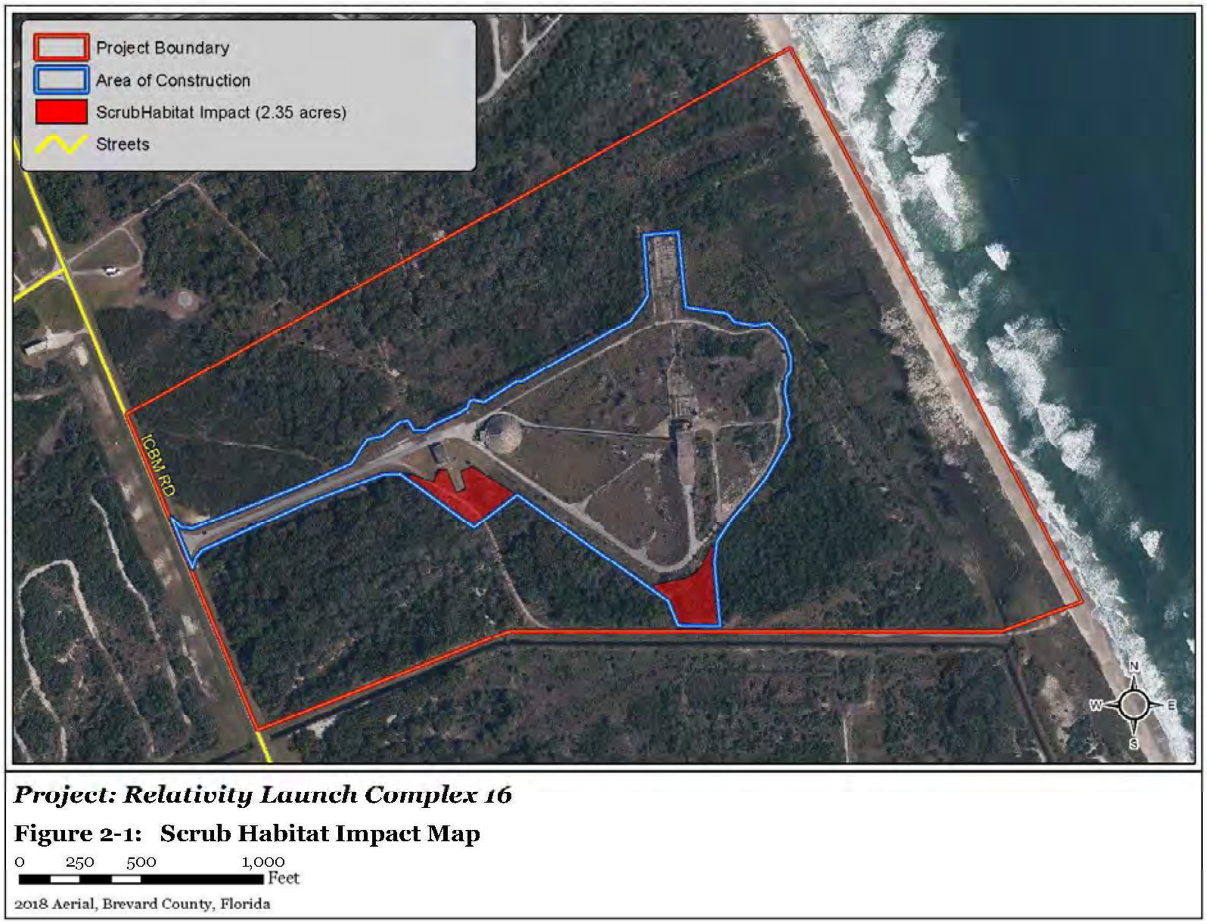

Figure 2-1. Boundary LC-16, area of construction, and proposed habitat removal

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.

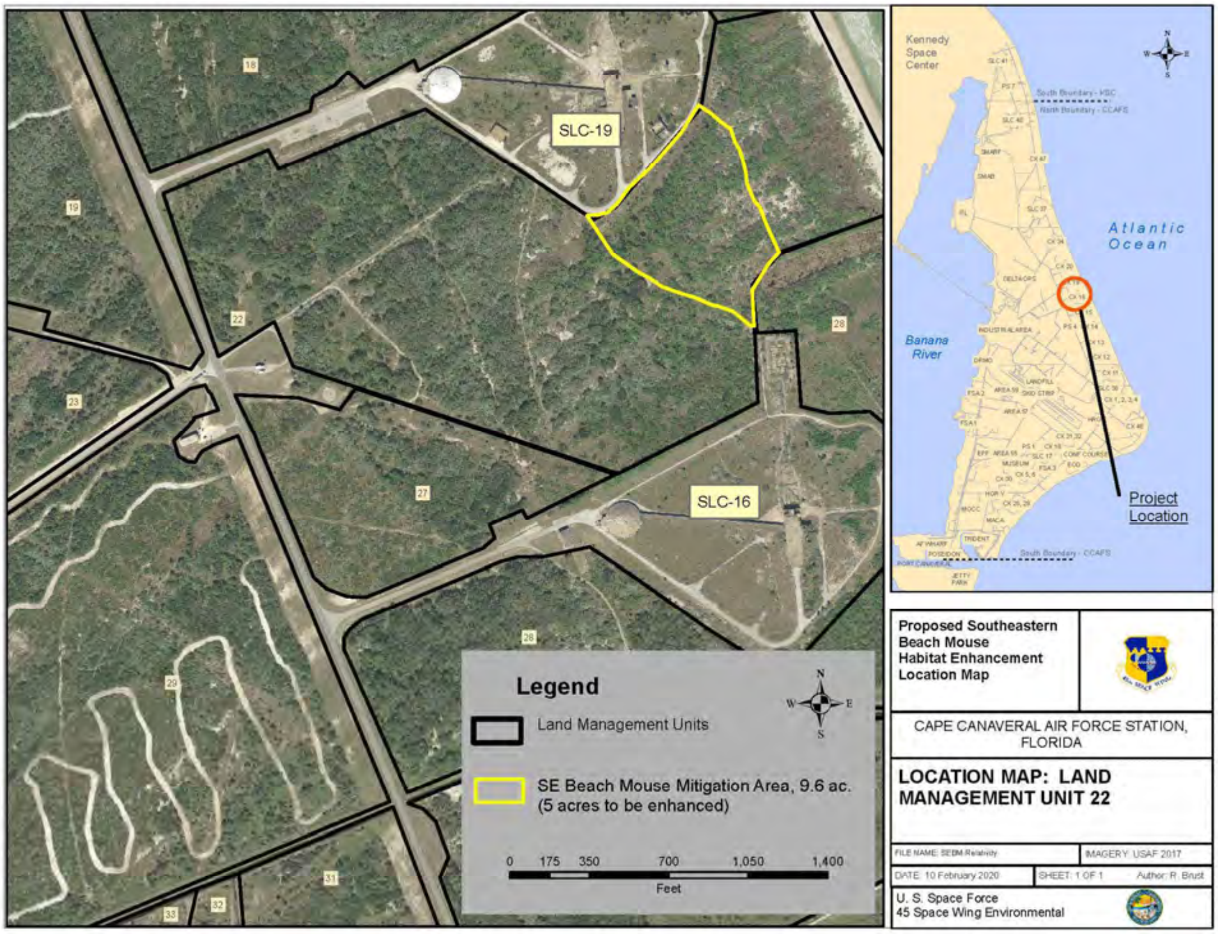

Figure 2-2. The proposed SEBM habitat enhancement area outlined yellow

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, Breininger 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).

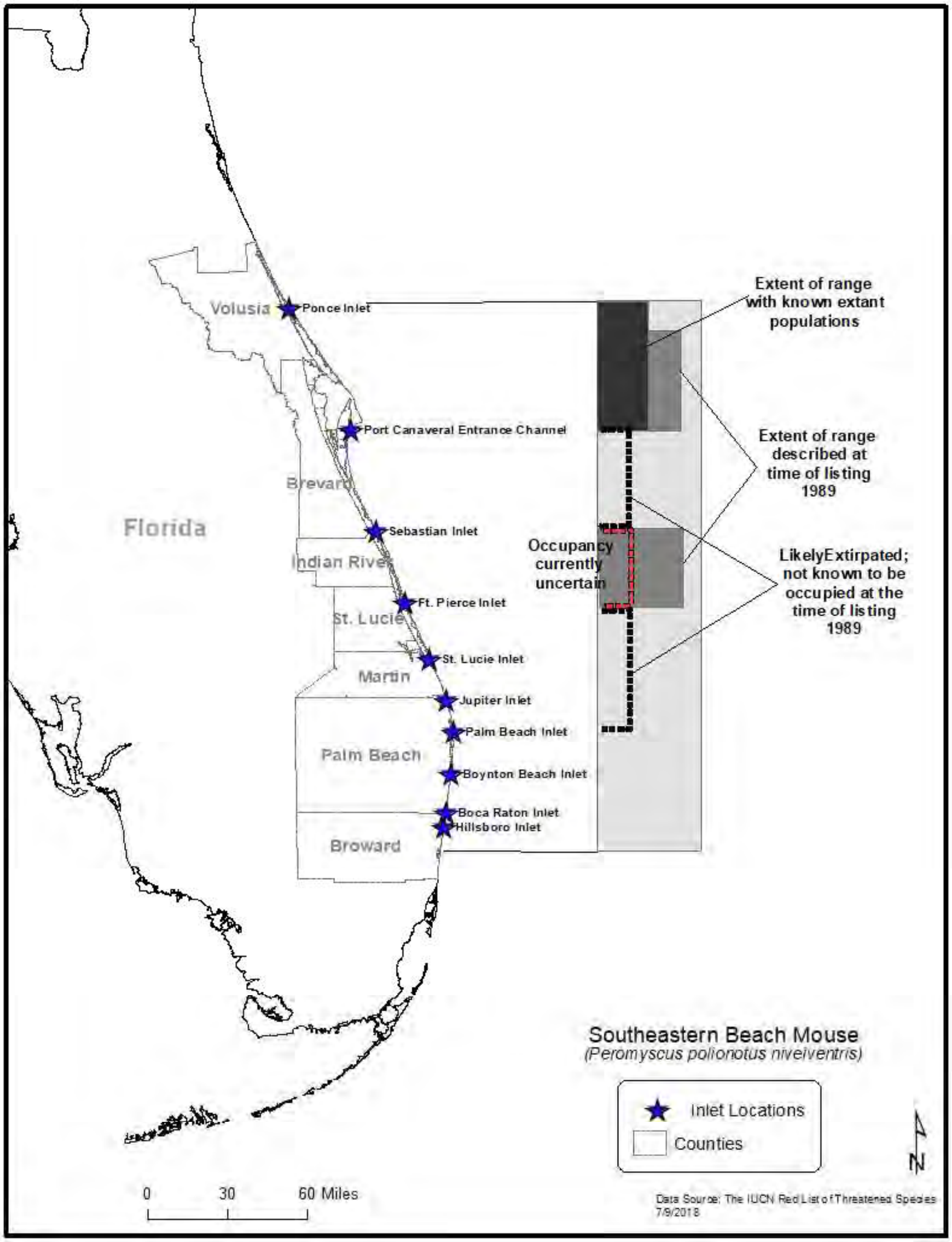

FIGURE 4.1 SEBM RANGE MAP – Extant and Likely Extirpated.

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 Chanel, 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 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 my 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 is 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 is 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 45th 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 H

USFWS Section 7 ESA Consultation

Appendix I

Cultural/Historical Consultation

Appendix I-1

Native American Tribal Government Coordination

Stephen Abille

From: JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C <taylor.janise.1@spaceforce.mil>
Sent: Tuesday, May 9, 2023 12:24 PM
To: Stephen Abille
Subject: FW: Relativity Environmental Assessment Request for Comments

Importance: High

For your Admin record.

From: PENDERS, THOMAS E CIV USSF SSC 45 CES/CEIE <thomas.penders@spaceforce.mil>
Sent: Thursday, April 27, 2023 1:28 PM
To: JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C <taylor.janise.1@spaceforce.mil>; NICELY, MEGAN E CIV USSF SSC 45 CES/CEIE-C <megan.nicely.1@spaceforce.mil>; BLAYLOCK, MICHAEL A CIV USSF HQSF 45 CES/CEIE <michael.blaylock.4@spaceforce.mil>
Subject: FW: Relativity Environmental Assessment Request for Comments
Importance: High

From: Bradley Mueller <bradleymueller@semtribe.com>
Sent: Thursday, April 27, 2023 11:52 AM
To: PENDERS, THOMAS E CIV USSF SSC 45 CES/CEIE <thomas.penders@spaceforce.mil>
Subject: [Non-DoD Source] RE: Relativity Environmental Assessment Request for Comments

SEMINOLE TRIBE OF FLORIDA
TRIBAL HISTORIC PRESERVATION OFFICE

TRIBAL HISTORIC PRESERVATION OFFICE
SEMINOLE TRIBE OF FLORIDA
30290 JOSIE BILLIE HIGHWAY
PMB 1004
CLEWISTON, FL 33440
THPO PHONE: (863) 983-6549
FAX: (863) 902-1117
THPO WEBSITE: WWW.STOFTHPO.COM

April 27, 2023

Subject: USSF - Space Launch Delta 45, Relativity Supplemental EA, Brevard County, Florida
THPO Compliance Tracking Number: 0033991

In order to expedite the THPO review process:

1. Please correspond via email and provide documents as attachments (a THPO FTP site is available for large files),
2. Please send all emails to THPOCompliance@semtribe.com,

3. Please reference the THPO Compliance Tracking Number if one has been assigned.

Dear Mr. Penders,

Thank you for contacting the Seminole Tribe of Florida – Tribal Historic Preservation Office (STOF-THPO) Compliance Section regarding the *USSF - Space Launch Delta 45, Relativity Supplemental EA, Brevard County, Florida.*

The proposed undertaking does fall within the STOF Area of Interest. We have reviewed all the additional information that you provided and completed our assessment pursuant to Section 106 of the National Historic Preservation Act (16 USC 470) as amended and its implementing regulations (36 CFR 800). We have no objections or other comments at this time. Please notify our office if any archaeological, historical, and/or burial resources are inadvertently discovered during project implementation and feel free to contact us with any questions or concerns.

Respectfully,

Bradley M. Mueller

Bradley M. Mueller, MA, Compliance Specialist
STOF-THPO, Compliance Review Section
30290 Josie Billie Hwy, PMB 1004
Clewiston, FL 33440
Fax: 863-902-1117
Email: THPOCompliance@semtribe.com

From: THPO Compliance
Sent: Thursday, April 27, 2023 11:29 AM
To: PENDERS, THOMAS E CIV USSF SSC 45 CES/CEIE <thomas.penders@spaceforce.mil>
Subject: RE: Relativity Environmental Assessment Request for Comments

Tom,

Excellent. I will send you a more formal "no objections" letter shortly.

Regards,
Bradley M.

From: PENDERS, THOMAS E CIV USSF SSC 45 CES/CEIE <thomas.penders@spaceforce.mil>
Sent: Thursday, April 27, 2023 10:46 AM
To: THPO Compliance <THPOCompliance@semtribe.com>; taylor.janice.1@spaceforce.mil
Cc: NICELY, MEGAN E CIV USSF SSC 45 CES/CEIE-C <megan.nicely.1@spaceforce.mil>; BLAYLOCK, MICHAEL A CIV USSF HQSF 45 CES/CEIE <michael.blaylock.4@spaceforce.mil>
Subject: RE: Relativity Environmental Assessment Request for Comments

The only cultural resources are the Launch Complex and the individual facilities within the launch complex. None are NRHP eligible. The surrounding area around the complex was subjected to a Phase 1 archaeological survey. No archaeological sites were documented. There are no Native American sites anywhere within the area of potential effect.

Tom Penders

From: THPO Compliance <THPOCompliance@semtribe.com>
Sent: Thursday, April 27, 2023 9:21 AM
To: PENDERS, THOMAS E CIV USSF SSC 45 CES/CEIE <thomas.penders@spaceforce.mil>; taylor.janice.1@spaceforce.mil
Cc: NICELY, MEGAN E CIV USSF SSC 45 CES/CEIE-C <megan.nicely.1@spaceforce.mil>; BLAYLOCK, MICHAEL A CIV USSF HQSF 45 CES/CEIE <michael.blaylock.4@spaceforce.mil>
Subject: [Non-DoD Source] RE: Relativity Environmental Assessment Request for Comments

SEMINOLE TRIBE OF FLORIDA
TRIBAL HISTORIC PRESERVATION OFFICE

TRIBAL HISTORIC PRESERVATION OFFICE
SEMINOLE TRIBE OF FLORIDA
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THPO WEBSITE: WWW.STOFTHPO.COM

TRIBAL HISTORIC PRESERVATION OFFICE
SEMINOLE TRIBE OF FLORIDA TRIBAL COUNCIL IN GOD WE TRUST

April 27, 2023

Subject: USSF - Space Launch Delta 45, Relativity Supplemental EA, Brevard County, Florida
THPO Compliance Tracking Number: 0033991

In order to expedite the THPO review process:

1. Please correspond via email and provide documents as attachments (a THPO FTP site is available for large files),
2. Please send all emails to THPOCompliance@semtribe.com,
3. Please reference the THPO Compliance Tracking Number if one has been assigned.

Dear Mr. Penders,

Thank you for your timely response to our request for additional information regarding the *USSF - Space Launch Delta 45, Relativity Supplemental EA, Brevard County, Florida.* We are pleased to see that the CCSFS survey is proceeding and nearing completion.

To provide some clarification: at this time we are only concerned with possible impacts to any burial resources or NRHP eligible, or potentially eligible, archaeological sites that might be located within the proposed Relativity Program expansion project area as indicated on “Figure 1” of your letter dated March 28, 2023. More specifically, our interest in archaeological sites is further limited to those that would be categorized as prehistoric and/or contact period. If this information is not currently available, we will withhold any final comments on the undertaking until we have been able to assess a final report. Please continue to consult with us on this undertaking and feel free to contact us with any questions or concerns.

Respectfully,

Bradley M. Mueller

Bradley M. Mueller, MA, Compliance Specialist
STOF-THPO, Compliance Review Section
30290 Josie Billie Hwy, PMB 1004
Clewiston, FL 33440
Fax: 863-902-1117
Email: THPOCompliance@semtribe.com

From: PENDERS, THOMAS E CIV USSF SSC 45 CES/CEIE <thomas.penders@spaceforce.mil>
Sent: Thursday, April 27, 2023 7:31 AM
To: THPO Compliance <THPOCompliance@semtribe.com>; taylor.janice.1@spaceforce.mil
Cc: NICELY, MEGAN E CIV USSF SSC 45 CES/CEIE-C <megan.nicely.1@spaceforce.mil>; BLAYLOCK, MICHAEL A CIV USSF HQSF 45 CES/CEIE <michael.blaylock.4@spaceforce.mil>
Subject: RE: Relativity Environmental Assessment Request for Comments
Importance: High

Brad,

The SLD 45 cultural resources management program has been systematically surveying CCSFS (PSFB was completed 5 years ago) for both archaeological sites and historic properties that includes the proposed construction areas. At this time we are awaiting reports from Wood PLC for the south half of CCSFS. Once their report is submitted (EOY 2023) all of CCSFS will have been surveyed for both sites and properties. We are also systematically having the historic properties being documented using high definition 3-D laser scanning ahead of the potential loss from climate change and sea level rise. We have also partnered with the Department of Anthropology at the University of Central Florida to create the Cape Canaveral Archaeological Mitigation Project. The purpose of CCAMP is to return to all the NRHP eligible sites and sites with known human remains and resurveying them to correct errors in boundaries and correct deficiencies in previous investigations. The other purpose is to mitigate the adverse effects from sea level rise and climate change ahead of significant damage from erosion, etc. I consulted with your office in 2016 regarding CCAMP. We still have at least 5 years to go on CCAMP. All the changes in boundaries, etc are being entered into our GIS system. As we complete surveys we will send copies for your review. We are behind on getting reports completed due to COVID.

If you wish a list of the surveys/references I can provide them to you.

v/r

Tom Penders

From: THPO Compliance <THPOCompliance@semtribe.com>
Sent: Wednesday, April 26, 2023 3:08 PM
To: taylor.janice.1@spaceforce.mil
Cc: PENDERS, THOMAS E CIV USSF SSC 45 CES/CEIE <thomas.penders@spaceforce.mil>
Subject: [Non-DoD Source] RE: Relativity Environmental Assessment Request for Comments

SEMINOLE TRIBE OF FLORIDA
TRIBAL HISTORIC PRESERVATION OFFICE

TRIBAL HISTORIC
PRESERVATION OFFICE

SEMINOLE TRIBE OF FLORIDA

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CLEWISTON, FL 33440

THPO PHONE: (863) 983-6549
FAX: (863) 902-1117

THPO WEBSITE: WWW.STOFTHPO.COM

April 26, 2023

Ms. Taylor Janice
45 CES/CEIE
1224 Jupiter Street
Mail Stop 9125
Patrick Space Force Base, Florida 32925
Phone: n/a
Email: taylor.janice.1@spaceforce.mil

Subject: USSF - Space Launch Delta 45, Relativity Supplemental EA, Brevard County, Florida
THPO Compliance Tracking Number: 0033991

In order to expedite the THPO review process:

1. Please correspond via email and provide documents as attachments (a THPO FTP site is available for large files),
2. Please send all emails to THPOCompliance@semtribe.com,
3. Please reference the THPO Compliance Tracking Number if one has been assigned.

Dear Ms. Janice,

Thank you for contacting the Seminole Tribe of Florida – Tribal Historic Preservation Office (STOF-THPO) Compliance Section regarding the *USSF - Space Launch Delta 45, Relativity Supplemental EA, Brevard County, Florida.*

The proposed undertaking does fall within the STOF Area of Interest. We have reviewed the documents that you provided pursuant to Section 106 of the National Historic Preservation Act and its implementing authority, 36 CFR 800. In order for us to complete our review we would like to request the following additional information:

- Does the proposed new construction occur within an area of potential effect that has been previously surveyed for cultural resources/historic properties, and

- If the proposed new construction does occur within and area that has been previously surveyed for cultural resources/historic properties, what were the results of that survey.

We look forward to the delivery of the additional information requested. Please continue to consult with our office and feel free to contact us with any questions or concerns.

Very Respectfully,

Bradley M. Mueller

Bradley M. Mueller, MA, Compliance Specialist
STOF-THPO, Compliance Review Section
30290 Josie Billie Hwy, PMB 1004
Clewiston, FL 33440
Fax: 863-902-1117
Email: bradleymueller@semtribe.com

From: Paul Backhouse <PaulBackhouse@semtribe.com>
Sent: Tuesday, April 4, 2023 9:30 AM
To: THPO Compliance <THPOCompliance@semtribe.com>
Cc: Juan Cancel <JuanCancel@semtribe.com>
Subject: Fwd: Relativity Environmental Assessment Request for Comments

Paul N. Backhouse, Ph.D., RPA

Senior Director, Heritage and Environment Resources Office and Tribal Historic Preservation Officer

---

From: PENDERS, THOMAS E CIV USSF SSC 45 CES/CEIE <thomas.penders@spaceforce.mil>
Sent: Tuesday, April 4, 2023 7:37:34 AM
To: Paul Backhouse <PaulBackhouse@semtribe.com>; Juan Cancel <JuanCancel@semtribe.com>
Cc: BLAYLOCK, MICHAEL A CIV USSF HQSF 45 CES/CEIE <michael.blaylock.4@spaceforce.mil>; NICELY, MEGAN E CIV USSF SSC 45 CES/CEIE-C <megan.nicely.1@spaceforce.mil>
Subject: Relativity Environmental Assessment Request for Comments

Good Morning,

The Space Launch Delta 45 of the United States Space Force requests your comments and concurrence for the attached supplemental environmental assessment.

v/r

Tom Penders

Appendix I-2

Sections 106 and 110 National Historic Preservation Act of 1966 Consultation Documentation

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

06 July 2023

MEMORANDUM FOR THE STATE HISTORIC PRESERVATION OFFICER
ATTENTION: MS. ALISSA SLADE LOTANE
FLORIDA STATE HISTORIC PRESERVATION OFFICE
R.A. GRAY BUILDING, 4TH FLOOR
500 SOUTH BRONOUGH STREET
TALLAHASSEE, FLORIDA 32399

FROM: 45 CES/CEIE-C
1224 Jupiter Street
Patrick AFB FL 32925-3343

SUBJECT: Additional Information on Reuse of Launch Complex 16 (LC-16), Cape Canaveral Space Force Station, Brevard County, Florida

1. The Space Launch Delta (SLD 45) had originally consulted with your office in 2019 and 2020 regarding the reuse of LC-16 (FDHR Project Nos. 2019-5052, 2019-5052-B, and 2019-5052).

2. Since the initial consultations additional information has been provided to the SLD 45 by the launch customer Relativity regarding impacts from sound. These impacts will affect the National Historic Landmark launch complexes LC-14, LC-19 and LC-34. It will also affect the blockhouse at LC-16, which is eligible for the National Register of Historic Places (NRHP) (Exhibit A).

3. A nose and vibration study was conducted for operations at LC-16 (Exhibit B), and it was determined that the affects would be minor and no different in impacts from similar operations occurring at other nearby active launch complexes.

4. While there will be no adverse effect to NRHP eligible or listed cultural resources, our position is that they have been adequately documented and any future adverse effects have been mitigated through the following actions:

a. Previous surveys documenting the facilities were submitted to the Florida SHPO for review and have been entered into the FMSF. All these survey reports are on file at the FMSF.

b. The SLD 45 has completed FMSF *Historic Structure Forms* for the facilities within the affected area which are on file at the FMSF.

c. The SLD 45 has submitted to the Florida SHPO historic photographs for all the cultural resources within the APE acquired from the Brevard County Historic Commission archives, Florida Historical Society archives, National Archives and Records Administration, and/or the SLD 45 History Office in electronic format, which are on file at the FMSF.

d. The SLD 45 has completed a HAERs of LC-14, 19 and 34 which are on file with the National Park Service and the FMSF.

e. The SLD 45 has submitted to the Florida SHPO electronic copies of all original construction drawings (as-builts) as well as subsequent drawings showing modifications to the facilities within the APE for the past 50+ years, which are on file at the FMSF.

f. The Air Force Space and Missile Museum maintains an archive of hard copies of all as-built drawings for facilities on CCSFS and includes these facilities.

g. The SLD 45 has created an electronic database that includes all of the data mentioned above. Furthermore, hard copies and electronic copies are maintained by the SLD 45 at CCSFS. Historic photographs are also archived at the SLD 45 History Office.

h. Launch Complexes 14, 19 and 34 were monitored and documented using high definition 3-D laser scanning for five years as part of an unrelated study to survey long-term degradation of historic launch complexes at CCSFS. Launch Complex 16 was also documented.

i. The SLD 45 in conjunction with the University of South Florida has created public access virtual tours and on-line documentation of the launch complexes (Exhibit C).

5. This consultation is being submitted in accordance with Section 106 of the National Historic Preservation Act and 36 CFR 800.

6. Point of contact for this matter is Tom Penders at 321-307-0075, or e-mail, Thomas.Penders@spaceforce.mil.

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

Enclosures:
as stated

cc:

National Historic Landmark Program, NPS

EXHIBIT A:

AREA OF POTENTIAL EFFECT

N

Source: National Register of Historic Places (NRHP) listings downloaded from National Park Service (NPS) GIS Database

Note: Only structures within 1:1000 claims boundary shown.

NRHP Eligible structures provided by Florida Division of Historical Resources Master Site File by email on June 1, 2023.

0 1 2 4 Miles

Legend

- Launch Location
- National Register of Historic Places (NRHP) Listed Structures
- NRHP Eligible Structures
- 1:1,000 claims
- 1:100 claims
- Area Potentially Damaging to Structures (≥ 130 dB Lmax)

EXHIBIT B:

SOUND STUDY

EXHIBIT C:

LINKS TO RESOURCES

Links to online applications, tools, and resources developed from this project:

1. WEBSITE VIRTUAL TOUR: Cape Canaveral Space History: A Virtual Tour – this tour includes 360 imagery, embedded 3D models and graphics, overview interactive map, animations and videography, and historic video linked content. The tour is optimized for viewing with virtual reality headsets or can be used on desktop and mobile devices. The tour is additive, and as new locations or updates become available; these can be incorporated into the tour. The tour is archived with the University of South Florida Libraries.
URL: https://arcweb.forest.usf.edu/dhhc/CCSFSLaunchComplexTour/
2. VIDEO: Web GIS Instructions for Cape Canaveral Cemeteries Project: https://vimeo.com/395883345
3. Web mapping tool – installation-wide, but with launch complex specific data added. Includes processed DSM from LiDAR, TLS data, historic imagery, and other relevant layers. URL: https://arcg.is/1qGb1T
4. Web mapping tool- specific for the Launch Complex 1-4 and Bomarc areas, includes processed TLS and aerial LiDAR DSMs, topobathymetric LiDAR DSM and hillshade, and historic aerial imagery. URL: https://arcg.is/195Cfa
5. Movie docushort (12:00) – Our Last Chance: Preserving Cape Canaveral. This award-winning movie short features interviews with the SLD45 CRM and Principal Investigators. Showcases 3D animations and on-site videography to tell the story of preservation and 3D documentation at Cape Canaveral. URL: https://vimeo.com/365904796 ; movie also available through the virtual tour as an embedded view option.
6. Movie promo for the docushort (:30) – URL: https://vimeo.com/364819939
7. Movie award announcement (:07) - Our Last Chance Award Announces: URL - https://vimeo.com/506209189
8. 3D Model Collections (all are in 3D, and are VR and AR optimized, some annotated)
   a. US Space Force Architecture: https://skfb.ly/osoGU
   b. Cape Canaveral Archaeology: https://skfb.ly/6GIKA
   c. Cape Canaveral Historic Launch Complexes: https://skfb.ly/6WCNJ
   d. Cape Canaveral Historic Cemeteries: https://skfb.ly/6YzFU
9. Animations from 3D models and point cloud fly-through visualizations:
   a. Theodolite at LC19: https://vimeo.com/173124996
   b. Mercury 7 Memorial: https://vimeo.com/672105759
   c. 3D Point Cloud of Mercury 7 Memorial: https://vimeo.com/671267269
   d. 3D Point Cloud of Beehive Blockhouse: https://vimeo.com/667346946
   e. 3D Point Cloud of Blast Wall at LC14: https://vimeo.com/667342845
   f. 3D Point Cloud of Launch Complex 21 - 22 Blockhouse: https://vimeo.com/667341090
   g. 3D Point Cloud of Launch Complex 14 Launch Pad: https://vimeo.com/667339198
   h. Documenting Launch Complex 19 in 3D: https://vimeo.com/665281876
   i. Point Cloud Animation of the Launch Pedestal at Complex 9 Launch Pad: https://vimeo.com/664984307
   j. Point Cloud Animation of the Navaho Blockhouse at Launch Complex 9 -10, Cape Canaveral: https://vimeo.com/664982391
   k. Point Cloud Animation of Blockhouse at Launch Complex 14, Cape Canaveral: https://vimeo.com/664980067
   l. Point Cloud Animation of Blockhouse 32 at Launch Complex 31-32, Cape Canaveral Space Force Station: https://vimeo.com/664970385
   m. Point Cloud Animation of Area 55, Cape Canaveral: https://vimeo.com/664969036
   n. Point Cloud Animation of Area 55, Cape Canaveral: https://vimeo.com/664963469

o. Point Cloud Animation for Building 49800: https://vimeo.com/664848781
p. 3D Model from Laser Scanning of Building 49800, Cape Canaveral: https://vimeo.com/664845780
q. Animation of Surface Elevation Consideration at Launch Complex 14: https://vimeo.com/664838842
r. Point Cloud Animation of the Bomarc Building: https://vimeo.com/664834879
s. Point Cloud Animation of Blockhouse 3-4: https://vimeo.com/664832569
t. Point Cloud Animation of Blockhouse 1-2: https://vimeo.com/664830276

10. LC 34 Comparative LiDAR swipe map (useful for examining vegetation and land feature change): https://usfaist.maps.arcgis.com/apps/CEWebViewer/viewer.html?3dWebScene=23eb2cec5ef448d097815446f5ab42a9
11. LC 19 Comparative LiDAR map (vegetation and land feature change): https://usfaist.maps.arcgis.com/apps/CEWebViewer/viewer.html?3dWebScene=5e938ff98c954c558939432529dbb071
12. Storymap virtual tour tool of 3D models: https://arcg.is/uSGmW
13. Storymap showing launch complexes, information, images, and 3D models: https://skfb.ly/orI8I
14. Gigapixel imagery from Blockhouse 34: http://gigapan.com/gigapans/177982
15. Gigapixel from LC19: http://gigapan.com/gigapans/177977
16. Gigapixel from LC19 pad area: http://gigapan.com/gigapans/177976

Web Pages and Content:

1. Cape Canaveral Historic Cemeteries: https://dhhc.lib.usf.edu/project/cape-canaveral-space-force-station-historic-cemetery-tour/
2. Cape Canaveral 3D Space History: https://dhhc.lib.usf.edu/project/cape-canaveral/
3. USF Libraries Digital Collection for Cape Canaveral: https://digital.lib.usf.edu/cape-canaveral-3d
4. Project Website: https://dhhc.lib.usf.edu/project/cape-canaveral-tour/
5. Open Heritage Site: https://openheritage3d.org/project.php?id=kz88-9d21
6. Google/Science Friday Feature Site (National): https://earth.google.com/web/@34.7325599,-94.20828246,312.18513029a,12000000d,35y,0h,0t,0r/data=CjASLhIgY2UzNDZlZDk4OGE0MTFlOWE5YzRlNTE3YzEyYmU4YmYiCnZveV9zcGxhc2g

News Items:

1. VIDEO: Space Age Technology Preserves Space History https://vimeo.com/173126179
2. USF ARTICLE : https://lib.usf.edu/news/our-last-chance-preserving-cape-canaveral/
3. USF ARTICLE : https://lib.usf.edu/news/awards-season-celebrates-cape-canaveral-docu-short/
4. VIDEO: https://lib.usf.edu/news/our-last-chance-preserving-cape-canaveral/
5. USF ARTICLE : https://lib.usf.edu/news/science-friday-celebrates-apollo-missions-50th-anniversary/
6. RADIO (National) and Web Content: https://www.sciencefriday.com/segments/uncovering-artifacts-and-archaeological-finds-with-lasers/
7. USF ARTICLE : https://lib.usf.edu/news/preserving-heritage-providing-open-access/
8. TV News (National): https://www.foxnews.com/science/florida-researchers-preserve-eroding-historic-launch-pads-along-space-coast
9. PRINT : https://lib.usf.edu/news/exploring-the-past-virtually/
10. RADIO and WEB: https://wusfnews.wusf.usf.edu/university-beat/2014-06-25/preserving-history-through-3-d-imaging
11. PRINT : https://www.tampabay.com/tampa/university-of-south-florida-researchers-document-cape-canaveral-launch-complexes-before-they-slip-into-the-sea-20190729/

12. RADIO (National) : https://www.sciencefriday.com/articles/nasa-launchpads-climate-change/
13. RADIO (National) : https://www.sciencefriday.com/segments/apollo-anniversary/
14. PRINT and WEB (National) : https://mashable.com/article/google-open-heritage-historical-sites-3d-rendering
15. RADIO (National) : https://www.sciencefriday.com/articles/the-best-of-science-friday-2019/
16. TV: https://www.fox5atlanta.com/news/usf-team-uses-laser-scanning-to-preserve-historic-cape-canaveral-launch-sites
17. Radio (CBC- Canada): https://www.cbc.ca/radio/spark/3d-archaeology-mapping-the-sounds-of-byzantine-churches-and-analyzing-yearbook-photo-smiles-1.3906947/preserving-historical-sites-in-3d-1.3907343
18. PRINT : https://issuu.com/usfucm/docs/usf-magazine-summer-2019-digital/14
19. PRINT : https://www.digitaltrends.com/cool-tech/preserving-the-history-of-apollo-11-on-earth-and-in-space/
20. PRINT : https://blog.lidarnews.com/usf-preserving-cape-canaveral-launch-complexes-3d/
21. TV: https://www.wesh.com/article/usf-researchers-preserve-cape-canaverals-history/3809622
22. PRINT : https://www.afcec.af.mil/News/Article-Display/Article/871472/air-force-cultural-resources-team-preserves-history-with-lasers/

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*, or at 850.245.6333 or 800.847.7278.

Sincerely,

Jason Aldridge
For

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

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

April 17, 2020

RE: DHR Project File No.: 2019-5052-B
Comments Concerning the Proposed Reuse of Launch Complex 16 (LC-16)
Cape Canaveral Air Force Station, Brevard County, Florida

Mr. Blaylock:

Please note that in our letter dated September 12, 2019, the finding of No Adverse Effect was for the following undertakings as described in Section 3.1 of your submittal:

- Lease of LC-16 by a non-Federal entity.
- Repair/upgrade existing roads and pads.
- Construction of new fences around the complex.
- Demolition of non-essential facilities.
- Reuse of existing launch pad.
- Reuse of the Facility 13122: LC-16 Blockhouse (8BR2322) as a launch building (Figures A-3 and A-4, Exhibit A).
- Repair and upgrade Facility 13122: LC-16 Blockhouse (8BR2322) (c.f. pressure wash and paint exterior, repair damaged concrete, repair/replace doors, repair periscopes, etc.) while maintaining the integrity.
- Upgrade utilities.

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

Sincerely,

Jason Aldridge
For

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

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

June 5, 2020

RE: DHR Project File No.: 2019-5052-C
Comments Concerning the Proposed Reuse of Launch Complex 16 (LC-16)
Cape Canaveral Air Force Station, Brevard County, Florida

Mr. Blaylock:

Please note that in our letters dated September 12, 2019 and April 17, 2020, the finding of No Adverse Effect was for the undertakings as described in Section 3.1 of your submittal and includes the physical launches of the Terran 1 Space vehicles and their paths.

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

Sincerely,

Jason Aldridge
For

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

Appendix J

Public Notice and Comments

Appendix J-1

Early Floodplain/Wetland Notice in Florida Today

Homeless tent cities being banned across US

Experts predict more people will be on streets as housing costs rise

Claire Thornton
USA TODAY

As the number of people experiencing homelessness increases across the country, more cities and states have passed laws making it illegal to live out of tents and cars or sleep in public spaces.

More than 100 jurisdictions have had such bans on the books for years, according to the National Homelessness Law Center. In recent months, high-profile measures have been approved targeting homelessness in many western U.S. cities and across entire states.

Federal data shows 582,462 people were experiencing homelessness on a single night in January 2022. Experts warn more people will enter homelessness as housing costs increase, as has been the case for decades in cities such as New York and in much of California.

If visible, unsheltered homelessness continues to grow, city leaders will have an easier time passing measures advocates say criminalize basic needs such as sleep and sheltering oneself, Eric Tars, legal director for the National Homelessness Law Center, told USA TODAY.

"The danger is that the worse the housing situation gets, the more people we see on the streets, the more will be the push for these punitive policies," Tars said.

These states and cities have passed laws making it illegal to live in tents or sleep on public property:

Missouri bans sleeping in parks

On Jan. 1, a statewide ban on sleeping on state-owned land took effect in Missouri, making it a misdemeanor to sleep in public spaces such as parks or under bridges.

Experts say Missouri's law is concerning because it covers the state and adds pressure on top of municipal bans.

It's wrong to assume people experiencing homelessness can just leave and go to another state, Tars said.

People have an "assumption" that "homeless people are infinitely mobile and they'll go somewhere else," Tars said. "But most people, contrary to this notion of vagrancy and transience, are homeless in the community where they were once housed."

Missouri's law also restricts state funding for permanent housing, a model taken from template legislation created by the conservative Cicero Institute, according to the Pew Research Center.

"To take funding away from housing that has the appropriate resources attached to it is devastating, problematic and perpetuates the issue of homelessness," said Kathy Connors, executive director of Gateway180 shelter in St. Louis. She added that people experiencing homelessness who are displaced from rural areas are forced to seek temporary services available only in cities, which is straining the system.

People experiencing homelessness shelter on a sidewalk in Miami. Federal data shows 582,462 people were experiencing homelessness on a single night in January 2022. Experts warn more people will enter homelessness as housing costs increase, as has been the case for decades in cities such as New York and in much of California. CHANDAN KHANNA/AFP VIA GETTY IMAGES FILE

Felony to live in tent in Tennessee

In July, Tennessee became the first state to make it a felony to live in a tent or sleep on state land.

Statewide bans have been introduced in recent years by legislators in five other states, Pew said.

"Policies like this are making homelessness worse," Tars said, because arrest, jail time and a criminal record put up steep barriers to employment, securing an apartment and accessing social services.

Portland bans tent living

The City Council in Portland, Oregon, voted in November to approve a plan to ban living in tents and will shift people living in encampments into six city-sanctioned mass encampment sites capped at 250 people.

The measure includes plans to build 20,000 additional affordable housing units and eventually would require everyone living on the streets to move into shelters, Oregon Public Broadcasting reported.

The American Civil Liberties Union of Oregon sent the Portland City Council a letter warning the new measure could be unlawful. Last month, the civil rights group sued the city of Phoenix over a similar ban, resulting in a temporary block from a federal judge.

Oregon Gov. Tina Kotek started her term by declaring a state of emergency for parts of the state that have seen huge increases in unsheltered homelessness, including Portland.

Nevada county bans living in cars

In December, Washoe County Commissioners in Nevada voted 3-2 to consider an ordinance to ban camping in tents or vehicles and storing personal items in public when it poses "significant harm to any person, or public area." Violators could be charged with a misdemeanor or a $500 fine. Within the county, Reno and Sparks already had similar ordinances in place.

In 2021, 25% of young people experiencing homelessness served by the Eddy House shelter in Reno lived on the streets, CEO Trevor Macaluso told USA TODAY. He added that people displaced by sweeps in Reno and Sparks usually relocate their encampment somewhere else in the city, which makes the bans ineffective.

Los Angeles bans some tent cities

A City Council-approved ban on tent living in certain areas was expanded in August 2022 to prohibit encampments within 500 feet of schools and day care centers after teachers and parents complained students couldn't access nearby sidewalks.

School administrators have said the ban isn't always enforced by the city and police, according to EdSource, an outlet covering education in California.

More recently, the mayors of Los Angeles and Long Beach and Los Angeles County declared states of emergency over the homeless crisis aimed at speeding up services to reduce and prevent homelessness.

Pangea Park is among the areas of Viera with extensive home construction activity. PHOTOS BY TIM SHORTT/ FLORIDA TODAY

A large amount of new home construction is underway in the Pangea Park area off of Pineda Boulevard in Viera, west of Interstate 95.

A construction crew works on a home in the Pangea Park area of Viera.

Viera

Continued from Page 1A

if there had been available inventory to sell."

Pokrywa said Viera's "active-adult" communities and those with "mid to high residential price points" have been less sensitive to the rise in interest rates.

"Currently, Viera is witnessing residential traffic and sales that is, while not as heated as 2020 to 2022, running at healthy pre-pandemic levels," Pokrywa said.

Among factors Pokrywa cited for the strength of Viera are "the business-friendly regulatory environment in Brevard County; less restrictive COVID-19 protocols, compared to other geographic locations; and the flexibility offered by remote work alternatives."

Also playing roles in Viera's strength, Pokrywa said, are job growth within the Space Coast in the commercial space, defense contracting and high-tech industries; the diversity of residential options at various price points within Viera; Viera's three emerging mixed-commercial hubs of Borrows West, the Pineda Interchange District and Viera Town Center; the A-rated schools; and Viera's central location within the county in an area not far from the Atlantic Ocean beaches.

In commenting on Viera's ranking, Zachary Nyberg, senior manager at John Burns Real Estate Consulting, said "Viera is known for its idyllic setting with a host of growing amenities, including trails, parks, fitness facilities and a town center. Viera is a popular choice for all generations, due to its well-regarded schools, proximity to jobs, wide range of home offerings and strong sense of community."

Viera recorded 722 sales of new homes in 2022.

Karl Pischke, vice president of RCLCO Real Estate Consultants, said Viera "is a strong example of the success that a development can achieve when community and thoughtful place-making are the primary focuses — both of which The Viera Co. has consistently prioritized."

Three other Florida planned communities were the top three on both lists — The Villages (3,923 sales in 2022), Lakewood Ranch in Sarasota (1,846 sales) and Silverleaf in St. Augustine (1,034 sales). Babcock Ranch in Punta Gorda was No. 5, with 934 sales. Viera's 722 sales tied with Wellen Park in Venice.

Scott Miller, senior vice president of sales and community development for The Viera Co., which is the developer of the Viera planned community, said reaching the top 10 in the rankings "has been a long-term goal for Viera" and one that he personally had long dreamed would arrive someday.

Viera has more than 30,250 residents and 13,300 residential housing units. It has more than 805 businesses employing more than 10,630 people.

When the 20,646-acre community is fully built out around 2050, it is expected to have more than 70,000 residents and 31,000 residential housing units. It will have more than 1,000 businesses employing more than 25,000 people.

An analysis of the nation's top 50 planned communities showed that Viera performed better than the national as a whole.

Among the key nationwide findings by RCLCO Real Estate Consultants:

- New-home sales among the 50 top-selling master-planned communities declined by 20% in 2022, compared with the pace set by 2021's top communities.
- Rising interest rates and affordability issues, particularly in the second half of the year, have had a significant impact on visitor traffic and new sales.
- Sales in the second half of 2022 were 13% lower than the first half of the year, further highlighting the struggles faced by buyers, as mortgage rates peaked above 7% in October.
- Florida represented about 46% of sales among ranked communities, followed by Texas at nearly 30%.

"High median new-home prices and rising mortgage rates have contributed to the long-term trend of declining housing affordability, and recent declines in permitting, starts and new home sales," RLCCO reported. "Nonetheless, the underlying demographic trends supporting long-term demand for new housing strongly indicate that permits, starts and new-home sales will likely rebound substantially following the stabilization of interest rates and further healing of supply-chain issues."

RCLCO said developers of the top-selling communities surveyed at the end of 2022 "generally tend to believe that the recent decline in new-home sales is a short-term trend, and the long-term future for the housing industry, and especially for home sales in master-planned communities, for which there is more underlying demand than supply, looks very positive."

Contact Berman at dberman@floridatoday.com, on Twitter at @bydaveberman and on Facebook at www.facebook.com/dave.berman.54.

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

PUBLIC NOTICE
FOR THE POTENTIAL IMPACT
FLOODPLAIN / WETLANDS AT CAPE CANAVERAL SPACE FORCE STATION, FLORIDA

The United States Space Force (USSF) is preparing a Supplemental Environmental Assessment (SEA) in compliance with the National Environmental Policy Act (NEPA) to evaluate the potential impacts associated with implementing Relativity Space, Inc.'s (Relativity) proposed Terran R Space Launch Program operations at the recently renovated Space Launch Complex (SLC) 16 at Cape Canaveral Space Force Station (CCSFS). This SEA is a supplement to the *Environmental Assessment for the Relativity Terran 1 Program Launch Complex 16, Cape Canaveral Space Force Station, FL*. The purpose of the Proposed Action is to provide versatile Terran R Launch Service from CCSFS SLC-16 to deploy and resupply satellite constellations for both Government and commercial sector client payload delivery to Low-Earth Orbit and Sun-Synchronous Orbit.

At this early stage of SEA preparation, the Proposed Action includes construction of new facilities and infrastructure and modification of existing assets to maximize mission capabilities. This Proposed Action is subject to requirements and objectives of Executive Order (EO) 11990, *Protection of Wetlands,* EO 11988, *Floodplain Management*, and EO 13690, Establishing a Federal Flood Risk Management Standard and *a Process for Further Soliciting and Considering Stakeholder Input*, as the proposed infrastructure improvements could potentially impact wetlands and occur within the 100-year floodplain. There are no practicable alternatives outside of floodplains and wetlands. Impacts would be minimized to the greatest practicable extent. Mitigation would be provided for unavoidable impacts to ensure no net loss of wetland or floodplain function in accordance with federal and state regulations.

Pursuant to EO 11990, EO 11988, EO 13690, and Air Force Instruction 32-7064, USSF requests advance public comment to determine if there are any public concerns regarding the Proposed Action's potential to impact floodplains and wetlands. The Proposed Action will be analyzed in the forthcoming EA, which the public will have the opportunity to review and provide comment when the Draft EA is released. Comments may be submitted to Ms. Taylor Janise, 45 CES/CEIE, 1224 Jupiter Street, Mail Stop 9125, Patrick Space Force Base, Florida 32925 or via email at taylor.janise.1@spaceforce.mil. Comments will be accepted for 30 days from the publication of this notice.

FT-GCI1002467-01

Appendix J-2

Public Comments on Early Floodplain/Wetland Notice

[redacted]

From: [redacted]
Sent: Friday, February 10, 2023 10:38 AM
To: [redacted]
Cc: [redacted]
Subject: [URL Verdict: Unknown][Non-DoD Source] Comments on: Relativity Terran R SLC-16, Cape Canaveral Space Force Station, Environmental Assessment Notice
Attachments: 230210IRLRT TerranRComments.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

To: [redacted] 45CES/CEIE
1224 Jupiter Street
Mail Stop 9125
Patrick Space Force Base Florida 32925

[redacted]

Subject: Public Scoping Comments on the forthcoming Supplemental Environmental Assessment for Relativity Terran R launch service from SLC-16, Cape Canaveral Space Force Station, Florida

Dear [redacted],

Please accept these Comments and confirm their receipt.

Respectfully,

[redacted]

For the IRL Roundtable: https://irlroundtable.com/forum/

INDIAN RIVER LAGOON ROUNDTABLE

A GRASSROOTS ENVIRONMENTAL DISCUSSION GROUP

https://irlroundtable.com/forum/

To: (b) (7)(C) [redacted]
45CES/CEIE
1224 Jupiter Street
Mail Stop 9125
Patrick Space Force Base
Florida 32925

Subject: Public Scoping Comments on the forthcoming Supplemental Environmental Assessment for Relativity Terran R launch service from SLC-16, Cape Canaveral Space Force Station, Florida

Dear (b) (7)(C) [redacted]

The Indian River Lagoon (IRL) Roundtable is a group of environmentally aware citizens who are concerned that the cumulative effect of current and planned development around our space-oriented facilities presents a serious threat to the future health of the lagoon. Unless controlled, this will damage our local economy, culture, and quality of life.

The IRL is a Federally designated Estuary of National Significance. It is declared by EPA and FLDEP an impaired waterway. It is in steep decline due primarily to human development. Brevard citizens are spending hundreds of millions of dollars through the Save Our Indian River Lagoon ½ sales tax plan repairing the results of past development done with inadequate consideration of impacts on the lagoon. Today KSC, Cape Canaveral and the surrounding areas are experiencing unprecedented new growth due to booming commercial space development, including the present Terran R SLC-16 project.

Our comments and requests for clarification include:

1.The Notice acknowledges that the current development plan will impact wetlands and 100-year floodplain and claims that there is “no practicable alternative” and that unspecified actions will be taken to minimize impacts and provide mitigation. Notably, the 2021 FAA FONSI for Terran 1 indicates that LC-16 is NOT located in the 100-year floodplain and “would not affect wetlands.”

   a. This appears to be a contradiction, and there may be others, please explain.

b. The FONSI states that space junk poses only "very temporary and very localized changes in pH," yet complaints to NOAA indicate that space junk may be disrupting important fishing areas.
c. What other alternatives were investigated as required by Air Force Instruction 32-7064?

2.We note that the environmental review process for this project will follow documents: EOs 11990, 11988, 13690, Air Force Instruction 32-7064 .

We would like further details on how the proposed unspecified actions meets these specifications including:

a. Modifications of existing and new assets with potential impacts on any and all wetlands.
b. Minimization of Impacts where unavoidable; where, how and when will this be accomplished?
c. Providing Mitigation to assure no net loss of wetlands or floodplains, where, how and when will this be accomplished?
d. What activities will be in the state's coastal zones and how is sea level rise being taken into account? Will mitigation be required through analysis of alternative actions?

3. Regarding the modification and construction of new facilities and infrastructure. Will the project make use of Low Impact Development techniques to be consistent with the requirements of EISA Section 438 and DOD directive UFC 3-210-10 change 3, dated March 1, 2020 ?

We look forward to your responses and to participating fully in the ongoing review of the proposed action.

This letter is fully endorsed by our Roundtable members.
https://irlroundtable.org/forum/irl-roundtable-members

If you have questions or need additional information, please let us know.

(b) (7)(C) [redacted]
For the IRL Roundtable: https://irlroundtable.com/forum/

(b) (7)(C) [redacted]

From: (b) (7)(C) [redacted]
Sent: Friday, February 10, 2023 1:37 PM
To: (b) (7)(C) [redacted]
Cc: (b) (7)(C) [redacted]
Subject: [URL Verdict: Neutral][Non-DoD Source] Public Scoping Comments on the forthcoming Supplemental Environmental Assessment for Relativity Terran R launch service from SLC-16, Cape Canaveral Space Force Station, Florida
Attachments: 230210BIRLC TerranRComments.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

BREVARD
INDIAN RIVER LAGOON
COALITION

To: (b) (7)(C) [redacted]
45CES/CEIE
1224 Jupiter Street
Mail Stop 9125
Patrick Space Force Base
Florida 32925

Dear (b) (7)(C) [redacted]

The Indian River Lagoon Coalition (BIRLC) is a 501c3 Non-Profit organization with a mission to educate and advocate for policies that will restore the health of the Indian River Lagoon.

We have reviewed the PUBLIC NOTICE FOR THE POTENTIAL IMPACT FLOODPLAIN /WETLANDS AT CAPE CANAVERAL SPACE FORCE STATION, FLORIDA, published on January 15, 2023.

Recognizing our role in supporting lagoon restoration and our awareness of this and other rapid private and public development taking place at Cape Canaveral Space Force Station, Kennedy Space Center, and the Space Florida Spaceport, we are interested parties and request that we be kept fully informed about developments with the current (and other) projects.

Thank you for your assistance in the matter and feel free to contact me if you have any questions or need further information.

Sincerely yours,

[redacted]

[redacted]

Brevard Indian River Lagoon Coalition

[redacted]

https://www.facebook.com/BIRLC/
@HelpTheLagoon
HelpTheLagoon.org https://twitter.com/HelpTheLagoon

BREVARD INDIAN RIVER LAGOON COALITION

To: [redacted]
45CES/CEIE
1224 Jupiter Street
Mail Stop 9125
Patrick Space Force Base
Florida 32925

Subject: Public Scoping Comments on the forthcoming Supplemental Environmental Assessment for Relativity Terran R launch service from SLC-16, Cape Canaveral Space Force Station, Florida

Dear [redacted]

The Indian River Lagoon Coalition (BIRLC) is a 501 c3 Non-Profit organization with a mission to educate and advocate for policies that will restore the health of the Indian River Lagoon.

We have reviewed the PUBLIC NOTICE FOR THE POTENTIAL IMPACT FLOODPLAIN /WETLANDS AT CAPE CANAVERAL SPACE FORCE STATION, FLORIDA, published on January 15, 2023.

Recognizing our role in supporting lagoon restoration and our awareness of this and other rapid private and public development taking place at Cape Canaveral Space Force Station, Kennedy Space Center, and the Space Florida Spaceport, we are interested parties and request that we be kept fully informed about developments with the current (and other) projects.

Thank you for your assistance in the matter and feel free to contact me if you have any questions or need further information.

Sincerely yours,
[redacted]
Brevard Indian River Lagoon Coalition
https://www.facebook.com/BIRLC/
@HelpTheLagoon
HelpTheLagoon.org
https://twitter.com/HelpTheLagoon

JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C

From: laurileethompson@aol.com
Sent: Tuesday, February 14, 2023 5:22 PM
To: JANISE, TAYLOR M CIV USSF HQSF 45 CES/CEIE-C
Subject: [Non-DoD Source] Scoping Comment for Relativity Terran R Launch Service from Cape Canaveral Space Force Station
Attachments: IMG_6397.JPG; IMG_6398.JPG; IMG_6400.JPG; IMG_6401.JPG; IMG_1837.JPG; IMG_1838.JPG; IMG_6415.JPG; IMG_6416.JPG; IMG-6487.jpg; IMG-6489 (1).jpg; IMG-6490.jpg

Follow Up Flag: Follow up
Flag Status: Flagged

Good Day Ms. Janise,

Thank you for the opportunity to comment on the Supplemental Environmental Assessment for Relativity Terran R Launch Service from SLC-16 at Cape Canaveral Space Force Station, Florida

My comments pertain to the impact from space launches on the commercial and recreational fishing folks that are based out of Port Canaveral Florida, as well as the impact to a very fragile underwater environment that exists offshore of Cape Canaveral. They are applicable to the Relativity Terran R Launch Service as well as other rocket launches.

The increase in launches from Kennedy Space Center is presenting challenges that no one envisioned 20 years ago. The time/area closures associated with space launches are wreaking havoc for the fishermen when a large area is closed for hours before and after a launch. Boats cannot enter the closed area. The fines for doing so are Draconian. Communications regarding launches and closed areas are hard to relay to the fishermen. Sometimes they stay offshore for a month and they don't know when a launch might occur as they are coming back to the Port and they might unknowingly stray right through a closed area. Some captains come from other locations that don't have closed areas for rocket launches and they have no clue they might enter a closed area. The area closures have caused difficulties for the Kingfish and Spanish Mackerel fleets, resulting in lost fishing time. They cannot cross through the areas to get to where the fish are. The same thing happens for the commercial bottom fishermen and the recreational fishermen.

Currently we experience about 4-6 closures a month. But I've heard that the goal is 300-400 rocket launches per year. When that happens, our ability to fish out of Port Canaveral will be lost unless the government will exempt small fishing vessels in the closed areas while keeping the cruise ships with thousands of passengers out of harm's way. The chances of rocket debris hitting a large cruise ship are much greater than it hitting a small fishing boat.

Another result of the rocket launches is debris on the bottom where we drag for shrimp. This has been an issue for many years. The fishermen have quietly dealt with it as debris encounters were rare in the beginning of the space age here. However, the frequency of encounters is increasing with the escalating launch cadence at Kennedy Space Center. The rocket debris tears up nets and causes lost fishing time for extraction of debris and repair of nets. The shrimpers lose their catch when the debris rips holes in their nets. It creates dangerous conditions for the crew when handling the debris as some of the rocket parts are quite large. Sometimes they lose their entire set of nets and doors and cables if the debris is too large to drag up to the surface. That's a $40,000 bill to replace entire sets of gear.

The offshore waters from Sebastian to St Augustine are the only place in the world where the fragile Ivory Tree Coral (Oculina varicosa) grows in mounds that are more than 100 feet tall. Some of the largest mounds are offshore of Cape Canaveral. The Oculina coral also grows on low relief hard bottom on the inshore and offshore sides of the coral mounds. The rare coral is protected by NOAA as Essential Fish Habitat. The official name for it is the Oculina Habitat Area of Particular Concern (OHAPC).

Oculina Habitat Area of Particular Concern | NOAA Fisheries

The rock shrimpers drag on the inshore and offshore sides of the Oculina Bank. If the rocket debris is falling into the areas where we fish for rock shrimp, then it is undoubtedly falling into the Oculina reef system itself. No one is allowed to trawl within or to anchor within the OHAPC in order to protect the coral. The specter of round rocket parts rolling around in the tide and crushing coral is deeply concerning as the Oculina Bank is the nursery ground for rock shrimp as well as a spawning area for many commercially and recreationally harvested finfish, including many species of snappers and groupers.

I attached some pictures of space debris that have been caught this season by rock shrimpers. You can see the rock shrimp that did not escape smashed in between the net and the rocket debris in a couple of pictures. You can see the size of one of the pieces in the last three images and imagine how dangerous it is with such large objects swinging from the rigging on a rocking rolling fishing vessel.

Following are some suggestions that will help reduce the burden on fishermen working out of Port Canaveral and protect the economically valuable and irreplaceable OHAPC Essential Fish Habitat.

1. Allow commercial and recreational fishermen to sign a waiver releasing the government from any responsibility if a rocket part falls on them if they are in a closed area. The chances of rocket debris striking a small fishing vessel are extremely small. They are willing to take that chance so they can fish.

2. Start a program to compensate fishermen for damage to equipment, lost fishing time and loss of catch when a fishing boat encounters space debris.

3. Encourage fishermen to bring space debris to the dock when feasible rather than drop it back into the ocean to be caught again. The government can establish a collection point at Port Canaveral. The government could offer a reward for bringing debris in. It will be far cheaper for the fishermen to bring space debris to the dock rather than the government hiring a salvage company to go out and collect the debris. The debris needs to be removed from the ocean bottom.

4. Devise a better way to communicate with offshore vessels as to when and where an area is closed. Don't extend the full window of closure if a launch is scrubbed. Open the area back up immediately.

5. Reduce the amount of closure time before and after launches.

6. Require companies that launch rockets to make them reusable and stop dropping their debris into the ocean.

7. Clean up the mess of rocket debris that is off of our coast. Our ocean is not a garbage can.

Thanks again for the opportunity to comment.

Sincerely,

Laurilee Thompson
laurileethompson@aol.com
321-794-6866