

Biological Assessment

SpaceX Starship/Super Heavy Launch Vehicle Program at the SpaceX
Boca Chica Launch Site

Cameron County, Texas

June 2021

Federal Aviation Administration
Office of Commercial Space Transportation

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Acronyms and Abbreviations

BA	Biological Assessment	VLA	Vertical Launch Area
BCO	Biological and Conference Opinion		
CFR	Code of Federal Regulations		
CWA	Clean Water Act		
dB	decibel(s)		
dba	A-weighted decibel(s)		
DOT	Department of Transportation		
EIS	Environmental Impact Statement		
ESA	Endangered Species Act		
FAA	Federal Aviation Administration		
FR	<i>Federal Register</i>		
L _{Amax}	Maximum Overall Sound Pressure Level		
LCH ₄	liquid methane		
LLCC	Launch and Landing Control Center		
LN ₂	liquid nitrogen		
LOX	liquid oxygen		
MBTA	Migratory Bird Treaty Act		
MT	megaton(s)		
NOTAM	Notice to Airmen		
NOTMAR	Notice to Mariners		
NOx	nitrous oxide		
NPS	National Park Service		
NWR	National Wildlife Refuge		
OASPL	Overall Sound Pressure Level		
PCE	Primary Constituent Elements		
psf	pound(s) per square foot		
SODAR	sound detection and ranging		
SpaceX	Space Exploration Technologies Corporation		
SPCC	Spill Prevention, Control, and Countermeasures		
SWPPP	Stormwater Pollution Prevention Plan		
TCEQ	Texas Commission on Environmental Quality		
TGLO	Texas General Land Office		
TPDES	Texas Pollutant Discharge Elimination System		
TPWD	Texas Parks and Wildlife Department		
TxDOT	Texas Department of Transportation		
U.S.	United States		
U.S.C.	United States Code		
USFWS	U.S. Fish and Wildlife Service		
UTRGV	University of Texas Rio Grande Valley		

1 INTRODUCTION

The Federal Aviation Administration (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 activity carried out by the federal government, such as National Aeronautics and Space Administration or Department of Defense 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.

In accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 United States Code [U.S.C.] 1531 et seq.), the FAA prepared this Biological Assessment (BA) to analyze the potential effects of issuing commercial space licenses or permits to SpaceX on ESA-listed species and designated critical habitat under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS). This BA is intended to support formal consultation between the FAA and USFWS as required by ESA Section 7 and 50 Code of Federal Regulations (CFR) § 402.14(c). This BA also supports informal consultation regarding species that may be affected but are not likely to be adversely affected by the FAA's Proposed Action.

Consultation History

In 2013, the FAA conducted ESA Section 7 consultation with the USFWS to address the potential effects to ESA-listed species and critical habitat from the proposed action of issuing SpaceX licenses or permits to conduct launches of Falcon 9, Falcon Heavy, and other reusable launch vehicles at a proposed launch site near Boca Chica Village, Texas (now referred to as the Boca Chica Launch Site). The action analyzed in the 2013 consultation included construction of the launch site, pre-flight activities, and launches. During the 2013 consultation, the FAA determined the proposed action *may affect and was likely to adversely affect* the following species and critical habitat: piping plover (*Charadrius melodus*) and piping plover critical habitat, red knot (*Calidris canutus rufa*), northern aplomado falcon (*Falco femoralis septentrionalis*), Gulf Coast jaguarundi (*Herpailurus yagouaroundi cacomitli*), ocelot (*Leopardus pardalis*), Kemp's ridley sea turtle (*Lepidochelys kempii*), hawksbill sea turtle (*Eretmochelys imbricata*), leatherback sea turtle (*Dermochelys coriacea*), loggerhead sea turtle (*Caretta caretta*), and green sea turtle (*Chelonia mydas*). The FAA determined the proposed action *may affect but was not likely to adversely affect* the West Indian manatee (*Trichechus manatus*). The FAA determined the proposed action would have *no effect* on the South Texas ambrosia (*Ambrosia cheiranthifolia*) and Texas ayenia (*Ayenia limitaris*).

The USFWS issued a Biological and Conference Opinion (BCO) on December 18, 2013 which concluded FAA's Section 7 obligations. The USFWS concurred with the FAA's *not likely to adversely affect* determination for the West Indian manatee, and concluded FAA's proposed action would not jeopardize the continued existence of the remaining species and would not adversely modify piping plover critical habitat. The conference opinion was for the red knot, which was proposed for listing at

the time. The FAA re-initiated consultation with the USFWS when the red knot was listed as threatened in 2015, and the USFWS confirmed its Conference Opinion as a Biological Opinion for the red knot. The BCO provided an incidental take statement and outlined conservation measures, reasonable and prudent measures, terms and conditions, and conservation recommendations. The FAA and SpaceX have updated the USFWS annually on the implementation of all the measures, terms and conditions, and recommendations outlined in the BCO.

SpaceX no longer plans to conduct launches of its Falcon launch vehicles at the Boca Chica Launch Site and has instead decided to use the launch site to conduct test operations and launches of its new launch vehicle, called the Starship/Super Heavy, which is currently being designed and constructed. SpaceX is also proposing to construct additional infrastructure at the launch site. Some Starship/Super Heavy launch operations and the proposed infrastructure fall outside the scope of the 2013 consultation.

2 PROJECT DESCRIPTION

2.1 PROPOSED ACTION

The FAA's Proposed Action is to issue one or more experimental permits and/or a vehicle operator license to SpaceX that would allow SpaceX to launch Starship/Super Heavy, including from the Boca Chica Launch Site. SpaceX's goal is to use Starship/Super Heavy for low Earth orbit, sun-synchronous orbit, geostationary transfer orbit, and interplanetary missions for cargo and humans.

This BA focuses on the Boca Chica Launch Site, including potential additional development at the site as explained below. The FAA may conduct environmental reviews of additional proposed launch and reentry sites if SpaceX further develops proposals. Such reviews would be part of additional ESA consultation with the USFWS, as applicable.

SpaceX's proposed operations consist of two phases: 1) the Program Development Phase; and 2) the Operational Phase. The Program Development Phase entails more testing operations (static fire engine tests and suborbital launches) and fewer orbital launches annually. If SpaceX becomes more successful with test flights, the Starship/Super Heavy launch vehicle program would transition into the Operational Phase, which entails more orbital launches and fewer testing operations.

Annual proposed launch operations include suborbital launches (see Section 2.1.3.3) and/or orbital launches (see Section 2.1.3.4). SpaceX's proposal also includes launch-related activities at the Boca Chica Launch Site, such as tank tests, static fire engine tests, expansion of the vertical launch area (VLA) and solar farm, and construction of additional infrastructure.

All elements of the Proposed Action and SpaceX's proposal are identified in Table 2-1. Detailed information about some of the launch-related infrastructure (e.g., exact location and design) is not currently available. Therefore, the BA makes assumptions about these unknowns using best available information and professional expertise. The analysis in this BA reflects the potential effects that may be expected to result from the Proposed Action and the assumptions. If SpaceX proposes modifications to the activities discussed below, and they fall outside the footprint of the proposed project or the scope of this BA, the FAA will reinitiate consultation.

Table 2-1. Elements of the Proposed Action

FAA Proposed Action	Elements of SpaceX’s Proposal	Brief Description
Issuance of an Experimental Permit or Vehicle Operator License	Program Development Phase – Test and Launch Operations	<ul style="list-style-type: none"> • Starship Static Fire Engine Tests • Super Heavy Static Fire Engine Tests • Starship Suborbital Launch • Super Heavy Launch • Starship Land Landing
	Operational Phase – Test and Launch Operations	<ul style="list-style-type: none"> • Starship Static Fire Engine Tests • Super Heavy Static Fire Engine Tests • Starship Suborbital Launch • Super Heavy Launch • Starship Land Landing • Super Heavy Land Landing
	Tank Tests	Test the structural capability of the launch vehicle stages
	Nominal Operational Closures	SpaceX anticipates the proposed operations would require 500 hours of annual closure
	Anomaly Response Closures	SpaceX anticipates debris cleanup would require up to 300 hours of annual closure to be used at the discretion of Cameron County, TPWD, and USFWS
	Launch-Related Infrastructure Construction	<ul style="list-style-type: none"> • Redundant Launch Pad (Launch Pad B) and Commodities (11 tanks) • Redundant Landing Pad • Integration Towers • Tank Structural Test Stands • Desalination Plant • Support Buildings and Parking Lots • Power Plant • Trenching • Payload Processing Facility • Natural Gas Pretreatment System • Liquefier • Expanded Solar Farm • State Highway 4 Pull-offs

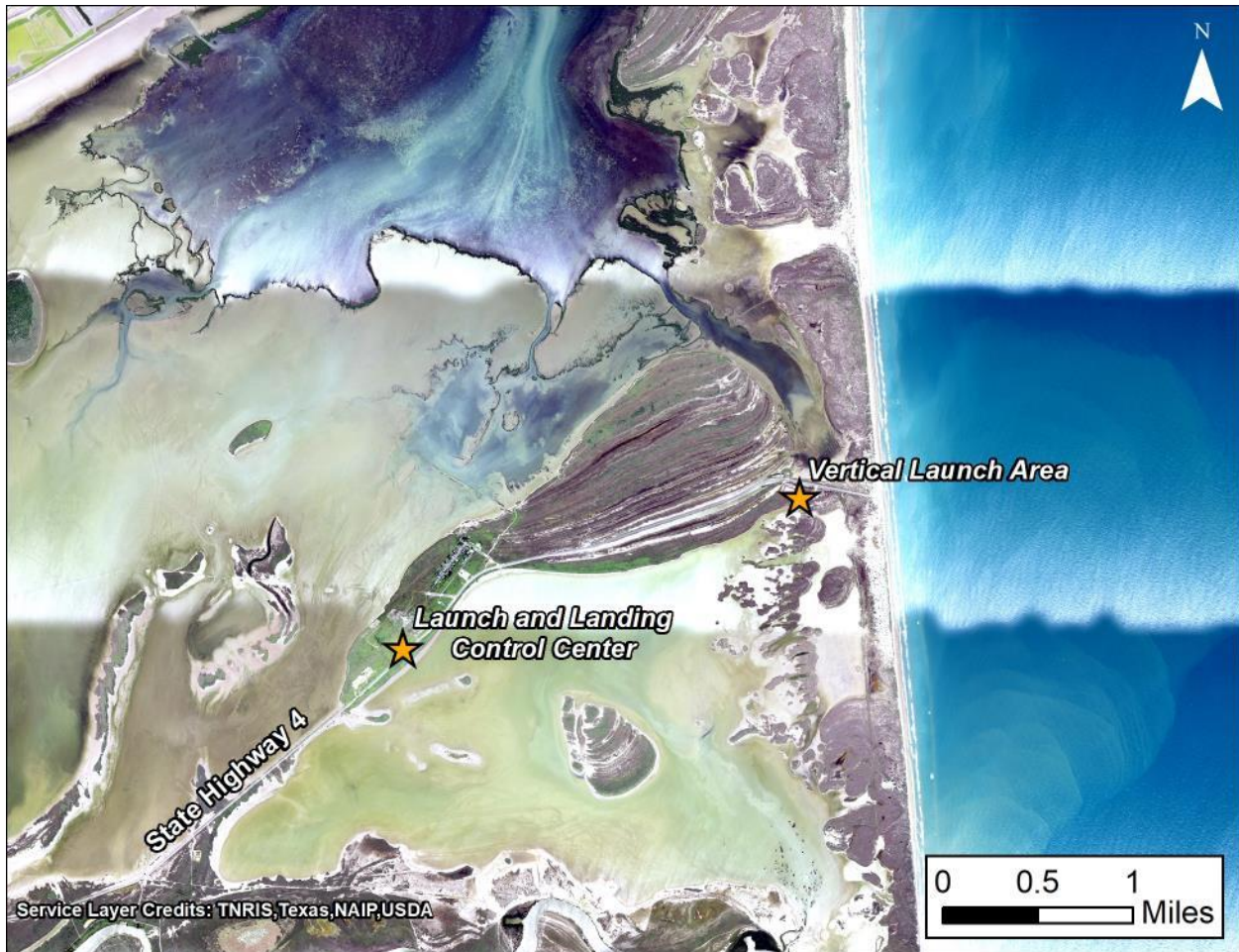
2.1.1 Location

The Boca Chica Launch Site is located on SpaceX-owned land in Cameron County, Texas, near the cities of Brownsville and South Padre Island. The launch site consists of the VLA, which is controlled by the launch and landing control center (LLCC). The VLA is approximately 2.2 miles north of the U.S./Mexico border and the LLCC is approximately 1.3 miles north of the U.S./Mexico border (Figure 2-1). The launch site is in a sparsely populated coastal area adjacent to the Gulf of Mexico, characterized by sand and mud flats. State Highway (SH) 4, which provides the only access to the public Boca Chica Beach (Figure 2-2) and to Texas Park and Wildlife Department's (TPWD) Boca Chica Tract, provides access to the launch site and terminates directly adjacent to the VLA. The LLCC consists of a two-story building (referred to as Stargate) and is located west of the VLA along SH 4, adjacent to the SpaceX manufacturing and production area.

Figure 2-1. Regional Map



Figure 2-2. Location of Vertical Launch Area and Launch and Landing Control Center

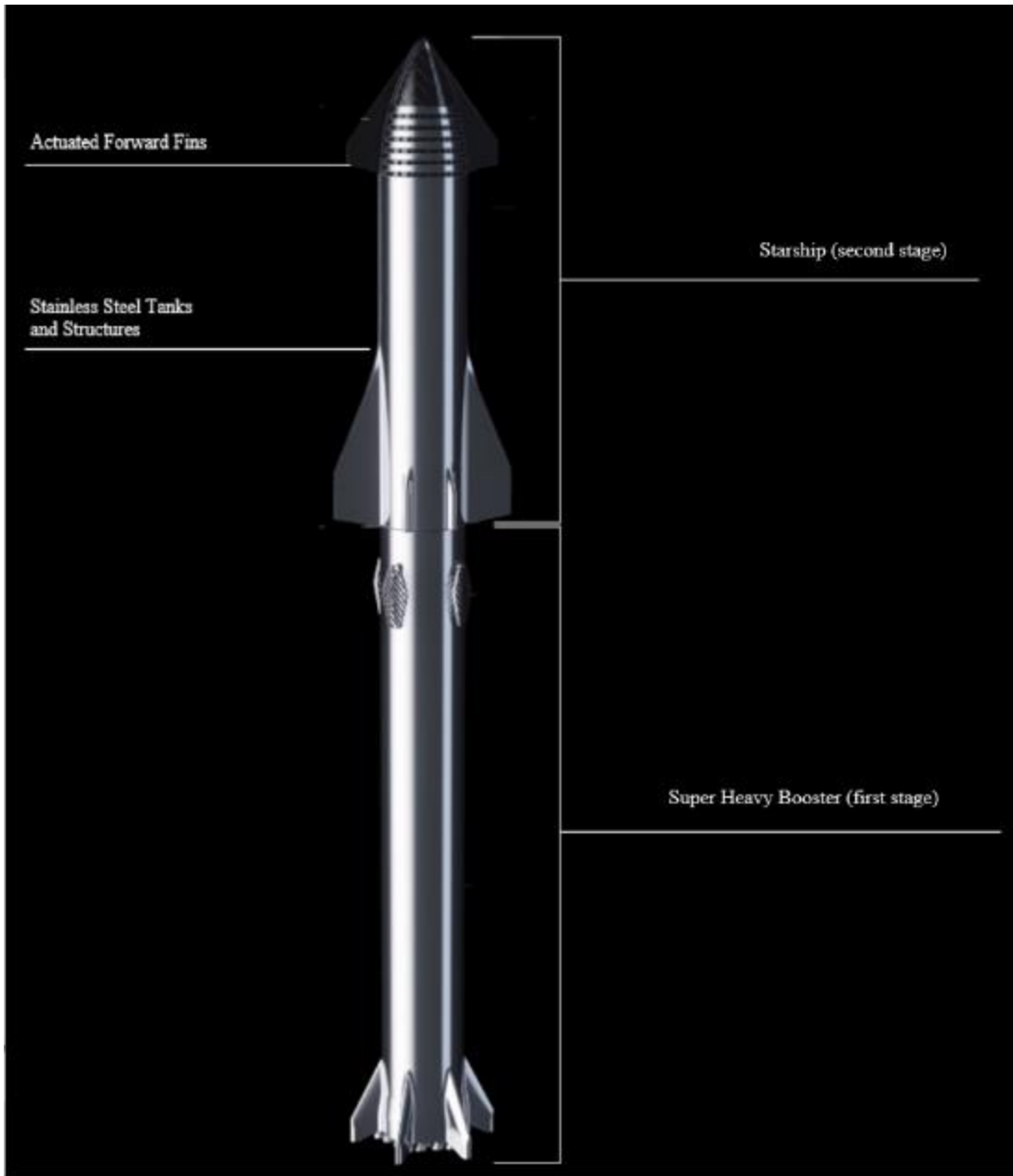


2.1.2 Launch Vehicle

Figure 2-3 shows a diagram of Starship/Super Heavy. The fully integrated launch vehicle is comprised of two stages: Super Heavy is the first stage (or booster) and Starship is the second stage. The fully integrated Starship/Super Heavy launch vehicle is expected to be approximately 400 feet tall and 30 feet in diameter. As designed, both stages are reusable, with any potential refurbishment actions taking place at SpaceX facilities. Both stages are expected to have minimal post-flight refurbishment requirements; however, they might require periodic maintenance and upgrades. Unlike the SpaceX Falcon launch vehicle, Starship/Super Heavy would not have separable fairings or parachutes.

Super Heavy is expected to be equipped with up to 37 Raptor engines, and Starship will employ up to six Raptor engines. The Raptor engine is powered by liquid oxygen (LOX) and liquid methane (LCH₄) in a 3.6:1 mass ratio, respectively. 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. Super Heavy, with all 37 engines, will have a maximum lift-off thrust of 74 meganewtons, allowing for a maximum lift-off mass of approximately 5,000 MT. Launch propellant and commodities are currently stored at the VLA in aboveground tanks (see Figure 2-5); this will not change under the Proposed Action. Commodities include liquid nitrogen (LN₂), water, gaseous oxygen, gaseous methane, gaseous nitrogen, helium, hydraulic fluid, LOX, and LCH₄.

Figure 2-3. Starship/Super Heavy Design Overview



2.1.3 Operations

Both operational phases (Program Development Phase and Operational Phase) include tank tests, pre-flight operations, suborbital launches, and orbital launches. SpaceX is still in the testing stages of the launch vehicle, including ongoing Starship prototype tests that have been approved under a separate license. SpaceX also will need to conduct similar tests of Super Heavy prototypes, which has not yet been approved under a separate license. During the Program Development Phase, SpaceX would conduct more tests (tank tests, static fire engine tests, and suborbital launches) and fewer orbital launches annually. As discussed below, if SpaceX becomes more successful with tests, the program will shift to more orbital launches and fewer tests (Operational Phase). While the number of each

operation may vary each year through the proposed launch program, SpaceX would not exceed the number of annual operations described below per year (Table 2-2).

Table 2-2. Proposed Annual Operations

Operation	Time ^a	Program Development Phase	Operational Phase
Starship Static Fire Engine Test	Day or Night	150 seconds	150 seconds
Super Heavy Static Fire Engine Test	Day or Night	135 seconds	135 seconds
Starship Suborbital Launch	Day or Night	20	5
Super Heavy Launch ^b	Day or Night	3	5
Starship Land Landing ^c	Day or Night	23	10
Super Heavy Land Landing ^c	Day or Night	0	5

Notes:

^a SpaceX is planning to conduct most launches (suborbital and orbital) between the hours of 7:00 a.m. and 7:00 p.m. However, there could be launch delays due to unforeseen issues with the launch vehicle, weather conditions, or certain missions that require launching at a specific time at night to achieve a particular orbital position. For conservative purposes, the environmental review is assuming 20 percent of annual operations involving engine ignition (i.e., static fire engine tests, suborbital launches, and orbital launches) would occur at night.

^b A Super Heavy launch could be orbital or suborbital and could occur by itself or with Starship attached as the second stage of the launch vehicle.

^c A Starship land landing means a landing at the VLA. Other landing options for Starship include landing on a floating platform in the Gulf of Mexico, Atlantic Ocean, or Pacific Ocean. Alternatively, SpaceX could expend Starship in the Gulf of Mexico, Atlantic Ocean, or Pacific Ocean.

^d A Super Heavy landing is part of a launch, as it would occur shortly after takeoff. A land landing means a landing at the VLA. Other landing options for Super Heavy include landing on a floating platform in the Gulf of Mexico or expending the booster in the Gulf of Mexico.

SpaceX would conduct most launches (suborbital and orbital) between the hours of 7:00 a.m. and 7:00 p.m. However, there could be launch delays due to unforeseen issues with the launch vehicle, weather conditions, or certain missions that require launching at a specific time at night to achieve a particular orbital position. For conservative purposes, this assessment assumes 20 percent of annual operations involving engine ignition (i.e., static fire engine tests, suborbital launches, and orbital launches) would occur at night. The difference in operations during nighttime launch activity versus a daytime launch activity would be SpaceX requiring bright spotlighting for periods of time (sometimes days) when illuminating the launch vehicle on the launch pad. These spotlights are typically metal halide.

In addition to nighttime launch activity, SpaceX would need to perform ground support operations 24 hours a day, 7 days a week, throughout the year. White lighting would be needed to ensure the protection and safety of SpaceX personnel. The number of pole lights would be finalized during the site design process. SpaceX will coordinate with the USFWS and National Park Service (NPS) on updating its Facility Design and Lighting Management Plan.

SpaceX plans to use a portable sound detection and ranging (SODAR) device to collect weather data needed for launch and landing. The SODAR sends out a short sonic pulse every 15 minutes that can reach 92 decibels (dB) at the source and dissipates to 60 dB within 100 feet. The SODAR would be located at the SpaceX production and manufacturing area at least 500 feet away from any SpaceX property line and would operate at all times.

2.1.3.1 Tank Tests

Prior to conducting a suborbital launch of a Super Heavy or Starship prototype, SpaceX must conduct tank tests to ensure the tank's reliability. This involves performing proof pressure tests prior to performing a static fire engine test to confirm the structural integrity of the launch vehicle. Proof pressure tests are broken into two main categories: pneumatic and cryogenic. Pneumatic proof pressure testing consists of pressurizing the launch vehicle's tank with gaseous media (either helium, nitrogen, oxygen, or methane) and holding pressure for an extended duration. Cryogenic proof pressure tests consist of loading the tank with a single propellant (typically LN₂, LOX, or LCH₄). The tanks are then pressurized past their rated limit to confirm their structural capability with appropriate factors of safety. These proof pressure tests are designed to not release any propellant to the environment. All propellant is recycled back into the ground system tanks after the test is completed.

In addition to the proof pressure tests, SpaceX may perform development tests on test tank articles to validate design improvements or characterize vehicle behavior. These development tests include hydrostatic and cryogenic burst tests, in which the tanks are filled with water, LN₂, or LOX, and pressurized to a specific limit or to deliberate failure to characterize the structural capability of the production vehicles. Burst testing includes the deliberate release of the test media (water, LN₂, or LOX) to the environment upon failure of the primary structure.

All tank tests could occur during the day or night. SpaceX is planning to conduct the tank tests described above for each Super Heavy and Starship prototype that is built until the test is successful. If a test is unsuccessful and results in damage to the test vehicle, a new test vehicle would be constructed and tested. Once tank tests are successful, SpaceX would conduct a static fire engine test.

SpaceX is still determining the number of prototypes that it will build and test. SpaceX is proposing to conduct approximately 10 tank tests a month. SpaceX estimates a 10 percent rate of anomalies during tank testing. An anomaly would result in an explosion and the spread of debris. The distance for which debris could spread is considered the blast danger area and would be determined by SpaceX prior to the test. The blast danger area for tank tests would be within the hard checkpoint area (Figure 2-4). Given the rates above, SpaceX estimates that one tank test each month may result in an anomaly and potentially an explosion.

2.1.3.2 Pre-flight Operations

Pre-flight operations include mission rehearsals and static fire engine tests. The goal of mission rehearsals is to verify that all vehicle and ground systems are functioning properly, as well as to verify that all procedures are properly written. After final systems checkout, SpaceX would conduct a mission rehearsal without propellants on the launch vehicle (referred to as a *dry dress rehearsal*), followed by a mission rehearsal with propellants on the launch vehicle (referred to as a *wet dress rehearsal*) to verify full launch readiness.

In addition to conducting dress rehearsals, SpaceX would conduct static fire engine tests. The goal of a static fire engine test is to verify engine control and performance. A static fire engine test is identical to a wet dress rehearsal, except engine ignition occurs. During a static fire engine test, the launch vehicle engines are ignited for approximately 5–15 seconds and then shut down.

Prior to a fully integrated Starship/Super Heavy launch, SpaceX would perform a Starship static fire engine test prior to being integrated with Super Heavy. SpaceX would also perform a Super Heavy static fire engine test, either by itself or with Starship integrated. SpaceX is proposing to conduct up to 135 seconds per year of static fire duration for Super Heavy and up to 150 seconds per year of static fire duration for Starship per year during the Program Development Phase (Table 2-2). There may be occasions when a static fire engine test is attempted and is unsuccessful (e.g., the test results in a mishap). If an engine test is unsuccessful, another attempt would be made.

During pre-flight operations, the launch vehicle would be connected to ground systems. After an operation involving propellant (i.e., wet dress rehearsal and static fire engine test), the propellant would be transferred back to the commodity tanks at the VLA. During an off-nominal operation (i.e., if the vehicle lost pneumatics and could not reconnect to the ground systems), SpaceX may release the LCH₄ to the atmosphere. The amount of methane in the largest tank (Super Heavy) that would be released is approximately 814 tons. This represents the worst-case scenario and would be a rare, unplanned event.

2.1.3.3 Suborbital Launches

SpaceX is proposing to conduct Starship suborbital launches. During a suborbital launch, Starship would launch from the VLA and ascend to high altitudes and then throttle down or shut off engines to descend, landing back at the VLA or downrange either directly in the Gulf of Mexico or on a floating platform in the Gulf of Mexico. As the suborbital launches increase in altitude, a sonic boom might be produced during descent; however, this would only occur when Starship lands downrange in the Gulf of Mexico, no closer than 19 miles from shore. Sonic boom modeling for a Starship landing predicts that the sonic boom would not impact land (see Attachment 1 for the sonic boom report).

Following a suborbital launch, Starship would have LOX and LCH₄ (approximately 10 metric tons) remaining in the tank. Remaining LOX would be vented to the atmosphere and remaining LCH₄ would likely be released to the atmosphere. Due to risks to personnel, SpaceX is unable to reconnect the launch vehicle to ground systems when LCH₄ remains on the vehicle. In the future, SpaceX may recycle LCH₄ back into tanks at the VLA as technology and design develops. For the purposes of the environmental review, the FAA is assuming all residual LCH₄ is released to the atmosphere.

During the Program Development Phase, SpaceX is proposing to conduct up to 20 Starship suborbital launches annually. During the Operational Phase, SpaceX is proposing to conduct up to five Starship suborbital launches annually. Each launch would include a landing (Table 2-2).

2.1.3.4 Orbital Launches

SpaceX is proposing to conduct up to five Starship/Super Heavy orbital launches annually. Starship/Super Heavy missions would include Lunar and Mars missions, satellite payload missions, and the possibility of future human flight to the moon and Mars. Orbital launches would primarily be to low inclinations with flight north or south of Cuba that minimize land overflight. Future launches may be to higher, 70-degree inclination with limited overflight of remotely populated portions of Mexico. There could be multiple launches in close succession required to support a single mission (e.g., Lunar resupply missions). SpaceX's launch manifest (i.e., scheduled launches) is incomplete at this time but would evolve as the Starship/Super Heavy program develops. During the Program Development Phase, SpaceX is proposing to conduct up to three Starship/Super Heavy orbital

launches annually (Table 2-2). During the Operational Phase, SpaceX is proposing to conduct up to five Starship/Super Heavy orbital launches annually (Table 2-2). SpaceX would not exceed five Starship/Super Heavy orbital launches annually. SpaceX estimates approximately 7 metric tons of LCH₄ would be released to the atmosphere during Starship fuel loading for an orbital launch of the integrated launch vehicle.

Starship/Super Heavy would launch from the VLA. During a launch, the exhaust plume would surround the launch pad and surrounding areas. The plume would extend radially from the pad approximately 0.6 mile until reaching ambient temperature. The launch exhaust cloud formed from the exhaust plume would generate a temporary and minimal volume of water condensing from the exhaust cloud.

SpaceX is still determining whether a diverter would be used under the launch mount. A diverter is a metal structure placed on the launch pad underneath the rocket to divert the rocket plume laterally away from the ground. SpaceX is also still considering whether deluge water would discharge on the plume during a launch or test. If water were used, most of the water would be vaporized. If treatment or retention of stormwater or wastewater is required, water would be contained in retention ponds adjacent to the launch mount. The exact number, location, and size of the retention ponds within the VLA would be determined based on quantities of deluge water and final site plans. SpaceX would develop appropriate sampling protocols and water quality criteria in coordination with the Texas Commission on Environmental Quality (TCEQ).¹ SpaceX would remove water containing contaminants that exceed the water quality criteria and haul it to an approved industrial wastewater treatment facility nearby. SpaceX would pump all other water not containing prohibited chemicals back to the water storage tanks at the VLA. If surface water discharge were required, SpaceX would apply for a TCEQ Texas Pollutant Discharge Elimination System (TPDES) permit prior to the discharge event. All water (including deluge and potable water) would be either delivered by truck or withdrawn from existing or new wells located adjacent to the launch pad.

Each Starship/Super Heavy orbital launch would include an immediate boost-back and landing of Super Heavy. Landing could occur down range in the Gulf of Mexico, no closer than approximately 19 miles off the coast, or at the VLA. During flight, Super Heavy's engines would cut off at an altitude of approximately 43 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 to conduct the retrograde burn, which would place it in the correct angle to land. Once Super Heavy is in the correct position, the engines would be cut 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.

If a Super Heavy landing occurred downrange on a floating platform, Super Heavy would be delivered by barge to the Port of Brownsville and transported the remaining distance to the Boca Chica Launch Site over the roadways. A floating platform would be a mobile vessel that would not attach to the seafloor. For Super Heavy landings at the VLA and offshore, a sonic boom(s) would be generated. For landings at the VLA, the sonic boom would impact parts of Texas. Based on the modeling for Starship

¹ Texas Administrative Code, Title 30 Environmental Quality, Part 1 - Texas Commission on Environmental Quality, Chapter 307: Texas Surface Water Quality

landings at the VLA, the sonic boom produced when landing downrange would not impact land (see Attachment 1 for the sonic boom report). A maximum of five Super Heavy landings could occur each year (Table 2-2).

Similarly, each Starship/Super Heavy orbital launch would include a Starship landing at the VLA or in the Gulf of Mexico, Atlantic Ocean, or Pacific Ocean on a floating platform after Starship completes its orbital mission (Table 2-2). Starship would land vertically on the pad or on a floating platform and go into an automated safing sequence (i.e., put the vehicle in a safe state). As Starship slows down during its landing approach, a sonic boom(s) would be generated and impact parts of Texas when landing at the VLA. Based on the modeling for Starship landings at the VLA, the sonic boom produced when landing downrange would not impact land (see Attachment 1 for the sonic boom report). After Starship is in a safe state, a mobile hydraulic lift would raise Starship onto a transporter. If a Starship landing occurred downrange on a floating platform, it would be delivered by barge to the Port of Brownsville and transported the remaining distance to the Boca Chica Launch Site over roadways. Following Starship landings at the VLA, it would be transported from the landing pad to the adjacent launch mount or to one of SpaceX's production locations for refurbishment.

Following an orbital launch, Starship and Super Heavy would have remaining LOX and LCH₄ in the vehicle. Remaining LOX would be vented to the atmosphere and remaining LCH₄ would likely be released to the atmosphere. Due to risks to personnel, SpaceX is unable to reconnect the vehicle to ground systems when LCH₄ remains on the vehicle. Super Heavy would have approximately 5 metric tons of LCH₄ onboard following an orbital flight. In the future, SpaceX may recycle LCH₄ back into tanks at the VLA as technology and design develops. For the purposes of the environmental review, the FAA assumes all residual LCH₄ is released to the atmosphere. During early unmanned orbital launches, SpaceX may require expending Super Heavy or Starship in the ocean downrange no closer than 18 miles offshore. If this occurs, SpaceX will not recover Super Heavy or Starship. SpaceX expects each stage would sink in the ocean.

2.1.3.5 Nominal Operational Closures

Tanks tests, wet dress rehearsals, static fire engine tests, and launches (suborbital and orbital) would require restricting public access in the vicinity of the VLA and securing land and water areas as part of public safety requirements. The areas on land that would be closed to public access is referred to as the *closure area* (Figure 2-4.). The closure area includes an area of Boca Chica Beach, ranging from the Brownsville Shipping Channel south to the U.S./Mexico border. The Brownsville Shipping Channel would be temporarily restricted during orbital launches and some suborbital launches, but not restricted during tank tests, wet dress rehearsals, or static fire engine tests. SpaceX would coordinate with the Port of Brownsville to establish the times that activity in the shipping channel would be restricted. In the event of an anomaly, SpaceX would also inform the Port of any continued hazards and effects to channel restrictions.

For purposes of the environmental review, the FAA defines an operational closure as follows:

A closure begins when local law enforcement, under the direction of an order from the Cameron County Commissioners Court, shuts down SH 4 and Boca Chica Beach for a tank test, wet dress rehearsal, static fire engine test, or launch. A closure ends when the operation is completed and local law enforcement open SH 4 and Boca Chica Beach.

The FAA does not have a direct role in approving beach closures. Therefore, closures that are planned but not implemented (e.g., SpaceX revokes the closure) do not meet the FAA's definition of a closure for the purposes of the environmental review. For an operation requiring a closure, SpaceX would operate in accordance with the Economic Development Agreement between Cameron County, Texas, Cameron County Spaceport Development Corporation, and SpaceX (Economic Development Agreement 2014).

There may be certain operations, anomalies, or emergencies that require notification of closure to occur within two weeks of the activity. In those instances, SpaceX would notify Cameron County Commissioner's Court immediately with a closure request. SpaceX would post written notices of the date, time, and the proposed closure online at the Cameron County website.² SpaceX would also coordinate with U.S. Customs and Border Protection, Cameron County and State of Texas law enforcement agencies, the U.S. Coast Guard, and Houston Air Route Traffic Control Center to ensure public safety and allow for the issuance of Notice to Mariners (NOTMAR) and Notice to Airmen (NOTAM). In addition, SpaceX would coordinate with the Secretariat of Communications and Transportation–Mexico if any land or water closures in Mexico were required.

SpaceX also would continue to send out notifications to regulatory and public land-managing agencies of anticipated closures. The agencies would continue to receive updates immediately when the closures go into place and when the closures end, as well as cancellations of requested closures. These notifications would be sent from the LLCC managing the operation to ensure the most up-to-date information. If an agency needs to access an area within a planned closure window, SpaceX will work with the agency to find the best opportunity to access the area.

Prior to an operation requiring a closure, the public would be notified through local media and through the use of NOTMARs and NOTAMs. SpaceX would also inform the cities of Brownsville and South Padre Island; NPS, including Palo Alto Battlefield National Historical Park; USFWS, including Lower Rio Grande Valley National Wildlife Refuge (NWR); TPWD; Texas General Land Office (TGLO); and Texas Department of Transportation (TxDOT) of the operation and associated closure schedules. Given the proximity of the Lower Rio Grande Valley NWR to the launch site, SpaceX has committed to work with the USFWS to fund additional resources or personnel necessary to enforce the closures required for launch operations.

SpaceX proposes to limit public access at four pre-defined checkpoints on SH 4 to ensure that unauthorized persons remain out of the flight hazard area³ (see Figure 2-4.). These checkpoints are similar to the checkpoints established during preparation of the FAA's 2014 Environmental Impact Statement (EIS) (FAA 2014) in coordination with the NPS and USFWS. The 2014 EIS and associated BA (FAA 2013) included two checkpoints: a soft checkpoint (located near the U.S. Customs and Border Patrol checkpoint) and a hard checkpoint (located near the LLCC). SpaceX is proposing a third checkpoint between those two checkpoints.

A soft checkpoint would be located at the intersection of Oklahoma Avenue and SH 4, just east of Brownsville. Government personnel, SpaceX personnel, and anyone with property beyond this soft

² See: <https://www.cameroncounty.us/space-x/>

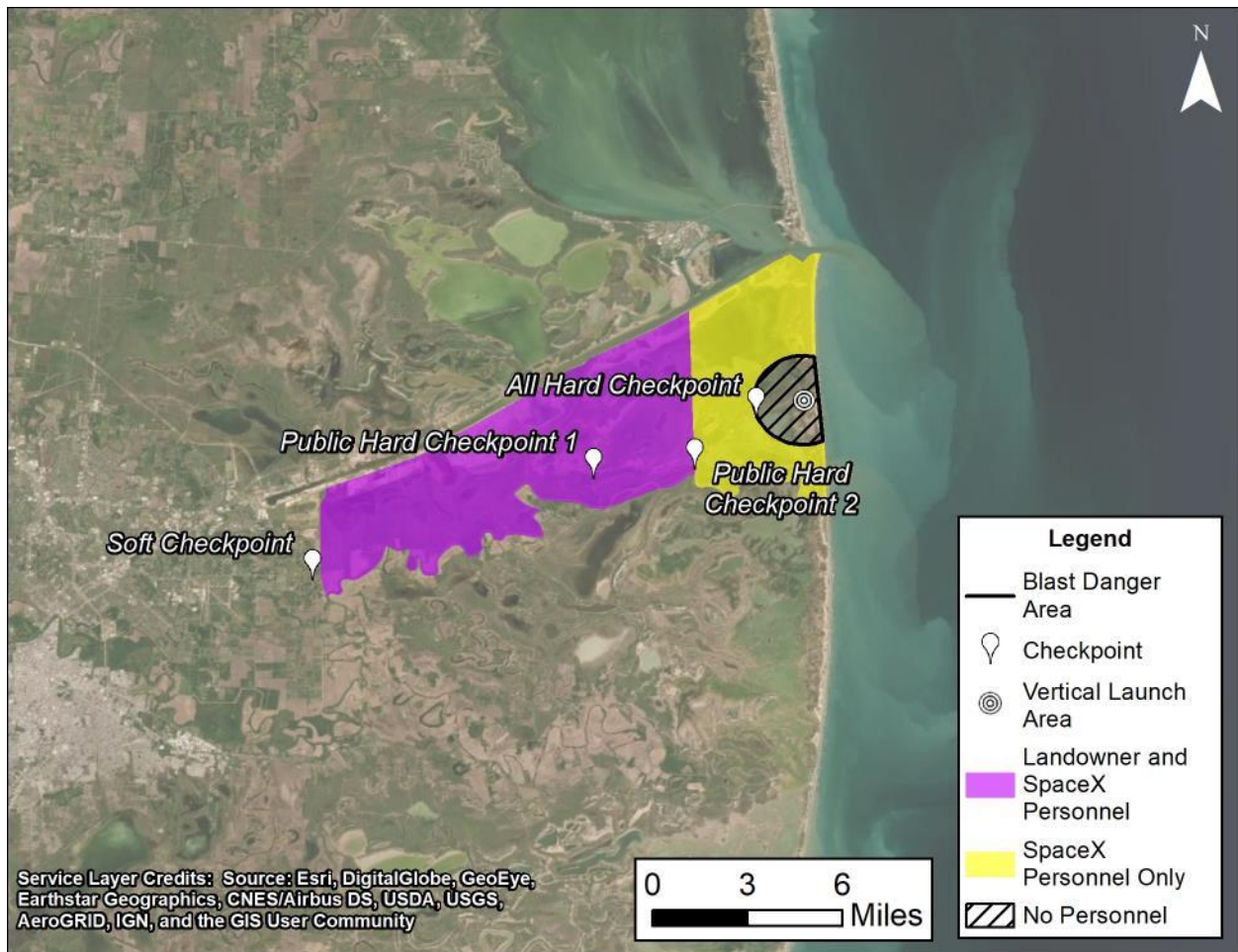
³Flight hazard area means any region of land, sea, or air that must be surveyed, controlled, or evacuated to ensure compliance with the safety criteria in 14 CFR § 450.101.

checkpoint could pass, but the general public would be denied access. The second checkpoint (referred to as “public hard checkpoint 1”) would be located at the intersection of Massey Way and SH 4. Only SpaceX personnel, government personnel, emergency personnel involved in SpaceX operations, and anyone with property beyond this checkpoint would be able to pass this checkpoint. The third checkpoint (referred to as “public hard checkpoint 2”) would be located at the intersection of SH 4 and Richardson Avenue. Only SpaceX personnel and FAA launch support personnel would be able to pass this checkpoint. The final checkpoint (referred to as “all hard checkpoint”) would be located just west of the LLCC. No one would be able to pass this checkpoint (Figure 2-4).

The Economic Development Agreement between Cameron County, Texas, Cameron County Spaceport Development Corporation, and SpaceX allows Cameron County to protect public safety and ensure that landowners and residents are absent from their property in the Safety Zone determined by the FAA flight safety analysis.

A closure for pre-launch operations, including tank tests, wet dress rehearsal, or static fire engine tests would be shorter than a closure for a launch (suborbital or orbital). The total number of closures and closure hours for tank tests, wet dress rehearsals, static fire engine tests, and launches would require approximately 500 hours of closure per year for nominal operations. The environmental review assumes SpaceX would not exceed 500 hours of closure per year. As of May 24, 2013, House Bill 2623 was signed by Texas Governor Rick Perry to amend the Texas Natural Resources Code Chapter 61 (Sec. 61.132) to allow for the TGLO and/or the Cameron County Commissioners Court to temporarily restrict access to public beaches for space flight activities, including launches. Per House Bill 2623, if the primary launch date falls on the major summer holidays of Memorial Day, Fourth of July, Labor Day, and/or summer weekends between Memorial Day and Labor Day weekends, additional approval from the TGLO is required. SpaceX expects to renegotiate an agreement with the Cameron County Commissioners Court to increase the closure hours to 500 hours per year.

Figure 2-4. Closure Area



2.1.3.6 Personnel Levels

Launch operations related to the Starship/Super Heavy launch program would result in an increase of permanent and temporary personnel. SpaceX expects a maximum of 450 full-time employees or contractors would be onsite to support the Starship/Super Heavy launch program. To minimize potential impacts to wildlife from vehicles and reduce the number of vehicles traveling along SH 4, SpaceX provides a shuttle from Brownsville to the launch site for employees.

2.1.3.7 Anomalies

A Starship/Super Heavy test operation or launch could fail (referred to as an anomaly or mishap). An anomaly on the launch pad represents the greatest risk to the environment. If this occurs, a number of possible outcomes could result, the most likely being a fire on the launch pad. An explosion on the launch pad would spread debris. As part of evaluating a license or permit application, the FAA evaluates SpaceX’s debris analysis to ensure the hazard area is of sufficient size to ensure public safety. In the event of an anomaly, the FAA expects the debris would be contained within the FAA-approved hazard area, which would be contained within the “all hard checkpoint” area shown in Figure 2-4 (black dashed area represented as “no personnel”).

In the event of an anomaly, SpaceX would evaluate the level of response based on the situation and notify the appropriate emergency personnel and land-managing agencies. SpaceX would contact Cameron County Emergency Management and Brownsville Fire Department. The U.S. Coast Guard would be contacted to report any impact to safety of waterways. SpaceX would also coordinate with the Cameron County judge, the Cameron County Commissioner, and the Cameron County Fire Marshal to provide information on the anomaly. SpaceX would adhere to its Fire Mitigation and Response Plan to prevent and respond to any fires.

SpaceX has established a communication process with TPWD and USFWS through an agreed upon point of contact for coordination of access to agency land, debris removal from agency land, and the status of closures to ensure safety following an anomaly. Immediately following an anomaly, it may be required to continue to restrict public access in the vicinity of the VLA to address any impacts and ensure public safety. SpaceX would request an extension of the closure from Cameron County. The closure would be released when the area is deemed safe for the public by TPWD, USFWS, SpaceX, and Cameron County. SpaceX estimates up to 300 anomaly-response hours would be needed for addressing impacts specifically from anomalies. These hours would not count towards the nominal operational closure hours and would be used at the discretion of Cameron County, TPWD, and USFWS. The hour count for nominal operations would stop when the launch operation is complete and the area is deemed safe for SpaceX or emergency personnel to enter. The anomaly-response hour count would start at that point to address debris removal and last until the area is deemed safe for the public and the closure is released.

If SpaceX suspects debris falls on foreign land, SpaceX will contact the U.S. Department of State. The State Department would lead any international coordination, and SpaceX would provide assistance upon request.

During a suborbital or orbital launch, the launch vehicle would be equipped with either a thrust termination or a destructive flight termination system, or both. In the event the vehicle varied from the planned trajectory, the vehicle would break up and debris could land within the hazard area or in the Gulf of Mexico.

2.1.4 Construction

SpaceX is proposing additional construction, including expanding the solar farm near the LLCC, adding infrastructure and facilities at the VLA, parking lots, a liquid natural gas pretreatment system, a liquefier, a payload processing facility, and trenching and pull-offs along SH 4. At the VLA, SpaceX is proposing to construct a redundant launch pad and commodities, a redundant landing pad, two integration towers, tank structural test stands, a desalination plant, additional support buildings, and a power plant. The FAA has informed SpaceX that any actions SpaceX takes to construct integration towers at the launch site, or any other action in furtherance of the Starship/Super Heavy launch vehicle program, will not prejudice any FAA environmental or licensing decisions. The draft Programmatic Environmental Assessment assumes the integration towers do not exist at the launch site.

This new infrastructure and facilities would result in expansion of the VLA footprint to SpaceX's property boundary, excluding the dune buffer zone, which is 1,000 feet from the mean high tide line. Since publishing the 2014 EIS (FAA 2014) and associated documents, SpaceX has surveyed the

property boundary of the VLA. The updated parcel boundary is shown in Figure 2-5. Figure 2-6 shows the proposed VLA layout, including existing and proposed license-related infrastructure. Figure 2-7 shows the overall layout of the SpaceX facilities, including the VLA, the LLCC, and other infrastructure within the scope of the FAA-licensed activities, as well as infrastructure related to non-licensed SpaceX activities in the private production and manufacturing area. The proposed infrastructure and facilities at the launch site are discussed in the following sections.

Figure 2-5. Survey-Verified Vertical Launch Area Parcel



Figure 2-6. Proposed Vertical Launch Area Layout

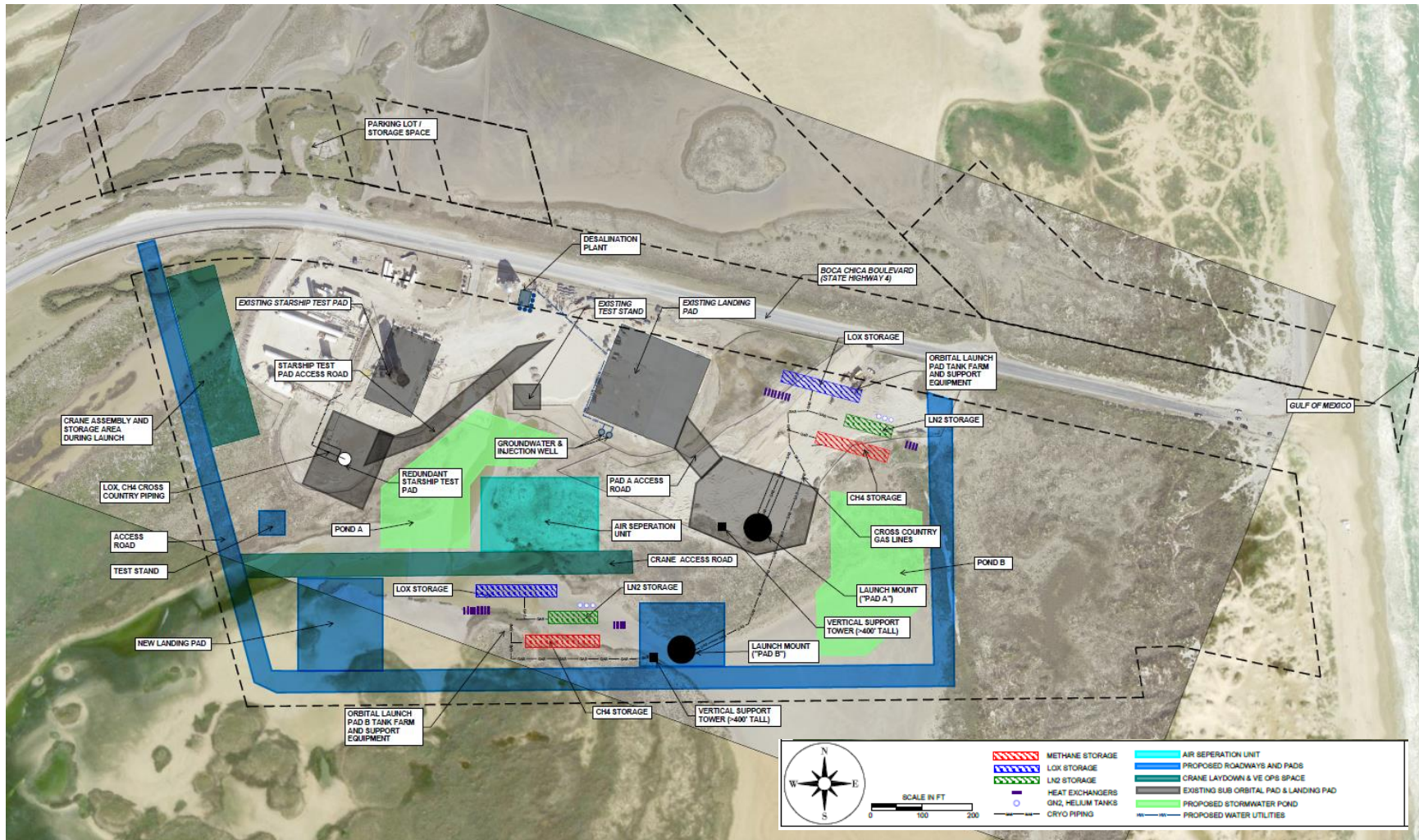
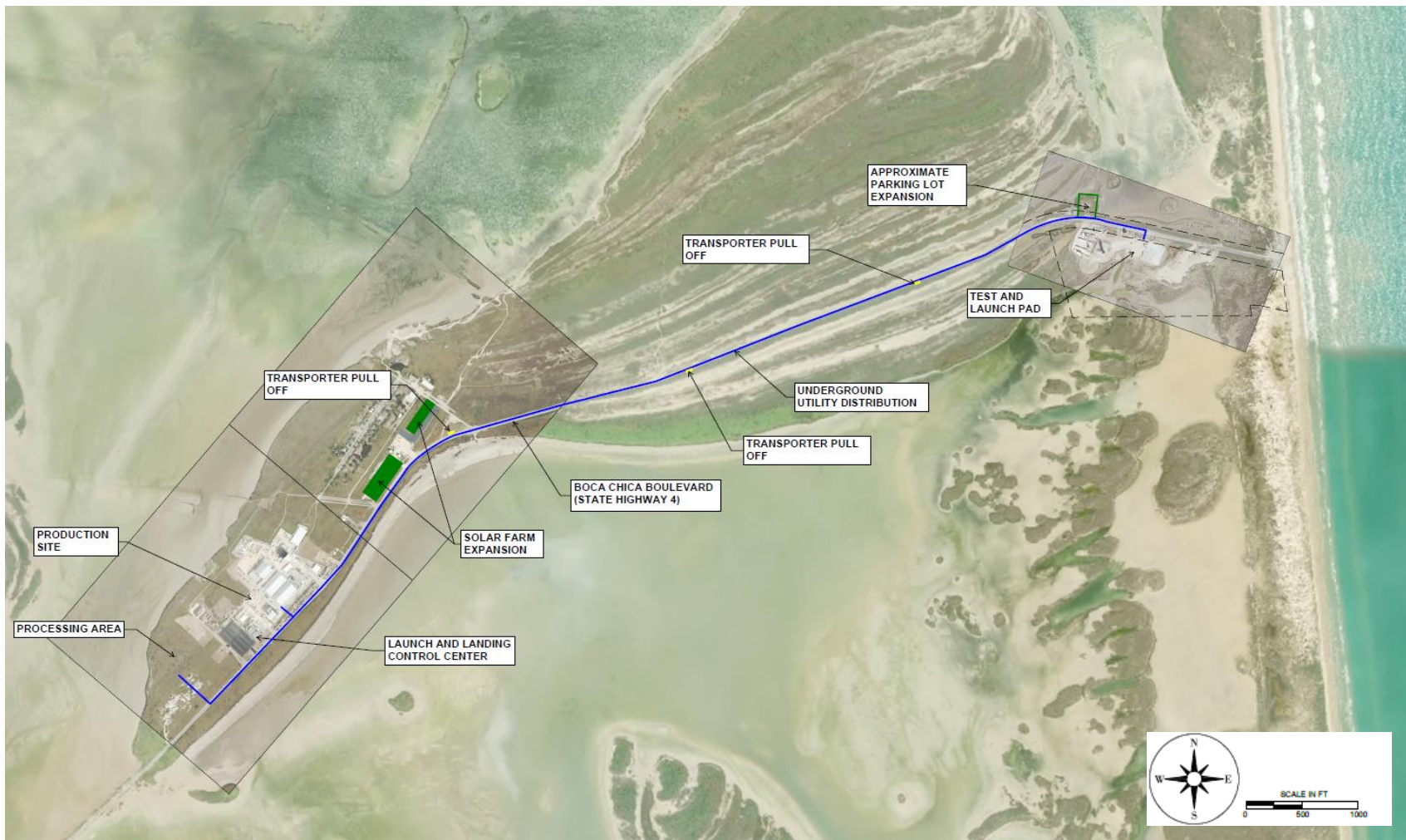


Figure 2-7. Site Overview



2.1.4.1 Redundant Launch Pad and Commodities

SpaceX is proposing to construct a redundant launch pad (denoted as “Launch Mount (‘Pad B’)” in Figure 2-6) adjacent to the existing launch pad (denoted as “Launch Mount (‘Pad A’)” in Figure 2-6). Pad B would be approximately 65 feet high with a similar footprint and layout as Pad A. SpaceX would expand the existing commodity farm. SpaceX is proposing to install approximately 11 commodity tanks, each up to 98 feet tall, near Pad A and proposed Pad B. The tanks would hold LOX, LN₂, water, helium, gaseous nitrogen, gaseous methane, and LCH₄.

2.1.4.2 Redundant Landing Pad

SpaceX is proposing to add a second landing pad in the southwest corner of the VLA. The pad would have similar dimensions as the existing landing pad (approximately 226 feet long by 226 feet wide). The redundant landing pad would be used when another launch vehicle is occupying the other landing pad or if the other landing pad is damaged by an anomaly.

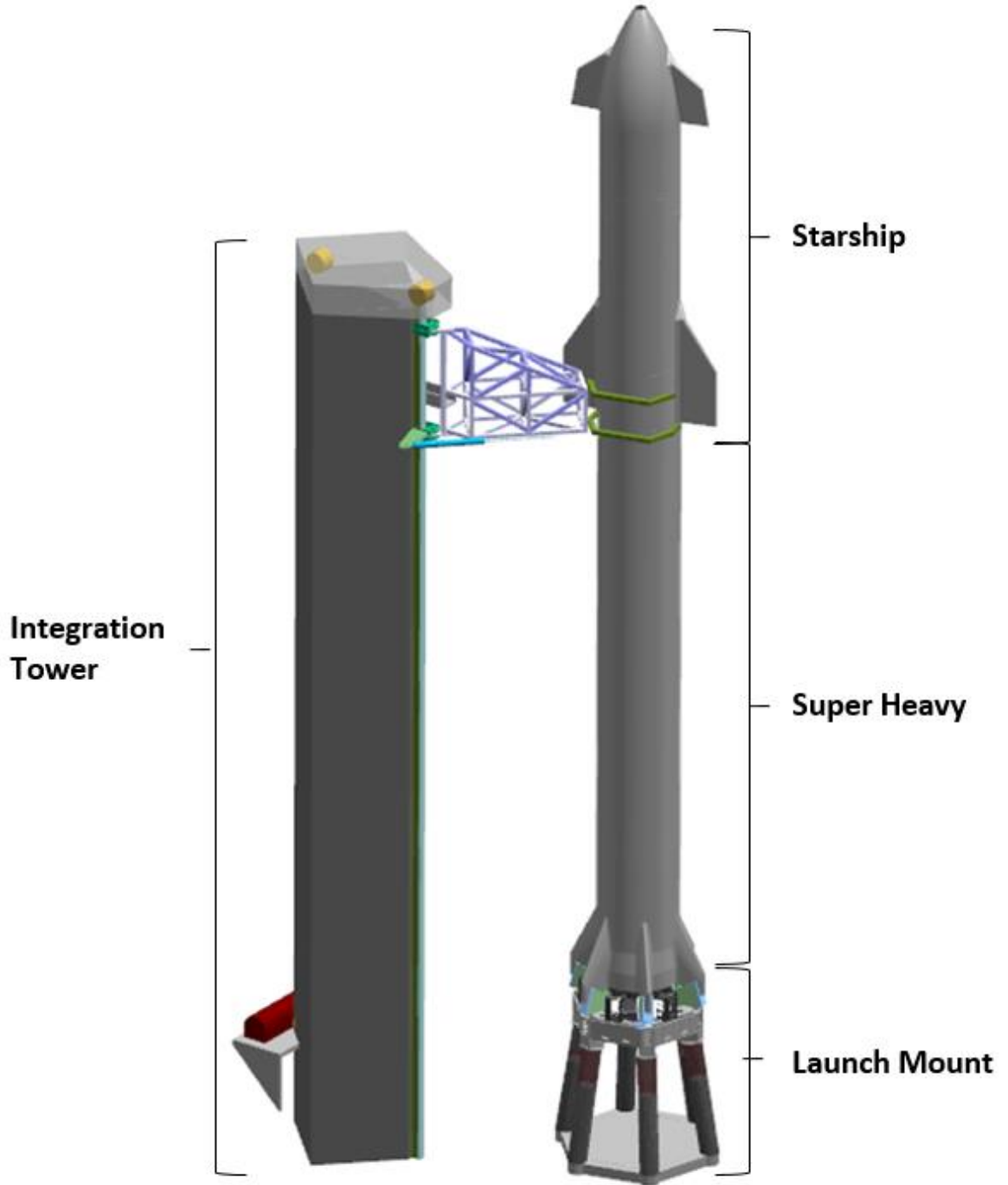
2.1.4.3 Integration Towers

SpaceX is proposing to construct two permanent integration towers to integrate the Starship/Super Heavy launch vehicle. Each tower would be approximately 480 feet tall with a 10-foot lightning rod on top and include black cladding. SpaceX would construct one integration tower adjacent to Pad A and another adjacent to proposed Pad B. The launch vehicle would be integrated vertically on the launch pad. Super Heavy would be mated to the launch mount, followed by Starship mated to Super Heavy. Figure 2-8 shows an integration tower and Starship/Super Heavy on a launch mount. Until the integration towers are constructed and operational, SpaceX would use a 450-foot-tall crane to integrate Starship/Super Heavy. SpaceX would store the crane in the northwest section of the VLA (Figure 2-6) when not in use. The crane would stay up most of the time and would be lowered to approximately 250 feet during launches.

2.1.4.4 Tank Structural Test Stands

SpaceX currently performs structural tank tests, which includes pneumatic, hydrostatic, and cryogenic testing (Section 2.1.3.1), at the VLA on a concrete pad with temporary infrastructure. SpaceX is proposing to add infrastructure to the existing tank structural test stand and construct another structural test stand. The footprints for the tank structural test stands would be approximately 60 feet long by 60 feet wide and would be 10–20 feet tall.

Figure 2-8. Launch Mount, Vehicle, and Integration Tower



2.1.4.5 Desalination Plant

SpaceX is proposing to construct a desalination plant at the VLA (Figure 2-6). The plant would be approximately 4,300 square feet in size. The desalination plant would treat water from two new source wells and the existing well at the VLA. SpaceX is proposing to drill two new wells approximately 650 feet deep. Groundwater would be extracted at an approximate rate of 40 gallons per minute (gpm). Well water would be desalinated through thermal evaporation, which would use a boiler, several holding tanks, and a brine tank pre-injection well. SpaceX is proposing to install an injection well for brine disposal. The injection well would be approximately 2,950 feet deep, and brine would be injected into the well at an approximate rate of 15 gpm. SpaceX would use the brine tank until the injection well was operational. SpaceX would use the water for sound and fire suppression during tests and launches. SpaceX would store the water in an aboveground tank at the VLA. SpaceX anticipates all desalination equipment would be below 30 feet tall, except the water storage tank, which would be approximately 70 feet tall.

2.1.4.6 Support Buildings and Parking Lots

SpaceX is proposing to construct additional support buildings at the VLA. The buildings would be below 30 feet in height. SpaceX is also proposing to construct parking lots for personnel working at the launch site. The parking lots would be built in combination with existing parking areas to accommodate the staff supporting tests and launches. One of the proposed parking lots would be located across from the VLA along SH 4 on SpaceX-owned land that was not previously assessed in the 2013 BA (FAA 2013). Parking lot construction materials could include permeable material, asphalt, road base, or concrete.

2.1.4.7 Power Plant

SpaceX is proposing to construct a power plant to generate power for activities at all SpaceX facilities, including the VLA. The power plant would be located at the VLA (Figure 2-6) or at the processing area (Figure 2-7). SpaceX has not determined the exact location, but it would not be outside the footprint analyzed in this document. The power plant would be approximately 5.4 acres in size. Power for the power plant would be generated using a large natural gas turbine and a steam turbine running in a combined cycle, and a small natural gas turbine and a steam turbine running in a combined cycle. The power plant would be comprised of multiple structures, including air intake, compressors, expanders, reflux tanks, surge tank, cold box, and cooling tower. Some of these structures would be less than 30 feet tall; however, some structures would be up to 150 feet tall. The power plant would operate 24/7, and lighting would be minimal at the facility. All lighting plans would be coordinated with the USFWS and NPS and included in the Facility Design and Lightning Management Plan.

2.1.4.8 Trenching

As previously described in the 2013 BA (FAA 2013), installation of conduit for underground utilities would require trenching along SH 4. Proposed utilities include water and communication lines. SpaceX would coordinate any modifications to SH 4 with TxDOT. The USFWS owns a portion of the SH 4 right-of-way. SpaceX would apply for a special use permit from the USFWS for work in this area.

2.1.4.9 Payload Processing Facility

SpaceX is proposing to construct a payload processing facility at SpaceX's manufacturing and production area (Figure 2-7). In 2013, SpaceX proposed constructing two payload processing facilities, each up to 14,670 square feet in size and 65–85 feet tall. SpaceX is now proposing to construct one payload processing facility up to 22,000 square feet in size and up to 240 feet tall. SpaceX has not determined the exact location of the facility within the manufacturing and production area.

2.1.4.10 Natural Gas Pretreatment System

SpaceX is proposing to construct a natural gas pretreatment system at the processing area (Figure 2-7) or at the VLA (Figure 2-6). SpaceX would process natural gas brought to the site for use as propellant and for power generation. The natural gas pretreatment system would remove impurities such as water, carbon dioxide (CO₂), and hydrocarbons heavier than methane from the extracted natural gas to create a stream of pure gaseous methane. Following pretreatment, methane would be liquefied for transportation. The natural gas pretreatment system would include a main de-ethanizer that would be approximately 200 feet tall and 16 feet in diameter and include smaller cylinders approximately 6 feet tall.

2.1.4.11 Liquefier

SpaceX is proposing to construct a liquefier in tandem with two heat exchangers at the processing area (Figure 2-7) or at the VLA (Figure 2-6). The heat exchangers would use cryogenic liquid nitrogen produced by the liquefier from compression and expansion of nitrogen to supercool gasses into liquid states for storage and transportation. One heat exchanger would be used for methane and the other for oxygen. Each liquefier would be approximately 12,300 square feet in size, with multiple structures including the two heat exchangers up to 26 feet tall.

2.1.4.12 Expanded Solar Farm

SpaceX is proposing to expand the solar farm to a total of 7 acres. Figure 2-9 shows the proposed layout of the solar farm, which includes the previously approved area and the proposed expansion area. The 5.4-acre area in green in the figure was assessed in the 2013 BA (FAA 2013) and subsequent Written Re-evaluations. SpaceX has constructed approximately 2 acres of solar farm (shown in white in the figure). SpaceX is proposing to expand the solar farm by approximately 1.7 acres into land not previously assessed (shown in blue in the figure). The solar farm consists of solar arrays and batteries for power storage. In conformity with the existing solar arrays, the new solar arrays would be about 6.5 feet tall and composed of non-highly reflective materials. Any new batteries would be housed in small structures, approximately 13 feet tall and 970 square feet in size.

Figure 2-9. Proposed Solar Farm Layout



2.1.4.13 Pull-offs along State Highway 4

SpaceX would transport Starship or Super Heavy from the SpaceX production area to the VLA along SH 4. Due to the large size of the vehicles and transporter, SpaceX, in coordination with local law enforcement, must stop traffic to allow for the passage of the transporter. SpaceX proposes to add three pull-offs along SH 4 to allow traffic to pull onto a widened shoulder so the transporter can pass. The proposed locations of the three pull-offs are shown in Figure 2-7. The pull-offs would be approximately 75 feet long by 30 feet wide and would be within the SH 4 right-of-way. The transporter moves at 2 miles per hour. The proposed locations of the three pull-offs would create a maximum wait time of about 20 minutes for drivers instead of necessitating a closure of SH 4 in both directions. SpaceX would coordinate construction of the pull-offs with TxDOT and Cameron County.

2.2 PROPOSED CONSERVATION MEASURES TO AVOID, MINIMIZE, AND MITIGATE POTENTIAL EFFECTS TO LISTED SPECIES AND CRITICAL HABITAT

The following sections describe conservation measures that the FAA would ensure SpaceX would implement to avoid, minimize, and mitigate potential effects on ESA-listed species and critical habitat. These measures would be captured in the Record of Decision, which would be referenced as a term and condition of future licenses.

2.2.1 Construction Measures

- 1) In conjunction with final design and Clean Water Act (CWA) permitting, SpaceX will be updating its Stormwater Pollution Prevention Plan (SWPPP). The SWPPP will include Best Management Practices for erosion and sedimentation controls, including techniques to diffuse and slow the velocity of stormwater to reduce potential impacts (e.g., soil loss and sedimentation) to water quality during construction. All construction activities with the potential to impact water quality from potential runoff from the site would be conducted in accordance with the stormwater permit, including measures identified in the SWPPP.
- 2) Prior to entry and exit into unpaved areas of the VLA, SpaceX would ensure heavy equipment traverses over a construction shaker or rumble plates or rock bed located at the VLA to remove any sediment and dirt for purposes of preventing the introduction and spread of non-native plant species. The equipment would be inspected to ensure that hydraulic fittings are tight, hydraulic hoses are in good condition (and replaced if damaged), and there are no petroleum leaks.
- 3) No excavated or fill material would be placed in delineated CWA Section 404 waters of the U.S. except as authorized by a permit from the U.S. Army Corps of Engineers. SpaceX would ensure that discharged water associated with concrete mixing and placement activities does not reach surrounding water bodies or pools unless specifically authorized in a Department of Army permit.
- 4) SpaceX would contract a qualified biologist to be present during the beginning of the construction period to provide all construction personnel with an environmental worker-education briefing that would include, but not be limited to, the following:
 - a. Wildfire prevention measures, including restricting smoking to areas clear of vegetation, ensuring no fires of any kind are ignited, and equipping vehicles with spark arrestors and fire extinguishers.
 - b. Information regarding noxious/invasive weeds; the spread of noxious/invasive weeds would be limited by routine inspections of the area and removal of any such species.
 - c. Requirements for safe handling and disposal of hazardous wastes.
 - d. Proper disposal of all organic and inorganic litter and garbage (including cigarette butts). Such material would be disposed of in covered containers. The construction contractor would dispose all trash and debris off site daily.
 - e. Requirements for safe handling and disposal of hazardous wastes.
- 5) If proposed construction activities occur during the avian breeding season (February 15 through August 31), SpaceX would ensure construction activities occur in accordance with the Migratory Bird Treaty Act (MBTA) to avoid impacts to nesting migratory birds within the project area. Specifically, a biologist would check the proposed areas of construction activities, including laydown areas, for nests (in shrubs and on the ground) once before the construction phase has begun. If the biologist finds an active nest, construction workers would not directly or indirectly disturb the nest or adjacent areas until the biologist determines the nest is no longer in use.
- 6) To comply with the MBTA, project design and any above-ground utility upgrades would

incorporate raptor protection measures, as applicable. For example, structures would be equipped with devices to discourage nest building and perching (e.g., monopole technology and visual fright devices).

- 7) SpaceX would educate its personnel on the potential for vehicle collisions with ocelots and jaguarundis and encourage personnel to reduce speeds along SH 4. Any contractor or employee disobeying speed limits would be disciplined.
- 8) Vehicles would be restricted to existing paved and unpaved roads, parking areas, and authorized construction sites. Vehicle operators within the VLA would not exceed 25 miles per hour.
- 9) SpaceX would continue contracting a qualified biologist to conduct pre-, during, and post-construction biological monitoring (vegetation and birds). This monitoring is ongoing and would continue to be conducted within 1 mile of construction areas. Monitoring reports would continue to be sent to the USFWS annually.

2.2.2 Operational Measures

- 1) SpaceX will update the existing Facility Design and Lighting Management Plan to account for Starship/Super Heavy launches and related infrastructure and send to the USFWS for review and approval. The intent of the plan is to minimize design and lighting effects on wildlife, including ESA-listed species. As SpaceX progresses with site design, SpaceX will update the plan and send to USFWS. Examples of lighting requirements that would be incorporated into the plan include:
 - a. Directing, shielding, or positioning facility lighting to avoid visibility from the beach, minimize lateral light spread, and decrease uplighting (without compromising safety and security of personnel).
 - b. Turning off lights when not needed.
 - c. Using low pressure sodium, to the extent practicable, during sea turtle nesting season. Limitations to the use of low-pressure sodium include the use of white lighting required for protection and safety of SpaceX personnel for ground support operations performed 24/7 throughout the year and the use of bright spotlighting during nighttime launch activities.
 - d. Installing new lighting with multiple levels of control so that lighting levels can be matched with specific activities.
 - e. Where lighting is not essential to safety or security of personnel, installing timers to switch lights off in the evening. Where applicable and not a threat to security, installing motion-detector switches.
- 2) SpaceX would educate its personnel on the potential for vehicle collisions with ocelots and jaguarundis and encourage personnel to reduce speeds along SH 4. Any contractor or employee disobeying speed limits would be disciplined. SpaceX-owned or -operated vehicles would be restricted to existing paved and dirt roads and parking areas. SpaceX vehicle operators would not exceed 25 miles per hour near the VLA.
- 3) SpaceX would continue contracting a qualified biologist to conduct pre- and post-launch biological surveys (vegetation and birds). Monitoring would be conducted within 1 mile of the VLA the day before a Starship or Super Heavy launch and the day after the launch. Monitoring

reports would be sent to the USFWS following compilation and analysis of the data.

- 4) SpaceX would continue working with Sea Turtle Inc. to provide sea turtle survey data within the action area to the USFWS annually.
- 5) In coordination with NWR staff, SpaceX would develop a protocol (e.g., Closure Notification Plan) providing as much advance notice as practicable to minimize disruption to refuge and land management activities.
- 6) In coordination with NWR staff, SpaceX would identify further options that would assist in protecting refuge lands and species habitats from impacts that may occur from public intrusions prior to closures. For example, vehicle barriers, in the form of short, spaced posts, sufficiently close together to prevent a truck or all-terrain vehicle from entering, but wide enough apart to allow for terrestrial animals to pass. This could be done alongside SH 4 or other identified roads where the footprint is already disturbed.
- 7) SpaceX would coordinate with the USFWS to fund additional resources or projects to enforce the closures required for launch operations.
- 8) Prior to operations requiring a closure, SpaceX would continue to coordinate with U.S. Customs and Border Protection, Cameron County; Cameron County and State of Texas law enforcement agencies; the City of Brownsville; the City of South Padre Island; NPS; Palo Alto Battlefield National Historic Park; USFWS, Lower Rio Grande Valley NWR; TPWD; TGLO; TxDOT, and USGC.
- 9) If an anomaly occurs, SpaceX will coordinate with TPWD and USFWS prior to retrieving or cleaning up launch vehicle components on land owned or managed by TPWD and USFWS. SpaceX would work with TPWD and USFWS to evaluate any damage and determine appropriate mitigation. SpaceX would be responsible for the cost to mitigate any damages. SpaceX would comply with its applicable site plans, including an Anomaly Response Plan, Security Plan, and Fire Mitigation and Response Plan.

3 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.” For the Proposed Action, the action area is defined by those areas exposed to noise (engine noise and sonic booms) during Starship/Super Heavy launches (which includes landings) and the closure area. These areas represent the largest geographical area for which effects to ESA-listed species and critical habitat could occur.

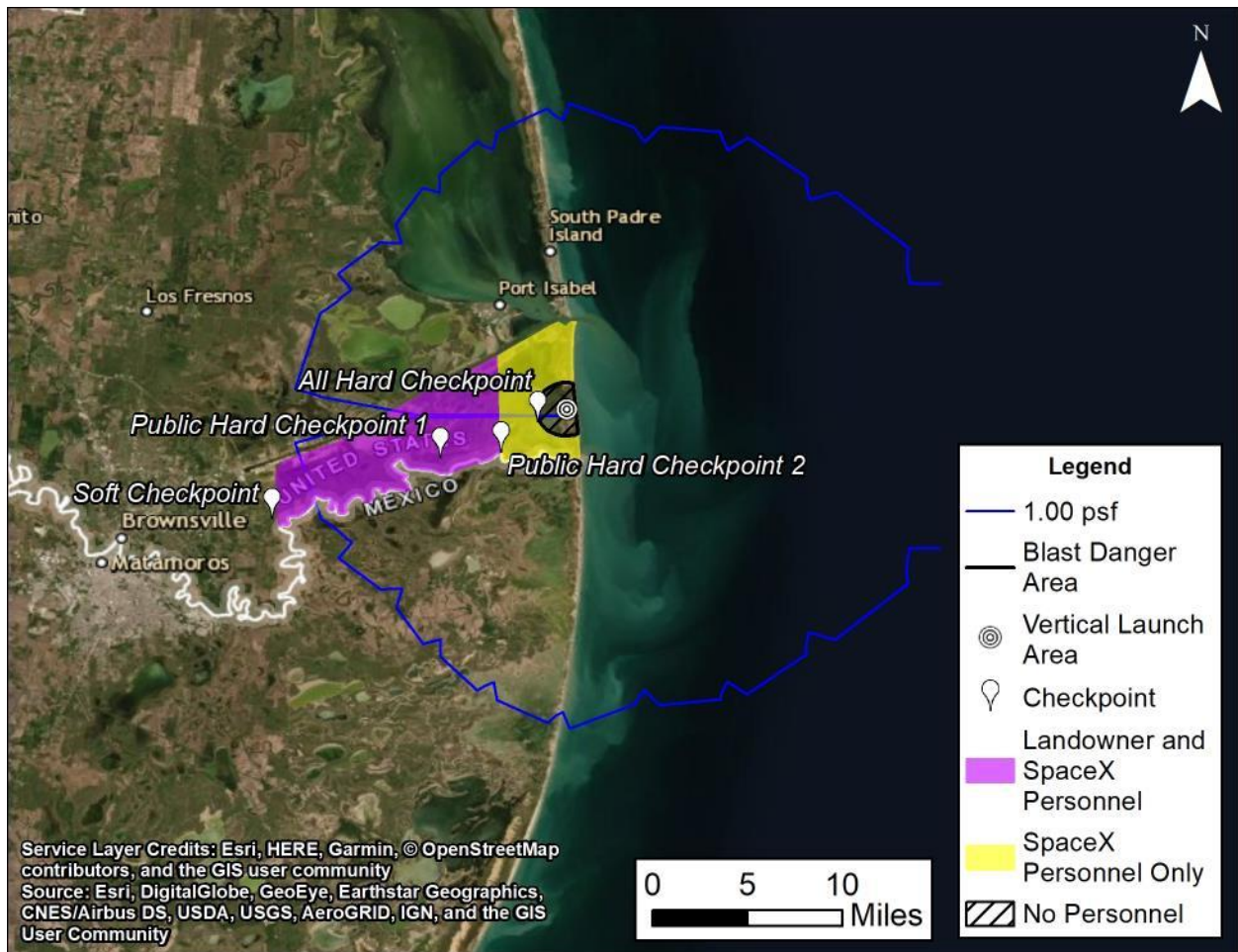
In accordance with the 2013 BA (FAA 2013), the engine noise component of the action area is defined by the 105 decibel (dB) maximum A-weighted sound level (L_{Amax}). Based on noise modeling conducted for the project, the 105 dB L_{Amax} is estimated to extend approximately 5 miles from the launch pad over land.

The sonic boom component of the action area includes those areas exposed to overpressures greater than 1 pound per square foot (psf). An overpressure of 1 psf is like a clap of thunder; overpressures less than 1 psf are not expected to adversely affect animals. Sonic booms would be generated during Super Heavy and Starship landings at the VLA (see Figures 5-2 and 5-3). The sonic boom modeling shows that a Super Heavy landing at the VLA would affect the greatest land area. Modeled overpressures for a Super Heavy booster landing that are greater than 1 psf extend about 13 miles from the launch pad (Figure 5-3). Beyond 13 miles, modeled overpressures are less than 1 psf.

The closure area (Figure 2-4) includes those areas that would be closed to the public during tanks tests, wet dress rehearsals, static fire engine tests, and launches (suborbital and orbital). Most of the closure area is subsumed by the overall action area defined by the engine noise and sonic boom, except for a small area by the soft checkpoint (see Figure 3-1).

Figure 3-1 shows the action area. In summary, the action area is delineated by the closure area and areas that would be exposed to sonic booms with modeled overpressures of at least 1 psf (which includes the area exposed to engine noise levels of 105 dB L_{Amax}).

Figure 3-1. Action Area



The existing conditions in the action area are like the conditions described in the 2013 BA except for the presence of SpaceX’s facilities. The launch site is located in a sparsely populated coastal area adjacent to the Gulf of Mexico and ecologically unique public lands owned by TPWD and USFWS Lower Rio Grande Valley NWR. The area is characterized by marsh and barrier island plant communities, shallow open water, algal flats, and unvegetated tidal flats. Uplands consist of low, newly forming sand dunes with their anchoring vegetation amidst bare sand flats. The open water areas are fringed with black mangroves and vegetated with seagrasses. Small, ecologically unique clay hills, known as “lomas,” support a diverse group of rare plants and terrestrial wildlife.

The Boca Chica Tract of the Lower Rio Grande Valley NWR comprises one of the last undeveloped, pristine coastal areas in Texas. Roughly measuring about 11,000 acres in size, it encompasses wind-tidal flats, mangrove forests, oyster beds, bays, beaches, dunes, including more than 8,000 acres of highly productive wetlands near the mouth of the Rio Grande (Turner 1988). Over 175 plant species and 344 wildlife species have been documented on/nearby Boca Chica Tract including 184 species of birds, 14 species of mollusks, 23 species of crab and shrimp, 61 species of fish, 40 species of reptiles and amphibians, and 22 species of mammals (Chaney and Pons 1987). The wind-tidal flats of the Boca

Chica Tract are also known to be important migration stopover sites for peregrine falcons (*Falco peregrinus*) (Maechtle 1987). Additionally, the Boca Chica Tract supports the highest concentrations of breeding snowy plovers (*Charadrius alexandrinus*) and Wilson’s plovers (*Charadrius wilsonia*) in the Lower Laguna Madre Region of Texas (Zdravkovic 2005).

The action area also includes developed areas in and around Port Isabel, Laguna Heights, South Padre Island, and along the Brownsville Ship Channel. These developed areas provided limited or no habitat for ESA-listed species.

Changes to existing conditions since 2013 include alterations to the existing natural and physical conditions at the VLA and LLCC. Since completion of the 2013 consultation, SpaceX conducted soil surcharging⁴ and pad area development at the VLA. Infrastructure at the VLA includes the launch pad, commodity storage areas, landing pad, launch mount, redundant suborbital test pad, and crane staging area (Figure 3-2). The LLCC consists of the Stargate building, where command and control of operations at the launch pad occurs. The solar farm area has also been developed and currently consists of solar arrays and batteries for power storage. The solar arrays are 6.5 feet (2 m) tall and composed of non-highly-reflective materials.

Figure 3-2. Current Vertical Launch Area Layout



The action area is located within the Lower Rio Grande Valley region. The USFWS currently recognizes 11 biotic communities in this region. The action area is located within the loma/tidal flats biotic community. This community is characterized by wooded islands in tidal flats that are periodically inundated by water from South Bay to the Gulf of Mexico. Lomas are formed from silt or clay particles deposited by wind on tidal flats. Dunes often form around the tidal flats. Typical plants found in

⁴ Soil surcharging is essentially laying soil on top of soil to compact the lower layer of soil to make it more conducive for foundations.

loma/tidal flats include sea ox-eye (*Borrchia frutescens*), saltwort (*Batis maritima*), and glasswort (*Salicornia virginica*) on vegetated portions of the flats, and gulf cordgrass (*Spartina spartinae*), Berlandier's fiddleneck (*Citharexylum berlandieri*), texas ebony (*Pithecellobium ebano*) and yucca (*Yucca treculeana*) on higher lomas (Jahrsdoerfer and Leslie 1988; USFWS 1997).

Vegetation communities in Texas were first mapped in detail in 1984 by McMahan et al. (1994). The action area is located within the Gulf Prairies and Marshes Ecoregion. Prior to European settlement, this ecoregion consisted of a mosaic of tallgrass coastal prairie, riparian bottomland hardwood forests, ephemeral freshwater wetlands, canebrake swamps, extensive coastal forests, chenier woodlands, freshwater tidal wetlands, brush mottes and corridors, barrier islands, estuaries, saltwater marshes, hypersaline lagoons, lomas and associated Tamaulipan Thornscrub habitats (The Nature Conservancy 2002). Within the ecoregion, most of the VLA is located within marsh/barrier islands subtype 3 (smooth cordgrass-marsh saltgrass-sea ox-eye marsh), which is generally dominated by sea ox-eye, black rush (*Juncus roemerianus*), saltwort, black mangrove (*Avicennia germinans*), glasswort, seashore paspalum (*Paspalum vaginatum*), and shoalgrass (*Halodule beaudettei*). On the eastern area of the Boca Chica Launch Site, from the high tide mark to leeward marshes, is an area of sand dunes that is characterized by marsh/barrier island subtype 4 (Seaoats- seacoast bluestem grassland). This vegetation type is generally dominated by beach croton (*Croton punctatus*), single-spike paspalum (*Paspalum monostachyum*), Pan American balsam scale (*Elionurus tripsacoides*), flat sedge (*Cyperus* spp.), sea purslane (*Sesuvium portulacastrum*), bulrush (*Scirpus* spp.), beach morning-glory (*Ipomoea imperati*), goatfoot morning-glory (*Ipomoea pes-caprae*), sea rocket (*Cakile edentula*), and lime pricklyash (*Zanthoxylum fagara*) (McMahan et al. 1984).

The wetlands at and around the VLA are comprised of scrub shrub and emergent wetlands, both of which are categorized as high marsh areas and unvegetated salt flats. Upland vegetation is typified by pricklypear (*Opuntia engelmannii*), honey mesquite (*Prosopis glandulosa*), little bluestem (*Schizachyrium scoparium*), gush bluestem (*Andropogon glomeratus*), giant reed (*Arundo donax*) (a non-native invasive species), cuman ragweed (*Ambrosia cumanensis*), and golden tickseed (*Coreopsis tinctoria*). Wetland vegetation is primarily comprised of saltgrass (*Distichlis spicata*), shoregrass (*Monanthocloe littoralis*), glasswort, shoreline sea purslane, sea ox-eye, and gulf cordgrass (*Spartina spartinae*) (USACE 2012, 2021). Other species observed during field surveys as part of the 2013 consultation include black mangrove and turtleweed (*Batis maritima*). Vegetation observed in the sand dunes in 2012 included beach croton, sea purslane, and beach morning-glory (USACE 2012). In 2020, vegetation observed in the sand dunes as part of conducting wetland delineations included camphor daisy (*Rayjacksonia phyllocephala*), *Prosopis reptans*, and saltgrass (USACE 2021). Recent biological surveys (as required by the 2013 BCO) conducted by the University of Texas Rio Grande Valley (UTRGV) found that the most species-diverse areas surrounding the VLA are the transitional salt flats (35 species) and the dunes (23 species); however, the average percent cover of any particular species rarely exceeded 5 percent (UTRGV 2019). Within each vegetation zone, bare area was the dominant ground cover, comprising 98 percent of cover in the mudflats, 82 percent in the transitional zones, and 74 percent in the dunes. Annual biological monitoring as required by the 2013 BCO has revealed that changes in species composition and vegetation coverage between the 2018 and 2019 sampling periods were small, and generally similar in magnitude to the changes observed between 2016 and 2018 (UTRGV 2019). These changes in species cover are well within the normal range of spatial and temporal variability for tidal flats, salt prairies, and coastal dunes in south Texas.

4 ESA-LISTED SPECIES AND CRITICAL HABITAT IN THE ACTION AREA

According to the USFWS's Information for Planning and Consultation system (USFWS 2021a), there are 14 ESA-listed species and critical habitat for the piping plover occurring in Cameron County, Texas (Table 4-1). The interior least tern (*Sterna antillarum athalassos*) was considered in FAA's 2013 BA but delisted on February 12, 2021 (86 FR 2564). The eastern black rail (*Laterallus jamaicensis* ssp. *jamaicensis*), which was not considered in the 2013 BA, was listed as threatened on November 9, 2020 (85 FR 63764) and is considered in this BA due to its potential occurrence in Cameron County.

The South Texas ambrosia historically occurred in Cameron, Jim Wells, Kleberg, and Nueces counties in South Texas. South Texas ambrosia occurs in Gulf coastal grasslands and mesquite shrublands in southern Texas on clay loam to sandy loam soils (USFWS 2010b; TPWD 2012a). Grasslands and mesquite shrublands with clay loam to sandy loam soils are not present within the action area. Since this species is no longer found within Cameron County and suitable habitat does not occur within the action area where construction would occur, the FAA has determined the Proposed Action would have *no effect* on the South Texas ambrosia. This species is not discussed further in this BA.

The Texas and Tamaulipan populations of Texas ayenia occur in Texas ebony-anacua/brasil (*Ebenopsis ebano-Ehretia anacua/Condalia hookeri*) forest association and the Texas ebony-snake-eyes (*Phaulothamnus spinescens*) shrubland association. It is found in a wide range of alluvial soil types, from fine sandy loam to heavy clay (USFWS 2010c; TPWD 2012b). These habitat associations or soil types do not occur within the action area where construction would occur. Two populations of the Texas ayenia have been found in Cameron County, Texas. One population was found in Harlingen in 2001 in Wood Municipal Park. The second population was found near the Arroyo Colorado north of Rio Hondo on privately-owned property. In addition, three pilot introduction populations have been established in Lower Rio Grande Valley NWR in Cameron County (USFWS 2010c; TPWD 2012b). Suitable habitat for this species does not occur within the action area where construction would occur. Therefore, the FAA has determined the Proposed Action would have *no effect* on the Texas ayenia. This species is not discussed further in this BA.

For the remaining 12 species in Table 4-1, this section provides updates to the information provided in the FAA's 2013 BA (FAA 2013) (e.g., information from new USFWS 5-year reviews of species) and provides information regarding the presence of the species and critical habitat in the action area. Refer to the 2013 BA (FAA 2013) for a description of each species' physical description, listing history, threats, ecology, and historical distribution.

Table 4-1. ESA-Listed Species and Critical Habitat for Cameron County, Texas

Species	ESA Status	Critical Habitat
Birds		
Eastern black rail (<i>Laterallus jamaicensis ssp. jamaicensis</i>)	T	No
Northern aplomado falcon (<i>Falco femoralis septentrionalis</i>)	E	No
Piping plover (<i>Charadrius melodus</i>)	T	Yes
Red knot (<i>Calidris canutus rufa</i>)	T	No
Mammals		
Gulf Coast jaguarundi (<i>Herpailurus yagouaroundi cacomitli</i>)	E	No
Ocelot (<i>Leopardus pardalis</i>)	E	No
West Indian manatee (<i>Trichechus manatus</i>)	T	No
Reptiles¹		
Green sea turtle (<i>Chelonia mydas</i>)	T	No
Hawksbill sea turtle (<i>Eretmochelys imbricata</i>)	E	No
Kemp's ridley sea turtle (<i>Lepidochelys kempii</i>)	E	No
Leatherback sea turtle (<i>Dermochelys coriacea</i>)	E	No
Loggerhead sea turtle (<i>Caretta caretta</i>)	T	No
Flowering Plants		
South Texas ambrosia (<i>Ambrosia cheiranthifolia</i>)	E	No
Texas ayenia (<i>Ayenia limitaris</i>)	E	No

Source: USFWS 2021a

Notes:

E = endangered; T= threatened.

¹ Sea turtles are under joint jurisdiction between the USFWS (nesting stage) and National Marine Fisheries Service (marine stage). This BA only addresses the nesting stage.

4.1 EASTERN BLACK RAIL

The eastern black rail (*Laterallus jamaicensis jamaicensis*) is a subspecies of black rail (*Laterallus jamaicensis*), a small, cryptic marsh bird that occurs in salt, brackish, and freshwater wetlands in the eastern United States (east of the Rocky Mountains), Mexico, Central America, and the Caribbean (USFWS 2019). The USFWS listed the eastern black rail as a threatened species on November 9, 2020 (85 FR 63764). The USFWS has not designated critical habitat for this species.

4.1.1 Distribution and Abundance

The eastern black rail occupies portions of the eastern United States (east of the Rocky Mountains), Mexico, Central America, and the Caribbean. The northeastern, southeastern, and interior United States differ in the quantity and quality of survey data available for the eastern black rail (USFWS 2019). The south Texas coast has had few reports of eastern black rails (Watts 2016). The current understanding of the species' distribution indicates a "possible" presence of the species in Cameron County (see Figure 2-6 in USFWS 2019). Historical breeding records for Cameron County indicate a "probable" breeding status, but recent records (2011–2016) indicate no eastern black rail breeding in Cameron County (see Figure 2-7 in USFWS 2019). Within the action area, the eastern black rail has been observed in 1995 and 2005 around the South Padre Island Nature and Birding Center (Lockwood et al. 2005). A single black rail was also reported on Kenedy Park Ranch in Kenedy County, about 50 miles north of the action area (Watts 2016). SpaceX's previous biological monitoring in the action area has not recorded an eastern black rail.

4.1.2 Habitat

The eastern black rail is a tropical migrant species that breeds and/or winters in Texas coastal marshes. Although primarily known from coastal areas, the eastern black rail has also been observed, periodically, in inland areas. Relatively little is known of the ecological requirements of the species, but it generally occurs in salt, brackish, and freshwater marshes with dense herbaceous vegetation (or cover). The USFWS has defined dense overhead cover as “the cover that exists in excess of the height of an eastern black rail, and is assessed from above in terms of herbaceous persistent emergent wetland plant cover (as defined by Cowardin et al. 1979, p. 20) versus non-vegetative cover of the ground, including bare ground itself.” Eastern black rails typically occupy areas with overhead cover that permits little or no view of bare ground.

On the Gulf Coast, in Texas coastal salt marshes, eastern black rails occupy high elevation zones dominated by gulf cordgrass and salt meadow cordgrass which may be accompanied by shrub species such as eastern baccharis or Jesuit’s bark (USFWS 2019). Eastern black rail suitable habitat (i.e., marsh with dense herbaceous vegetation) is not present at or near (within 0.6 miles) the launch site.

4.1.3 Life History

Because eastern black rails are typically hidden from view (inside dense marsh grasses), they are a difficult species to observe. From late winter through spring, males establish and defend territories up to 10 acres in extent (Cornell Lab of Ornithology 2021). Males are known to sign at all times of day or night, depending on their location. Most studies suggest that eastern black rails are monogamous, though little is known about their behavior during courtship. Both parents remain active near the nest, sharing incubation duties, and both typically shepherd the tiny chicks after hatching (Cornell Lab of Ornithology 2021).

Eastern black rails are small birds that make easy prey for marsh hunters like great blue herons, great egrets, northern harriers, and owls. Mammals like raccoons, foxes, and cats presumably also eat eastern black rails or their eggs, as do snakes. The rails are especially vulnerable to predators when flooded out of their preferred habitats (Cornell Lab of Ornithology 2021).

4.1.4 Population Dynamics

Regional populations still exist for this subspecies; however, the best available scientific data suggest that the remaining populations support a relatively small total population size across the contiguous United States. There were an estimated 1,299 individuals on the upper Texas coast within specific protected areas prior to Hurricane Harvey (USFWS 2019). In 2016, there was an estimated 100–500 breeding pairs in Texas; however, the uncertainty of this estimate was considered high (USFWS 2019)

Given that there is not consistent monitoring or survey results for the eastern black rail throughout the Caribbean, Central America, and Brazil, it is likely that the birds still occur throughout this region; however, there is no information to indicate that the bird is present in large numbers (USFWS 2019).

4.1.5 Reasons for Listing/Threats to Survival

The Service has concluded that the eastern black rail is at risk of extinction within the foreseeable future due to continued wetland habitat loss, sea level changes, increasing storm frequency and intensity and increased flood events (which are both associated with high tides and storms), wetland

subsidence, and land management practices (e.g., incompatible prescribed fire, grazing, and mechanical treatment activities) (85 *FR* 63797).

4.1.6 Section 4(d) Rule

Under the ESA, the USFWS has broad authority to issue regulations for the conservation of threatened species. The ESA provides a specific list of prohibitions for endangered species under section 9 but does not automatically provide these same prohibitions to threatened species. Section 4(d) of the ESA allows the USFWS to establish prohibitions or exceptions to prohibitions for threatened species.

In its final rule (85 *FR* 63764), the USFWS established a 4(d) rule for the eastern black rail. The primary goals of this 4(d) rule are to minimize incidental take of eastern black rails and ensure that the dense overhead cover that the eastern black rail needs is maintained.

Prohibited Activities

- Purposeful “take” of eastern black rail, to include capture, handling, or other activities.
- Incidental take of an eastern black rail from the following activities: prescribed burns (unless utilizing best management practices); mowing, haying, and other mechanical treatment activities in the bird’s habitat during the nesting or brooding periods; grazing activities on public lands that occur in the bird’s habitat and do not support the maintenance of dense overhead cover in at least 50% of habitat in any given calendar year within a management boundary; and long-term or permanent damage, fragmentation, or conversion of eastern black rail habitat and the contiguous wetland-upland transition zone to other habitat types (such as open water) that do not support the bird.
- Possession and other acts with unlawfully taken eastern black rails.
- Import or export of eastern black rails.
- Possession of unlawfully taken specimens of eastern black rails or conducting any other acts with unlawfully taken specimens of eastern black rails.
- Engaging in interstate or foreign commerce of eastern black rails in the course of commercial activity.
- Selling eastern black rails or offering eastern black rails for sale.

Activities Excepted from Prohibitions

- Activities expressly permitted by 50 CFR §17.32 (permits issued for scientific purposes, enhancement of propagation or survival, economic hardship, zoological exhibition, educational purposes, incidental taking, or special purposes consistent with the purposes of the ESA).
- “Take” of an eastern black rail during the course of official duties by any employee or agent of the USFWS, National Marine Fisheries Service, or a State conservation agency, operating a conservation program for the bird.
- Incidental take resulting from haying, mowing or other mechanical treatment activities in persistent emergent wetlands during the nesting and brooding periods that is a maintenance

requirement to ensure safety and operational needs. This includes maintaining existing infrastructure such as fire-breaks, roads, rights-of-way, levees, dikes, fence lines, airfields, and surface water irrigation infrastructure (e.g., head gates, ditches, canals, water control structures, and culverts).

- Incidental take resulting from haying, mowing or other mechanical treatment activities in persistent emergent wetlands during the nesting and brooding periods and occur from the control of woody encroachment and other invasive plant species in order to restore degraded eastern black rail habitat.
- Incidental take of an eastern black rail resulting from actions taken to control wildfires.
- Incidental take of an eastern black rail resulting from the establishment of new fire-breaks (for example, to protect wildlands or man-made infrastructure) and new fence lines.
- Incidental take of an eastern black rail resulting from prescribed burns, grazing, and mowing or other mechanical treatment activities in existing moist soil management units or prior converted croplands (e.g., impoundments for rice or other cereal grain production).

Of the several prohibited activities identified in the 4(d) rule, the one that is most applicable to the Proposed Action is long-term or permanent damage, fragmentation, or conversion of eastern black rail habitat and the contiguous wetland-upland transition zone to other habitat types (such as open water) that do not support the bird. However, eastern black rail suitable habitat is not located at or near the launch site.

Based on the 4(d) rule, the only aspect of the Proposed Action that would be exempt from the ESA's take prohibitions are actions taken to control a wildfire if SpaceX's launch operations created a wildfire.

4.2 NORTHERN APLOMADO FALCON

In 2014, the USFWS released a 5-year review for the northern aplomado falcon (USFWS 2014a). Current causes of decline include the increased presence of the great-horned owl (*Bubo virginianus*) which preys upon the falcons (Hunt et al. 2013), degraded grasslands, and drying climatic conditions on prey populations (Hector 1987; Gulf South Research Corporation and La Tierra Environmental Consulting 2013). Habitat loss and degradation on the breeding and wintering grounds of migratory birds negatively impact important avian prey species for aplomado falcons, such as mourning doves (*Zenaida macroura*) and meadowlarks (*Sturnella* spp.) (DeSante and George 1994; Gulf South Research Corporation and La Tierra Environmental Consulting 2013).

Northern aplomado falcon surveys were conducted on USFWS lands within the action area in the vicinity of the Port of Brownsville from 1993 to 2003. Aplomado falcons were observed foraging and nesting within this area. In 1999, 2001, and 2003, no aplomado falcon nests were observed during these surveys; however, several aplomado falcons were observed. However, in 1996, 1997, 1998, 2000, and 2002, an aplomado falcon nest was observed (Blanton & Associates 2001, 2002, 2003). Currently, there are 23 artificial nest platforms that have been constructed within this survey area. The two closest platforms are approximately 2.7 miles to the southwest and 4.5 miles to the northwest of the LLCC (USFWS 2012b). No aplomado falcon nests or observations were observed on these nest platforms during the surveys.

In 2010 and 2011, the Peregrine Fund conducted surveys in the Laguna Atascosa NWR in Cameron County and Matagorda Island NWR in Calhoun County, over 99 miles north of the action area. In 2010, the surveyors observed 82 falcons in 32 of 40 known territories (Laguna Atascosa NWR – 18/24; Matagorda Island NWR – 14/16) (Peregrine Fund 2010). In 2011, the surveyors observed 79 falcons occupying 34 of 44 known territories (Laguna Atascosa NWR – 20/26; Matagorda Island NWR – 14/18) (Peregrine Fund 2011).

Hunt et al. (2013) conducted northern aplomado falcon surveys to assess success of Peregrine Fund-released falcons along the mid-coast of Texas. Researchers documented that the Brownsville subpopulation of falcons extends some 34 miles northward from the Mexican border through the Laguna Atascosa NWR and beyond (Jenny et al. 2004; Hunt et al. 2013). The researchers observed territories within a 3 to 7-mile-wide band of prairie and prairie-brushland within 12 miles of the Laguna Madre, with the densest aggregation found within and nearby the action area between Brownsville and Highway 100. From 2008 to 2013, Hunt et al. (2013) found the nesting territory occupancy of the Brownsville subpopulation to be between 14 and 17 adult nesting pairs.

Potential foraging habitat for the northern aplomado falcon exists within the action area. Some perching and nesting sites (trees and yuccas) occur within the vicinity of the LLCC and the VLA.

As part of implementing the terms and conditions of the 2013 BO, UTRGV most recently conducted bird surveys between October 10, 2018 and November 25, 2019 on accessible U.S. soil within 3 miles of the Boca Chica Launch Site. Since surveys began in 2015, no aplomado falcons have been recorded during these surveys (UTRGV 2019).

4.3 PIPING PLOVER

In its most recent 5-year review, the USFWS (2020a) identifies destruction, modification, and loss of habitat as continuing threats to the piping plover coastal migration and wintering range. The migration and wintering ranges show continued loss and degradation of habitat due to shoreline and inlet stabilization efforts (Rice 2016, 2017). Human disturbance represents an increasing threat to plovers (USFWS 2020a). Gibson et al. (2018) found piping plovers using disturbed sites across North Carolina, South Carolina, and Georgia had lower true annual survival rates than those using undisturbed sites. Storm-formed coastal habitats can benefit or adversely affect piping plovers of all life stages (Saunders et al. 2014; Bourque et al. 2015). Saunders et al. (2014) found that adult piping plover survival was negatively correlated with hurricane frequency. Severe cold weather can also lead to reductions in survival, as seen by Gibson et al. (2017) in a group of piping plovers in Georgia that declined by 52 percent during a period of cold weather. Wind farms are becoming an increasing concern in Texas, where they may increase the threats of collision with turbine blades, habitat modification, and presence of avian predators (USFWS 2020a). Additionally, accelerating sea level rise coupled with development of beaches is predicted to increase piping plover's vulnerability to sea level rise and limit their ability to adapt (USFWS 2020a).

In 2009, Coastal Bird Conservation conducted migratory (September 4 through October 9) and wintering (November 17 through December 14) surveys for piping plovers within the Lower Laguna Madre region in South Texas. A portion of the lower Laguna Madre region is within the action area; the remaining area extends north. Surveys were conducted on federal, state, county and private lands and covered all areas designated as critical habitat for wintering piping plovers. The objective was to

thoroughly survey all known and potential nonbreeding shorebird habitat within the study area. During the migratory surveys, 801 piping plovers were observed, while 881 were documented during the wintering surveys. This is an increase from 459 plovers observed during a 2006 International Piping Plover Census. During the migratory survey, the surveyors recorded two piping plovers on Boca Chica Beach and five piping plovers on Boca Chica flats. During the wintering surveys, the surveyors did not observe any piping plovers on Boca Chica Beach and observed 11 piping plovers on Boca Chica Flats (Zdravkovic and Durkin 2011).

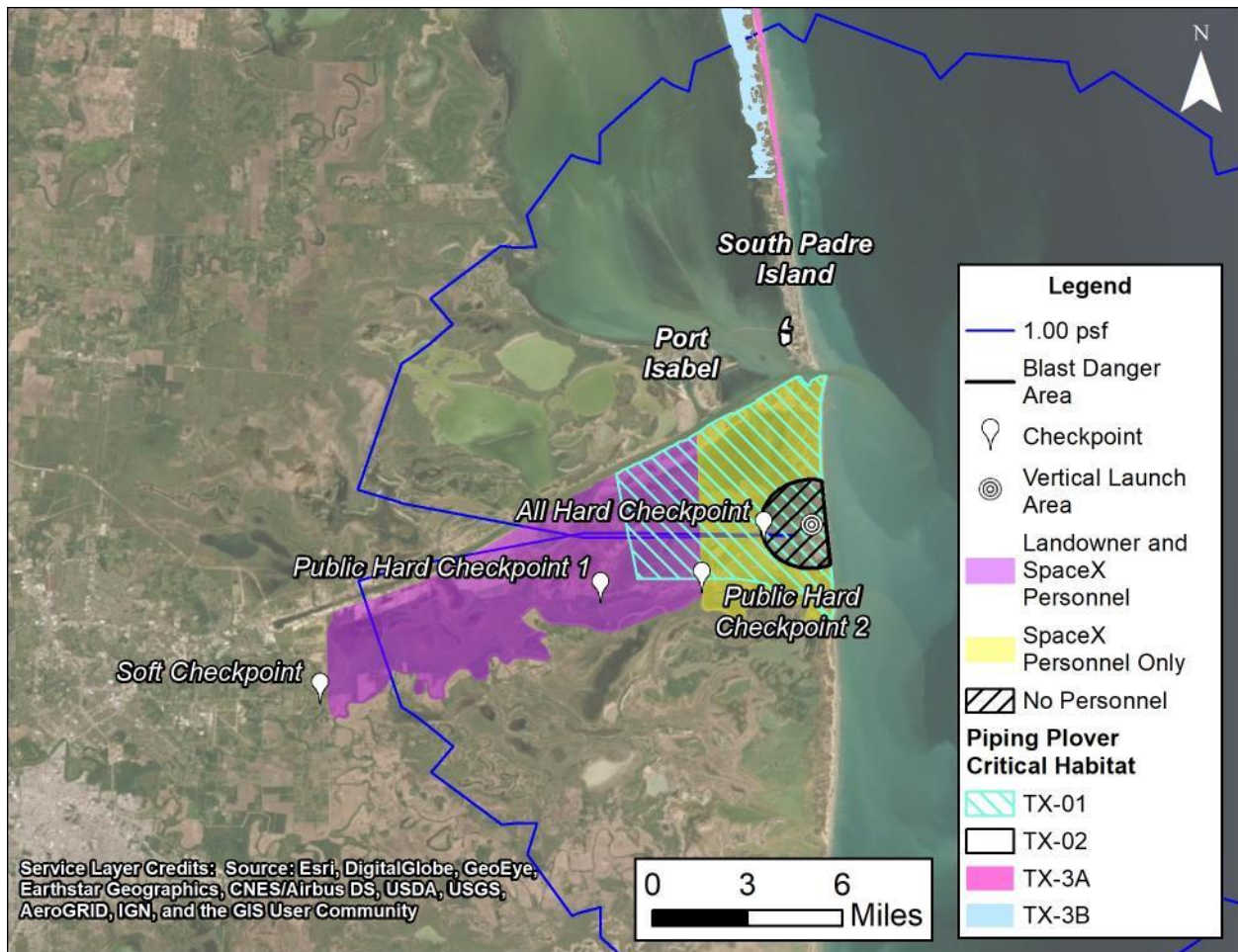
During both the migratory and wintering survey periods, the surveyors observed most of the piping plovers using barrier island/peninsular habitats (85% and 62%, respectively). Piping plovers demonstrated limited use of other coastal habitats; mainland coastal bays (migratory 6%, wintering 3%), mainland beach (migratory and wintering 1%), and river mouth (migratory 3%, wintering 0%). In addition, the 2009 surveys found that piping plovers in the Lower Laguna Madre region preferred habitats with mixed substrate habitat (combination of two or more substrates such as sand, algal, mud, shell, wrack, etc.) (Zdravkovic and Durkin 2011).

Approximately 45 miles north of the action area, Christmas Bird Counts in 2014 documented a newly identified group of 363 plovers in Land Cut in the Laguna Madre (USFWS 2020a).

As part of implementing the terms and conditions of the 2013 BO, UTRGV most recently conducted bird surveys between October 10, 2018 and November 25, 2019 on accessible U.S. soil within 3 miles of the Boca Chica Launch Site. A cursory analysis of uniquely marked piping plovers observed on multiple occasions between 2016 and 2019 showed a tight spatial clustering of foraging sites along the Gulf of Mexico shoreline, indicating considerable site fidelity and territoriality during the non-breeding season (UTRGV 2019).

On July 10, 2001, the USFWS designated 142 areas along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas as critical habitat for the wintering population of the piping plover (66 *Federal Register* [FR] 36038). In 2009, the USFWS published a final rule revising critical habitat for the wintering population of the piping plover, which divided Unit TX-3 into subunits 3A and 3B (74 *FR* 23476). The action area encompasses all of Critical Habitat Unit TX-1 (South Bay and Boca Chica), TX-2 (Queen Isabella Causeway), and the southern portions of TX-3A (South Padre Island- Gulf of Mexico Shoreline), and TX 3B (South Padre Island- Interior) (Figure 4-1). The SpaceX Boca Chica Launch Site is located within Unit TX-1. The TX-1 unit includes wind tidal flats that are infrequently affected by season winds, and a tidal flats area known as South Bay. It does not include densely vegetated habitat within those boundaries. Portions of Unit TX-1 are owned and managed by the Lower Rio Grande Valley NWR, South Bay Coastal Preserve, Boca Chica State Park, and private citizens (USFWS 2001).

Figure 4-1. Piping Plover Critical Habitat within the Action Area



The primary constituent elements (PCEs) essential for the conservation of wintering piping plovers are those habitat components that support foraging, roosting, and sheltering and the physical features necessary for maintaining the natural processes that support these habitat components. The PCE are found in geologically dynamic coastal areas that support or have the potential to support intertidal beaches and flats (between annual low tide and annual high tide) and associated dune systems and flats above annual high tide (65 FR 41782; 66 FR 36038).

Important components of intertidal flats include sand and/or mud flats with no or very sparse emergent vegetation. In some cases, these flats may be covered or partially covered by a mat of blue-green algae. Adjacent unvegetated or sparsely vegetated sand, mud, or algal flats above high tide are also important, especially for roosting piping plovers. Such sites may have debris, detritus (decaying organic matter), or microtopographic relief (less than 20 inches above substrate surface) offering refuge from high winds and cold weather (65 FR 41782; 66 FR 36038).

Unvegetated salt flats with little to no topographic relief—important PCE—are present within the areas of proposed VLA expansion and at the proposed parking lot across from the VLA. Other areas within the vicinity of the VLA consist of heavily vegetated areas with upland steep dunes to the east paralleling the coast. The areas of high marsh are also heavily vegetated and would not provide PCE

for wintering piping plover critical habitat. None of the land near the LLCC contains PCE for wintering piping plover habitat.

4.4 RED KNOT

Since completing the 2013 BA, the red knot was listed as threatened on December 11, 2014 (79 *FR* 73705). The USFWS has not designated critical habitat for this species.

The red knot is listed as a threatened species due to loss of both breeding and nonbreeding habitat; likely effects related to disruption of natural predator cycles on the breeding grounds; reduced prey availability throughout the nonbreeding range; and increasing frequency and severity of asynchronies (mismatches) in the timing of the birds' annual migratory cycle relative to favorable food and weather conditions. The USFWS has concluded there is insufficient data to provide a precise range-wide population estimate. However, the western Gulf of Mexico/Central America population is estimated at approximately 6,000 birds, with about 2,000 to 4,000 in Texas and northern Mexico (USFWS 2021c).

Red knots have been recorded within the action area. The Laguna Madre supports wintering red knots (USFWS 2014d). Records indicate the red knot has been observed in the action area prior to 1996 on Boca Chica Beach (Skagen et al. 1999); in Laguna Atascosa NWR (Skagen et al. 1999; USFWS 2010d), portions of which are within the action area; and on nearby Padre Island (Audubon Society 2009; Niles et al. 2009 as cited in USFWS 2011).

Coastal Bird Conservation also conducted migratory and wintering surveys for red knot in 2009. Within the action area, at Boca Chica Beach and Laguna Atascosa NWR, the surveyors did not observe the red knot. The surveyors observed red knots within the action area on South Padre Island and approximately 15 miles north of the action area at Mansfield Channel spoil islands (Zdarvkovic and Durkin 2011).

As part of implementing the terms and conditions of the 2013 BO, UTRGV most recently conducted bird surveys between October 10, 2018 and November 25, 2019 on accessible U.S. soil within 3 miles of the Boca Chica Launch Site construction area. The surveyors observed red knots in the survey area; however, their presence was erratic and unpredictable. The surveyors recorded an average group size of 4.66 individuals in each quadrat, with a maximum group size of 15 individuals; however, UTRGV noted that this estimate may underestimate actual numbers of individuals. On one occasion in early May 2019, the UTRGV surveyors observed a large group of red knots (>150 individuals) on the Boca Chica route, but the survey could not be completed due to flooding. UTRGV also found that the species exhibits widespread use of the survey area during the study period and exhibits narrow time windows of occupancy during the year (UTRGV 2019).

4.5 GULF COAST JAGUARUNDI

In addition to the threats of habitat loss and predator control, the 2013 Jaguarundi Recovery Plan identified mortality from vehicle collisions, possible competition with bobcats (Sanchez-Cordero et al. 2008), and increases in temperature and decreases in precipitation resulting from climate change as threats to the Gulf Coast jaguarundi (USFWS 2014b). The last known record of a jaguarundi in the United States was a roadkill in 1986 along SH 4, just east of Brownsville. Unconfirmed jaguarundi sightings within the vicinity of the action area include those observed in Lower Rio Grande Valley NWR and Laguna Atascosa NWR (USFWS 2004, USFWS 2014b). The area surrounding the Boca Chica Launch

Site has very little shrub cover and therefore does not contain quality habitat for the jaguarundi. However, the action area encompasses large regions of the South Texas Refuges Complex made up of Santa Ana NWR, Laguna Atascosa NWR, and Lower Rio Grande Valley NWR. These NWRs, as well as the habitat between them, represent a wide north-south coastal corridor on the eastern boundary of the Rio Grande delta that supports a matrix of native rangeland wetlands and upland communities that may be suitable for jaguarundi movement (USFWS 2004).

4.6 OCELOT

In addition to threats from habitat loss and vehicle strikes, the 2016 Ocelot Recovery Plan identifies small population sizes in Texas and isolation from conspecifics in Mexico threatens ocelots in Texas with inbreeding (USFWS 2016a; Janečka et al. 2011; Korn 2013). Additionally, issues associated with barriers such as the border fence and border wall on the U.S.-Mexico border and agent patrols of border areas further exacerbate the isolation of Texas and Arizona ocelots from those in Mexico (Lorey 1999; Grigione and Mrykalo 2004; Flesch et al. 2009).

The Laguna Atascosa NWR supports the largest known U.S. population of the ocelot. The Laguna Atascosa NWR is a complex of lands, and portions of the complex occur within the action area. Currently, the USFWS estimates approximately 10–25 ocelots occur on and adjacent to the Laguna Atascosa Unit of the Refuge (USFWS 2010a). There have also been reports of ocelot sightings from the Lower Rio Grande Valley NWR in the past 25 years (USFWS 1997, 2004). In 1998, one ocelot was observed and trapped traveling along SH 4 within the action area, approximately 3.5 miles west (by road) of the LLCC (Blanton & Associates 1998). Areas in the vicinity of the SpaceX Boca Chica Launch Site do not contain quality habitat for the ocelot. However, the action area is located within the center of the South Texas Refuges Complex made up of Santa Ana NWR, Laguna Atascosa NWR, and Lower Rio Grande Valley NWR. These NWRs, as well as the habitat between them, represent a wide north-south coastal corridor on the eastern boundary of the Rio Grande delta that supports a matrix of native rangeland wetlands and upland communities that may be suitable for ocelot movement (USFWS 2004).

4.7 WEST INDIAN MANATEE

In April of 2017, the USFWS reclassified the West Indian manatee from endangered to threatened (85 FR 1668). Of the 69 records of manatees from Texas since 1912, only 11 have been within the action area; nine are from 1912–1919 near the mouth of the Rio Grande (Gunter 1941; Fertl et al. 2005), and a single manatee was seen in 1992 and 1994 in the Lower Laguna Madre near Port Isabel (

Table 4-2). Since that time, there have been no recorded sightings of manatees within the action area.

Table 4-2. West Indian Manatee Occurrences in and near the Action Area

Date	Number of Individuals	Location	Distance from Action Area	Source
1912–1919	~7	Mouth of Rio Grande	Within	Gunter 1941; Fertl et al. 2005
1913/1914	2	2 miles north of mouth of Rio Grande	Within	Fertl et al. 2005
1977	2	Padre Island	28 miles north	Fertl et al. 2005
1992	1	Padre Island	15 miles north	Fertl et al. 2005
1992	1	Port Isabel, Laguna Madre	Within	Fertl et al. 2005

Date	Number of Individuals	Location	Distance from Action Area	Source
1994	1	Port Isabel, Laguna Madre	Within	Fertl et al. 2005
1995	2	Port Mansfield Pass	24 miles north	Fertl et al. 2005
2004	1	Willacy County Navigation Ramp	22 miles north	Fertl et al. 2005
2005	1	Port Mansfield	28 miles north	Brezosky 2005
2006	1	Port Mansfield	28 miles north	USFWS 2012b

4.8 GREEN SEA TURTLE

In Texas, green sea turtles are known to nest on the beaches of North Padre Island (approximately 24 miles north of the action area) and South Padre Island (approximately 11 miles of which are within the action area) (NPS 2012a). In 2019, one green sea turtle false crawl was documented within the action area on Boca Chica Beach; however, no green sea turtles were documented nesting on Boca Chica Beach (Sea Turtle, Inc. 2020). From 2008 to 2012, 25 green sea turtles were documented nesting on either Padre Island National Seashore or South Padre Island (8 in 2012, 6 in 2011, 5 in 2010, 1 in 2009, and 5 in 2008) (Shaver 2009, 2010, 2011, 2012; NPS 2012c, d). From 2013 to 2019, 65 nests were documented in Texas (11 in 2019, 5 in 2018, 29 in 2017, 0 in 2016, 5 in 2015, 0 in 2014, 15 in 2013) (Shaver 2020).

4.9 HAWKSBILL SEA TURTLE

The only hawksbill nest documented on the Texas coast was in 1998 at Padre Island National Seashore, approximately 24 miles north of the action area (NPS 2012b). No hawksbill sea turtles have been recorded nesting in the action area (Sea Turtle, Inc. 2020).

4.10 KEMP’S RIDLEY SEA TURTLE

In addition to the threats discussed in the 2013 BA (FAA 2013), oil spills and global warming are expected to adversely impact Kemp’s ridley habitat (NMFS and USFWS 2016). Harmful algal blooms known as ‘red tide,’ as well as strandings, also threaten the species (NMFS and USFWS 2016).

In the United States, Kemp’s ridley nesting primarily occurs in Texas, especially at the Padre Island National Seashore, about 24 miles north of the action area (NMFS and USFWS 2015). Within the action area, at Boca Chica Beach, six Kemp’s ridley nests were recorded in 2019, 7 in 2018, 23 in 2017, 9 in 2016, 0 in 2015, 2 in 2014, and 3 in 2013 (Shaver 2020). From 2008 to 2012, 38 Kemp’s ridley nests were recorded on Boca Chica Beach (10 in 2012, 3 in 2011, 4 in 2010, 9 in 2009, and 12 in 2008) (Shaver 2009, 2010, 2011, 2012; NPS 2012c, d). From 2013 to 2019, 1,410 nests were documented on Texas coasts (Shaver 2020).

4.11 LEATHERBACK SEA TURTLE

In addition to the threats discussed in the 2013 BA, impacts from climate change, especially global warming, are likely to become apparent in future years and affect leatherback sea turtle prey distributions and habitat conditions in water and on beaches (NMFS and USFWS 2013). Leatherbacks are also threatened by the inadequacy of existing regulatory mechanisms for their protection (NMFS and USFWS 2013).

No leatherback sea turtles have been recorded nesting within the action area. In 2008, the first leatherback nest confirmed on the Texas coast since the 1930s was found on Padre Island National Seashore, approximately 24 miles north of the action area (Shaver 2009).

4.12 LOGGERHEAD SEA TURTLE

One loggerhead sea turtle nest was documented on Boca Chica Beach in 2006 (Sea Turtle, Inc. 2020). From 2008 to 2012, 17 loggerhead sea turtles have nested on the Texas coast – all nesting areas except South Padre Island are more than 25 miles north of the action area (3 in 2008 on Padre Island National Seashore, Mustang Island, and Bolivar Peninsula; 9 in 2010 on Padre Island National Seashore; 0 in 2011; and 5 in 2012 at Quintana Beach, North Padre Island, Padre Island National Seashore, and South Padre Island) (Shaver 2009, 2010, 2011, 2012). From 2013 to 2020, 50 nests were documented in Texas, outside of Boca Chica Beach (8 in 2019, 6 in 2018, 8 in 2017, 6 in 2016, 7 in 2015, 2 in 2014, and 13 in 2013) (Shaver 2020).

5 ANALYSIS OF POTENTIAL EFFECTS

5.1 APPROACH TO ANALYSIS

This section presents an analysis of potential effects to ESA-listed species and critical habitat from the Proposed Action. Activities that may affect ESA-listed species and critical habitat include launch site-related construction, daily operations, and launch operations (tank tests, wet dress rehearsals, static fire engine tests, suborbital launches, and orbital launches).

Effects of the action are all consequences to listed species or critical habitat that are caused by the Proposed Action, including consequences of other activities that are caused by the Proposed Action (50 CFR § 402.02). Direct effects are the direct or immediate effects of the project on the species or its habitat. Indirect effects are those that are caused by the Proposed Action and are later in time, but still are reasonably certain to occur (e.g., attraction of predators due to development and human presence). All direct and indirect project effects on listed species in this BA have been further classified and evaluated based on their anticipated longevity (i.e., temporary or permanent effects). Effects can also include 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 (50 CFR 402.17). Under the Proposed Action, there are no other activities that would cause consequences to listed species or critical habitat.

As they relate to the ESA-listed species considered in this BA, direct and indirect effects from proposed activities within the action area have been evaluated herein based upon: (1) an understanding of the methods and equipment that would be used during construction and operations within the Boca Chica Launch Site, (2) knowledge of the potential for such methods and equipment to disturb the natural resources on which the subject species depend, and (3) awareness of the types of effects that have resulted from similar actions in the past.

The FAA identified threats associated with proposed construction and operations based on previous consultations as well as review of various species recovery plans. Eleven threats were identified (see Table 5-1). Section 5.2 provides an overview of each of these threats. Section 5.3 discusses the effects analysis and determinations for the ESA-listed species and critical habitat.

Table 5-1. Potential Effects to ESA-Listed Species and Critical Habitat Based on Stressors/Threats Associated with the Proposed Action

Number	Stressor or Threat	Potential Effect on Species	Species Potentially Affected
1	Visual Presence and Noise from Launches	Disturbance to species from noise depends on the type of noise generated, the proximity to the noise source, duration of the sound, frequency of events, the species, and the history of exposure to noise events by individuals of a species. For instance, vehicular traffic can mask bird calls (such as alarm calls) and inhibit breeding birds to find mates and to defend territories. Sudden noise events can cause birds to abandon nests or roosts which may increase the potential for predation. Noise events associated with construction and operations (including launches) are generally thought to result in short-term behavioral responses which may be considered harassment, but sustained noise events may render habitat unusable.	<ul style="list-style-type: none"> • Piping plover • Red knot • Aplomado falcon • Eastern black rail • Jaguarundi • Ocelot • All sea turtles
2	Rocket Heat Plume	The heat plume generated from Starship/Super Heavy launches would travel away from the launch pad, with temperatures of 212 °F approximately 0.3 mile from the launch pad and temperatures reaching ambient temperature (90°F) 0.6 mile from the launch pad. Individual animals caught in the heat plume would likely die or be injured.	<ul style="list-style-type: none"> • Piping plover • Red knot • Aplomado falcon • Eastern black rail • Jaguarundi • Ocelot • All sea turtles
3	Launch-Related Closures	Launch-related closures during sea turtle nesting season could impact the ability of sea turtle patrol personnel to locate nests and collect eggs for off-site incubation. Launch-related closures could also impact researchers and Refuge staffs' ability to conduct bird and vegetation surveys.	<ul style="list-style-type: none"> • Piping plover • Red knot • All sea turtles
4	Night Lighting	Lighting on beaches or offshore may disrupt hatchling emergence from sea turtle nests. Hatchlings that crawl toward artificial light sources are following the same instinctive response that leads them seaward. This effect may result in harassment or harm to sea turtle species. Inappropriate lighting may also result in abandonment of nesting and roosting areas by terrestrial birds. Inappropriate lighting would not be expected to result in adverse effects to mammal species.	<ul style="list-style-type: none"> • Piping plover • Red knot • Aplomado falcon • Eastern black rail • Jaguarundi • Ocelot • All sea turtles
5	Hazardous Materials	During operations, there is the potential for spills of hazardous materials. The likelihood that an ESA-listed species would come into contact of a hazardous material during a spill is low given SpaceX's immediate clean-up response.	<ul style="list-style-type: none"> • Piping plover • Red knot • Aplomado falcon • Eastern black rail • Jaguarundi • Ocelot • All sea turtles
6	Ground Vibrations	Short-term ground vibrations could occur during construction and launches. There is a potential for ground vibrations to disturb nesting turtles and impact eggs.	<ul style="list-style-type: none"> • All sea turtles
7	Increased Traffic and Human Presence	An increase in vehicle traffic during daily operations from construction and SpaceX operations personnel could potentially increase the likelihood of wildlife being killed by a collision with a vehicle. In addition, increased traffic and human presence could cause wildlife to avoid the area.	<ul style="list-style-type: none"> • Piping plover • Red knot • Aplomado falcon • Eastern black rail • Jaguarundi • Ocelot

Number	Stressor or Threat	Potential Effect on Species	Species Potentially Effected
8	Tall Structures	The construction of new structures could pose a potential collision impact to birds.	<ul style="list-style-type: none"> • Piping plover • Red knot • Aplomado falcon • Eastern black rail
9	Habitat Loss (including Critical Habitat)	Direct loss of habitat reduces a species ability to reproduce, find food, find shelter, and survive.	<ul style="list-style-type: none"> • Piping plover • Red knot • Eastern black rail
10	Invasive Species Introductions	Construction activities could potentially increase the potential for the introduction of invasive species from equipment or fill material. These introductions can degrade habitats by altering native species composition and structure.	<ul style="list-style-type: none"> • Piping plover • Red knot • Aplomado falcon • Eastern black rail • Jaguarundi • Ocelot • All sea turtles
11	Anomaly	A launch or test could fail. An anomaly of Starship/Super Heavy on the launch pad represents the most substantial potential for impact. Should this occur, several possible outcomes could result, the most likely being a fire on the launch pad. An explosion on the launch pad would likely spread debris. An anomaly could also cause the launch vehicle to impact the water, intact or via debris.	<ul style="list-style-type: none"> • Piping plover • Red knot • Aplomado falcon • Eastern black rail • Jaguarundi • Ocelot • All sea turtles
12	Increased Boat Traffic	A potential increase in boat traffic during launch days could increase the potential for seagrass beds to be disturbed from rotor wash and therefore result in a decrease in a food source for the manatee. In addition, the risk to manatees from boat strikes would increase.	<ul style="list-style-type: none"> • West Indian manatee

5.2 STRESSORS OR THREATS ASSOCIATED WITH THE PROPOSED ACTION

5.2.1 Visual Presence and Noise from Launches

The greatest effects to the ESA-listed species from launches would be from the visual effect of the launch vehicle and launch noise. The duration of a noise source can be continuous (constant), transient (short duration), or impulsive (typically less than 1 second). Launch noise is classified as a transient noise event and sonic booms (i.e., shock waves created from supersonic flight when a launch vehicle travels faster than the speed of sound) are classified as impulsive noise events. A transient noise event has a beginning and an end where the sound temporarily rises above the background and then fades back into it. Transient sounds are typically associated with a sound source that moves, such as an aircraft overflight (USACHPPM 2005). Impulsive sound is of short duration and high intensity. It has an abrupt onset, rapid decay, and often a rapidly changing spectral composition, and is typically associated with sources such as explosions or the discharge of firearms (USACHPPM 2005).

The L_{Amax} represents the maximum A-weighted sound level measured during an event. A-weighting approximates the natural range and sensitivity of human hearing (USACHPPM 2005). The L_{Amax} is used for the analysis of noise impacts to humans and wildlife.

Studies have shown that wildlife react to visual stimuli (e.g., aircraft overflights) that are below 1,000 feet above ground level (Lamp 1989; Bowles 1995). Vehicle launches and the associated noise can affect wildlife directly. Wildlife responses may include increased movement after a launch, avoiding

or leaving areas where a launch occurs, changes in foraging patterns, and arousal of species-specific defensive behaviors (e.g., flight, aggression). Noise from vehicle launches may also have indirect effects on wildlife such as masking. Masking occurs when noise interferes with the perception of a sound of interest. For example, masking may affect predator avoidance and the detection of social signals (Bowles 1995).

The effects of noise and sonic booms from vehicle launches are difficult to assess because several adaptive responses may be involved, making the overt behavioral or physiological changes in response to noise highly variable. These responses include the acoustic startle, the orienting response, other species-typical and individual strategies for coping with novelty, species-typical defensive behaviors, and responses conditioned by previous exposures to noise. The primary concern with rocket launches, and the associated noise, is the startle effect. For example, this occurs when birds are surprised by sudden, unexpected loud noises and leave the nest or perch suddenly. Possible negative impacts from this behavior include 1) the expulsion of eggs or nestlings from the nest as the parent leaves suddenly, 2) increased predation of eggs or young when parents are off the nest, 3) eggs or young may become chilled if the parent is off the nest for an extended period of time and/or 4) cause young, flightless birds to jump out of a nest. Launches could cause a noise-induced startle response at a critical time in the nesting cycle of any bird. Repeated nest failures could eventually trigger desertion of a nesting area. A literature review of studies of aircraft and noise impacts on birds, which included various species of songbirds, upland game birds, waterfowl, seabirds, and raptors, showed that reactions vary boom to boom but birds “occasionally run, fly, or crowd” in response to a sonic boom (Manci et al. 1988). The accompaniment of engine noise with the sonic boom and visual disturbance may temper any impact from the sonic boom because the species would likely already be alert.

The effects of sonic booms on wildlife have been investigated in scientific studies. The following is a summary of some of the more relevant studies addressing potential effects to wildlife from sonic booms. Teer and Truett (1973) tested the effects of sonic booms on quail eggs at 2, 4, and 5.5 psf and found no adverse effects. Heinemann and LeBrocq (1965) exposed chicken eggs to sonic booms at 3–18 psf and found no adverse effects. In a mathematical analysis of the response of avian eggs to sonic boom overpressures, Ting et al. (2002) determined that it would take a sonic boom of 250 psf to crack an egg. Bowles (1995) states that it is physically impossible for a sonic boom to crack an egg because one cannot generate sufficient sound pressure in air to crack eggs.

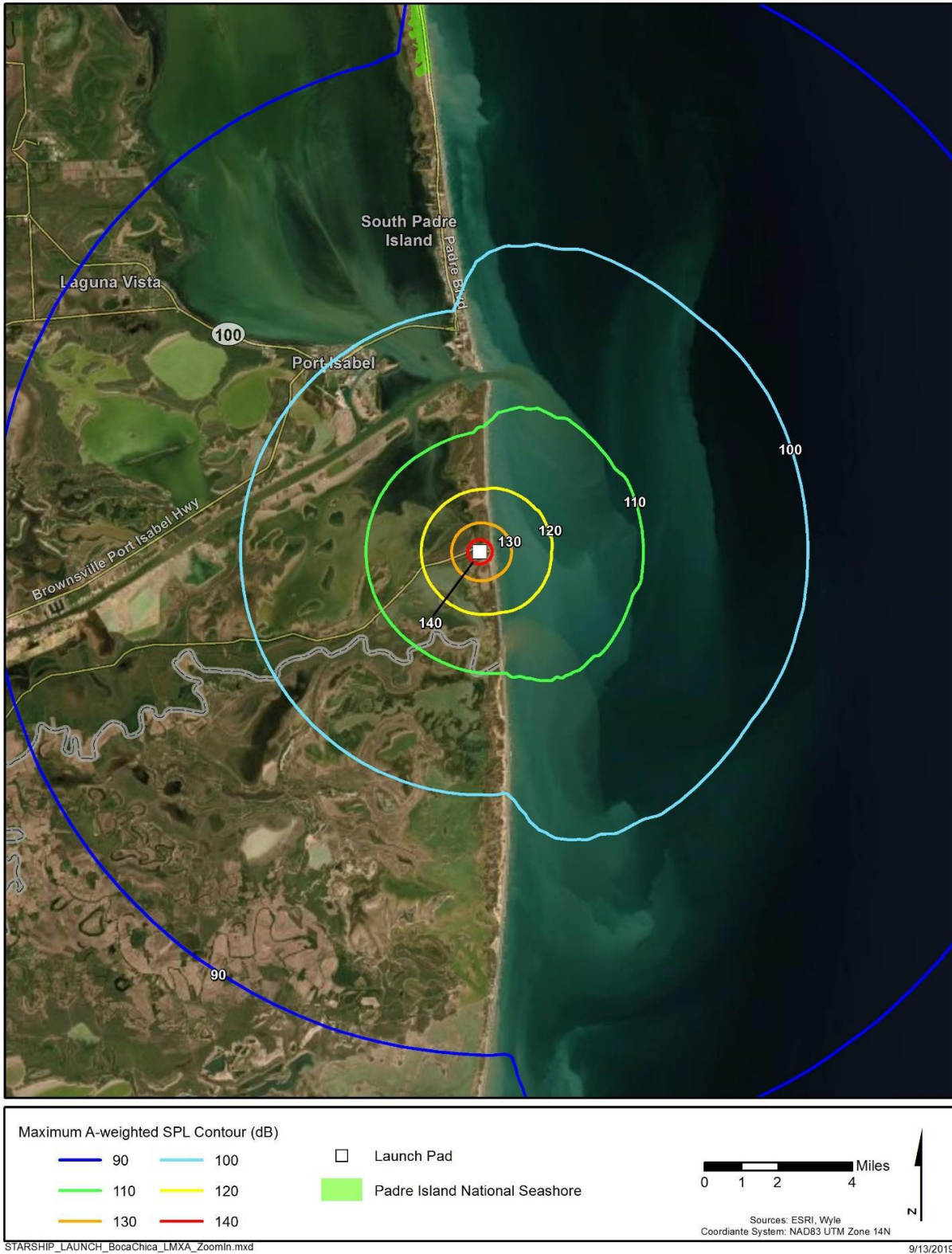
Teer and Truett (1973) examined reproductive success in mourning doves, mockingbirds, northern cardinals, and lark sparrows when exposed to sonic booms of 1 psf or greater and found no adverse effects. Awbrey and Bowles (1990) in a review of the literature on the effects of aircraft noise and sonic booms on raptors found that the available evidence shows very marginal effects on reproductive success. Ellis et al. (1991) examined the effects of sonic booms (actual and simulated) on nesting raptor species. While some individuals did respond by leaving the nest, the response was temporary and there were no adverse effects on nesting overall. Lynch and Speake (1978) studies the effects of real and simulated sonic booms on the nesting and brooding of eastern wild turkey (*Meleagris gallopavo silvestris*) in Alabama. Hens at four nest sites were subjected to between 8 and 11 combined real and simulated sonic booms. All tests elicited similar responses, including quick head lifting and apparent alertness for between 10 and 20 seconds. No apparent nest failure occurred as a result of the sonic booms.

Cape Canaveral, Florida provides a long history of launches and limited impacts to wildlife. The ESA-listed Florida scrub-jay (*Aphelocoma coerulescens*) was monitored for behavior after Delta, Atlas, and Titan launches with no apparent impacts from noise; these data came from 42 launches at a rate of 16 launches per year (Schmalzer et al. 1998). Monitoring associated with the Space Shuttle program (135 launches over 30 years or 4.5 launches per year) found that there was an initial flight response from birds in the vicinity, but no long-term impacts were observed (NASA 2014). In addition, nesting wood storks (a federally listed wading bird species) were observed flying off active nests in response to launches but would typically return within 4 minutes during the Kennedy Space Center Space Shuttle program.

Most of the effects of noise on wildlife are mild enough that they may never be detectable as changes in population size or population growth against the background of normal variation (Bowles 1995). Many other environmental variables (e.g., predators, weather, changing prey base, ground based human disturbance) may influence reproductive success and confound the ability to tease out the ultimate factor in limiting productivity of a certain nest, area, or region (Smith et al. 1988). In contrast, the effects of other human intrusions near nests, foraging areas, dens, etc. (e.g., hiking, bird watching, boating) are readily detected and substantial (USFS 1992).

On behalf of SpaceX, KBR conducted engine noise modeling to predict the noise levels generated during Starship/Super Heavy launches (KBR 2020; see Attachment 1). The modeled noise levels are shown in Figure 5-1.

Figure 5-1. Starship/Super Heavy Launch from the Boca Chica Launch Site: Maximum A-Weighted Sound Levels



The L_{Amax} 90 dB through 140 dB contours shown in Figure 5-1 represent the maximum levels estimated for a Starship/Super Heavy launch at the Boca Chica Launch Site. The higher L_{Amax} contours (100–140 dB) are located within about 7 miles of the launch pad. The 100-dB contour extends into parts of South Padre Island and Port Isabel. The 90-dB contour extends into Laguna Vista and eastern parts of Brownsville.

In addition to engine noise, a sonic boom would be generated while Starship and Super Heavy are supersonic during their descents, above an altitude of approximately 15 miles and 5 miles, respectively. Suborbital launches of Starship would not result in sonic booms when landing at the VLA, as the vehicle would not reach Mach 1 during descent. Starship suborbital launches with landings downrange in the Gulf of Mexico may create a sonic boom; however, these sonic booms would not impact land. Also, sonic booms generated during ascent would not impact land.

Depending on the distance from the landing pad, the sonic boom may be heard before or within a few seconds following the landing of Starship or Super Heavy. SpaceX used PCBOOM to model the overpressures of Starship and Super Heavy landings. Starship landing is planned to occur at the landing pad at the VLA or downrange in the Gulf of Mexico. Super Heavy would land downrange on a floating platform in the Gulf of Mexico or on the landing pad at the VLA.

The sonic boom modeling predicts that overpressures up to 15 psf for Super Heavy and 2.2 psf for Starship would be generated during landings (see Figure 5-2 and Figure 5-3). Because of the trajectory, most of the sonic boom during a Starship landing would impact the ocean, with areas of South Padre Island experiencing 1 to 2 psf. For Starship landings, the location of maximum overpressure will vary with weather conditions, so it is unlikely that any given location would experience the maximum estimated level more than once over multiple events.

Overpressure levels for a Super Heavy landing at the VLA range from 1 psf to 15 psf (Figure 5-3). Brazos Island State Park, Boca Chica Bay, Boca Chica State Park, and portions of Lower Rio Grande Valley NWR would experience levels up to 15 psf. Boca Chica and the southern tip of South Padre Island are within the 6.0 psf contour. South Padre Island, Port Isabel, and the Port of Brownsville ship channel are included in the 4.0 psf contour. Sonic booms up to 1 psf would be expected to reach up to 15 miles from the VLA.

Figure 5-2. Sonic Boom Contours for Starship Landing at the VLA

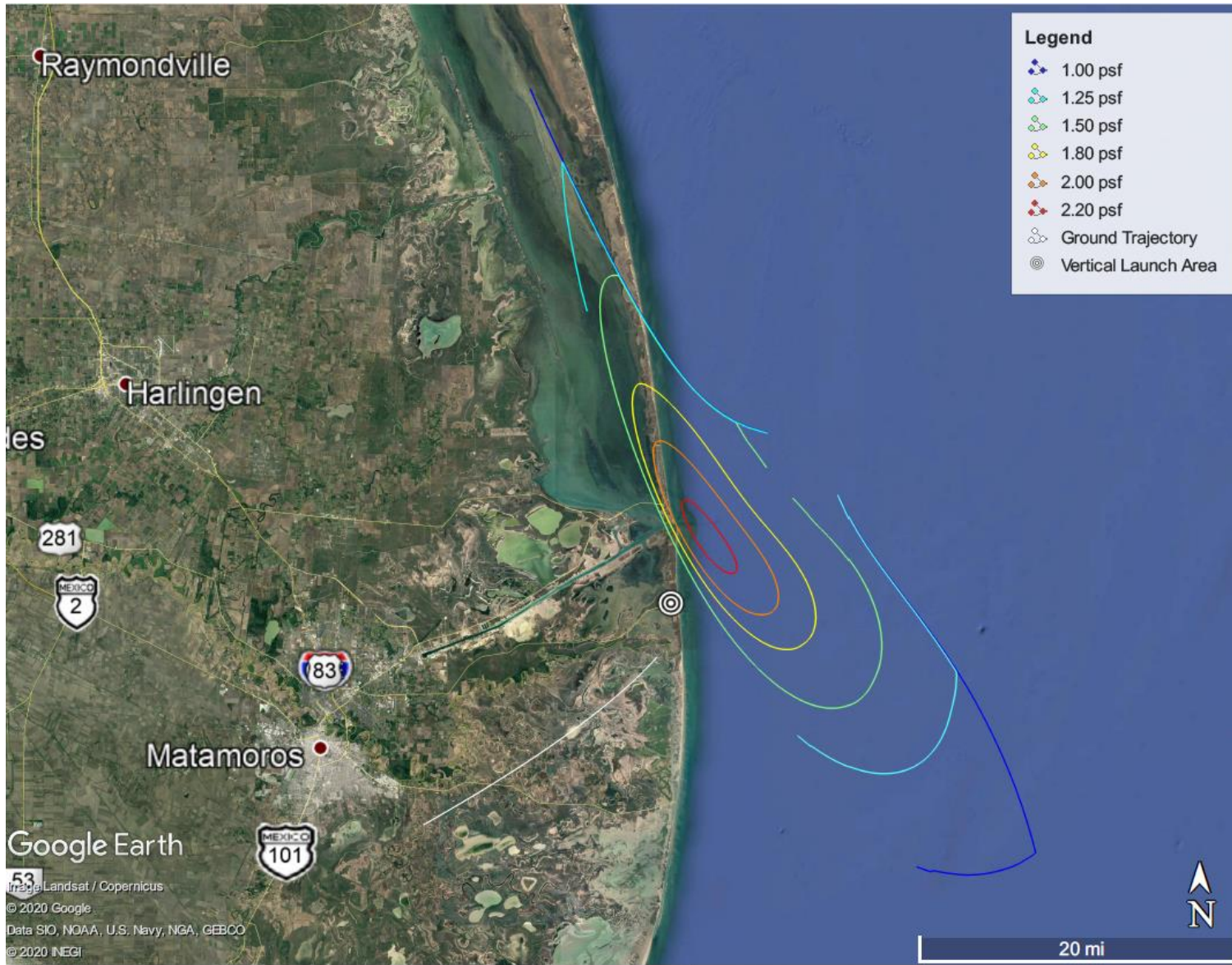
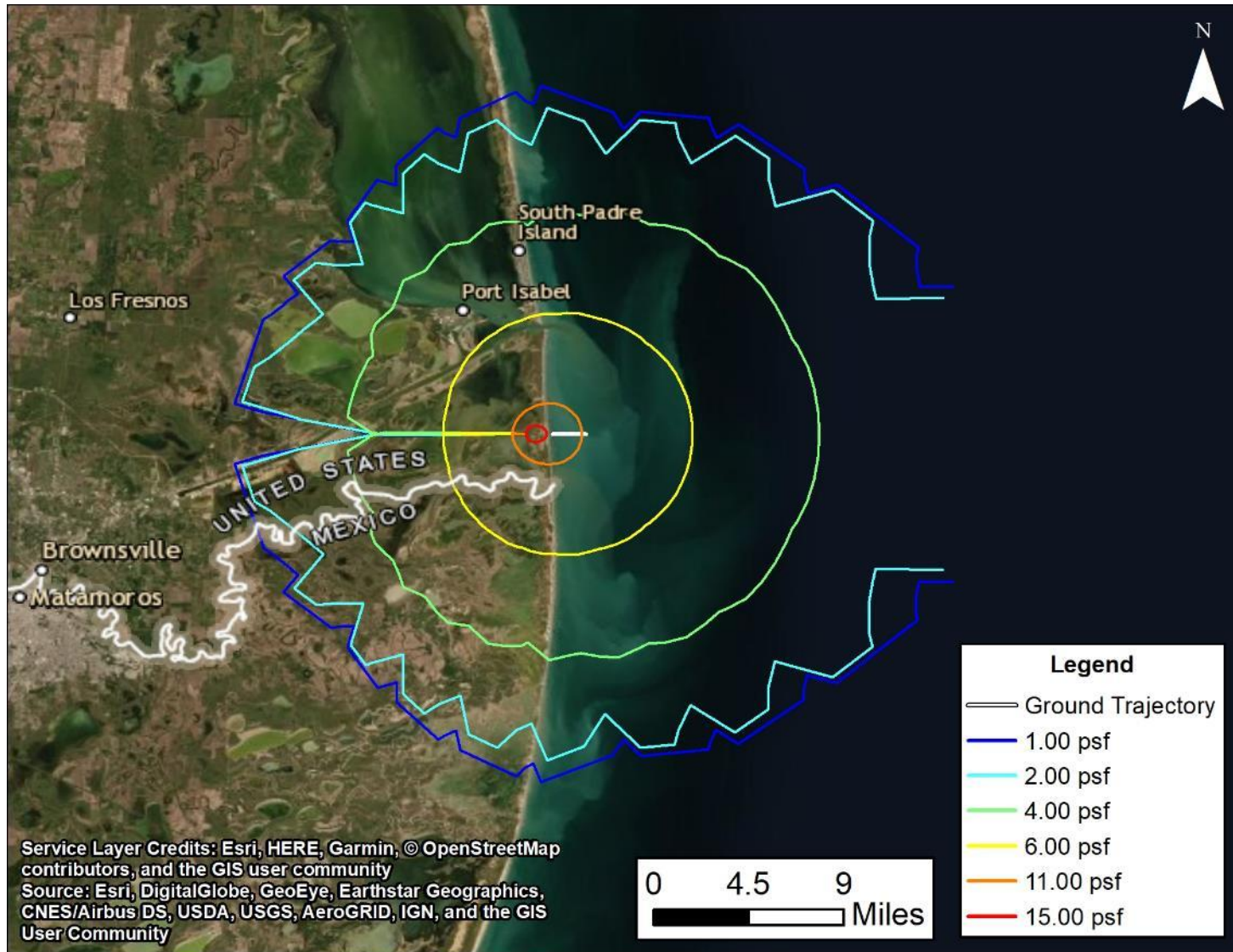


Figure 5-3. Sonic Boom Contour for Super Heavy Landing at the VLA



ESA-listed species in the action area would be exposed to sonic booms generated by Starship and Super Heavy up to ten times per year (sonic booms impacting land would only occur during Starship/Super Heavy orbital missions).

5.2.2 Rocket Heat Plume

Ignition of the Starship and Super Heavy Raptor engines during static fire engine tests and launches (including landings) would generate a heat plume. The plume would consist of water vapor, carbon dioxide, carbon monoxide, hydrogen, methane, nitrogen oxides (NO_x), and oxygen. While all operations involving engine ignition would cause a heat plume, orbital launches would create the largest and hottest plume from the ignition of all Super Heavy's 37 Raptor engines. Static fire engine tests, landings, and suborbital launches would all require fewer engines and would generate a smaller, cooler plume compared to an orbital launch. The heat plume generated from Starship/Super Heavy orbital launches would travel away from launch pad, with temperatures of about 212 °F approximately 0.3 mile from the launch pad and temperatures reaching ambient temperature (90 °F) approximately 0.6 miles from the launch pad. These temperatures would be intermittent and temporary in nature and would only occur during engine ignition. The maximum heat plume from Starship/Super Heavy orbital launches would occur up to 5 times a year.

Noise associated with engine ignition would likely cause animals in the vicinity of the vehicle to disperse; however, less mobile animals or animals unable to disperse quickly enough could be exposed to the heat plume and be injured or killed.

The heat plume may cause some alterations to the plant community and could lead to vegetation changes. Changes include loss of sensitive species, loss of plant community structure, reduction in total cover and replacement of some native species with weed species. The heat plume would dissipate within minutes.

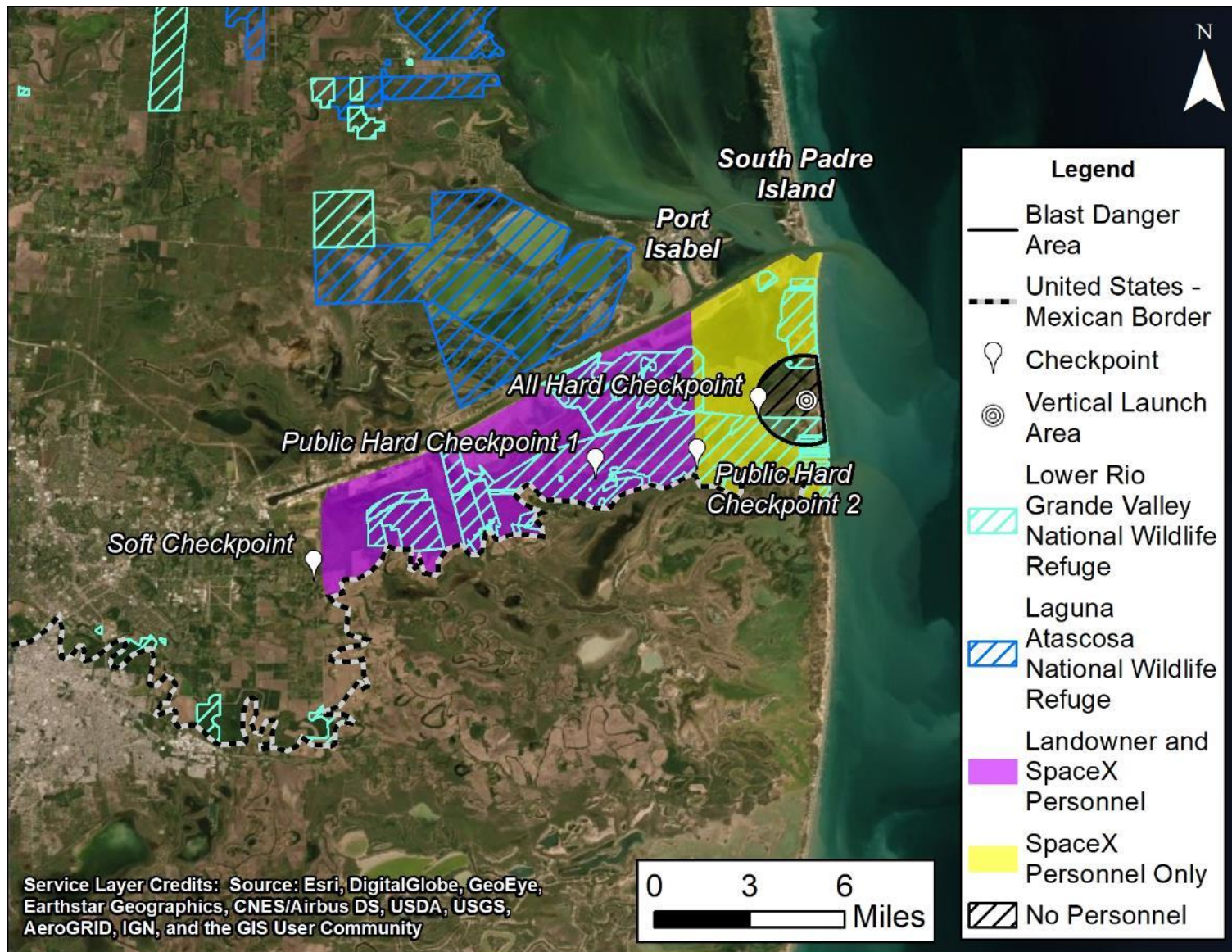
5.2.3 Launch-Related Closures

The Proposed Action would require temporary closure of areas in the vicinity of the Boca Chica Launch Site, which would preclude public access, including folks that conduct species surveys (e.g., sea turtle beach patrols) in the action area. The closure area was developed in consultation with the USFWS during preparation of the 2013 BA (FAA 2013) and 2014 EIS (FAA 2014). In addition to including the FAA-approved hazard area, the closure area includes the entire Lower Rio Grande Valley NWR because the USFWS expressed concern over potential public intrusion in these sensitive areas during launch operations. The closure area includes areas along SH 4, on Boca Chica Beach, and offshore areas (Figure 2-4). Figure 5-4 shows the closure area in relation to the NWRs in the area.

SpaceX estimates that its operations that require restricting public access to protect public safety (i.e., wet dress rehearsals, static fire engine tests, and launches) will require up to 500 hours of closure per year. This represents approximately 5.7 percent of the total number of hours in a year. During closures, only landowners and their guests would be allowed to access their property within the soft checkpoint area. SpaceX uses drones to monitor the closure area for unauthorized individuals and would not conduct ground sweeps. Therefore, closures would not cause direct physical effects to ESA-listed species or critical habitat in the action area.

While the closures would serve to prevent public intrusion and adverse effects to listed species and critical habitat during SpaceX operations, USFWS staff and staff from other wildlife organizations (e.g., Sea Turtle, Inc.) would be prevented from conducting daily duties in the area as part of their regulatory or mission responsibilities while the closure is in effect. This could cause delays to scheduled research or monitoring for any of the species in the area and may also result in missed sea turtle nests. This may also limit Lower Rio Grande Valley NWR staff from being able to conduct maintenance activities within the closure area. These operational related impacts would be temporary and only occur when a closure is established. SpaceX is proposing measures to minimize the potential impacts associated with a closure (see Section 2.2.2).

Figure 5-4. Road Closures and Checkpoints in Relation to National Wildlife Refuges



5.2.4 Night Lighting

Night lighting represents a potential stressor to nesting sea turtles on nearby Boca Chica Beach as well as migrating birds and nocturnal species. Kemp's ridley sea turtles nest during the day and is the most common species of sea turtle to nest in the action area. Lighting (e.g., sky glow) at night can disorient or interrupt the nesting process of the other species of sea turtles, which nest nocturnally. All sea turtle nests detected on Texas beaches are collected, and the eggs are incubated in facilities. Sky glow from nighttime lighting at the launch site could cause emerging hatchlings (from those eggs that are not collected) to crawl in the wrong direction (i.e., away from the ocean). Hatchlings whose sea-finding is disrupted by unnatural stimuli often die from exhaustion, dehydration, predation, or other causes (Witherington et al. 2014).

SpaceX would attempt to conduct most launches and tests between the hours of 7:00 a.m. and 7:00 p.m. However, there could be delays or missions that require launching at a specific time at night to achieve a particular orbital position. For conservative purposes, this BA assumes that 20 percent of annual operations would occur at night. During nighttime launch activity, SpaceX would require bright spotlighting for short durations when illuminating the launch vehicle. In addition to nighttime launch activity, SpaceX would need to perform ground support operations 24/7 at the VLA throughout the year using white lighting for the safety of SpaceX personnel.

5.2.5 Hazardous Materials

Hazardous materials have the potential to impact the ESA-listed species and the piping plover's critical habitat in the action area. The likelihood that an ESA-listed species would come into contact of a hazardous material during a spill during construction and operations is low given SpaceX's immediate clean-up response.

5.2.5.1 Construction

Construction activities would require the use of hazardous materials. Most of the hazardous materials expected to be used are common to construction activities and include diesel fuel, gasoline, and propane to fuel the construction equipment; hydraulic fluids, oils, and lubricants; welding gases; paints; solvents; adhesives; and batteries. An accidental release of hazardous materials during construction (e.g., equipment fuel spill) could affect individual ESA-listed species if they were exposed to the contaminant, which could cause injury, sickness, or death. Accidental spills could also affect vegetated habitat, including designated critical habitat, by damaging or killing plants, which could affect plant density and diversity. SpaceX personnel and associated contractors would be required to comply with appropriate hazardous materials handling and management procedures. The FAA expects that any release of hazardous materials during construction would be small and would affect a limited area, and that SpaceX's immediate clean-up response would avoid or minimize effects on species and habitat.

In accordance with the CWA, SpaceX would continue to operate under the construction storm water discharge permit and the SWPPP would be updated prior to the commencement of new construction activities. Every outdoor storage area where hazardous materials are proposed to be stored or staged during construction would be identified in the SWPPP and inspected on a recurring basis during the construction phase and until the permit is terminated.

Hazardous materials associated with construction activities would be delivered and stored in a manner that would prevent these materials from leaking or spilling, in accordance with applicable federal and state 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 U.S. Department of Transportation (DOT) regulations.

Hazardous materials would be stored in their original containers with their original product labels and would not be stored directly on the ground. These materials would be stored on pallets under cover and with secondary containment. Incompatible materials would not be stored together, and sufficient space would be provided between stored containers to allow for spill cleanup and emergency response access. Storage units would meet building and fire code requirements and would be located away from vehicle traffic. Storage instructions would be posted, and construction employees would be trained in proper receiving, handling, and storage procedures. Material Safety Data Sheets for all hazardous materials stored at the launch site would be provided and available to all site personnel.

Hazardous waste would be generated during construction activities, including empty hazardous material containers, spent solvents, paints, sealants, adhesives, waste oil, spill cleanup materials (if used), batteries, and various universal wastes (e.g., fluorescent bulbs). Other hazardous materials, such as welding gases, are expected to be consumed in their entirety, and the empty gas cylinders would be returned to the suppliers. Construction contractors would be responsible for safely removing these construction-generated wastes from the site and for arranging for recycling or disposal in accordance with applicable regulations. Compliance with appropriate handling and management procedures during construction activities would avoid or minimize potential effects to ESA-listed species and critical habitat.

5.2.5.2 Operations

Potential impacts to ESA-listed species and critical habitat during operations would be similar to those described for construction. Starship/Super Heavy launch operations would require the use and storage of hazardous materials for launches as well as for routine maintenance and flight support activities. Most of these materials would be stored as near to their point of use as possible to minimize the potential for accidental spills. The hazardous materials storage tanks would be located within secondary containment designed to hold at least 110 percent of the tank's maximum volume. The main propellants used for launch operations, LOX and LCH₄, are both gaseous at room temperature and thus would not contaminate vegetation or habitats if released.

Because the Boca Chica Launch Site is located within the 100- and 500-year floodplains, SpaceX would ensure that the storage of hazardous materials would implement flood control measures such as locating water-sensitive equipment, supplies, chemicals, etc. above flood level. The implementation of these measures would reduce the likelihood that a flood event might result in a release of stored hazardous materials.

Operations would result in the use of products containing hazardous materials, including paints, solvents, oils, lubricants, acids, batteries, surface coating, and cleaning compounds. Hazardous materials such as propellants, chemicals, and other hazardous material payload components would

be transported to the facilities in accordance with DOT regulations governing interstate and intrastate shipment of hazardous materials, as applicable (e.g., 49 CFR 100–199).

SpaceX's Spill Prevention, Control, and Countermeasures Plan (SPCC Plan) would be revised in accordance with the CWA requirements included in 40 CFR Part 112 to outline proper management and spill response procedures for changes in the oils and fuels stored at the SpaceX Boca Chica Launch Site.

Small quantities of hazardous waste would be generated during routine operations. Most of the hazardous materials would be consumed, so substantial volumes of hazardous waste would not require disposal. Launch vehicle maintenance, propellant and fuel storage and dispensing, and facility and grounds maintenance are among those activities that may generate very small quantities of hazardous wastes. The sources of hazardous waste include waste fuel, waste oils, spent solvents, paint waste, spill response materials, and used batteries. The estimated amount of hazardous waste anticipated to be generated at the launch site would qualify the site as a small quantity generator of hazardous waste or a conditionally exempt small quantity generator as defined by 30 Texas Administrative Code Part 1 § 335(c).

Hazardous wastes would be managed on site in accordance with applicable federal, state, and local regulations. Hazardous wastes would be prepared for transport in accordance with DOT regulations, and the wastes would be disposed of at approved Treatment, Storage, and Disposal facilities and would be transported using appropriately licensed contractors. Compliance with appropriate handling and management procedures during operations would avoid or minimize potential effects to ESA-listed species and critical habitat.

During a Starship/Super Heavy orbital launch, up to 350,000 gallons of deluge water could be used. Because SpaceX uses LOX and LCH₄ propellants, deluge water following the launch would convert to steam with insignificant amounts of hazardous materials that would degrade quickly. The steam is expected to generate negligible impacts on surface water quality or vegetation and habitats near the VLA, because of the small volume of water expected to condense from the exhaust cloud. Water that is not vaporized or expelled would be contained in retention basins adjacent to the launch pad. This water would then be sampled and analyzed to determine if the water contained controlled contaminants at levels that exceed the TCEQ water quality standards. Water containing contaminants that exceed the water quality criteria would be removed and hauled to an approved industrial wastewater treatment facility outside the VLA. All other water not containing prohibited chemicals would be pumped back to the water tanks.

5.2.6 Ground Vibrations

Short-term ground vibrations could occur during construction and launches. There is a potential for ground vibrations to disturb nesting turtles. Vibrations from rocket launches could frighten nesting turtles, causing them to abandon their nesting attempt. However, vibrations from launch operations would last a few minutes, reducing the likelihood that vibration would occur during the time a sea turtle is attempting to nest.

Vibrations could also harm incubating eggs. However, current standard procedure in Texas for protecting and conserving the species is for all eggs to be retrieved from each nest and transported

to an incubation facility. Sea Turtle, Inc. administers nesting sea turtle patrols and relocation of eggs on Boca Chica Beach. Therefore, any vibrations from a rocket launch would most likely only have the potential to affect eggs that were laid the same day of the launch or were not previously found due to a beach closure.

5.2.7 Increased Traffic and Human Presence

An increase in vehicle traffic during daily operations from construction and SpaceX operations personnel would increase the potential for vehicle collisions with wildlife, including ESA-listed species. In addition, increased traffic and human presence could cause wildlife to avoid the area. Most of the traffic from construction and operations would occur during daylight hours. Peak ocelot activity is around sunset and sunrise, with activity continuing during the night; however, jaguarundis are known to be primarily diurnal. SpaceX anticipates that up to 55 construction vehicles a day would be associated with the construction period. In addition, up to 450 SpaceX staff vehicles would be expected per day in the area as well. The Proposed Action is anticipated to add up to 505 vehicles per day within the Lower Rio Grande Valley NWR corridor and within the corridor providing access to Boca Chica Beach and the VLA. The proposed environmental protection measures discussed in Section 2.2 would minimize the chance of vehicle collisions with wildlife, including ESA-listed species. To date, there have been no recorded vehicle collisions with jaguarundi or ocelots by SpaceX or contractor personnel.

5.2.8 Tall Structures

The construction of new structures could pose a potential collision impact to birds. According to the USFWS, collision hazards for birds depend on several factors related to the bird, infrastructure, and location. Research indicates that collision mortality increases with structure height for most structures (e.g., communication towers and wind turbines) (USFWS 2020b). During the daytime, birds collide with windows because they see reflections of the landscape in the glass (e.g., clouds, sky, vegetation, or the ground); or they see through glass to perceived habitat (including potted plants or vegetation inside buildings) or to the sky on the other side (USFWS 2016b). At night, during spring and fall bird migrations when inclement weather occurs, birds can be attracted to lighted structures resulting in collisions, entrapment, excess energy expenditure, and exhaustion (Manville 2009). The Proposed Action involves the construction of several tall structures. These structures do not include glass windows and would be comprised of opaque surfaces, which are of less risk regarding bird collisions (LEED 2020). Potential effects from lighting would be reduced by complying with established lighting policy for minimizing disorienting effects on migratory birds.

5.2.9 Habitat Loss (including Critical Habitat)

The expansion of the vertical launch area would result in the direct removal of piping plover habitat. Direct loss of habitat reduces a species' ability to reproduce, find food, find shelter, and survive. Destruction, modification, and loss of habitat have been identified by the USFWS as continuing threats to the piping plover. Additionally, habitat loss and degradation on the breeding and wintering grounds of migratory birds negatively impact important avian prey species for aplomado falcons, such as mourning doves (*Zenaidura macroura*) and meadowlarks (*Sturnella* spp.) (DeSante and George 1994; Gulf South Research Corporation and La Tierra Environmental Consulting 2013). The small amount of habitat that would be affected by the Proposed Action would not substantially affect the recovery of

the piping plover or the breeding and wintering grounds of migratory birds. The proposed addition of three pull-offs along SH-4 would be located alongside the highway on uplands. The pull-offs would be less than a quarter of an acre and would be adjacent to a paved two-lane highway. These areas would not significantly contribute to the runoff of the area and impact to habitat would be minimal.

5.2.10 Invasive Species Introductions

Proposed construction activities have the potential to increase the movement and spread of invasive plant species within the action area, which would degrade habitat and potentially directly or indirectly affect ESA-listed species. Habitat degradation or changes in vegetation and habitat structure from establishment and spread of invasive plants could result in conditions that would no longer support ESA-listed species. Invasive species might be accidentally introduced to the area through construction of the launch site infrastructure or shipment of supplies and equipment to the launch site. Species that might be introduced or spread include various plants, such as vitex, that can degrade habitat by displacing native species and ultimately reduce food or important nesting or roosting habitat. To prevent invasive species from spreading, SpaceX would continue to perform routine inspections of construction areas to identify and remove any invasive species (see Section 2.2.1). The successful implementation of specific invasive species control procedures would restrict the movement of invasive species within the action area.

5.2.11 Anomaly

A Starship/Super Heavy test operation or launch could fail (referred to as an anomaly or mishap). Immediately following an anomaly, it may be required to continue to restrict public access in the vicinity of the VLA to address any impacts and ensure public safety. In the event of an anomaly, a limited number of SpaceX staff would enter the debris field and conduct an initial evaluation. Following the initial evaluation of the area, SpaceX would coordinate with TPWD and USFWS prior to any attempt of cleanup, to minimize damage to the Refuge lands and sensitive historic, biological, and geological resources. The method of debris cleanup would be assessed on a case-by-case basis and would be approved by TPWD and USFWS. Conditions that would be assessed include location of the debris, weather, condition of the soil, number of support staff, etc.

Cleanup of debris on State Highway 4 would be the first priority, followed by Refuge or TPWD lands, and then SpaceX property. SpaceX would coordinate with USFWS and TPWD to minimize impacts to the Refuge during cleanup. Entry of SpaceX staff into the Refuge would be done on foot as much as possible, and the use of vehicles on refuge land would be coordinated with Refuge staff to minimize impacts.

In the event of an anomaly, an explosion could injure or kill wildlife species adjacent to the launch pad or within areas impacted by debris. In addition, fires could potentially start from an explosion that could result in a loss of habitat. The habitat would be lost until vegetation has been restored or grows back. Should an anomaly occur on the launch pad, several possible outcomes could result, the most likely being a fire on the launch pad. An explosion on the launch pad would likely spread debris within the FAA-approved hazard area and vegetation across the hazard area would likely be burned. Liquid methane could be released. Because some propellant would likely be burned prior to failure, it is unlikely that the maximum amount of liquid methane held in the tanks would be released. The liquid methane would quickly vaporize and burn.

Debris may temporarily impact habitat. Debris may cause ruts in the unvegetated salt flats or depressional wetlands upon impact or during recovery. SpaceX would coordinate with the Refuge and TPWD to determine the least invasive removal option. The temporary impacts would be restored following the debris removal.

SpaceX would follow the emergency response and cleanup procedures outlined in the Hazardous Materials Emergency Response Plan and Fire Mitigation and Response Plan (if a fire occurs). Procedures include containing a chemical spill using appropriate disposable containment materials such as absorbent berms, fences, trenches, sandbags, and cleaning the area with absorbents or other material to reduce the magnitude and duration of any effects. If the spill is greater than 25 gallons of petroleum or of any size that affects or threatens to affect surface waters (i.e., one that creates a sheen, emulsion, or sludge), SpaceX would report the spill within two hours to the National Response Center, the Texas State Emergency Response Commission, and the TCEQ. SpaceX would collect as much debris as possible from the near-shore marine environment and dispose of it in accordance with federal, state, and local regulations. Short-term effects on the near-shore marine environment may result, but long-term effects would be negligible due to the emergency response and cleanup procedures and the buffering capacity of the waters of the Gulf of Mexico.

5.3 EFFECTS ANALYSIS AND DETERMINATION FOR ESA-LISTED SPECIES AND CRITICAL HABITAT

The following effects analysis considers the threats and stressors discussed above and summarized in Table 5-1 and focuses on those effects that could lead to adverse effects (i.e., take of a listed species or critical habitat).

5.3.1 Eastern Black Rail

Potential suitable eastern black rail habitat exists within the action area, and individuals have been documented within Cameron County (Watts 2016; Lockwood et al. 2005). However, recent records (2011–2016) indicate no eastern black rail breeding in Cameron County (USFWS 2019). Suitable habitat is not present at or near the launch site.

Launch noise and the heat plume represent the greatest potential impact on the eastern black rail. Launch noise could extend into potentially suitable habitat and could temporarily displace any individuals present in the area. These potential effects would be short term as noise levels associated with a launch would last a few minutes and occur on an intermittent basis. Sonic booms generated during landing would also impact the action area. Up to ten sonic booms, each lasting less than a second, could occur under the Proposed Action. The sonic booms would be up to 15 psf in the vicinity of the VLA (see Figure 5-3), which would startle eastern black rails.

The heat plume generated during engine ignition events could impact eastern black rails that may be present in the vicinity (up to 0.6 miles) of the launch pad. Individual animals caught in the heat plume may be injured or killed. Noise and human presence associated with pre-launch operations and the engines may cause individuals to disperse from the area prior to being exposed to the heat plume. The heat plume is not expected to affect eastern black rails because suitable habitat is not present at or near (within 0.6 miles) the launch site and breeding individuals were not recorded in Cameron County in the years 2011–2016.

Based on the above analysis of potential direct and indirect effects on the eastern black rail from the proposed construction and operations, lack of suitable habitat at and near the launch site, and recent eastern black rail survey data indicating the eastern black rail is not present in Cameron County, the FAA has determined the Proposed Action **may affect and is not likely to adversely affect** the eastern black rail (i.e., potential effects are insignificant or discountable). A determination of **may affect** is warranted for the Proposed Action based on the following rationale:

- Potential suitable habitat occurs within the action area.
- Possible presence of eastern black rails in Cameron County.
- Noise and human presence from construction and operations may temporarily disturb or displace eastern black rails.
- The heat plume could injure or kill an eastern black rail if it was present within 0.6 mile of the vertical launch area during a Starship/Super Heavy launch.

A determination of **not likely to adversely affect** is warranted for the Proposed Action based on the following rationale:

- Lack of suitable habitat at and near (within 0.6 miles) the vertical launch area.
- No recent documented presence of eastern black rail in the action area.
- No recent indication of eastern black rail breeding in Cameron County (USFWS 2019).

If an eastern black rail was recorded within the action area, the FAA would immediately reinstate ESA Section 7 consultation with the USFWS.

5.3.2 Northern Aplomado Falcon

Potential foraging habitat for the northern aplomado falcon exists within the action area. Limited perching and nest site areas (trees, yuccas, and power poles) occur within the vicinity of the LLCC and VLA, but outside the project footprint. Falcons have been observed within the action area west of Boca Chica Beach. Increased vehicular traffic, noise, and human presence from construction and operations may startle or displace aplomado falcons. However, human presence and vehicular traffic is already prevalent near the launch site since Boca Chica Beach is a popular recreational area.

Tall structures could attract falcons to the launch site for nesting and perching. The heat plume from engine ignition could harm or kill individual falcons; however, operational noise (e.g., gas venting from the launch vehicle tank) would likely cause falcons that are located near the launch vehicle during an operation to fly away prior to engine ignition.

Based on the above analysis of potential direct and indirect effects on the northern aplomado falcon from the proposed construction and operations, the FAA has determined the Proposed Action **may affect, and is likely to adversely affect** the northern aplomado falcon. A determination of **may affect** is warranted for the Proposed Action based on the following rationale:

- Potential presence of Northern aplomado falcons in the action area.
- Potential foraging habitat occurs in the action area.

A determination of **likely to adversely affect** is warranted for the Proposed Action based on the following rationale:

- Proposed infrastructure, including the proposed integration towers, could attract falcons to the launch site for nesting and perching thereby exposing them to human presence and

disturbance, and potential injury or death from structure collisions.

- Noise and human presence from construction and operations may startle or displace northern aplomado falcons. Disturbance during nesting may cause the adult to leave the nest, exposing eggs or small young to inclement weather or predators. Disturbance may also reduce foraging efficiency and feeding time.

5.3.3 Piping Plover

The Boca Chica Launch Site is located within designated piping plover critical habitat Unit TX-1, and the action area also includes Unit TX-2, TX-3A, and TX-3B. Construction is only proposed within Unit TX-1; the critical habitat description within Unit TX-1 specifically states that it does not include densely vegetated habitat. Areas surrounding the Boca Chica Launch Site include a mix of densely vegetated and unvegetated flats and depressional wetlands which are considered critical habitat.

The 2013 BA determined that approximately 0.70 acre of unvegetated flats and depressional wetlands that occur within the footprints of the VLA would be filled. In addition, 0.31 acre of unvegetated wetland salt flats would be indirectly impacted and cut off by tidal influence. Under the Proposed Action, the expansion of the VLA would fill 11.03 acres of piping plover critical habitat (0.20 acres of depressional wetlands and 10.83 acres of unvegetated salt flats). The proposed location of the parking lot across from the VLA is mostly disturbed uplands, with the central portion of the site being a remnant paved/concrete pad. Construction of the parking lot would fill 0.14 acres of piping plover critical habitat (0.06 acres of unvegetated salt flats and 0.08 acres of depressional wetlands). A total of 11.17 acres of piping plover critical habitat would be filled under the Proposed Action. As part of CWA Section 404 permitting, SpaceX will be required to mitigate wetland impacts. Initial construction of the VLA filled 0.70 acres of piping plover critical habitat. In total, 11.87 acres of piping plover critical habitat would be filled by the completed and proposed construction of the VLA.

The proposed addition of three pull-offs along SH-4 would be located alongside the highway on uplands and would not affect piping plover critical habitat (Figure 4-1). SpaceX is also proposing to expand the total solar farm area by approximately 1.8 acres into land not previously assessed. Land cover in the solar farm expansion area consists primarily of mowed grass. The 2016 National Land Cover Database identifies this expansion area primarily as a mix of low intensity developed and medium intensity developed (EPA 2020). Therefore, the proposed solar farm expansion would not affect piping plover critical habitat.

The total area designated as piping plover critical habitat in Texas is 71,053 acres. The small amount of critical habitat that would be affected by the Proposed Action would not affect the recovery of the species. There is other habitat nearby that the piping plover could use. Based on recent migratory and wintering surveys for piping plovers conducted within the Lower Laguna Madre region in south Texas, the piping plover is not known to use areas within the action area in large numbers (Zdravkovic and Durkin 2011). Surveys conducted between 2018 and 2019 within 3 miles of the VLA estimated piping plover to be the most prevalent of the monitored bird species, with average group sizes of 4.09 individuals, and a maximum group size of 45 individuals (UTRGV 2019). The piping plover does not nest within the action area; therefore, the Proposed Action would not impact piping plover nesting. During engine ignition, the heat plume from the Raptor engines would cause high temperatures in the vicinity of the launch pad; however, these temperatures would be temporary and would not be expected to cause permanent damage to the unvegetated flats used by piping plover. If water is to be

used on the plume, the water would be evaporated and would not impact the piping plover habitat. Individual animals caught in the heat plume could be injured or killed. Noise associated with the engines and pre-launch operations may cause individuals to disperse from the area prior to being affected by the heat plume.

Increased vehicular traffic and human presence from construction and operations may displace the piping plover. However, the annual avian modeling performed by UTRGV from 2016 through 2020 shows an abundance of piping plovers and there has not been a major influence on variation of local populations. The mean number of individual piping plovers compared year to year to test for a temporal trend showed a slight negative trend but likely not significant (UTRGV 2020). In addition, human presence and vehicular traffic is already prevalent within the project area since Boca Chica Beach is a popular recreational area. Direct mortality from construction equipment is unlikely since human presence and activity are likely to disperse wildlife prior to any equipment use.

Noise from launch operations would extend into piping plover habitat and most likely temporarily displace piping plovers. However, these impacts would be short term as noise levels associated with testing and launch operations would last a few minutes. Sonic booms generated during landing would impact the area. Up to ten sonic booms, each lasting less than a second, would occur under the Proposed Action. The sonic booms are modeled to be up to 15 psf in the vicinity of the VLA, and would likely startle individuals, causing them to disperse. Based on a previous ESA section 7 consultation between the USFWS and National Aeronautics and Space Administration for proposed launches at the Wallops Flight Facility, Virginia, and potential effects to piping plovers, the USFWS concluded that launches were not likely to jeopardize the continued existence of the piping plover (NASA 2005).

During an operation involving deluge water, water tanks may discharge up to 350,000 gallons of water onto the launch pad. During a launch, most of the water would evaporate. Remaining deluge water would be collected and tested. The water would be analyzed to determine if the water contained controlled contaminants at levels that exceed the TCEQ water quality standards. Water containing contaminants that exceed the water quality criteria would be removed and hauled to an approved industrial wastewater treatment facility outside the VLA. All other water not containing prohibited chemicals would be pumped back to the water tower.

Even though the launch pad is located next to an unvegetated flat that provides habitat for the piping plover, no deluge water would reach the critical habitat during a launch. While there is a small potential for water vapor to reach this unvegetated area, the amount of water vapor from a maximum of five orbital launches per year is not expected to alter the habitat and cause vegetation to grow on the unvegetated flat and adversely modifying piping plover critical habitat.

Based on the results of the biological monitoring that has occurred to date and the above analysis of potential direct and indirect effects on the piping plover and its designated critical habitat from the proposed construction and operations, the FAA has determined the Proposed Action **may affect, and is likely to adversely affect** the piping plover and its critical habitat. A determination of **may affect** is warranted for the Proposed Action based on the following rationale:

- The documented presence of piping plovers in the action area.
- The presence of critical habitat within the proposed construction area.

A determination of **likely to adversely affect** is warranted for the Proposed Action based on the

following rationale:

- Loss and degradation of foraging and roosting habitat, which could result in decreased fitness and survivorship of wintering piping plovers.
- Rocket heat plume may injure or kill individual plovers.
- Proposed construction would result in permanent loss of 11.17 acres of piping plover critical habitat.

5.3.4 Red Knot

Potential foraging habitat for the red knot exists within the action area. The red knot has been observed in action area; it is a transient winter visitor to Boca Chica Beach.

Increased vehicular traffic and human presence from construction and operations may displace the red knot. However, the annual avian modeling performed by UTRGV from 2016 through 2020 shows that there has not been a major influence on variation of local red knot populations. The mean number of individual red knots compared year to year to test for a temporal trend showed a slight negative trend but likely not significant (UTRGV 2020). In addition, human presence and vehicular traffic is already prevalent within the project area since Boca Chica Beach is a popular recreational area. Direct mortality from construction equipment is unlikely since human presence and activity are likely to disperse wildlife prior to any equipment use.

Noise from launch operations would extend into red knot habitat and most likely temporarily displace red knots. However, these effects would be short term as noise levels associated with a launch would last a few minutes and occur on an intermittent basis. Sonic booms generated during landing would also impact the action area. Up to ten sonic booms, each lasting less than a second, could occur under the Proposed Action. The sonic booms would be up to 15 psf in the vicinity of the VLA, which would startle red knots.

In addition, individual red knots present in the vicinity of the launch pad may be impacted by the heat plume generated during engine ignition. Individual animals caught in the heat plume may be injured or killed. Noise associated with pre-launch operations (e.g., gas venting from the launch vehicle tank) and the engines may cause individuals to disperse from the area prior to being exposed to the heat plume.

Based on the results of the biological monitoring that has occurred to date and the above analysis of potential direct and indirect effects on the red knot from the proposed construction and operations, the FAA has determined the Proposed Action **may affect and is likely to adversely affect** the red knot. A determination of **may affect** is warranted for the Proposed Action based on the following rationale:

- Potential foraging habitat occurs within the action area.
- Documented presence of red knot in the action area.

A determination of **likely to adversely affect** is warranted for the Proposed Action based on the following rationale:

- Noise and human presence from construction and operations may temporarily disturb or displace wintering red knots.
- Rocket heat plume may injure or kill individuals.

5.3.5 Gulf Coast Jaguarundi and Ocelot

The Laguna Atascosa NWR supports the largest known U.S. population of the ocelot, and portions of the NWR are within the action area. The launch site and adjacent areas do not include suitable habitat for the jaguarundi and ocelot. The area near the launch site could act as a travel corridor connecting suitable habitat. Travel through these areas of unsuitable habitat could expose jaguarundis and ocelots to increased risk of mortality from vehicle collision. While there currently is traffic along SH 4, the Proposed Action would increase vehicle traffic during construction and daily operations. This could increase the potential for ocelot and jaguarundi vehicle collisions. Most of the project-related traffic would occur during daylight hours. Peak ocelot activity is around sunset and sunrise, with activity continuing during the night. Jaguarundis are known to be primarily diurnal. SpaceX anticipates up to 55 construction vehicles per day would be associated with the construction period. In addition, SpaceX anticipates up to 450 SpaceX staff vehicles per day in the area as well during construction. The Proposed Action is anticipated to add up to 505 vehicles per day within the Lower Rio Grande Valley NWR corridor and within the corridor providing access to Boca Chica Beach. Implementation of the proposed conservation measures discussed in Section 2.2 would avoid or minimize effects to the ocelot and jaguarundi, including 1) the continued education of construction and SpaceX personnel on the potential for vehicle collisions with ocelots and jaguarundis, 2) reduction of vehicle speeds along SH 4 near the LLCC and VLA, and 3) the “Watch Out for Ocelots/Jaguarundis” or “Watch Out for Wildlife” signs along both sides of SH 4. To date, there have been no recorded vehicle collisions with jaguarundi or ocelots in the vicinity of the launch site since SpaceX began initial construction of the launch site.

Construction and operations would also increase noise and human activity, which could temporarily cause ocelots and jaguarundis to avoid the area. Launch noise levels would last a few minutes. Sonic booms generated during landing could also startle jaguarundis or ocelots in the action area. Up to ten sonic booms, each lasting less than a second, could occur under the Proposed Action. The sonic booms would be up to 15 psf in the vicinity of the VLA. Ocelot and jaguarundi response to noise could potentially cause the species to expend energy, increase their risk of vehicular collision, or cause individuals to abandon their movements through the area and decrease opportunities to improve genetic diversity within the Texas populations.

Ocelot and jaguarundi could be affected by the heat plume generated during engine ignition. While the area surrounding the VLA that would be exposed to high heat of the engine plume does not contain suitable habitat, individuals may be present in the area traveling to suitable habitat during operations. If individual cats were present and within the high temperature areas of the heat plume, they may be injured. Individuals may be discouraged from traveling through the area during operations due to the noise and human activity that would take place in support of the operations.

An anomaly could also affect an ocelot and jaguarundi, particularly if a wildfire is started and burns many acres of suitable cat habitat. The loss of habitat could affect species movement and potentially affect migration corridors. The habitat would be lost until vegetation has been restored or grows back. SpaceX would implement its Fire Mitigation and Response Plan to avoid or minimize these potential effects.

Based on the above analysis of potential direct and indirect effects on the Gulf Coast jaguarundi and ocelot from the proposed construction and operations, the FAA has determined the Proposed Action

may affect, and is likely to adversely affect the jaguarundi and ocelot. A determination of **may affect** is warranted for the Proposed Action based on the following rationale:

- The documented presence of ocelot and jaguarundi in the action area.
- The action area could act as a travel corridor connecting suitable habitat.

A determination of **is likely to adversely affect** is warranted for the Proposed Action based on the following rationale:

- Construction and operations would increase traffic within the action area, thereby increasing the risk of vehicle collisions with jaguarundi and ocelot.
- Animals may avoid lit areas and seek other north-south travel corridors through the lomas, expending additional energy and increasing the potential for vehicular mortality.
- Rocket heat plume may injure or kill individual cats exposed to the plume.

5.3.6 West Indian Manatee

None of the proposed construction areas are located within manatee habitat. This species has not been observed within the action area since 1914. A launch event could increase boat traffic within the vicinity of the VLA during launch days. This would increase the potential for seagrass beds to be disturbed from rotor wash and therefore result in a decrease in a food source for the manatee. In addition, the risk to manatees from boat strikes would increase due to an increase in boat traffic. Potential effects to manatees present in the action during a launch event would be avoid or minimized by an educational outreach program to inform vessel operators about manatees in the area and why and how to avoid them. Given the lack of species presence in the action area and the education outreach program, the FAA has determined the Proposed Action **may affect and is not likely to adversely affect** the West Indian manatee.

5.3.7 Sea Turtles

The Kemp's ridley, loggerhead, green, hawksbill, and leatherback sea turtles have all been recorded nesting within the action area in the past. However, the Kemp's ridley sea turtle is the only species that has been recently recorded to nest on Boca Chica Beach with any regularity (Sea Turtle, Inc 2020). Kemp's ridley sea turtles primarily nest on windy days, when launch operations are unlikely to occur because of poor weather conditions (Sea Turtle, Inc. 2012).

Noise and vibrations from rocket launches could frighten nesting turtles, causing them to abandon their nesting attempt. However, noise and vibrations from launch operations would last a few minutes; reducing the likelihood for the noise and vibrations to occur during the time a sea turtle is attempting to nest. Vibrations could also harm incubating eggs. However, current standard procedure for all nests that are observed in Texas is for all eggs to be retrieved from each nest and transported to an incubation facility. Sea Turtle, Inc. administers nesting sea turtle patrols and relocation of eggs on Boca Chica Beach. Therefore, any vibrations from a rocket launch would most likely only impact eggs that were laid the same day of the launch or were not found due to an operational beach closure. There is also potential for a nest to be missed by patrol and therefore not relocated. These nests that are not found in time to be relocated could potentially be affected by nest predators, vehicles driving on the beach and dunes, or from human poachers. It is possible that activities associated with digging up sea turtle eggs and relocating them to an incubating facility would potentially subject sea turtle eggs to greater vibration and noise levels than those vibrations and noise levels received during engine

ignition while buried on the beach. The FAA is not aware of any effects to sea turtle eggs during transport to an incubating facility due to vibration or noise.

The areas where construction and operations are proposed to occur are not located in sea turtle nesting habitat. The heat plume, however, would expose Boca Chica Beach to high temperatures during engine ignition. The heat plume is not expected to affect sea turtle nests because the eggs are buried in the sand and Sea Turtle, Inc. administers nesting sea turtle patrols and relocation of eggs on Boca Chica Beach. Nesting females and hatchlings could be affected by the heat plume if they were present on the beach at the time of engine ignition. Kemp's ridley sea turtles are the only sea turtle species that have been documented to nest on Boca Chica Beach with any regularity (Sea Turtle, Inc 2020). This species primarily nests on windy days (Sea Turtle, Inc. 2012). SpaceX is not likely to conduct launch operations during windy days. The remaining sea turtle species nest during the night, when 20 percent of operations, including 1 launch, could occur.

While lighting at the VLA could potentially be visible on the beach, it is not likely to affect (disorient) hatchlings because eggs are retrieved and transported to an incubation facility. However, there is potential for a nest to be missed by patrol and therefore not relocated. In addition, during launch days, patrol personnel would potentially not be able to access the beach. As a result, there is potential for some eggs to not be collected and thus hatchlings to emerge near the launch site. These emerging hatchlings could be disoriented by lighting at the VLA. The risk would be highest when a launch vehicle is present on a pad and pad lighting is used. SpaceX would avoid or minimize potential effects from lighting on sea turtles by complying with established lighting policy for minimizing disorienting effects on sea turtle hatchlings. SpaceX is currently updating its existing Facility Design and Lighting Management Plan and will send the updated plan to the USFWS for review.

Based on the above analysis of potential direct and indirect effects on sea turtles from the proposed construction and operations, the FAA has determined the Proposed Action **may affect, and is likely to adversely affect** the loggerhead, green, leatherback, hawksbill, and Kemp's ridley sea turtles. A determination of **may affect** is warranted for the Proposed Action based on the following rationale:

- Sea turtles have been recorded nesting in the action area, including along South Padre Island and Boca Chica Beach.

A determination of **is likely to adversely affect** is warranted for the project based on the following rationale:

- Noise and vibrations from rocket launches could frighten nesting turtles, causing them to abandon their nesting attempt.
- On launch days during sea turtle nesting season, sea turtle nest patrol personnel could potentially be unable to access the beach, thereby missing a sea turtle nesting event and failure to collect and relocate eggs.
- Lighting could cause adult females to false crawl or hatchlings that were not relocated to become disoriented and reduce nesting success / hatchling survival.
- Sea turtles (adults and hatchlings) present near the VLA at the time of engine ignition could be injured or killed by the rocket heat plume.

6 CUMULATIVE EFFECTS ANALYSIS

“Cumulative effects” under the ESA 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). The FAA conducted a thorough review of the action area to identify state or private activities that, when combined with the Proposed Action, may result in cumulative effects to the ESA-listed species and critical habitat addressed in this BA. The FAA conducted a search within each of the municipalities and unincorporated areas within the action area to identify private projects planned to occur within the action area. The FAA identified projects at the Port of Brownsville, Port Isabel, and South Padre Island, as well as several Texas Department of Transportation projects within the action area. None of SpaceX’s proposed future activities occur within designated critical habitat for the piping plover. These actions and the potential cumulative effects to ESA-listed species are described below.

6.1 PORT OF BROWNSVILLE

There are 2 major projects at the Port of Brownsville:

- **Construction of Liquid Cargo Dock 6 and Rehabilitation of Liquid Cargo Dock 3.** The Port of Brownsville is constructing a new liquid cargo dock, Liquid Cargo Dock 6, and rehabilitating Liquid Cargo Dock 3, to improve and expand marine delivery and shipment of refined petroleum products including asphalt, gasoline, and low-sulfur diesel fuel.
- **Administration Complex Rehabilitation and Building Additions.** The Port of Brownsville is rehabilitating existing buildings and constructing new buildings for the administration facilities at 100 Foust Road. Activities include construction of new buildings, rehabilitation of existing buildings, and construction of a new parking area (Port of Brownsville 2020).

6.2 PORT ISABEL

A grant request was submitted to the Texas Community Development Block Grant (TxCDBG) Program for \$500,000 for the installation of ADA-compliant sidewalks, street lighting, drainage improvements and street improvements in the City of Port Isabel. The application is under review (Port Isabel 2020).

6.3 SOUTH PADRE ISLAND

6.3.1 Wind and Water Park

The City of South Padre Island has signed a lease agreement with a property owner and has been working towards developing a Wind and Water Sports Park. The project site is located on a 107-acre parcel of land, wind tidal flats, and salt marsh contiguous with the Laguna Madre, approximately 0.3 miles north of Beach Access Road 4 along Ocean Boulevard (Park Road 100), South Padre Island, Cameron County, Texas. The City proposes to place approximately 13,423 cubic yards of “Geoweb” stabilizing material and crushed stone into 2.332 acres of tidal flats (0.16 acre), estuarine marsh (1.98 acres) and palustrine wetlands (0.192 acre) to construct a permeable vehicular path from Park Road 100 to the Laguna Madre to improve recreational access for non-motorized wind and water-based activities (wind surfing, kayaking, fishing, etc.). Four permeable parking areas would be constructed, one of which would also include a permeable vehicle unloading zone and two equipment setup/rigging areas. The four parking areas would provide parking for up to 309 vehicles both within and outside of jurisdictional waters. A “Green Flush” restroom facility would be constructed in an upland area to avoid direct impacts (USACE 2020).

6.3.2 Laguna Boulevard Improvements

The City of South Padre Island is planning to improve Laguna Boulevard. Proposed improvements include 11 foot-travel lanes and an elevated 8-foot shared use path on the west side of the street. The project will improve the drainage and incorporate low impact development so the City can become more resilient (South Padre Island 2020).

6.4 TEXAS DEPARTMENT OF TRANSPORTATION ACTIVITIES

The Texas Department of Transportation Project Tracker identifies multiple transportation improvement projects within the action area that may result in potential cumulative effects to ESA-listed species or critical habitat when combined with the Proposed Action. Most of the projects consist of pavement rehabilitation and preventative maintenance activities. These types of projects are typically implemented within each facility's existing right-of-way. Several road widening projects are also planned to occur within the next four years, as well as a small amount of road construction in new locations (Texas DOT 2020).

6.5 MAGIC VALLEY ELECTRIC COOPERATIVE

Magic Valley Electric Cooperative (MVEC) is planning to upgrade the existing power line from Brownsville to Boca Chica Village. The line upgrade will include construction along Hwy 4 of aboveground, overhead lines using utility poles. The line will go underground at the intersection of Richardson Ave and Hwy 4 and continue to Boca Chica Village.

6.6 OTHER SPACEX ACTIVITIES

SpaceX is in the construction and continued planning and design phase for its production and manufacturing facility on privately owned property near the LLCC. SpaceX is developing the manufacturing area to include the following:

- Additional large production tents
- Support buildings
- Extension of existing buildings
- Additional parking lots

Further west of the production area is the SpaceX processing area. SpaceX is developing the processing area and is proposing to include the following:

- Office space
- Storage foundations for Starship and Superheavy vehicles
- Water wells and desalination equipment

SpaceX anticipates that the processing and manufacturing areas—which will operate 24 hours a day, 7 days a week—will be staffed by approximately 450 people.

SpaceX's manufacturing and processing activities and associated development will occur on private land, are privately funded, do not require any federal approval, and are planned to continue regardless of whether the FAA issues SpaceX licenses for Starship/Super Heavy operations. For example, the components manufactured and processed in Boca Chica could be shipped to support launch and test

activities at any of SpaceX's facilities, including Vandenberg Air Force Base; McGregor, TX; or CCAFS. The air separation unit and natural gas production area will be used for production-related purposes, and the refined fuel will also support SpaceX operations at other sites. Accordingly, these anticipated activities have independent utility from the FAA's Proposed Action.

6.7 CUMULATIVE EFFECTS ANALYSIS

As identified in Section 5.1.1, the FAA identified 11 threats associated with proposed construction and operational activities, including noise; ground vibrations; increased traffic and human presence; potential invasive species introductions; launch-related closures; potential gas, fuel, oil, or solvent spills; lighting; habitat loss; potential anomalies; rocket heat plume; and tall structures. The projects identified above create the same types of threats to the ESA-listed species addressed in this BA and could result in adverse cumulative effects to the species when combined with the Proposed Action. The Service is continually working with private and state entities to review proposed projects, offer technical assistance, and provide recommendations on avoidance and minimization measures and reintroduction and restoration measures to protect the listed species, including their habitats, addressed in this BA. By continued cooperative efforts to replace, secure, and improve such habitats and connect optimal habitat that exists on NWR and private lands, the FAA does not believe that the potential cumulative effects are likely to jeopardize the continued existence of the listed species addressed in this BA.

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Attachment 1 – Noise Report



U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of Commercial Space Transportation

800 Independence Ave., SW.
Washington, DC 20591

August 10, 2021

Cathy Tortorici
Division Chief
Endangered Species Act Interagency Cooperation Division
Office of Protected Resources
National Marine Fisheries Service
Submitted to: Cathy.Tortorici@noaa.gov

RE: Endangered Species Act Section 7 Consultation for Proposed Starship/Super Heavy Launch Vehicle Operations at SpaceX's Boca Chica Launch Site, Cameron County, TX (SER-2013-10162 and SER-2016-17894)

Dear Ms. Tortorici,

The Federal Aviation Administration (FAA) is reinitiating Endangered Species Consultation (ESA) for the SpaceX Exploration Technologies Corporation's (SpaceX) proposal to operate Starship/Super Heavy launch vehicles at its Boca Chica Launch Site (formerly referred to as the Texas Launch Site) in Cameron County, Texas. Based on the analysis outlined in this letter, the FAA has determined the Proposed Action **may affect but is not likely to adversely affect** ESA-listed species and critical habitat under National Marine Fisheries Service (NMFS) jurisdiction. The FAA seeks NMFS concurrence with the FAA's determination that the Proposed Action would not adversely affect ESA-listed species or critical habitat under NMFS's jurisdiction.

SpaceX must obtain an experimental permit or launch license from the FAA to operate Starship/Super Heavy at the Boca Chica Launch Site. The FAA is currently assessing the potential environmental impacts of issuing SpaceX an experimental permit and/or a Vehicle Operator License, including potential effects to species listed and critical habitat designated under ESA. The FAA's issuance of a permit or license to SpaceX is a federal action subject to ESA section 7.

As summarized below, the FAA previously conducted ESA consultation with NMFS for SpaceX Falcon launch vehicle operations at the Boca Chica Launch Site (SER-2013-10162). SpaceX's planned launch operations have changed since the previous consultation and therefore the FAA is reinitiating ESA consultation with NMFS. This letter (or biological evaluation [BE]) provides a brief consultation history on previous FAA actions related to SpaceX launch operations at the Boca Chica Launch Site and an update to the project description, action area, and effects analysis.

Consultation History for FAA Actions Associated with the SpaceX Boca Chica Launch Site

- **2013:** The FAA submitted a consultation letter to NMFS on January 4, 2013 regarding SpaceX Falcon 9 and Falcon Heavy commercial launch vehicle operations at the Boca Chica Launch Site.

The FAA requested concurrence that the FAA's proposed issuance of licenses or permits to SpaceX for Falcon launch vehicle operations would not adversely affect ESA-listed species or critical habitat. Falcon launch operations analyzed in the consultation included landing operations in the Gulf of Mexico. On March 5, 2013, NMFS issued a Letter of Concurrence to the FAA (**SER-2013-10162**).

- **2016:** The National Aeronautics and Space Administration, FAA, and U.S. Air Force submitted a request for concurrence under ESA section 7 to NMFS for SpaceX launch operations occurring from Cape Canaveral Air Force Station (CCAFS), Kennedy Space Center (KSC), and 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 (**SER-2016-17894**).

Proposed Action

The FAA's Proposed Action is to issue one or more experimental permits and/or a Vehicle Operator License to SpaceX that would allow SpaceX to launch Starship/Super Heavy from the Boca Chica Launch Site.

Overview of SpaceX's Proposed Operations

SpaceX's goal is to use Starship/Super Heavy for low Earth orbit, sun-synchronous orbit, geostationary transfer orbit, and interplanetary missions for cargo and humans. SpaceX's proposed launch operations include suborbital and orbital launches. SpaceX's proposed operations also include launch-related activities at the launch site such as tank tests, static fire engine tests, expansion of the vertical launch area (also referred to as the VLA) and solar farm, and construction of additional infrastructure. All elements of the Proposed Action and SpaceX's proposal are identified in Table 1.

Construction

None of the proposed construction areas are located within the vicinity of marine waters. The eastern most property boundary (i.e., nearest the Gulf of Mexico shoreline) excludes the dune buffer zone and is 1,000 feet from the mean high tide line. Therefore, construction activities and the resulting infrastructure would have **no effect** on ESA-listed species and critical habitat under NMFS jurisdiction and therefore is dismissed from further discussion in this BE.

Operations

SpaceX's proposed Starship/Super Heavy launch operations include landing and recovery operations in the Gulf of Mexico and Pacific Ocean, as further discussed below. SpaceX's Starship/Super Heavy program is still in the early development phases; therefore, SpaceX has not yet identified all potential marine landing locations. However, SpaceX has identified the Gulf of Mexico and one location in the Pacific Ocean (offshore Kauai Island, Hawaii) as landing locations. These landing locations are addressed in this BE. Any new marine landing locations identified by SpaceX in the future would be addressed in another ESA section 7 consultation.

SpaceX's proposed operations consist of two phases: 1) the Program Development Phase; and 2) the Operational Phase. The Program Development Phase entails more testing operations (e.g., suborbital launches) and fewer orbital launches annually. If SpaceX becomes more successful with test flights, the

Starship/Super Heavy launch vehicle program would transition into the Operational Phase, which entails more orbital launches and fewer testing operations.

Table 1. Elements of the Proposed Action

FAA Proposed Action	Elements of SpaceX's Proposal	Brief Description
Issuance of an Experimental Permit or Vehicle Operator License	Program Development Phase – Test and Launch Operations	<ul style="list-style-type: none"> • Starship Static Fire Engine Tests • Super Heavy Static Fire Engine Tests • Starship Suborbital Launch* • Super Heavy Launch* • Starship Land Landing
	Operational Phase – Test and Launch Operations	<ul style="list-style-type: none"> • Starship Static Fire Engine Tests • Super Heavy Static Fire Engine Tests • Starship Suborbital Launch* • Super Heavy Launch* • Starship Land Landing • Super Heavy Land Landing
	Tank Tests	Test the structural capability of the launch vehicle stages
	Nominal Operational Closures	SpaceX anticipates the proposed operations would require 500 hours of annual closure
	Anomaly Response Closures	SpaceX anticipates debris cleanup would require up to 300 hours of annual closure
	Launch-Related Infrastructure Construction	<ul style="list-style-type: none"> • Redundant Launch Pad (Launch Pad B) and Commodities (11 tanks) • Redundant Landing Pad • Integration Towers • Tank Structural Test Stands • Desalination Plant • Support Buildings and Parking Lots • Power Plant • Trenching • Payload Processing Facility • Natural Gas Pretreatment System • Liquefier • Expanded Solar Farm • State Highway 4 Pull-offs

* Aspect of the proposed action with the potential to affect ESA-listed species and critical habitat in the marine environment.

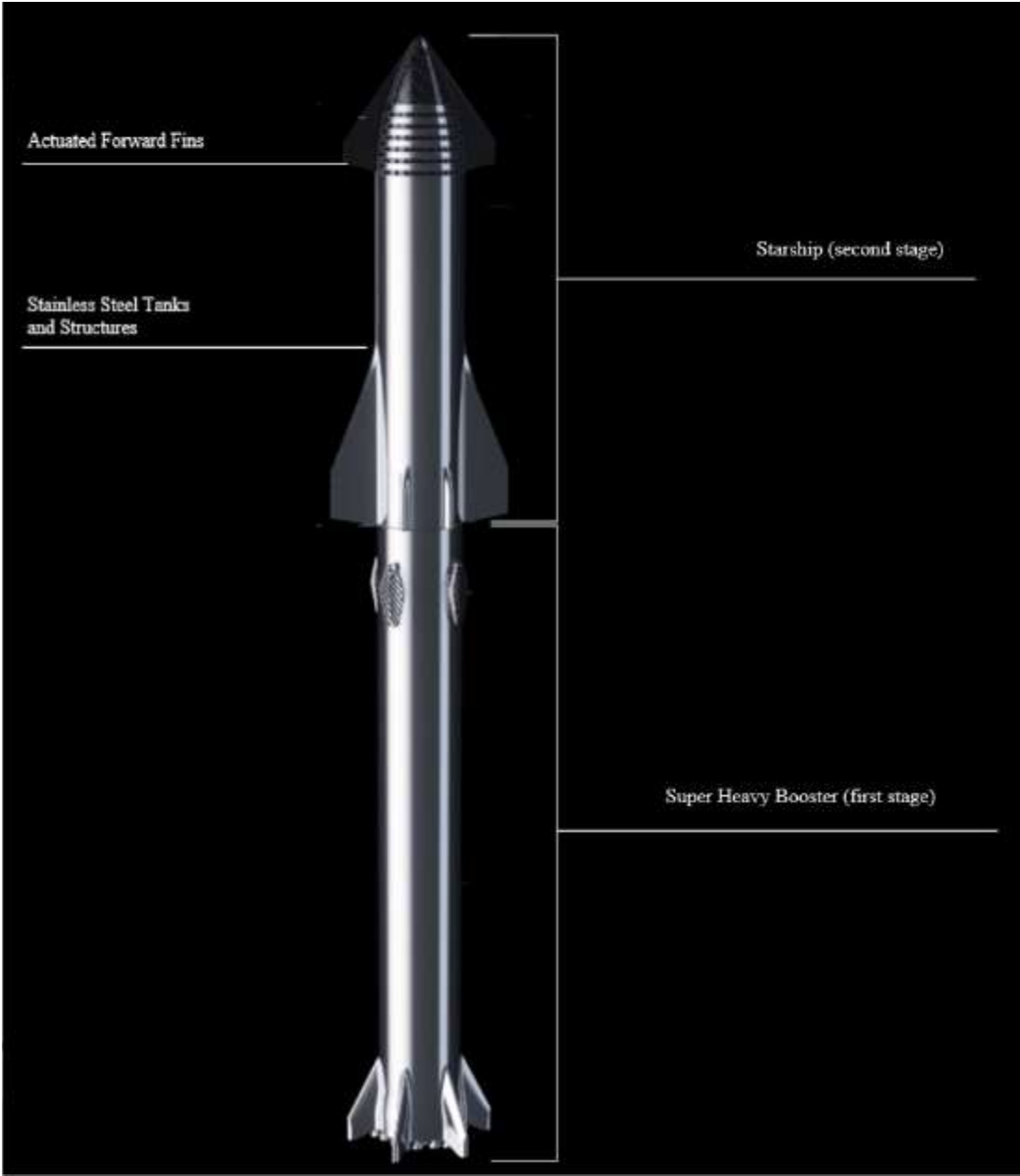
Location

The Boca Chica Launch Site is located at the same location as analyzed in the 2013 consultation. It is located on SpaceX-owned land in Cameron County, Texas, near the cities of Brownsville and South Padre Island. The launch site consists of the vertical launch area, which is controlled by the launch and landing control center. The vertical launch area is approximately 2.2 miles north of the U.S./Mexico border and the control center is approximately 1.3 miles north of the U.S./Mexico border. State Highway 4 provides access to the launch site and terminates directly adjacent to the vertical launch area. The control center is located west of the vertical launch area along SH 4, adjacent to the SpaceX manufacturing and production area.

Launch Vehicle

Figure 1 shows a diagram of Starship/Super Heavy. The fully integrated launch vehicle is comprised of two stages: Super Heavy is the first stage (or booster) and Starship is the second stage. The fully integrated Starship/Super Heavy launch vehicle is expected to be approximately 400 feet tall and 30 feet in diameter. Both stages are designed to be reusable. Unlike the SpaceX Falcon launch vehicle that was assessed in the 2013 consultation, Starship/Super Heavy would not have separable fairings or parachutes. Super Heavy is expected to be equipped with up to 37 Raptor engines, and Starship will employ up to six Raptor engines. The Raptor engine is powered by liquid oxygen (LOX) and liquid methane (LCH₄) in a 3.6:1 mass ratio, respectively. 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. Super Heavy, with all 37 engines, will have a maximum lift-off thrust of 74 meganewtons, allowing for a maximum lift-off mass of approximately 5,000 MT. Launch propellant and commodities are currently stored at the VLA in aboveground tanks; this will not change under the Proposed Action. Commodities include liquid nitrogen, water, gaseous oxygen, gaseous methane, gaseous nitrogen, helium, hydraulic fluid, LOX, and LCH₄.

Figure 1. Starship/Super Heavy Design Overview



Launch Operations

The following information provides an overview of Starship/Super Heavy launches, which include landings. The information focuses on the aspects of the operations that have the potential to effect ESA-listed species and critical habitat in the marine environment—namely SpaceX landing and recovery operations in the Gulf of Mexico and offshore Kauai, Hawaii. Table 2 provides a summary of annual operations that have the potential to effect ESA-listed species and critical habitat in the marine environment.

Table 2. Proposed Annual Operations

Operation	Time^a	Program Development Phase	Operational Phase
Starship Suborbital Launch	Day or Night	20	5
Super Heavy Launch ^b	Day or Night	3	5

Notes:

^a SpaceX is planning to conduct most launches (suborbital and orbital) between the hours of 7:00 a.m. and 7:00 p.m. However, there could be launch delays due to unforeseen issues with the launch vehicle, weather conditions, or certain missions that require launching at a specific time at night to achieve a particular orbital position.

^b A Super Heavy launch could be orbital or suborbital and could occur by itself or with Starship attached as the second stage of the launch vehicle.

Preflight Operations

SpaceX would deploy weather balloons just prior to launch to measure weather data. The data, including wind speeds, is necessary to create the required wind profiles that are used to determine if the vehicle is safe to launch and land. The weather balloons are made of latex with radiosondes attached to each balloon. Data from the balloons is gathered and transmitted to SpaceX via the radiosonde. Each radiosonde is relatively small (about the size of a milk carton) and is powered by a 9-volt battery. The latex balloon attached to each weather balloon typically has a diameter at launch of approximately four feet. When a balloon is deployed, it rises to approximately 12–18 miles into the air and then bursts. This bursting causes the balloon to shred into many pieces that fall back to Earth, along with the radiosonde, all which land in the open marine waters. The radiosonde is expected to rapidly sink to the ocean floor. It should be noted that the National Weather Service releases weather balloons twice a day, every day of the year, from almost 900 locations worldwide to obtain weather data and conduct research (NOAA 2021).

Suborbital Launches

SpaceX is proposing to conduct Starship suborbital launches. During a suborbital launch, Starship would launch from the VLA and ascend to high altitudes and then throttle down or shut off engines to descend, landing back at the VLA or downrange either directly in the Gulf of Mexico or on a floating platform in the Gulf of Mexico. A floating platform would be a mobile vessel that would not attach to the seafloor. As the suborbital launches increase in altitude, a sonic boom might be produced during descent; however, this would only occur when Starship lands downrange in the Gulf of Mexico, no closer than 19 miles from shore.

During the Program Development Phase, SpaceX is proposing to conduct up to 20 Starship suborbital launches annually. During the Operational Phase, SpaceX is proposing to conduct up to five Starship suborbital launches annually. Each launch would include a landing, which could occur in the Gulf of Mexico.

Orbital Launches

SpaceX is also proposing to conduct up to five Starship/Super Heavy orbital launches annually. Orbital launches would primarily be to low inclinations with flight north or south of Cuba that minimize land overflight. Future launches may be to higher, 70-degree inclination with limited overflight of remotely populated portions of Mexico. During the Program Development Phase, SpaceX is proposing to conduct up to three Starship/Super Heavy orbital launches annually (Table 2). During the Operational Phase, SpaceX is proposing to conduct up to five Starship/Super Heavy orbital launches annually (Table 2). SpaceX would not exceed five Starship/Super Heavy orbital launches annually.

Each Starship/Super Heavy orbital launch would include an immediate boost-back and landing of Super Heavy. Landing could occur at the vertical launch area or downrange in the Gulf of Mexico (either on a floating platform or expended in the Gulf of Mexico), no closer than approximately 19 miles off the coast. During flight, Super Heavy's engines would cut off at an altitude of approximately 43 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 to conduct the retrograde burn, which would place it in the correct angle to land. Once Super Heavy is in the correct position, the engines would be cut 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.

If a Super Heavy landing occurred downrange in the Gulf of Mexico on a floating platform, Super Heavy would be delivered by barge to the Port of Brownsville and transported the remaining distance to the Boca Chica Launch Site over the 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 pounds per square foot (psf). A maximum of five Super Heavy landings in the Gulf of Mexico could occur each year (Table 2).

Similarly, each Starship/Super Heavy orbital launch would include a Starship 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 in the Pacific Ocean approximately 54 nautical miles north of Kauai, Hawaiian Islands (expended in the ocean). As Starship slows down during its landing approach, a sonic boom(s) with a maximum predicted overpressure of 2.2 psf would be generated. If a Starship landing occurred downrange in the Gulf of Mexico on a floating platform, it would be delivered by barge to the Port of Brownsville and transported the remaining distance to the Boca Chica Launch Site over roadways.

It is SpaceX's intent to recover and reuse Starship and Super Heavy boosters. However, as noted above, SpaceX may require expending Super Heavy or Starship in the ocean (Gulf of Mexico and Pacific Ocean, near Kauai) during early launches as its program develops. If this occurs, SpaceX would not recover Super Heavy or Starship. SpaceX expects Super Heavy and Starship would breakup on impact. SpaceX expects

most of the launch vehicle would sink because it is made of steel. Lighter items (e.g., items not made of steel, such composite overwrapped pressure vessels) may float but are expected to eventually become waterlogged and sink. If there are reports of large debris, SpaceX would coordinate with a party specialized in marine debris to survey the situation and sink any large floating debris.

Environmental Protection Measures

SpaceX's Starship/Super Heavy launch operations will include the following environmental protection measures. These are similar to the measures provided in the 2016 consultation noted above (**SER-2016-17894**).

Education and Observation

- SpaceX will instruct all personnel associated with launch operations about the presence of species protected under the ESA and the Marine Mammal Protection Act (MMPA).
- SpaceX 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 during all in-water activities including transiting marine waters to retrieve launch vehicle stages or debris. Observers will survey the area where the launch vehicle landed in the water to determine if any ESA-listed or MMPA-protected were injured or killed during in-water activities. Injured or dead animals will be reported as noted below. The observer will use binoculars. The observer will keep a logbook noting the date, time, location, species, number of animals, distance and bearing from the watercraft, direction of travel, and other relevant information, for all sightings.
- SpaceX will advise all personnel that there are civil and criminal penalties for harming, harassing, or killing ESA-listed species or marine mammals.

Reporting Stranded, Injured, or Dead Animals

- SpaceX will immediately report any collision(s) with and/or injury to any ESA-listed or MMPA-protected species to NMFS's Protected Resources Division (PRD) at (1-727-824-5312) or by email to takereport.nmfsser@noaa.gov.
- SpaceX will report any smalltooth sawfish sightings to 941-255-7403 or via email to Sawfish@MyFWC.com.
- SpaceX will report any giant manta ray sightings via email to manta.ray@noaa.gov.
- SpaceX will report any stranded, injured, or dead sea turtles or marine mammals to 1-877-WHALE HELP (1-877-942-5343).

Watercraft Operations

- All watercraft operators will be on the lookout for and avoid collision with ESA-listed and MMPA-protected species. Watercraft operators will maintain a safe distance by following these protective measures:
 - Maintain a minimum distance of 150 feet from sea turtles.

- Maintain a minimum distance of 300 feet (100 yards) from all other ESA-listed and MMPA-protected species.
- Check various communication media for general information regarding avoiding ship strikes. These include National Oceanic and Atmospheric Administration weather radio, U.S. Coast Guard NAVTEX broadcasts, and Notices to Mariners.
- 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.
- Reduce speed to 10 knots or less when mother/calf pairs or groups of marine mammals are observed.

Hazardous Materials Emergency Response

- In the event of a failed launch operation, SpaceX will follow the emergency response and cleanup procedures outlined in its Spill Prevention, Control, and Countermeasure Plan, and Anomaly Response 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, 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 environmental conditions).

Annual Reporting to NMFS

- The FAA, in collaboration with SpaceX, will prepare and submit reports to NMFS by December 31 of each year documenting the outcome of each Starship/Super Heavy launch mission involving landing and recovery operations in the marine environment. The FAA will report on FAA-licensed launches (i.e., commercial launches). Annual reports will include the following: 1) the dates of all missions; 2) approximate locations (GPS coordinates) of all landing areas; 3) any available information on the fate of unrecovered stages; and 4) any evidence that ESA-listed or MMPA-protected species were adversely affected by the operation.

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.” The action area is defined by the Starship and Super Heavy landing locations in the Gulf of Mexico and Pacific Ocean. The action area in the Gulf of Mexico is shown in Figure 2. SpaceX Super Heavy and/or Starship landing and recovery operations could occur anywhere within this area of the Gulf of Mexico. The action area in the Gulf of Mexico is a minimum of 19 nautical miles off the coast. The action area in the Pacific Ocean is shown in Figure 3. This is the area in the Pacific Ocean where SpaceX is proposing to land Starship after an orbital mission. The landing area is located approximately 54 nautical miles north of Kauai, Hawaii. The only component of SpaceX's landing and recovery operations that occurs near (less than 5 nautical miles offshore) the coast is the watercraft(s) transiting to and from a port when recovering the vehicle on a floating platform or recovering launch vehicle components in the ocean.

Figure 2. Action Area in the Gulf of Mexico



Figure 3. Action Area in the Pacific Ocean near Kauai, Hawaiian Islands



ESA-Listed Species and Critical Habitat in the Action Area

Table 3 lists the ESA-listed species under NMFS jurisdiction in the action area in the Gulf of Mexico. Table 4 lists the ESA-listed species under NMFS jurisdiction in the action area in marine waters off the coast of Hawaii. A description of the critical habitat in or near the action area follows the tables.

Table 3. ESA-listed Species Potentially Present in the Action Area in the Gulf of Mexico

Species	ESA Listing in FR	Critical Habitat Designation in FR	Status
Mammals			
Bryde’s whale (Gulf of Mexico subspecies) <i>Balaenoptera edeni</i>	April 15, 2019 (84 FR 15446)	Not designated	E
Fin whale <i>Balaenoptera physalus</i>	December 2, 1970 (35 FR 18319)	Not designated	E
Sei whale <i>Balaenoptera borealis</i>	December 2, 1970 (35 FR 18319)	Not designated	E
Sperm whale <i>Physeter macrocephalus</i>	December 2, 1970 (35 FR 18319)	Not designated	E
Sea Turtles			
Green turtle – North and South Atlantic DPS <i>Chelonia mydas</i>	April 6, 2016 (81 FR 20057)	September 2, 1998 (63 FR 46693)	T

Species	ESA Listing in FR	Critical Habitat Designation in FR	Status
Hawksbill turtle <i>Eretmochelys imbricata</i>	June 2, 1970 (35 FR 8491)	September 2, 1998 (63 FR 46693)	E
Kemp's ridley turtle <i>Lepidochelys kempii</i>	December 2, 1970 (35 FR 18319)	Not designated	E
Leatherback turtle <i>Dermochelys coriacea</i>	June 2, 1970 (35 FR 8491)	March 23, 1979 (44 FR 17710)	E
Loggerhead turtle – Northwest Atlantic Ocean DPS <i>Caretta caretta</i>	September 22, 2011 (76 FR 58868)	July 10, 2014 (79 FR 39856)	T
Fishes			
Giant manta ray <i>Manta birostris</i>	January 22, 2018 (83 FR 2916)	Not designated	T
Gulf sturgeon <i>Acipenser oxyrinchus desotoi</i>	September 30, 1991 (56 FR 49653)	March 19, 2003 (68 FR 13370)	T
Nassau grouper <i>Epinephelus striatus</i>	July 29, 2016 (81 FR 42268)	Not designated	T
Oceanic whitetip shark <i>Carcharhinus longimanus</i>	January 30, 2018 (83 FR 4153)	Not designated	T
Smalltooth sawfish – U.S. population <i>Pristis pectinata</i>	April 1, 2003 (68 FR 15674)	September 2, 2009 (74 FR 45353)	E

Notes:

Source: NMFS 2020

DPS = distinct population segment; E = endangered; FR = Federal Register; T = threatened

Table 4. ESA-listed Species Potentially Present in the Action Area in Marine Waters off the Coast of Hawaii

Species	ESA Listing in FR	Critical Habitat Designation in FR	Status
Mammals			
Blue whale <i>Balaenoptera musculus</i>	December 2, 1970 (35 FR 18319)	Not designated	E
False killer whale – Hawaiian Insular <i>Pseucomcorca crassidens</i>	December 28, 2012 (77 FR 70915)	July 24, 2018 (82 FR 35062)	E
Fin whale <i>Balaenoptera physalus</i>	December 2, 1970 (35 FR 18319)	Not designated	E
North Pacific right whale <i>Eubalaena japonica</i>	March 6, 2008 (73 FR 12024)	April 8, 2008 (73 FR 19000)	E
Sei whale <i>Balaenoptera borealis</i>	December 2, 1970 (35 FR 18319)	Not designated	E
Sperm whale <i>Physeter macrocephalus</i>	December 2, 1970 (35 FR 18319)	Not designated	E
Hawaiian monk seal <i>Neomonachus schauinslandi</i>	November 23, 1976 (41 FR 51611)	August 21, 2015 (80 FR 50925)	E
Sea Turtles			
Green turtle – Central North Pacific DPS <i>Chelonia mydas</i>	April 6, 2016 (81 FR 20057)	September 2, 1998 (63 FR 46693)	T
Hawksbill turtle	June 2, 1970	September 2, 1998 (63 FR 46693)	E

Species	ESA Listing in FR	Critical Habitat Designation in FR	Status
<i>Eretmochelys imbricata</i>	(35 FR 8491)		
Leatherback turtle <i>Dermochelys coriacea</i>	June 2, 1970 (35 FR 8491)	Not designated	E
Loggerhead turtle, North Pacific DPS <i>Caretta caretta</i>	September 22, 2011 (76 FR 58868)	Not designated	E
Olive ridley turtle <i>Lepidochelys olivacea</i>	July 28, 1978 (43 FR 32800)	Not designated	T
Fishes			
Giant manta ray <i>Manta birostris</i>	January 22, 2018 (83 FR 2916)	Not designated	T
Oceanic whitetip shark <i>Carcharhinus longimanus</i>	January 30, 2018 (83 FR 4153)	Not designated	T
Shortfin mako shark <i>Isurus oxyrinchus</i>	April 15, 2021 (86 FR 19863)	Not designated	C

Notes:

Source: NMFS 2021a

C = candidate; DPS = distinct population segment; E = endangered; FR = Federal Register; T = threatened

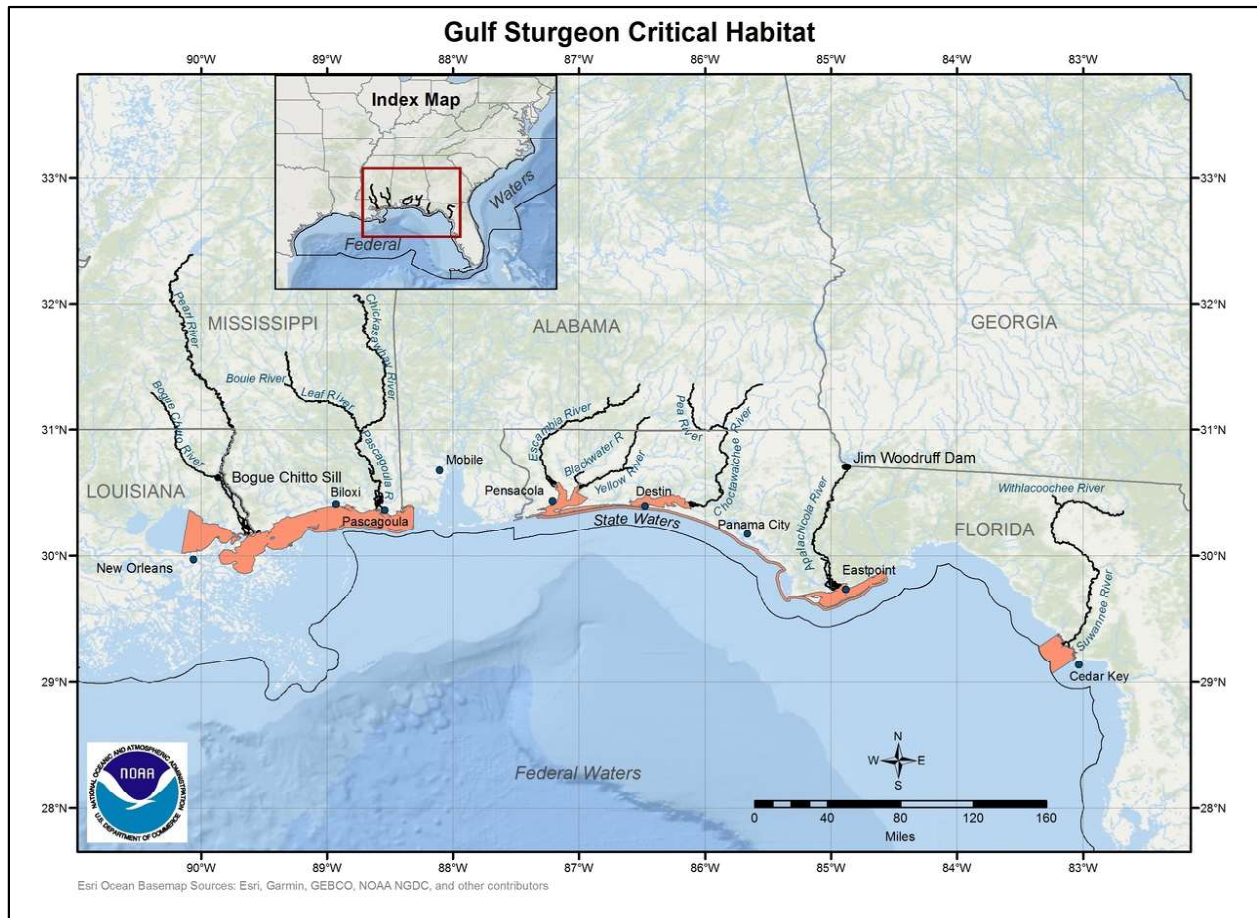
The action area (or areas adjacent to the action area) contains critical habitat for the following species: gulf sturgeon, loggerhead sea turtle, and smalltooth sawfish.

Gulf Sturgeon

Areas adjacent to the action area in the Gulf of Mexico include gulf sturgeon critical habitat (Figure 4). 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 primary constituent elements (PCEs) essential for the conservation of Gulf sturgeon are those habitat components that support feeding, resting and sheltering, reproduction, migration, and physical features necessary for maintaining the natural processes that support these habitat components. The PCEs relevant to 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
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 4. Gulf Sturgeon Critical Habitat



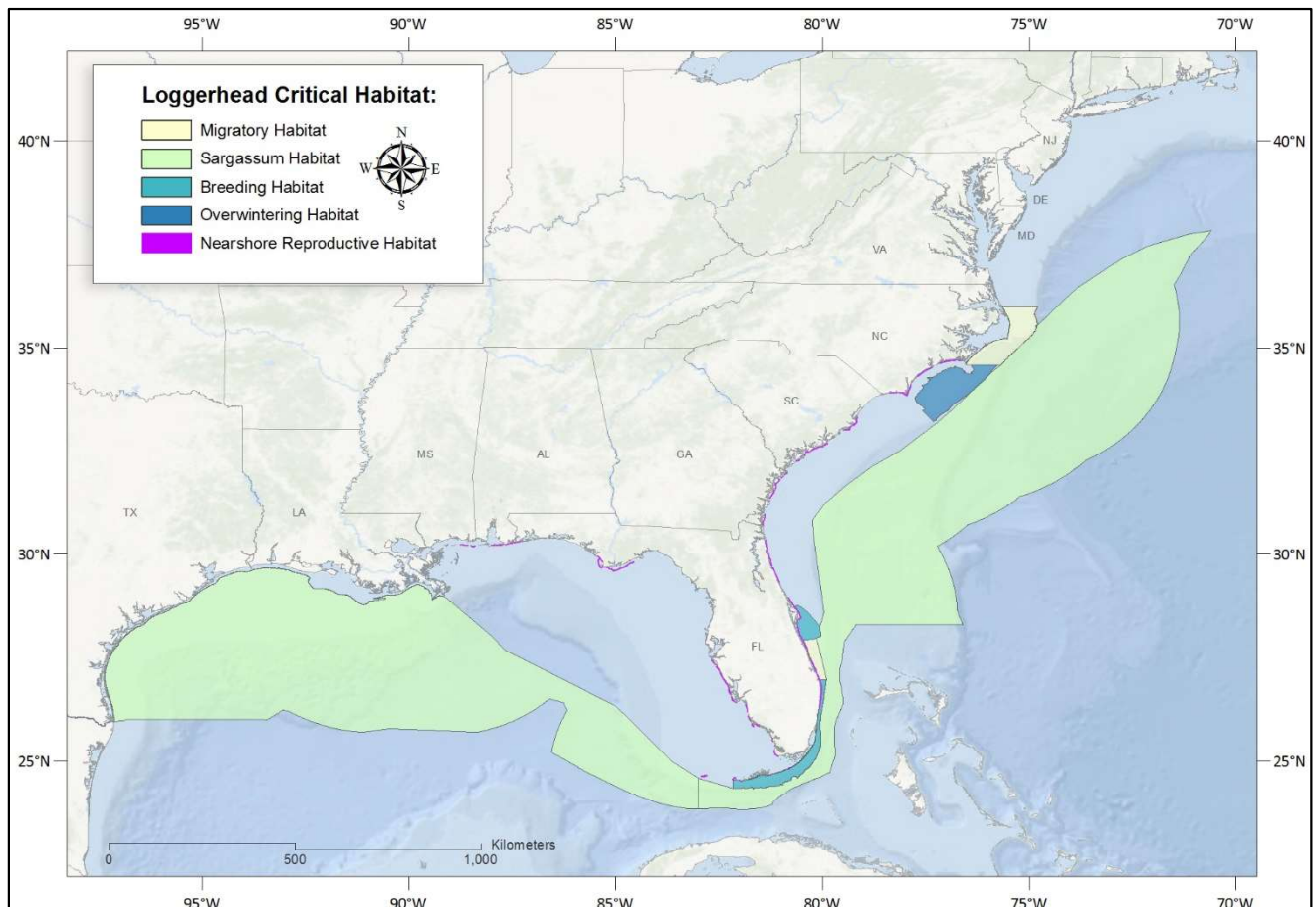
Loggerhead Sea Turtle

The action area includes loggerhead sea turtle critical habitat in the Gulf of Mexico, specifically *Sargassum* habitat (Figure 5). Areas adjacent to the action area also include loggerhead sea turtle critical habitat, specifically nearshore reproduction habitat and breeding habitat.

- Sargassum* habitat:** the physical or biological features 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 inhabitation 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 meters in depth.

- Nearshore reproductive habitat:** The physical or biological features 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.
- Breeding habitat:** the physical or biological features 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.

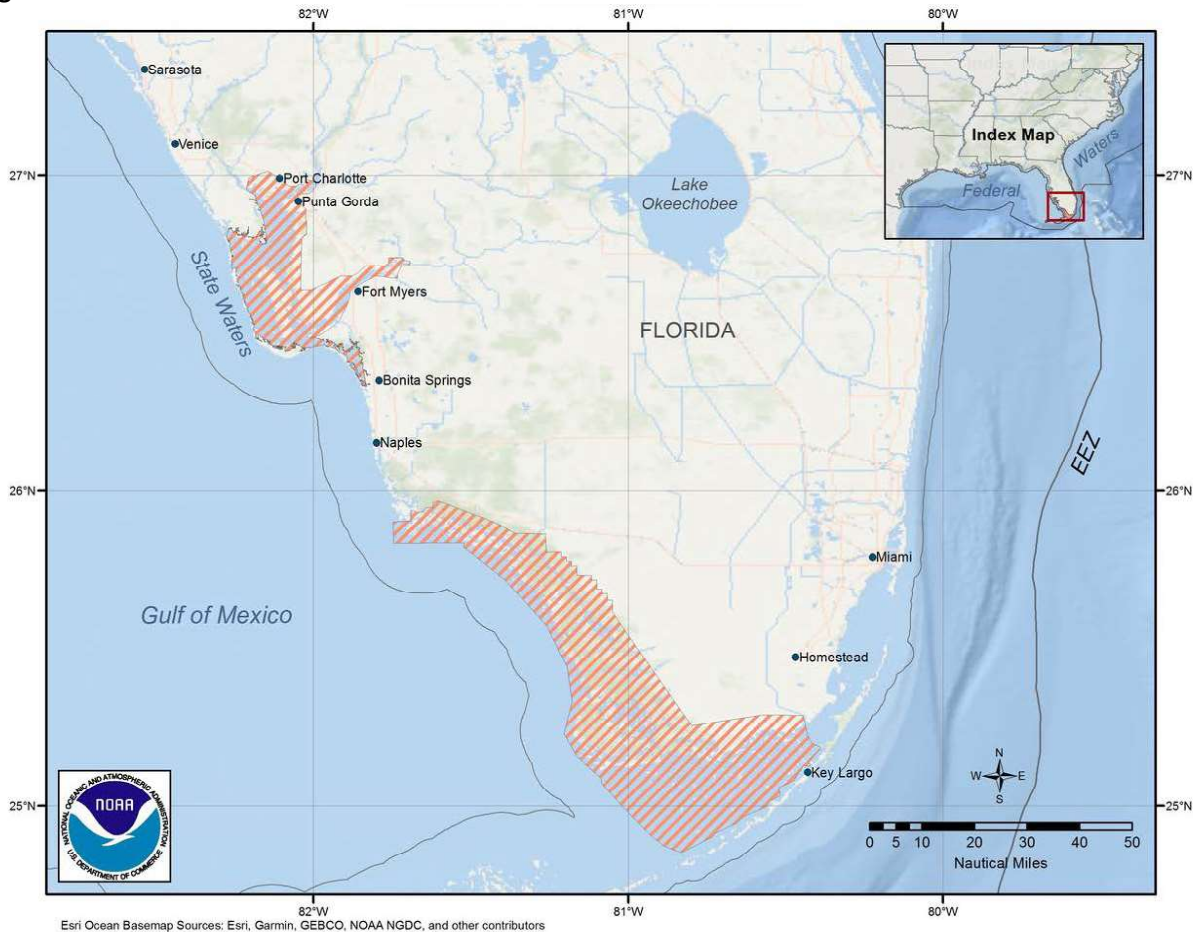
Figure 5. Loggerhead Sea Turtle Critical Habitat



Smalltooth Sawfish

Areas adjacent to the action area in the Gulf of Mexico include smalltooth sawfish critical habitat (Figure 6). Smalltooth sawfish critical habitat consists of two units: the Charlotte Harbor Estuary Unit, which comprises approximately 221,459 acres of coastal habitat, and the Ten Thousand Islands/Everglades Unit, which comprises approximately 619,013 acres of coastal habitat. The two units are located along the southwestern coast of Florida between Charlotte Harbor and Florida Bay. The key conservation objective NMFS identified for the smalltooth sawfish is the need to facilitate recruitment into the adult sawfish population by protecting juvenile nursery areas. NMFS determined that the physical and biological habitat features essential to the conservation of the species are red mangroves and shallow euryhaline habitats characterized by water depths between the Mean High Water line and 3 feet (0.9 meters) measured at Mean Lower Low Water. These essential features are necessary to facilitate recruitment of juveniles into the adult population because they provide for predator avoidance and habitat for prey in the areas currently being used as juvenile nursery areas.

Figure 6. Smalltooth Sawfish Critical Habitat



Effects on ESA-Listed Species in Action Area

Potential stressors to the ESA-listed species in the action area from the project include the following:

- Ingestion of an expended radiosonde or weather balloon fragments
- Being struck by a launch vehicle or radiosonde
- Being struck by watercraft
- Being exposed to a hazardous material
- Being exposed to a sonic boom (overpressure) generated during an ocean landing

Potential effects to the ESA-listed species from these stressors are discussed below.

Ingestion

Foraging individuals at or near the sea surface could ingest the expended radiosonde or weather balloon fragments. Ingestion of debris may cause a physical blockage in the digestive system to the point of starvation or that results in ulceration or rupture, cause the animal to feel satiated and reduce its foraging effort and overall fitness, or to introduce toxic chemicals into the tissues of animals, causing adverse health or reproductive consequences (Laist 1997; Derraik 2002). Commonly cited research (Burchette 1989) asserts that nearly all latex balloons at burst altitude rupture into small, ribbon-like fragments (approximately four inches). This was confirmed by researchers at the University of Colorado and National Oceanic and Atmospheric Administration (University of Colorado and NOAA 2017). As such, it is assumed the weather balloons would land in the oceans in small shreds. These balloon pieces would be positively buoyant, float on the surface, and begin to photooxidize due to ultraviolet light exposure. Degradation would occur at a slower rate than on land due to less heat buildup and the biofouling. Numerous studies show 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).

As the latex balloon fragments float on the surface, they would become a substrate for microflora, such as algae, and eventually become weighted down with heavy-bodied epifauna, such as tunicates (Foley 1990). In addition to further degradation of the latex material, the embedded organisms would cause the material to become negatively buoyant, making it slowly sink to the ocean floor. Sinking balloon fragments could appear to look like potential prey, and pieces could be ingested by sea turtles; however, commonly cited research (Burchette 1989) concluded that due to the wide scattering of the small pieces, it would be extremely unlikely that the soft rubber would block the digestive tract of a sea turtle.

The degree to which such colonization would occur would correspond to the amount of time the balloon would remain at or near the ocean's surface. Additionally, an area's geographic latitude (and corresponding climatic conditions) has been shown to have a marked effect on the degree of biofouling on marine debris. 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).

The whales identified in Tables 3 and 4 occur in deep ocean waters (Watkins and Schevill 1976; Goldbogen et al. 2007; Horwood 2009; Goldbogen et al. 2011). Sperm whales tend to forage in waters deeper than mysticetes (e.g., 400 to 600 meters) and sometimes at or near the benthos (Mathias et al. 2012; Miller et al. 2013), but not at the depths where the radiosonde and balloon fragments are expected to settle (> 3,000 meters). False killer whales prefer even deeper offshore waters; they are known to dive as deep as 2,000 meters (Hatton 2008).

Hawaiian monk seals live in warm, subtropical waters and spend two-thirds of their time at sea. They use the waters surrounding atolls and islands and areas farther offshore on reefs and submerged banks; they also use deepwater coral beds as foraging habitat. When on land, monk seals haul-out to rest, molt, give birth and nurse on sand, coral rubble, and volcanic rock shorelines. They generally prefer sandy, protected beaches surrounded by shallow waters for pupping (NMFS 2021b).

A marine mammal encountering a piece of a SpaceX weather balloon is very unlikely (discountable) because of the small size of the balloon fragments, because the fragments would be widely dispersed, and because of the small number of times annually SpaceX would release weather balloons (Table 2). If ingested, the very small pieces of balloon fragments would be unlikely to harmfully affect the ESA-listed mammals (Burchette 1989). The likelihood of any marine mammal encountering ingestible material once it has settled over the long-term is expected to be so low as to be discountable.

In a comprehensive review of 37 sea turtle debris ingestion studies undertaken since Balazs (1985), Schuyler et al. (2014) found that, while all species had been reported to ingest debris, leatherbacks and greens were the most susceptible to plastic ingestion, likely due to their feeding preferences. Of the multiple stages in a sea turtle's life, the oceanic phase appears to be at greatest risk (Schuyler et al. 2014). Earlier research by Schuyler et al. (2012) on greens and hawksbills found most materials ingested by sea turtles were positively buoyant, resulting in the presence of these items in the portion of the water column occupied by oceanic post-hatchling sea turtles.

The probability of the ESA-listed mammals, sea turtles, or fish encountering and ingesting a radiosonde or piece of a weather balloon is unlikely and discountable. SpaceX deployment of weather balloons would be infrequent (Table 2-2), and the pieces entering the ocean are small, thus limiting the opportunity for aquatic species to encounter the material.

In summary, regarding potential effects associated with ingestion, the release of weather balloons **may affect, but is not likely to adversely affect**, ESA-listed species, because the species are so unlikely to encounter and ingest the material (i.e., potential effects are discountable).

Struck by a Launch Vehicle or Radiosonde

The species identified in Tables 3 and 4 could potentially be struck by a launch vehicle or radiosonde during SpaceX operations (including landings). It is highly unlikely that protected species would be struck by a launch vehicle or radiosonde given the relatively small size of the boosters and radiosonde compared to vast open ocean.

The ESA-listed fish species that might be present in the action area do not spend a large majority of time at the shallower surface depths where direct strikes could occur. They are expected to be distributed throughout deeper depths in the water column (e.g., salmonids, sharks), or located along the shelf or substrate waters less than 110 meters deep (e.g., smalltooth sawfish, groupers, and sturgeon species).

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. Since fish are able to detect an object descending in the water column (e.g., sensing the pressure wave or displacement of water) and are highly mobile, they have the ability and would likely be able to swim away from an oncoming object.

Marine mammals, sea turtles, and giant manta ray spend time at the surface to bask and breathe and thus may be at a higher risk of interacting with the launch vehicle or radiosonde compared to fish species. Since turtles and whales spend most of their time submerged as opposed to on the surface, the risk of being directly hit by a landing launch vehicle or radiosonde is extremely low. Expended materials from rocket launches have been occurring for decades with no known interactions with any of these species.

In summary, regarding potential effects associated with a direct strike, SpaceX launch operations (including landings) **may affect, but are not likely to adversely affect**, ESA-listed species, because it would be extremely unlikely for an ESA-listed species to be directly struck by a landing launch vehicle or radiosonde (i.e., potential effects are discountable).

Struck by a Watercraft

SpaceX would use watercraft to recover launch vehicle stages that land on a floating platform in the ocean as well as to recover or sink debris. Therefore, recovery operations would have the potential to result in a watercraft strike of ESA-listed species that spend time at or near the surface of the water (i.e., the marine mammals, sea turtles, and giant manta ray). These species spend most of their time submerged in the ocean as opposed to on the surface. All watercraft operators would be required to comply with the conservation measures identified above.

Given the protected species spend little time at the surface (NMFS 2019) and all watercraft operations would have a dedicated observer on board, SpaceX recovery operations **may affect, but are not likely to adversely affect**, ESA-listed species, because watercraft strikes would be extremely unlikely to occur (i.e., potential effects are discountable).

Exposure to Hazardous Materials

Residual LOX and LCH₄ may be on the Starship or Super Heavy during a landing, including a splashdown in the ocean. Super Heavy would have approximately 5 metric tons of LCH₄ onboard following an orbital flight. Starship may contain between 1 to 10 metric tons of LCH₄. In the event the propellant tank ruptures on impact, the propellant would evaporate quickly (hours) or be diluted by seawater.

In the event of a failed launch operation, SpaceX would follow its emergency response and cleanup procedures outlined in its Spill Prevention, Control, and Countermeasure Plan, and Anomaly Response Plan. 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 or be diluted seawater.

Regarding potential effects associated with an exposure to a hazardous material, SpaceX launch operations (including landings) **may affect, but are not likely to adversely affect**, ESA-listed species, because the propellants would evaporate quickly (hours) after release and the chances of an individual ESA-listed species encountering a hazardous material are extremely low due to the small operational area compared to the vast open ocean; therefore, potential effects are discountable.

Sonic Boom

A sonic boom would be generated during Starship and Super Heavy landings in the ocean. For landings in the ocean, overpressures impacting the ocean's surface could be up to 15 psf. Boom intensity, in terms of psf, is greatest under the flight path and progressively weakens with greater horizontal distance away from the flight track. It should be noted that the impact area receiving the maximum overpressure (around 15 psf) will typically be a small fraction of the overall impact area (i.e., the maximum overpressure contour would be focused directly beneath the stage in the landing area [near the floating platform and splashdown location]).

The overpressures from sonic booms are not expected to affect marine species underwater. Acoustic energy from in-air noise does not effectively cross the air/water interface; therefore, most of the noise is reflected off the water surface (Richardson et al. 1995). In addition, underwater sound pressure levels from in-air noise are not expected to reach or exceed threshold levels for injury. Previous research conducted by the U.S. Air Force supports this conclusion with respect to sonic booms, indicating there is no risk of harassment for protected marine species in water (U.S. Air Force Research Laboratory 2000). Therefore, sonic booms would have **no effect** on ESA-listed species while under water.

In summary, sonic booms associated with launch operations **may affect, but are not likely to adversely affect**, because it is extremely unlikely an ESA-listed species would be at the water's surface at the time the sonic boom impacts the water's surface due to the small operational area compared to the vast open ocean (i.e., potential effects are discountable).

Effects on Critical Habitat in Action Area

As discussed below, nominal Starship/Super Heavy launch operations are not expected to affect any of the PCEs or essential features of the critical habitat discussed. However, a launch anomaly has the potential to affect critical habitat.

Gulf Sturgeon

Gulf sturgeon critical habitat occurs in the Gulf of Mexico (Figure 4). Nominal launch operation (including landing) would not occur within this critical habitat. None of the proposed launch activities has the potential to affect the species' PCEs (abundant prey items; substrates necessary to support subadult and adult life stages; water quality and sediment quality parameters necessary for normal behavior, growth, and viability of all life stages; and safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats). However, a launch anomaly has the potential to temporarily affect water quality. Water quality may be temporarily degraded from a launch anomaly that occurred near the critical habitat. Potential effects to water quality could result from debris and propellants. Emergency response and cleanup procedures would reduce the magnitude and duration of any impacts. Given the limited number of annual launches and the unlikely scenario of a launch failure near the gulf sturgeon's critical habitat, it is highly unlikely that impacts to the water quality conditions essential feature of Gulf sturgeon critical habitat would occur. Therefore, the Proposed Action **may affect, but is not likely to adversely affect**, Gulf sturgeon critical habitat. If adverse effects were identified after a launch failure, the FAA would re-initiate ESA Section 7 consultation with NMFS.

Loggerhead Sea Turtle

Loggerhead sea turtle critical habitat (*Sargassum* habitat) occurs in the action area (Figure 5). All operations would be short-term, and most would occur well offshore in deep waters. Launch operations (including landings) would not occur within 5 nautical miles of the coast where nearshore reproductive habitat is located. None of the proposed operations has the potential to affect *Sargassum* habitat. However, a launch anomaly has the potential to temporarily affect the loggerhead's critical habitat. Water quality may be temporarily degraded from a launch anomaly that occurred within or near the critical habitat. Potential effects to water quality could result from debris and propellants. Emergency response and cleanup procedures would reduce the magnitude and duration of any impacts. Given the limited number of annual launches and the unlikely scenario of a launch failure within or near the loggerhead's critical habitat, it is highly unlikely that impacts to the critical habitat would occur. Therefore, the Proposed Action **may affect, but is not likely to adversely affect**, loggerhead sea turtle critical habitat. If adverse effects were identified after a launch failure, the FAA would re-initiate ESA Section 7 consultation with NMFS.

Smalltooth Sawfish

Smalltooth sawfish critical habitat is located in southern Florida (Figure 6). Nominal launch operations (including landings) would not occur within this critical habitat. None of the proposed launch activities has the potential to affect the habitat features essential to the conservation of the species (red mangroves and shallow euryhaline habitats). However, a launch anomaly has the potential to temporarily affect the quality of the shallow euryhaline habitat. Water quality may be temporarily degraded from a launch anomaly that occurred near the critical habitat. Potential effects to water quality could result from debris and propellants. Emergency response and cleanup procedures would reduce the magnitude and duration of any impacts. Given the limited number of annual launches and the unlikely scenario of a launch failure near the smalltooth sawfish's critical habitat, it is highly unlikely that impacts to shallow euryhaline habitat would occur. Therefore, the Proposed Action **may affect, but is not likely to adversely affect**, smalltooth sawfish critical habitat. If adverse effects were identified after a launch failure, the FAA would re-initiate ESA Section 7 consultation with NMFS.

Conclusion

Based on the analysis above, the FAA has determined the Proposed Action **may affect but is not likely to adversely affect** ESA-listed species and critical habitat under NMFS jurisdiction. We seek your concurrence on this determination. Thank you for your assistance in this matter. Please provide your response to Chelsea Clarkson via e-mail at Chelsea.Clarkson@faa.gov.

Sincerely,

JAMES R
REPCHECK

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JAMES R
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Date: 2021.08.10
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Randy Repcheck
Manager, Safety Authorization Division

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