
Federal Aviation Administration

# Final Programmatic Environmental Assessment for the SpaceX Starship/Super Heavy Launch Vehicle Program at the SpaceX Boca Chica Launch Site in Cameron County, Texas

June 2022

**Programmatic Environmental Assessment for the SpaceX Starship/Super Heavy Launch Vehicle Program at the SpaceX Boca Chica Launch Site in Cameron County, Texas**

**AGENCIES**: Federal Aviation Administration (FAA), lead federal agency; National Aeronautics and Space Administration, National Park Service, U.S. Coast Guard, U.S. Army Corps of Engineers, and U.S. Fish and Wildlife Service, cooperating agencies.

This final Programmatic Environmental Assessment (PEA) is submitted pursuant to the following: Section 102(2)(C) of the National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S.C. 4321, et seq.); Council on Environmental Quality NEPA-implementing regulations (40 CFR Parts 1500 to 1508); Section 4(f) of the Department of Transportation Act (49 U.S.C. § 303); Section 106 of the National Historic Preservation Act (16 U.S.C. § 470); Executive Order 11988, *Floodplain Management*; DOT Order 5650.2, *Floodplain Management and Protection*; and FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*.

**DEPARTMENT OF TRANSPORTATION, FEDERAL AVIATION ADMINISTRATION:** The FAA is evaluating SpaceX's proposal to operate Starship/Super Heavy launch vehicles at its Boca Chica Launch Site. SpaceX must obtain an experimental permit and/or a vehicle operator license from the FAA to operate Starship/Super Heavy.

Issuing a permit or license is considered a major federal action subject to environmental review under NEPA. The FAA's Federal Action is to issue an experimental permit(s) and/or a vehicle operator license to SpaceX for Starship/Super Heavy launch operations originating at the Boca Chica Launch Site. The FAA's Federal Action also includes the FAA's issuance of temporary airspace closures.

**PUBLIC REVIEW PROCESS**: In accordance with the applicable requirements, the FAA initiated a public review and comment period for the draft PEA. The 45-day public comment period began on September 17, 2021 and ended on November 1, 2021. The FAA received approximately 17,000 public comment submissions. Refer to Appendix I of this final PEA for responses to comments.

**CONTACT INFORMATION**: Questions regarding the PEA can be addressed to Ms. Amy Hanson, Environmental Protection Specialist, Federal Aviation Administration, 800 Independence Avenue, SW, Suite 325, Washington, DC 20591; email Amy.Hanson@faa.gov.

This PEA becomes a federal document when evaluated, signed, and dated by the responsible FAA Official.

Responsible FAA Official:

MICHELLE S MURRAY Digitally signed by MICHELLE S MURRAY
Date: 2022.06.13 08:01:20 -04'00'

_____ Date: June 13, 2022

Michelle S. Murray
Manager, Safety Authorization Division

**NOTE:** The PEA for the Starship/Super Heavy Program was prepared by SpaceX under the supervision of the FAA. The FAA has an obligation, consistent with 40 CFR 1506.5(a) and 14 CFR 450.47, to independently evaluate and to take responsibility for the contents of the PEA. Subsequent to that independent evaluation, the PEA becomes a Federal document supporting the Federal actions described in the analyses. While the FAA's authority under the Commercial Space Launch Act only extends to launch activities, the PEA provides a broader analysis of all reasonably foreseeable activities and effects expected to be caused by the proposed permitting or licensing action, such as the building of infrastructure to support the launch activities.

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# Acronyms & Abbreviations

| | |
|---|---|
| ACHP | Advisory Council on Historic Preservation |
| APE | Area of Potential Effects |
| ARTCC | Air Route Traffic Control Center |
| BA | Biological Assessment |
| BMPs | Best Management Practices |
| BO | Biological Opinion |
| CCSFS | Cape Canaveral Space Force Station |
| CDNL | C-weighted Day-Night Average Sound Level |
| CEQ | Council on Environmental Quality |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| $CO_2$ | carbon dioxide |
| CO | carbon monoxide |
| CWA | Clean Water Act |
| CZMA | Coastal Zone Management Act |
| dB | decibels |
| dBA | A-weighted decibels |
| DNL | Day-Night Average Sound Level |
| DOT | Department of Transportation |
| EA | Environmental Assessment |
| EFH | Essential Fish Habitat |
| EIS | Environmental Impact Statement |
| EO | Executive Order |
| EPA | Environmental Protection Agency |
| ESA | Endangered Species Act |
| FAA | Federal Aviation Administration |
| FEMA | Federal Emergency Management Agency |
| FR | Federal Register |
| GHG | greenhouse gas |
| gpm | gallons per minute |
| GWP | global warming potential |
| HAP | hazardous air pollutant |
| IPaC | Information for Planning and Consultation |
| KSC | Kennedy Space Center |
| $L_{Amax}$ | maximum A-weighted instantaneous sound level |
| LC | Launch Complex |
| LCH4 | liquid methane |
| LLCC | Launch and Landing Control Center |
| $L_{max}$ | maximum instantaneous sound level |
| LOA | Letter of Agreement |
| LOX | liquid oxygen |
| MGD | million gallons per day |
| mg/L | milligrams per liter |
| MGY | million gallons per year |
| MN | meganewton(s) |
| MOA | Memorandum of Agreement |
| MSATs | Mobile Source Air Toxics |
| MT | metric ton(s) |
| MW | megawatt(s) |
| NAAQS | National Ambient Air Quality Standards |
| NASA | National Aeronautics and Space Administration |
| NEPA | National Environmental Policy Act |
| NFIP | National Flood Insurance Program |
| NHL | National Historic Landmark |
| NHPA | National Historic Preservation Act |
| NMFS | National Marine Fisheries Service |
| NOAA | National Oceanic and Atmospheric Administration |
| NOTAM | Notice to Air Missions |
| NOTMAR | Notice to Mariners |
| NOx | nitrogen oxide |
| NPDES | National Pollutant Discharge Elimination System |
| NPS | National Park Service |
| NRHP | National Register of Historic Places |
| NWR | National Wildlife Refuge |

| | |
|---|---|
| OSHA | Occupational Safety and Health Administration |
| PA | Programmatic Agreement |
| PEA | Programmatic Environmental Assessment |
| PM | particulate matter |
| $PM_{10}$ | particulate matter less than or equal to 10 microns in diameter |
| $PM_{2.5}$ | particulate matter less than or equal to 2.5 microns in diameter |
| psf | pound(s) per square foot |
| RCRA | Resource Conservation and Recovery Act |
| ROD | Record of Decision |
| ROW | right-of-way |
| SAL | State Antiquities Landmark |
| SEL | sound exposure level |
| SH | State Highway |
| SHPO | State Historic Preservation Officer |
| SLC | Space Launch Complex |
| $SO_2$ | sulfur dioxide |
| SODAR | Sound detection and ranging |
| SpaceX | Space Exploration Technologies Corporation |
| SPCC | Spill Prevention, Control, and Countermeasures |
| SWPPP | Stormwater Pollution Prevention Plan |
| TAC | Texas Administrative Code |
| TCEQ | Texas Commission on Environmental Quality |
| TCMP | Texas Coastal Management Program |
| TGLO | Texas General Land Office |
| THC | Texas Historical Commission |
| TPDES | Texas Pollutant Discharge Elimination System |
| TPWD | Texas Parks and Wildlife Department |
| TDS | Total Dissolved Solids |
| TxDOT | Texas Department of Transportation |
| U.S. | United States |
| U.S.C. | United States Code |
| USACE | U.S. Army Corps of Engineers |
| USCG | U.S. Coast Guard |
| USFWS | U.S. Fish and Wildlife Service |
| VSFB | Vandenberg Space Force Base |
| VLA | Vertical Launch Area |
| VOC | Volatile Organic Compound |
| WR | Written Re-evaluation |

# Chapter 1.
# **Introduction**

The Federal Aviation Administration (FAA) is evaluating Space Exploration Technologies Corporation's (SpaceX) proposal to operate its Starship/Super Heavy launch vehicle at its existing Boca Chica Launch Site in Cameron County, Texas. SpaceX's proposed operations include launches originating from this site, as well as landings at this site, in the Gulf of Mexico, or in the Pacific Ocean off the coast of Kauai, Hawaii (refer to Chapter 2 for a detailed description of SpaceX's proposed operations).[1] SpaceX must obtain an experimental permit and/or a vehicle operator license from the FAA for Starship/Super Heavy launch operations. Issuing an experimental permit or a vehicle operator license is considered a major federal action under the National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code [U.S.C.] 4321, et seq.), and the Council on Environmental Quality (CEQ) NEPA-implementing regulations (40 Code of Federal Regulations [CFR] Parts 1500–1508 [2020][2]) and requires an environmental review. The FAA is the lead federal agency for this environmental review.

SpaceX has applied to the FAA for a license for the Starship/Super Heavy launch vehicle (as defined above). SpaceX may require a number of new or modified experimental permits or vehicle operator licenses from the FAA in order to execute its Starship/Super Heavy program over time. Thus, SpaceX has prepared this Programmatic Environmental Assessment (PEA) under the supervision of the FAA, which evaluates the potential environmental impacts of the activities associated with SpaceX's Starship/Super Heavy program. A programmatic document is a type of general, broad NEPA review from which subsequent NEPA documents can be tiered, focusing on the issues specific to the subsequent actions. Programmatic NEPA documents may be prepared for broad federal actions, such as a proposed program, policy, plan, or suite of projects, which address actions occurring over large areas or systems and may include groupings of similar actions or repeating actions over longer periods of time than other NEPA reviews.[3] The use of a programmatic environmental impact statement (EIS) or EA, and subsequent

[1] SpaceX has applied to the FAA for a vehicle operator license for Starship/Super Heavy launch operations discussed in Chapter 2. If, upon receiving a complete application or a license modification request from SpaceX, the FAA determines SpaceX's proposed launch operations fall outside the scope of impacts discussed in this PEA, the FAA will conduct further environmental review, which could include preparing another NEPA document that tiers from this PEA.

[2] CEQ published a final rule in the Federal Register on April 20, 2022, which became effective on May 20, 2022, to amend certain provisions of its regulations for implementing NEPA. However, this PEA was begun in 2021 and thus prepared in accordance with the 2020 NEPA-implementing regulations. This PEA examines all reasonably foreseeable effects expected to be caused by the proposed permitting or licensing action and, as noted in the preamble to CEQ's April 20, 2022 final rule "Nothing in the CEQ regulations requires agencies to categorize effects separately in this manner; instead, well-organized NEPA documents address the direct, indirect, and cumulative effects of particular resources in a cohesive and comprehensive manner." (87 FR 23453, 23467).

[3] CEQ's December 2014 guidance, *Effective Use of Programmatic NEPA Reviews*, states "[i]n the absence of certainty regarding the environmental consequences of future proposed actions, agencies may be able to make broad program decisions and establish parameters for subsequent analyses based on a programmatic review that adequately examines the reasonably foreseeable consequences of a proposed program, policy, plan, or suite of projects."

preparation of a project specific EIS or EA, is referred to as "tiering" the environmental review. The FAA has recognized that a programmatic review and tiering may be appropriate "to sequence environmental documents from the early stage of a proposed action to a subsequent stage to help focus on issues that are ripe for decision and exclude from consideration issues not yet ripe or already decided."[4] The FAA may tier subsequent documents from this PEA to focus on environmental impacts specific to the Starship/Super Heavy program under a new or different license application.

The applicant has provided the FAA with a mission profile of proposed launch operations that is analyzed in this PEA. The FAA's Federal Action is to issue experimental permit(s) and/or a vehicle operator license to SpaceX for this mission profile, which is described in more detail in Section 2.1. If SpaceX modifies or adds operations as part of its Starship/Super Heavy program in the future, the FAA would analyze the environmental impacts of those activities in a tiered environmental document, which would summarize the issues discussed in this PEA that remain applicable (e.g., the environment around the Boca Chica launch site) and concentrate on the issues specific to the subsequent action (e.g., a mission profile involving a new landing site).

The completion of the environmental review process does not guarantee that the FAA will issue an experimental permit or vehicle operator license to SpaceX for Starship/Super Heavy launches at the launch site. SpaceX's license application must also meet FAA safety, risk, and financial responsibility requirements per 14 CFR Chapter III.

## 1.1 Background

In 2014, the FAA published the *Final Environmental Impact Statement for the SpaceX Texas Launch Site* (2014 EIS; FAA 2014a) and Record of Decision (ROD).[5] The 2014 EIS analyzed the environmental consequences of issuing SpaceX licenses and/or experimental permits for Falcon 9 and Falcon Heavy launch operations, as well as operation of reusable suborbital launch vehicles, from a new launch site in Cameron County, Texas (i.e., the Boca Chica Launch Site). The analysis in the 2014 EIS also analyzed the potential impacts from construction of infrastructure and operation of the launch site. SpaceX no longer plans to conduct launches of its Falcon launch vehicles at the launch site.

Over the past several years, SpaceX has constructed launch facilities, including a launch and landing control center (LLCC) and vertical launch area (VLA). In 2019, SpaceX developed the Starship technology as part of the reusable suborbital launch vehicle classification analyzed in the 2014 EIS. SpaceX is currently testing Starship prototypes under an existing license[6] at the launch site as part of its Starship experimental test program. This involves static fire engine tests and a series of suborbital launches from

[4] See Paragraph 3-2, FAA Order 1050.1F, Environmental Impacts: Policies and Procedures. See also 40 CFR 1501.11 (2020).

[5] See: https://www.faa.gov/space/environmental/nepa_docs/spacex_texas_eis/.

[6] SpaceX is currently authorized under FAA license LRLO 20-119 to conduct flights using the Starship prototype vehicle from SpaceX's Boca Chica Launch Site. See: https://www.faa.gov/about/office_org/headquarters_offices/ast/licenses_permits/media/License%20and%20Orders%20SpaceX%20LRLO%2020-119%20Starship%20Prototype%202022-05-27.pdf.

just a few inches above ground level to up to 30 kilometers (18 miles) above ground level. To support the test operations, SpaceX developed additional infrastructure at the VLA.

Subsequent to publishing the 2014 EIS and ROD, the FAA prepared Written Re-evaluations (WRs) (FAA 2014c, 2017, 2019a, 2019b, 2019c, 2020a, 2020b, and 2020c) to determine if SpaceX modifications to the launch site and operations fell within the scope of the 2014 EIS.[7] Some of these WRs included an analysis of the Starship experimental test program. Each WR concluded that: 1) SpaceX's modifications conformed to the prior environmental documentation; 2) the data contained in prior environmental documentation remained substantially valid; 3) there were no significant environmental changes; and 4) all pertinent conditions and requirements of the prior approvals were met or would be met in the current action at the time.

Now, SpaceX is developing a new launch vehicle called the Starship/Super Heavy. SpaceX has informed the FAA that it plans to apply for an experimental permit(s) or license for suborbital and orbital launches of the Starship/Super Heavy at the Boca Chica Launch Site. To receive a permit or license, SpaceX must complete a safety review and develop agreements for the license application in addition to the environmental review. SpaceX has indicated it is considering additional launch (which includes landing for suborbital missions) and reentry locations for the Starship/Super Heavy program beyond the Boca Chica Launch Site. Such proposals are not yet sufficiently developed for environmental review. The FAA may tier its environmental review of such proposals off this PEA when they become ripe for decision.

## 1.2 Federal Agency Roles

### 1.2.1 Federal Aviation Administration

As the lead federal agency, the FAA is responsible for analyzing the potential environmental impacts of the Proposed Action. The Commercial Space Launch Act of 1984, as amended and codified at 51 U.S.C. §§ 50901–50923, authorizes the Secretary of Transportation to oversee, license, and regulate commercial launch and reentry activities, and the operation of launch and reentry sites within the United States or as carried out by U.S. citizens. Section 50905 directs the Secretary to exercise this responsibility consistent with public health and safety, safety of property, and the national security and foreign policy interests of the United States. In addition, Section 50903 requires the Secretary to encourage, facilitate, and promote commercial space launches and reentries by the private sector. As codified at 49 CFR § 1.83(b), the Secretary has delegated authority to carry out these functions to the FAA Administrator.

The regulatory requirements pertaining to commercial launches and individual launch operators are described in 14 CFR Chapter III, Parts 400–460. SpaceX is the exclusive user of the Boca Chica Launch Site. Therefore, SpaceX is not required to apply for and obtain a launch site operator license.[8] SpaceX

[7] See https://www.faa.gov/space/environmental/nepa_docs/spacex_texas_eis/.

[8] *See* 14 CFR Part 420 (2022). *See also Licensing and Safety Requirements for Operation of a Launch Site*, 65 Fed. Reg. 62,812, 62,815 (Oct. 19, 2000) ("A launch operator operating a private site for its own launches does not need a license to operate a launch site [under Part 420] because its launch license would cover the safety issues associated with the launch site.").

could apply for and obtain an experimental permit and/or license for Starship/Super Heavy launches at the Boca Chica Launch Site as part of its Starship/Super Heavy program, as follows:

- **Vehicle operator license** – authorizes a licensee to conduct one or more launches or reentries using the same vehicle or family of vehicles. (14 CFR § 450.3(a))
- **Experimental permit** – authorizes the launch of a reusable suborbital rocket for one of the following purposes:
    - Research and development to test new design concepts, new equipment, or new operating techniques;
    - A showing of compliance with requirements for obtaining a license; or
    - Crew training before obtaining a license for a launch or reentry using the design of the rocket for which the permit would be issued.

  Experimental permits are valid for one year and authorize launches and reentries of a specified reusable suborbital rocket design from a specified site. The permit must also specify the modifications that may be made to the suborbital rocket without changing the design to an extent that would invalidate the permit. Experimental permits are not renewable. (14 CFR Part 437)

The FAA is also responsible for creating airspace closure areas in accordance with FAA Order 7400.2M, *Procedures for Handling Airspace Matters*, to ensure public safety.

### 1.2.2 Cooperating and Participating Agencies

The following agencies accepted the FAA's request to participate in the NEPA process as cooperating agencies[9] due to their special expertise: the National Park Service (NPS), U.S. Fish and Wildlife Service (USFWS), the U.S. Coast Guard (USCG), the U.S. Army Corps of Engineers (USACE), and the National Aeronautics and Space Administration (NASA). An agency has "special expertise" if it has statutory responsibility, agency mission, or related program experience regarding a proposal (40 CFR § 1508.1(ee)).

The NPS provides special expertise with respect to historic properties, including National Historic Landmarks (NHLs) and National Historic Parks. The Palmito Ranch Battlefield NHL (referred to as the "NHL" in this PEA) and the Palo Alto Battlefield National Historical Park are located approximately 3 and 19 miles, respectively, from the Boca Chica Launch Site. There are also other historic properties located near the launch site.

The USFWS provides special expertise with respect to threatened and endangered species and national wildlife refuges. There is suitable habitat, including federally designated critical habitat, for species listed

[9] A cooperating agency is any federal agency (and a state, tribal, or local agency with agreement of the lead agency) other than a lead agency that has jurisdiction by law or special expertise with respect to any environmental impact involved in a proposal (or a reasonable alternative) for legislation or other major federal action that may significantly affect the quality of the human environment. (40 CFR § 1508.1(e)).

under the Endangered Species Act (ESA) located near the launch site. The Lower Rio Grande National Wildlife Refuge (NWR; referred to as "the NWR" in this PEA) is located adjacent to the launch site. In addition, USFWS manages a large area of the NHL.

The USCG provides special expertise with respect to providing maritime safety and security during launch operations.

NASA provides special expertise with respect to potential environmental impacts from space launches and the operation of a launch site. NASA also has special expertise and interest in the operation of reusable suborbital and orbital launch vehicles through its programs, which are intended to help foster the development of the commercial reusable suborbital and orbital space transportation industry. Additionally, NASA uses Space Act Agreements and contracts, as well as competitions to promote technology development and demonstration. NASA's partnerships with commercial suppliers and private enterprises are expanding such that NASA may have a direct or indirect contribution to a commercial or government payload. For these reasons, NASA requested to be a cooperating agency in the development of this EA.

The USACE is responsible for regulating the deposition of dredged and/or fill material in waters of the United States and provides special expertise with respect to impacts on waters of the United States, which include wetlands. SpaceX is required to obtain a Clean Water Act (CWA) Section 404 permit for filling wetlands associated with the construction of the some of the proposed infrastructure identified in Chapter 2. The USACE will conduct a separate analysis for practicability of impacts to waters of the United States pursuant to 40 CFR part 230 (Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material). The USACE will issue its decision on SpaceX's proposal after completion of its review and compliance with its own procedures.

Additionally, the FAA invited the Texas Parks and Wildlife Department (TPWD), Texas Historical Commission (THC), Texas Government Land Office (TGLO), and Texas Department of Transportation (TxDOT) to be participating agencies[10] due to the location of the launch site relative to state-managed properties and due to special expertise of the agencies. These agencies participated in the NEPA process through activities such as attending project calls and reviewing and providing comments on administrative versions of the PEA.

## 1.3 Purpose and Need

The FAA's authority with respect to SpaceX's license application is stated above in Section 1.2. The purpose of SpaceX's proposal is to provide greater mission capability to NASA, Department of Defense, and commercial customers. SpaceX's activities would continue to fulfill U.S. expectation that space transportation costs are reduced to make continued exploration, development, and use of space more affordable. The Space Transportation section of the National Space Transportation Policy of 1994 addressed the commercial launch sector, stating that "assuring reliable and affordable access to space through U.S. space transportation capabilities is fundamental to achieving National Space Policy goals."

[10] A participating agency is any federal, state, tribal, or local agency participating in an environmental review or authorization of an action (14 CFR § 1508.1(w)).

SpaceX's proposal is needed to increase operational capabilities and cost effectiveness of space flight programs. Satisfaction of these needs benefits government and public interests and reduce operation costs. Demand for launch services has continued to increase over the past 20 years and the space industry growth projections indicate this will continue into the foreseeable future. The proposed Starship/Super Heavy launch capability and pad expansion would provide necessary redundancy (launch capability from one pad in case there the other is disabled by an anomaly) and allow SpaceX to prove the capability and reliability of Starship in support of commercial, NASA, and national security missions with minimal disruption to critical Falcon 9, Falcon Heavy, and Dragon missions that must continue from other launch sites.

SpaceX is now developing a multi-mission, fully reusable, super heavy-lift launch vehicle (Starship/Super Heavy). Starship/Super Heavy would reduce the cost of access to space, exceeding the capabilities of the Falcon 9 and Falcon Heavy launch vehicles, enabling cost-effective delivery of cargo and people to the Moon and Mars. SpaceX's proposal would satisfy requirements for more efficient and effective space transportation methods and continue the U.S. goal of encouraging activities by the private sector to strengthen and expand U.S. space transportation infrastructure.

## 1.4 Public Involvement

The FAA used multiple methods of stakeholder engagement and public outreach to solicit comments and feedback regarding the proposal. The FAA conducted a public scoping process and published the draft PEA for public review and comment. Public comments received during the comment period for the draft PEA can be accessed at: https://www.faa.gov/spacexstarship/starshipsuperheavy/comments-draft-programmatic-environmental-assessment-pea-spacex.

### 1.4.1 Scoping

Scoping provides an opportunity for the general public, government agencies, and interested parties to learn about a proposed project and provide input. The FAA sent an email on November 23, 2020, to interested parties notifying them that the FAA was in the beginning stages of conducting an environmental review for SpaceX's Starship/Super Heavy proposal. The list of interested parties was developed from individuals and entities that participated in the environmental review process for the 2014 EIS.[11] The FAA also sent an email on December 22, 2020, stating that the agency was holding a public scoping period to determine the scope of issues for analysis in the draft PEA. The email provided an overview of the proposed project and the indication that the FAA would be considering the preparation of a programmatic EA as well as an overview of the FAA's overall environmental review process. The scoping comment period was open through January 22, 2021.

A total of 321 comments were received between December 22, 2020, and January 26, 2021. Concerns raised by commenters about the project included the following:

[11] The FAA has and will continue to update its list of interested individuals and entities. Members of the public may join the list at https://www.faa.gov/space/stakeholder_engagement/spacex_starship/.

- Potential impacts on protected species and habitat
- Potential cumulative effects of the proposed project and other development projects in the Rio Grande Valley
- Restrictions on access to public areas such as local roads and Boca Chica Beach
- Level of environmental review (i.e., the appropriateness of an EA versus an EIS)
- Potential impacts on airspace
- Potential impacts on minority and low-income residents
- Potential impacts on land of cultural importance
- Safety of launch operations given the proximity to nearby liquefied natural gas facilities
- Degradation of the environment due to test and launch operations

Positive impacts raised by commenters included the following:

- Economic benefits to the regional economy
- Continued innovation and progress in commercial space transportation
- Benefits of reusable launch vehicles
- Job creation
- Ideal southerly location

All comments received during the scoping period were given equal consideration in the preparation of the draft PEA.

### 1.4.2 Public Review of the Draft PEA

In accordance with CEQ's NEPA-implementing regulations and FAA Order 1050.1F, the FAA released the draft PEA for a 30-day public review on September 17, 2021. The FAA sent an email announcing the availability of the draft PEA on the FAA's project website,[12] notice of a public comment period and request for comments, and notice of two virtual public hearings. After receiving requests for an extension, the FAA extended the public review period to 45 days. The 45-day public comment period ended on November 1, 2021. The FAA received approximately 17,000 public comment submissions.

In addition to posting the draft PEA, the FAA posted a summary of the draft PEA in both Spanish and English on the FAA's project website. The draft PEA and summary were also available in three public buildings in Brownsville, Texas, which were chosen after the FAA consulted with Cameron County, Texas officials:

- Brownsville Public Library, Main Branch located at 2600 Central Blvd, Brownsville, TX 78520

[12] See: https://www.faa.gov/space/stakeholder_engagement/spacex_starship/.

- Brownsville Public Library, Southmost Branch located at 4320 Southmost Road, Brownsville, TX 78521
- The Dancy Building County Judge Office located at 1100 E Monroe St Suite 218, Brownsville, TX 78520

The FAA also held two virtual public hearings on October 18, 2021, and October 20, 2021. Notice of all of this information appeared on FAA's website and FAA social media pages.

In response to public comments, the FAA revised the draft PEA, as appropriate, and prepared this final PEA. The final PEA reflects the FAA's consideration of comments, and the FAA has provided responses to comments in Appendix I.

In addition, SpaceX clarified aspects of its proposed action in response to public and agency comments as well as other developments. These include the following:

- Removed construction and operation of the desalination plant, natural gas pretreatment system, liquefier, and power plant.
    - The desalination plant was included in the draft PEA because it would have been used to facilitate deluge for the launch pad. SpaceX is still considering whether to use deluge water for the launch pad, but, in the event it will, it has decided that it will use truck water, rather than a desalination plant. A desalination plant is not in the reasonably foreseeable future.
    - The natural gas pretreatment system and liquefier are no longer needed due to advances in the design and capabilities of SpaceX's Raptor engines. Previously, additional refinement of methane to purer levels than commercially available was anticipated to be needed. However, as a result of engine advances, SpaceX can rely on commercially available methane without refinement. Accordingly, SpaceX is no longer proposing a natural gas pretreatment system and liquefier.
    - Because SpaceX is no longer proposing a desalination plant, natural gas pretreatment system, and liquefier, SpaceX does not require a power plant.
- Removed the "Program Development" phase identified in the draft PEA, including the advancement of Starship through testing under SpaceX's existing license. Under the Proposed Action, SpaceX may continue to conduct some prototype testing and suborbital launches. However, SpaceX plans to shift focus to orbital launches and conduct fewer suborbital launch operations.
- Modified the Raptor engine and engine configuration. SpaceX increased the thrust of the Raptor engine; therefore, SpaceX has reduced the total number of engines. This change would not constitute any discernable changes in environmental impacts. An increase from 61.7 meganewtons (MN) to 74 MN would result in a less than 1 decibel change and would constitute a negligible change to the noise contours. The maximum thrust for Super Heavy would not exceed 74 MN. Additionally, modeled emissions of the modified Raptor engine were analyzed.

PEA Section 3.3.4.2 and Appendix G were updated to reflect these changes. These changes would not constitute any discernable changes in environmental impacts.

Provisions contained in CEQ's NEPA-implementing regulations and in FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*, require the preparation of a supplemental EA if the applicant makes substantial modifications in the proposed action that are relevant to environmental concerns or there are significant new circumstances or information relevant to environmental concerns or bearing on the proposed action or its impacts (see, e.g., FAA Order 1050.1F, Paragraph 9-3). After independently reviewing SpaceX's project modifications noted above, the FAA does not consider these modifications to be "substantial" in the context of presenting new or additional potential impacts beyond the scope already addressed in the draft PEA. Further, the removal of the proposed infrastructure reduces the Proposed Action's anticipated environmental consequences.

## 1.5 Other Licenses, Permits, and Approvals

To proceed with all of its proposed Starship/Super Heavy operations and associated construction identified in Chapter 2, SpaceX would require several environmental and regulatory permits and approvals in addition to the FAA's license or permit. The FAA has identified the following additional environmental permits and approvals for SpaceX's proposal, but others may be required.

- **Air emissions** from applicable operations would be permitted by the Texas Commission on Environmental Quality. Typical ground-processing operations of the size proposed at the VLA are estimated to require small capacity storage and use of fuel and are not expected to produce emissions above the potential to emit threshold levels established as major sources of pollution listed in the Texas Administrative Code Title 30 Chapter 116.

- **Endangered Species Act**. In accordance with ESA Section 7, the FAA conducted consultation with the USFWS and National Marine Fisheries Service (NMFS). NMFS concurred with the FAA's determination that the Proposed Action *may affect, but would not likely adversely affect*, ESA-listed species and critical habitat under NMFS jurisdiction. The FAA determined the Proposed Action *may affect and is likely to adversely affect* ESA-listed species and critical habitat under USFWS jurisdiction and conducted formal consultation with the USFWS. The USFWS issued a Biological Opinion (BO), which concluded the Proposed Action is not likely to jeopardize the continued existence of any federally listed species or adversely modify designated critical habitat. The BO contains Reasonable and Prudent Measures and associated Terms and Conditions to avoid, minimize, and mitigate the effects on listed species and critical habitat. SpaceX must implement the Terms and Conditions. Refer to PEA Appendix D for a copy of the BO.

- **Magnuson-Stevens Fishery Conservation and Management Act**. The FAA determined there may be temporary adverse effects to Essential Fish Habitat (EFH), particularly in the event of launch failure involving the spread of debris and release of hazardous material (e.g., liquid propellant). The FAA consulted NMFS regarding potential adverse effects to EFH, and NMFS provided two Conservation Recommendations pursuant to 50 CFR §600.920, which SpaceX and the FAA have agreed to implement. Refer to Section 3.10.

- **Coastal Zone Management Act**. The Coastal Zone Management Act (CZMA) places obligations on both the FAA and SpaceX to ensure actions proposed within or affecting the coastal zone are consistent with the enforceable policies of the state's approved coastal zone management program. For FAA permitting or licensing approvals, if the proposed action is specifically listed within an existing coastal zone management program, the FAA must ensure that the requirements of 15 CFR, Subpart D, Consistency for Activities Requiring a Federal License or Permit, are satisfied. For unlisted activities, like the Proposed Action, compliance with this subpart is also required where the responsible state agency specifically indicates to the FAA that approval for a proposed project would affect coastal zone resources and that it intends to review the approval.

  On December 20, 2021, TGLO emailed SpaceX and stated TGLO will not be conducting a consistency review because the Proposed Action is not a listed activity and is not subject to review under the Texas Coastal Management Program (TCMP). However, TGLO stated that the Texas Commission on Environmental Quality (TCEQ) would conduct a federal consistency review for the USACE's modification of SpaceX's CWA Section 404 permit (see PEA Appendix J). SpaceX is responsible for ensuring its activities within the coastal zone comply with the policies of the TCMP (i.e., state laws) and will be conducted in a manner consistent with the TCMP.

- **National Historic Preservation Act**. As part of National Historic Preservation Act (NHPA) Section 106 consultation, the FAA determined the Proposed Action would create an *adverse effect* on historic properties. The FAA, Texas State Historic Preservation Officer (SHPO), NPS, Advisory Council on Historic Preservation (ACHP), and SpaceX executed a Section 106 Programmatic Agreement (PA) to resolve the adverse effects. Refer to PEA Appendix C for a copy of the PA.

- **Clean Water Act**. SpaceX's proposal includes filling wetlands, which requires a CWA Section 404 permit. Also, a Texas Pollutant Discharge Elimination System (TPDES) permit, equivalent to a National Pollutant Discharge Elimination System (NPDES) permit, is required for point source discharges from SpaceX facilities during construction or operations. TCEQ administers the NPDES program in Texas. SpaceX would update its facility Construction and Industrial Stormwater Pollution Prevention Plans (SWPPPs) prior to conducting FAA-permitted or -licensed operations to maintain compliance with the TPDES permit.

- **National Wildlife Refuge System Administration Act.** In the event of an anomaly that creates debris on NWR fee-owned or managed lands, SpaceX would be required to obtain a Special Use Permit on an emergency basis from the USFWS, as applicable, for clean-up activities.

# Chapter 2.
# Description of Proposed Action and Alternatives

## 2.1 Proposed Action

The FAA's Federal Action is to issue one or more experimental permits and/or a vehicle operator license to SpaceX that would allow SpaceX to operate its Starship/Super Heavy launch vehicle at its existing Boca Chica Launch Site in Cameron County, Texas. The Federal Action also includes the FAA's issuance of temporary airspace closures. SpaceX's proposed operations include launches originating from this site, as well as landings at this site, in the Gulf of Mexico, or in the Pacific Ocean off the coast of Kauai, Hawaii, as discussed below. The FAA may tier off of this PEA environmental reviews of additional proposed landing sites from launches at the SpaceX Boca Chica Launch Site if SpaceX further develops proposals for such sites. 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 annual launch operations include suborbital launches and/or orbital launches. SpaceX's proposal also includes launch-related activities at the Boca Chica Launch Site, including tank tests, static fire engine tests, expansion of the 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 exact design) is not currently available. However, SpaceX has identified the general location of the proposed infrastructure (i.e., SpaceX's VLA, processing area, and production and manufacturing area; see Figures 2-6 and 2-7) but has not completed final design and engineering such that exact locations are known. Therefore, the PEA makes assumptions about these unknowns using best available information and professional expertise. The FAA may re-evaluate this PEA to ensure that the conclusions reached in this document remain valid when the infrastructure's final design and engineering are ripe for review.

The analysis in this PEA reflects the environmental impacts that may result from the Proposed Action. If SpaceX proposes modifications to the activities discussed below, and they fall outside the footprint of the proposed project or the scope of this environmental review, the FAA will conduct additional environmental analysis.

**Table 2-1. Elements of the Proposed Action**

| FAA Action | Elements of SpaceX's Proposal | Brief Description |
|---|---|---|
| Issuance of an Experimental Permit or Vehicle Operator License | Test and Launch Operations | • Starship static fire engine tests<br>• Super Heavy static fire engine tests<br>• Starship suborbital launch<br>• Super Heavy launch<br>• Starship landing at the VLA, on a floating platform in the Gulf of Mexico or the Pacific Ocean, or expended in the Gulf of Mexico or Pacific Ocean<br>• Super Heavy landing at the VLA, on a floating platform in the Gulf of Mexico, or expended in the Gulf of Mexico |
| | Tank Tests | • Test the structural capability of the launch vehicle stages |
| | Nominal Operational Access Restrictions | • SpaceX anticipates the proposed operations would require 500 hours of annual access restriction |
| | Anomaly Response Access Restrictions | • If an anomaly occurred, SpaceX anticipates debris clean-up would require up to 300 hours of annual access restriction |
| | Related Infrastructure Construction | • Redundant launch pad (Launch Pad B) and commodities (approximately 15 vertical tanks)<br>• Redundant landing pad<br>• Integration towers<br>• Tank structural test stands<br>• Support buildings and parking lots<br>• Trenching<br>• Payload Processing Facility<br>• Expanded solar farm<br>• State Highway 4 pull-offs |

Some infrastructure required to conduct Starship/Super Heavy launches and associated tests was already built to support the Starship prototype test operations. The FAA determined the environmental impacts of this construction were not significantly different from those analyzed in the 2014 EIS and therefore did not complete a supplemental NEPA analysis. The following subsections provide a description of the proposed project's location, the launch vehicle, proposed operations, and proposed construction.

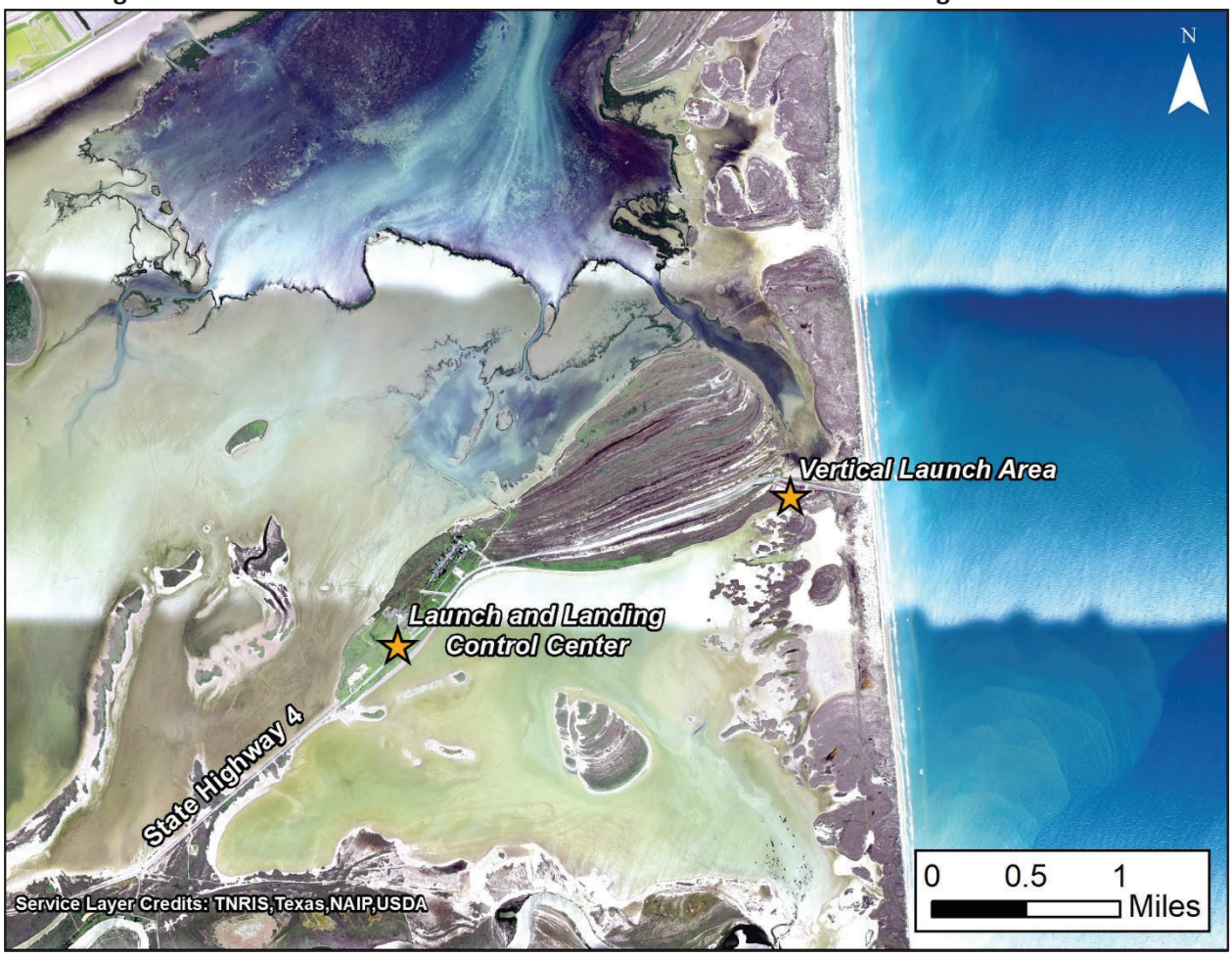
### 2.1.1 Location

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 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 marsh and barrier island plant communities, shallow open water, algal flats, and unvegetated tidal flats (refer to Section 3.10.3.1 for more detailed information). State Highway (SH) 4, which provides the only access to the public Boca Chica Beach (Figure 2-2) and to TPWD's Boca Chica Tract, provides access to the launch site and terminates 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. The LLCC is approximately 0.7 acres in size.

The larger area around the Boca Chica Launch Site includes several private and public industries, including the SpaceX production and manufacturing facility, the Port of Brownsville, the City of Port Isabel, San Roman Wind Farm, and development on South Padre Island. Boca Chica Village now includes support infrastructure, such as housing, restaurants, and offices used in connection with SpaceX's production and manufacturing facility near Boca Chica Village. Infrastructure from these industrial areas, including large high rises on South Padre Island, tall container cranes, and industrial infrastructure at the Port, and wind turbines at the San Roman Wind Farm, are visible along SH 4 on the way to the Boca Chica Launch Site. Recreation in the area includes on and off-road vehicle use on Boca Chica Beach and surrounding areas.

**Figure 2-1. Regional Map**

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



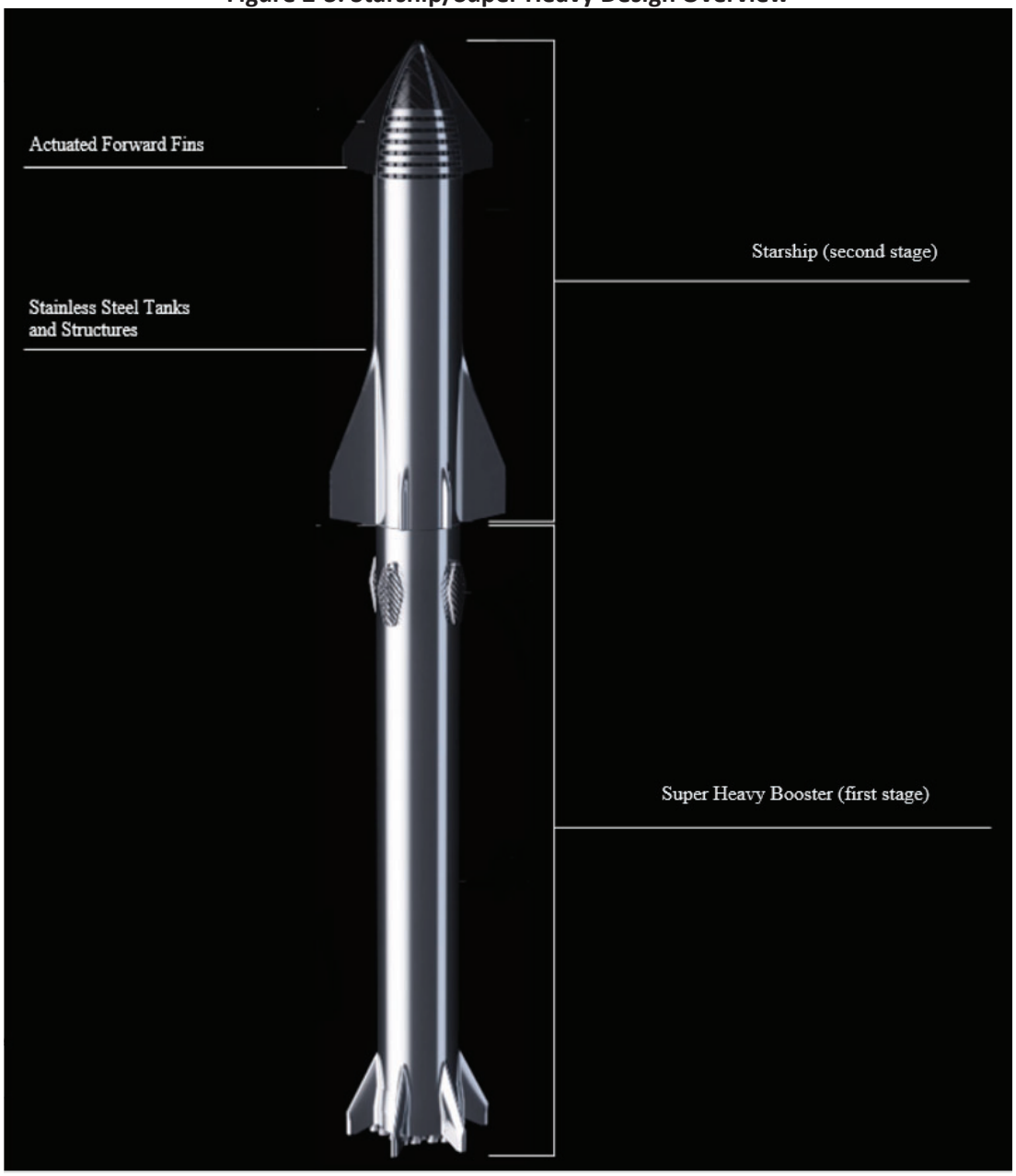

## 2.1.2 Launch Vehicle

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, including at the VLA, SpaceX production and manufacturing locations in Boca Chica Village, Hawthorne, CA, or McGregor, TX. 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 ($LCH_4$) 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 (MN), allowing for a maximum lift-off mass of approximately 5,000 MT. Starship, with six engines, will have a maximum lift-off thrust of 12 MN,

allowing for a maximum lift-off mass of approximately 1,000 MT. Launch propellant and commodities are currently stored at the VLA in aboveground tanks (see Figure 2-6). Commodities include liquid nitrogen ($LN_2$), water, gaseous oxygen, gaseous methane, gaseous nitrogen, helium, hydraulic fluid, LOX, and $LCH_4$.

**Figure 2-3. Starship/Super Heavy Design Overview**




### 2.1.3 Operations

The Starship/Super Heavy program includes 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, as discussed above. SpaceX also will

need to conduct similar tests of Super Heavy prototypes, which has not yet been approved under a separate license. In the early stages of the Starship/Super Heavy program, SpaceX would still conduct tests (tank tests, static fire engine tests, and suborbital launches). As shown in Table 2-2, SpaceX plans to shift to orbital launches.

**Table 2-2. Proposed Annual Operations**

| Operation | Time | Operational Limit |
|---|---|---|
| Starship Static Fire Engine Test[a] | Day | 150 seconds |
| Super Heavy Static Fire Engine Test[a] | Day | 135 seconds |
| Starship Suborbital Launch | Day or Night | 5 |
| Super Heavy Launch[b] | Day or Night | 5 |
| Starship Landing[c] | Day or Night | 10 |
| Super Heavy Landing[d] | Day or Night | 5 |

Notes:
[a] static fire engine test is defined by the FAA as a launch licensed event beginning at functional Autonomous Flight Termination System installation and integration of the Starship and Super Heavy at the pad.
[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 landing could occur at the VLA, on a floating platform in the Gulf of Mexico, or on a floating platform in the Pacific Ocean. Alternatively, SpaceX could expend Starship in the Gulf of Mexico or Pacific Ocean. Further environmental review of landing at sites not described in this document would be necessary if proposed in the future.
[d] A Super Heavy landing is part of a launch, as it would occur shortly after takeoff. Super Heavy could land at the VLA or on a floating platform in the Gulf of Mexico. Alternatively, SpaceX could expend Super Heavy in the Gulf of Mexico. Further environmental review of landing at sites not described in this document would be necessary if proposed in the future.

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., 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 short durations (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 is needed to ensure the protection and safety of SpaceX personnel. SpaceX would finalize the number of pole lights during the site design process. SpaceX will coordinate with the USFWS, NPS, TPWD, and THC on the 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 on a SpaceX private parcel in the production and manufacturing area, north of the solar farm.

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 it is safe to launch and land the vehicle. 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 will land in the open marine waters. The radiosonde is expected to rapidly sink to the ocean floor. There are negligible environmental impacts from the use of these weather balloons. This is similar to the National Weather Service's release of weather balloons, which occurs twice a day, every day of the year, from almost 900 locations worldwide to obtain weather data and conduct research (NOAA 2021a). NMFS has found that this activity produces negligible impact to the environment (NMFS 2017).

#### 2.1.3.1 Tank Tests

Prior to conducting a static fire engine test or 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 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 $LN_2$, LOX, or $LCH_4$). 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 break tests, in which the tanks are filled with water, $LN_2$, or LOX, and pressurized to a specific limit or to deliberate failure in order to characterize the structural capability of the production vehicles. Break testing includes the deliberate release of the test media (water, $LN_2$, or LOX) to the environment upon failure of welds on 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, SpaceX would construct and test a new test vehicle.

SpaceX is still determining the number of prototypes that it will build and test. For the purposes of the environmental impact analysis, SpaceX estimates a 10 percent rate of tank test anomalies; this is a conservative, upper bound estimate intended to capture the maximum potential impact. An anomaly during a tank test operation could result in an explosion of debris, but it is unlikely. For example, a failure could result in buckling of the tank only. If the test did result in an explosion of debris, the probability of debris spreading outside the launch pad boundary is low because this type of test does not involve mixing of explosive commodities. Given the rates above, SpaceX estimates that one tank test each month may result in a tank test 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.

After completing 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 (Table 2-2). It is possible, but not expected, that a static fire engine test is attempted and is unsuccessful (e.g., the test results in an anomaly). If an engine test is unsuccessful, SpaceX would attempt another.

During pre-flight operations, SpaceX would connect the launch vehicle to ground systems. After an operation involving propellant (i.e., wet dress rehearsal and static fire engine test), SpaceX would transfer the propellant back to the commodity tanks at the VLA. During Starship fuel loading for a static fire engine test of the integrated launch vehicle, SpaceX estimates approximately 7 metric tons of $LCH_4$ would be released to the atmosphere. During an off-nominal operation (i.e., if the vehicle lost pneumatics and could not reconnect to the ground systems), SpaceX may release the $LCH_4$ 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 an 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 at least 19 miles offshore and downrange either directly in the Gulf of Mexico or on a floating platform in the Gulf of Mexico. For suborbital launches, Starship would not reach supersonic speed during descent towards the VLA and therefore would not generate a sonic boom that would impact land (see Appendix B for the sonic boom analysis). Starship landings that occur downrange in the Gulf of Mexico may reach supersonic speeds and may create a sonic boom; however, the sonic boom would impact the water and not impact land because the landing would be no closer than 19 miles from shore.

Following a suborbital launch, Starship would have LOX and $LCH_4$ (approximately 10 metric tons) remaining in the tank. SpaceX would vent remaining LOX to the atmosphere and remaining $LCH_4$ would likely be released to the atmosphere. The $LCH_4$ vented to the atmosphere would evaporate within hours. Due to risks to personnel, SpaceX is unable to reconnect the launch vehicle to ground systems

when $LCH_4$ remains on the vehicle. In the future, SpaceX may recycle $LCH_4$ back into tanks at the VLA as technology and design develops. For the purposes of the PEA, the FAA is assuming all residual $LCH_4$ is released to the atmosphere.

During the program's development, SpaceX is proposing to conduct up to 20 Starship suborbital launches annually. As the program progresses, 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. From the Boca Chica Launch Site, orbital launches would primarily be to low inclinations with flight trajectories north or south of Cuba that minimize land overflight. Future launches from the site may be to higher, 70-degree inclination with limited overflight of remotely populated portions of Mexico. SpaceX's launch manifest (i.e., scheduled launches) is still being developed at this time and would evolve as the Starship/Super Heavy program develops. SpaceX would not exceed five Starship/Super Heavy orbital launches annually. SpaceX estimates approximately 7 metric tons of $LCH_4$ 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, 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 appear clear and consist of water vapor, carbon dioxide ($CO_2$), carbon monoxide (CO), hydrogen, $CH_4$, nitrogen oxides (NOx), 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 Raptor engines. Static fire engine tests, landings, and suborbital launches all require fewer engines and thus 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 300 °F reaching the edge of the VLA, 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. The heat plumes and increased temperatures in this area would be temporary in nature and would only occur during engine ignition and dissipate within minutes. The maximum heat plume from Starship/Super Heavy orbital launches would occur up to 5 times a year.

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 it would use deluge water during a launch or test. If SpaceX used deluge water, most of the water would be vaporized by the heat of the rocket engines. If treatment or retention of deluge water, stormwater, or wastewater is required, SpaceX would retain the water in retention ponds adjacent to the launch mount. SpaceX would determine the exact number, location, and size of the retention ponds within the VLA based on quantities of deluge water and final site plans. Retention ponds would be lined to prevent percolation of contaminants into the groundwater and would be maintained and monitored by SpaceX. SpaceX would

develop appropriate sampling protocols and water quality criteria in coordination with the TCEQ.[13] 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 TPDES permit prior to the discharge event. All water (including deluge and potable water) would be either delivered by truck or withdrawn from the existing well 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 at the VLA 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 40 miles and the booster would separate from Starship. Shortly thereafter, Starship's engines would start and burn to the desired orbit location. After separation, Super Heavy would rotate and ignite 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 [CCSFS]).

For Super Heavy landings at the VLA or downrange on a floating platform in the Gulf of Mexico, once near the landing location, Super Heavy would ignite its engines to conduct a controlled landing. Super Heavy would land vertically and go into an automated safing sequence (i.e., put the vehicle in a safe state).

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. A floating platform would be a mobile vessel that would not attach to the seafloor. Recovery operations of the Super Heavy from a downrange landing, including transport of the floating platform, are analyzed in Chapter 3. Super Heavy landings would generate a sonic boom(s). For Super Heavy landings at the VLA, the sonic boom would impact parts of Texas and Mexico (refer to Section 3.5.4.6). Based on the modeling that was done for Super Heavy landings at the VLA, the sonic boom produced when landing downrange in the Gulf of Mexico would not impact land (see Appendix B 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 mission would include a Starship landing after Starship completes its orbital mission. Starship landing could occur at the VLA or downrange in the Gulf of Mexico (on a floating platform or expended in the Gulf of Mexico), or Pacific Ocean (on a floating platform or expended in the Pacific Ocean) (Table 2-2). Starship would land vertically at the VLA or on a floating platform in the Gulf of Mexico or the Pacific Ocean 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 (refer to Section 3.5.4.6). Based on the modeling for Starship landings at the VLA, the sonic boom produced when landing downrange

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

would not impact land (see Appendix B 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 in the Gulf of Mexico or Pacific Ocean 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 $LCH_4$ in the vehicle. Remaining LOX would be vented to the atmosphere and remaining $LCH_4$ would likely be released to the atmosphere. Due to risks to personnel, SpaceX is unable to reconnect the vehicle to ground systems when $LCH_4$ remains on the vehicle. Super Heavy would have approximately 5 metric tons of $LCH_4$ onboard following an orbital flight. In the future, SpaceX may recycle $LCH_4$ back into tanks at the VLA as technology and design develops. For the purposes of the PEA, the FAA assumes all residual $LCH_4$ is released to the atmosphere.

During early unmanned orbital launches, SpaceX may require expending Super Heavy or Starship downrange in the Pacific Ocean or Gulf of Mexico, or for Starship only, in the Pacific Ocean, no closer than 19 miles offshore. If this occurs, SpaceX would not recover Super Heavy or Starship. SpaceX expects each stage would break up upon impact with the water's surface. 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 or recover as necessary any large floating debris. SpaceX would coordinate with all land and water regulatory authorities as required, prior to taking action to recover debris.

As part of SpaceX's first orbital launch, SpaceX intends to expend (i.e., not recover) Starship off the coast of Hawaii. This PEA evaluates this activity. The location of the expendable landing is approximately 62 nautical miles north of Kauai, Hawaiian Islands near the Pacific Missile Range Facility. While SpaceX does not anticipate that debris from expending Starship in the water would remain afloat, personnel would follow routine notification processes and procedures to manage floating debris. See Appendix D for the NMFS consultation regarding this activity. As SpaceX develops its landing capabilities downrange, SpaceX may plan to land the Starship on islands in the Pacific Ocean. Proposed landing activities on islands would be analyzed in a separate NEPA document, which may tier off this PEA, if plans develop.

### 2.1.3.5 Nominal Operational Access Restrictions

#### Ground Access Restrictions

Tanks tests, wet dress rehearsals, static fire engine tests, and launches (suborbital and orbital) would require temporarily restricting public access in the vicinity of the VLA and securing land and water areas as part of public safety requirements. SpaceX refers to the areas on land that would be closed to public access as the *access restriction area* (Figure 2-4). The access restriction 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 PEA, the FAA is defining an operational access restriction as follows:

> An access restriction 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 to support the FAA-permitted or FAA-licensed activity, which may include a tank test, wet dress rehearsal, static fire engine test, or launch. An access restriction ends when the operation is completed, and local law enforcement opens SH 4 and Boca Chica Beach.

The FAA does not have a role in approving road and beach access restrictions. Therefore, access restrictions that are planned but not implemented (e.g., Cameron County revokes the access restriction) do not meet the FAA's definition of an access restriction for this PEA. Under the authority granted in the 2013 Memorandum of Agreement (MOA) between Cameron County and the TGLO, Cameron County would coordinate access restrictions with SpaceX (TGLO 2013).[14]

SpaceX will perform the following notifications prior to a planned access restriction and in accordance with SpaceX's Access Restriction Notification Plan:

- Provide a forecast of planned access restrictions one to two weeks in advance of the access restriction on the County's website and send via email to the agency distribution list. Information about the proposed access restriction would be available on Cameron County's website.[15] The Cameron County judge issues a public notice of a Cameron County order to temporarily close Boca Chica Beach and SH 4 anywhere from a few hours to a few days after receiving SpaceX's request to close.
- Send access restriction notifications to the regulatory and public land-managing agencies as plans finalize 48 hours prior to the access restriction. The agencies would continue to receive updates immediately when the access restrictions go into place and when the access restrictions end, as well as cancellations of requested access restrictions. SpaceX personnel at the LLCC would send these notifications to ensure the most up-to-date information is distributed.
- Send real time status and updates on access restrictions through a text message alert service. Subscribers can text "BEACH" TO 1-866-513-3475 to receive updates.

If an agency needs to access an area within a planned access restriction window, the agency is encouraged to contact SpaceX directly to find the best opportunity to access the area and avoid any conflict in operations.

There may be certain operations, anomalies, or emergencies that require notification of access restriction to occur less than a week in advance of the activity. In those instances, SpaceX would notify Cameron County Commissioner's Court immediately with an access restriction request. SpaceX would

[14] SpaceX and Cameron County are updating its coordination agreement based on the Starship/Super Heavy.

[15] See: https://www.cameroncounty.us/space-x/.

also coordinate with U.S. Customs and Border Protection, Cameron County and State of Texas law enforcement agencies, the USCG, and Houston Air Route Traffic Control Center (ARTCC) in order to ensure public safety and allow for the issuance of Notice to Mariners (NOTMAR) and Notice to Air Missions (NOTAM). In addition, SpaceX would coordinate with the Secretariat of Communications and Transportation–Mexico if any airspace, land, or water access restrictions in Mexico were required.

Prior to an operation requiring an access restriction, 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.

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 area[16] (see Figure 2-4). These checkpoints are similar to the checkpoints established during the 2014 EIS in coordination with the NPS and USFWS. The 2014 EIS included two checkpoints: a soft checkpoint (located near the U.S. Customs and Border Patrol checkpoint) and a hard checkpoint (located near the LLCC[17]). SpaceX is proposing a third checkpoint at Massey's Way and a fourth checkpoint at Richardson Avenue 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, emergency personnel, and anyone with property beyond this soft 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 east of the LLCC. No one would be able to pass this checkpoint (Figure 2-4).

The 2013 MOA between TGLO and Cameron County provides Cameron County with the authority (TGLO 2013) 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.

An access restriction for pre-launch operations, including tank tests, wet dress rehearsals, or static fire engine tests, would be shorter than an access restriction for a launch (suborbital or orbital). Based on the access restriction definition above, SpaceX estimates that the total number of access restriction hours for tank tests, wet dress rehearsals, static fire engine tests, and launches will be no more than 500 hours per year for nominal operations. The PEA assumes SpaceX would not exceed 500 hours of nominal access restriction per year.

On May 24, 2013, Texas 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

[16] Flight 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 40 CFR § 450.101.

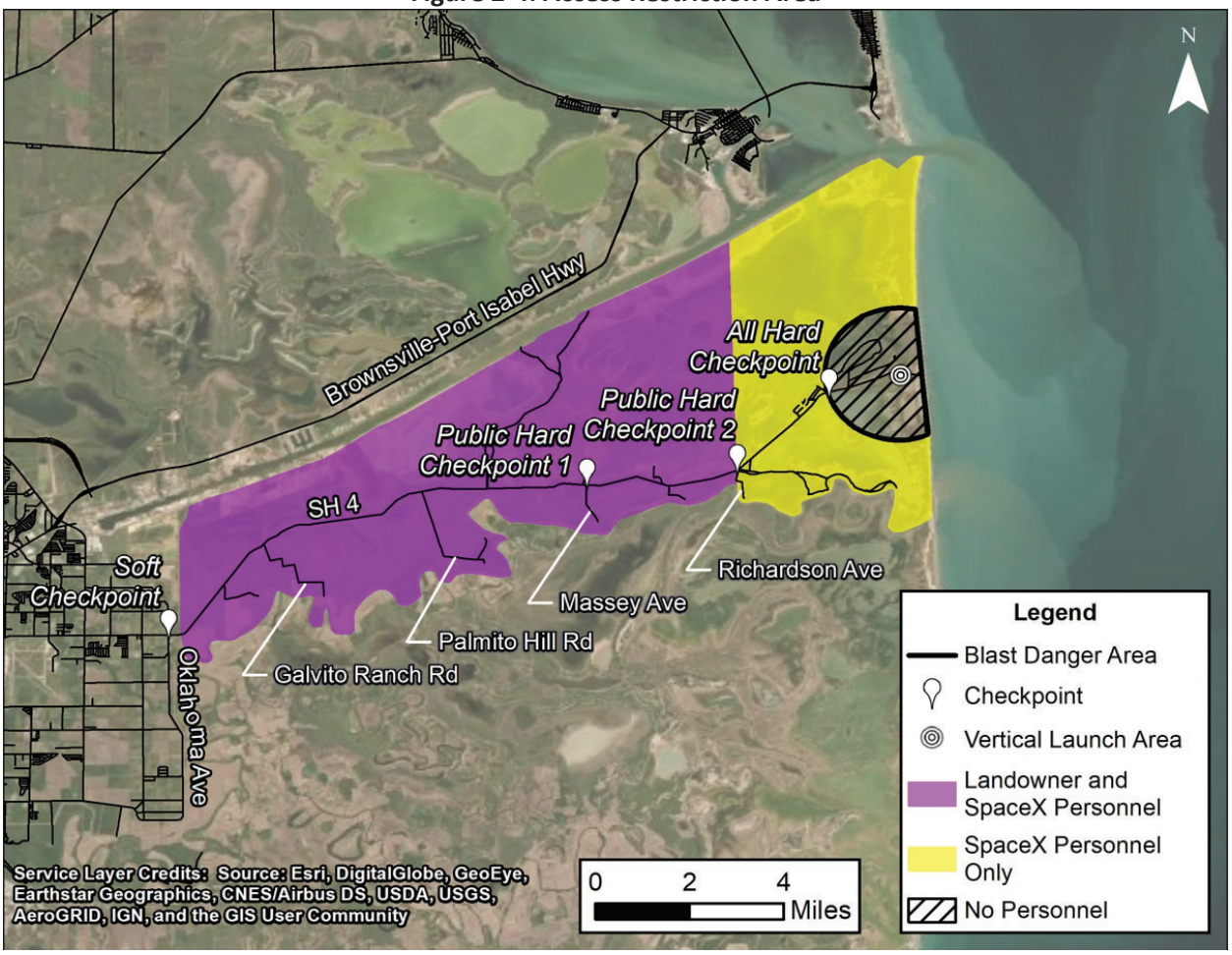
[17] For the first mission, SpaceX intends to clear Stargate, and would operate the first mission from a temporary structure on another SpaceX privately owned property. For suborbital missions and future orbital missions, beyond the first mission, SpaceX intends to operate from the LLCC in Stargate.

Commissioners Court to temporarily restrict access to public beaches for space flight activities, including launches.

SpaceX will implement the following measures to limit access restrictions:

1. No SH 4 access restrictions on the following holidays: Memorial Day, Labor Day, July 4th, MLK Day, Presidents' Day, Texas Independence Day, Cesar Chavez Day, Emancipation Day in Texas (also referred to as Juneteenth), Veteran's Day, Good Friday, Easter, Father's Day, Mother's Day, Thanksgiving Day, Christmas Day, New Year's Day ("Holidays").
    a. Where any of the Holidays falls annually on a Monday or Friday, no Weekend Access Restrictions, as defined in #4 below, shall be permitted.
    b. Where any of the Holidays does not fall annually on a Monday or Friday, but falls on a Monday or Friday in a particular year, no Weekend Access Restrictions, as defined in #4 below, shall be permitted for that year.
    c. For Thanksgiving, no access restrictions shall be permitted from Thanksgiving Day through the Sunday immediately following Thanksgiving.
2. Except as provided in #4 below, from Memorial Day to Labor Day (the times of greatest visitor beach uses and enjoyment), no Weekend Access Restrictions from Friday at 6:00 a.m. through Sunday. Road access restrictions for any SpaceX activities would occur from Monday through Friday at 6:00 a.m. This predictive schedule ensures the public access to all open areas of the NWR (e.g., Boca Chica Beach) from Friday at 6:00 a.m. through Sunday from Memorial Day through Labor Day.
3. Except as provided in #4 below, from the day after Labor Day to the day before Memorial Day (throughout the winter months), no Weekend Access Restrictions on Saturday or Sunday.
4. When a SpaceX activity requires at least one road access restriction between Fridays at 6:00 a.m. and Sundays from Memorial Day to Labor Day, or on weekends from the day after Labor Day to the day before Memorial Day, it is considered a "Weekend Access Restriction."
    a. SpaceX may request a Weekend Access Restriction up to five times per calendar year.
5. For any SH 4 road access restriction, SpaceX will request, at least 48 hours prior to the start of the access restriction period, that the Cameron County Commissioners Court implement the access restriction. This notice requirement is intended to give the public a minimum 48-hour notice to reduce impacts to the recreational users. Any requested Weekend Access Restriction shall count toward the total five annual Weekend Access Restrictions unless cancellation of the Weekend Access Restriction is publicized more than 24 hours prior to the start of the requested access restriction period.
6. Exception to the above is for activities deemed to be anomalies per FAA regulations.

**Figure 2-4. Access Restriction Area**




## Waterway Hazard Warnings

All launch and reentry operations would comply with necessary notification requirements, including issuance of NOTMARs, as defined in agreements required for a launch license issued by the FAA. A NOTMAR provides a notification regarding a temporary hazard within a defined area (a Ship Hazard Area [SHA]) to ensure public safety during proposed operations. A NOTMAR itself does not alter or close shipping lanes; rather, the NOTMAR provides a notification regarding a temporary hazard within a defined area to ensure public safety during the proposed operations.

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

The USCG publishes NOTMARs weekly and as needed, informing the maritime community of temporary changes in conditions or hazards in navigable waterways. Notices in international areas are published by the National Geospatial Intelligence Agency. Advance notice via NOTMAR and the identification of SHAs would assist mariners in scheduling around any temporary disruption of shipping activities in the area of

operation. The Proposed Action would not require shipping lanes to be altered or closed. Launches and reentries would be infrequent, of short duration, and scheduled in advance to minimize interruption to ship traffic.

### Airspace Closures

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

To comply with the FAA's licensing requirements, SpaceX has entered into a Letter of Agreement (LOA) with the Houston ARTCC, Miami ARTCC, Corpus Christi Terminal Radar Approach Control Facility, Air Traffic Organization Space Operations, Merida ACC (an airport in Mexico), Monterrey ACC (an airport in Mexico), and SENEAM[18] to accommodate the flight parameters of Starship and Super Heavy. The LOA outlines procedures and responsibilities applicable to operations including notification of launch activity; communication procedures prior to, during, and after a launch; planning for contingencies/emergencies; NOTAM issuance; and any other measures necessary to protect public health and safety. The Proposed Action would not require the FAA to alter the dimensions (shape and altitude) of the airspace. However, temporary closures of existing airspace may be necessary to ensure public safety during the proposed operations.

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

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

[18] SENEAM is a Mexican government-run enterprise under the control of the Ministry of Communication and Transport.

the Aircraft Hazard Area information to produce an Airspace Management Plan, which describes the launch/reentry information and any associated impacts to the National Airspace System.

Airspace controlled by the FAA may be restricted through the activation of airspace closures. The most common type of airspace closures are Temporary Flight Restrictions and altitude reservations. The FAA generally uses Temporary Flight Restrictions to protect airspace over land up to 12 nautical miles offshore and altitude reservations to protect oceanic airspace beyond 12 nautical miles offshore. The NOTAM would establish a closure window that is intended to warn aircraft to keep out of a specific region throughout the time that a hazard may exist. The length of the window is primarily intended to account for the time needed for the operator to meet its mission objectives. The location and size of the closure area is defined to protect the public. For a launch or reentry, typically the keep-out must begin at the time of launch and ends when the mission has been completed, terminated, or cancelled.[19]

Airspace closures are immediately released once the mission has successfully cleared the area and no longer imposes a risk to the public. The actual duration of airspace closure is normally much less than the original planned closure, especially if the launch or reentry window is relatively long and the launch or reentry occurs at the beginning of the window. The FAA typically begins to clear airspace and reroute aircraft in advance of a launch or reentry and directs aircraft back into the released airspace after the mission to recover to normal flow and volume.

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

### 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 at any given time, 24 hours a day, 7 days a week to support the Starship/Super Heavy launch program.

[19] Orbital Starship/Super Heavy launches may have separate closures (in both location and time of occurrence) for the launch and landing/reentry elements of the mission. Airspace closures typically occur either 30 minutes prior to de-orbit burn or at the start of de-orbit burn for reentries. For the first launch, the closure would be initiated at the time of the launch.

### 2.1.3.7 Anomalies

A Starship/Super Heavy test operation or launch could result in a deviation from what is expected (referred to as an anomaly). An anomaly on the launch pad could cause a fire on the launch pad and/or an explosion that spreads debris. While anomalies are unexpected, as part of evaluating a launch 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, SpaceX would evaluate the level of response based on the situation and notify the appropriate emergency personnel and land-managing agencies according to the SpaceX Anomaly Response Plan. SpaceX would contact Cameron County Emergency Management and Brownsville Fire Department. The USCG 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, TGLO, 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 access restrictions to ensure safety following an anomaly per the 2021 MOA between SpaceX and TPWD, which is included in Appendix K and described in more detail below. In addition, in the event of an anomaly that creates debris on NWR fee-owned or managed lands, SpaceX would be required to obtain a Special Use Permit on an emergency basis from USFWS, as applicable, prior to clean-up activities. Immediately following an anomaly, SpaceX 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 access restriction from Cameron County. The anomaly access restriction would be released when the area is deemed safe for the public by SpaceX and Cameron County. This determination by SpaceX and Cameron County would be made with input provided by public land-managing agencies (i.e., TPWD, TGLO, and/or USFWS).

SpaceX estimates up to 300 hours of access restrictions per year could be needed to address issues such as ensuring public safety and debris removal on public land. These hours would not count towards the nominal operational access restriction hours and would be used, as needed, to address debris removal on public land. 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 access restriction hour count would start at that point to address debris removal and last until the area is deemed safe for the public and the access restriction is released.

The access restriction area for an anomaly would be smaller than the access restriction area established for the launch (Figure 2-4). After securing the area, SpaceX would inform local law enforcement that they can open SH 4 up to the "all hard checkpoint." The area within the "all hard checkpoint" (Figure 2-4) would remain closed until SpaceX, in collaboration with Cameron County, determines the area is safe to open.

If SpaceX suspects debris falls on foreign land, SpaceX would 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 applicable system would be initiated, and the vehicle would break up.

### 2.1.4 Construction

SpaceX is proposing additional launch-related construction, including expanding the solar farm near the LLCC, adding infrastructure and facilities at the VLA, parking lots, 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, additional support buildings, and parking lots. Regarding the integration towers, SpaceX has started constructing the tower at Pad A. SpaceX has also conducted ground disturbance at the proposed location of the parking lot across the road from the VLA. 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. This means that the FAA does not have the authority to prevent an applicant from constructing infrastructure on private property, but its presence will not predetermine the FAA's environmental or licensing decisions. For the purpose of the impact analysis, the PEA nonetheless assumes 1) the integration towers do not currently exist at the launch site and 2) SpaceX has not started constructing the parking lot across the road from the VLA. The PEA evaluates the impacts of building and operating the towers and parking lot.

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. The VLA would be expanded from approximately 17 acres to a total of approximately 40 acres. Since publishing the 2014 EIS 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**

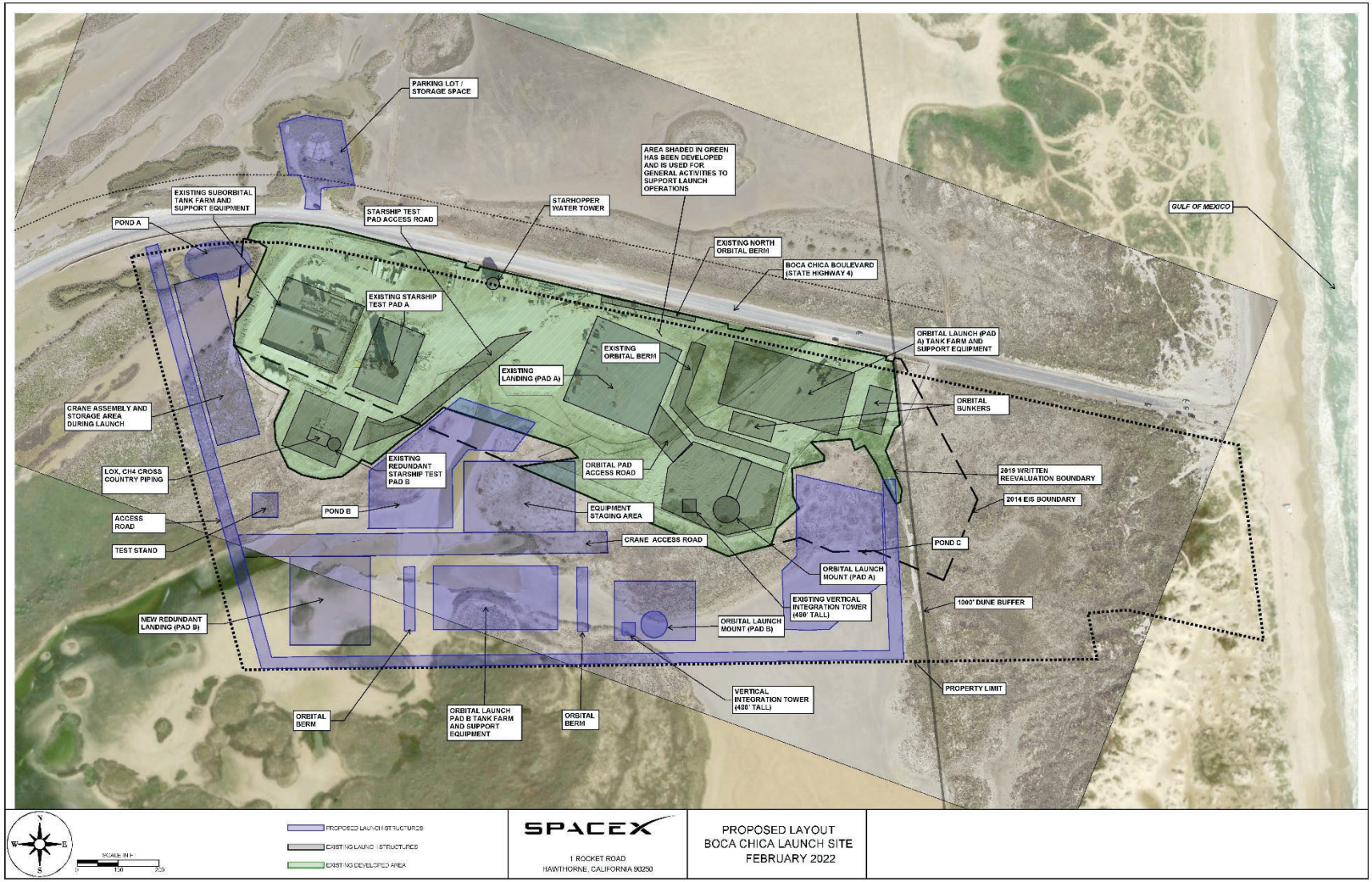
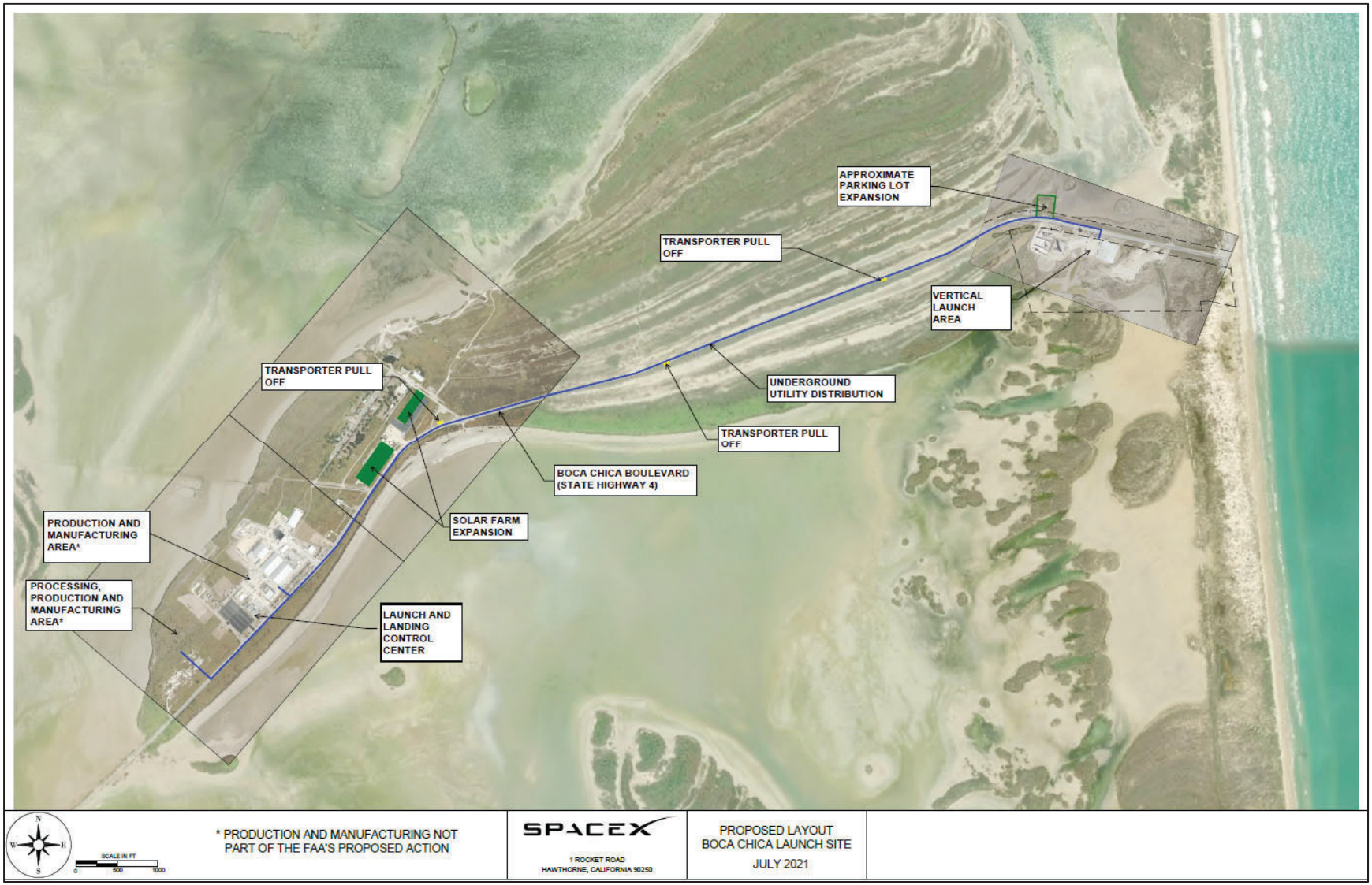


**Figure 2-7. Site Overview**



### 2.1.4.1 Redundant Launch Pad and Commodities

SpaceX is proposing to construct a redundant launch pad (denoted as "Orbital Launch Mount (Pad B)" in Figure 2-6) adjacent to the existing launch pad (denoted as "Orbital 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 15 vertical commodity tanks, each up to 100 feet tall, near Pad A and proposed Pad B. The tanks would hold LOX, $LN_2$, water, helium, gaseous nitrogen, gaseous methane, and $LCH_4$.

### 2.1.4.2 Redundant Landing Pad

SpaceX is proposing to add a second landing pad in the southwest corner of the VLA (denoted as "New Redundant Landing (Pad B)" in Figure 2-6). 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.

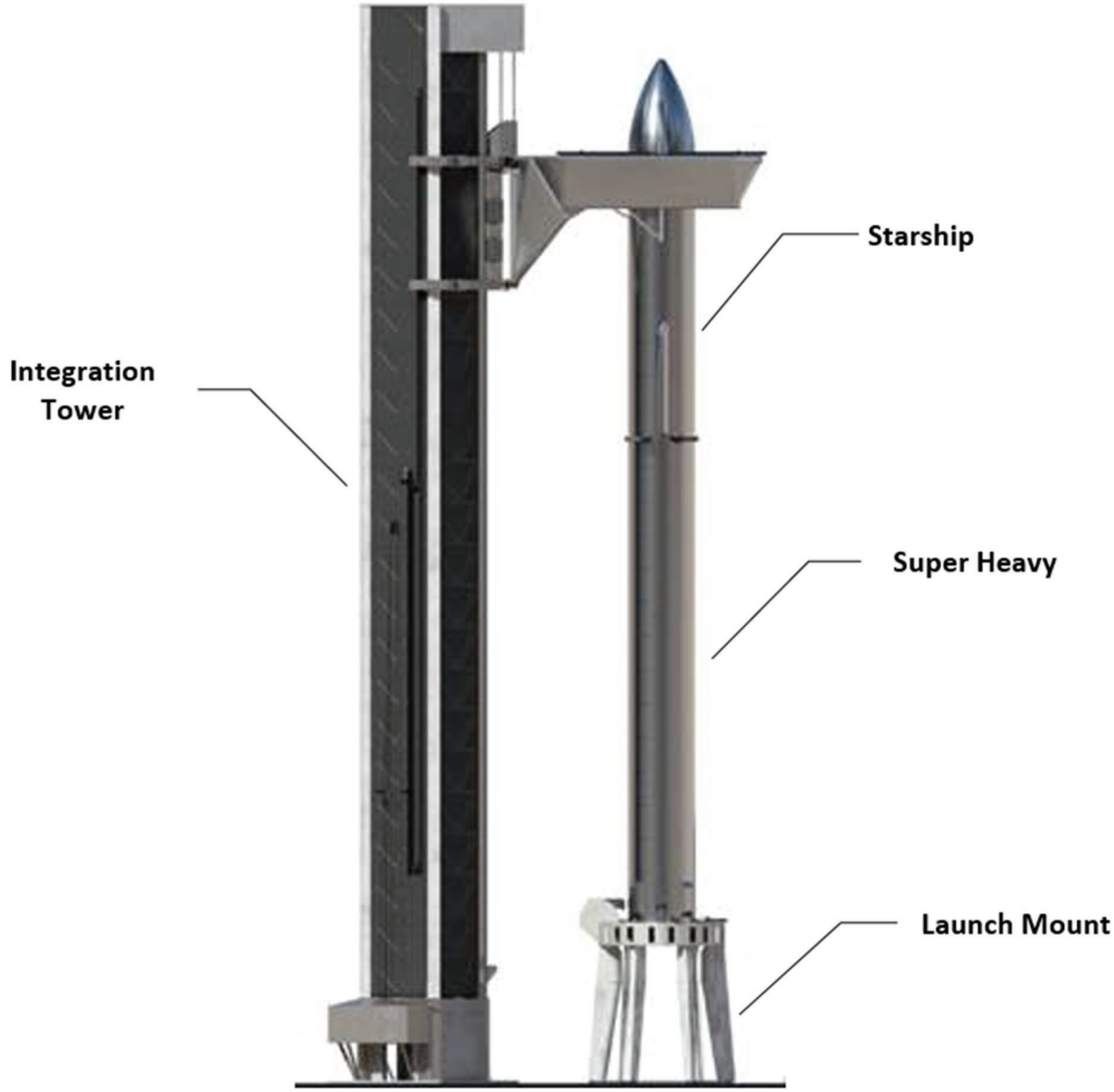
### 2.1.4.3 Integration Towers

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 (Figure 2-6). 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 when not in use (Figure 2-6). The crane would stay up most of the time and would be lowered to approximately 250 feet during launches. Following construction of the integration towers, the crane would remain at the VLA and would be used to move large articles, such as vehicles and tanks.

### 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, Launch Vehicle, and Integration Tower**




### 2.1.4.5 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 2014 EIS (FAA 2014a). Parking lot construction materials could include permeable material, asphalt, road base, or concrete.

#### 2.1.4.6 Trenching

As previously described in the 2014 EIS (FAA 2014a), installation of conduit for underground utilities would require trenching along SH 4 (Figure 2-7). Proposed utilities include water and communication lines. SpaceX would coordinate any modifications to SH 4 with TxDOT and USFWS as needed.

#### 2.1.4.7 Payload Processing Facility

SpaceX is proposing to construct a payload processing facility at SpaceX's manufacturing and production area (Figure 2-7). In the 2014 EIS (FAA 2014a), 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.

#### 2.1.4.8 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 2014 EIS and WRs (FAA 2014a, 2014b, 2017). SpaceX has constructed approximately 2 acres of the 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**


### 2.1.4.9 Pull-offs along State Highway 4

SpaceX would transport Starship or Super Heavy from the SpaceX manufacturing and 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 ROW. 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 an access restriction of SH 4 in both directions. SpaceX would coordinate construction of the pull-offs with TxDOT and Cameron County.

## 2.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue new experimental permits or licenses to SpaceX for any test or launch operations at the Boca Chica Launch Site. In this situation, SpaceX's non-licensed production and manufacturing would continue in the Boca Chica area and infrastructure would

expand at its production facility. Non-licensed testing operations, including tank tests and static fire engine tests, would also continue at the VLA. In addition, SpaceX could conduct missions of the Starship prototype launch vehicle as authorized by the current license (LRLO 20-119).[20] The license expires on May 27, 2023. This alternative provides the basis for comparing the environmental consequences of the Proposed Action.

## 2.3 Alternatives Considered but Eliminated from Further Consideration

The FAA's authority with respect to SpaceX's license application is stated in PEA Section 1.2. SpaceX's goals are identified in the purpose and need statement (PEA Section 1.3). Further, CEQ defines "reasonable alternatives" as those "that are technically and economically feasible, meet the purpose and need for the proposed action, and, where applicable, meet the goals of the applicant" (40 CFR § 1508.1(z)). SpaceX's goal for the Starship/Super Heavy program is to test prototypes and eventually launch full-scale Starship/Super Heavy launch vehicles to orbit and beyond. To meet SpaceX's goals and the purpose and need of SpaceX's proposed Starship/Super Heavy launch program, SpaceX determined that action alternatives must meet the following criteria:

- **Ability to Support the Program Development and Operations** – All testing and launch elements of the Starship/Super Heavy program must be supported in parallel with the Falcon program and without impeding the Falcon program. This is because SpaceX must be able to maintain its Falcon program to serve U.S. government and commercial customers and demonstrate and scale the Starship/Super Heavy program in parallel.

- **Scheduling Flexibility** – Starship/Super Heavy test and launch operations must have low probability of being impacted by the federal government's priority use of the launch range and airspace. Title 10, Chapter 135 of the U.S. Code, states it is the policy of the United States for the President to undertake actions appropriate to ensure, to the maximum extent practicable, that the United States has the capabilities necessary to launch and insert United States national security payloads into space whenever such payloads are needed in space (10 U.S.C. §2273). This includes prioritizing the use of airspace and launch range resources for the Air Force and intelligence agencies. Additionally, the 1997 MOA among the Department of Defense, FAA, and NASA on Federal Interaction with Launch Site Operators states that critical national security or civil sector mission requirements may take precedence over commercial use of federal launch property and launch services. In addition, the launch site must have a high probability of meeting tight launch windows, where a launch window is defined as the period of time when a launch can occur and still meet customer requirements. This is critical for a commercial launch company and can only occur if the commercial operator has exclusive use of the launch site and the launch site is not located in proximity to another launch site. If the commercial operator

[20] See: https://www.faa.gov/about/office_org/headquarters_offices/ast/licenses_permits/media/License%20and%20Orders%20SpaceX%20LRLO%2020-119%20Starship%20Prototype%202022-05-27.pdf.

does not have exclusive use or is located near another launch facility, they can be "bumped" and miss valuable and, in some cases, mission-critical launch windows.

- **Utilization of Existing Infrastructure** – Starship/Super Heavy test and launch operations must be able to use, to the maximum extent practicable, existing infrastructure, including commodity farms, fiber connections, and launch infrastructure, at one of SpaceX's launch sites. Using the existing infrastructure is necessary to reduce the costs of developing a new exclusive-use commercial launch site. This use of existing infrastructure must not impede other SpaceX operations (i.e., Falcon 9 and Falcon Heavy launches, including landings).

- **Privately Owned/Controlled Land** – In order to provide needed scheduling flexibility, the launch site should be an exclusive-use commercial launch site and the land must be owned or fully controlled by SpaceX. This results in the site being subject to commercially applicable regulations only, as opposed to additional government/military regulations which often do not apply to commercial operations, and results in higher costs and reduced schedule and operational flexibility.

- **Geographic Diversity** – Similar to how airlines have multiple locations around the country from which they operate, the launch site must be in a different location than other sites that SpaceX uses to diversify risk and operations. This allows the company to continue launching if one site is disabled (e.g., natural disaster, anomaly).

- **Trajectory** – Similar to how airlines have multiple locations around the country from which they operate, the launch site must be able to support different flight paths. Specifically, the launch site must be able to support both low Earth orbit and geostationary transfer orbit trajectories. Low Earth orbit generally applies to orbits less than 1,200 miles above Earth's surface, while geostationary transfer orbit is a transfer orbit on the way to geostationary orbit, which is more than 22,000 miles above Earth's surface. To reach these trajectories, the site must have the ability to support launches towards the east to avoid a "dogleg," a bent trajectory which severely compromises the performance to orbit. If the vehicle could not launch to the east, it would need a lot more fuel and could thus carry much less mass into orbit, which would compromise SpaceX's overall business objectives and goals.

- **Latitude** – The launch site must be at a low latitude in order to maximize the payload mass that the launch vehicle can place in orbit. Lower latitudes increase performance due to the smaller orbital plane changes (changes in the orientation of a satellite's orbit to meet customer requirements) needed to enter into geostationary orbit, which is the most important and common orbit for commercial payloads. Lower latitudes also increase performance due to the extra velocity provided by the faster Earth rate.

- **Annual Launch Capacity** – The launch site must add to SpaceX's existing annual launch capacity for required trajectories. Due to operational constraints, SpaceX is able to launch a certain number of rockets from each of its launch pads per year, which means that SpaceX requires more launch pads to increase its launch capacity. Operational constraints include trajectories, latitude, existing infrastructure, U.S. government priority use of airspace and launch pads, and weather.

- **Access to Propellants (LOX and $LCH_4$)** – Ready access to sufficient quantities of propellants to support all elements of the Starship/Super Heavy program must be provided.
- **Proximity to SpaceX's Starship/Super Heavy Manufacturing and Production Facilities** – To minimize delay, Starship/Super Heavy test and launch operations should be located near existing Starship/Super Heavy manufacturing and production facilities.

Using the criteria above, SpaceX considered alternative locations for Starship/Super Heavy test and launch operations. SpaceX evaluated its existing launch and landing facilities at CCSFS (Space Launch Complex 40 [SLC-40]), Kennedy Space Center (KSC) (LC-39A), Vandenberg Space Force Base (VSFB) (SLC-4), and an offshore fixed platform as preliminary candidates for supporting Starship/Super Heavy test and launch operations. SpaceX currently conducts Falcon launches at the federal launch complexes. NASA completed an EA and on September 19, 2019, issued a Finding of No Significant Impact for proposed Starship/Super Heavy orbital launches at KSC LC-39A (NASA 2019). The FAA was a cooperating agency in the preparation of NASA's EA. NASA's EA analyzed full-scale orbital launches; the EA did not analyze developmental testing operations or suborbital launches as proposed for the Boca Chica Launch Site. SpaceX has started construction of a Starship/Super Heavy orbital launch pad at KSC LC-39A.

SpaceX considered SLC-40, LC-39A, SLC-4, and an offshore fixed platform for supporting the proposed Starship/Super Heavy testing and launch operations. However, SpaceX dismissed these launch sites from detailed review based on the following reasons:

- **Ability to Support the Development and Operations** – The existing facilities at CCSFS, KSC, and VSFB do not have the ability to support all components of the development or operation of the Starship/Super Heavy program, including test operations. As described above, iterative testing is required to proof vehicle components and confirm reliability, and CCSFS, KSC, and VSFB do not have required test infrastructure. Even where further infrastructure could be developed, the needs for scheduling flexibility, redundancy, and more launch capacity to support the development of the Starship/Super Heavy program would not be met. Frequent test operations (and developmental launches) would impede the continued progress of the Falcon program, including launches of NASA astronauts, U.S. national security payloads, and NASA earth science and planetary defense missions and SpaceX's service to its commercial customers.
- **Scheduling Flexibility** – The existing facilities at CCSFS, KSC, and VSFB are located on federal launch ranges and close to multiple launch sites that support civil, commercial, and defense operations. Therefore, Starship/Super Heavy testing and developmental commercial launch operations would be delayed due to the federal government's priority use of the range at CCSFS, KSC, and VSFB. In addition, operations by other commercial launch providers at launch pads near SpaceX's launch pads at CCFS, KSC, and VSFB would restrict SpaceX's ability to perform Starship/Super Heavy test and launch operations. For these reasons, SpaceX would be "bumped" and could miss valuable, and in some cases, mission-critical launch windows.
- **Utilization of Existing Infrastructure** – Existing infrastructure at CCSFS, KSC, and VSFB is used to support Falcon operations, including the launch pads, payload processing facilities, launch operational facilities, and customer operational facilities. Use of this infrastructure to support the Starship/Super Heavy developmental program at CCAFS, KSC, and VSFB would impede

customer launches on Falcon rockets and the continued progress of the Falcon program that is increasing its cadence. The Falcon program supported 31 launches in 2021 and is expected to support several more in 2022. Even where further infrastructure could be developed, the needs for scheduling flexibility, redundancy, and more launch capacity to support the Starship/Super Heavy program would not be met.

- **Privately Owned/Controlled Land** – CCSFS, KSC, and VSFB are on U.S. government owned/controlled land. Although these sites provide for some launch capacity, the sites do not fulfill the need for scheduling flexibility because they are subject to the federal government's priority use and conflicting demands of other commercial launch operators. Additionally, government/military ownership of these sites and the applicability of additional regulations would limit SpaceX's ability to conduct tests and launches from these sites.

- **Geographic Diversity** – If KSC LC-39A was not available due to a hurricane, fire, anomaly, or other event, SpaceX requires another location to ensure the Starship/Super Heavy program can continue to operate, including from the required trajectories and latitudes.

- **Trajectory** – VSFB does not provide the required trajectories. Although CCSFS and KSC have the required trajectories, they do not provide scheduling flexibility, are not on privately owned/controlled land, do not increase launch capacity, do not provide geographic diversity, and do not support the Starship/Super Heavy program.

- **Latitude** – VSFB does not provide the required latitude. Although CCAFS and KSC have the required latitudes, they do not provide scheduling flexibility, are not on privately owned/controlled land, do not increase launch capacity, do not provide geographic diversity, and do not support Starship/Super Heavy program.

- **Annual Launch Capacity** – SpaceX's existing launch sites do not have sufficient capacity given existing and reasonably foreseeable future use of those sites for federal and commercial launch activities under the Falcon program. KSC LC-39A is currently the only launch site from which SpaceX can launch humans (in furtherance of its NASA and commercial astronaut contracts) because of the existing and human-rated infrastructure at the site. SpaceX is currently the only organization providing launch of NASA astronauts. Additional launch capacity at LC-39A is used for launching cargo to the International Space Station for NASA and payloads for the U.S. Air Force or other similar organizations. SpaceX is one of only two certified providers offering these launch services to the U.S. Space Force National Security Space Launch Program, and one of two operational providers supporting NASA satellite launches with intermediate-to-heavy lift capability. Because LC-39A is used for launches of humans and U.S. government programs, SLC-40 is used for launching commercial satellites. In the event that LC-39A or SLC-40 is unavailable due to a natural disaster or anomaly, the non-affected site's extra launch capacity would be used to avoid delays in SpaceX's manifest. For these reasons, LC-39A and SLC-40 do not have additional launch capacity for Starship/Super Heavy developmental launches. VSFB is used for a mix of U.S. government and commercial missions, but the site does not have additional launch capacity required for Starship/Super Heavy due to the trajectories available from the site, as described above.

- **Access to Propellants (LOX and $LCH_4$)** – The existing facilities at CCSFS, KSC, and VSFB routinely support Falcon launch operations. The Falcon launch vehicle uses LOX and Rocket Propellant 1 (kerosene) as fuel. As such, the existing infrastructure supports the storage of these propellants. Accordingly, ready access to sufficient quantities of propellants to support all elements of the Starship/Super Heavy program are not provided at CCSFS, KSC, or VSFB. A potential offshore fixed platform would not have readily accessible propellants to support all elements of the Starship/Super Heavy program. Propellant would need to be barged to the offshore location. Logistics and cost of the transportation of these propellants would delay the program and inhibit the cost effectiveness and flexibility of the Starship/Super Heavy program.
- **Proximity to SpaceX's Starship/Super Heavy Manufacturing and Production Facilities** – The existing infrastructure at CCSFS, KSC, and VSFB is located near SpaceX facilities that manufacture components of the Starship/Super Heavy launch vehicle. However, major components for the Starship/Super Heavy launch vehicle are fabricated at SpaceX's manufacturing and production facilities near Boca Chica Village. Transportation of these components to CCSFS, KSC, VSFB, or a potential offshore fixed platform would result in delays that would inhibit implementation development, when iterative design changes and testing are required for developmental launches.

In the future, SpaceX may need to further increase the launch capacity, provide more diversity or redundancy of Starship/Super Heavy launch sites, and/or accommodate new trajectories and therefore evaluate additional launch facilities in addition to the Boca Chica Launch Site. This may include launching the Starship/Super Heavy launch vehicle from an additional launch facility at KSC or an offshore facility constructed, attached, and fixed to the Outer Continental Shelf (OCS) in the Gulf of Mexico. At this time, an offshore fixed platform capable of supporting Starship/Super Heavy launch/landing operations is not available. Any future OCS project or additional launch site would have independent utility and be analyzed in a separate NEPA document. Any future OCS or other new launch site would not fulfill the purpose and need of this Proposed Action because it would not meet the following factors outlined above: proximity to manufacturing and production facilities, access to propellants, ability to support development and operations, geographic diversity, utilization of existing infrastructure. Additionally, SpaceX is unable to take Starship/Super Heavy operations offshore as SpaceX is still designing and evaluating the feasibility of a fixed offshore launch platform; therefore, technology and infrastructure needed to support an offshore launch site and operations are not available at this time. Accordingly, an offshore launch and landing facility on the OCS or additional launch site at KSC would not fulfill the purpose and need of this action at this time and is not a feasible alternative location for the proposed activities discussed above.

# Chapter 3.
# Affected Environment and Environmental Consequences

## 3.1 Introduction

This chapter provides a description of the affected environment and potential environmental consequences for the environmental impact categories that have the potential to be affected by the Proposed Action. The environmental impact categories assessed in this EA include air quality; climate; noise and noise-compatible land use; visual effects; cultural resources; Department of Transportation (DOT) Act, Section 4(f); water resources; biological resources; coastal resources; land use; hazardous materials, solid waste, and pollution prevention; natural resources and energy supply; and socioeconomics, environmental justice, and children's environmental health and safety risks. The study area varies based on the environmental impact category being analyzed and is defined for each environmental impact category in this chapter. The level of detail provided in this chapter is commensurate with the importance of the potential impact on the environmental impact categories.

The following environmental impact categories are not analyzed in detail for the reason stated.

- **Farmlands**. No prime farmland, unique farmland, or farmland of statewide or local importance is present within the vicinity of the Boca Chica Launch Site (NRCS 2021). Therefore, the Proposed Action would not impact farmlands.
- **Wild and Scenic Rivers**. There are no wild and scenic rivers protected by the Wild and Scenic Rivers Act located within the water resources study area. The nearest wild and scenic river is a segment of the Rio Grande that is over 400 miles away from the Boca Chica Launch Site (USFS 2019). The nearest river listed on the Nationwide Rivers Inventory[21] is the Sabinal River, which is over 260 miles away from the launch site (NPS 2020). Therefore, the Proposed Action would not affect a wild and scenic river.

NEPA requires that Federal agencies include analysis of potential transboundary effects extending across the border and affecting another country's environment. Because of the proximity of the VLA to the U.S./Mexico border, the FAA considered the potential for transboundary impacts and consulted the Mexican government through the State Department. The FAA did not receive any comments from the Mexican government regarding the environmental review.[22] For the purposes of this PEA, transboundary impacts are considered in Section 3.5, *Noise and Noise-Compatible Land Use*, and Section 3.6, *Visual Effects*, as the potential for transboundary impacts would occur from noise during launches

[21] The Nationwide Rivers Inventory, which is maintained by the NPS, lists more than 3,400 rivers or river segments that appear to meet the minimum Wild and Scenic Rivers Act eligibility requirements based on their free-flowing status and resource values (NPS 2020).

[22] The FAA met with the Mexican State of Tamaulipas in October 2021. Secretary Gilberto Estrella, Secretary of Urban Development and Environment for the State of Tamaulipas, contacted the Mexican Federal environmental office. The FAA provided information on the public hearings to Secretary Estrella.

and visual effects from construction and operations. The FAA does not expect transboundary impacts on other environmental impact categories.

# 3.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue new permits or licenses to SpaceX for any test or launch operations at the Boca Chica Launch Site. SpaceX could conduct missions of the Starship prototype launch vehicle as authorized by the current license (LRLO 20-119). The license expires on May 27, 2023. Under the No Action Alternative, impacts to the human environment from Starship prototype suborbital launches would be similar to the types of launch-related impacts discussed in the FAA's 2014 EIS (FAA 2014a) as well as similar airspace closures associated with the launches. However, in general, the intensity of the impacts would be less than the impacts discussed in the 2014 EIS because the Starship prototype is a smaller launch vehicle and uses fewer engines (and therefore has less thrust) than the Falcon Heavy. Also, the Starship prototype uses methane for fuel compared to Falcon Heavy's use of kerosene. SpaceX would continue its existing production and testing infrastructure and operations, which are not subject to FAA licensing.

# 3.3 Air Quality

## 3.3.1 Definition of Resource and Regulatory Setting

Air quality is the measure of the condition of the air expressed in terms of ambient pollutant concentrations and their temporal and spatial distribution. Air quality regulations in the United States are based on concerns that high concentrations of air pollutants can harm human health, especially for children, the elderly, and people with compromised health conditions; as well as adversely affect public welfare by damage to crops, vegetation, buildings, and other property.

Under the Clean Air Act, the U.S. Environmental Protection Agency (EPA) developed the National Ambient Air Quality Standards (NAAQS) for six common air pollutants known as "criteria" pollutants (EPA 2020). These criteria air pollutants are CO, nitrogen dioxide, ozone, particulate matter, sulfur dioxide ($SO_2$), and lead. The EPA determined that these criteria air pollutants may harm human health and the environment, and cause property damage. The EPA regulates these pollutants to permissible levels through human health-based (primary standards) and environmental-based (secondary standards) criteria. The TCEQ has adopted the NAAQS, which are presented in Table 3-1.

Based on measured ambient criteria pollutant data, the EPA designates all areas of the U.S. as having air quality better than the NAAQS (attainment), worse than the NAAQS (nonattainment), or unclassifiable (40 CFR Part 81, Subpart C, Section 107). The designation of attainment for any NAAQS is based on the evaluation of ambient air quality monitoring data collected through federal, state, and/or local monitoring networks.

Toxic air pollutants, also called hazardous air pollutants (HAPs), are a class of pollutants that do not have ambient air quality standards but are examined on an individual basis when there is a source of these pollutants. HAPs emitted from mobile sources are called Mobile Source Air Toxics (MSATs). MSATs are compounds emitted from highway vehicles and non-road equipment that are known or suspected to

cause cancer or other serious health and environmental effects. MSATs would be the primary HAPs emitted by mobile sources during launch activity and any offshore recovery operations of Starship or Super Heavy vehicles that land downrange in the Gulf of Mexico or the Pacific Ocean on a floating platform. The vessels and boat used during such operations would likely vary in age and have a range of emission controls. SpaceX anticipates that recovery equipment and vehicles would be operated for approximately five days for each launch with a recovery and would produce negligible ambient pollutant emissions in a widely dispersed area. HAPs from the combustion of fossil fuel, which is the cause of emissions from mobile sources, are emitted in quantities anywhere from one to three orders of magnitude less than criteria pollutant emissions from these sources. Because of the small scale of the emissions and the context of the minimal mobile source operations required by the Proposed Action, HAP emissions are not considered for the mobile sources in this analysis but are considered for ground-processing activities.

More information about air quality can be found in Chapter 1 of the FAA Order 1050.1F Desk Reference (FAA 2020d).

**Table 3-1. National Ambient Air Quality Standards**

| Pollutant | | Primary/ Secondary | Averaging Time | Level | Form |
|---|---|---|---|---|---|
| Carbon Monoxide | | primary | 8 hours | 9 ppm | Not to be exceeded more than once per year |
| | | | 1 hour | 35 ppm | |
| Lead | | primary and secondary | Rolling 3-month average | 0.15 µg/m$^3$ (1) | Not to be exceeded |
| Nitrogen Dioxide | | primary | 1 hour | 100 ppb | 98th percentile of 1-hour daily maximum concentrations, averaged over 3 years |
| | | primary and secondary | 1 year | 53 ppb (2) | Annual Mean |
| Ozone | | primary and secondary | 8 hours | 0.070 ppm (3) | Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years |
| Particulate Matter | $PM_{2.5}$ | primary | 1 year | 12.0 µg/m$^3$ | annual mean, averaged over 3 years |
| | | secondary | 1 year | 15.0 µg/m$^3$ | annual mean, averaged over 3 years |
| | | primary and secondary | 24 hours | 35 µg/m$^3$ | 98th percentile, averaged over 3 years |
| | $PM_{10}$ | primary and secondary | 24 hours | 150 µg/m$^3$ | Not to be exceeded more than once per year on average over 3 years |

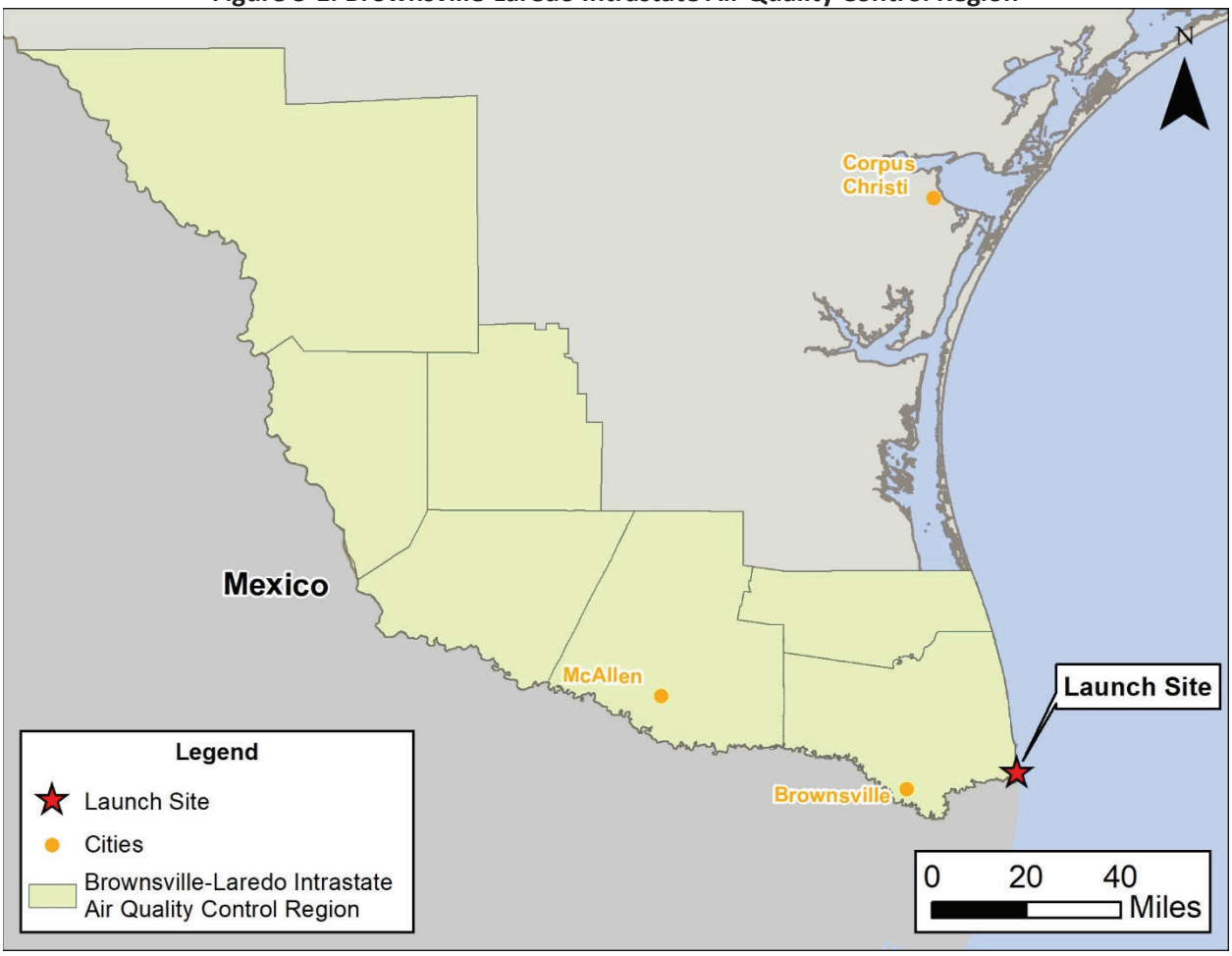
| Pollutant | Primary/ Secondary | Averaging Time | Level | Form |
|---|---|---|---|---|
| Sulfur Dioxide | Primary | 1 hour | 75 ppb (4) | 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years |
| | Secondary | 3 hours | 0.5 ppm | Not to be exceeded more than once per year |

Source: 40 CFR 50, EPA 2020. Criteria Air Pollutants NAAQS
Notes: $mg/m^3$ = milligrams per cubic meter; $\mu g/m^3$ = micrograms per cubic meter; ppb = parts per billion; ppm = parts per million; $PM_{10}$ = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = fine particulate matter 2.5 microns or less in diameter
(1) In areas designated nonattainment for the lead standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 $\mu g/m^3$ as a calendar quarter average) also remain in effect.
(2) The level of the annual nitrogen dioxide standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.
(3) Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) ozone standards additionally remain in effect in some areas. Revocation of the previous (2008) ozone standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.
(4) The previous $SO_2$ standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2) any area for which implementation plans providing for attainment of the current (2010) standard have not been submitted and approved and which is designated nonattainment under the previous $SO_2$ standards or is not meeting the requirements of a SIP call under the previous $SO_2$ standards (40 CFR 50.4(3)), A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.

### 3.3.2 Study Area

The study area for air quality includes the Boca Chica Launch Site and the surrounding area that would receive air emissions from Starship/Super Heavy launches and construction, and extends up to the mixing height, which is nominally 3,000 feet above ground level. The mixing height is defined as the vertical region of the atmosphere where pollutant mixing occurs. Pollutants released above this height generally do not mix with ground level emissions and do not have an effect on ground level concentrations in the local area. The study area for air quality is located in the Brownsville-Laredo Intrastate Air Quality Control Region (40 CFR § 81.135), which includes the Texas counties of Cameron, Hidalgo, Jim Hogg, Starr, Webb, Willacy, and Zapata (see Figure 3-1).

**Figure 3-1. Brownsville-Laredo Intrastate Air Quality Control Region**




## 3.3.3 Existing Conditions

According to the EPA, as of April 2021, Cameron County is in attainment for all criteria pollutants. There are three ambient air monitoring stations located in Cameron County. One is located in Brownsville and collects data on $PM_{2.5}$, volatile organic compounds, and meteorological parameters. The second site is located in Isla Blanca State Park on South Padre Island and collects data on $PM_{2.5}$ and meteorological conditions. The third site is located in Harlingen and collects data on ozone and meteorological conditions.

## 3.3.4 Environmental Consequences

Air quality impacts would be significant if the action would cause pollutant concentrations to exceed one or more of the NAAQS, as established by the EPA under the Clean Air Act, for any of the time periods analyzed in this PEA, or to increase the frequency or severity of any such existing violations. Impacts to air quality would result from the proposed construction, pre-launch and launch operations, the occasional operation of generators, and ground vehicle emissions. These effects on air quality on a local and regional scale are expected to be minimal.

#### 3.3.4.1 Construction

Some details of construction at the Boca Chica Launch Site are not known at this time because some elements of the project are still in the design phase. The air quality impacts of the construction planned under the Proposed Action is comparable to the impacts of construction operations of similar scale that were assessed in 2014. Impacts have been estimated based on best available data. Where data are limited, the analysis uses conservatively high estimates of construction activities, construction vehicles, and associated emissions. As determined in 2014 and concluded for this PEA, the estimated emissions from construction of the VLA represent extremely small percentages of the Cameron County regional emissions and would not cause an exceedance of any NAAQS; therefore, the construction impacts on air quality would not be significant.

The best available data for the Proposed Action includes the emissions modeling and analysis that was conducted during the 2014 EIS. While the 2014 EIS does not directly address or include the elements of the current Proposed Action, the scale of the construction activities (in both square footage and duration) is comparable to the construction activities proposed in 2014. SpaceX determined that the construction elements of the Proposed Action would not cause or create a reasonably foreseeable emission increase over the construction elements of the Proposed Action as analyzed in the 2014 EIS. Additionally, the actual construction activities (i.e., building of a launch pad and support infrastructure) are similar to those activities analyzed in the 2014 EIS. Cameron County is still in attainment for all NAAQS, as it was in 2014. Accordingly, the data and analyses contained in the 2014 EIS related to construction emissions accurately reflect the anticipated impacts under the Proposed Action.

As described in the 2014 EIS, there would be temporary increases in emissions of regulated air pollutants in the construction area during site preparation. Dust from the exposure of topsoil and exhaust from heavy machinery would impact the air quality of the site. Air pollutants generated could include particulate matter ($PM_{10}$ and $PM_{2.5}$), $SO_2$, nitrogen oxides, and others. These emissions would be temporary, and after construction completion, the air quality would return to average ambient levels.

Particulates and fugitive dust would be controlled with periodic water spraying. The emission of any air pollutants as a result of ground disturbance, use of equipment, coatings application, or other construction activities would be controlled by the incorporation of Best Management Practices (BMPs), to include minimal idling of engines, watering of soils to be disturbed, and use of low volatility coatings and other recognized controls.

Emissions associated with the construction of the additional infrastructure described under the Proposed Action would be temporary and less than the total emissions considered in the 2014 EIS. The 2014 EIS estimated the following maximum construction emissions (in tons/year):

- Volatile organic compounds (VOCs) – 0.86
- CO – 11.47
- $NO_x$ – 8.73
- $SO_2$ – 0.10
- $PM_{10}$ – 18.07

- $PM_{2.5}$ – 2.21

The 2014 EIS concluded that these estimated emissions from the construction and operation of the launch site would represent an extremely small percentage of the Cameron County regional emissions and would not cause any NAAQS to be exceeded. Air quality impacts from proposed construction activities would be minimal and of short duration and would not cause any NAAQS to be exceeded. Therefore, they are not considered significant.

### 3.3.4.2 Operations

Air quality impacts from generators, vehicles, and non-toxic substances are often associated with ground-processing activities, such as moving or integrating the launch vehicle or maintenance on the ground systems. Typical ground processing operations of the size proposed at the VLA are estimated to require small capacity storage and use of fuel and are not expected to produce emissions above the potential to emit threshold levels established as major sources of pollution listed in the Texas Administrative Code (TAC) Title 30 Chapter 116. For that reason, the ground-processing activity emissions are estimated to have minimal air quality impacts.

Proposed activities at the VLA include tank tests, static fire engine tests, and launches. As stated in Section 2.1.3.1, tank tests are designed to not release any propellant to the environment. The emissions during static fire engine tests and launches would be typical of a LOX/$CH_4$ plume. The plume constituents consist of water vapor, $CO_2$, CO, hydrogen, $CH_4$, nitrogen oxides, and oxygen. No HAP emissions are anticipated from launch operations.

Effects of the vehicle dynamics and multiple engines are difficult to estimate. Necessary assumptions were made to best capture the characteristics of the LOX/$CH_4$ plume. On behalf of SpaceX, Sierra Engineering & Software, Inc. modeled emissions assuming a single Raptor engine firing into a stable environment within 215 feet of the engine exhaust. The analysis from the single engine was then extrapolated to estimate the emissions for a maximum of 37 Raptor engines that would be fired during an orbital launch (Sierra 2022; see Appendix G). Additionally, the presence of any water used for sound suppression could change the environment, likely cooling the near-plume air. This could slow the rate of combustion; therefore, as the rocket gains altitude, the more efficient the combustion process becomes.

Rocket engine combustion emissions are not subject to limitations on production or use because the EPA has not set emissions standards for rocket engines. The proposed launch activities do not generate ozone depleting substances. Air permits are not required for emissions from the launches as these are mobile sources, are temporary in nature, and not considered to be major emissions of criteria pollutants or HAPs. Although permitting is not required, the air pollutant emissions of the Proposed Action are still required to be analyzed for potential impacts.

Most CO emitted by the liquid fuel engines is oxidized to $CO_2$ during afterburn in the exhaust plume. The resulting $CO_2$ would disperse in the atmosphere and have no impact on air quality. (See Section 3.4 for discussion of climate effects of $CO_2$.) Ground-level concentrations of pollutants are not expected to approach or exceed the NAAQS due to the short period of time the rockets are close to the ground. Launch emissions below 3,000 feet would be of short duration (a matter of seconds) as the vehicle rises above the launch pad and accelerates or during static fire testing. The high temperatures of the exhaust products would cause them to rise rapidly and disperse with prevailing winds. A small amount of

thermal $NO_x$ is formed, all as nitric oxide. The CO emissions would be emitted at no greater than 38.62 kilograms per second for the Super Heavy and 8.19 kilograms per second for Starship (Appendix G). The $NO_x$ emissions would be emitted at no greater than 84.12 kilograms per second for the Super Heavy and 17.84 kilograms per second for Starship (Appendix G). Starship/Super Heavy launches would be expected to reach the upper limit of the mixing zone, or 3,000 feet, within approximately 31 seconds. Static fire engine tests are also of limited duration; engines are ignited for approximately 5–15 seconds for each test.

The following calculations are based on the maximum proposed number of each type of operation annually (see Table 3-2). For the maximum launch frequency of five orbital launches per year, Starship/Super Heavy would emit 14.37 and 6.60 US tons per year each of $NO_x$ and CO, respectively. Suborbital flights of the Starship vehicle would emit 2.02 and 0.93 US tons each of $NO_x$ and CO per year, respectively. During landing, 1.41 and 0.65 US tons per year each of $NO_x$ and CO, respectively, would be emitted for Starship and 1.48 and 0.68 US tons per year each of $NO_x$ and CO, respectively, for the Super Heavy booster. Annually, 150 seconds of static fire for Starship testing would emit 2.95 and 1.35 tons each of $NO_x$ and CO, respectively. For Super Heavy, 135 seconds of static fire testing would produce 12.52 and 5.75 tons each of $NO_x$ and CO, respectively, annually.

The emission of VOC, $NO_x$, and CO during launch and landing represent a small percentage of Cameron County regional emissions of 25,504, 7,134, and 66,212 US tons, respectively, reported in the EPA National Emissions Inventory (EPA 2019b). These levels are also well below the 100 US tons per year General Conformity Rule threshold established for each criteria pollutant. While the General Conformity Rule does not apply for regulatory reasons since Cameron County is in attainment, these values are useful for assessing the scale of the operational emissions. The Proposed Action emission levels are well below the General Conformity Rule *de minimis* thresholds and would be expected to have little or no impact on regional air quality. Further, because Cameron County is not designated by the EPA as a nonattainment area, a Conformity Evaluation is not required. The total maximum estimated annual operation emissions are summarized by criteria pollutant in Table 3-2.

**Table 3-2. Total Maximum Estimated Annual Operation Emissions (US Tons Per Year) for the Proposed Action**

| Annual Emissions Source | VOC | NOx | CO | $SO_2$ | PM |
|---|---|---|---|---|---|
| Starship/Super Heavy Launches (5) | -- | 14.37 | 6.60 | -- | -- |
| Starship Suborbital Launches (5) | -- | 2.02 | 0.93 | -- | -- |
| Starship Landings (10) | -- | 1.41 | 0.65 | -- | -- |
| Super Heavy Landings (5) | -- | 1.48 | 0.68 | -- | -- |
| Starship Static Test Fires (150 seconds ) | -- | 2.95 | 1.35 | -- | -- |
| Super Heavy Static Test Fires (135 seconds) | -- | 12.52 | 5.75 | -- | -- |
| **Total** | **--** | **34.75** | **15.96** | **--** | **--** |
| GCR *de minimis* thresholds | 100 | 100 | 100 | 100 | 100 |
| Exceedance of GCR Threshold | No | No | No | No | No |

Notes: VOC= Volatile Organic Compounds, $NO_x$ = Nitrogen Oxides, CO= Carbon Monoxide, $SO_2$= Sulphur dioxide, PM= Particulate Matter, GCR = General Conformity Rule

Based on these estimates, the total potential emissions of all the criteria pollutants under the Proposed Action do not exceed the General Conformity Rule threshold of 100 tons per year are not anticipated to lead to concentrations that would exceed any NAAQS.

Airspace closures associated with the Proposed Action would result in additional aircraft emissions mainly from aircraft being re-routed and expending more fuel. Minimal, if any, additional emissions would be generated from aircraft departure delays because the FAA has rarely received reportable departure delays associated with commercial space transportation launches. Based on SpaceX's proposal, airspace-related impacts could increase up to 15 times a year under the Proposed Action (Table 2-2). Any delays in aircraft departures from affected airports would be short-term. Thus, any increases in air emissions from grounded aircraft are expected to be minimal and would occur in attainment areas. Further, it is likely that grounded aircraft would not have its engines idling during such a foreseeable delay, further minimizing increases in air emissions. Therefore, these emissions increases are not expected to result in an exceedance of a NAAQS for any criteria pollutant. Emissions from aircraft being re-routed would occur above 3,000 feet (the mixing layer) and thus would not affect ambient air quality.

In summary, the Proposed Action is not expected to result in significant impacts to air quality.

### 3.3.5 Mitigation and Monitoring

The FAA would ensure that SpaceX implements the following measures to minimize impacts on air quality:

1. Periodic water spraying to control particulates and fugitive dust.
2. BMPs such as minimal idling of engines, watering of soils to be disturbed, and use of low volatility coatings.
3. Compliance with TCEQ's authorization under the Oil and Gas Standard Permit, including adherence to any permit conditions.

## 3.4 Climate

### 3.4.1 Definition of Resource and Regulatory Setting

Climate change is a global phenomenon that can have local impacts. Scientific measurements show that Earth's climate is warming, with concurrent impacts including warmer air temperatures, increased sea level rise, increased storm activity, and an increased intensity in precipitation events. Research has shown there is a direct correlation between fuel combustion and greenhouse gas (GHG) emissions. GHGs are defined as including $CO_2$, $CH_4$, nitrous oxide ($N_2O$), hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. $CO_2$ is the most important anthropogenic GHG because it is a long-lived gas that remains in the atmosphere for up to 100 years.

GHGs have varying global warming potential (GWP). The GWP is the potential of a gas or aerosol to trap heat in the atmosphere. "Specifically, it is a measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to the emissions of 1 ton of carbon dioxide ($CO_2$)" (EPA 2021a). Therefore, $CO_2$ has a GWP of 1. The larger the GWP, the more that a given gas warms the Earth compared to $CO_2$ over that time period. The time period usually used for GWPs is 100 years (EPA 2021a). The other main GHGs that have been attributed to human activity include $CH_4$, which has a GWP of 28,

and $N_2O$, which has a GWP of 265 (Myhre et al. 2013). $CO_2$, followed by $CH_4$ and $N_2O$, are the most common GHGs that result from human activity. $CO_2$, and to a lesser extent, $CH_4$ and $N_2O$, are products of combustion and are generated from stationary combustion sources as well as vehicles. The following formula is used to calculate the Carbon Dioxide Equivalent ($CO_2e$).

$$CO_2e = (CO_2 \times 1) + (CH_4 \times 28) + (N_2O \times 265)$$

The FAA has developed guidance for considering GHGs and climate under NEPA, as published in the Desk Reference to Order 1050.1F (FAA 2020d). An FAA NEPA review should follow the basic procedure of considering the potential incremental change in $CO_2$ emissions that would result from the proposed action and alternative(s) compared to the no action alternative for the same timeframe and discussing the context for interpreting and understanding the potential changes. For such reviews, this consideration could be qualitative (e.g., explanatory text), but may also include quantitative data (e.g., calculations of estimated project emissions).[23] However, at present, no methodology exists that would enable estimating the specific impacts (if any) that this change in GHGs would produce locally or globally.

### 3.4.2 Study Area

GHG emissions for this project are considered globally since climate change is a global issue. This means GHG emissions are considered at all altitudes for a Starship/Super Heavy launch and for all proposed construction activities.

### 3.4.3 Existing Conditions

The regional climate along the Gulf coast in Cameron County, Texas is characterized by an extended summer season and a mild fall and winter, generally with high humidity. Data from the Brownsville South Padre Island International Airport meteorological station from 1981 through 2010 shows the average daily temperatures range from lows of 63° Fahrenheit in the winter to 84° Fahrenheit in the summer. Average annual precipitation in the region is 27.5 inches recorded over the same period (National Climate Data Center 2012). Wind speeds in the region are usually moderate, although extremely strong winds accompany hurricanes that strike the region. Wind speeds are fairly consistent in the coastal area where the Boca Chica Launch Site is located. Due to Cameron County's coastal location, the area is likely to be more susceptible to the potential impacts of climate change such as sea-level rise and increased frequency of extreme weather events such as hurricanes. Conversely, because this is a coastal area, some adaptation measures are likely to already be in place, such as hurricane evacuation routes.

Relative sea level rise along the South Texas coast is caused by natural and human-induced land surface subsidence and a global rise in ocean level. Tide gauge records in South Texas, which include the effects of land subsidence, show that relative sea level has risen at a rate of 0.14 inches/year at South Padre Island since 1958. Land subsidence caused by groundwater withdrawal and oil and gas production

[23] This analysis is consistent with Executive Order (EO) 13990, *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*, 86 Federal Register 7037 (Jan. 25, 2021).

decreases pore pressures in underlying sediments, allowing further compaction. In addition, sand supply needed to sustain the Gulf shoreline through restoration and replenishment efforts is lacking.

### 3.4.4 Environmental Consequences

The FAA has not established a significance threshold for climate, nor has the FAA identified specific factors to consider in making a significance determination for GHG emissions. There are currently no accepted methods of determining significance applicable to commercial space launch projects given the small percentage of global GHG emissions they contribute. There is a considerable amount of ongoing scientific research to improve understanding of global climate change, and FAA guidance will evolve as the science matures or if new federal requirements are established.

Proposed construction and operations would involve mobile source fuel combustion that would generate GHG emissions from associated construction equipment, launch, reentry/landing, and test operations. The GHG emissions associated with the estimated emissions for the Proposed Action is compared to global and U.S. emissions in Table 3-3 below. The maximum number of each launch operation was used in the GHG emission calculations to represent the maximum potential emissions for the Proposed Action.[24] The estimated $CO_2$ emissions from annual operations of the Starship/Super Heavy Program are significantly less than the total GHG emissions generated by the United States in 2018 and the total $CO_2$ emissions generated worldwide (Energy Information Administration 2018; WRI 2018). $CO_2$ emissions from landing of the Starship or Super Heavy booster would be appreciably less than emissions from launches because fewer engines would be relit.

Airspace closures associated with the Proposed Action would result in additional aircraft emissions mainly from aircraft being re-routed on established alternative flight paths and expending more fuel. These emissions include $CO_2$, which is a GHG. Based on SpaceX's proposal, these temporary increases in aircraft emissions could increase up to 10 times per year (Table 2-2). The amount of time that affected aircraft spend being re-routed would be short-term. In addition, the number of aircraft that would be impacted per launch would not be expected to produce additional emissions that would have a notable impact on climate. Therefore, the increases in GHGs caused by short-term airspace closures during commercial space operations is not expected to result in significant climate-related impacts.

In summary, the Proposed Action GHG emissions are not significant and would not cause any appreciable addition of GHGs into the atmosphere.

**Table 3-3. Estimated Carbon Dioxide Equivalent Emissions Comparison**

| Annual Emissions Source | Metric Tons Carbon Dioxide Equivalent per Year |
|---|---|
| Global 2018 Total $CO_2$ Emissions | $3{,}710 \times 10^{11}$ |
| U.S. 2018 Total GHG Emissions | $5{,}140 \times 10^{6}$ |
| Starship/Super Heavy Launches (5) | 16,650 |
| Starship Suborbital Launches (5) | 393 |
| Starship Landings (10) | 273 |
| Super Heavy Landings (5) | 573 |

[24] However, as mentioned in Section 3.3.4.2, the net emissions (i.e., the proposed action emission levels minus the no action emission levels) are estimated to be lower, as the Boca Chica Launch Site is an active launch site.

| Annual Emissions Source | Metric Tons Carbon Dioxide Equivalent per Year |
|---|---|
| Starship Static Test Fires (150 seconds) | 573 |
| Super Heavy Static Test Fires (135 seconds) | 2,430 |
| Methane venting | 23,000 |
| **Starship/Super Heavy Operations Annual Total** | **43,892** |

Source: EPA 2014, Tables C-1 and C-2 to Subpart C of 40 CFR 98.

# 3.5 Noise and Noise-Compatible Land Use

## 3.5.1 Definition of Resource and Regulatory Setting

Sound is a physical phenomenon consisting of pressure fluctuations that travel through a medium, such as air, and are sensed by the human ear. Noise is considered any unwanted sound that interferes with normal activities (e.g., sleep, conversation, student learning) and can cause annoyance. Noise sources can be constant or of short duration and contain a wide range of frequency (pitch) content. Determining the character and level of sound aids in predicting the way it is perceived. Both launch noise and sonic booms are classified as short-duration events.

The compatibility of existing and planned land uses with proposed FAA actions is usually determined in relation to the level of aircraft (or launch vehicle) noise. Federal compatible land use guidelines for a variety of land uses are provided in Table 1 in Appendix A of 14 CFR part 150, *Land Use Compatibility with Yearly Day-Night Average Sound Levels*. Compatible land use analysis considers the effects of noise on special management areas, such as national parks, national wildlife refuges, and other sensitive noise receptors. Special consideration needs to be given to the evaluation of the significance of noise impacts on noise sensitive areas within Section 4(f) properties, such as national parks and national wildlife and waterfowl refuges and historic sites, if the foregoing noise significance threshold is not relevant to the value, significance, and enjoyment of the area in question. The concept of land use compatibility corresponds to the objective of achieving a balance between the Proposed Action and the surrounding environment.

The FAA has determined that the cumulative noise energy exposure of individuals to noise resulting from FAA actions must be established in terms of yearly Day-Night Average Sound Level (DNL), the FAA's primary noise metric. DNL accounts for the noise levels of all individual aircraft/launch vehicle events, the number of times those events occur, and the period of day/night in which they occur. The DNL metric logarithmically averages sound levels at a location over a complete 24-hour period, with a 10-decibel (dBA) adjustment added to those noise events occurring from 10:00 p.m. to 7:00 a.m. The 10-dB adjustment is added because of the increased sensitivity to noise during normal nighttime hours and because ambient (without aircraft/launch vehicles) sound levels during nighttime are typically about 10-dB lower than during daytime hours. More information about noise and noise-compatible land use can be found in Chapter 11 of the FAA Order 1050.1F Desk Reference (FAA 2020d).

Chapter 11 of the FAA Order 1050.1F Desk Reference (FAA 2020d) provides that DNL should be supplemented by other noise metrics to describe and assess noise effects for commercial space operations. Accordingly, this PEA also analyzes the Sound Exposure Level (SEL) and the maximum A-weighted sound level ($L_{Amax}$). $L_{Amax}$ represents the highest A-weighted measure of the sound level at any

given time during a noise event. A-weighting approximates the natural range and sensitivity of human hearing. SEL represents both the magnitude of a sound and its duration. SEL provides a measure of the cumulative noise exposure from an acoustic event, but it does not directly represent the sound level heard at any given time. Mathematically, it represents the sound level of a constant sound that would, in one second, generate the same acoustic energy as the actual time-varying noise event. For this reason, SEL is expected to be greater than $L_{Amax}$. However, because SEL does not measure the sound heard at any given time during a noise event, it is not used to measure interference of a noise event with human hearing, conversation, sleep, or other common activities. Instead, $L_{Amax}$ is used for the analysis of noise impacts to humans and wildlife, because it approximates the sensitivity and range of human hearing. The PEA also analyzes $L_{max}$, which measures the maximum overall sound pressure level for an individual event. $L_{max}$ is used to assess potential structural damage. Ground areas were modeled as acoustically soft, and water acoustically hard. Ground effect was based on a weighted average over the propagation path.

Chapter 11 of the FAA Order 1050.1F Desk Reference (FAA 2020d) states the FAA should evaluate whether the Occupational Safety and Health Administration (OSHA) hearing damage criteria from 29 CFR § 1910.95 and the National Academy of Sciences' guidelines for structural damage (National Academy of Sciences 1977) may be exceeded for a project. Guidelines on permissible noise exposure limits from OSHA (OSHA 2020) are designed to protect human hearing from long-term, continuous exposures to high noise levels and aid in the prevention of noise-induced hearing loss.

### 3.5.2 Study Area

The study area for noise and noise-compatible land use includes the Boca Chica Launch Site and surrounding area exposed to construction and launch-related noise (i.e., engine noise and sonic booms). On behalf of SpaceX, KBR, Inc. (KBR) conducted a noise assessment using the model RNOISE for Starship/Super Heavy test and launch operations at the Boca Chica Launch Site (KBRwyle 2020; see Appendix B). SpaceX used PCBOOM to estimate single event sonic boom levels during Starship and Super Heavy landings (sonic booms generated during ascent would not impact land). SpaceX's sonic boom assessment is located in Appendix B. Figures 1 and 2 in SpaceX's sonic boom assessment show sonic boom contours for a Starship and Super Heavy landing, respectively, at the VLA.

In Appendix B, each contour with a specific number represents the noise or sonic boom level that is expected at the distance where the contour is located. Thus, the noise or sonic boom level is expected to decrease as a function of distance within each of the contour rings.

KBR's report shows noise, vibration, and sonic boom contours for different types of activities within the scope of the Proposed Action. KBR's report shows that noise, vibration, and sonic booms effects will encompass Boca Chica Village, Port Isabel, portions of South Padre Island, and/or Tamaulipas, Mexico to varying degrees, depending on the type of activity, and that the affected area may include some or all of the DOT Act Section 4(f) resources listed in Section 3.8, including historic resources (which area also listed in Section 3.7), depending on the type of activity. The specific areas affected by noise, vibrations, and sonic booms are addressed in this section.

### 3.5.3 Existing Conditions

Noise sensitive areas[25] in the study area include the DOT Act Section 4(f) resources addressed in Section 3.8 and some of the historic resources addressed in Section 3.7, including Brazos Island State Park, Boca Chica State Park, portions of the NHL, parts of the NWR, Boca Chica Village, and areas of Port Isabel and South Padre Island. Refer to Section 3.7 for a description of the historic resources that are noise sensitive areas, and Section 3.8 for a description of the Section 4(f) resources. Boca Chica Village is a small residential area, and it has 10 remaining residences; two homes are occupied full time and the remaining eight homes are seasonal or have been vacant in recent years. The village is located adjacent to SpaceX's production and manufacturing area and is subject to consistent industrial noise and intermittent, short periods of noise from testing and launches of Starship prototypes. Boca Chica State Park, portions of the NHL, parts of the NWR, and Boca Chica Village, which border SH 4, the VLA, or other areas of construction or operation (e.g., SpaceX's solar farm), currently experience intermittent and small increased sound levels from SpaceX daily operations and construction and transient, intermittent increases in sound levels for short durations during SpaceX test and launch operations.

Noise sensitive areas within Port Isabel and South Padre Island include schools, churches, cemeteries, and residences, among other receptors typically seen in urban areas. These areas experience transient, intermittent increases in sound levels for short durations during SpaceX test and launch operations, but no increase in noise from SpaceX's daily operations or construction. Cameron County does not have land use designations (FAA 2014a).

Existing sources of sound in the study area include vehicle traffic on SH 4, day-to-day SpaceX maintenance activities, construction activities, and Starship prototype launch and landing operations (including static fire engine tests and suborbital launches). As one moves away from the launch site, background sound levels are primarily driven by vehicle traffic on SH 4 and sound from the wind and ocean. Sound sources at Port Isabel and South Padre Island include vehicular and boat traffic and sound associated with commercial and residential land use. Industrial land use is also present in southwestern Port Isabel.

Background DNL values in the study area were estimated using American National Standards Institute/American Standards Association S12.9-2013/Part 3, which provides estimated background sound levels for different land use categories and population densities. Table 3-4 shows estimated DNL for rural or remote areas and several different categories of suburban and urban residential land use which can be used to represent DNL for the land uses in the study area. According to these daytime values, many of the remote areas would be expected to have a DNL less than 49 dBA, while urban areas would be expected to have a DNL as high as 59 dBA.

[25] A noise sensitive area is an area where noise interferes with normal activities associated with its use. Normally, noise sensitive areas include residential, educational, health, and religious structures and sites, and parks, recreational areas, areas with wilderness characteristics, wildlife and waterfowl refuges, and cultural and historical sites. (FAA Order 1050.1F, Paragraph 11-5.b(10)).

**Table 3-4. Estimated Background Sound Levels**

| Example Land Use Category | Average Residential Intensity (people per acre) | DNL (dBA) | Leq (dBA) | |
|---|---|---|---|---|
| | | | Daytime | Nighttime |
| Rural or remote areas | <2 | <49 | <48 | <42 |
| Quiet suburban residential | 2 | 49 | 48 | 42 |
| | 4 | 52 | 53 | 47 |
| | 4.5 | 52 | 53 | 47 |
| Quiet urban residential | 9 | 55 | 56 | 50 |
| Quiet commercial, industrial, and normal urban residential | 16 | 58 | 58 | 52 |
| | 20 | 59 | 60 | 54 |

Source: American National Standards Institute/American Standards Association S12.0-2013/Part 3
dBA = A-weighted decibels; Leq = equivalent sound level

## 3.5.4 Environmental Consequences

Per the FAA's Part 150 land use compatibility guidelines, noise impacts would be significant if the action would increase noise by DNL 1.5 dB or more for a noise-sensitive area that is exposed to noise at or above the DNL 65 dB noise exposure level, or that will be exposed at or above the DNL 65 dB level due to a DNL 1.5 dB or greater increase, when compared to the no action alternative for the same timeframe. For example, an increase from DNL 65.5 dB to 67 dB is considered a significant impact, as is an increase from DNL 63.5 dB to 65 dB. Section 3.5.4.5 discusses the results of KBR's DNL analysis.

Special consideration needs to be given to the evaluation of the significance of noise impacts on noise sensitive areas within DOT Act Section 4(f) properties (including, but not limited to, noise sensitive areas within national parks; national wildlife and waterfowl refuges; and historic sites, including traditional cultural properties) where the land use compatibility guidelines in 14 CFR part 150 are not relevant to the value, significance, and enjoyment of the area in question. For example, the DNL 65 dB threshold does not adequately address the impacts of noise on visitors to areas within a national park or national wildlife and waterfowl refuge where other noise is very low and a quiet setting is a generally recognized purpose and attribute. Refer to Section 3.8 for a discussion of the effects of noise, vibration, and sonic boom on these types of properties. Refer to Section 3.10 for a discussion of potential noise, vibration, and sonic boom effects on wildlife.

### 3.5.4.1 Construction

The Proposed Action would result in short-term increases in noise from the use of heavy equipment during construction and modification of the launch site. SpaceX would conduct construction activities during normal working hours to the greatest extent possible; however, due to late arrival of construction supplies, launch critical work, or other unexpected events, there may continue to be construction during nighttime hours. Construction noise would be loudest at the site being developed, and adjacent areas would experience elevated noise levels. The closest populated area is Boca Chica Village. Sound levels at Boca Chica Village would be elevated during construction associated with the solar farm and any construction near the LLCC. Construction is expected to occur over 24 months; however, construction activities are not anticipated to be continuous during this time. As described in the 2014 EIS, noise impacts would vary widely, depending on the phase of construction and specific activities being undertaken. However, all construction related noise impacts would be of short duration. Consistent with the significance determination in the 2014 EIS for a project similar in scale to the

Proposed Action, and given the temporary and intermittent nature of construction, construction activities are not expected to result in significant noise impacts per the FAA's Part 150 land use compatibility guidelines. Refer to Section 3.8.4 for a discussion of the effects of noise, vibration, and sonic boom on Section 4(f) properties.

### 3.5.4.2 Static Fire Engine Tests

Starship and Super Heavy static fire engine tests are planned to occur with all 6 and 37 engines, respectively, firing for up to approximately 15 seconds. KBR modeled sound levels for static fire engine tests. The $L_{Amax}$ 90 dB contour for a Starship static fire engine test extends about 2.5 miles west of the launch site while the SEL 90 dBA contour extends about 7 miles west of the launch site to include some populated areas of Port Isabel and South Padre Island (see Figures 27 and 28 in KBR's report located in Appendix B). The $L_{Amax}$ 90 dBA contour for a Super Heavy static fire engine test extends about 4 miles west of the launch site while the SEL 90 dBA contour extends about 10 miles west of the launch site (see Figures 29 and 30 in KBR's report). To the east of the launch site, these contours for both Starship and Super Heavy extend much farther out due to the effects of modeling sound propagation over water compared with propagation over land to the west.

The 90 dBA $L_{Amax}$ contours for static fire engine tests overlap Brazos Island State Park, Boca Chica State Park, portions of the NHL, parts of the NWR, and Boca Chica Village. No residents (including Boca Chica Village residents) or members of the public would be near the VLA during a static fire engine test or experience noise levels above OSHA's 115-dBA threshold. Static fire events will last approximately 15 seconds. There would be up to 150 seconds per year of Starship static fire engine tests and up to 135 seconds per year of Super Heavy static fire engine tests. This amounts to approximately 10 Starship static fire engine tests per year and 9 Super Heavy static fire engine tests per year, or less than one Starship and one Super Heavy static fire engine test per month, or less than 30 seconds of static fire per month. For these reasons, the intermittent and temporary nature of this noise level resulting from a static fire engine test is not expected to be significant.

Residents of Brownsville may hear static fire engine tests above 60 dBA, and particularly at night, if onshore wind conditions favor sound propagation to the west. As noted in Section 2.1.3, static fire tests are not planned to occur at night.

### 3.5.4.3 Launch (Takeoff) Noise

KBR modeled sound levels for a Starship/Super Heavy orbital launch, which includes all 37 engines firing. The $L_{Amax}$ 90 dBA through 140 dBA contours shown in Figures 3 and 4 in KBR's report (Appendix B) represent the maximum levels estimated for each orbital launch; Figure 4 shows these contours using a zoomed in map scale to better show the extent of the noise exposure relative to cities located around the launch site. The higher $L_{Amax}$ contours (100–140 dBA) are located within approximately 7 miles of the launch site. A small portion of the southern portion of South Padre Island and Port Isabel is expected to experience close to $L_{Amax}$ 100 dBA. Laguna Vista, eastern parts of Brownsville, and eastern parts of Tamaulipas, Mexico are expected to experience close to $L_{Amax}$ 90 dbA. If a Starship/Super Heavy launch occurs during the day, when background levels are in the 50 dBA to 60 dBA range, residents of Brownsville and Harlingen may notice launch noise levels above 70 dBA and up to 90 dBA. If the same launch occurs during the night, when background levels are lower than during the day (e.g., below 40

dBA to 50 dBA range), these residents may notice launch noise levels that exceed 60 dBA. A prevailing on-shore or off-shore breeze may also strongly influence noise levels in these communities.

Figures 5 and 6 in KBR's report show estimated SEL contour levels of 90 dBA through 150 dBA for each orbital launch. The 100 dBA SEL contour is expected to extend west into Brownsville and south into Tamaulipas, Mexico, and the 90 dBA SEL contour is expected to extend further west and north into Harlingen and Raymondville, and further southwest into Tamaulipas, Mexico.

The 90 dBA $L_{Amax}$ contour for launch operations overlaps Brazos Island State Park, Boca Chica State Park, portions of the NHL, parts of the NWR, Isla Blanca Park on South Padre Island, and Boca Chica Village. SpaceX would enforce the access restriction area during a launch, as discussed in Section 2.1.3.5. Isla Blanca Park is not within the access restriction area. Visitors at Isla Blanca Park during a launch would experience close to 100 dBA during an orbital launch and closer to 90 dBA during a suborbital launch. During an orbital launch, a portion of Tamaulipas, Mexico is within the 90 dBA $L_{Amax}$ contour. Therefore, some populated areas in Mexico would experience elevated sound levels.

No residents (including Boca Chica Village residents) or members of the public will experience above OSHA's 115-dbA threshold during an orbital launch. A portion of Port Isabel and a small portion of the southern part of South Padre Island (including Isla Blanca Park) are expected to experience close to 100 dBA during launch. Laguna Vista, eastern parts of Brownsville, and eastern parts of Tamaulipas, Mexico are expected to experience close to 90 dBA during an orbital launch. Peak launch noise events last 120 seconds at most at a single location. There are only five orbital launches per year resulting in 10 minutes of these maximum sound levels per year. Therefore, the intermittent and temporary nature of this noise level resulting from launch is not significant.

KBR also modeled noise levels for Starship suborbital launches. Refer to Section 3.2 of KBR's report. Sound levels during Starship suborbital launches would be less than Starship/Super Heavy orbital launches because fewer engines are used for suborbital launches.

### Structural Damage Potential

In general, structural damage to buildings due to launch noise is rare. This is due to the fact that sound pressure levels would have to be very high to excite building structural elements vibrationally to the point of damage. In addition, residential buildings are usually located at certain distances away from launch facilities which further reduce launch noise levels. Few studies are available which provide relationships between launch noise and actual building vibrational response. Theoretically, multi-second launch noise at a high sound pressure level could cause a different building response than a shorter transient event at a similar sound pressure level, but reliable and extensive datasets are not available to explicitly determine such responses.

The National Academy of Sciences' "Guidelines for Preparing Environmental Impact Statements on Noise" (National Academy of Sciences 1977) state that one may conservatively consider all sound lasting more than one second with levels exceeding 130 dB (unweighted) as potentially damaging to structures. A study of structural damage claims from rocket ground tests indicates that, based on Maximum Unweighted Sound Level ($L_{max}$), approximately one damage claim will result per 100 households exposed at 120 dB and one damage claim per 1,000 households exposed at 111 dB, but the study did not characterize the nature of the damage that may result from these claims (Guest and Slone 1972). That

study was based on community responses to 45 ground tests of the first and second stages of the Saturn V rocket system conducted in Southern Mississippi over five years in the 1960s. It is important to note that the sound levels collected were for static ground tests from rocket engines that were generally of greater durations than the exposure expected during a launch event. In addition, during ground tests, the engine remains in one position which results in a longer exposure duration to continuous levels as opposed to the transient noise occurring from the moving vehicle during a launch event. Therefore, as noted by Guest and Slone (1972), the $L_{max}$ values of 111 dB and 120 dB may be used as a very conservative threshold for potential risk of structural damage claims.

More recently, in 2016, the United Kingdom Ministry of Defense Land Ranges commissioned a study to ascertain whether test, evaluation, demilitarization, and training activities of items such as weapons systems, ordinance, and munitions (i.e., short duration, transient sound) would cause structural damage (Fenton and Methold 2016). Unlike the Guest and Slone study, the Fenton and Methold study developed criteria to assess the likelihood of structural damage (see Table 3-5). To create the criteria, the study reviewed previous similar studies, relevant British Standards, and academic literature, and it ultimately relied on the U.S. Bureau of Mines and British Industry Standards as key information sources. As indicated in the table below, there is consensus that damage becomes improbable below 140 dB. No glass or plaster damage is expected below 140 dB. No damage is expected below 134 dB.

**Table 3-5. Air Overpressure Thresholds for Damage Effects on Building Structure**

| Air Overpressure Threshold Scale[1,7] | | |
|---|---|---|
| **dB (lin)** | **Categorisation** | **Source** |
| 180[6] | Onset of structural damage | BS 6472, BS 5228 |
| 171[5] | General window breakage | USBM [34] |
| 170 | Most windows crack | BS 6472, BS 5228 |
| 160 | Cracking of pre-stressed or poorly mounted windows | BS 6472, BS 5228 |
| 151[4] | Some window breakage | USBM [41] |
| 150 | Pre-stressed or poorly mounted windows may crack | BS 6472, BS 5228 |
| 140[3] | Reasonable threshold to prevent glass and plaster damage | USBM [34] |
| 134[2] | USBM 'Safe' maximum | USBM [34] |
| 120 | Secondary vibration effects including rattling windows and objects | BS 6472, BS 5228, USBM [34] |
| <120 | No material effect | - |

**TABLE 5.3: AIR OVERPRESSURE THRESHOLDS FOR DAMAGE EFFECTS ON BUILDING STRUCTURE**

*Notes:*
*[1] – Compendium of advised thresholds from BSi and USBM sources.*
*[2] – USBM [34]. Level based on measurements with high pass filtering at 0.1 Hz. Precautionary advice for design of blasting, pre-supposes groundborne vibration components. Not recognised by BSi. Included for information.*
*[3] – USBM [34] – 'Despite the widely varied source characteristics, assumptions of damage probabilities and experimental design, and also the differing interpretations among the studies, there is a consensus that damage becomes improbable below approximately 140 dB'.*
*[4] - Perkins and Jackson (as cited in USBM [42]) – damage thresholds for 'poorly mounted glass under stress'*
*[5] – USBM [34] – 'Damage to properly mounted glass is reported to have occurred at overpressures of 170 dB to 172 dB, while none was observed at 167 dB to 168 dB'. Mean value of 171 adopted.*
*[6] – BS 6472 -2. 'Structural damage would not be expected at air overpressure levels below 180 dB(lin)'.*
*[7] – Shaded entries originate from primary sources of information and are recommended for application to the main study.*

KBR assessed the potential for structural damage due to orbital launch events. The $L_{max}$ 110 dB through 150 dB contours estimated for orbital launch events are shown in Figures 7 and 8 in KBR's report (see Appendix B). There are no third-party structures in the 150 dB contour, and with the exception of two historical resources, there are no third-party structures in the 140 dB contour. (The potential for structural damage to historic resources is addressed in Section 3.7 below.) Boca Chica Village is in the 130 dB contour. Starship/Super Heavy orbital launch events are estimated to generate $L_{max}$ of 120 dB approximately 8 miles from the launch pad, which includes Port Isabel and approximately 4 miles north of the southernmost point of South Padre Island, including the majority of the municipal boundary. The modeled 111 dB contour extends approximately 19 miles from the launch pad and includes Laguna Vista, an additional 11 miles of South Padre Island, the easternmost areas of Brownsville, and approximately 17 miles into Tamaulipas, Mexico.

Based on KBR's noise assessment and Table 3-5 above, no structural damage or significant impact to third-party structures is expected from launch operations. Using the conservative numbers from Guest and Slone (1972), it is possible there could be damage claims for structures in the 111 dB and 120 dB contours. However, because Guest and Slone did not characterize damage, it is expected that any

damage would be similar to that characterized at the 140 dB level by Fenton and Methold, which is minor.

It should be noted that it is not uncommon for individuals to report concern about the potential for structural damage to property because the onset for annoyance due to noise and/or vibration in the human population occur at much lower magnitudes than those established for the onset of potential structural damage. It is possible that concerns or claims reported may be invalid because damage was the result of other factors (e.g., building settling) or the damage was only perceived and did not manifest. For example, in the Guest and Slone study, only 20 percent of damage claims between 110 dB and 120 dB were judged valid and consequently paid.

#### 3.5.4.4 Landing Noise

KBR modeled sound levels for Super Heavy booster and Starship landings at the VLA during orbital missions. Sound levels during landing events would be less than sound levels during an orbital launch due to the much lower total engine thrust and burn time used for landing operations.

For Super Heavy landings, Port Isabel is expected to experience approximately 90 dBA $L_{Amax}$ and the southern portion of South Padre Island is expected to experience approximately 90–95 dBA (see Figures 21 and 22 in KBR's report). All other populated areas are expected to experience 90 dBA or below. Residents of Brownsville may hear booster landing events above 60 dB, particularly during nighttime landings. Noise during offshore Super Heavy landing events is not expected to be noticed by residents along the coast (see Figures 25 and 26 in KBR's report).

For Starship orbital landings at the VLA, a portion of Port Isabel and the southern part of South Padre Island are expected to experience 90 dBA $L_{Amax}$ (see Figure 13 in KBR's report). Residents of Brownsville may notice levels above 60 dB $L_{Amax}$ especially for nighttime landing events. Noise during downrange offshore Starship landing events is not expected to be noticed by residents along any coast (see Figures 15 and 16 in KBR's report).

KBR also modeled sound levels for Starship landings during suborbital launches. A small portion of Port Isabel and a small portion of the southern part of South Padre Island are expected to experience 90 dB $L_{Amax}$. All other populated areas are expected to experience below 90 dBA $L_{Amax}$ (see Figures 17 and 18 in KBR's report). Residents of Brownsville may notice levels above 60 dB $L_{Amax}$ especially for nighttime landing events. Noise during downrange offshore Starship landing events would be similar in levels as the VLA landings.

Similar to launch, the 90 dBA $L_{Amax}$ contours for landing operations overlaps Brazos Island State Park, Boca Chica State Park, portions of the NHL, parts of the NWR, Isla Blanca Park on South Padre Island, and Boca Chica Village. SpaceX would enforce the access restriction area during a launch, as discussed in Section 2.1.3.5. Isla Blanca Park is not within the access restriction area. Visitors at Isla Blanca Park during a landing event would experience close to 90 dBA. Some populated areas in Tamaulipas, Mexico would experience elevated sound levels.

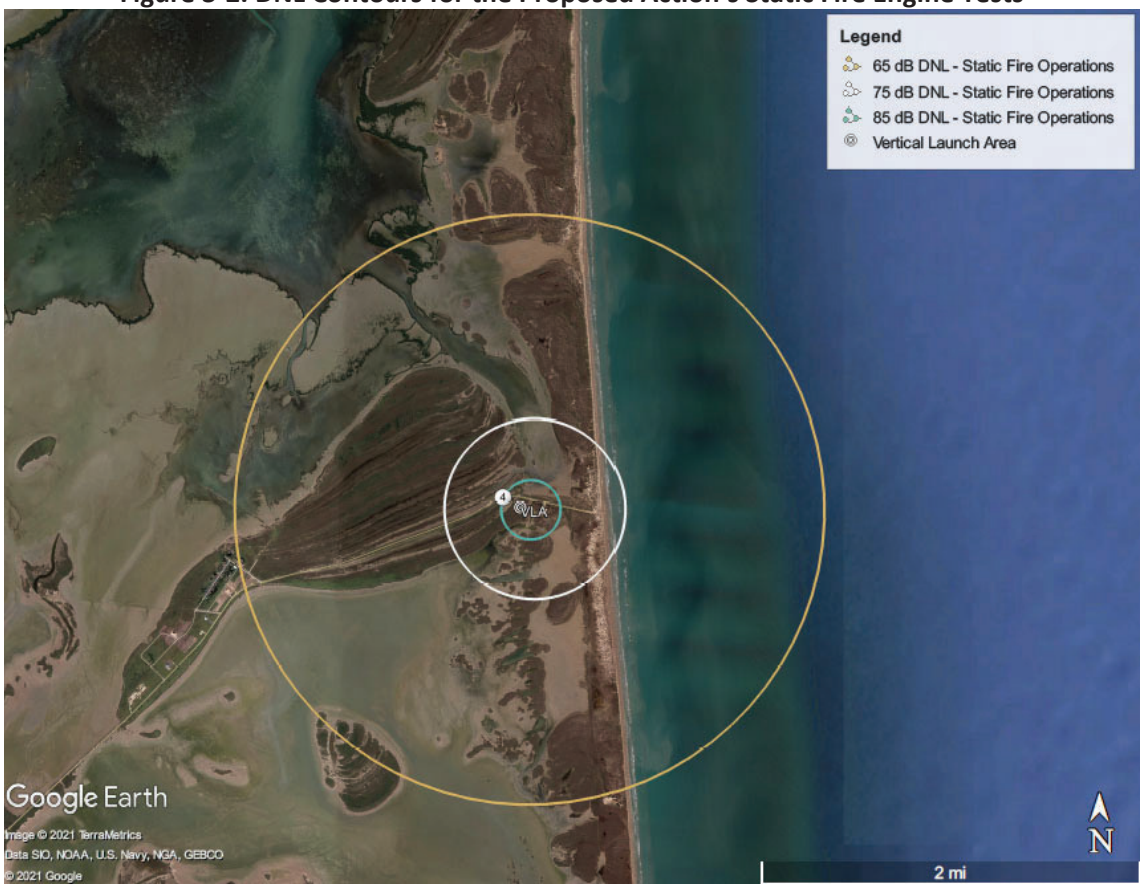
No residents (including Boca Chica Village residents) or members of the public would experience above OSHA's 115 dBA-threshold during landing operations. Port Isabel and the southern part of South Padre Island (including Isla Blanca Park) are expected to experience 90–95 dBA $L_{Amax}$ during landing operations.

Noise on landing is expected to last approximately 1 minute and the peak exposure for a single location will last approximately 20 seconds. Therefore, the intermittent and temporary nature of the noise levels resulting from landing are not expected to be significant.

### 3.5.4.5 Cumulative Noise Levels for Starship/Super Heavy Launch Operations

Though an operational access restriction would be in place, Boca Chica Village is not expected to be cleared of residents during any static fire engine tests. SpaceX estimated DNL for proposed static fire engine tests to assess whether village residents would be exposed to significant noise impacts, per the FAA's noise significance threshold identified above. This DNL calculation does not include launch and landing operations, because residents would not be present in the village during those operations. The predicted DNL 65 contour for static fire engine tests is located about 1.5 miles west of the VLA entirely in areas that are unpopulated and east of the village (Figure 3-2).

**Figure 3-2. DNL Contours for the Proposed Action's Static Fire Engine Tests**

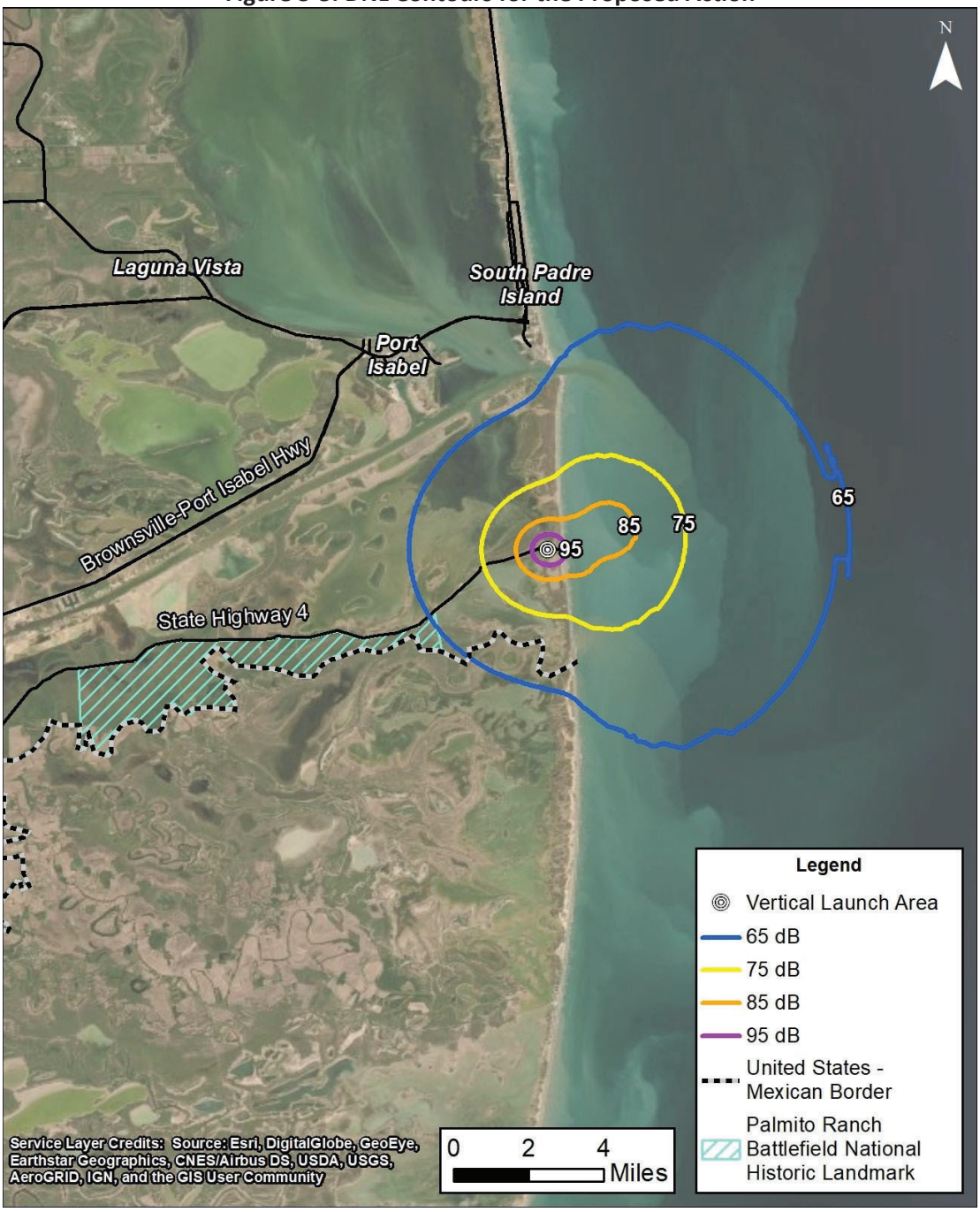



KBR estimated cumulative noise levels (DNL) for projected launch, landing, and static fire engine test operations shown in Table 2-2. Figure 3-3 below shows the estimated DNL contours for these operations. DNL is intended to measure the effect of cumulative sound on humans. The DNL 65 contour for the Proposed Action is located within about 4 miles of the VLA entirely in areas that are unpopulated, except for Boca Chica Village. SpaceX would enforce the access restriction area during launch operations, as discussed in Section 2.1.3.5. Thus, no visitors or village residents would be present

at noise sensitive areas within the 4-mile radius, and therefore, there would be no noise impacts to visitors.

In summary, noise from individual launch, landing, and static fire engine test events is expected to be heard by people in the surrounding communities, including Brownsville, Laguna Vista, Port Isabel, and South Padre Island. These individual noise events are not expected to cause general annoyance or pose health concerns due to the sound levels and expected frequency of events, though noise complaints may occur. Cumulative noise in these surrounding communities, whether from multiple events of a single operation type or from all these individual events combined, is estimated to be below levels associated with adverse noise exposure. Therefore, the Proposed Action is not expected to result in significant noise impacts. Because DNL is intended to measure the cumulative effect of sound on humans and no humans will be present in the DNL 65 contour during launch or landing operations, there will be no significant impact to humans. Noise-sensitive areas within the 65 DNL contour include Boca Chica State Park, a portion of the NWR, a small portion of the NHL, and a small portion of the South Bay Coastal Preserve. As explained above, there is less than 30 seconds of static fire engine tests per month, less than ten minutes of peak orbital launch noise per year, and any sonic booms from orbital landings are 300 milliseconds (there would be no sonic booms from suborbital landings). As such, noise will be intermittent, of short duration, and temporary, and therefore the Proposed Action would not result in significant impacts to these noise sensitive areas.

**Figure 3-3. DNL Contours for the Proposed Action**




### 3.5.4.6 Sonic Booms

A sonic boom is the sound associated with the shock waves created by a vehicle traveling through the air faster than the speed of sound. A sonic boom trace is an impulsive event that lasts for less than 300 milliseconds. A sonic boom would be generated during vehicle ascent, but it would not impact land areas. A sonic boom would also be generated during Starship and Super Heavy landings as the vehicle approaches the landing location. SpaceX used PCBOOM to estimate single event sonic boom levels

during Starship and Super Heavy descent. SpaceX's sonic boom analysis via PCBOOM is located at the end of Appendix B.

For suborbital launches, Starship would not reach supersonic speed during descent towards the VLA and therefore would not generate a sonic boom. Starship landings that occur downrange in the Gulf of Mexico during a suborbital launch may create a sonic boom; however, the sonic boom would not impact land, because the landing would be at least 19 miles offshore. For Starship/Super Heavy orbital launches, the vehicle will reach supersonic speeds during ascent, but the sonic booms would impact areas more than 19 miles offshore.

Figures 1 and 2 in the SpaceX's sonic boom analysis (Appendix B) show sonic boom contours for a Starship orbital landing and Super Heavy landing, respectively, at the VLA. Predicted overpressure levels for a Starship orbital landing at the VLA range from 1.2 to 2.2 pounds per square foot (psf). The 2.2 psf contour is estimated to be offshore and not impact land. Overpressures between 2 and 1 psf are predicted to impact the southern part of South Padre Island. Port Isabel, Brownsville, and Mexico are not predicted to be impacted by Starship sonic booms.

Predicted overpressure levels for a Super Heavy landing at the VLA range from 2.5 psf to 15 psf. A very small area of Boca Chica State Park to the south of the VLA is predicted to experience up to 15 psf. A small portion of Brazos Island State Park and portions of Boca Chica State Park is predicted to experience levels of 11–15 psf. Public access to Boca Chica State Park, portions of the NWR, and Brazos Island State Park would be restricted during launch and landing operations (see Section 2.1.3.5). Boca Chica Village is predicted to experience 9 psf. The southern portion of South Padre Island is predicted to experience 6 psf and Port Isabel and Laguna Heights are expected to experience 4–6 psf. The remainder of South Padre Island is expected to experience between 2–4 psf, and Laguna Vista and Tamaulipas, Mexico is expected to experience 2 psf.

For a Super Heavy booster landing in the Gulf of Mexico, predicted overpressure levels range from 0.2 psf to approximately 12 psf. The modeled sonic boom footprint for this scenario is entirely over water. People, such as oil rig workers, located within about 20 miles of a Gulf of Mexico landing site are expected to hear the sonic boom. People working in the vicinity of the floating platform during a landing are likely to be startled, although they would be expecting the sonic boom. SpaceX would notify the oil rig workers within the anticipated area of the sonic boom impact area or if they were inside the NOTMAR of the planned launch activity and expected a sonic boom.

For Starship landings in the Pacific Ocean, following an orbital mission, predicted overpressure levels are up to 2 psf. The modeled sonic boom footprint is entirely over water for the landing location 62 nautical miles north of Kauai, Hawaiian Islands. Given the distance from land, no damage to structures is expected.

The following paragraphs discuss potential sonic boom impacts in terms of human annoyance and structural damage. Impacts to species, noise-sensitive resources, and historic resources are further discussed separately below in their respective sections.

In general, sonic booms in the 0.2 to 0.3 psf range could be heard by someone who is expecting them and listening for them, but usually would not be noticed. Sonic booms of 0.5 psf are more likely to be noticed, and sonic booms of 1.0 psf and above are certain to be noticed (1 psf is similar to a clap of

thunder). Sonic booms of 1 to 2 psf are produced by supersonic aircraft flying at normal operating altitudes.

Cumulative sonic boom levels were converted to a C-weighted DNL (CDNL) to allow for comparison to FAA's significance threshold in DNL.[26] Populated areas on a portion of South Padre Island would not be exposed to overpressures above 2.5 psf during Starship landings at the VLA or up to 6 psf during Super Heavy landings at the VLA. The cumulative 2.5 psf and up to 6 psf contour for sonic booms is approximately equivalent to CDNL 54, which is less than FAA's significance threshold for noise. SpaceX would provide public notice of upcoming Starship and Super Heavy landings to educate the public about the expected sonic boom, which would help reduce startle reactions to these noise events. Sonic booms generated during downrange landings in the Gulf of Mexico would not impact land.

Table B-1 in Appendix B shows the range of possible types of structural damage at increasing sonic boom overpressure values. The location of maximum overpressure from a sonic boom would vary with weather conditions, and landings at the VLA are limited to 5 per year (some of which are expected to be downrange); thus, it is unlikely that any given location would experience the maximum estimated level of overpressure more than once over multiple events. Windows and plaster are the most sensitive parts of a structure to overpressure (National Academy of Sciences 1977). In general, the threshold for building damage due to sonic booms is 2 psf (Haber and Nakaki 1989), below which damage is unlikely. At 10 psf, the probability of glass breakage is between one in 100 and one in 1,000. Laboratory tests involving glass (White 1972) have shown that properly installed window glass will not break below 10 psf, even when subjected to repeated booms.

As noted above, there are no structures in the 10 psf contour for sonic booms for Starship/Super Heavy landings. Structures in Boca Chica Village, South Padre Island, Port Isabel, and the Port of Brownsville are predicted to experience sonic booms in the 4 psf to 6 psf range. However, given the limited number of Super Heavy landings per year (some of which would be in the ocean and cause no overpressure on land) and the mitigation described in Section 3.5.5, including SpaceX's responsibility for claims of structural damage pursuant to FAA-required insurance, impacts to structures below 10 psf are not expected to be significant. A portion of South Padre Island would experience 2 psf from Starship landings and structural damage is expected to be rare with only minor impacts such as glass breakage if it does occur. No impacts to humans other than a startle response are expected to occur during Starship and Super Heavy landings.

#### 3.5.4.7 Airspace Closures

Airspace closures associated with the Proposed Action could result in temporarily grounded aircraft at affected airports and re-routing of en-route flights on established alternate flight paths. As noted above, the FAA has rarely received reportable departure delays associated with commercial space transportation launches.

Aircraft could be temporarily grounded if airspace above or around the airport is closed. Ground delays are also used under some circumstances to avoid airborne reroutes. If aircraft were grounded, noise levels at the airport could temporarily increase if the planes sit idle; some aircraft would likely shut

[26] C-weighting is preferred over A-weighting for impulsive noise sources with large low-frequency content such as sonic booms.

down engines altogether until the closure has lifted. Also, depending on the altitude at which aircraft approach an airport, there could be temporary increases in noise levels in communities around the airports. Aircraft would travel on existing routes and flight paths that are used on a daily basis to account for weather and other temporary restrictions. Launch and reentry missions would not affect the same aircraft routes or the same airports, and re-routing associated with launch-related closures represents a small fraction of the total amount of rerouting that occurs from all other reasons in any given year. Any incremental increases in noise levels at individual airports would only last the duration of the airspace closure on a periodic basis and are not expected to meaningfully change existing day-night average sound levels at the affected airports and surrounding areas. Therefore, airspace closures due the Proposed Action are not expected to result in significant noise impacts.

### 3.5.5 Mitigation and Monitoring

The FAA would ensure that SpaceX uses its notification plan to educate the public and announce when a launch or landing event would occur. Announcements of upcoming Starship/Super Heavy launches and landings would serve to warn people about these noise events and would likely help reduce human adverse reactions to these noise events. The plan would involve issuing statements to news outlets and law enforcement so that when noise is heard, the public would understand what has occurred. This approach is consistent with the public notification efforts conducted by SpaceX at CCSFS and VSFB. While the overall impact of sonic booms would not be significant, SpaceX's advance public notice would help reduce human adverse reactions. SpaceX would be responsible for resolving any structural damage caused by a sonic boom.

Per FAA regulations and the Commercial Space Launch Act, SpaceX is required to carry insurance to cover claims by third parties that result from licensed activities, including any structural damage. The FAA requires that SpaceX carry insurance in the amount of the "Maximum Probable Loss," which is determined on a launch-by-launch basis by the FAA and is up to $500,000,000 per launch. In the event that structural damage results from noise-induced vibrations or sonic booms, any such claims of damage would be subject to the insurance policy terms and process specified by the Commercial Space Launch Act and FAA regulations.

## 3.6 Visual Effects

### 3.6.1 Definition of Resource and Regulatory Setting

Visual effects deal broadly with the extent to which the project would either: 1) produce light emissions that create annoyance or interfere with activities; or 2) contrast with, or detract from, the visual resources and/or the visual character of the existing environment. Visual effects can be difficult to define and assess because they involve subjectivity. Proposed aerospace actions do not commonly result in adverse visual effects, but these effects may occur in certain circumstances.

For clarity and uniformity, visual effects are broken into two categories: 1) light emission effects; and 2) visual resources and visual character. *Light emissions* include any light that emanates from a light source into the surrounding environment. Examples of sources of light emissions include lighting to support nighttime commercial space launches and light generated from such launches. Glare is a type of light

emission that occurs when light is reflected off a surface (e.g., window glass, solar panels, or reflective building surfaces). *Visual resources* include buildings, sites, traditional cultural properties, and other natural or manmade landscape features that are visually important or have unique characteristics. In unique circumstances, the nighttime sky may be considered a visual resource. *Visual character* refers to the overall visual makeup of the existing environment where the project would be located. For example, areas in close proximity to densely populated areas generally have a visual character that could be defined as urban, whereas less developed areas could have a visual character defined by the surrounding landscape features, such as open grass fields, forests, mountains, deserts, etc.

Some visual resources are protected under federal, state, or local regulations. Protected visual resources generally include, but are not limited to, federal, state, or local scenic roadways/byways; Wild and Scenic Rivers; National Scenic Areas; scenic easements; trails protected under the National Trails System Act or similar state or local regulations; biological resources; and features protected under other federal, state, or local regulations.

Although there are no federal special purpose laws or requirements specific to light emissions and visual effects, there are special purpose laws and requirements that may be relevant. Laws protecting resources that may be affected by visual effects include Section 106 of the NHPA, DOT Act Section 4(f), the Wild and Scenic Rivers Act, the CZMA, and state and regional coastal protection acts. More information about visual resources and visual effects can be found in Chapter 13 of the FAA Order 1050.1F Desk Reference (FAA 2020d).

## 3.6.2 Study Area

The study area for visual resources is a 10-mile area centered at the VLA. This is the same study area as defined for cultural resources, which corresponds to the Area of Potential Effects (APE) for architectural resources protected under Section 106 of the NHPA (refer to Section 3.7 for more information on cultural resources and Appendix C for an APE figure).

## 3.6.3 Existing Conditions

### 3.6.3.1 Light Emissions

Sources of light emissions in the study area include launch site lighting, nighttime launch events, residences along SH 4 (including Boca Chica Village), SpaceX's production and manufacturing area, SpaceX employee/customer parking lighting, airborne and ground-based aircraft operations, and roadway lighting. Other sources of light emissions include glare from existing surfaces of structures and launch vehicles at the Boca Chica Launch Site, lights on South Padre Island and the Port of Brownsville to the north, and the oil rigs in the Gulf of Mexico to the east.

### 3.6.3.2 Visual Resources and Visual Character

The Boca Chica Launch Site is surrounded by several private and public industries, including the SpaceX production and manufacturing facility, the Port Isabel airport, the Brownsville airport, the Port of Brownsville, the City of Port Isabel, San Roman Wind Farm, and South Padre Island and associated municipalities. Boca Chica Village now includes support infrastructure for employees and contractors,

such as housing, a restaurant, and offices for the SpaceX production and manufacturing facility. Infrastructure from these industrial areas, including large high rises on South Padre Island, tall container cranes and industrial infrastructure at the Port of Brownsville, wind turbines at the wind farm, and aircraft are visible from the study area. Notable visible structures at and near the launch site include the Stargate facility (which houses the LLCC), the solar farm area, infrastructure at the VLA (including vertical tanks up to 120 feet tall), and structures at SpaceX's production and manufacturing area (including the 260-foot-tall Highbay 1, the 325-foot Highbay 2, and the 145-foot-tall midbay.

The remainder of the study area includes no built structures and can be characterized as having high visual sensitivity. Viewers along SH 4, at the NWR, and at the adjacent parks may have a high sensitivity to change (i.e., change would be perceptible) given the high natural harmony and lack of built environment outside of the infrastructure described above.

Visual resources within the study area include sensitive wildlife species and habitat, coastal resources, Section 4(f) resources, and historic properties. For more information on the characteristics of these resources, see Sections 3.10 (wildlife species and habitat), 3.11 (coastal resources), 3.8 (Section 4(f) resources), and 3.7 (historic properties).

The landscape is analyzed from SH 4, where it is safe to pull over, because that is the vantage point from which most observers would view it (refer to Appendix F for photos of the area). The landscape near the VLA is panoramic in nature with broad expansive views and few visual intrusions. Views to the north of the VLA (Figure A in Appendix F) include the tall, rectangular, blocky forms and straight lines of the buildings on South Padre Island and the undulating lines of the dunes in the background. Cylindrical forms and straight lines of the historic Palmetto and Cypress Bridge Pilings and the gently undulating lines of Boca Chica Bay are visible in the middle ground. In the foreground, the irregular forms of the vegetation (palm trees and low shrubs) and straight lines of a concrete house foundation are present.

Views to the south of the VLA (Figure B in Appendix F) are broad and open with few to no forms present on the landscape other than irregularly shaped palm trees and low shrubs. Lines are horizontal and straight and formed largely by the horizon. Views to the west (Figure C in Appendix F) include the low, rectangular forms of the houses, the triangular and domed forms of the trees, the linear forms of the tall towers and the wide, rectangular production buildings in the background, and the cylindrical forms of the Palmetto and Cypress Bridge Pilings in the middle ground. Views to the east (Figure D in Appendix F) include the triangular and trapezoidal forms of the dunes, and the square, blocky form of the service station/bait shop, and the vertical, linear form of the telephone poles. Eichorn Boulevard and SH 4 create sharp, straight lines.

### 3.6.4 Environmental Consequences

The FAA has not established a significance threshold for light emissions or visual resources/visual character. Factors to consider when assessing the significance of potential visual effects include the degree to which the action would have the potential to:

- Create annoyance or interfere with normal activities from light emissions;
- Affect the visual character of the area due to the light emissions, including the importance, uniqueness, and aesthetic value of the affected visual resources.

- Affect the nature of the visual character of the area, including the importance, uniqueness, and aesthetic value of the affected visual resources;
- Contrast with the visual resources and/or visual character in the study area; and
- Block or obstruct the views of visual resources, including whether these resources would still be viewable from other locations.

Potential visual impacts to the landscape in the study area include glare from the proposed infrastructure and Starship/Super Heavy launch vehicles at the Boca Chica Launch Site and light emissions during nighttime launch and testing operations. SpaceX would not be able to avoid some nighttime light emissions. During nighttime construction, SpaceX would use spotlights to illuminate areas under construction to maintain safe lighting levels for workers (see Figures K–M in Appendix F). This lighting is expected to be visible along SH 4 approximately five miles away and not visible ten miles away (see Figures H and J in Appendix F). Additionally, when the launch vehicle is at the VLA at night, SpaceX would use spotlights to illuminate the vehicle for worker safety. All of SpaceX's lighting at the VLA would comply with SpaceX's Lighting Management Plan, which was originally developed in collaboration with the NPS, USFWS, TPWD, and THC, and is currently being revised in collaboration with these agencies as part of the NHPA Section 106 consultation process. This plan will include measures that are intended to reduce nighttime lighting impacts in the surrounding areas and minimize sky glow. Measures to minimize lighting impacts include directing, shielding, or positioning lighting to avoid visibility from the beach, minimize lateral light spread, and decrease uplighting; turning off lights when not needed; using low-pressure sodium to the extent practicable; installing lighting with multiple levels of control (i.e., some, all, or none of the lights can be turned on); and installing lighting timers where appropriate. Adherence to this plan, existing preclusion of nighttime visitors to the NWR and Boca Chica State Park, and presumably low nighttime visitation to the nearby state parks and NHL (see Figure 3-4) would minimize the potential for annoyance or interference from light emissions and potential effects on the visual character of the area.

Given the location of the Boca Chica Launch Site, the towers and crane would be visible to visitors of the state parks, NWR, NHL, and South Padre Island (a major beach destination) (see images in Appendix F) from certain distances and vantage points. SpaceX would construct two permanent integration towers, approximately 480 feet tall, adjacent to the launch mount for vertical integration of the rocket at each pad. A 450-foot-tall crane would be present at the VLA and would remain at that height at most times. When on the launch pad, the integrated Starship/Super Heavy would be approximately 450 feet above ground level.

Figures E–G in Appendix F depict visual simulations of the proposed integration towers and Starship/Super Heavy on the launch pads. Figure E shows the view from a nearby location on Boca Chica Beach dunes; Figure F shows the view from the Palmetto Pilings Historical Marker along SH 4, which is within Boca Chica State Park; Figure G shows the view from a nearby location in the NWR; and Figure I shows the view from the NHL. As shown in Figure I in Appendix F, the Boca Chica launch site is not visible 10 miles away. SpaceX has developed an area near Boca Chica Village for its production and manufacturing activities, including the addition of numerous tall structures and facility lighting. Figure C in Appendix F shows structures at SpaceX's production and manufacturing area (as viewed from the VLA, which is approximately two miles away), which are visible from SH 4. The proposed infrastructure

analyzed in this PEA would look similar to the existing infrastructure from a distance (e.g., high rises on San Padre Island, SpaceX's production and manufacturing facilities), to the extent that such existing infrastructure was in the viewshed, and would not contrast with the visual character of the study area.

The Starship/Super Heavy launch vehicle and proposed infrastructure, plus temporary construction equipment, at the VLA would be visible from some vantage points along SH 4 (the primary travel route to the launch site). The proposed infrastructure would be hardly visible and indistinguishable from the existing infrastructure at 5 miles away, to the extent that such existing infrastructure was in the viewshed, and would not be visible 10 miles away. The addition of tall new structures, such as the integration towers and the launch vehicle, may affect the nature of the visual character of the area, including the uniqueness and the aesthetic value of the nearby public lands, by adding tall structures to the landscape, but the impact is not expected to be significant.

SpaceX operations under the Proposed Action would have little to no impact on the light emissions in the area during daylight hours. Nighttime launch operations and construction would result in higher levels of light emissions than when the VLA is not under construction or in operation; however, SpaceX would minimize these impacts through compliance with its Lighting Management Plan.

In summary, the Proposed Action is not expected to result in significant visual impacts so long as the mitigation measures identified below are implemented.

### 3.6.5 Mitigation and Monitoring

The FAA would ensure that SpaceX implements the following measures to minimize visual effects:

1. Management of Launch Site Lighting
    a. Exterior lights used expressly for safety or security purposes are limited to the minimum number and configuration required to achieve their functional roles.
    b. Minimization measures include directing, shielding, or positioning lighting to avoid visibility from the beach, minimize lateral light spread, and decrease uplighting; turning off lights when not needed; using low-pressure sodium to the extent practicable; installing lighting with multiple levels of control (i.e., some, all, or none of the lights can be turned on); and installing lighting timers where appropriate.
    c. SpaceX will issue annual notices to all complex personnel prior to sea turtle nesting season reminding personnel of light use requirements and responsibilities.
2. Monitoring Launch Site Lighting
    a. To minimize lighting impacts to sea turtles, SpaceX will monitor its lighting. This monitoring will be conducted to verify SpaceX's compliance with the SpaceX Boca Chica Launch Site Lighting Management Plan.
    b. A qualified biologist will conduct lighting inspections to eliminate unnecessary lighting before nesting season and weekly during the nesting-hatching season (March 15th to October 1st) and send the results of the inspections to the FAA.
    c. SpaceX will conduct evening inspections between 9:00 p.m. and 5:00 a.m. monthly during sea turtle nesting season.

d. Data from monitoring and unannounced inspections, as well as any compliance issues and remedies, will be summarized in SpaceX's annual monitoring report, per the requirements of the USFWS's BO.

# 3.7 Cultural Resources

## 3.7.1 Definition of Resource and Regulatory Setting

Cultural resources encompass a range of sites, properties, and physical resources relating to human activities, society, and cultural institutions. Such resources include past and present expressions of human culture and history in the physical environment, such as prehistoric and historic archaeological sites, structures, objects, and districts that are considered important to a culture or community. Cultural resources also include aspects of the physical environment, namely natural features and biota that are a part of traditional ways of life and practices and are associated with community values and institutions.

The major law that protects cultural resources is the NHPA. Cultural resources listed on or determined eligible for the National Register of Historic Places (NRHP) are properly known as historic properties. Section 106 of the NHPA requires a federal agency to consider the effects of its action (referred to as the *undertaking*[27]) on historic properties. The Section 106 process is outlined in 36 CFR Part 800, as amended August 5, 2004. Compliance with Section 106 requires consultation with the SHPO, Tribal Historic Preservation Officer (THPO) and other interested parties, including Native American tribes. Major steps in the Section 106 process require identifying the Area of Potential Effects (APE),[28] identifying and evaluating any historic properties within the APE, and assessing the effect of the undertaking on any historic properties. If a historic property would be adversely affected by the undertaking, the Section 106 process includes continuing consultation to resolve adverse effects. More information about cultural resources can be found in Chapter 8 of the FAA Order 1050.1F Desk Reference (FAA 2020d).

## 3.7.2 Study Area

In accordance with 36 CFR § 800.4(a)(1), the FAA, in consultation with the SHPO, determined an APE in consideration of the undertaking's potential effects, and the APE was used as the study area (see Appendix C for an APE figure). In defining the APE, the FAA considered the potential visual, auditory, and vibrational effects from launches and daily operations, including engine noise and sonic booms, potential direct effects from ground-disturbing activities from potential anomalies and construction, increased traffic and visitors, and temporary access restrictions for launch operation or anomalies. The APE is a 10-mile area centered at the VLA. This area encompasses the area that is predicted to experience ground-disturbing activities and engine noise levels of at least 120 dB (linear). Sound pressure levels below 120 dB (linear) are considered to have no material effects on structures (Fenton

[27] *Undertaking* means a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency, including those carried out by or on behalf of a Federal agency; those carried out with Federal financial assistance; and those requiring a Federal permit, license, or approval. (36 CFR § 800.16(y))

[28] The APE is the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. (36 CFR § 800.16(d))

and Methold 2016). Within the APE (or study area), the FAA, in consultation with the SHPO, identified an archeological resources study area for the ground-disturbing activities, including construction activities and potential launch anomalies (see Appendix C for the archeological resources study area).

## 3.7.3 Existing Conditions

### 3.7.3.1 Architectural Resources

On behalf of SpaceX, SEARCH, Inc. (SEARCH) conducted an architectural resources survey to identify and document all buildings, structures, canals, ditches, bridges, and roads built before 1975 within the APE. The survey included Port Isabel, South Padre Island, and other points within the APE.

Previous architectural history surveys in support of the 2014 EIS (FAA 2014a) included documentation of resources within a 5-mile radius of the same general project location; therefore, the survey for the proposed undertaking did not include a re-assessment of any of the buildings or structures documented as part of the January 2013 survey (FAA 2013a), except review of potential resources within 5 miles of the VLA that had turned 50 years old since 2012 (buildings constructed between 1962 and 1970). Although the survey did not include new documentation of buildings previously surveyed, recommendations were revised, as needed, for any NRHP-eligible or NRHP-listed structures that may now be adversely affected by the proposed undertaking.

In total, SEARCH identified 20 previously recorded resources and 596 new resources in the APE. Two architectural resources are listed in the NRHP and were identified during the Section 106 consultation in 2012–2014. In accordance with Section 106 of the NHPA, on August 31, 2021, the FAA submitted SEARCH's survey results to the SHPO, the Executive Director of the THC and requested SHPO concurrence with properties meeting NRHP criteria. In a letter dated October 22, 2021, THC concurred that the following architectural resources are listed in or determined eligible for listing in the NRHP:

- Palmito Ranch Battlefield (41CF93)—listed in the NRHP in 1993 and designated as an NHL in 1997.
- Palmetto Pilings 1936 Centennial Historic Marker.
- Point Isabel Lighthouse (41CF10)—Listed in the NRHP in 1976 under Criterion A for Transportation and designated as a State Antiquities Landmark (SAL) in 1983.
- Queen Isabel Inn—Eligible for listing in the NRHP under Criterion A for Tourism and Economic Development and awarded an Official Texas Historic Marker (OTHM (Subject Marker)) in 1991.
- Alta Vista Apartments—Eligible for listing in the NRHP under Criterion A for Tourism and Economic Development and Criterion C for its architecture and designated as a Recorded Texas Historic Landmark in 1988.
- Charles Champion Building—Eligible for listing in the NRHP under Criterion A for Economic Development, Criterion B for its historic association with significant local businessperson Charles Champion, and Criterion C for its architecture, and awarded an OTHM (Subject Marker) in 1996.

- Port Isabel Cemetery—Eligible for listing in the NRHP under Criterion A for Ethnic History, Criterion C for its design, and Criterion D for its potential to yield important information about nineteenth-century Tejano and Mexican cultural groups, and meeting Criteria Consideration D for its age and distinctive design features. Port Isabel Cemetery was awarded an OTHM (Subject Marker) in 1990.
- Old Point Isabel Lighthouse 1936 Centennial Historic Marker—Eligible for listing in the NRHP under Criterion A for Social History and meeting Criteria Consideration F for Commemorative Properties.
- Queen Isabella Causeway (BC-AH1, SH 100 over the Laguna Madre)—Eligible for listing in the NRHP under Criterion A for Tourism and Economic Development and Criterion C for Engineering.
- Long Island Swing Bridge (BC-AH2, South Garcia Street over the Gulf Intracoastal Waterway)—Eligible for listing in the NRHP under Criterion A for Tourism and Economic Development and Criterion C for Engineering.

THC recommended in their letter to FAA dated October 22, 2021, that the following properties in the APE also be considered for NRHP eligibility:

- Point Isabel Coast Guard Building, Wallace L. Reed Road, South Padre Island. Constructed in 1923 and used by the U.S. Coast Guard until 1974, significant in the area of Maritime History and for its architecture. An OTHM (Subject Marker) was placed at the site in 1988.
- Port Isabel Firemen's Hall, 205 North Longoria Street, Port Isabel, pre-dates 1962, and may possibly date to the 1940s or earlier.
- Former Bahia Mar and Bahia Grande Condominiums, 6300 Padre Boulevard, South Padre Island. Constructed from 1972-1975, operated initially by a subsidiary of Braniff Airlines and designed by the firm of Swanson, Hiester, Wilson, and Claycomb. Significant in the area of Tourism and Economic Development.
- Former Sea Island Resort Hotel, 500 Padre Boulevard, South Padre Island. Opened circa 1960 and significant in the area of Tourism and Economic Development.
- Former Ship Café, 419–421 East Maxan Street, Port Isabel, likely dating to the 1930s or 1940s. The former Ship Café building represents a good, if modest, example of Spanish Colonial Revival commercial architecture.
- White Sands Motel, 418 West Highway 100, Port Isabel, likely constructed in the mid-1950s.

The remaining previously recorded historic resources within the APE are ineligible for inclusion in the NRHP or remain unevaluated for eligibility for inclusion in the NRHP.

A notable historic property within the APE is the Palmito Ranch Battlefield NHL. When an NHL is identified within an APE, 36 CFR § 800.10(a) requires the federal agency, to the maximum extent possible, undertake such planning and actions as may be necessary to minimize harm to the NHL that may be directly and adversely affected by the proposed undertaking. Furthermore, 36 CFR § 800.10(c) requires that the federal agency notify the Secretary of the Interior of any consultation that involves an

NHL and invite the Secretary to participate in the consultation where there may be an adverse effect to the NHL. The USFWS and NPS are consulting parties in the Section 106 consultation for the proposed undertaking.

The Palmito Ranch Battlefield was listed in the NRHP in 1993 and was designated an NHL in 1997. The 1997 NHL nomination included a detailed description of the cultural landscape of the 5,991-acre property. The NHL is a roughly 5-mile stretch of land that is the site of the final battle of the Civil War, fought on May 12-13, 1865, approximately 1 month after the signing of the peace treaty at Appomattox Courthouse, Virginia. The core battlefield (assigned Smithsonian Trinomial Number 41CF93) area is located at Palmito Ranch in the approximate center of the NHL. Also, within the boundaries of the NHL are a number of Civil War-era ranches including Tulosa Ranch, Palmito Ranch, White's Ranch, and Cobb's Ranch. These ranches are considered non-contributing to the historic significance of the NHL until further research is completed (NPS 1997).

A Civil War Union railroad camp located near Cobb's Ranch is considered a contributing resource to the historic significance of the NHL. The southern boundary of the NHL is the Rio Grande, and the northern boundary is SH 4. The western boundary of the NHL is a line extending southward to the Rio Grande from Loma Del Muerto. The eastern boundary of the NHL is a line extending southward to the Rio Grande from the westernmost tip of Vertolaga Lake (NPS 1997). The eastern boundary of the NHL lies approximately 3 miles west of the VLA. The setting and feeling of the Palmito Ranch Battlefield is little changed from what was present in 1865, with virtually no development occurring in the ensuing years. It is considered to still retain its integrity of setting, feeling, and association (NPS 1997). The NHL is listed in the NRHP under Criteria A and D of the NRHP Criteria for Evaluation (36 CFR § 60.4). The NHL is located on lands owned by the USFWS but is managed by the NPS.

### 3.7.3.2 Archaeological Resources

As part of the 2014 EIS, 69 acres were inventoried for archaeological resources (FAA 2013b). The archaeological survey resulted in the identification of one newly recorded historic site and 19 isolated finds. Additional details of these sites are provided in the EIS (FAA 2014a). In 2014 and 2017, metal detector surveys were conducted at the request of THC in support of expansions to the project area (FAA 2014c, 2017). No historic resources were identified by either survey.

Ten archaeological surveys have been conducted within 1 mile of the archaeological resources study area. Three of these surveys are directly adjacent to, or overlap, the study area. The survey conducted in 2012 (Atlas Number 8500068806) in support of the 2014 EIS overlaps portions of the proposed trenching area and highway pull-offs, and also abuts the proposed solar farm expansion area. Two linear surveys (Atlas Numbers 8400000852 and 8500079969) along Boca Chica Boulevard conducted in 2016 and 1999 overlap the proposed trenching area.

SEARCH conducted an inventory of previously recorded sites within the archaeological resources study area for the current undertaking by searching the Texas Historic Sites and Texas Archaeological Sites databases. SEARCH also conducted archaeological surveys that consisted of a combination of intensive pedestrian survey, systematic shovel testing, deep testing, metal detection, and magnetometer survey.

Given the proximity of Site 41CF117 (the Palmetto and Cypress Bridge Pilings) to the proposed parking lot area, SEARCH reassessed the southwestern boundary of the site. SEARCH also conducted a

systematic metal detection survey in the solar farm expansion areas based on the proximity of several previously identified Mexican War and Civil War-related archaeological sites. SEARCH conducted a systematic metal detection survey in the vicinity of 41CF117, including the extant 1846 pilings, the 1864-1865 pilings, and the associated surface scatter. SEARCH performed a shovel probe and auger survey on landforms characterized as having high to moderate sensitivity for containing buried archaeological resources. High sensitivity areas were defined as being Mesa del Gavilan and Boca Chica Beach; moderate sensitivity areas were defined as being the margins of Boca Chica inlet. Finally, SEARCH conducted a remote-sensing survey along the beachfront areas of the archeological study area using a near-shore magnetometer.

SEARCH also conducted a beach shipwreck magnetometer survey that identified 10 preliminary magnetic anomalies and 123 magnetic anomalies in the refined dataset. SEARCH investigated a total of 12 anomalies (preliminary and refined) via shovel testing and/or hand probing in an attempt to verify the source(s) of the magnetic anomalies. Of the 12 anomalies subjected to ground-truthing activities, SEARCH identified four anomalies (M001/PM001, M003, M026/PM002, and M088/PM003) that share characteristics with verified shipwreck magnetic signatures (e.g., spatial extent, general dipolar complexity with the main negative lobe oriented in the northern hemisphere, a main pole-to-pole declination of +/- 26 degrees from magnetic north, amplitude/duration ratio, duration, amplitude, and amplitude gradient). SEARCH ground-truthed anomalies (M001/PM001, M003, M026/PM002, and M088/PM003) and encountered no subsurface features or no cultural material.

Additionally, the Texas coast is a very dynamic environment, and the possibility exists for the presence of cultural material associated with discontinuous sites in the survey area. Information concerning identified signatures and patterns of distribution from discontinuous sites is lacking in the archaeological record. To test for the possibility of such resources in the survey area, SEARCH selected a sample of anomalies whose magnetic characteristics resemble single source debris objects. As there are no defined criteria established for the identification of discontinuous sites in the magnetic record, attributes for selected debris anomalies range and illustrate a cross-sample of magnetic signature types. SEARCH conducted ground-truthing activities at eight anomalies (M030/PM004, M31/PM005, M041/PM010, M057, M062/PM006, M106/PM007, M114/PM008, M123/PM009) as representative examples of single-source debris objects and encountered no subsurface features or no cultural material.

Based upon several characteristics of the magnetic anomalies and similarities to verified shipwreck magnetic signatures and proximity to a reported shipwreck, avoidance of Anomalies M001/PM001, M003, M026/PM002, and M088/PM003 by a distance of 50 meters (164 feet) from the outer edge of the refined magnetic anomalies must be maintained. Magnetic Anomalies M030/PM004, M031/PM005, M041/PM010, M057, M062/PM006, M106/PM007, M114/PM008, M123/PM009 do not share characteristics with verified shipwreck magnetic signatures (e.g., minimal spatial extent, general dipolar complexity with the main negative lobe oriented in the eastern hemisphere); however, its potential relationship to Magnetic Anomalies M001/PM001, M003, M026/PM002, and M088/PM003; the proximity to recorded beached shipwrecks; the proximity to charted shipwrecks with high locational accuracies; and the dynamic nature of coastal Texas warrant additional investigation should the source(s) of Magnetic Anomalies M001/PM001, M003, M026/PM002, and M088/PM003 prove to be a submerged cultural resource.

In accordance with Section 106 of the NHPA, on August 31, 2021, the FAA submitted SEARCH's archaeological survey results to the SHPO/THC. In a letter dated October 22, 2021, THC explained that the Palmetto and Cypress Bridge Pilings (41CF117) are considered by the THC and the Texas Archeological Research Laboratory to be a single trinomial. THC concurred components of 41CF117 are eligible for listing in the NRHP and as an SAL. THC concurred that the following sites are not eligible for the NRHP:

- 41CF124 appears to have been destroyed and therefore is not eligible for listing under federal or state designation.
- 41CF217 appears to have been destroyed and therefore is not eligible for listing under federal or state designation.
- 41CF238 is not eligible due its recent age, lack of historical or architectural significance, and lack of research potential.

While THC was not able to concur with the results of SEARCH's beach shipwreck magnetometer survey, for the purpose of the project, these locations should be considered sensitive areas that have the potential to contain shipwrecks. Such deeply buried sites can become exposed after storm conditions, such as nearby site 41CF125. As none of the sources of the targets were discovered, a recommendation for avoidance is required by TAC, Title 13, Part 2, Chapter 28, Rules §28.2, §28.6, and §28.9.

## 3.7.4 Environmental Consequences

The FAA has not established a significance threshold for cultural resources. Factors to consider when assessing the significance of potential impacts on cultural resources include whether the action would result in a finding of *adverse effect* through the Section 106 process. However, an adverse effect finding does not automatically trigger preparation of an EIS.

Potential effects on historic properties could result from visual, auditory, or vibration effects. Other potential effects could result from increased visitation and use of the area due to SpaceX's presence and, for some properties, potential effects from debris from anomalies. The FAA made a *finding of adverse effect* for 17 historic properties, because the effects could diminish the integrity of the properties, which is one of the criteria for listing on the NRHP. The adversely affected properties include the Palmito Ranch Battlefield NHL, Palmetto and Cypress Bridge Pilings, Palmetto Pilings Historical Marker, Queen Isabella Memorial Causeway, Long Island Swing Bridge, Queen Isabel Inn, Alta Vista Apartments, Point Isabel Lighthouse and THC Marker, Charles Champion Building, Port Isabel Cemetery, Del Mar, Point Isabel Coast Guard Building, Port Isabel Firemen's Hall, Former Bahia Mar and Bahia Grande Condominiums, Sea Island Resort Hotel, Former Ship Café Building, and White Sands Motel (Table 3-6).

**Table 3-6. NRHP-Listed and Eligible Cultural Resources Potentially Affected by the Proposed Action**

| Resource No. | Resource Name | Resource Type | NRHP Status | Effect (type of) |
|---|---|---|---|---|
| 41CF93 | Palmito Ranch Battlefield | Civil War battlefield | Listed; NHL | Adverse Effect (visual, visitation, addition of permanent industrial infrastructure) |

| Resource No. | Resource Name | Resource Type | NRHP Status | Effect (type of) |
|---|---|---|---|---|
| 41CF117 | Palmetto and Cypress Bridge Pilings | 1846 and 1864-1865 historic bridge pilings | Eligible | Adverse Effect (vibration, launch anomalies, visitation) |
| THC Marker No. 3917 (1936) | Palmetto Pilings Centennial Marker | 1936 stone historic marker | Eligible | Adverse Effect (vibration, launch anomalies, visitation) |
| BC-AH1 | Queen Isabella Memorial Causeway | 20th century bridge | Eligible | Adverse Effect (vibration) |
| BC-AH2 | Long Island Swing Bridge | 20th century swing span bridge | Eligible | Adverse Effect (vibration) |
| 5061004143 | Queen Isabel Inn | Early 20th century Inn | Eligible | Adverse Effect (auditory, vibration; visual) |
| 5061004143 | Alta Vista Apartments | Apartment building | Eligible | Adverse Effect (auditory, vibration; visual) |
| 2076002014 | Point Isabel Lighthouse | Lighthouse | Listed | Adverse Effect (auditory, vibration; visual) |
| | | THC Historical Marker | Eligible | Adverse Effect (vibration, visual, auditory) |
| 5507014006 | Charles Champion Building | 20th century general store, U.S. Customs House, and post office | Eligible | Adverse Effect (auditory/vibration; visual) |
| 7061008405 | Port Isabel Cemetery | Cemetery | Eligible | Adverse Effect (auditory, vibration; visual) |
| Not Applicable | Point Isabel Coast Guard Building | 1923 Coast Guard building | Potentially Eligible | Adverse effect (auditory, vibration; visual) |
| Not Applicable | Port Isabel Firemen's Hall | Ca. 1950s structure | Potentially Eligible | Adverse effect (auditory, vibration; visual) |
| Not Applicable | Former Bahia Mar and Bahia Grande Condominiums | Ca. 1975 condominiums | Potentially Eligible | Adverse effect (auditory, visual) |
| Not Applicable | Former Sea Island Resort Hotel | 1959 resort hotel | Potentially Eligible | Adverse effect (auditory, vibration; visual) |
| Not Applicable | Former Ship Café Building | 1940s café | Potentially Eligible | Adverse effect (auditory, vibration; visual) |
| Not Applicable | White Sands Motel | ca. 1950s motel | Potentially Eligible | Adverse effect (auditory, vibration; visual) |

## Auditory

Small increases in noise levels along SH 4, the north boundary of the NHL, would be expected from operation of delivery trucks, construction, and personnel vehicles. Increased noise levels would typically be greatest during commuting hours, although these periods would be of relatively short duration. The increased noise levels would be perceptible along the northern extent of the NHL that borders SH 4 but would decrease further to the south on the property. Noise from average daily operations traffic under the Proposed Action is unlikely to be perceptible in the core battlefield area, which is more than 0.5 mile from SH 4. The Palmetto and Cypress Bridge Pilings and Palmetto Pilings Historic Marker are also along SH 4 and so small increases in noise are expected at these sites. The noise would be temporary and of short duration (i.e., during construction or commuter hour). Therefore, noise from traffic associated with average daily operations would not result in adverse effects to the setting of the NHL or the Palmetto and Cypress Bridge Pilings or Palmetto Pilings Historic Marker. For all other historic objects, structures, and buildings, no increase in noise due to SpaceX daily operations or construction is expected. As such, no significant impact is expected from the Proposed Action's daily operational and construction noise.

Starship/Super Heavy launches (including landings and static fire engine tests) would produce a short-term noise impact on the historic sites, objects, structures, and buildings listed in Table 3-6. However, there would be no people at the NHL and Palmetto and Cypress Bridge Pilings or Palmetto Pilings Historic Marker during launch operations due to temporary access restrictions. In addition, a quiet setting is not a feature that qualifies the Queen Isabella Memorial Causeway or the Long Island Swing Bridge for protection under Section 106. For all other historic properties, the high sound levels produced during these launch operations would be short-term and temporary. At all other times, the quiet setting of the historic properties would persist. FAA Order 1050.1F indicates additional factors should be considered when determining the significance of noise impacts on noise sensitive areas within national parks. The NHL is within the DNL 65 dBA noise contour for the modeled launch event scenario shown in Figure 3-3. In the 2014 EIS, $L_{Amax}$ was used to examine noise impacts to the NHL based on the 115 dBA hearing conservation guidelines (FAA 2014a). Modeling for Starship/Super Heavy launch indicates that the 115 dBA hearing conservation would not be exceeded at the NHL (KBRwyle 2020). In addition, launches are limited to 5 times per year. For these reasons, no significant impact is expected from launch operational noise.

Pursuant to the Section 106 PA, and as agreed to by the consulting agencies, any adverse effects from auditory effects will be resolved through noise reduction of construction equipment and minimization of truck traffic noise, as described further below.

## Vibration/Sonic Boom

Vibration and sonic booms caused by launch operations may adversely affect the historic properties listed in Table 3-6, except the NHL. The Palmetto and Cypress Bridge Pilings and Palmetto Pilings Historic Marker would experience 140 dB and all other historic properties would experience between 111 dB and 120 dB. There were no contributing buildings or structures associated with the battlefield identified in the NHL nomination (Myers 1994); therefore, no adverse effects from damage by vibration are anticipated on the NHL.

As explained above in Section 3.5.4, there is consensus that damage becomes improbable below 140 dB. Glass or plaster damage is expected at 140 dB. No damage is expected below 134 dB. Using the conservative numbers from Guest and Slone (1972), it is possible there could be damage claims for structures in the 111 dB and 120 dB contours. However, because Guest and Slone did not characterize damage, it is expected that the damage subject to the claims would be similar to that characterized at the 140 dB in the Fenton and Methold study, which is minor. Buildings that are in a poor state of repair will tend to be more vulnerable to the possibility of damage arising from vibration, but as described below, SpaceX will monitor historic properties to identify potential for structural damage, stabilize resources that could be susceptible to damage, and repair any actual damage of the historic properties.

Super Heavy landings have the potential to create sonic booms that could cause structural damage to historic properties. Overpressure from these landings ranges from 1–15 psf. No historic buildings, structures, or objects would experience 15 psf. The Palmetto and Cypress Bridge Pilings and Palmetto Pilings Historic Marker would experience 11 psf. Queen Isabella Memorial Causeway, Long Island Swing Bridge, Alta Vista Apartments, Queen Isabel Inn, Point Isabel Lighthouse and THC Marker, Charles Champion House, Port Isabel Cemetery, Point Isabel Coast Guard Building, Port Isabel Firemen's Hall, Bahia Mar and Bahia Grande Condominiums, Former Sea Island Resort Hotel, Former Ship Café Building, and White Sands Motel would experience 2–4 psf. Table B-1 in Appendix B shows the range of possible types of structural damage at increasing sonic boom psf values. Windows and plaster are the most sensitive parts of a building to overpressure.[29] The location of maximum overpressure from a sonic boom would vary with weather conditions, and landings at the VLA are limited to 5 per year (some of which are expected to be in the ocean and not impact land), and so it is unlikely that any given location would experience the maximum estimated level of overpressure more than once over multiple events. As described below, SpaceX is undertaking several mitigation measures to monitor potential damage and repair of any actual damage resulting from vibrations or sonic booms.

Palmetto and Cypress Bridge Pilings Site and the Palmetto Pilings Historical Marker are the closest historic properties to the VLA (within 2,000 feet) and therefore have structural features that would be susceptible to noise-induced vibrations from launches. Potential damage could include displacement or breakage of the structural features of the pilings, cracking of the marker's foundation, or the marker toppling over. Thus, these historic properties may be physically damaged from vibrations caused by high sound levels, which was determined to be an *adverse effect* to the historic properties from vibration (FAA 2014a, FAA 2014b). Pursuant to the Section 106 PA and as agreed to by the consulting agencies, prior to the first orbital launch, SpaceX will hire a qualified professional to undertake a pre-launch condition assessment to take baseline vibration levels of these historic properties. The results will be used to develop a monitoring plan for the first launch event. If the assessment finds that the resources are likely to be damaged by any elevated levels of vibration, the qualified professionals will stabilize them following the Secretary of the Interior's Standards for the Treatment of Historic Properties so that historic fabric is not damaged and character-defining features are not altered. For the first five orbital launches, vibration will be monitored at the resources. This monitoring would determine whether dynamic events have caused any small incremental damage prior to noticeable damage. If the assessment determines that resources may be unlikely to withstand any elevated levels of vibration,

[29] The National Research Council on the "Guidelines for Preparing Environmental Impact Statements on Noise" (Committee on Hearing, 1977)

SpaceX will hire a qualified professional to make recommendations for the stabilization and protection of the resource. If permanent stabilization is necessary, it will be done following the Secretary of the Interior's Standards for the Treatment of Historic Properties and SpaceX will pay for the stabilization and protection. Given these conditions imposed in accordance with 36 CFR § 800.5(b), adverse effects would be resolved and there would be no adverse effects. Therefore, no significant impact is expected.

The Queen Isabella Memorial Causeway, Long Island Swing Bridge, Alta Vista Apartments, Queen Isabel Inn, Point Isabel Lighthouse and THC Marker, Charles Champion House, Port Isabel Cemetery, Point Isabel Coast Guard Building, Port Isabel Firemen's Hall, Former Bahia Mar and Bahia Grande Condominiums, Former Sea Island Resort Hotel, Former Ship Café Building, and White Sands Motel are also within range of possibly noise-induced vibration levels. The FAA has made a finding of *adverse effect* for these historic properties from vibration. Pursuant to the Section 106 PA and as agreed to by the consulting agencies, for the first five orbital launches, vibration will be monitored at the Port Isabel Lighthouse and two, three, and eight miles from the launch site to determine whether the lighthouse and other historic properties located further from the site could potentially be damaged. This monitoring would determine whether dynamic events have caused any small incremental damage prior to noticeable damage. If the assessment determines that historic properties may be unlikely to withstand any elevated levels of vibration, SpaceX will hire a qualified professional to make recommendations for the stabilization and protection of the resource. If permanent stabilization is necessary, it will be done following the Secretary of the Interior's Standards for the Treatment of Historic Properties and SpaceX will pay for the stabilization and protection. Given this monitoring and mitigation to ensure protection of the historic properties, no significant impact is expected.

### Visual

Some elements of the Proposed Action, such as the integration towers and the integrated launch vehicle, would be more visible than the existing structures due to their height. The taller infrastructure at the VLA has the potential to be seen from the distance from the historic properties listed in Table 3-6.

The Queen Isabella Memorial Causeway and Long Island Swing Bridge were built to serve vital transportation functions and possess the character-defining features of their respective bridge types. These character-defining features or the bridges' utilitarian purpose, however, does not relate to their viewshed along Laguna Madre. The FAA has found that the proposed project activities would have *no adverse visual effect* to the historic bridges' historic integrity. For these reasons, the FAA has determined there is no adverse visual effects to these properties and therefore no significant impact is expected.

The FAA determined that construction of permanent facilities and taller infrastructure at the VLA would result in *adverse effects* to the NHL. During the day, new VLA infrastructure 100 feet or taller would be visible to visitors at the NHL in parts of the property, but not from the core-battlefield area, which hosts the interpretive platform and is where the public visiting the battlefield would likely visit (see Figure I in Appendix F to the PEA). In addition, as illustrated in Appendix F, Figure J, lights from the VLA would not be visible, resulting in no change to nighttime viewshed from the property. Pursuant to the Section 106 PA, any visual effects to this property will be resolved through installation of utilities underground, completion of a historical context report, development of interpretive signage, and funding of educational outreach, as described below. For these reasons, no significant impact is expected.

Properties built along the coastline were situated to maximize views of Laguna Madre, South Padre Island, and the Gulf of Mexico. Properties built on parcels adjacent to the coastline, like the Queen Isabella Inn and Alta Vista Apartments, were built with multi-story heights to maximize views from a distance. The Point Isabel Lighthouse construction was sited with the purpose of providing clear views of Laguna Madre for navigation purposes. The Port Isabel Cemetery is located approximately 500 feet south of the coastline with an unobstructed view of Laguna Madre from its northwest corner. The cemetery is several feet higher in elevation than the surrounding street. For these resources, ocean views may be a component of these historic properties' significance. Launch-related infrastructure at the VLA 100 feet or taller, such as the integration towers and integrated launch vehicle, has the potential to effect the integrity of setting, feeling, and association by introducing new industrial infrastructure. However, these historic properties are more than 5 miles from the VLA and there are other modern intrusions in the area, such as the San Roman Wind Farm, San Padre Island high-rise buildings, and vertical industrial elements of SpaceX's private manufacturing and production facilities. As such, the impacts from the new VLA infrastructure in the viewshed is expected to be minimal. Similarly, any change to the nighttime viewshed is expected to be minimal due to the distance between historic properties on the coast and the VLA. The FAA made a *finding of adverse effects* for visual for 11 of these resources: the Alta Vista Apartments, Queen Isabel Inn, Charles Champion House, Port Isabel Lighthouse and THC Marker, Port Isabel Cemetery, Point Isabel Coast Guard Building, Port Isabel Fireman's Hall, Bahia Mar and Bahia Grande Condominiums, Former Sea Island Resort Hotel, Former Ship Café Building, and White Sands Motel. SpaceX has agreed to mitigate and resolve any potential adverse visual effects as described above for the NHL. For these reasons, no significant impact is expected.

The FAA has found that each launch event will carry the potential for an individual and distinct visual impact from this project and other launch activities.

### Temporary Access Restrictions

Under the Proposed Action, the NHL would be subject to temporary access restrictions for launch operations, but not anomalies. Temporary road closures, construction-related traffic, and other activity may inhibit visitation to the NHL and may diminish the experience of those seeking to visit the Palmito Ranch Battlefield as a site of exceptional historic integrity. However, the access restrictions would be intermittent, temporary, and short, subject to advance-notice requirements, planned to avoid times of high visitation (holidays) as noted in Section 2.1.3.5, and conducted to minimize disruption for agencies that own or manage the property. If all potential 500 hours of temporary access restrictions for launch operations were used, and the properties were open 24 hours per day 365 days per year, the property would remain open approximately over 94% of the year. Assuming public access was available only 12 hours per day, 365 days per year, and all temporary access restrictions occurred during those open hours and all of the 500 hours for launch operations were used in a year, the property would still remain accessible to the public 89% of the time. It is not expected that the NHL would be subject to access restrictions for anomalies given the distance of the NHL from the VLA. If an anomaly were to occur, the closure area would be smaller; access would only be restricted to the areas where debris landed. As such, the FAA determined temporary access restrictions on the NHL would have *no adverse effect* to the historic property. Temporary restrictions on access to the Palmetto and Cypress Bridge Pilings would be in effect for launch operations and anomalies. However, the FAA has determined that such restrictions

would not result in an adverse effect for the same reasons described above for the NHL. No other historic properties are subject to temporary access restrictions.

### Traffic/Visitors

Starship/Super Heavy launch operations could attract visitors to the area between launch campaigns, which could adversely affect the NHL, Palmetto and Cypress Bridge Pilings Site, and the Palmetto Pilings Historic Marker. An increased number of people would bring greater attention to these historic properties, which could result in increased foot traffic or vehicular traffic, particularly for off-road vehicles. Thus, the FAA determined that the potential increased numbers of visitors and traffic in the area would result in *adverse effects* to these historic properties. The largest number of visitors are expected for launch operations. To mitigate potential effects, SpaceX will maintain checkpoints during launch operations, which would restrict people from accessing them during this time. In addition, pursuant to the Section 106 PA and agreed to by the consulting agencies, SpaceX will 1) pay for one-time replication and installation of the missing star and wreath on the marker; 2) develop interpretive signage in English and Spanish that will educate visitors on the importance of cultural areas and the need to stay within defined access areas and the legal implications of vandalism and artifact collecting; and 3) fund educational outreach about the region's cultural heritage. No other historic properties sensitive to this type of effect are expected to experience an increase in the number of visitors or traffic. Given this monitoring and mitigation to ensure protection of the historic properties, no significant impact is expected and adverse effects would be resolved.

### Potential Impacts from Anomaly Debris

Anomalies at the launch pad could generate debris that may impact cultural resources within the 700-acre area developed to assess potential effects of debris and debris retrieval (referred to as the "debris study area"), which includes Palmetto and Cypress Bridge Pilings Site and the Palmetto Pilings Historic Marker. Figure 3-4 provides a map with the debris study area and historic properties. Pursuant to the Section 106 PA and as agreed to by the consulting agencies, SpaceX will monitor the pilings and marker post-anomaly to confirm any potential damage. In the event of an anomaly impacting the resource, SpaceX will hire a qualified professional to make recommendations for restoration of the historic property to pre-disturbed conditions given any damage and pay for the restoration. All work will be done following the Secretary of the Interior's Standards for the Treatment of Historic Properties, with conditions imposed in accordance with 36 CFR § 800.5(b) to ensure there would be no adverse effects. Based on SEARCH's survey, one piling was damaged by SpaceX anomaly debris (the SN11 anomaly[30]), and the FAA and SpaceX will work with THC to restore the piling following the Secretary of the Interior's Standards for the Treatment of Historic Properties. Agreed upon mitigation will be reported to Section 106 consulting parties in accordance with the notification stipulations in the PA. Anomalies will become increasingly unlikely as the Starship/Super Heavy program develops and further damage from debris to historic properties is more unlikely. Additionally, potential site damage caused by onlookers who may venture off the road in search of rocket debris may also occur; however, this would be minimal because SpaceX would maintain the access restriction until as much debris as possible would be collected

[30] On March 30, 2021, a SpaceX Starship prototype (referred to as SN11) test launch at the Boca Chica Launch Site resulted in anomaly.

following the anomaly. None of the other historic properties from Table 3-6 are within the debris study area.

In summary, the FAA has made a *finding of adverse effect* for 17 historic properties. The FAA received concurrence from the SHPO on April 25, 2022, and the findings are available in Appendix C. The FAA, SHPO, NPS, Advisory Council on Historic Preservation (ACHP), TPWD, USFWS, and SpaceX executed a Section 106 PA to resolve the adverse effects.

In conclusion, with the resolution of adverse effects on historic properties through the Section 106 PA, the Proposed Action would not result in significant impacts on historical, architectural, archeological, or cultural resources.

### 3.7.5 Mitigation and Monitoring

The FAA would ensure that SpaceX implements the measures identified in the Section 106 PA. The PA contains the following measures to avoid, minimize, or mitigate adverse effects:

1. Installing all utility lines between the LLCC and VLA underground to avoid visual effects to the Palmito Ranch Battlefield NHL.
2. Preparing a historical context report (i.e., historical narrative) of the historic events and activities of the Mexican War (1846–1848) and the Civil War (1861–1865) that took place in the geographic area associated with and including the APE.
3. Funding the development and production of five interpretive signs (in English and Spanish) that describe the history and significance of the historic properties in the APE.
4. Funding educational outreach (i.e., webpage content for agency websites, informative videos) to the public about the region's cultural heritage.
5. Documenting the landscape of the Palmito Ranch Battlefield following the Level I Historic American Landscapes Survey standards and guidelines for nationally significant properties.
6. Implementing measures to reduce noise levels generated by construction equipment.
7. Implementing measures to minimize noise from truck (construction, tanker, concrete, water, delivery) traffic
8. Conducting a vibration monitoring program to gather data on the effects of launches on the Palmetto Pilings Historical Marker, Palmetto Pilings, Port Isabel Lighthouse, and at the 2-, 3-, and 8-mile distances from the VLA. The program will also include a structural assessment from vibration data to assess any impacts and address any structural damage given any impact from launch operations.
9. Replicating and installing the missing stars and wreaths on the Palmetto Pilings Historical Marker
10. Maintaining access restriction to the area west of the existing U.S. Customs and Border Protection checkpoint at a location east of where SH 1419 crosses SH 4 and west of where an

unnamed north-south canal crosses SH 4, as generally depicted in Appendix C, to include the entire extent of the Palmito Ranch Battlefield NHL.

11. Placing temporary construction barriers around the Palmetto Pilings Historical Marker during construction.

12. If an anomaly affects a historic property, SpaceX will hire a qualified professional to make recommendations for restoration of the historic property. All work will be done following the Secretary of the Interior's *Standards for the Treatment of Historic Properties.* The proposed restoration will be subject to the review process described in PA Stipulation V. Upon review and approval, SpaceX will hire a qualified professional to restore the historic property.

13. In addition, an Unanticipated Discoveries Plan will be prepared to outline the processes to be followed when previously unknown cultural resources or human remains are discovered during construction or operation of the Proposed Action.

# 3.8 Department of Transportation Act, Section 4(f)

## 3.8.1 Definition of Resource and Regulatory Setting

Section 4(f) of the U.S. DOT Act of 1966 (now codified at 49 U.S.C. § 303) protects significant publicly owned parks, recreational areas, wildlife and waterfowl refuges, and public and private historic sites. Section 4(f) provides that the Secretary of Transportation may approve a transportation program or project requiring the *use* of publicly owned land of a public park, recreation area, or wildlife or waterfowl refuge of national, state, or local significance, or land of an historic site of national, state, or local significance, only if there is no feasible and prudent alternative to the using that land and the program or project includes all possible planning to minimize harm resulting from the *use*.

A Section 4(f) *use* would occur if the proposed action or alternative(s) would involve a physical *use* of Section 4(f) property through purchase of land or a permanent easement, physical occupation of a portion or all of the property, or alteration of structures or facilities on the property. Another type of physical *use,* known as *temporary occupancy,* results when a transportation project results in activities that require a temporary easement, right-of-entry, project construction, or another short-term arrangement involving a Section 4(f) property. A *temporary occupancy* is considered a Section 4(f) *use* unless all the conditions listed in Appendix B, Paragraph 2.2.1 of FAA Order 1050.1F and the Section 4(f) regulations at 23 CFR 773.13(d) are satisfied:

1. Duration must be temporary, i.e., less than the time needed for construction of the project, and there should be no change in ownership of the land;
2. Scope of the work must be minor, i.e., both the nature and the magnitude of the changes to the Section 4(f) property are minimal;
3. There are no anticipated permanent adverse physical impacts, nor will there be interference with the protected activities, features, or attributes of the property, on either a temporary or permanent basis;
4. The land being used must be fully restored, i.e., the property must be returned to a condition which is at least as good as that which existed prior to the project; and

5. There must be documented agreement of the official(s) with jurisdiction over the Section 4(f) resource regarding the above conditions.

A physical *use* may be considered *de minimis* if, after taking into account avoidance, minimization, mitigation, and enhancement measures, the result is either 1) a determination that the project would not adversely affect the activities, features, or attributes qualifying a park, recreation area, or wildlife or waterfowl refuge for protection under Section 4(f); or 2) a Section 106 *finding of no adverse effect* or *no historic properties affected*. Before the FAA may finalize a determination that a physical use is *de minimis*, the official(s) with jurisdiction must concur in writing that the project will not adversely affect the activities, features, or attributes that make the property eligible for Section 4(f) protection.

*Use*, within the meaning of Section 4(f), includes not only the physical taking of such property, but also *constructive use*. The concept of *constructive use* is that a project that involves no actual physical use of a Section 4(f) property via permanent incorporation or *temporary occupancy*, but may still, by means of noise, air pollution, water pollution, or other proximity-related impacts, substantially impair important features, activities, or attributes associated with the Section 4(f) property. *Constructive use* may also occur in some circumstances if access restrictions substantially diminish the utility of a significant publicly owned park, recreation area, or a historic site. The Section 4(f) regulations do not identify access restrictions as a potential for *constructive use* of a wildlife or waterfowl refuge. *Constructive use* occurs when the impacts of a project on a Section 4(f) property are so severe that the activities, features, or attributes that qualify the property for protection under Section 4(f) are substantially impaired. Substantial impairment occurs only when the protected activities, features, or attributes of the Section 4(f) property that contribute to its purpose and significance are substantially diminished. This means that the value of the Section 4(f) property, in terms of its prior purpose and significance, is substantially reduced or lost. As noted in FHWA's Section 4(f) Tutorial,[31] "[c]onstructive use involves an indirect impact to the Section 4(f) property of such magnitude as to effectively act as a permanent incorporation." Per the FAA 1050.1F Desk Reference,[32] which provides guidance for FAA NEPA practitioners and is used to help FAA integrate applicable special purpose laws and requirements, a proximity-related impact's consequences must amount to "taking" a property or a portion of a property in order for a *constructive use* determination to be made.

Procedural requirements for complying with Section 4(f) are set forth in DOT Order 5610.1C, *Procedures for Considering Environmental Impacts*. The FAA also uses Federal Highway Administration (FHWA) regulations (23 CFR part 774) and FHWA guidance (e.g., Section 4(f) Policy Paper) when assessing the potential for *use* of Section 4(f) properties. These requirements are not binding on the FAA; however, the FAA may use them as guidance to the extent relevant to FAA projects.

To be a Section 4(f) resource, public parks, recreation facilities, and wildlife or waterfowl refuges must be considered *significant*. Pursuant to 23 CFR §771.135(c), Section 4(f) resources are presumed to be significant unless the official having jurisdiction over the site concludes that the entire site is not significant. Historic sites qualifying for Section 4(f) protection must be officially listed on or eligible for

[31] Available online at: https://www.environment.fhwa.dot.gov/section4f/default.aspx

[32] Available online at: https://www.faa.gov/about/office_org/headquarters_offices/apl/environ_policy_guidance/policy/faa_nepa_order/desk_ref/

inclusion on the NRHP or contribute to a historic district that is eligible for or listed on the NRHP. More information about DOT Act, Section 4(f) can be found in Chapter 5 of the FAA Order 1050.1F Desk Reference (FAA 2020d).

## 3.8.2 Study Area

The study area for Section 4(f) resources is the 90 dB $L_{Amax}$ noise contour for Starship/Super Heavy orbital launch operations (see Appendix B, Figure 3). When compared to the 5-mile APE and access restricted area analyzed in the 2014 EIS, this study area represents a conservative and comprehensive limit because it captures a wider area where proximity-related impacts may result in a substantial impairment of the activities, attributes, or features of a Section 4(f) property. The 90 dB $L_{Amax}$ noise contour encompasses the study area for visual resources (Section 3.6.2) and cultural resources (Section 3.7.2). The proposed infrastructure would not be visible beyond the 90 dB $L_{Amax}$ noise contour. The study area also encompasses the APE for historic properties, as well as parks, recreational areas, and wildlife refuges that may be affected by the Proposed Action (i.e., those resources within the 90 dB $L_{Amax}$ noise contour); and the hazard and access restriction areas where public access would be limited or restricted. Although the use of a potential landing site approximately 62 nautical miles north of the Hawaiian island of Kauai would result in noise and visual impacts in the area, there are no Section 4(f)-eligible properties nearby that could be affected.

## 3.8.3 Existing Conditions

### 3.8.3.1 Public Parks, Recreation Areas, and Refuges

Within the study area, the following publicly owned parks, recreation areas, and refuges qualify as Section 4(f) properties:

- Andy Bowie County Park
- Arturo Galvan Coastal Park
- Bejarano-McFarland Memorial County Park
- Boca Chica State Park
- Brazos Island State Park
- Butterfly Park
- Edwin King Atwood Park
- Isla Blanca Park
- Jaime J. Zapata Memorial Boat Ramp
- John L. Tompkins Park
- Laguna Atascosa NWR
- Laguna Madre Nature Trail
- Laguna Vista Veterans Park
1. Lis Memorial Park
2. Lower Rio Grande Valley NWR
3. Pompano Park Boat Ramp
4. Port Isabel Lighthouse Park
5. Port Isabel Public Pool
6. Port Isabel Veterans Park
7. Queen Isabella Memorial Park
8. Roloff Park
9. South Bay Coastal Preserve
10. Trail Park
11. Turtle Park
12. Washington Park
13. Water Tower Park

The Proposed Action would not result in a *use* via permanent incorporation of any Section 4(f) property. Therefore, the only possible Section 4(f) *use* of the 4(f) properties in the study area would be through *temporary occupancy* or *constructive use*.

Most of the parks, recreation areas, and refuges were not evaluated in detail because the potential for noise or other proximity-related impacts to substantially impair the attributes, activities, or features that qualify these resources for protection under Section 4(f) would be negligible. There is no reasonable potential for launch-related noise to substantially impair these properties, because a quiet setting is not part of the significant attributes or features qualifying these properties for protection under Section 4(f).

The following public parks, recreation areas, and refuges were evaluated in detail for the potential for *constructive use* resulting from the Proposed Action: Boca Chica State Park, Brazos Island State Park, the NWR (Boca Chica Tract), the South Bay Coastal Preserve (Preserve), Isla Blanca Park, Laguna Atascosa NWR, Trail Park, and Laguna Madre Nature Trail. The potential for the *constructive use* of Boca Chica Beach was considered as part of the assessment of Boca Chica State Park, Brazos Island State Park, and the NWR, depending on location.

**Boca Chica State Park**, owned by the state of Texas and leased to USFWS to maintain its management, encompasses approximately 1,000 acres that border the south shore of South Bay. Although the park has no visitor facilities, it is open for swimming, snorkeling, surfing, fishing, bird watching, and kite surfing (City-Data 2021). The quiet, natural setting of Boca Chica State Park is a notable feature. The primary use of this particular property is recreational. The official hours of operation are sunrise to sunset.

Established in 1957, **Brazos Island State Park** provides 217 acres on the north side of SH 4 for swimming, surfing, ocean fishing, camping, and nature study. The park is owned by the state of Texas and managed by TPWD (Texas State Historical Association 2021). The quiet, natural setting of Brazos Island State Park is a notable feature. The primary use of this particular property is recreational. No official hours of operation were available online, as the park does not have an official website.

**The Lower Rio Grande Valley NWR** includes lands managed by private landowners, non-profit organizations, and the State of Texas, along the last 275 miles of the Rio Grande; the NWR itself is managed by the USFWS (USFWS 2013a). The primary use of the NWR is wildlife conservation. Secondary uses include wildlife-dependent recreational use. Lands within the NWR System are set aside for the conservation of fish, plants, and wildlife. More than 40,000 acres of the NWR are open to the public for fishing, watching or photographing wildlife, walking nature trails, hunting, and special organized events (USFWS 2013a). Boca Chica Beach is part of the NWR and approximately 63 percent of all visitations to the NWR is to the beach for traditional uses such as fishing, beachcombing, picnicking, and general enjoyment (USDOI 2021). The quiet, natural setting of the NWR is a notable feature. As explained on the NWR's website, the primary purpose of this property is to protect wildlife and secondary uses include wildlife-dependent recreational use. The NWR is open from official sunrise to official sunset.

Northwest of the VLA is the **South Bay Coastal Preserve**. The Preserve was established in 1984 and includes 3,500 acres west of Brazos Island between the Brownsville Ship Channel and the Rio Grande River. Managed by the TPWD and TGLO, the Preserve provides occasional and seasonal recreational use for fishing and waterfowl hunting and considerable commercial oyster landings. Its emergent and submergent vegetation and algal tidal flats provide breeding and foraging areas for numerous species of finfish, shellfish, and birds, and a winter habitat for migratory birds (TPWD 2022). The quiet, natural setting of the Preserve is a notable feature. The website for the preserve states as follows: "Human activities are low in the Bay due to its remote location." The preserve provides breeding and foraging

areas for numerous species of fish and birds and habitat for migratory birds. No official hours of operation were noted.

**Isla Blanca Park**, approximately 5.5 miles north of the VLA, is managed by the Cameron County Parks and Recreation Department and is available to the public for recreation purposes. The park includes beachfront pavilions, fishing areas, recreational vehicle hookup sites, a water park, a boat ramp, beach access, and other recreational amenities (Cameron County 2021). No official hours of operation were noted for park facilities, but the park registration office is open seven days a week between 8:00 a.m. and 7:00 p.m. during peak season and 8:00 a.m. and 6:00 p.m. during the offseason.

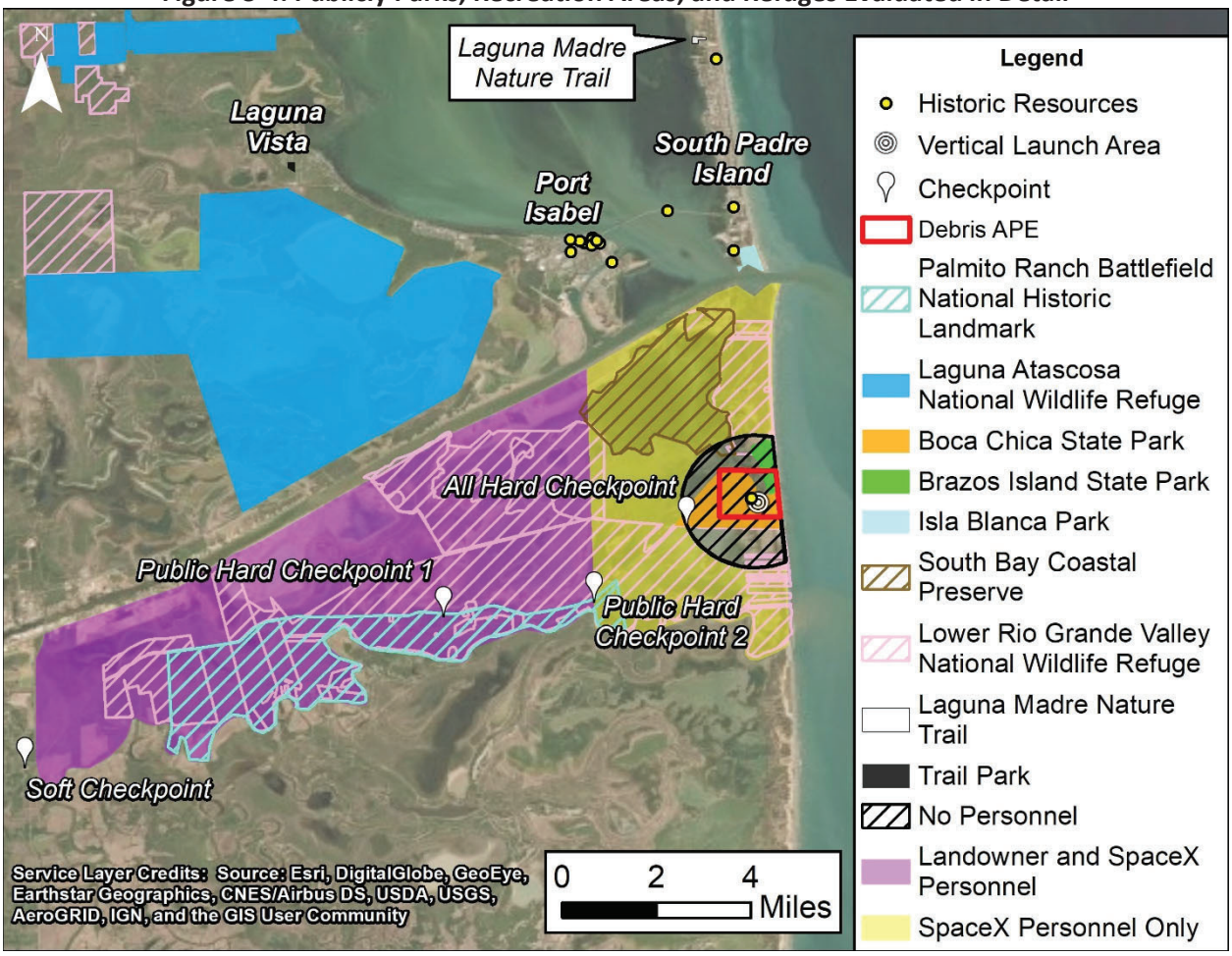
**The Laguna Atascosa NWR**, owned by the U.S. government and managed by USFWS, is a 97,000-acre wildlife refuge northwest of the VLA. Similar to the Lower Rio Grande Valley NWR, lands within the System are set aside for the conservation of fish, plants, and wildlife. Portions of the NWR are open to the public for wildlife watching, hunting, fishing, and other special events (USFWS 2021b). The quiet, natural setting of the NWR is a notable attribute and no official hours were noted.

**Trail Park**, owned and operated by the City of Laguna Vista, is a 15-acre site with a natural walking trail (Laguna Vista Nature Trail). The park includes observation areas for natural ponds, with defined quiet zones (Town of Laguna Vista 2021). No official hours of operation were noted on the City of Laguna Vista Parks and Recreation website; however, according to the Laguna Vista City Hall, Trail Park is open 7 days a week from 7 am to 7 pm (Town of Laguna Vista 2021).

**The Laguna Madre Nature Trail**, owned by Cameron County, is a boardwalk trail located in northern South Padre Island that crosses four acres of coastal marshland (South Padre Island Convention and Visitors Bureau 2021). A quiet setting is a notable feature of the trail, as it is known for bird watching. No official hours of operation were noted on the Cameron County Parks and Recreation website or the South Padre Island Convention and Visitors Bureau website; however, according to the South Padre Island Visitor's Center, the Laguna Madre Natural Trail has no set hours of operation (South Padre Island Convention and Visitors Bureau 2021).

Refer to Figure 3-4 for a map of the public parks, recreation areas, and refuges within the study area that were evaluated in detail.

**Figure 3-4. Publicly Parks, Recreation Areas, and Refuges Evaluated in Detail**




### 3.8.3.2 Historic Sites

As described in Section 3.7.3, the SHPO concurred that there are a total of 17 historic properties in the study area that are listed in, eligible for listing in, or should be treated as eligible for listing in the NRHP (see Table 3-6). These historic properties qualify for protection under Section 4(f).

## 3.8.4 Environmental Consequences

Impacts on Section 4(f) properties would be significant if the Proposed Action involves more than a minimal (i.e., *de minimis*) physical use of a Section 4(f) resource or constitutes a *constructive use* based on an FAA determination that the project would substantially impair the Section 4(f) resource.

### 3.8.4.1 Construction

Construction of the proposed infrastructure associated with the Proposed Action would not result in a permanent incorporation of any Section 4(f) property. All proposed infrastructure is within SpaceX-owned land. The proposed parking lot would be directly adjacent to the 41CF117, but the final design of the parking lot would not incorporate or overlap with any of the historic resource. Accordingly, the FAA

has determined that the Proposed Action would not result in a *use* of any Section 4(f) properties through permanent incorporation.

Construction includes trenching to install underground utilities within the ROW along SH 4 between the LLCC and the VLA. The 2014 EIS evaluated similar work (FAA 2014a), during which the USFWS disputed the TxDOT's claim of ownership of the SH 4 ROW in this area, indicating that the ROW traversing the NWR property is owned by the USFWS (USFWS 2013b). At that time, the FAA determined that if the USFWS owns the SH 4 ROW in this area, then the upgrade and installation of power and data lines would involve a *temporary occupancy* of land on a Section 4(f) property. The FAA analyzed the impacts of the *temporary occupancy* of the NWR property and concluded the upgrade of the power lines leading to the LLCC and the underground installation of the power and data lines in SH 4 ROW would constitute a *de minimis* impact because SpaceX would restore all temporary disturbance to the ROW after installation. The USFWS concurred with this determination. In 2020, the USFWS provided maps delineating its claimed ownership of a portion of SH 4, which ends 2.1 miles from the terminus of the road, adjacent to the western edge of the SpaceX solar farms (USFWS 2020a). The State of Texas continues to dispute USFWS claim of ownership to SH 4. USFWS does not dispute that the State of Texas has a public ROW over the SH 4 land. The FAA has determined that if the USFWS owns SH 4 in this area, then SpaceX's installation of utilities along the SH 4 ROW would involve a *temporary occupancy* and impacts would be *de minimis* because the FAA would ensure that SpaceX restores the ROW to pre-disturbance conditions after installation. The USFWS concurred with this determination on May 13, 2022.

The FAA considered the potential for the construction of Starship/Super Heavy infrastructure to result in adverse effects on each of the historic properties listed in Table 3-6 from visual effects. As discussed in Section 3.7.4, visual effects from project infrastructure will result in no adverse effects for four of the resources, and as such, the FAA has determined there is no *constructive use* of these four properties from visual effects under Section 4(f). For the thirteen historic properties for which visual effects from project infrastructure will result in adverse effects, for the reasons described below, the FAA has determined that the visual effects on historic resources eligible for Section 4(f) are expected to be minimal due to the distance between the resource and the infrastructure, other industrial infrastructure in the area, and SpaceX mitigating and resolving any adverse visual effects through the Section 106 PA.

With regards to the NHL, during the day, new VLA infrastructure over 100 feet would be visible to visitors only in parts of the property, but not from the core-battlefield area, which hosts the interpretive platform (see Figure I in Appendix F). In addition, as illustrated in Figure J, Appendix F, lights from the VLA would not be visible from 10 miles away, but would be visible from 5 miles away. However, the lights would be similar to the existing lighting from SpaceX's manufacturing and production area, resulting in no change to nighttime viewshed from the property. For these reasons, the FAA determined that the visual effects of the new VLA infrastructure would not substantially diminish visual resources on the property and the historic integrity of the property, which qualifies if for Section 4(f). In addition, pursuant to the Section 106 PA, any visual effects will be resolved through installation of utilities underground, completion of a historical context report, development of interpretive signage, and funding of educational outreach.

With regards to the other historic resources in Table 3-6 for which the FAA determined there were adverse visual effects, launch related infrastructure at the VLA 100 feet or taller, such as the integration towers and integrated launch vehicle because this infrastructure had the potential to affect the integrity

of setting, feeling, and association by introducing new industrial infrastructure. However, these historic properties are more than 5 miles from the VLA and there are other modern intrusions in the area, such as the San Roman Wind Farm, the Brownsville Ship Channel cranes, San Padre Island tall buildings and lighting, and vertical industrial elements of SpaceX's private manufacturing and production facilities. As such, the impacts from the new VLA infrastructure in the viewshed is expected to be minimal. Similarly, any change to the nighttime viewshed is expected to be minimal. In addition, SpaceX has agreed to mitigate and resolve any potential adverse visual effects for the same reasons described above for the NHL.

Thus, the visual effects would not substantially impair the historic integrity of these thirteen historic resources or enjoyment for the public in their larger setting and there would be no *constructive use* of these properties under Section 4(f) resulting from visual effects.

The FAA considered the potential for the construction of Starship/Super Heavy infrastructure to result in a *constructive use* of Boca Chica State Park, Brazos Island State Park, the NWR, the Preserve, Isla Blanca Park, Laguna Atascosa NWR, Trail Park, and Laguna Madre Natura Trail. For the reasons described below, the FAA has determined that visual effects of the Proposed Action would not substantially impair the protected activities, features, or attributes of these properties; and therefore, there is no *constructive use* of these properties under Section 4(f) from visual effects.

Boca Chica State Park and Brazos Island State Park are primarily used by the public for wildlife-dependent recreation. New launch-related infrastructure at the VLA over 100 feet tall, such as the integration towers and integrated launch vehicle and some lighting, would be visible from the parks. However, this visual effect would not substantially impair recreational activities, the most popular of which are surfing, beachcombing, and fishing, as the area already has visual intrusions from tall buildings and lighting on South Padre Island. Other wildlife-dependent recreational activities would also not be substantially impaired by visual effects. With regards to lighting, according to the USFWS website, Boca Chica State Park is not open after dark and, as a result, lights at the VLA will not substantially impair the public's experience of visual resources of that property. Even if the public uses the property after dark, visitation is presumably low and lighting effects from the VLA will be reduced through the lighting mitigation described in PEA Section 3.6.5.

Approximately 30,000 visitors per year or 37 percent of all NWR visitation access La Puerta, La Sal del Rey, Schaleben, Teniente, and East Lake combined for wildlife observation, photography, and environmental education and interpretation. The VLA is not visible from La Puerta, La Sal del Rey, Schaleben, Teniente, and East Lake, and therefore, the project would have no visual effect to this portion of the NWR. As explained above, there is no *constructive use* of Boca Chica State Park from visual effects. Although certain launch-related infrastructure at the VLA would be visible from portions of the NWR (other than Boca Chica Beach, La Puerta, La Sal del Rey, Schaleben, Teniente, and East Lake), particularly those along SH 4, the VLA is not visible from most of these other locations. In addition, there is existing industrial infrastructure in the viewshed, particularly along SH 4 that borders both the north and south boundaries of the property. For example, tall cranes and infrastructure are visible at the Port of Brownsville. With regards to lighting impacts, this property is not open after dark and, as a result, lights at the VLA will not substantially impair the public's experience of visual resources of that property As such, the quiet, natural setting of the property would not substantially change with the additional infrastructure in the viewshed.

The website for the South Bay Preserve states that "[h]uman activities are low in the Bay due to its remote location."[33] The preserve provides breeding and foraging areas for numerous species of fish and birds and habitat for migratory birds, none of which would be impaired by visual effects of the project. For these reasons, and for the reasons discussed above with respect to other Section 4(f) properties in the area, visual effects are expected to have little to no impact on the use or enjoyment of the property.

During the day, launch-related infrastructure would be visible from the viewshed of Isla Blanca Park, but would generally not be visible from Laguna Atascosa NWR, Trail Park, and Laguna Madre Nature Trail, as these are 10 miles or more from the VLA. Isle Blanca Park is primarily used for recreational purposes and the visual effect would not substantially impair recreational activities for the same reasons described above for Boca Chica State Park. The Laguna Atascosa NWR is primarily a wildlife refuge, and secondary uses include wildlife-dependent recreational uses. Visual effects would not substantially impair the property for the same reasons described in relation to the NWR, and the property is further from the VLA than the NWR and has existing industrial infrastructure in the viewshed from the San Roman Wind Farm and South Padre Island. Laguna Madre Nature Trail and Trail Park are approximately 10 miles from the VLA and have existing industrial infrastructure in the viewshed, such as that on South Padre Island and the San Roman Wind Farm. In addition, the South Padre Island Convention Center is immediately adjacent to Laguna Madre Nature Trail. Therefore, any change to the viewshed for the properties are expected to be minimal. In addition, the nighttime viewshed is not expected to change for the properties. Any visual effects on visitors and wildlife would be negligible due to the distance from the VLA. Therefore, any change to the viewshed for these properties are expected to be minimal.

### 3.8.4.2 Launch Operations

#### Access Restrictions for Nominal Activities and Anomalies

The proposed launch activities related to Starship/Super Heavy would have temporary, intermittent impacts on public access to Boca Chica State Park, Brazos Island State Park, the Preserve, and major portions of the NWR, the NHL, and the Palmetto and Cypress Bridge Pilings and Palmetto Pilings Historic Marker. The Palmetto and Cypress Bridge Pilings and Palmetto Pilings Historic Marker, Brazos State Park, the Preserve, Boca Chica State Park, would be subject to temporary access restrictions for both launch operations and anomalies. The NHL and NWR would only be subject to access restrictions for launch operations, not anomalies. Access restrictions would be for safety and security reasons and to alleviate concerns regarding the potential impacts to public lands from the viewing public (e.g., increased traffic/visitors during launch operations) (see Figure 3-4). No other Section 4(f) properties are subject to access restrictions.

If all 500 hours of temporary access restrictions for launch operations and 300 hours for anomalies each year were used (which is not expected), and the properties were open 24 hours per day, 365 days per year, the properties would remain open approximately 91% of the year. Not including access restrictions resulting from anomalies, the properties would remain open approximately over 94% of the year. Assuming public access would otherwise be available only 12 hours per day, 365 days per year, and that all temporary access restrictions occurred during those open hours and all of the 500 hours for launch

[33] See: https://tpwd.texas.gov/landwater/water/conservation/txgems/southbay/index.phtml (last visited February 21, 2021)

operations and 300 hours for anomalies were used (which is not expected), the properties would still remain accessible to the public 82% of the time. Not including access restrictions resulting from anomalies, the properties would remain open 89% of the time.

Temporary access restrictions would not impede USFWS staff or their contractors, partners, or guests from completing habitat or species management activities within Boca Chica State Park. SpaceX has provided funding to USFWS for the purpose of hiring an employee to assist with coordination between USFWS and SpaceX. To further reduce impacts on USFWS's access, SpaceX will maintain a roster/badge system to identify staff, contractors, partners, and guests of USFWS and other agencies. On days with planned access restrictions, personnel so identified by USFWS will have access to the state park and other state and federal lands in the vicinity at all times except for a reasonable period associated with ignition events or tests that could pose a safety risk, and when conditions may otherwise be unsafe.

As explained in the mitigation in Section 3.8.5, as part of its Access Restriction Notification Plan, SpaceX would provide a forecast of planned access restrictions one to two weeks in advance of the access restrictions on the County's website and/or through the email distribution list, and SpaceX would also notify the USFWS, TPWD, THC, and TGLO of access restrictions 48 hours in advance of launch operations so the agencies could plan for the access restrictions and avoid conflicts for special events or programs. As part of its Access Restriction Notification Plan, SpaceX would also maintain a roster and badge system to identify staff and contractors, partners, and guests of state and federal management agencies to allow for continued access to state and federal lands in the vicinity of the launch site at all times, except for a reasonable period associated with events that may present a safety risk or other unsafe conditions. Refer to Section 3.8.5 for additional measures that SpaceX would implement to minimize the impacts of temporary access restrictions.

With regards to the Preserve, temporary restrictions on access are not expected to cause a substantial impairment of this property for the same reasons discussed above for other properties in the area. Additionally, as the website for the preserve explains, "Human activities are low in the Bay due to its remote location."[34] As such, temporary access restrictions are expected to have even less of an impact on the public's use and enjoyment of the property and would have no impact on wildlife.

Based on the temporary and short duration of the access restrictions, the notification and planning with the applicable land-management agencies, and the avoidance of days of higher public use, the FAA determined that the access restrictions associated with launch operations and anomalies would not substantially impair the activities, features, or attributes that qualify Boca Chica State Park, Brazos Island State Park, the Preserve, the NWR, the NHL, the Palmetto and Cypress Bridge Pilings, and Palmetto Pilings Historic Marker for protection under Section 4(f).

Overall, the access restrictions on all Section 4(f) properties affected by the Proposed Action would be intermittent, temporary, short, subject to advance-notice requirements, planned to avoid times of high visitation, and conducted to minimize disruption for agencies that own or manage the property. Temporary access restrictions for anomalies would be even rarer than those for launch operations. Therefore, for the reasons described above, the FAA has determined that no *constructive use* under Section 4(f) would result from temporary access restrictions from launch operations or anomalies.

[34] See: https://tpwd.texas.gov/landwater/water/conservation/txgems/southbay/index.phtml.

## Launch Noise/Sonic Booms

A quiet setting is an important attribute of the state parks, Preserve, NWR, Trail Park, Laguna Atascosa NWR, and Laguna Madre Nature Trail. Therefore, the FAA evaluated noise from launch operations to determine whether noise increases would result in the substantial impairment of significant activities, features, or attributes that qualify these properties as a Section 4(f) resource, thus constituting a *constructive use*. The assessment used the 90 dB $L_{Amax}$ noise contour for launch operations. The noise modeling demonstrates that all of Boca Chica State Park and Brazos Island State Park, the Preserve, the NWR, Isla Blanca Park, Trail Park, and Laguna Madre Nature Trail would be within the 90 dB $L_{Amax}$ noise contour for the launch event scenarios. However, due to temporary access restrictions, no people would be present in Boca Chica State Park, Brazos Island, or the Preserve during launches, and as such, the public's experience of the properties' setting will not be substantially impaired by noise impacts. For Isla Blanca Park, the NWR, Trail Park, and Laguna Madre Nature trail, as described in Section 3.5.4, launch noise will be intermittent and of short duration. At all other times, the quiet setting of the Section 4(f) properties would persist. Because of the short-term and intermittent nature of the impacts from noise during operational activities, the FAA has determined that noise from operations would not substantially diminish the activities, features, and attributes of the NWR, Isla Blanca Park, Laguna Atascosa NWR, Trail Park, and Laguna Madre Nature Trail. Therefore, the FAA has determined that noise from launch operational activities would not constitute a *constructive use* of these Section 4(f) properties.

The FAA considered the potential for noise from launch operations to result in adverse effects on historic properties listed in Table 3-6. As described in Section 3.7.4, the FAA determined there was no adverse effect to the NHL, the Palmetto and Cypress Bridge Pilings, and Palmetto Pilings Historic Marker, and the causeway bridges. Because there is no adverse effect, in accordance with Chapter 5 of the FAA Order 1050.1F (FAA 2020d), the FAA has determined there is no *constructive use*. For all other historic properties, because of the short-term and intermittent nature of the impacts from noise during operational activities (as described in Section 3.5.4), the FAA has determined that noise from operations would not substantially diminish the activities, features, and attributes of these properties. Therefore, the FAA has determined there is no *constructive use* of the properties resulting from launch operation noise.

The FAA considered the potential for the Starship/Super Heavy launch operations to result in adverse effects on historic properties listed in Table 3-6 from launch vibrations and sonic booms. As discussed in Section 3.7.4, vibrations and sonic booms will result in no adverse effects for the NHL, and as such, in accordance with Chapter 5 of the FAA Order 1050.1F (FAA 2020d), the FAA has determined there is no *constructive use* of this historic resource from vibrations or sonic booms under Section 4(f).

For all other historic resources, the FAA determined that vibrations and sonic booms would result in adverse effects. Regarding the Palmetto and Cypress Bridge Pilings, and Palmetto Pilings Historic Marker, launch noise and sonic booms could cause physical damage to the structural features of these objects, such as displacement or breakage of the structural features of the pilings, cracking of the marker's foundation, or the marker toppling over. SpaceX will hire a qualified professional to make recommendations for the stabilization and protection of the resource. If permanent stabilization is necessary, it will be done following the Secretary of the Interior's Standards for the Treatment of Historic Properties and SpaceX will pay for the stabilization and protection. Given these conditions imposed in accordance with the Section 106 of the NHPA regulations at 36 CFR § 800.5(b), there would

be no adverse effects. As described in Section 3.7.4, SpaceX would conduct a pre-launch condition assessment and monitoring for the first five orbital launches, and if damage is likely to occur or occurs, stabilize the resources.

All other historic resources would experience between noise levels of 111–130 dB during orbital launches. As explained above in Section 3.5.4, potential structural damage is not expected at or below 130 dB. Sound levels of 111 dB and 120 dB may be used as a conservative threshold for potential risk of structural damage claims, based on a study of structural damage claims from rocket static fire tests of 125–135 seconds (Guest and Slone 1972). The study qualifies that the results do not imply that similar responses would necessarily be observed from all other rocket tests or launch sites. The National Academy of Sciences' 130-dB threshold was developed as a standard that could be applied across different projects. Therefore, no potential structural damage is expected to these other historic resources. Even if there were to be structural damage at or below 130 dB, it is expected to be in the form of minor cracks in windows or plaster.

With the exception of the Palmetto and Cypress Bridge Pilings, and Palmetto Pilings Historic Marker, which are discussed above, all historic resources are expected to experience overpressure of 4–6 psf from sonic booms. As explained in Section 3.5.4, the probability of glass breakage is between one in 100 and one in 1,000 at 10 psf. Laboratory tests involving glass (White 1972) have shown that properly installed window glass will not break below 10 psf, even when subjected to repeated booms. Therefore, no structural damage to these other historical resources is expected. The location of maximum overpressure from a sonic boom would vary with weather conditions, and landings at the VLA are limited to 5 per year (some of which are expected to be in the ocean and not impact land), and so it is unlikely that any given location would experience the maximum estimated level of overpressure more than once over multiple events. As described below, SpaceX is undertaking several mitigation measures to monitor potential damage and repair of any actual damage resulting from vibrations or sonic booms. For these reasons described above, the FAA determined that vibrations and sonic booms from launch operations would not constitute a *constructive use* of historic properties.

The FAA considered the potential for structural damage from vibration and sonic booms from Starship/Super Heavy launch operations to substantially impair the features of the state parks, NWR, the Preserve, Laguna Atascosa NWR, Trail Park, and Laguna Madre Nature Trail. Other than the Palmetto and Cypress Bridge Pilings and Palmetto Pilings Historic Marker, which are discussed above, Boca Chica State Park, Brazos Island State Park, the Preserve, and NWR have no structures in the noise and sonic boom contours (see Figure 7 and Figure 8 in KBR's report at Appendix B and Figure 2 in SpaceX's memorandum in Appendix B). Laguna Atascosa NWR and Laguna Madre Nature Trail are approximately 10 miles from the VLA and are expected to experience 111 dB and 4 psf. Isla Blanca Park is expected to experience 120-130 dB and 6 psf. Therefore, as explained in Section 3.5.4, damage to structures in Laguna Atascosa NWR and the Laguna Madre Nature Trail is extremely unlikely and expected to be rare in Isla Blanca Park. For these reasons, the FAA has decided that launch operation vibrations and sonic booms would not result in a *constructive use* of the Isla Blanca Park, Laguna Atascosa NWR, or Laguna Madre Nature Trail.

Noise and vibrational impacts from launch operations and sonic booms are not expected to substantially impair wildlife values on the NWR or other properties. Monitoring to date has not shown any harm to listed species resulting from launch operations, and conservative estimates of *take* have not been found

to appreciably reduce the likelihood of survival or recovery of the species. As further explained in Section 3.10 and ESA Section 7 consultation, and consistent with the findings of studies of wildlife effects of launch operations at other launch sites near wildlife areas, intermittent, short-term noise from launch operations is not expected to substantially harm wildlife, which are expected to resume normal behavior after a launch operation. In addition, any harm to turtle eggs and nests would be unlikely because it is standard procedure in Texas to retrieve and incubate eggs each day of the nesting season.

Even if wildlife were to avoid nesting and other use of the area immediately surrounding the VLA due to vibrations, noise, and/or other effects, other parts of the Boca Chica State Park and the NWR will continue to serve as valuable habitat for birds and other wildlife, and no population-level effects are expected.

### 3.8.4.3 Anomalies

In Section 3.8.4.2, the FAA considered whether access restrictions from anomalies would constitute a *constructive use* of Section 4(f) properties. In addition, the FAA considered whether the potential for debris and debris-response activities could result in a *temporary occupancy* of Section 4(f) properties. Anomalies would not result in a permanent incorporation of Section 4(f) properties. The FAA has not historically analyzed potential impacts from debris and debris-response activities arising from commercial space launch activity to public parks, recreation areas, or wildlife and waterfowl refuges under Section 4(f). The FAA nonetheless opted to consider the possibility of a *temporary occupancy* resulting from debris and debris-response activities in order to more broadly inform review of the potential effects.

A Starship/Super Heavy anomaly could result in an explosion on the launch pad, which would spread debris. Debris is expected to be contained within the debris study area, which is a 700-acre area within the “all hard checkpoint” area shown in Figure 2-4 (black dashed area represented as “no personnel”) of the PEA. SpaceX’s SN11 anomaly created the largest debris filed of all launch anomalies to-date and although debris spread outside the launch pad, it was contained to the debris study area. The debris study area includes the following 4(f) resources: Boca Chica State Park, Brazos Island, Palmetto and Cypress Bridge Pilings, and Palmetto Pilings Historic Marker.

SpaceX has entered into an MOA with TPWD to mitigate and restore any impacts from anomalies at Boca Chica State Park, Brazos Island State Park, and other TPWD land. The MOA provides a protocol for responding to events, recovering debris, and implementing, monitoring, and adapting restoration efforts to restore impacts. By implementing, monitoring, and adapting restoration efforts, it is expected that any affected land can be restored and long-term impacts to the natural, cultural, and recreational values of TPWD lands and habitat would be avoided. The following paragraphs describe actions SpaceX is required to take pursuant to the MOA and SpaceX’s Anomaly Response Plan.

In the event of an anomaly, a limited number of SpaceX staff would enter the debris field on foot and conduct an initial evaluation. Following the initial evaluation of the area, SpaceX would coordinate with TPWD, TGLO, and USFWS, as applicable, prior to clean-up, in order to minimize damage to sensitive resources. SpaceX must obtain a Special Use Permit on an emergency basis from the USFWS as applicable, prior to clean-up activities for any anomaly on NWR fee-owned or managed lands. The method of debris removal would be assessed on a case-by-case basis and would be coordinated with

applicable landowners or public land-managing agencies. SpaceX would consult TPWD and/or USFWS prior to any activity that may impact sensitive wildlife habitat. SpaceX would enter Section 4(f) properties on foot as much as possible and coordinate the use of vehicles with TPWD, TGLO, and USFWS, as applicable, to minimize impacts. SpaceX would perform an initial assessment of the debris to geotag and pick up debris by hand. Once the parking lot is constructed, SpaceX would not allow employees to park along SH 4 near the VLA.

Protocols for debris removal include the following: (1) prohibit dragging or winching of debris; (2) no vehicles or equipment on the property without the express written consent of TPWD or USFWS; (3) large pieces of debris are to be accessed on foot and dismantled or cut up using tools carried on foot (except as otherwise approved in accordance with (2)); (4) tarps or liners are to be placed under areas where cutting occurs to prevent shavings and particulates from contaminating the ground and any such shavings or particulates are to be disposed of off-site; and (5) except in an emergency, retrieval of debris from the property should take place only during daylight hours.

In addition to the spread of debris, an anomaly on the launch pad may cause a fire that could extend to Boca Chica State Park. Consistent with monitoring to date and studies of the impact on wildlife from prescribed burns, the impacts of such a fire are expected to be insubstantial. Following a fire resulting from an anomaly on July 24, 2019, experts at the University of Texas Rio Grande Valley prepared an assessment of wildlife impacts (Hicks and Contreras 2019). The assessment found that direct fire mortality of wildlife was low and "large motile species (e.g., vertebrates) were likely able to vacate the area at the time of the burn or survive in unburned patches." No evidence of impacts to any listed species were found. The assessment found direct fire mortality of a single individual coastal-plain toad (*Ollotis nebulifer*) and only several blue land crabs (*Cardisoma guanhumi*) and black land crabs (*Gecarcinus quadratus*). Many crab burrows exhibited post-fire activity, showing that "it is likely that many of the crabs were able to survive the fire by retreating into subterranean burrows." The assessment concluded that direct fire mortality of wildlife was low and impacts to wildlife and habitat were not significant and "similar to those which would occur during a prescribed burn in comparable habitats." The experts explained that "[p]rescribed burns in tidal marshes and grasslands are routinely used to improve habitat for waterfowl and furbearers, control invasive species, and reduce wildfire risk." The assessment found that the majority of the burned area was not habitat for piping plover or only marginal habitat.

All SpaceX efforts to restore any impacts to Section 4(f) properties would be conducted as quickly as possible in coordination with TPWD, TGLO, and USFWS, as applicable. Occupancy of the Section 4(f) properties would be short term, and there would be no permanent or residual effects to the properties lasting beyond the occupancy.

The FAA has determined that the *temporary occupancy* of Boca Chica State Park and Brazos Island State Park resulting from anomalies constitutes a *use* under Section 4(f). However, the FAA has determined that, through the implementation of the terms of the MOA, the debris and debris-response activities would not adversely affect the activities, features, or attributes that make Boca Chica State Park and Brazos Island State Park eligible for Section 4(f) protection and any such impacts are expected to be *de minimis*, because debris and debris-response activities would be temporary and there would be no permanent effects to the property. TPWD concurred with this determination on May 11, 2022. The USFWS concurred with the determination on June 2, 2022.

As described in Section 3.7.4, anomalies at the launch pad could generate debris that may impact the Palmetto and Cypress Bridge Pilings Site and Palmetto Pilings Historic Marker. As noted above, SpaceX's SN11 anomaly damaged one of the pilings, but given the frequency of anomalies, the limited number of launches per year, and the size of the resources, it is unlikely that the same damage would occur in the future. As discussed in Section 3.7.4, in the event of an anomaly impacting the resource, SpaceX will hire a qualified professional to make recommendations for restoration of the historic resource to pre-disturbance conditions given any damage and pay for the restoration. All work will be done following the Secretary of the Interior's Standards for the Treatment of Historic Properties. Given these conditions imposed in accordance with 36 CFR § 800.5(b), and the monitoring and mitigation to ensure protection of the Palmetto and Cypress Bridge Pilings and Palmetto Pilings Historic Marker, there would be no adverse effects to the pilings and historic marker. The FAA made a *finding of no adverse effect* for the Palmetto and Cypress Bridge Pilings Site and the Palmetto Pilings Historic Marker. The FAA has determined that an anomaly could result in a *temporary occupancy* of the Palmetto and Cypress Bridge Pilings and the Palmetto Pilings Historic Marker as a result of debris and debris-response activities. However, following the Section 106 *finding of no adverse effect,* the FAA has determined that any potential *temporary occupancy* of the historic properties would be *de minimis*. The Texas SHPO concurred with this finding on April 25, 2022.

#### 3.8.4.4 Daily Operations

Small and temporary increases in noise levels from delivery trucks and personnel vehicles would be expected along SH 4, which is adjacent to the NWR, NHL, Palmetto and Cypress Bridge Pilings or Palmetto Pilings Historic Marker and Boca Chica State Park. Increased noise levels would be greatest during commuting hours, although these periods would be of relatively short duration. Although portions of the NWR border SH 4, the vast majority of the NWR extends far beyond both sides of SH 4, where minimal traffic noise would be perceptible. Small increases in noise levels at the northern boundary of the NHL that is along SH 4 and Boca Chica State Park would also be expected. The increased noise levels would be perceptible along the northern extent of the NHL that borders SH 4 and areas of the state park that border the highway but would decrease further south of the road. Noise from average daily operations traffic under the Proposed Action is unlikely to be perceptible in the core battlefield area, which is more than 0.5 mile from SH 4. For these reasons, the FAA has determined that noise from daily operations traffic would not substantially diminish the quiet setting of the NWR, NHL, and Boca Chica State Park. Therefore, the FAA has determined the noise generated by daily operations would not constitute a *constructive use* of these Section 4(f) properties. No increase in noise from daily operations is expected at Brazos Island State Park, the Preserve, Isla Blanca Park, Laguna Atascosa NWR, Trail Park, and Laguna Madre Nature Trail.

The FAA considered the potential for daily operational noise to result in adverse effects on historic properties other than the NHL (which is addressed above). As discussed in Section 3.7.4, the FAA determined there would be no adverse effect to any historic properties from daily operational noise. Because there is no adverse effect, the FAA has determined there is no *constructive use* of historic properties resulting from daily operational noise

The Proposed Action is expected to increase the number of visitors to the NWR, Boca Chica State Park, and Brazos Island State Park, particularly during launch, landing, and testing operations. However, any impacts from noise and other effects from increased visitation and associated traffic are expected to be

minimal. Although there could be a concern about off-road vehicles or foot traffic, the public has regularly driven on and across Boca Chica State Park and other surrounding areas for decades, without causing any permanent adverse impacts. To help reduce potential effects from public off-road vehicle use to the properties and habitat, however, SpaceX will coordinate with USFWS NWR staff to identify options that would assist in protecting NWR lands and species habitats from impacts that may result from public vehicle intrusions. Upon USFWS and SpaceX agreement of locations alongside SH 4 or other identified roads where the footprint is already disturbed, SpaceX will provide up to $10,000 annually for purchasing vehicle barrier materials to prevent a truck or ATV from entering. SpaceX will also coordinate with TxDOT regarding funding the installation of up to 5 additional wildlife crossing signs along SH 4 for a total of 10 signs (5 in each direction). Five wildlife crossing signs have already been installed along SH 4. For these reasons, the FAA has determined that any increased visitation and associated traffic effects of the Proposed Action would not substantially impair the protected activities, features, or attributes of these properties. No other public parks or wildlife or waterfowl refuges are expected to experience increased visitation or traffic resulting from the Proposed Action.

Management of parks, recreational areas, wildlife refuges, or historic sites would continue to follow the regulations and management plans, as applicable, of the agencies that currently administer the lands. Likewise, within the context of Section 4(f), increased visitation to publicly owned parks, recreational areas, and wildlife refuges in the study area that are open during launches (Isla Blanca Park and portions of the NWR) would not result in induced impacts that would substantially impair the activities, features, and attributes of these resources. All visitors would be subject to the same rules and regulations concerning entry and use of the park, recreation area, or refuge. Moreover, increased visitation before, during, or after a launch event could result in beneficial impacts from additional revenues from entry fees (if applicable) and furthering the mission of the parks, recreational areas, and wildlife refuges to enrich the lives of citizens through outdoor recreational opportunities and natural and cultural heritage education programs.

The FAA considered the potential for increased traffic and visitors to result in adverse effects on historic properties in Section 3.7.4. The presence of increased numbers of people would bring greater attention to historic sites including the NHL, and possibly Palmetto and Cypress Bridge Pilings Site, and the Palmetto Pilings Historical Marker. Increased foot or vehicular traffic, particularly from off-road vehicles, could impact the NHL, Palmetto and Cypress Bridge Pilings Site, and the Palmetto Pilings Historic Marker. The largest number of visitors are expected for launch operations. To mitigate, SpaceX would undertake the mitigation measures described in Section 3.7.4, including maintaining checkpoints, and developing interpretive signage in English and Spanish that will educate visitors on the importance of cultural areas and the need to stay within defined access areas and the legal implications of vandalism and artifact collecting. Given this monitoring and mitigation to ensure protection of the historic resources, the FAA has determined there is no substantial impairment to the NHL, Palmetto and Cypress Bridge Pilings Site, and the Palmetto Pilings Historical Marker. Therefore, FAA has determined that daily operations would not result in a constructive use of these Section 4(f) properties. No other historic resources are expected to experience an increase in the number of visitors or traffic.

In summary, the FAA has determined the Proposed Acton would not result in more than a minimal (i.e., *de minimis*) physical use of a Section 4(f) resource and would not constitute a *constructive use*. The FAA has consulted with the officials having jurisdiction over the 4(f) properties in the study area and has

considered their comments and those of the public in making the final 4(f) determinations identified in this PEA.

### 3.8.5 Mitigation and Monitoring

The FAA would ensure that SpaceX implements the following measures to avoid, minimize, or mitigate impacts on Section 4(f) resources.

1. SpaceX would restore the SH 4 ROW to pre-disturbance conditions after installation of utilities.
2. In the event of an anomaly, SpaceX would notify TPWD, TGLO, and/or USFWS, as applicable, per the procedure outlined in SpaceX's Anomaly Response Plan.
3. Following an anomaly, SpaceX would release the access restriction area west of the "All Hard Checkpoint" (Figure 2-4) to allow visitors to continue to access the NHL and NWR while anomaly-response actions are taken. SpaceX would keep the "All Hard Checkpoint" in place to protect public safety and implement the measures outlined in its Anomaly Response Plan.
4. SpaceX or a qualified contractor would conduct debris removal in accordance with a method as determined by TPWD and agreed to by SpaceX.
5. Restoration measures regarding any adverse impacts to landforms include monitoring disturbed areas for spread of non-native vegetation and removal upon discovery, spreading seeds found locally from preferred grass species, and regrading disturbed land to its pre-existing condition. Alternative restoration approaches may be considered as determined by TPWD and agreed to by SpaceX.
6. Restoration areas with respect to algal flats include grooming of tracks with the use of hand tools and ambient soils to prevent further impacts, removing fill, establishing the proper slope within the tidal range, and inoculating the soils with a mixture of the dominant algal species, or any other approach as determined by TPWD and agreed to by SpaceX.
7. SpaceX would implement the additional measures outlined in TPWD's concurrence letter, dated May 11, 2022, which include the following:
    a. Strict compliance with all terms and conditions of the MOA executed September 2, 2021, between TPWD and SpaceX.
    b. Completion and maintenance of bollard-and-cable traffic control fencing along SH 4 demarcating the boundaries of TPWD lands. SpaceX at its sole cost will survey the SH 4 boundary and will leave two or three gaps in the western portion of the fence only as necessary to provide reasonable access to privately owned inholdings at access points recorded in the real property records of Cameron County. Signage will be placed at each gap with contact information for legitimate landowners to gain access to their property.
    c. SpaceX will take all necessary measures to make TPWD-owned lands at Boca Chica accessible to researchers and all TPWD and/or USFWS-authorized personnel at all times except during ignition events.
    d. SpaceX will cover the cost of a contract with TPWD and/or Texas A&M Corpus Christi/Texas A&M system to develop specific protocols for test restoration of impacts to

tidal/algal flats at Boca Chica resulting from the SN11 anomaly within 30 days of presentation of such a contract. The scope of the contract will include the cost of a principal investigator, one or two graduate students and all related equipment, materials, overhead, administrative, and publication costs.

e. In the event Texas A&M University is unable to provide the services outlined above, TPWD staff will work in good faith to identify another academic institution or similarly qualified third party to undertake the proposed project and will keep SpaceX staff apprised of its progress.
f. During the first "restoration season" as recommended by and following the study referenced in the preceding paragraphs, SpaceX, at its sole expense, will hire a qualified environmental firm to undertake a test restoration per the recommendations of the study, covering a minimum of five net acres of tidal/algal flats affected by the impacts of debris and debris retrieval following the SN11 anomaly. SpaceX will work cooperatively with TPWD to designate the specific footprint of the test restoration.
g. SpaceX, at its sole cost, will pay for monitoring the success of the test restoration relative to success criteria described in the protocols developed in the study. If no such protocols have been developed, success of the test restoration will be monitored relative to success criteria developed by the implementing environmental firm and agreed to by TPWD. A report on the progress of the restoration will be submitted to TPWD not less than 22 nor more than 26 months after implementation.
h. If the test restoration is determined to be successful, SpaceX, at its sole cost, will arrange the restoration of an additional 15 acres to be determined in consultation with TPWD and implemented no later than the restoration season following submission of the report refenced in paragraph #7.g above.
i. If the test restoration is determined to be unsuccessful, SpaceX, at its sole cost, will consult with the investigators and/or authors of the report referenced in paragraph #7.d and #7.e above and based on that input will repeat the measures in paragraphs #7.f, #7.g and #7.h above. These steps will be repeated until successful restoration of 20 acres is achieved. TPWD may waive this condition if it advises FAA in writing that all reasonable attempts to restore habitat result in more harm than good.
j. Once a successful restoration protocol is established, SpaceX will take steps to implement restoration of any new impacts that occur pursuant to activities permitted or licensed by the FAA immediately upon request by TPWD.

8. SpaceX would issue notifications prior to a planned access restriction and in accordance with its Access Restriction Notification Plan, including:

    a. Providing a forecast of planned access restrictions one to two weeks in advance of the access restriction on the County's website and/or send via email to the agency distribution list. Information about the proposed access restriction would be posted on Cameron County's website.[35]
    b. Sending access restriction notifications to the regulatory and public land-managing agencies as plans finalize (48 hours prior to the access restriction). The agencies would

[35] See: https://www.cameroncounty.us/space-x/.

continue to receive updates immediately when the access restrictions go into place and when the access restrictions end, as well as cancellations of requested access restrictions. SpaceX personnel at the LLCC would send these notifications to ensure the most up-to-date information is distributed.

c. Sending real time status and updates on access restrictions through a text message alert service. Subscribers can text "BEACH" TO 1-866-513-3475 to receive updates.

9. SpaceX would implement the following measures to limit access restrictions:

    a. No SH 4 access restrictions on the following holidays: Memorial Day, Labor Day, July 4th, MLK Day, Presidents' Day, Texas Independence Day, Cesar Chavez Day, Emancipation Day in Texas (also referred to as Juneteenth), Veteran's Day, Good Friday, Easter, Father's Day, Mother's Day, Thanksgiving Day, Christmas Day, New Year's Day ("Holidays").

        i. Where any of the Holidays falls annually on a Monday or Friday, no Weekend Access Restrictions, as defined in 9.d below, shall be permitted.
        ii. Where any of the Holidays does not fall annually on a Monday or Friday, but falls on a Monday or Friday in a particular year, no Weekend Access Restrictions, as defined in 9.d, shall be permitted for that year.
        iii. For Thanksgiving, no access restrictions shall be permitted from Thanksgiving Day through the Sunday immediately following Thanksgiving.

    b. Except as provided in 9.d, from Memorial Day to Labor Day (the times of greatest visitor beach uses and enjoyment), no Weekend Access Restrictions from Friday at 6:00 a.m. through Sunday. Road access restrictions for any SpaceX activities would occur from Monday through Friday at 6:00 a.m. This predictive schedule ensures the public access to all open areas of the NWR (e.g., Boca Chica Beach) from Friday at 6:00 a.m. through Sunday from Memorial Day through Labor Day.
    c. Except as provided in 9.d, from the day after Labor Day to the day before Memorial Day (throughout the winter months), no Weekend Access Restrictions on Saturday or Sunday.
    d. When a SpaceX activity requires at least one road access restrictions between Fridays at 6:00 a.m. and Sundays from Memorial Day to Labor Day, or on weekends from the day after Labor Day to the day before Memorial Day, it is considered a "Weekend Access Restriction."

        i. SpaceX may request a Weekend Access Restriction up to five times per calendar year.

    e. For any SH 4 road access restriction, SpaceX will request, at least 48 hours prior to the start of the access restriction period, that the Cameron County Commissioners Court implement the access restriction. This notice requirement is intended to give the public a minimum 48-hour notice to reduce impacts to the recreational users. Any requested Weekend Access Restriction shall count toward the total five annual Weekend Access Restrictions unless cancellation of the Weekend Access Restriction is publicized more than 24 hours prior to the start of the requested access restriction period.
    f. Exception to the above is for activities deemed to be anomalies per FAA regulations.

10. SpaceX would implement measures identified in the Section 106 PA.

11. SpaceX would implement the lighting mitigation measures from Section 3.6.5.

12. SpaceX would implement the insurance requirements noted in Section 3.5.5, which require that SpaceX pay for any structural damage that may occur, thereby ensuring restoration and reducing the impact to a Section 4(f) resource.

In addition to the measures identified above, SpaceX would implement the following measures to mitigate impacts on recreational activities:

13. SpaceX would collaborate with TPWD and USFWS to meet USFWS fishing objectives for the region. To accomplish this goal, SpaceX would:

    a. Provide improved, enhanced, or new access for fishing opportunities in the Gulf of Mexico, Rio Grande, Brownsville Shipping Channel, and/or South Bay. SpaceX will provide $5,000 annually to enhance the existing TPWD Tackle Loaner Program. This funding may be used to purchase fishing equipment (rods, reels, and tackle boxes with hooks, sinkers, and bobbers) for use at existing, heavily visited sites and/or allow the program to expand to new locations.
    b. Participate in fishing introduction and instruction opportunities on-site. SpaceX will provide the opportunity for Fishing's Future representatives to participate in the monthly beach cleanups and teach environmental stewardship and increase awareness for the protection, conservation, and restoration of aquatic natural resources.

14. SpaceX would collaborate with USFWS to meet wildlife observation, interpretation, and photography objectives for the area, as well as NHL priorities. To accomplish this goal, SpaceX would:

    a. Coordinate with the USACE, TxDOT, and USFWS to explore the feasibility of constructing one safe pull off along Highway 4, east of the first public hard checkpoint, or other roads adjacent to the NWR. At this location, which will be determined by USFWS in coordination with SpaceX, SpaceX will construct a wildlife viewing platform and associated signage; the signage will address the resident wildlife, NHL, and the SpaceX launch site.
    b. Provide enhanced satellite monitoring via solar powered Starlink for remote wildlife viewing opportunities. Enhanced satellite monitoring will be provided at location(s) to be determined by USFWS, in coordination with SpaceX.
    c. Participate in wildlife photography introduction and instruction opportunities on-site. SpaceX will provide the opportunity for wildlife photographers to instruct the public during the monthly beach cleanups and/or provide wildlife photography information and instructions at the wildlife viewing platform.
    d. Provide improvements to the site interpretive message system along the SH 4 corridor east of the first public hard checkpoint. Locations and sign content will be determined by USFWS, in coordination with SpaceX. Improvements will also benefit NHL interpretation.
    e. Participate in public event(s), such as the Coastal Expo, that focus on joint SpaceX, TPWD, USFWS, and NPS mission outreach. SpaceX will participate in one event annually.

15. SpaceX would collaborate with USFWS to meet environmental education objectives. To accomplish this goal, SpaceX will provide onsite Science, Technology, Engineering, and Math

based learning opportunities. SpaceX will host regular site tours and one annual educational event for students in the Brownsville Independent School District. On the site tours, SpaceX will educate the students on the sensitive resources and habitat surrounding the SpaceX facilities. SpaceX would coordinate with the USFWS on the information to be shared relevant to the sensitive resources and habitat surrounding the SpaceX facilities. At the annual educational event, SpaceX will invite USFWS, TPWD, and NPS to participate to speak to the importance of studying the Life and Physical Sciences.

# 3.9 Water Resources

## 3.9.1 Definition of Resource and Regulatory Setting

Water resources are surface waters and groundwater that are vital to society; they are important in providing drinking water and in supporting recreation, transportation and commerce, industry, agriculture, and aquatic ecosystems. This impact category includes surface waters, groundwater, floodplains, and wetlands. These resources do not function as separate and isolated components of the watershed but rather as a single, integrated natural system. Disruption of any one part of this system can have consequences to the functioning of the entire system. The analysis includes not only disruption of the resources but also potential impacts on the quality of the water resources. Because of the close and integrated relationship of these resources, their analysis is conducted under the all-encompassing impact category of water resources. Wild and Scenic Rivers are included because impacts on these rivers can result from obstructing or altering the free-flowing characteristics of a designated river, an impact more closely resembling an impact on a water resource.

The major laws and EOs pertaining to water resources include the CWA; EO 11990, *Protection of Wetlands*; EO 11988, *Floodplain Management*; Safe Drinking Water Act; and Wild and Scenic Rivers Act. The CWA establishes the basic structure for regulating the discharge of pollutants into waters of the United States, including wetlands. EO 11990 require federal agencies to avoid to the extent possible the long- and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative. However, EO 11990 does not apply to the issuance by federal agencies of permits, licenses, or allocations to private parties for activities involving wetlands on non-Federal property. EO 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of 100-year floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative.

More information about water resources can be found in Chapter 14 of the FAA Order 1050.1F Desk Reference (FAA 2020d).

## 3.9.2 Study Area

The study area for water resources is defined as surface water, groundwater, wetlands, and floodplains within or adjacent to the SpaceX Boca Chica Launch Site. The study area also includes portions of the

open ocean water of the Gulf of Mexico and Pacific Ocean (see Figures 3 and 5 in the NMFS Letter of Concurrence in Appendix D).[36]

## 3.9.3 Existing Conditions

The existing conditions for water resources in the study area were described in the 2014 EIS (FAA 2014a) and have not substantially changed. Therefore, the 2014 EIS information is incorporated by reference and summarized below. New or updated existing conditions information (e.g., FEMA floodplain mapping) developed since the 2014 EIS is included in the descriptions below.

### 3.9.3.1 Surface Waters

Surface waters are streams, rivers, lakes, ponds, estuaries, bays, and oceans. The proposed project is located within the South Laguna Madre watershed, which is within the Bahia-Grande Brownsville Ship Channel watershed, a 363-square mile subwatershed to the Southwestern Texas Coastal Basin. The study area for surface waters includes South Bay, Laguna Madre, the Rio Grande, and the nearshore waters of the Gulf of Mexico adjacent to the Boca Chica Launch Site.

The wetland delineation (see Section 3.9.3.3) did not identify any surface waters within the boundary or footprint of the proposed project, but the previously listed surface waters in the study area are adjacent to or in the vicinity of the proposed project.

South Bay is an inland bay along the Gulf of Mexico located within the Laguna Madre hypersaline lagoon system and is the southernmost bay in Texas (TCEQ 2020b). South Bay is separated from the Gulf of Mexico by Brazos Island. On the northern boundary of South Bay is an inlet where water flows freely from South Bay into the Brownsville Shipping Channel, which connects the Port of Brownsville to the Gulf of Mexico. On the southern end of South Bay is Boca Chica Bay, where Boca Chica State Park is located. Boca Chica Bay is located approximately 165 feet from the VLA.

Waters of the Gulf of Mexico and the Laguna Madre are included on the 2020 Texas 303(d) List for impaired waters (TCEQ 2020a). Causes of Gulf of Mexico impairment include the presence of mercury in fish tissue and bacteria in the water (recreation use). Causes of the Laguna Madre impairment include bacterial in water (recreation and oyster use) and depressed dissolved oxygen. South Bay (including Boca Chica Bay) and the Rio Grande segment near the proposed project are not listed as impaired surface waters (TCEQ 2020a).

### 3.9.3.2 Groundwater

Available groundwater in the vicinity of the Boca Chica Launch Site is primarily within the Gulf Coast Aquifer which is found along the Gulf Coast from Texas, Louisiana, Mississippi, Alabama, and western Florida. Sediment thickness within this aquifer increases from west to east toward the Gulf of Mexico with a minimum sediment thickness of 1,200 feet up to a maximum of 3,200 feet. The aquifer shows less variation in thickness along the north-south direction (Baker 1979).

[36] Due to the programmatic nature of this document and the lack of mission-specific details at this time, the open ocean elements of the study area are discussed more broadly.

The EPA has not designated any Sole Source Aquifers within the vicinity of the Boca Chica Launch Site (EPA 2021b); the closest Sole Source Aquifer is located over 250 miles away, just north of San Antonio, Texas. According to the Texas Water Development Board, there is an identified groundwater well at the VLA for industrial use. The next closest water withdrawal well is located approximately 5.6 miles to the north on South Padre Island (TWDB 2020a).

In general, recharge to the aquifers in the study area is through precipitation. Water that does not run off and is not lost through evapotranspiration percolates into the subsurface. The soils of the project area are characterized by many different types varying in permeability from less than 0.06 inch per hour (low) to 6 inches per hour (high). Recharge can also occur by infiltration of excess irrigation water. Along the Rio Grande and the numerous unlined floodways and irrigation canals in the study area, water percolates into the subsurface when the local water table is lower than the streambed (McCoy 1990). Collectively, the different regions in and around the study area form a large, leaky artesian system in which recharge can occur wherever there are permeable sands (Muller and Price 1979). The recharge to these aquifers generally occurs inland to the west, and the discharge of these aquifers occurs along the Gulf Coast, largely due to the pattern of sedimentation thickness described above.

Although significant quantities of groundwater occur in the Gulf Coast Aquifer in sections where sands are dominant, much of this resource is not directly usable; salinity generally exceeds 1,000 milligrams per liter (mg/L) total dissolved solids (TDS) (slightly saline) and often exceeds 3,000 mg/L TDS (moderately saline) (McCoy 1990). This is greater than the National Secondary Drinking Water Regulations standard of 500 mg/L. Additionally, constituents such as chloride and sulfate often exceed the Texas Department of Health recommended drinking water standards. The groundwater in the vicinity of the VLA has TDS greater than the Texas Department of Health recommended drinking water standards; this was confirmed at the VLA with TDS testing at the existing VLA groundwater well.

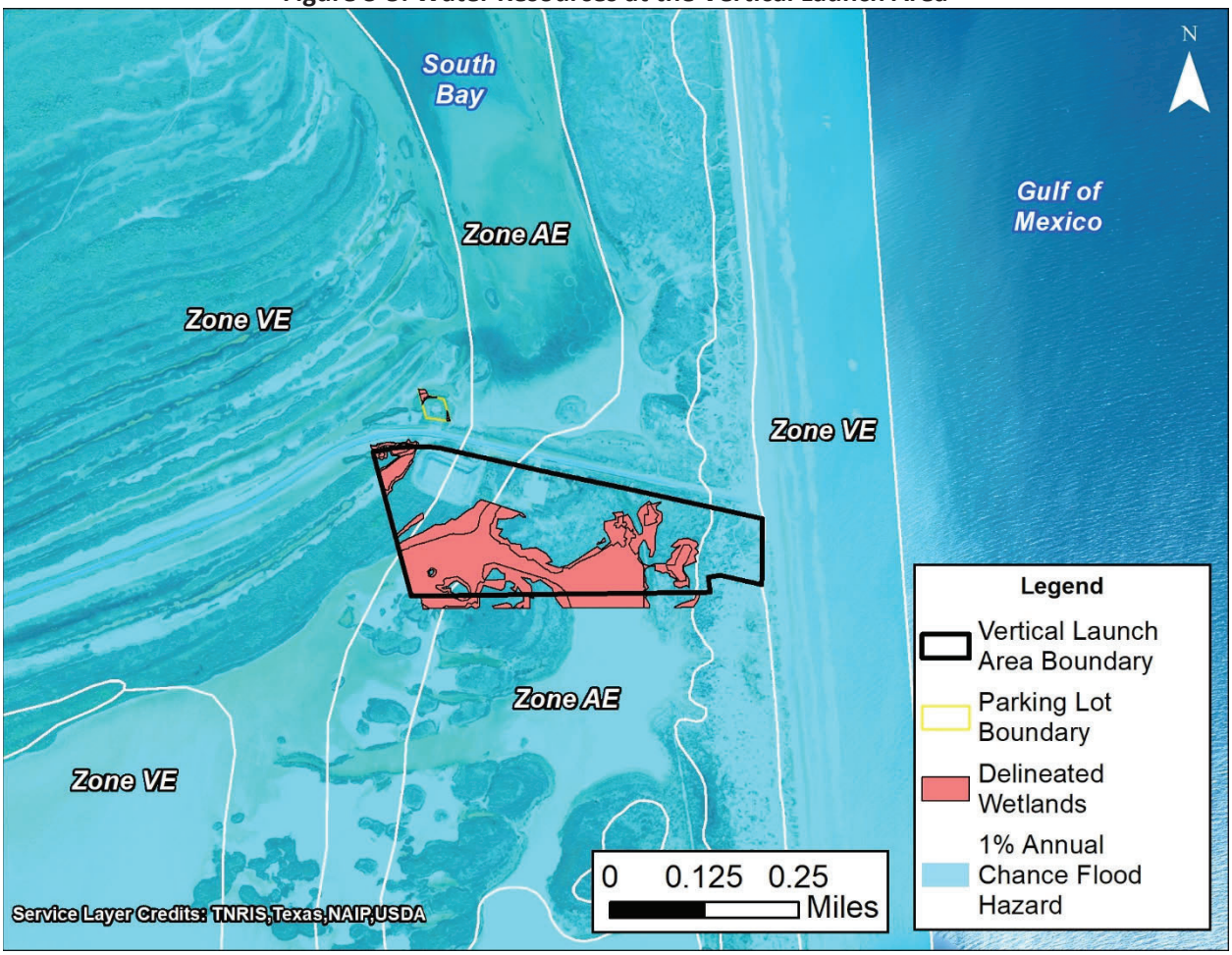
Groundwater demand in the study area is described in detail in Section 3.14.

#### 3.9.3.3 Wetlands

Wetlands were delineated within the VLA, solar expansion sites, and parking lot using the 1987 USACE Wetland Delineation Manual (USACE 1987) and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain (USACE 2010). The delineation for the 2014 EIS was conducted in May 2012. During the wetland delineation, it was determined that only the vertical launch area and Parcel 3 of the control center area contained wetlands. Of the entire 69 acres, a total of 25.5 acres of wetlands were present at the VLA and 0.05 acre of wetlands in Parcel 3 of the control center area. The USACE issued a preliminary Jurisdictional Determination on August 31, 2012 and provided concurrence on the wetland boundaries and area. Approximately 3.3 acres of wetland delineated in 2012 at the vertical launch area were subsequently filled or indirectly affected during the vertical launch area site development. In September and October of 2020, Cardno GS verified the boundaries of wetland previously delineated and not impacted at the VLA and delineated the 1.9 acres of previously un-surveyed property at the VLA, as well as the 0.7-acre parking lot area. At the VLA property outside of the existing pad boundaries, 18.70 acres of wetlands were delineated on SpaceX property, and 2.96 acres delineated outside SpaceX property. At the parking lot area, 0.12 acre of wetlands were delineated. No wetlands were identified at the solar farm expansion or pull-off areas. The USACE is working on issuing a preliminary Jurisdictional Determination on the 2020 wetland

verification and delineation (Figure 3-5). The mudflats, estuarine, and non-tidal wetlands within the project area are considered Aquatic Resources of National Importance pursuant to CWA Section 404q.

**Figure 3-5. Water Resources at the Vertical Launch Area**




### 3.9.3.4 Floodplains

The Boca Chica Launch Site is located within the 100-year flood zone. The VLA is located within Zone AE and Zone VE, and the remainder of the SpaceX facility is located within Zone AE (FEMA 2018). Zone VE is considered a high-risk coastal area, with a 1 percent or greater chance of flooding and an additional hazard associated with storm waves. Zone AE is considered a high-risk area, and these zones generally extend from the landward VE zone limit to the limits of the 100-year flood from coastal sources, or until it reaches the confluence with riverine flood sources. There are slight changes in elevation in the different parts of the project area; these and the detailed flood zone designations are explained in detail in FAA 2014a.

## 3.9.4 Environmental Consequences

According to FAA Order 1050.1F, impacts on surface waters would be significant if the action would 1) exceed water quality standards established by federal, state, local, and tribal regulatory agencies; or 2) contaminate public drinking water supply such that public health may be adversely affected.

Impacts on wetlands would be significant if the action would:

- Adversely affect a wetland's function to protect the quality or quantity of municipal water supplies, including surface waters and sole source and other aquifers;
- Substantially alter the hydrology needed to sustain the affected wetland system's values and functions or those of a wetland to which it is connected;
- Substantially reduce the affected wetland's ability to retain floodwaters or storm runoff, thereby threatening public health, safety or welfare (the term welfare includes cultural, recreational, and scientific resources or property important to the public);
- Adversely affect the maintenance of natural systems supporting wildlife and fish habitat or economically important timber, food, or fiber resources of the affected or surrounding wetlands;
- Promote development of secondary activities or services that would cause the circumstances listed above to occur; or
- Be inconsistent with applicable State wetland strategies.

Impacts on groundwater would be significant if the action would 1) exceed groundwater quality standards established by federal, state, local, and tribal regulatory agencies; or 2) contaminate an aquifer used for public water supply such that public health may be adversely affected.

Impacts on floodplains would be significant if the action would cause notable adverse impacts on natural and beneficial floodplain values. Natural and beneficial floodplain values are defined in Paragraph 4.k of DOT Order 5650.2, *Floodplain Management and Protection*.

This section addresses impacts to water resources. Determination of water resource impacts is based on an analysis of the potential for activities to affect surface water, groundwater, wetlands, and floodplains, as defined by applicable laws and regulations.

### 3.9.4.1 Surface Waters

Construction activities could affect surface waters through ground disturbance activities and use of construction equipment. Construction would involve clearing, grading, filling, and excavation that could cause erosion and mobilize sediment in stormwater runoff to nearby waterways. Sediment entering waterways has the potential to cause increased turbidity and suspended solids and carry pollutants contained in the sediment into the surrounding waterways. Increased turbidity in surface waters may smother fish eggs, aquatic insects, and oxygen producing plants, increase water temperatures, and reduce oxygen levels.

Use of construction equipment could result in release of contaminants (e.g., leaks, drips, and spills of petro-chemicals) that could reach nearby waterways and adversely affect water quality. However, SpaceX would implement its Spill Prevention, Control, and Countermeasures (SPCC) Plan to minimize the potential for accidental releases of polluting substances from construction equipment. SpaceX's adherence to the SPCC Plan would minimize or altogether avoid the potential for a contaminant to reach a surface water and impact water quality.

SpaceX would manage surface water discharges from runoff during construction and operations according to the requirements of the TPDES. SpaceX would update its facility Construction and Industrial Stormwater Pollution Prevention Plans (SWPPPs) prior to conducting FAA-permitted or -licensed operations to maintain compliance with the TPDES permit, the state equivalent of a NPDES permit. The SWPPPs include BMPs to prevent indirect impacts from erosion and sedimentation to the nearby water bodies. Thus, SpaceX would minimize impacts associated with an increase of stormwater runoff to surface waters by implementing the BMPs.

The facilities will be constructed above ground level and where possible, creating a natural drainage away from the facilities through designated outfalls in accordance with TCEQ storm water discharge permit conditions. Runoff will be into areas surrounding the VLA and the parking lot. As will be described in the SWPPP, these conditions would be documented and appropriate BMPs would be implemented. Any applicable sampling and inspection schedule would also be provided. Appropriate BMPs would include pollution prevention measures, such as rip rap, swales, implementation of SPCC Plans, vegetation, and/or retention.

Boca Chica Launch Site operations with the most potential to affect surface waters include testing and launches. Water generated from pad washdown and launch deluge (if utilized) from launch and testing operations at the VLA has potential to reach nearby waterways and effect water quality if not properly contained. However, a containment area adjacent to the launch mount that would include retention ponds would minimize or altogether avoid this potential impact. If water treatment or retention is required, water would be contained in the retention ponds. 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. Retention ponds would be lined to prevent percolation of contaminants into the groundwater and would be maintained and monitored by SpaceX. SpaceX would develop appropriate sampling protocols and water quality criteria in coordination with the TCEQ in accordance with Texas Surface Water Quality Standards. SpaceX would remove water containing contaminants that exceed the water quality criteria and haul it to an approved industrial wastewater treatment facility. SpaceX would pump all other water not containing prohibited contaminants back to the water storage tanks for reuse. Exhaust clouds formed from the exhaust plume and evaporation and subsequent condensation of deluge water, if utilized, could also affect surface water drainage systems from the launch pad. The exhaust cloud would consist largely of steam with insignificant amounts of hazardous materials from LOX and $LCH_4$ propellants that would degrade quickly. The containment and treatment of deluge water and temporary and minimal volume of water condensing from the exhaust cloud would minimize or altogether avoid impacts to adjacent surface water quality.

A launch anomaly or planned ocean landing could spill fuel and potentially affect surface waters. However, no residual spilled fuel is expected from a test flight planned to land in the ocean or a failed launch or landing, as any cryogenic propellants would either be combusted or would rapidly become gaseous. A test flight planned landing in the ocean or an anomaly where Starship or Super Heavy survived the water impact essentially intact would be anticipated to have short-term impacts on water quality because any fuel not consumed by combustion or not contained inside the tank would dissipate within hours.

During a landing in the ocean, launch vehicle components could affect water quality in the area of the landing site. Vehicle components could include non-recoverable items (debris) from a landing anomaly

that would sink to the ocean bottom. However, the non-recoverable items are made of inert materials and are not anticipated to affect water quality. Recovery operations would result in typical discharges to surface waters (bilge water, residual diesel fuel #2, oils, and lubricants) associated with commercial shipping activities. SpaceX would mitigate these impacts and potential larger fuel spills by adherence to proper marine vessel operating procedures and use of appropriate BMPs in the event of a spill.

Due to the capture, containment, and treatment of surface water runoff during construction and operations; required water quality permitting measures; insignificant amounts of hazardous materials in launch clouds; inert vehicle components; and adherence to marine vessel operating procedures and BMPs, the construction and operation of the Proposed Action would not have a significant impact on surface waters.

### 3.9.4.2 Groundwater

Construction activities would not require significant quantities of groundwater. Potential impacts to groundwater quality during construction include contamination from spills or leaks from construction vehicles and machinery. If such fluids were spilled on the ground, they could migrate to shallow groundwater underlying the Boca Chica Launch Site. However, compliance with the SPCC Plan would minimize the potential for accidental releases of polluting substances from construction equipment. Therefore, construction impacts to groundwater would not be significant.

The driving of piles to support infrastructure at the VLA is not anticipated to impact groundwater resources. Pile installation would not exceed the limits of the overlying sediments associated with Rio Grande Alluvium. The thickness of this deposit ranges from 50 to 300 ft and the water bearing portion of this deposit is located over 10 miles west of the VLA between the City of Brownsville and Rio Grande City. Therefore, the installation of support piles would not breach confining layers to any underlying drinking water aquifers and no drinking water sources within the Rio Grande Alluvium would be affected.

Aquifer drawdown from the operational activities was conservatively calculated assuming a transmissivity of 49,500 gpd/feet and aquifer storativity of 0.0001 (FAA 2014a). It is estimated that the water production well screened in the discontinuous sand and clay beds of the Chicot aquifer would produce water at an average rate of approximately 25 gallons per minute (gpm), based on the maximum projected water yield of 13,000,000 gallons for the launch operations, assuming a constant pumping rate[37]. Using the Theis equation[38] to calculate drawdown, the maximum drawdown at one well would range up to 0.60 feet after 20 years of withdrawal.

The groundwater quality at the VLA would be affected by runoff from percolation of launch deluge, if utilized, and washdown water or accidental spills that percolate into the surficial aquifer. The construction of required stormwater management systems may increase the chance of unintended introduction of pollution to the aquifer. However, percolation rates are low in the VLA area and SpaceX

[37] This amount assumes a 60% brine rejection rate, the water demand for the launch operations would be 5,200,000 gal of water.

[38] The Theis equation uses time, the pumping rate of the well, transmissivity and storativity of the aquifer around the well, and distance from the pumping to the point where the drawdown is observed to determine the drawdown.

plans to recirculate the water or dispose of it as waste. Regardless, the Proposed Action would have minimal impact to the groundwater quality with stormwater treatment and industrial wastewater systems that are properly designed and operated in accordance with permit conditions. Impacts to groundwater from accidental spills are possible but would be mitigated by proper design redundancies of commodity storage facilities, containment around all hydraulic systems, safety measures included in launch vehicle processes, and spill response and clean-up measures employed by SpaceX. Therefore, operational launch impacts to groundwater would not be significant.

### 3.9.4.3 Wetlands

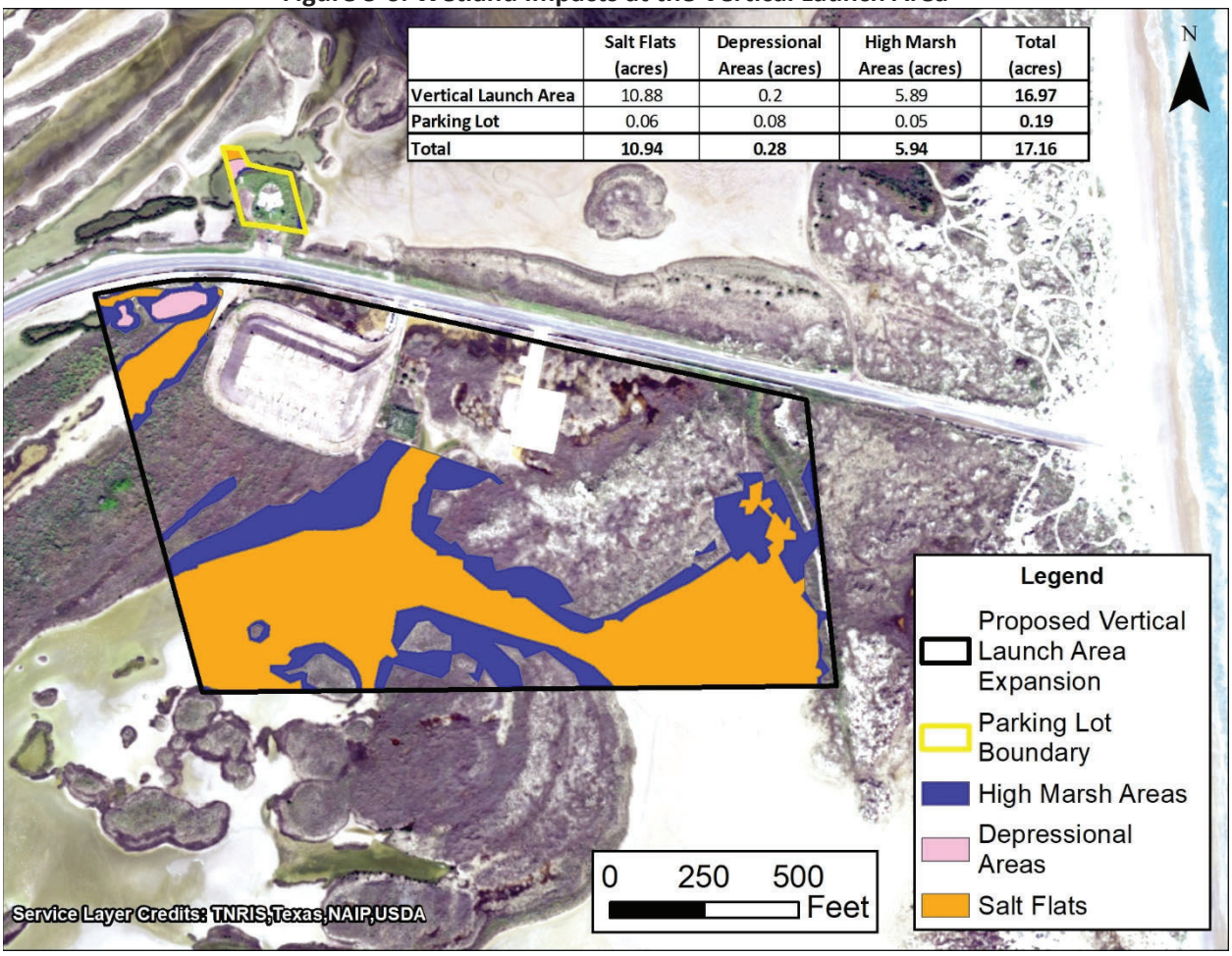
Construction of the proposed project is anticipated to permanently fill 10.94 acres of salt flats, 0.28 acres of depressional areas, and 5.94 acres of high marsh areas for 17.16 acres of wetland impact (Figure 3-6). These wetlands would be converted to uplands and therefore would not retain any of the previous wetland functions or values, such as groundwater recharge and flood storage. Avoidance and minimization measures were implemented to reduce impacts to jurisdictional features, including locating the parking area predominantly in uplands, locating additional parking in other areas of installation, and siting payload and processing facilities away from wetlands. Retaining walls were evaluated but did not meet site safety requirements. SpaceX has implemented a shuttle service to reduce the parking lot size; however, a parking lot is still needed for launch support staff in the event of an emergency, staging of equipment, and in the event the shuttle service is down. The Proposed Action includes measures to minimize harm to wetlands that may result from construction.

Construction activities could also affect adjacent wetlands through ground disturbance activities and use of construction equipment. These potential impacts and measures to minimize or altogether avoid these potential impacts are similar to those described in section 3.9.4.1, *Surface Waters*.

SpaceX will need to obtain a Department of the Army permit from the USACE for the proposed permanent filling of 17.16 acres of wetlands. The USACE is currently evaluating SpaceX's proposed impacts and wetland mitigation pursuant to CWA section 404(b)(1) Guidelines (40 CFR 230) and section 404q, which require SpaceX to avoid, minimize, and mitigate impacts to aquatic resources, including Aquatic Resources of National Importance. Wetland mitigation for permanently filled wetlands would include in-kind mitigation for both mudflats and estuarine wetland impacts through creation and enhancement of wetlands within the watershed, and wetland preservation. The USACE will evaluate an application from SpaceX under Section 404 of the CWA, which requires review of various issues including alternatives and appropriate mitigation for wetland impacts. The USACE will issue a separate decision on SpaceX's permit application after completion of its review. With the replacement of lost wetland functions through the Section 404 permitting and mitigation process, construction impacts on wetlands are not anticipated to be significant per the significance thresholds identified at beginning of Section 3.9.4.

Operational impacts would be limited to a potential increase in stormwater discharges to adjacent wetlands from new impervious surfaces. As previously discussed, SpaceX would implement its SPCC Plan to minimize the potential for accidental releases of polluting substances. SpaceX would train employees trained in spill response specific to the materials they use. Additionally, SpaceX would incorporate spill response procedures into regular safety meetings. Further, SpaceX would manage discharges during operations at the site according to requirements of the TPDES permit, as described in Section 3.9.4.1.

**Figure 3-6. Wetland Impacts at the Vertical Launch Area**




## 3.9.4.4 Floodplains

Floodplain impacts to floodplains can be thought of as a displacement issue. If fill is placed in a floodplain, an equal amount of capacity to hold floodwaters is removed from the floodplain. Potential impacts from floodplain development and the subsequent filling of floodplains include the obstruction and diversion of floodwaters to other areas, increased flood levels, reduction in the storage capacity of floodwaters, and increased water velocities during flooding.

Fill material would be required to elevate areas of proposed expansion out of the floodplain. SpaceX would source fill material from on-site whenever possible. If necessary, additional clean fill material would be sourced from the local region. At the VLA, SpaceX would fill approximately 18.3 acres of floodplain in Zone AE and approximately 4.7 acres in Zone VE. It is assumed that the VLA would require 3.3 feet of fill, and the total amount of fill needed at the VLA would be 220,980 cubic yards.

At the proposed parking lot parcel, SpaceX would fill approximately 0.6 acre in Zone VE. At the solar farm, SpaceX would fill approximately 2 acres in the expansion areas. For both the solar farm area and the proposed parking lot, it is assumed that 1 foot of fill would be required. The total amount of fill at the proposed parking lot parcel would be 1,050 cubic yards and at the solar farm there would be 3,270

cubic yards of fill placed. Flood Zones AE and VE have different designations and are therefore quantified separately.

SpaceX would coordinate the proposed construction with the Cameron County floodplain administrators to obtain a development permit. Cameron County is a participating community in FEMA's National Flood Insurance Program (NFIP), so SpaceX's proposed development in the 100-year flood zone requires SpaceX to comply with the FEMA-approved floodplain development requirements that are part of Cameron County's floodplain development requirements. As part of the floodplain development permit process, SpaceX would conduct a hydraulic analysis of the floodplain associated with the VLA and LLCC areas during the preliminary engineering design phase of the project. The hydraulic analysis would determine if the fill and construction of facilities within the floodplain would affect the base flood elevation. If the study determines that construction would not affect the base flood elevation, SpaceX would submit a "No-Rise" Determination to the county. However, if the hydraulic study determined that the base flood elevation would be affected, SpaceX would conduct further engineering design to mitigate for the change in base flood elevation in order to comply with NFIP and Cameron County building regulations as required by the National Flood Insurance Act (42 U.S.C. Part 50). The hydraulic study would also ensure that no flood storage would be lost and that the facility is adequately designed to prevent flotation, collapse, or lateral movement of the structure due to hydrodynamic and hydrostatic loads, including the effects of buoyancy. The design engineer will certify that the design elevation will withstand the depth and velocity of 100-year flood events (hydrostatic and hydrodynamic loads), any potential increase in wind load, or any other relevant load factors. Compliance with the NFIP as well as county regulations would ensure that the construction will have no significant impacts on floodplain storage and base flood elevations.

There would not be any significant adverse impacts to floodplain function from operation of the water deluge system if used, as most water would be vaporized and the remaining collected in adjacent retention basins. While the launch pad is surrounded by floodplain and located next to an unvegetated flat, no water would reach the ground during the launch period. While there is a small potential for water vapor to reach this unvegetated area, it is not expected that the amount of water vapor from launches would be enough to alter vegetation and the floodplain function.

In the event of a flood or storm event, SpaceX would implement flood control measures which could include locating water-sensitive equipment, supplies, chemicals, etc. above flood level, and moving hazardous waste outside of the floodplain when substantial storms are imminent. The implementation of these measures would reduce the likelihood that a flood or storm event might result in loss of life, injury to persons, or damage to property or otherwise would be considered a "critical action" as defined in EO 11988, *Floodplain Management*.

The construction activities would also be required to comply with EO 11988, Floodplain Management, through the procedures identified in DOT Order 5650.2. To determine if construction activities associated with the Proposed Action would result in a significant floodplain encroachment per DOT Order 5650.2, each of the three scenarios are addressed below:

***The action would have a considerable probability of loss of human life:***

The proposed construction activities associated with the Proposed Action would not result in considerable probability of loss of human life. No part of these areas would be designed or constructed

for human habitation or as a human dwelling. The proposed modifications would not prohibit people from entering or exiting the areas should a flood event occur.

***The action would likely have substantial, encroachment-associated costs or damage, including interrupting aircraft service or loss of a vital transportation facility (e.g., flooding of a runway or taxiway, important navigational aid out of service due to flooding, etc.).***

The Boca Chica Launch Site is located within a large contiguous floodplain that spans an area of approximately 5,475 acres. The proposed expansions would result in the filling of 25.8 acres of floodplain. Filling this relatively small area (less than 1 percent of the contiguous area) would not result in new areas being subject to 100-year floods, nor would it result in existing areas subject to 100-year floods becoming more prone to floods. Under the no action alternative, SpaceX would not fill the additional 25.8 acres of floodplain; however, SpaceX would continue to develop areas within the production and manufacturing areas, which are located in Zone AE.

***The action would cause a notable adverse impact on natural and beneficial floodplain values.***

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

- A small loss of flood storage capacity would occur. Some minor benefits resulting from the filtering capacity of the floodplain would be lost due to the proposed construction. The portion of the floodplain removed from performing a filtering function is a small percentage of the overall floodplain, and stormwater facilities constructed as part of the Proposed Action would restore some of this capacity.
- The Proposed Action would adversely affect approximately 11 acres of piping plover critical habitat and 23.2 acres of proposed red knot critical habitat in the floodplain. As described in Section 3.10, the total area designated piping plover critical habitat in Unit TX-1 is 7,217 acres, and the total designated piping plover critical habitat in all of Texas is 71,053 acres. The total area proposed as red knot critical habitat in Texas is 186,240 acres; the total area proposed in TX-11 is 15,243 acres. Thus, the amount affected by the Proposed Action (11 acres of piping plover habitat and 23.2 acres of proposed red knot critical habitat) would make up a small percentage of all available piping plover and red knot critical habitat. Additionally, SpaceX would adhere to the Terms and Conditions included in the USFWS's BO to avoid, minimize, and mitigate impacts to critical habitat. Further, compensatory mitigation for wetland impacts, which include critical habitat, would be required in accordance with CWA Section 404. Accordingly, these impacts are not considered significant as the habitat loss represents only a small percentage of similar habitat located within the floodplain.
- Some operations at the Boca Chica Launch Site would require restricting public access to recreational areas within the floodplain. For the reasons discussed in Section 3.8.4.2, notable

adverse impacts to recreational uses in the floodplain are not anticipated to occur under the Proposed Action.

- A Starship/Super Heavy launch could result in a deviation from what is expected (referred to as an anomaly). Section 3.8.4.3 provides the FAA's analysis of potential effects from debris and debris removal activities. 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 applicable public land-managing agencies prior to any attempt of clean-up to minimize damage to public lands and sensitive resources. SpaceX would assess the method of debris clean-up on a case-by-case basis and coordinated with the applicable public land-managing agencies. SpaceX would assess conditions such as the location of the debris, weather, condition of the soil, number of support staff, etc. SpaceX would prioritize clean-up of debris on SH 4, followed by public lands, and then SpaceX property. SpaceX entry into public lands would be done on foot as much as possible, and SpaceX use of vehicles on public land would be coordinated with public officials. SpaceX would open the area as soon as possible following an anomaly. Therefore, notable adverse impacts to uses in the floodplain from anomalies are not anticipated to occur.

In summary, the Proposed Action would not result in significant floodplain encroachment per DOT Order 5650.2 based on the analysis above. Therefore, the Proposed Action would not result in significant impacts to floodplains.

## 3.9.5 Mitigation and Monitoring

The FAA would ensure that SpaceX implements the following measures to minimize impacts on water resources.

1. SpaceX would implement its SPCC Plan to minimize the potential for accidental releases of polluting substances.
2. In conjunction with final design and CWA permitting, SpaceX would submit a Notice of Intent to TCEQ for application of the general permit authorization for point source discharges of stormwater associated with industrial activity to surface water in the state. SpaceX would develop a SWPPP that would adhere to the permit effluent limitations and requirements applicable to the industrial activities.
3. If water treatment or retention is required, SpaceX would contain water in retention ponds. Retention ponds would be lined to prevent percolation of contaminants into the groundwater and would be maintained and monitored by SpaceX.
4. SpaceX would develop appropriate sampling protocols and water quality criteria in coordination with the TCEQ in accordance with Texas Surface Water Quality.
5. SpaceX would manage any deluge water according to state and local water quality requirements (e.g., pretreatment permits, NPDES permits, etc.).
6. SpaceX would adhere to proper marine vessel operating procedures and use of appropriate BMPs in the event of a recovery operation discharge or spill.

7. SpaceX would employ proper design redundancies of commodity storage facilities, containment around all hydraulic systems, safety measures in launch vehicle processes, and spill response and clean-up measures.
8. Pursuant to CWA Section 404, SpaceX would coordinate with USACE to develop an appropriate compensatory mitigation plan for unavoidable impacts to wetlands.
9. SpaceX would coordinate with Cameron County floodplain administrators to obtain a development permit in accordance with the NFIP as well as county regulations.
10. Following an anomaly, SpaceX would release the access restriction area west of the "All Hard Checkpoint" (Figure 2-4) to allow visitors to continue to access the NHL and NWR while anomaly-response actions are taken. SpaceX would keep the "All Hard Checkpoint" in place to protect public safety and implement the measures outlined in its Anomaly Response Plan.
11. Debris removal would occur by a method as determined by TPWD and agreed to by SpaceX.
12. In the event of an anomaly, SpaceX must obtain a Special Use Permit on an emergency basis from USFWS as applicable, prior to clean-up activities on NWR fee-owned or managed lands.
13. Restoration measures regarding any adverse impacts to landforms include monitoring disturbed areas for spread of non-native vegetation and removal upon discovery, spreading seeds found locally from preferred grass species, and regrading disturbed land to its pre-existing condition. Alternative restoration approaches may be considered as determined by TPWD and agreed to by SpaceX.
14. Restoration actions with respect to algal flats include grooming of tracks with the use of hand tools and ambient soils to prevent further impacts, removing fill, establishing the proper slope within the tidal range, and inoculating the soils with a mixture of the dominant algal species, or any other approach as determined by TPWD and agreed to by SpaceX.

# 3.10 Biological Resources

## 3.10.1 Definition of Resource and Regulatory Setting

Biological resources are valued for their intrinsic, aesthetic, economic, and recreational qualities, and include fish, wildlife, and plants, and their respective habitats. Typical categories of biological resources include terrestrial and aquatic plant and animal species, game and non-game species, special status species (state or federally listed threatened or endangered species, marine mammals, or species of concern, such as species proposed for listing or migratory birds), and environmentally sensitive or critical habitats.

Section 7(a)(2) of the Endangered Species Act (ESA) requires that each federal agency, in consultation with the USFWS or NMFS, ensures that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. The FAA is required to consult the USFWS or NMFS if an action may affect a federally listed species or critical habitat.

The MBTA (16 U.S.C. §703 et seq.) protects migratory birds by prohibiting the taking, killing, or possessing of migratory birds (including their eggs, nests, and feathers). An activity has a significant adverse effect on migratory birds if, over a reasonable period of time, it diminishes the capacity of a population of a migratory bird species to maintain genetic diversity, to reproduce, and to function effectively in its native ecosystem.

The Marine Mammal Protection Act (MMPA) of 1972 prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas. If an action has the potential to impact marine mammals, the FAA is required to consult the USFWS (for sea and marine otters, walruses, polar bears, three species of manatee, and the dugongs) and/or NMFS (for all other marine mammals). Often the marine mammals present in a project area are also listed under the ESA.

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. §§1801 et seq.) requires federal agencies to consult with NMFS regarding any activity or proposed activity that is authorized, funded, or undertaken by the agency that may adversely affect Essential Fish Habitat (EFH). EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity, and is described and identified by NMFS and regional fishery councils for all federally managed species.

Texas laws and regulations pertaining to state endangered or threatened animal species are contained in TPWD Code, Chapters 67 and 68 and TAC Sections 65.171-65.176 of Title 31. Laws and regulations pertaining to endangered or threatened plant species are contained in Chapter 88 of the TPWD Code and Sections 69.01-69.9 of the TAC. The threatened and endangered and wildlife regulations prohibit the taking, possession, transportation, or sale of any threatened or endangered animal species without the issuance of a permit. The threatened and endangered plant regulations prohibit commerce of these species and the collection of these plant species from public lands without a permit. More information about biological resources can be found in Chapter 2 of the FAA Order 1050.1F Desk Reference (FAA 2020d).

### 3.10.2 Study Area

The biological resources study area includes the areas that have the potential to be directly or indirectly impacted by the construction and operation of the Proposed Action. At the Boca Chica Launch Site, the areas exposed to noise (engine noise and sonic booms) represent the largest geographical area for which effects to Endangered Species Act (ESA)-listed species and critical habitat could occur. This geographical area also includes the access restriction area, which would be closed to the public during tank tests, wet dress rehearsals, static fire engine tests, and launches (suborbital and orbital).

The engine noise component of the study area is defined by the 105 decibel (dB) maximum A-weighted instantaneous noise level ($L_{Amax}$). This noise level is considered the reasonable noise level at which wildlife might exhibit a response (e.g., startle response) to the short-term noise associated with operations (FRA 2005; Manci et al. 1988; Dufour 1980; McKechnie and Gladwin 1993; Bradley et al. 1990; Lee and Fleming 2002). 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 (see Figure 3-1 in the FAA's BA contained in Appendix D).

The sonic boom component of the study area includes those areas exposed to overpressures greater than 1 pound per square foot (psf). An overpressure of 1 psf is similar to a clap of thunder; overpressures less than 1 psf are not expected to affect animals. The 1 psf contour extends about 13 miles from the launch pad (see Figures 1 and 2 in SpaceX's sonic boom memo contained in Appendix B).

The study area also includes landing locations in the Gulf of Mexico and Pacific Ocean. The study area in the Gulf of Mexico is shown in Figure 2 of the NMFS consultation in Appendix D and is a minimum of 19 nautical miles off the coast (note that the study area is referred to as the "action area" under ESA regulations). SpaceX Super Heavy and/or Starship landing and recovery operations could occur anywhere within this area of the Gulf of Mexico. The study area in the Pacific Ocean is shown in Figure 3 of the NMFS consultation in Appendix D. 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 62 nautical miles north of Kauai, Hawaii.

As the Starship/Super Heavy program is still in the early development phases, SpaceX has not identified all potential options for landing sites at this time. As stated in Chapter 1, proposed landing activities outside of the defined study area would be analyzed in a separate NEPA document, which may tier off this PEA.

## 3.10.3 Existing Conditions

This section describes the terrestrial habitats at the Boca Chica Launch Site, and habitats and wildlife in the Gulf of Mexico within the study area. It is organized into three primary subsections; terrestrial habitat and wildlife, marine habitat and wildlife, and protected species and critical habitat. The existing conditions for biological resources in the study area were described in the 2014 EIS (FAA 2014a) and have not substantially changed. Therefore, the 2014 EIS information is incorporated by reference, and the sections below focus on new or updated information that has been obtained since the completion of the 2014 EIS.

### 3.10.3.1 Terrestrial Habitat and Wildlife

The Boca Chica 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. The refuges and the native habitat between them provide a wide north-south coastal corridor along the Rio Grande delta, supporting a matrix of native rangeland wetlands and upland communities that are valuable for wildlife (USFWS 2004). 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. Numerous species of vertebrates, invertebrates, mammals, and birds are known to be found in the study area. For additional information regarding common wildlife species, refer to the 2014 EIS.

Site visits were conducted in 2012 and 2020 to delineate wetlands and to collect habitat and wildlife information in the vicinity of the SpaceX launch facility (see Section 3.9.3.3 for wetland information). Wetlands within the study area include depressional areas, unvegetated salt flats, and high marsh areas.

The Gulf of Mexico lies to the southeast of the VLA with miles of beach and dune habitats at the water land interface. Undisturbed and disturbed upland is also present within the study area.

There are potentially 312 terrestrial species designated as species of greatest conservation need (SGCN) in the study area based on the presence of potential suitable habitat, including 10 reptile species, 3 amphibian species, 54 bird species, 21 mammal species, 123 invertebrate species, and 101 plant species. SGCN are native animals or plants that are declining or rare and in need of attention to recover or prevent the need to list under state or federal regulation. Notably, the Boca Chica flea beetle (*Chaetocnema rileyi*) is a SGCN that is only known to inhabit an area within the study area – the dunes located at the terminus of SH 4 (Riley and King 2009). These beetles inhabit the stems of sedges in the dunes. *Chaetocnema* larvae are known to be subterranean, feeding on the underground portions of their host plants (Jolivet & Hawkeswood 1995), which are found up and down the Gulf Coast.

### 3.10.3.2 Marine Habitats and Wildlife

Starship/Super Heavy recovery operations would occur in the Gulf of Mexico or Pacific Ocean. Starship and/or Super Heavy may land on a floating platform or, in the event of an anomaly or early unmanned missions, be expended in the ocean down range no closer than 19 miles offshore. Marine wildlife resources in the study areas include mammals, fish, reptiles, birds, and invertebrates (e.g., shrimp, mollusks, jellyfish, etc.). Additionally, there are potentially 84 marine species designated as SGCN in the study area, including 23 fish species, 17 mammal species, 5 reptile species, and 39 shark species.

SpaceX has not identified specific locations in the Atlantic Ocean where recovery operations would occur. Therefore, this assessment includes a discussion of general impacts that would occur in the Atlantic Ocean, but impacts specific to protected resources (e.g., ESA-listed species, EFH, etc.) cannot be determined at this time. Once SpaceX identifies locations in the Atlantic Ocean, the FAA would conduct further environmental review and reinitiate interagency consultations as needed.

#### Essential Fish Habitat Assessment

The Essential Fish Habitat (EFH) Assessment assesses the waters of the Gulf of Mexico and Pacific Ocean in the study area (refer to Figures 3 and 5 in the NMFS Letter of Concurrence in Appendix D for the study area, which is the same as the “action area”). This study area has several areas designated as EFH. EFH is defined as those waters and substrate necessary for fish spawning, feeding, or growth to maturity. As defined in Section 3 of the MSA, “fish” includes finfish, mollusks, crustaceans, and all other forms of marine animal and plant life, other than marine mammals and birds. Various types of communities, including diverse physical and biological features, are considered EFH.

EFH communities range from naturally occurring hardbottom areas and artificial reefs to floating mats of *Sargassum* algae. Habitat utilized by a species can change with life history stage, abundance of the species and competition from other species, and environmental variability in time and space. The type of habitat available, its attributes, and its functions are important to species productivity and societal benefits. Some potential threats to habitat include certain fishing practices, marine construction, navigation projects, dredging, alteration of freshwater input into estuaries, and runoff. The Western Pacific Regional Fishery Management Council identifies EFH that occurs within the Pacific Ocean near SpaceX’s proposed landing site off of the coast of Hawaii in support of the first orbital launch (Table 3-7).

The Gulf of Mexico Fishery Management Council identifies EFH that occurs within the study area in the Gulf of Mexico (Table 3-7).

In addition to establishing EFH, the MSA also directs the identification of habitat areas of particular concern (HAPCs). HAPCs are subsets of EFH that are, especially ecologically important, particularly susceptible to human-induced degradation, or located in environmentally stressed areas (50 CFR §600.815(a)(8)). There are no HAPCs identified in the study area.

**Table 3-7. Essential Fish Habitat and Associated Fishery Management Plan in the Study Area**

| Species/Management Unit | Habitat Type | Fishery Management Plan |
|---|---|---|
| **Western Pacific Regional Fishery Management Council*** | | |
| Amberjack | Water column and all bottom habitat extending from the shoreline to the outer limit of the EEZ down to a depth of 600 m. | Bottomfish and Seamount Groundfish |
| Black Jack | Water column and all bottom habitat extending from the shoreline to the outer limit of the EEZ down to a depth of 600 m. | Bottomfish and Seamount Groundfish |
| Sea Bass | Water column and all bottom habitat extending from the shoreline to the outer limit of the EEZ down to a depth of 600 m. | Bottomfish and Seamount Groundfish |
| Blue Stripe Snapper | Water column and all bottom habitat extending from the shoreline to the outer limit of the EEZ down to a depth of 600 m. | Bottomfish and Seamount Groundfish |
| Gray Jobfish | Water column and all bottom habitat extending from the shoreline to the outer limit of the EEZ down to a depth of 600 m. | Bottomfish and Seamount Groundfish |
| Giant Trevally | Water column and all bottom habitat extending from the shoreline to the outer limit of the EEZ down to a depth of 600 m. | Bottomfish and Seamount Groundfish |
| Pink Snapper | Water column and all bottom habitat extending from the shoreline to the outer limit of the EEZ down to a depth of 600 m. | Bottomfish and Seamount Groundfish |
| Red Snapper | Water column and all bottom habitat extending from the shoreline to the outer limit of the EEZ down to a depth of 600 m. | Bottomfish and Seamount Groundfish |
| Longtail Snapper | Water column and all bottom habitat extending from the shoreline to the outer limit of the EEZ down to a depth of 600 m. | Bottomfish and Seamount Groundfish |
| Yellowtail Snapper | Water column and all bottom habitat extending from the shoreline to the | Bottomfish and Seamount Groundfish |

| Species/Management Unit | Habitat Type | Fishery Management Plan |
|---|---|---|
| **Western Pacific Regional Fishery Management Council*** | | |
| | outer limit of the EEZ down to a depth of 600 m. | |
| Snapper | Water column and all bottom habitat extending from the shoreline to the outer limit of the EEZ down to a depth of 600 m. | Bottomfish and Seamount Groundfish |
| Silver Jaw Jobfish | Water column and all bottom habitat extending from the shoreline to the outer limit of the EEZ down to a depth of 600 m. | Bottomfish and Seamount Groundfish |
| Thicklip Trevally | Water column and all bottom habitat extending from the shoreline to the outer limit of the EEZ down to a depth of 600 m. | Bottomfish and Seamount Groundfish |
| **Gulf of Mexico Regional Fishery Management Council** | | |
| **Balistidae – Triggerfishes (all life stages)**<br>Gray triggerfish | Gulf of Mexico sand bottoms near reef habitats, upper water column, continental shelf waters deeper than 10 meters. | Reef Fish Fishery |
| **Carangidae – Jacks (all life stages)**<br>Greater amberjack<br>Lesser amberjack<br>Almaco jack<br>Banded rudderfish | Gulf of Mexico waters and substrates extending from the US/Mexico border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council from estuarine waters out to depths of 100 fathoms. | Reef Fish Fishery |
| **Labridae – Wrasses (all life stages)**<br>Hogfish | Gulf of Mexico coral reefs and rocky flats. | Reef Fish Fishery |
| **Lutjanidae – Snappers (all life stages)**<br>Queen snapper<br>Mutton snapper<br>Schoolmaster<br>Blackfin snapper<br>Red snapper<br>Cubera snapper<br>Gray (mangrove) snapper<br>Dog snapper<br>Mahogany snapper<br>Lane snapper<br>Silk snapper<br>Yellowtail snapper<br>Wenchman<br>Vermilion snapper | Gulf of Mexico waters and substrates extending from the US/Mexico border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council from estuarine waters out to depths of 100 fathoms. | Reef Fish Fishery |

| Species/Management Unit | Habitat Type | Fishery Management Plan |
|---|---|---|
| **Western Pacific Regional Fishery Management Council*** | | |
| **Malacanthidae – Tilefishes (all life stages)**<br>Goldface tilefish<br>Blackline tilefish<br>Anchor tilefish<br>Golden Tilefish | Gulf of Mexico waters and substrates extending from the US/Mexico border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council from estuarine waters out to depths of 100 fathoms. | Reef Fish Fishery |
| **Serranidae – Groupers (all life stages)**<br>Dwarf sand perch<br>Sand perch<br>Rock hind<br>Speckled hind<br>Yellowedge grouper<br>Red hind<br>Goliath grouper<br>Red grouper<br>Misty grouper<br>Warsaw grouper<br>Snowy grouper<br>Nassau grouper<br>Marbled grouper<br>Black grouper<br>Yellowmouth grouper<br>Gag<br>Scamp<br>Yellowfin Grouper | Gulf of Mexico waters and substrates extending from the US/Mexico border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council from estuarine waters out to depths of 100 fathoms. | Reef Fish Fishery |
| Coastal Migratory Pelagics (all life stages) | Gulf of Mexico waters and substrates extending from the US/Mexico border to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council from estuarine waters out to depths of 100<br>Fathoms. | Coastal Migratory Pelagic Resources (Mackerels) |
| **Shrimp (all life stages)**<br>Brown shrimp<br>White Shrimp<br>Pink Shrimp<br>Royal red shrimp | Gulf of Mexico waters and substrates extending from the US/Mexico border to Fort Walton Beach, Florida from estuarine waters out to depths of 100 fathoms; waters and substrates extending from Grand Isle, Louisiana to Pensacola Bay, Florida between depths of 100 and 325 fathoms; waters and substrates<br>March 2004 Final EIS for EFH for the Gulf of Mexico FMPs extending from Pensacola Bay, Florida to the boundary | Shrimp Fishery |

| Species/Management Unit | Habitat Type | Fishery Management Plan |
|---|---|---|
| **Western Pacific Regional Fishery Management Council*** | | |
| | between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 35 fathoms, with the exception of waters extending from Crystal River, Florida to Naples, Florida between depths of 10 and 25 fathoms and in Florida Bay between depths of 5 and 10 fathoms | |
| Sailfish (adult life stage) | Central Gulf waters from Texas, Louisiana, and the Florida panhandle | Amendment 10 to the 2006 Consolidated HMS FMP: EFH |
| Scalloped Hammerhead Shark (Neonate life stage) | Coastal waters of the Gulf of Mexico from Texas to Florida. | Amendment 10 to the 2006 Consolidated HMS FMP: EFH |
| Blacktip Shark (Gulf of Mexico Stock – Juvenile/Adult life stage) | Coastal waters of the Gulf of Mexico from Texas to the Florida Keys. | Amendment 10 to the 2006 Consolidated HMS FMP: EFH |
| Blacknose Shark (Gulf of Mexico Stock- Juvenile/Adult life stage) | Localized in the coastal waters of Texas, western Louisiana, and Mississippi to Florida, and to the Florida Keys. | Amendment 10 to the 2006 Consolidated HMS FMP: EFH |
| Atlantic Sharpnose Shark (Gulf of Mexico Stock- Juvenile/Adult, Neonate life stages) | Coastal waters of the Gulf of Mexico from Texas to the Florida Keys. | Amendment 10 to the 2006 Consolidated HMS FMP: EFH |
| Bonnethead Shark (Gulf of Mexico Stock – Adult, Juvenile, Neonate life stages) | Coastal shallow waters in the Gulf of Mexico with sandy and muddy bottoms around Texas, eastern Mississippi, and to the Florida Keys. | Amendment 10 to the 2006 Consolidated HMS FMP: EFH |

Notes: *Life stages found at location for all species is Post-Hatch
Source: NOAA 2021b

### 3.10.3.3 Protected Species and Critical Habitat

This subsection describes the wildlife species and habitats with legal protection status, including species and habitat protected by the ESA, Marine Mammal Protection Act, and the Bald and Golden Eagle Protection Act. Section 7 of the ESA requires all federal agencies to consult with USFWS and or NMFS before initiating any action that may affect a federally listed species or designated critical habitat. For additional information on the species and habitat with legal protection status, refer to Appendix D.

#### Terrestrial

The FAA used the USFWS Information for Planning and Consultation system (IPaC) (USFWS 2020b) to identify ESA-listed, proposed to be listed, or candidates for listing in the study area. Per IPaC, there are 14 ESA-listed species and critical habitat for the piping plover occurring in Cameron County, Texas (Table 3-8). The interior least tern (*Sterna antillarum athalassos*) was considered in FAA's 2014

EIS but delisted on February 12, 2021 (86 *FR* 2564). The eastern black rail (*Laterallus jamaicensis* ssp. *jamaicensis*), which was not considered in the 2014 EIS, was listed as threatened on November 9, 2020 (85 *FR* 63764) and is considered in this PEA 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 2010a; TPWD 2012a). Grasslands and mesquite shrublands with clay loam to sandy loam soils are not present within the study area. Since this species is no longer found within Cameron County and suitable habitat does not occur within the study 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 PEA.

The Texas and Tamaulipan populations of Texas ayenia occur in the 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 2010b; TPWD 2012b). These habitat associations or soil types do not occur within the study 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 or 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 2010b; TPWD 2012b). Suitable habitat for this species does not occur within the study 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 PEA.

For the remaining 12 species in Table 3-8 and for state listed species, this section provides updates since the 2014 EIS (FAA 2014a) on species in the study area. Refer to the 2014 FAA EIS for a description of each species' physical description, listing history, threats, ecology, and historical distribution.

**Table 3-8. ESA-Listed Species and Critical habitat for Cameron County, Texas**

| Species | ESA Status | Critical Habitat |
|---|---|---|
| **Birds** | | |
| Eastern black rail (*Laterallus jamaicensis ssp. jamaicensis*) | T | No |
| Northern aplomado falcon *(Falco femoralis septentrionalis)* | E | No |
| Piping plover *(Charadrius melodus)* | T | Yes |
| Red knot *(Calidris canutus rufa)* | T | Proposed |
| **Mammals** | | |
| Gulf Coast jaguarundi *(Herpailurus yagouaroundi cacomitli*) | E | No |
| Ocelot *(Leopardus pardalis)* | E | No |
| West Indian manatee *(Trichechus manatus)* | T | No |
| **Reptiles**[1] | | |
| Green sea turtle *(Chelonia mydas)* | T | No |
| Hawksbill sea turtle *(Eretmochelys imbricata)* | E | No |
| Kemp's ridley sea turtle *(Lepidochelys kempii)* | E | No |
| Leatherback sea turtle *(Dermochelys coriacea)* | E | No |
| Loggerhead sea turtle *(Caretta caretta)* | T | No |

| Species | ESA Status | Critical Habitat |
|---|---|---|
| **Flowering Plants** | | |
| South Texas ambrosia (*Ambrosia cheiranthifolia*) | E | No |
| Texas ayenia (*Ayenia limitaris*) | E | No |

Since the 2014 EIS, no sightings of ocelots have been documented, and a recent study by expert biologists in the area that included 36,000 camera trap nights found no ocelots or jaguarundi. The last known record of a jaguarundi in the United States was in 1986 along SH 4. The last documented occurrence of an ocelot in the area of SH 4, that borders SpaceX facilities, occurred over twenty years ago, in 1998. Although the Laguna Atascosa NWR supports a population of ocelot, that area is approximately 20 miles away and across the shipping channel from Boca Chica Launch Site. Based on the recent camera trap study, the fact that the most recent siting of an ocelot in the area was over 20 years ago, and the distance of the nearest ocelot population from the study area, it is unlikely that SpaceX's activities will have a significant impact on these species. Nevertheless, impacts from SpaceX's activities that could affect the ocelot and jaguarundi and mitigation measures to prevent any impacts are described below.

Regarding sea turtles, Sea Turtle, Inc has monitored nesting activity over the last 15 years, and they have observed that sea turtle nesting on Boca Chica has generally followed a similar pattern to nesting on South Padre Island (i.e., high years, low years, etc.). Nest numbers on Boca Chica Beach remained consistent during the 2020 and 2021 nesting seasons. Given the limited number of years that SpaceX has been present in Boca Chica area, Sea Turtle Inc is not currently detecting any meaningful changes in the nesting data (Sea Turtle, Inc 2021).

Northern aplomado falcons do not currently occupy the immediate vicinity of the LLCC or VLA, where there are limited perching and nesting sites. Only one northern aplomado falcon has been recorded (in 2016) within 3 miles of the Boca Chica Launch Site since the USFWS initiated surveys in 2015 (UTRGV 2020). The nearest artificial nest platforms, neither of which have been used by nesting falcons, are approximately 1 mile and 4.3 miles from the LLCC.

Seven state-listed species (that are not also federally listed) occur or have the potential to occur within the study area: peregrine falcon, reddish egret, sooty tern, white-tailed hawk, white-faced ibis, wood stork, and black-striped snake (FAA 2014a). Since the completion of the 2014 EIS, updates to the state listed species and status of several species have occurred as of 2019[39] with an additional thirteen species becoming state listed in Cameron County: one amphibian (sheep frog [*Hypopachus variolosus*]), three birds (swallow-tailed kite [*Elanoides forficatus*], black rail [*Laterallus jamaicensis*], Botteri's sparrow [*Peucaea botterii*]), six fish (Rio Grande shiner [*Notropis jemezanus*], river goby [*Awaous banana*], Mexican goby [*Ctenogobius claytonia*], Shortfin Mako shark [*Isurus oxyrinchus*], Oceanic whitetip shark [*Carcharhinus longimanus*], smalltooth sawfish [*Pristis pectinate*]), and three mollusks (Texas hornshell [*Popenaias popeii*], Salina mucket [*Potamilus metnecktayi*], Mexican fawnsfoot [*Truncilla cognata*]) (TPWD 2021a). These species have the potential to occur in the study area due to the presence of suitable habitat. The status of four state-listed species has changed: two species were downlisted from endangered to threatened (West Indian manatee [*Trichechus manatus*] and green sea turtle [*Chelonia mydas*]) (TPWD 2021a); two species were delisted at the state level and are now listed as Species of

[39] https://tpwd.texas.gov/gis/rtest.

Greatest Conservation Need (SGCN) by the state of Texas (southern yellow bat [*Lasiurus ega*] and Texas indigo snake [*Drymarchon melanurus erebennus*]) (TPWD 2021b). IPaC was also used to identify birds of conservation concern; 21 species were identified for the study area (USFWS 2020b).

In December 2020, the USFWS determined that listing the monarch butterfly (*Danaus plexippus*) as an endangered or threatened species is warranted but precluded by higher priority listing actions (USFWS 2020c). With this 12-month finding, the monarch butterfly became a candidate for listing. Candidate species are provided no statutory protection under ESA but could be listed as threatened or endangered in the future.

Monarch butterflies breed and migrate throughout Texas. During the breeding season, monarchs lay their eggs on obligate milkweed host plants (primarily *Asclepias* spp.), and emerging larvae feed on milkweed, sequestering toxic chemicals as a defense against predators. The Texas coast is an important fall migration pathway for the eastern U.S. monarch population en route to the monarch's primary overwintering site in Mexico. Peak fall migration through South Texas occurs in late October to late November. The USFWS recommends conservation of native grasslands and other pollinator habitats by seeding and replanting existing rights-of-way or disturbed sites with native grasses, milkweeds, and nectar plants that are native to the area.

A field containing *Asclepias oertheroides*, a host and nectaring plant of the Monarch butterfly (*Danaus plexippus*) is located north of the VLA (within the study area).

### Marine

In 2017 and 2018, the FAA conducted ESA consultations with NMFS for the Falcon Program at KSC (FAA 2020e). A total of 10 marine mammals, 6 species of sea turtles, and 13 species of fish were considered in the consultations. Note that the 2017 ESA consultation with NMFS also included species in the Atlantic and Pacific Oceans. In 2020 and 2021, the FAA prepared the *Programmatic Endangered Species Act Consultation for Launch and Reentry Vehicle Operations in the Marine Environment* to address the potential effects of space launch and landing operations on marine species listed by NMFS. This consultation supersedes the above-mentioned consultations. A total of 14 marine mammals, five species of sea turtles, and 31 species of fish were considered in the consultations. Refer to the NMFS consultation letter in Appendix D for additional information regarding the federally protected species.

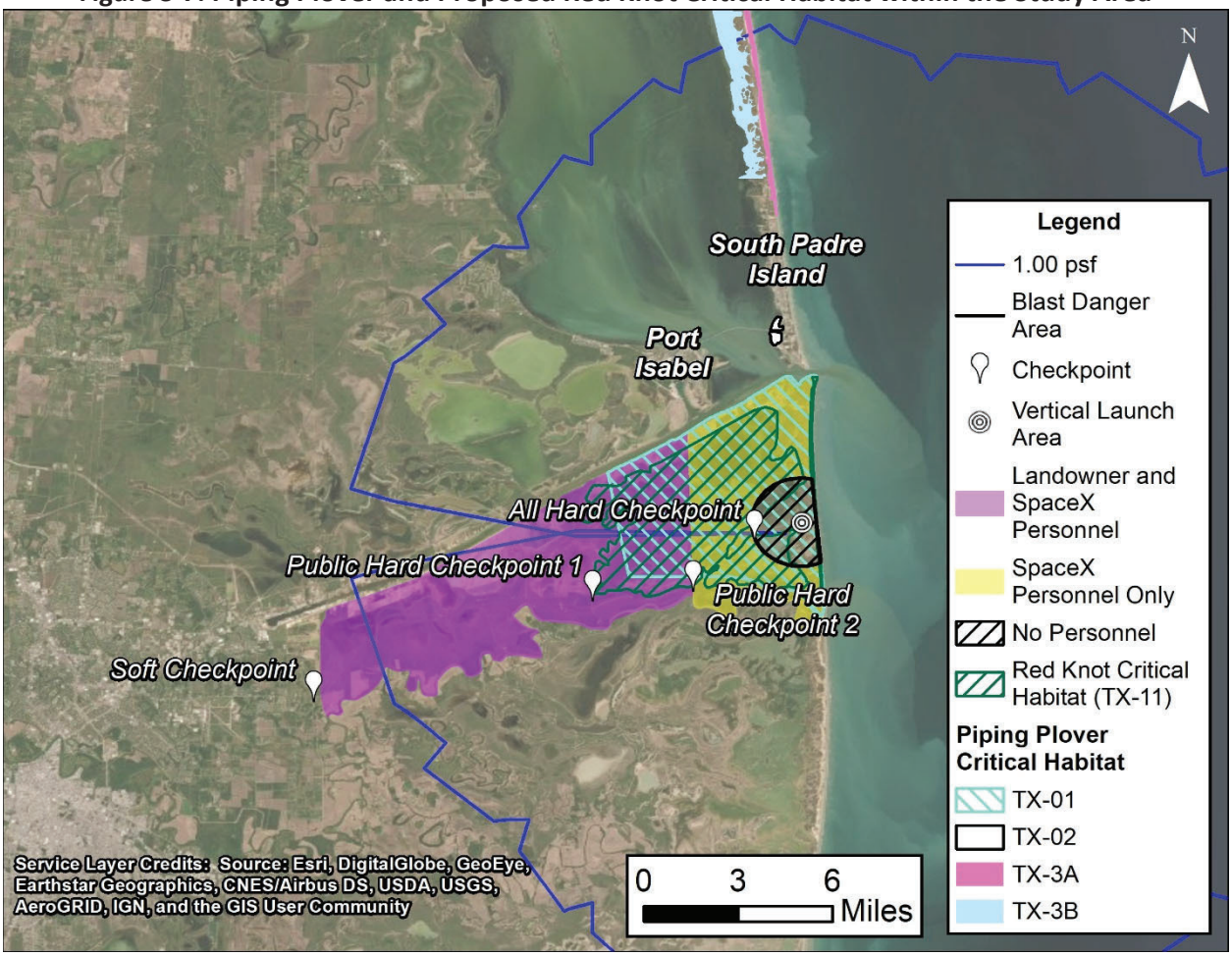
### Critical Habitat

As described in the 2014 EIS, the SpaceX Boca Chica Launch Site is located within piping plover critical habitat Unit TX-1 (Figure 3-7). The TX-1 unit includes wind tidal flats that are infrequently affected by season winds, and 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 USFWS (NWR), TPWD and TGLO (Preserve and Boca Chica State Park), and private citizens (USFWS 2001, FAA 2014a). Refer to Appendix D for additional information regarding piping plover critical habitat.

On July 15, 2021, the USFWS issued a proposed rule to designate critical habitat for the red knot (86 *FR* 37410). The Boca Chica Launch Site is located within proposed red knot critical habitat Unit TX-11. Unit TX-11 unit consists of approximately 15,243 acres in Cameron County, Texas. This unit

overlaps with designated critical habitat for the piping plover (Figure 3-7). The unit includes wind tidal flats and all seagrass beds that are infrequently inundated and/or exposed at low tides, and the tidal flats within the area known as South Bay. Refer to Appendix D for additional information regarding red knot proposed critical habitat and specific habitat types within this unit.

**Figure 3-7. Piping Plover and Proposed Red Knot Critical Habitat within the Study Area**




## 3.10.4 Environmental Consequences

A significant impact on biological resources would occur if the USFWS or NMFS determines that the action would be likely to jeopardize the continued existence of a federally listed threatened or endangered species, or would result in the destruction or adverse modification of federally designated critical habitat. The FAA has not established a significance threshold for unlisted species. Factors to consider when assessing the significance of potential impacts on unlisted species and habitats include whether the action would have the potential for:

- A long-term or permanent loss of unlisted plant or wildlife species, i.e., extirpation of the species from a large project area;
- Adverse impacts to special status species (e.g., state species of concern, species proposed for listing, migratory birds, bald and golden eagles) or their habitats;

- Substantial loss, reduction, degradation, disturbance, or fragmentation of native species' habitats or their populations; or
- Adverse impacts on a species' reproductive success rates, natural mortality rates, non-natural mortality (e.g., road kills and hunting), or ability to sustain the minimum population levels required for population maintenance.

This section addresses impacts on biological resources from SpaceX's proposed activities, including Starship/Super Heavy launch, landing, and test operations. These types of impacts and impact mechanisms have been addressed in the previous EIS for the SpaceX Texas Launch Site (FAA 2014a) and in the EA for Starship/Super Heavy at Kennedy Space Center (NASA 2019). Impacts are briefly summarized in this section, with focus on potential impacts from the Proposed Action at the SpaceX Boca Chica Launch Site.

### 3.10.4.1 Terrestrial Habitats and Wildlife

#### Construction

Construction activities have the potential to impact terrestrial habitats and wildlife (including SGCN species) through habitat loss, use of construction equipment/human activity, hazardous materials, lighting, and invasive species. Construction activities would consist of expanding the existing solar farm, adding infrastructure and facilities at the VLA, a parking lot across from the VLA, a payload processing facility, and trenching and pull-offs along SH 4. At the VLA, SpaceX is proposing to construct two integration towers, tank structural test stands, a redundant launch pad and commodities, relocation of the existing landing pad, and additional support buildings. 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.

**Habitat loss:** Approximately 17.1 acres of wetland habitat (Section 3.9.3.3 for more detail) and approximately 9.1 acres of upland habitat would be removed as a result of the construction. This permanent loss of upland and wetland vegetation and habitat due to direct impacts would be a small fraction of vegetation and habitat available in the Lower Rio Grande Valley. Overall, impacts to these habitats are not anticipated to cumulatively adversely affect local or regional habitat availability. SpaceX will continue to work with USFWS and TPWD to select appropriate native plant species to revegetate temporarily disturbed areas and to provide wildlife friendly soil stabilization (i.e., avoid using plastic mesh matting and hydromulch that includes plastics that could injure or kill wildlife due to entanglement).

**Construction equipment/human activity:** Use of construction equipment and human activity can generate noise that could displace wildlife in the vicinity of construction, and construction equipment could result in wildlife strikes. Displacement from noise and human activity can affect normal foraging, migratory, and breeding behaviors. However, this impact would be short-term and only last the duration of construction. Direct mortality or injury from construction equipment striking wildlife is unlikely for more mobile species since human presence and activity are likely to disperse wildlife prior to any equipment use. Less mobile species may be more susceptible to injury or mortality from construction equipment, but similar to measures implemented in the 2014 EIS, SpaceX employees and contractors will be educated

on the potential for vehicle collisions with wildlife, particularly ocelot, jaguarundi, Texas indigo snake, and Texas tortoise. The law requires that SpaceX obey speed limits on SH 4. Vehicles will also be restricted to existing paved and dirt roads, parking areas, and authorized construction sites. SpaceX will take precautions to help prevent attracting animals (i.e., minimize and/or cover pits, utilize predator-proof secured lids) to further minimize the potential risk to wildlife. Additionally, biological monitoring will be conducted before and after construction activities.

**Hazardous materials:** Construction activities would require the use of construction equipment and hazardous materials. Release of hazardous materials during construction (e.g., petrochemicals and solvents) could affect individual wildlife if they were exposed to the hazardous material, which could cause injury or sickness, or result in mortality. SpaceX personnel and associated contractors would be required to comply with appropriate hazardous materials handling and management procedures. With the temporary nature of construction and equipment use, and compliance with industry standard handling and management procedures and TCEQ regulations for hazardous materials, construction impacts on habitats and wildlife are anticipated to be less than significant. Therefore, potential impact is unlikely and promptly remediated using best management practices.

**Lighting:** Construction occurring at night at the VLA would increase light emissions in the vicinity of the VLA. Lighting on beaches 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, however, Sea Turtle Inc. conducts nesting surveys on Boca Chica Beach to collect sea turtle eggs, so only nests that were missed by surveys would potentially be affected by the nighttime lighting. Lighting may also result in abandonment of nesting and roosting areas by terrestrial birds. Lighting would not be expected to result in adverse effects to mammal species. Any impacts would therefore be minimized with adherence to the Lighting Management Plan.

**Invasive species**: Impacts could result from the potential introduction and spread of invasive species during construction. At the time of the field surveys conducted in preparation for the 2014 EIS, the giant reed (*Arundo donax*) was the only invasive species observed. The movement and spread of invasive plant and animal species within the project areas as a result of the Proposed Action could degrade habitat. Invasive species might be accidentally introduced to the area through construction of the facilities or shipment of supplies and equipment to the proposed facilities. Species that might be introduced or spread include plants such as vitex that can degrade habitat by displacing native species and ultimately reducing food or important nesting or roosting habitat. However, given the mitigation measures in place to prevent the introduction of invasive species into the study area, this will not significantly impact wildlife.

Permanent construction impacts (i.e., habitat removal) would be localized and small compared to the overall available habitat Lower Rio Grande Valley, and the effects of the use of construction equipment, hazardous materials, lighting would be primarily short-term and reduced through mitigation and monitoring measures (See Section 3.10.5). Potential introduction and spread of invasive plants would be avoided or minimized through mitigation measures (See Section 3.10.5). Therefore, the Proposed Action is not expected to result in significant impacts on terrestrial habitats or wildlife populations.

## Operations

Operational activities have the potential to impact terrestrial habitats and wildlife through the presence of new structures, increased vehicle traffic and presence of humans, launch related noise and vibration impacts, exhaust/heat plumes, lighting, and anomalies.

**Presence of new structures:** The presence of newly constructed structures, including the integration towers and expanded solar farm could pose a potential collision impact to birds, due to height and glare. However, as described in BA (Appendix D), these structures do not include glass windows and would be comprised of opaque surfaces, which are of less risk regarding bird collisions. Avian monitoring has been conducted within 3 miles of the VLA from 2016 to 2020 for pre-construction and active construction monitoring and launch activity for past SpaceX activities. Monitoring focused on five of the most sensitive bird species in the study area, including piping plover, red knot, aplomado falcon, Wilson's plover, and snowy plover. These previous construction and operations activities have not documented any mortality or otherwise shown a statistically significant impact on the piping plover, red knot, and snowy plover (aplomado falcon was never observed during any monitoring event). A preliminary trend analysis found little to no evidence of meaningful trends, either increasing or decreasing, in the number of birds observed through time for all four target species (SWCA Environmental Consultants 2022). Based on these monitoring data, FAA anticipates that construction under the Proposed Action to expand existing infrastructure and facilities would have a similar negligible impact on species. As described in the BA, SpaceX would implement USFWS measures to reduce the risk of bird collisions.

**Vehicle traffic and human presence:** An increase in vehicle traffic during daily operations from construction and SpaceX operations could potentially increase the likelihood of wildlife being killed by a collision with a vehicle. The law requires that SpaceX obey speed limits on SH 4. Human presence and vehicular traffic is already prevalent within the project area since Boca Chica Beach is a popular recreational area. However, as described in Section 3.10.5, SpaceX would coordinate with USFWS NWR staff to identify options that would assist in protecting NWR lands and species habitats from impacts that may result from public vehicle intrusions. Upon USFWS and SpaceX agreement of locations alongside SH 4 or other identified roads where the footprint is already disturbed, SpaceX will provide up to $10,000 annually for purchasing vehicle barrier materials to prevent a truck or ATV from entering. To help reduce potential effects from increased visitation and associated traffic, SpaceX will coordinate with TxDOT regarding funding the installation of up to 5 additional wildlife crossing signs along SH 4 for a total of 10 signs (5 in each direction). Five wildlife crossing signs have already been installed along SH 4.

**Launch-related noise and vibration impacts:** Noise from general operations, launches, landings, and static fire tests could also affect wildlife. Wildlife in the study area would be exposed to noise generated by the engines during tests, takeoff and landing events, as well as sonic booms generated during landing. The Proposed Action would be expected to interrupt normal wildlife behavior periodically in the study area during these operations, which would be up to a few minutes in duration. Because impacts from operations would be intermittent and of short duration, they are not expected to significantly affect wildlife.

Cape Canaveral, Florida provides a long history of launches with limited impacts to wildlife located in the surrounding wildlife refuge. The federally listed Florida scrub-jay was monitored for behavioral changes after Delta, Atlas, and Titan launches with no apparent impacts from noise; these data came from a total of 42 launches at a cadence 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 KSC Space Shuttle program.

Vibration and sonic booms have the potential to temporarily disturb wildlife. Sonic booms during vehicle landing would also cause a startle response in animals. A noise-induced startle response could occur from launches and/or sonic booms from landings at a critical time in the reproductive cycle of any animal. A startle response from nesting birds can result in broken eggs or cause immature young that are not flight-capable to flee the nest. Repeated nest failures could eventually trigger desertion of a nesting area. Noise from the Proposed Action would not be expected to cause a significant impact because the noise events are infrequent and short-term and would not result in impacts at the population level.

Section 5.2.1 of the Biological Assessment discusses studies of the effects of sonic booms on the reproductive success of domestic and wild birds and finds cracking of eggs or other disruptions in reproductive behavior due to sonic booms unlikely and not significant. For example, a study at the Vandenberg Air Force Base in California of sonic booms on sea birds found no significant impact, including to the reproductive physiology, hatchability of eggs, viability of chicks, and nesting (Supplement to the Final Environmental Impact Statement, Space Shuttle Program, Vandenberg AFB, California, 1983). The Air Force and NASA predicted that in the worst case, on ascent from Vandenberg Air Force Base, the Space Shuttle would create sonic booms of 10-30 psf in a focal region over the Northern Channel Islands, and then decrease to 4-6 psf downrange (Supplement to the Final Environmental Impact Statement, Space Shuttle Program, Vandenberg AFB, California, 1983). Similarly, a study of the effects of launch operations in Cape Canaveral, Florida on the federally listed Florida scrub-jay and other birds, including from the Space Shuttle, which created noise effects comparable to Super Heavy/Starship, found an initial flight response from birds in the vicinity but no longer-term impacts. Although these results are from different species than at issue in the VLA area, they support the conclusion that the intermittent and short-duration sonic booms from the project will have no significant impact on birds. Sonic booms or vibration could cause wildlife to avoid use of the area immediately adjacent to the VLA. However, intermittent, short-term impacts are not expected to substantially harm or disturb wildlife, which are expected to resume normal behavior after a launch operation. Additionally, other wildlife habitat in the vicinity of the VLA will continue to serve as valuable habitat for birds and other wildlife, and no population-level effects are expected.

**Exhaust/heat plumes:** The heat plume generated from launches would travel away from launchpad, with temperatures of $212^0$ F approximately 0.3 mile from the launch pad and temperatures reaching ambient ($90^0$ F) 0.6 mile from the launch pad. The heat plume may cause some alterations to the plant community and could lead to vegetation changes, including loss of

plant community structure, reduction in total cover, and replacement of same native species with weed species. These temperatures would be short-lived (heat plume would dissipate within minutes) and not expected to permanently damage the vegetation.

Changes to terrestrial habitat structure might occur from fire in small areas adjacent to the launch mount and landing pad. Vegetative land cover in these areas is classified as barren or grasslands, both of which would recover quickly post-fire. Consistent with monitoring to date and studies of the impact on wildlife from prescribed burns, the impacts of such a fire are expected to be insubstantial. For example, effects were observed from 15 Delta, 22 Atlas, and 8 Titan launches between May 1995 and December 1997 at Cape Canaveral (Schmalzer et al. 1998), including the 1997 Delta II explosion, and found some heat scorching to vegetation as well as small brush fires from Titan, but noted that past singeing did not permanently affect vegetation near launch pads.

As explained above, as assessment of wildlife impacts was prepared following a fire resulting from an anomaly on July 24, 2019. Hicks & Contreras, Biological Assessment Boca Chica Test Launch Wildfire (Aug. 2019). The assessment found that direct fire mortality of wildlife was low and impacts to wildlife and habitat were not significant and "similar to those which would occur during a prescribed burn in comparable habitats," which "are routinely used to improve habitat for waterfowl and furbearers, control invasive species, and reduce wildfire risk."

Noise from the Raptor engines would cause a startle response of animals and would effectively direct them away from the area and reduce the risk of being affected by the heat of the plume. While unlikely, individual animals caught in the heat plume could be injured or killed, but the infrequent launches and quick dissipation of heat is not anticipated to affect species at the population level. And, as discussed above, noise-induced startle responses from operations-related noise and vibration impacts would not likely have a significant impact on wildlife. Post-launch monitoring conducted to date has not found any species killed or injured from heat plumes. Boca Chica flea beetles that may be present would be exposed to these high temperatures could be injured or killed. If dune vegetation burned, Boca Chica flea beetles (if present) on the surface of plants could be injured or killed. However, this would occur in the immediate area surrounding the launch pad. As described above, the flea beetle may potentially be located in areas outside of the area adjacent to the VLA, which would not be expected to be impacted by the plume.

Starship/Super Heavy would use liquid fuels, LOX and LCH4. No acid or particulate deposition nor permanent damage to surrounding vegetation would occur from a plume of these fuels. Any impacts to vegetation adjacent to the VLA are anticipated to be minimal, and therefore, minimal for wildlife occupying the area.

**Lighting:** Nighttime operations at the VLA would increase light emissions in the vicinity of the VLA. Lighting on beaches 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, however, Sea Turtle Inc. conducts nesting surveys on Boca Chica Beach to collect sea turtle eggs, so only nests that were missed by surveys would potentially be affected by the nighttime lighting. Lighting may

also result in abandonment of nesting and roosting areas by terrestrial birds. Lighting would not be expected to result in adverse effects to mammal species. Any impacts would therefore be minimized with adherence to the Lighting Management Plan.

**Anomalies:** Debris impacts and fire from anomalies also have the potential to impact terrestrial habitats and wildlife. However, debris response activities would be temporary, and the impacted land would be restored by SpaceX in consultation with the landowner. By implementing, monitoring, and adapting restoration efforts, it is expected that any affected land can be restored and long-term impacts to wildlife habitat would not be expected.

While debris from anomalies could impact habitat in the vicinity of the VLA, a direct wildlife strike would be very unlikely. Debris may cause ruts in the unvegetated salt flats or depressional wetlands upon impact or during recovery. Debris or debris clean-up could impact the dune vegetation where the Boca Chica flea beetle inhabits. SpaceX would coordinate with USFWS and the landowner(s) to determine the least invasive removal option and adhere to the Anomaly Response Plan. The method of debris removal would be assessed on a case-by-case basis and would be approved by USFWS and landowner(s). All debris would be attempted to be removed by hand and carried out on foot. If any debris were not able to be removed by hand, equipment or vehicles would be coordinated with USFWS and landowner(s). No motorized vehicles would be used on the mud flats and would stay within established paths. Restoration measures would be employed to restore any adverse physical impacts from anomalies in accordance with the MOA between TPWD and SpaceX. Restoration would include regraded disturbed land to its pre-existing condition. If dune vegetation burned, Boca Chica flea beetles (if present) on the surface of plants could be injured or killed. However, as described above, the flea beetle may potentially be located in areas beyond those at the VLA, which would not be expected to be impacted by anomalies.

### 3.10.4.2 Marine Habitats and Wildlife

Potential activities that may affect marine habitats and wildlife (including SGCN species) include downrange platform landings, expendable ocean landings, and vessel traffic to and from downrange platform landing locations. Starship/Super Heavy is a more advanced system that is not designed to nominally land in the ocean; the vehicle and booster return directly to land or to an offshore platform. During early unmanned test flights or in the event of an anomaly, SpaceX may require expending Super Heavy or Starship downrange in the Pacific Ocean, Atlantic Ocean, or Gulf of Mexico. Given the low frequency of the Starship/Super Heavy ocean reentry operations, and the fact that marine wildlife, marine mammals, and special status species spend the majority of their time submerged as opposed to on the surface, it is extremely unlikely they would be impacted (e.g., struck) by a Starship/Super Heavy ocean landing on the platform or from an anomaly (e.g., vehicle misses the platform). Direct strikes by falling debris and the ocean landing of the spacecraft are extremely unlikely for all species of concern, fish, sea turtles, and marine mammals. This is also due to the small size of the components as compared to the vast open ocean. The relative availability of these animals at the ocean surface, spatially and temporally, combined with the low frequency of the Proposed Action, reduce the likelihood of impacts to extremely low. Additionally, there are no known interactions with any of these species after decades of similar rocket launches.

Sonic booms created by landings intercept the ocean surface. They are expected to intercept the ocean surface no closer than 18.6 miles of the reentry location. Due to the low magnitude of the boom during reentry, and the substantial attenuation of a sonic boom at the air/water interface, coupled with exponential attenuation with water depth, the sonic boom would not result in impacts to marine species beneath the surface. The only impact expected may be a startle-type response as described in U.S. Air Force (2014) and NMFS (2017). Sonic booms are infrequent, and marine species in the ocean's surface waters more than 18.6 miles offshore are present in low densities. Sonic boom events associated with landings would remain relatively infrequent and are not expected to negatively affect the survival of any marine species (USAF 2014, NMFS 2017).

The same impact mechanisms and effects described and assessed as part of the 2017 and 2021 NMFS consultation are applicable to non-protected species. The consultation concluded with NMFS concurring that SpaceX's landing and recovery operations would be unlikely to adversely affect federally listed threatened and endangered species. Based on the same reasoning, it is unlikely that non-protected marine wildlife would be adversely affected and that the effects from ocean landing and recovery operations would be negligible.

Given the low frequency of ocean reentry operations, and the fact that marine species spend most of their time submerged, it is extremely unlikely individuals would be impacted (e.g., struck, degradation of water quality) by a Starship/Super Heavy. Therefore, the Proposed Action would not be expected to result in significant impacts on marine habitats and wildlife.

### Essential Fish Habitat Assessment

There is no EFH in the construction area, and no in-water construction activities are proposed to occur. Therefore, impacts to substrate or marine sediments from construction are not anticipated. Downrange platform landings would not be anticipated to impact EFH, as all elements of the operation would occur at the ocean surface. Downrange expendable ocean landings may have the potential to impact EFH. Offshore EFH in the areas that could be affected by downrange expendable ocean landings consists of the water column and unconsolidated sand substrate. Expendable stage landings would not result in permanent changes to physical parameters (temperature, salinity, oxygen concentration, etc.) of the water column. The amount of propellant, metals, or other substances that could leach or dissolve into the water column or substrate after the Starship sinks to the ocean floor would be minimal and would not result in detectable changes to water or sediment quality. Additionally, the probability an expended Starship impacting EFH would be considered negligible given the small number of number (five) of landings per year in the study area.

In the event of a failure, there could be a potential impact on marine species and EFH as the spacecraft and launch vehicle debris would fall into the ocean areas. 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 or recover as necessary any large floating debris. Debris would include the liquid propellant, which is considered a negligible hazard because virtually all hazardous materials would be consumed in the destruct action, dispersed in the air, and only

structural debris remains could strike the water. Structural debris is made of inert materials and are not anticipated to affect water quality.

In summary, there may be temporary adverse effects to EFH, particularly in the event of launch failure involving the spread of debris and release of hazardous material (e.g., liquid propellant). The FAA consulted NMFS regarding this EFH adverse effect determination. NMFS provided two Conservation Recommendations pursuant to 50 CFR §600.920, which SpaceX and the FAA have agreed to implement:

- *Conservation Recommendation 1*: Prior to any in-water work (i.e., debris recovery or sinking), SpaceX will ensure all ballast and vessel hulls do not pose a risk of introducing new invasive species and that project implementation will not increase abundance of invasive species present at the project site. SpaceX will sanitize any equipment that has been previously used in an area known to contain invasive species prior to its use for project activities.
- *Conservation Recommendation 2*: The FAA will coordinate with NMFS in the case of a launch failure and any vessel grounding to determine if consultation re-initiation is appropriate.

### 3.10.4.3 Protected Species and Habitat

This section addresses impacts on protected species and habitat from SpaceX's proposed activities, including Starship/Super Heavy launch, landing, and test operations. As stated above, the types of impacts and impact mechanisms have been addressed in the previous EIS for the SpaceX Texas Launch Site (FAA 2014a) and in the EA for Starship/Super Heavy at Kennedy Space Center (NASA 2019). Impacts are briefly summarized in this section, with focus on potential impacts from the Proposed Action at the SpaceX Boca Chica Launch Site. Detailed analysis on potential impacts on federally threatened and endangered species can be found in Appendix D.

#### Terrestrial Species

Potential activities that may affect federally- and state-listed species include construction activities, daily operations, and launch and test operations; and the impact types and mechanisms associated with these activities are the same as described in the Sections 3.10.4.1 and 3.10.4.2. above, but these species may be more sensitive than non-protected species. Of the new state-listed species, one species, the black rail, is federally listed, and one species is a candidate species, the monarch butterfly. Eleven threats associated with proposed construction and operational activities were identified including noise; ground vibrations; increased traffic and human presence; invasive species introductions; access restriction of the beach; gas, fuel, oil, or solvent spills; inappropriate night lighting; habitat loss; anomalies; the rocket heat plume; and tall structures.

Potential impacts on state-listed wildlife species would be similar to those described above for wildlife. Approximately 17.1 acres of wetland habitat (Section 3.9.3.3 for more detail) and approximately 9.1 acres of upland habitat would be removed as a result of the construction. However, this permanent loss of habitat would impact only a small fraction of the suitable habitat available in the Lower Rio Grande Valley and would not adversely impact population of state-listed species. In addition, increased vehicular traffic and human presence, as well as noise from construction, may temporarily displace state-listed wildlife species from the area of proposed construction activities. With implementation of

proposed mitigation and monitoring measures for biological resources (see Section 3.10.5), significant impacts on state-listed species are not anticipated.

The FAA identified threats associated with proposed construction and operations based on previous consultations as well as review of various species recovery plans. Table 3-9 provides an overview of potential effects identified to ESA-listed species. In accordance with ESA Section 7, the FAA prepared a BA and entered into formal consultation with the USFWS to address potential impacts to ESA-listed species, species proposed for listing, and critical habitat. BA Section 5, *Analysis of Potential Effects* (Appendix D), provides the full impact analysis on ESA-listed species and critical habitat.

The FAA has determined the Proposed Action *may affect and is likely to adversely affect* the following species and critical habitat: piping plover and piping plover critical habitat, red knot and proposed red knot critical habitat, northern aplomado falcon, Gulf Coast jaguarundi, ocelot, Kemp's ridley sea turtle, hawksbill sea turtle, leatherback sea turtle, loggerhead sea turtle, and green sea turtle. The FAA determined the Proposed Action *may affect but is not likely to adversely affect* the West Indian manatee and the eastern black rail. The FAA determined the Proposed Action would have *no effect* on the South Texas ambrosia and Texas ayenia. The monarch butterfly is a species currently listed as a candidate species by the USFWS, but is provided no statutory protection by ESA, although the FAA and USFWS are including this species in the ESA consultation. The USFWS's BO includes voluntary conservation measures for the monarch butterfly which SpaceX may implement. SpaceX's implementation of any of these measures will be documented in the annual report sent to the USFWS per the BO.

ESA Section 7 consultation with the USFWS was completed with the USFWS's issuance of a BO. The BO concurred with FAA's findings for the West Indian manatee and eastern black rail and concluded the Proposed Action is not likely to jeopardize the continued existence of listed species. The BO includes non-discretionary Reasonable and Prudent Measures and associated Terms and Conditions to avoid, minimize, and mitigate the impacts to listed species and critical habitat. The BO also includes discretionary Conservation Recommendations that are intended to avoid or minimize adverse effects on listed species and critical habitat. SpaceX must implement the Terms and Conditions outlined in the BO. The BO is provided in Appendix D.

**Table 3-9. Impacts to ESA-Listed Species and Critical habitat**

| Stressor or Threat | Potential Effect on Species | Species Potentially Affected |
|---|---|---|
| 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. 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 in some cases render habitat unusable.<br><br>Because noise impacts from operations would be intermittent and of short duration, they are not expected to significantly affect any listed or other species. As discussed above, studies at other launch sites, support this conclusion. Additionally, jaguarundi and ocelots are not believed to occupy the study area. | • Piping plover<br>• Red knot<br>• Aplomado falcon<br>• Eastern black rail<br>• Jaguarundi<br>• Ocelot<br>• All sea turtles |
| Rocket Heat Plume | The heat plume generated from Starship/Super Heavy launches would travel away from the launch pad, with temperatures of 212 $^0$F approximately 0.3 mile from the launch pad and temperatures reaching ambient temperature (90$^0$F) 0.6 mile from the launch pad. Individual animals caught in the heat plume could die or be injured.<br><br>Due to the infrequency of launches and quick dissipation of heat plumes, the plumes are not anticipated to cause significant effects on ESA-listed species or their habitat. As discussed above and supported by studies at other launch sites, noise-induced startle responses from operations-related noise and vibration impacts would not likely have a significant impact on wildlife. Post-launch monitoring conducted to date has not found any species killed or injured from heat plumes. Additionally, jaguarundi and ocelots are not believed to occupy the study area. | • Piping plover<br>• Red knot<br>• Aplomado falcon<br>• Eastern black rail<br>• Jaguarundi<br>• Ocelot<br>• All sea turtles |
| 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 NWR staffs' ability to conduct bird and vegetation surveys. As described above, to date, access restrictions have had minimal effect on sea turtles. However, because these closures are only periodic and of short duration, they are unlikely to significantly impact ESA-listed species. Moreover, a badge system will be administered to facilitate access of agency personnel. | • Piping plover<br>• Red knot<br>• All sea turtles |

| Stressor or Threat | Potential Effect on Species | Species Potentially Affected |
|---|---|---|
| Night Lighting | Lighting on beaches 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. As discussed above, Sea Turtle Inc. conducts nesting surveys on Boca Chica Beach to collect sea turtle eggs, so only nests that were missed by surveys would potentially be affected by the nighttime lighting. Lighting effects on terrestrial birds would be minimized with adherence to the Lighting Management Plan. With these measures, lighting is not be expected to result in significant effects to ESA-listed species. No impacts to nesting sea turtles has been found to date. | • Piping plover<br>• Red knot<br>• Aplomado falcon<br>• Eastern black rail<br>• Jaguarundi<br>• Ocelot<br>• All sea turtles |
| Hazardous Materials | There is the potential for spills of hazardous materials. However, the likelihood that an ESA-listed species would come into contact of a hazardous material during a spill is low given measures to prevent spills, the likelihood that a spill would be confined to the VLA, and prompt clean-up responses in the event any spill occurs. Additionally, jaguarundi and ocelots are not believed to occupy the study area, and it is unlikely that turtles would be in the vicinity of any hazardous materials. | • Piping plover<br>• Red knot<br>• Aplomado falcon<br>• Eastern black rail<br>• Jaguarundi<br>• Ocelot<br>• All sea turtles |
| Ground Vibrations | Short-term ground vibrations could occur during construction and launches. There is a potential for ground vibrations to disturb nesting turtles and birds and potentially to impact eggs. The likelihood of significant disturbance is low given the short-term, infrequent nature of vibration impacts, Sea Turtle, Inc.'s monitoring of sea turtle nests and retrieval of eggs, and studies of impacts on nesting birds and eggs conducted at other launch site (as described above). | • All sea turtles |
| 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. The area is already trafficked by humans, and to date, monitoring has not shown any documented "take" of ESA-listed species due to vehicle strikes involving SpaceX. As set forth in the BO, SpaceX will also be required to implement mitigation measures to further reduce the risk of vehicle strikes. Because of this, the impact to ESA-listed species and other species is unlikely to be significant. Additionally, as noted above, jaguarundi and ocelots have not been found to occupy the study area. | • Piping plover<br>• Red knot<br>• Aplomado falcon<br>• Eastern black rail<br>• Jaguarundi<br>• Ocelot |
| Tall Structures | The construction of new structures could pose a potential collision impact to birds. The impact to birds is unlikely to be significant because, as described in BA (Appendix D), these structures do not include glass windows and would be comprised of opaque/non-glare surfaces, which are of less risk regarding bird collisions. Moreover, as discussed above, monitoring has not shown any take of listed birds resulting from collisions with existing SpaceX structures. | • Piping plover<br>• Red knot<br>• Aplomado falcon<br>• Eastern black rail |

| Stressor or Threat | Potential Effect on Species | Species Potentially Affected |
|---|---|---|
| Habitat Loss (including Critical Habitat) | Direct loss of habitat reduces a species ability to reproduce, find food, find shelter, and survive. As explained in the BO, there will be no significant adverse modification to the critical habitat of the piping plover or to the red knot, and the Proposed Action is unlikely to adversely affect the eastern black rail. Monitoring has shown that the land immediately around the VLA is not habitat or at best only marginal habitat for these species. The larger area will continue to provide high quality habitat for these species. | • Piping plover<br>• Red knot<br>• Eastern black rail |
| 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. No significant impact from invasive species is expected given required mitigation measures to prevent the introduction of invasive species. | • Piping plover<br>• Red knot<br>• Aplomado falcon<br>• Eastern black rail<br>• Jaguarundi<br>• Ocelot<br>• All sea turtles |
| Anomaly | An anomaly could result in impacts including debris and fire As discussed above, in the event an anomaly that causes debris impacts occurs required response actions will ensure that effects are minimal and that impacted land is restored. Fires are unlikely and, consistent with monitoring to date, are not expected to cause a significant impact on any species, including ESA-listed species. | • Piping plover<br>• Red knot<br>• Aplomado falcon<br>• Eastern black rail<br>• Jaguarundi<br>• Ocelot<br>• All sea turtles |
| 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 any manatees, sea turtles, and other marine species from boat strikes would increase. As further explained in the BA and consultation with NMFS, because launches are infrequent and of short-duration, increases in boat traffic associated with the launch are not expected to significantly impact ESA-listed species. There has been no documented take of ESA-listed species associated SpaceX-related boat traffic. | • West Indian manatee |

## Marine Species

The FAA consulted NMFS regarding potential effects of the Proposed Action on ESA-listed species in the marine environment, including potential ship strikes on sea turtles and marine mammals. The ESA consultation concluded with NMFS concurring that the Proposed Action is not likely to adversely affect ESA-listed species or critical habitat under NMFS jurisdiction. The consultation includes measures that SpaceX must implement to avoid or minimize effects to listed species and habitat (see Appendix D for NMFS's Letter of Concurrence).

### Critical Habitat

A total of 11.17 acres of piping plover critical habitat and 23.2 acres of proposed red knot critical habitat would be filled under the Proposed Action. The BA includes the full impact analysis on piping plover critical habitat and proposed red knot critical habitat, where FAA determined the Proposed Action would *likely adversely affect* this critical habitat (Appendix D). While the Proposed Action would adversely affect critical habitat, the small amount of habitat that would be affected by the Proposed Action would not substantially affect the recovery of the piping plover and red knot or the breeding and wintering grounds of migratory birds.

The USFWS's BO provides the results of the consultation on designated critical habitat (Appendix D). The BO concludes that the Proposed Action is not likely to adversely modify piping plover designated critical habitat.

## 3.10.5 Mitigation and Monitoring

The FAA would ensure that SpaceX implements the following measures to avoid, minimize, or mitigate impacts on biological resources.

**Construction Measures**

1. In conjunction with final design and CWA permitting, SpaceX will update its SWPPP to address the additional facilities proposed for the site and ensure compliance with its TCEQ stormwater permit. The updates will be completed before construction begins under the Proposed Action. The SWPPP identifies BMPs 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 permitted construction activities with the potential to impact water quality from potential runoff from the site will be conducted in accordance with the stormwater permit, including measures identified in the SWPPP. SpaceX will provide a copy of the SWPPP for permitted construction activity under the Proposed Action to the FAA and USFWS before such construction begins and will provide the USFWS and FAA with written notice of updates to the SWPPP on a quarterly basis.
2. Prior to entry into or exit from unpaved areas of the VLA, SpaceX will ensure that heavy equipment (i.e., vehicles and machinery that are larger than a typical passenger truck) and vehicles to the maximum extent possible traverse 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. SpaceX would inspect the equipment to ensure that hydraulic fittings are tight, hydraulic hoses are in good condition (and replaced if damaged), and there are no petroleum leaks. SpaceX will document the location(s) of the construction shakers or rumble plates installed at the VLA in its annual report to the USFWS.
3. SpaceX will implement a SPCC Plan. SpaceX will provide a copy of the SPCC Plan for permitted construction activity under the Proposed Action to the FAA and USFWS before such construction begins and will provide the USFWS and FAA with written notice of updates to the SPCC Plan on a quarterly basis.
4. SpaceX will not place excavated or fill material in delineated CWA Section 404 waters of the

United States except as authorized by a permit from the USACE. SpaceX will 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. SpaceX will provide to the USACE written notice documenting completion of the activity authorized under Section 404 of the CWA; compliance with all associated terms and conditions; and implementation of any required compensatory mitigation for impacts to waters of the United States. SpaceX will provide the notice to USACE within 30 days of completion of the activities authorized by the USACE and will include a copy of this notification in its annual report to the USFWS.

5. SpaceX will continue contracting a qualified biologist to conduct pre-, during, and post-construction biological monitoring (vegetation and birds). This monitoring is ongoing and will continue to be conducted within 3 miles of construction areas. Monitoring reports will continue to be sent to the USFWS annually.
6. SpaceX will limit vehicle operation to existing paved and unpaved roads, parking areas, and authorized construction sites. Vehicle operators within the VLA will not exceed 25 miles per hour.
7. SpaceX would incorporate raptor protection measures into project design and any above-ground utility upgrades. For example, SpaceX would equip structures with devices to discourage nest building and perching (e.g., monopole technology and visual fright devices).
8. SpaceX will initiate coordination with the USFWS within 60 days of the start of construction under the Proposed Action to identify practicable opportunities to protect, restore, and/or enhance habitat for the ocelot, jaguarundi, piping plover, and/or red knot. SpaceX intends to continue coordination with the USFWS to complete one or more habitat protection, restoration, or enhancement projects to benefit the cats and the birds and contribute to the conservation of these species.
9. Within 6 months of the issuance the BO, SpaceX will coordinate with the USFWS, USACE, and TxDOT to determine the feasibility of constructing wildlife crossings along SH 4 west of the first public hard checkpoint to benefit the ocelot and jaguarundi. If a wildlife crossing is deemed feasible by each of the coordinating parties, pending regulatory or other approvals from applicable agencies, SpaceX will fund the construction on one wildlife crossing west of the first public hard checkpoint within 1 year of the mutual determination of feasibility.
10. SpaceX will make an annual contribution of $5,000 to the Friends of Laguna Atascosa NWR Adopt-an-Ocelot Program within 3 months of the issuance of the BO and by March 1 of each year thereafter for the duration of the BO. Funds donated to the program are intended to pay for:
    a. Wildlife guzzlers
    b. Camera trapping sets
    c. Special events to raise awareness about the ocelot
    d. Important supplies that allow biologist to monitor ocelot dispersal, behavior and habitat needs.

11. SpaceX will make an annual contribution of $5,000 to the Peregrine Fund within 3 months of the issuance of the BO and by March 1 of each year thereafter for the duration of the BO. These funds will provide assistance with increased releases, repairing or replacing existing hack sites and/or nest boxes, or constructing new hack sites and/or nest boxes if falcons are observed in a new location.

12. If proposed construction activities under the Proposed Action occur during the avian breeding season (February 15 through August 31), a biologist will search the proposed areas of construction activities, including laydown areas, for nests (in shrubs and on the ground) one time no more than two days before the start of construction within the surveyed area. If the biologist finds an active nest, construction workers and activity, including the operation of vehicles, equipment, or tools, within 50 meters (164 feet) of the nest will be avoided until the biologist determines the nest is no longer in use. SpaceX will mark the avoidance zone with flagging, fencing, or similar signage within 24 hours of detecting the nest and will inspect the marking daily, repairing or replacing as needed, to ensure that it remains intact and visible through the duration of the nesting activity. SpaceX will document inspections and provide a summary of inspections and avoidance actions to the FAA and USFWS with the annual report.

**Operational Measures**

13. SpaceX will operate an employee shuttle between Brownsville and the project site and between parking areas at LLCC and the VLA to reduce the number of project-related vehicles traveling to and from the project site. SpaceX will encourage employees to use the shuttle by providing information on shuttle operation in new hire onboarding materials, routine staff communications (such as staff meetings), and in contractor environmental trainings. SpaceX will mandate use of the shuttle as practicable.

14. SpaceX will update its Lighting Management Plan to account for Starship/Super Heavy launches and related infrastructure that is the subject of the Proposed Action. These updates will be completed at least 30 days before the beginning of sea turtle nesting season that starts on March 15 of each year.

    Consistent with safety and security needs, SpaceX will initiate coordination with the USFWS and TPWD with the intent of incorporating the agencies' recommendations for minimizing lighting effects on ESA-listed species. This measure will minimize the modification of sea turtle habitat and minimize the likelihood of false crawls and disoriented hatchlings. Upon agreement with the USFWS and TPWD, SpaceX will implement the updated Lighting Management Plan. At a minimum, the plan will include:

    a. Directing, shielding, or positioning facility lighting to avoid or minimize visibility from the beach, minimize lateral light spread, and minimize uplighting without compromising safety and security of personnel.

    b. Turning off lights when not needed to maintain a safe and secure facility.

    c. Using low pressure sodium lights, 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 (i.e., some, all, or none of the lights can be turned on) 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.

15. SpaceX will continue contracting a qualified biologist to conduct pre- and post-launch biological monitoring (vegetation and birds). Monitoring will be conducted within 1 mile of the VLA up to a week before a Starship or Super Heavy launch and the day after the launch. Monitoring reports will be sent to the USFWS within two weeks following compilation and analysis of the data.

16. SpaceX will continue to collaborate with Sea Turtle, Inc. by supplying and storing field equipment and to provide sea turtle survey data within the action area to the USFWS annually. This measure supports activities that reduce the likelihood of death or injury to individual sea turtles.

17. Upon USFWS and SpaceX agreement of locations alongside SH 4 or other identified roads where the footprint is disturbed, SpaceX will fund the purchase of vehicle barrier materials to prevent trucks or ATVs from entering the NWR. The amount needed in any given year will be determined by NWR staff and is not to exceed $10,000 annually. SpaceX will install the barriers and USFWS staff will perform general maintenance and repairs of the barriers. Funds will be issued within 3 months from the issuance of the BO, and by March 1 of each year afterwards for the duration of the BO. SpaceX will be responsible for replacing or restoring damaged barriers caused by SpaceX personnel or an anomaly.

18. In coordination with NWR staff, SpaceX will develop a protocol (e.g., Access Restriction Notification Plan) providing as much advance notice as practicable to minimize disruption to refuge and land management activities.

19. SpaceX would coordinate with the USFWS to fund additional resources or projects to enforce the access restrictions required for launch operations.

20. SpaceX would implement any applicable avoidance or minimization measures included in NMFS's Letter of Concurrence when operating in the marine environment.

**Environmental Worker Educational Briefings**

21. SpaceX will develop educational training materials and submit to the USFWS for approval. Once approved, SpaceX will provide all on-site personnel, including staff and contractors, with an environmental worker education briefing(s) prior to the start of construction activities that will include the following topics: species identification, instruction on implementing the conservation measures described in the BO, wildfire prevention measures, information regarding noxious or invasive weeds, requirements for safe handling and disposal of hazardous waste, proper disposal of litter and garbage, and the employee shuttle. SpaceX will also provide this environmental worker education briefing on an ongoing basis to all new hires of on-site staff and contractors before starting on-site work and will offer refresher briefings to all on-site staff and contractors on an annual basis. SpaceX will document completion of these educational

briefings in its annual report to the USFWS.

**Anomaly Measures**

22. If an anomaly occurs, prior to taking action to recover debris on land outside the VLA, SpaceX will notify the appropriate emergency personnel, land-managing agencies, and water regulatory authorities, as required. In addition, SpaceX will comply with the terms of the MOA between TPWD and SpaceX, including coordinating with TPWD and the USFWS prior to debris removal and clean-up and consulting with TPWD and/or the USFWS prior to any anomaly-response activity that may impact sensitive wildlife habitat.
23. In the event of an anomaly that creates debris on NWR fee-owned or managed lands, SpaceX would be required to obtain a Special Use Permit on an emergency basis from the USFWS, as applicable, for clean-up activities.
24. If an anomaly occurs, SpaceX will comply with its Anomaly Response Plan, Security Plan, and Fire Mitigation and Response Plan, as applicable.

**Essential Fish Habitat Conservation Recommendations**

25. Prior to any in-water work (i.e., debris recovery or sinking), SpaceX will ensure all ballast and vessel hulls do not pose a risk of introducing new invasive species and that project implementation will not increase abundance of invasive species present at the project site. SpaceX will sanitize any equipment that has been previously used in an area known to contain invasive species prior to its use for project activities.
26. The FAA will coordinate with NMFS in the case of a launch failure and any vessel grounding to determine if consultation re-initiation is appropriate.

**BO Terms and Conditions**

27. The FAA will ensure that any license or permit to SpaceX related to the Proposed Action will include a condition that SpaceX implement all of the terms and conditions of the BO.
28. SpaceX will implement the conservation measures, many of which include related monitoring and reporting measures, described in the Proposed Action that address aspects of construction, operation, anomaly response, educational briefings, and other conservation measures and voluntary offsets. These measures minimize habitat modification, which can cause take via harm, for the ocelot, jaguarundi, northern aplomado falcon, piping plover, red knot, and/or sea turtles. These conservation measures require implementation, with updates as described, of certain facility and operational plans:
    a. Lighting Management Plan
    b. Fire Mitigation and Response Plan
    c. SPCC Plan
    d. SWPPP
    e. Anomaly Response Plan
    f. Access Restriction Notification Plan

g. Site Security Plan

h. Traffic Control Plan

i. Biological Monitoring Plan

SpaceX will provide the USFWS and FAA with written notice of updates to these plans on a quarterly basis.

29. SpaceX will conduct quarterly SH 4 clean-up efforts east of the first public hard checkpoint to reduce garbage and litter along the road. The clean-up efforts will take place within the SH 4 right-of-way. SpaceX will keep all vehicles used to support cleanups on designated roadways. SpaceX will report the dates of the cleanups in the annual monitoring report submitted to the USFWS. This measure minimizes the severity of habitat modifications (i.e., the presence of litter or garbage) that may attract animals that prey on or compete with northern aplomado falcons, piping plovers, red knots, or sea turtles. This measure also benefits ocelots and jaguarundis by minimizing the likelihood or severity of increased prey concentrations along SH 4 that could lead to increased vehicle collision mortality.

30. SpaceX will ensure that staff and contractors place non-hazardous waste materials, litter, and other discarded materials, such as construction waste, on the VLA in containers until removed from the site. All trash containers will have predator-proof secured lids and be kept closed at all times and trash will be removed regularly. This measure minimizes the severity of habitat modifications (i.e., the presence of litter or garbage) that may attract animals that prey on or compete with northern aplomado falcons, piping plovers, red knots, or sea turtles. This measure also benefits ocelots and jaguarundis by minimizing the likelihood or severity of increased prey concentrations along SH 4 that could lead to increased vehicle collision mortality.

31. SpaceX will perform quarterly beach cleanups of Boca Chica Beach to reduce the likelihood of attracting predators (i.e., minimizing habitat modification) of the piping plover, red knot, and sea turtles to the beach. SpaceX will perform these beach cleanups for 1.5 miles north and south of the VLA. SpaceX will provide the opportunity for resource agencies (i.e., TGLO, USFWS) to participate and teach the community about the area's wildlife, sensitive areas, beach debris, and beach clean-up. SpaceX will report the dates of the cleanups in the annual monitoring report submitted to the USFWS.

32. SpaceX will coordinate with TxDOT to help ensure that the shoulders of SH 4 east of the first public hard checkpoint are maintained by regular mowing and trimming to keep vegetation shorter than 12 inches. SpaceX will notify TxDOT that maintenance may be warranted when vegetation along SH 4 exceeds approximately 9 inches. TxDOT will be responsible for performing roadway vegetation maintenance. This measure minimizes vegetation cover along SH 4 and minimizes the likelihood of vehicle collisions with ocelots or jaguarundis.

33. SpaceX will construct a barrier along the northern boundary of the VLA to assist in keeping debris from entering the NWR, help deflect off-gassing of liquid nitrogen, reduce sound transmission. Construction of the barrier wall will be completed prior to the start of launch operations. This measure will minimize the extent and severity of habitat modification for piping plovers and red knots that use areas adjacent to the VLA.

34. Cryogenic testing and other pressure tanks used under the Proposed Action will be tethered by cables when practicable to the VLA site to help prevent debris from leaving the VLA. This measure will minimize the extent and severity of habitat modification for piping plovers and red knots that use areas adjacent to the VLA.

35. SpaceX will minimize noise from generators that may be used during construction and/or operations at the VLA under the Proposed Action. SpaceX will ensure that generators are placed within baffle boxes (a sound-resistant box that is placed over or around a generator), have an attached muffler, or use another noise-abatement method consistent with industry standards. This measure minimizes the severity of habitat modification for piping plovers and red knots that use areas adjacent to the VLA.

36. SpaceX will perform inspections of the lighting installed as part of the Proposed Action on a biweekly basis during the sea turtle nesting and hatching season (March 15 to October 1) to ensure that the minimization measures specified in the Lighting Management Plan are installed and in good working order. SpaceX will document compliance with the Lighting Management Plan and note any deviations. SpaceX will address deviations with the USFWS on a timely manner to implement corrective actions. SpaceX will report any deviations and responsive actions to the USFWS in its annual report. This measure minimizes the severity of habitat modification for sea turtles.

37. SpaceX will monitor nighttime light levels on the beach within 1.5 miles of the VLA at least once before the start of the sea turtle nesting season and biweekly during the sea turtle nesting and hatching season (March 15 to October 1). SpaceX will perform this monitoring at least once per year at a time when there is a launch vehicle at the VLA (i.e., a condition when more lighting at the site is needed for safety and security), even if this monitoring event occurs outside of the sea turtle nesting and hatching season. SpaceX will perform this monitoring between 9:00pm and 5:00am. SpaceX will use the information to identify any practicable opportunities for modifying lighting at the VLA (with updates to the Lighting Management Plan, as appropriate) that reduce light levels at the beach while maintaining operational needs for safety and security. SpaceX will document and summarize its monitoring and any responsive actions in the annual report to the USFWS. This measure minimizes the severity of habitat modification for sea turtles.

38. SpaceX will implement the water resources mitigation measures described in Section 3.9.5. These measures address compliance with TCEQ TPDES permits, updates and/or implementation of its SPCC Plan and SWPPPs, and development and implementation of associated water quality monitoring in coordination with TCEQ.

39. SpaceX will seek input from the USFWS on updates to its SWPPP prior to the start of construction activities under the proposed action. SpaceX will ensure that the updated SWPPP includes best practices appropriate to coastal ecosystems that minimize the transport of sediment and the discharge of freshwater runoff outside of the VLA and maximize the retention or infiltration of runoff within the VLA. This measure will minimize modification of habitat for piping plovers and red knots that use areas adjacent to the VLA (e.g., habitat modification resulting from discharges of sediment and freshwater runoff into the wind tidal flats adjacent to

the VLA).

40. SpaceX will clearly demarcate the perimeter of all areas to be disturbed during construction activities under the Proposed Action using flagging or temporary construction fence and no disturbance outside that perimeter will be authorized. This measure minimizes the extent of habitat modification for the piping plover and red knot that use area adjacent to the VLA.
41. SpaceX shall use areas within the project boundary or other area subject to prior disturbance for staging, parking, and equipment storage in connection with the Proposed Action. This measure minimizes the extent of habitat modification for the piping plover and red knot that use area adjacent to the VLA.
42. SpaceX will obtain any gravel or topsoil needed during construction activities under the Proposed Action from existing developed or previously used sources, and not from undisturbed areas that provide habitat for the ocelot, jaguarundi, piping plover, or red knot. The measure minimizes the extent of habitat modification for ocelots, jaguarundis, piping plovers and red knots.
43. Consistent with TCEQ stormwater permit conditions, during construction activities associated with the Proposed Action, SpaceX will ensure that best practices are applied at the VLA that minimize the deposit of eroded materials outside the boundary of the VLA. This measure minimizes the severity of habitat modification for the piping plover and red knot (via deposit of materials that could alter the microtopography of adjacent flats) that use areas adjacent to the VLA.
44. In coordination with TxDOT and the USFWS, SpaceX will install five signs along SH 4 to inform the public on areas (such as sensitive areas of the NWR and the dunes) where they may not watch ongoing activities and launches. Signs would be installed within 6 months of issuance of the BO.
45. SpaceX will initiate coordination with TxDOT within 30 days of issuance of the BO regarding the installation of up to five additional wildlife crossing signs along SH 4 for a total of ten signs (five in each direction) to reduce the risk of collision mortality for ocelots and jaguarundis. SpaceX has already installed five wildlife crossing signs. Pending TxDOT approval, SpaceX will purchase and install the additional five signs. Installation of the signs will be completed within 6 months of issuance receiving TxDOT approval of the sign locations.
46. SpaceX security patrol vehicles or other necessary SpaceX vehicles on Boca Chica Beach will be driven above the “wet line” (i.e., the line on the beach where waves reach and repeatedly wet the sand at the time the driver passes by) and at a speed not to exceed 15 miles per hour. This measure minimizes the severity of habitat modification for piping plovers and red knots.
47. SpaceX will continue to implement the SpaceX Boca Chica Launch Site Biological Monitoring Plan to survey for sea turtles, birds, and vegetation changes. Monitoring reports will be included as part of the SpaceX’s annual monitoring report submitted to the USFWS. After five years of monitoring, and when SpaceX applies for a renewal or extension of its license or permit, the USFWS, FAA, and SpaceX will evaluate the need to modify, adapt, or discontinue the monitoring. Sea turtle monitoring on Boca Chica Beach will be conducted prior to implementation of access

restrictions and security sweeps for, and as soon as practicable after, suborbital and orbital launches. Post-launch monitoring can be conducted by Sea Turtle Inc.; however, the use of drones is acceptable if Sea Turtle Inc. is unable to conduct monitoring in-person. Findings will be included in the annual report to the USFWS.

48. SpaceX will continue to offer enhanced satellite monitoring via solar powered Starlink to the Peregrine Fund for continuous video coverage of northern aplomado falcon habitat to aid in biological monitoring.
49. If sea turtle nests are discovered prior to closure and security sweeps, SpaceX will coordinate with Sea Turtle Inc. to remove eggs prior to launch. Findings will be included in the annual report to the USFWS.
50. SpaceX will provide a dedicated space for Sea Turtle, Inc. volunteers on SpaceX property to monitor Boca Chica Beach use and to conduct pre-and post- launch surveys at Boca Chica Beach.
51. If SpaceX plans to conduct more than two of the ten annual launches under the Proposed Action at night during the sea turtle nesting and hatching season (March 15th – October 1st), SpaceX and the FAA will contact the USFWS within 30 days of the third nighttime launch (and any subsequent nighttime launches planned during that year) to discuss if there is a need for additional take authorization.
52. SpaceX will submit an annual monitoring report to the USFWS by March 1st for the preceding calendar year. The annual report will include monitoring results, measures implemented during project activities, success of such measures, incidences, and any recommendations on improvements to those measures. Reports should be sent to: U.S. Fish and Wildlife Service, Texas Coastal Ecological Services Field Office, ATTN: Field Supervisor, 4444 Corona, Suite 215, Corpus Christi, Texas 78411 or email to dawn_gardiner@fws.gov.
53. If the FAA issues SpaceX a vehicle operator license for Starship/Super Heavy launch operations at the Boca Chica Launch Site, the BO would expire concurrent with the expiration of the FAA's license. SpaceX will notify the USFWS if SpaceX plans to continue FAA-licensed activities (i.e., applying for license renewal or a new license) no later than 6 months before FAA's license expires. The FAA would conduct its consultation obligations as required under ESA Section 7 as part of its evaluation of SpaceX's license application.

# 3.11 Coastal Resources

## 3.11.1 Definition of Resource and Regulatory Setting

Coastal resources include natural resources occurring within coastal waters and their adjacent shorelands. Coastal resources include islands, transitional and intertidal areas, salt marshes, wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as fish and wildlife and their respective habitats within these areas.

Relevant laws pertaining to coastal resources that are applicable to this project include the Coastal Barrier Resources Act (16 U.S.C. § 3501 *et seq.*) and the CZMA (16 U.S.C. §§ 1451-1466). The Coastal

Barrier Resources Act is administered by the USFWS to preserve the ecological integrity of areas that protect the US mainland from storms, to provide important habitats for fish and wildlife, and to protect coastal barrier islands. Per the CZMA and its regulations (15 CFR 930), an applicant seeking a permit, license, or other authorization from a federal agency must consult the relevant state agency to ensure its project is consistent with the state's coastal management program. More information about coastal resources can be found in Chapter 4 of the FAA Order 1050.1F Desk Reference (FAA 2020d).

Texas exercises its authority to implement the TCMP under the CZMA through 31 TAC §501.3, which defines Coastal Natural Resource Areas as those areas that include coastal barriers, coastal historic areas, coastal preserves, coastal shore areas, coastal wetlands, critical dune areas, critical erosion areas, gulf beaches, hard substrate reefs, oyster reefs, submerged land, special hazard areas, submerged aquatic vegetation, tidal sand or mud flats, water of the open Gulf of Mexico, and water under tidal influence. In Texas, TGLO administers the federally approved TCMP. A Federal Consistency Review is conducted by the TGLO on behalf of the Coastal Coordination Council when construction occurs within the Texas coastal zone boundary.

The goals of the TCMP are attained by enforcement of the policies of the State as codified within the TAC. "Policy" or "policies" of the TCMP means the enforceable provisions of the present or future applicable statues of the State of Texas or regulations promulgated duly thereunder (31 TAC § 501). The statutes cited as policies of the TCMP were selected because they reflect the overall program goals of developing and implementing a balanced program for the protection of the natural resources, as well as promoting sustainable economic development of the coastal area.

### 3.11.2 Study Area

The study area for coastal natural resource areas, as defined in the TAC, is the Boca Chica Launch Site and nearshore habitat that may be affected by the Proposed Action.

### 3.11.3 Existing Conditions

Coastal natural resource areas, as defined by 31 TAC § 501.3, are present in the study area. The property boundary for the VLA is immediately adjacent to critical dune areas, and an area of sand dunes occurs on the eastern portion of the property. These areas are defined as a protected sand dune complex on the Gulf shoreline parallel to and within 1,000 ft of mean high tide designated by a dune protection line established by local governments. Cameron County established a dune protection line, which changes as the shoreline changes (Cameron County 2018).

The VLA is located within the Coastal Barrier Resource System Unit T12 and within and adjacent to the Otherwise Protected Area Unit T12P (USFWS 2021a), as mapped under the Coastal Barrier Resources Act.

There are no Marine Protected Areas in the vicinity of the Proposed Action. As of March 2012, the NWR is listed as eligible for a Marine Protected Area but is not a member. Boca Chica State Park was deemed not eligible as a Marine Protected Area (NOAA 2018). Therefore, Executive Order (EO) 13158 does not apply to the Proposed Action. Additional, eligible preserves located in south Texas are the Laguna Atascosa NWR and the Padre Island National Seashore (NOAA 2021c).

### 3.11.4 Environmental Consequences

According to FAA Order 1050.1F, the FAA has not established a significance threshold for coastal resources. Factors to consider when assessing the significance of potential impacts on coastal resources include situations in which the action would have the potential to:

- be inconsistent with the relevant state coastal zone management plan(s);
- impact a coastal barrier resources system unit (and the degree to which the resource would be impacted);
- pose an impact on coral reef ecosystems (and the degree to which the ecosystem would be affected);
- cause an unacceptable risk to human safety or property; or
- cause adverse impacts on the coastal environment that cannot be satisfactorily mitigated.

The Proposed Action would take place in the coastal zone. Downrange landings would occur no closer than 19 miles offshore. Landing and recovery operations would not take place in intertidal areas, salt marshes, estuaries, or coral reefs. The Proposed Action does not include any coastal construction or seafloor disturbing activities and would be consistent with commonly occurring Gulf of Mexico maritime operations. The Proposed Action is not prohibited for development within the Coastal Barrier Resource System Unit, as the project is not federally funded. SpaceX is responsible for coordinating with the TGLO to ensure its activities are consistent with the TCMP. The FAA may not issue a permit or license to SpaceX unless SpaceX's proposed activities meet the consistency requirements of the TCMP. During preparation of the 2014 EIS, the TGLO did not raise any objections to SpaceX's Falcon proposal.

As stated above, TGLO did not conduct a federal consistency review because the issuance of a commercial space experimental permit or license is not a listed activity and is not subject to review under the TCMP. Therefore, the Proposed Action is not expected to result in significant impacts to coastal resources.

## 3.12 Land Use

### 3.12.1 Definition of Resource and Regulatory Setting

Land use is the classification of activities occurring at a given location whether the land is in a natural state or has been modified or developed. Land uses are often identified by general plans, management plans, and land use policies that determine the type and extent of land use allowable in specific areas and protect specially designated or environmentally sensitive areas. Ordinances (e.g., zoning) regulate the types of activities determined to be acceptable within the identified land uses.

The compatibility of existing and planned land uses with an aerospace proposal is usually associated with noise impacts (Section 3.5). In addition to the impacts of noise on land use compatibility, other potential impacts may also affect land use compatibility (e.g., disruption of communities, relocation, induced socioeconomic impacts, and land uses protected under Section 4(f) of the DOT Act). More

information about land use can be found in Chapter 9 of the FAA Order 1050.1F Desk Reference (FAA 2020d).

### 3.12.2 Study Area

The study area for land use is the area that may be affected by the Proposed Action. In this case, the study area is Cameron County, Texas.

### 3.12.3 Existing Conditions

The Boca Chica Launch Site is located on privately owned land in Cameron County, Texas. The land surrounding the launch site is primarily used for recreational purposes and includes Boca Chica State Park, the NWR (Boca Chica Tract), Boca Chica Beach, the Preserve, Brazos Island State Park, Isla Blanca Park, and the NHL. While the Boca Chica area has long supported outdoor recreation, much of the land has been managed by state, federal, and private partners as conservation lands.

State parks are managed by the TPWD and are considered public lands. Boca Chica State Park and the Loma Ecological Preserve, although owned by the TPWD, are leased by the USFWS and managed as part of the NWR. South Bay Coastal Preserve is cooperatively managed by the TGLO and TPWD. Under the Open Beaches Act, Boca Chica State Park is considered public land up to the high tide line or the line of vegetation. Isla Blanca Park, approximately 5 miles north of the VLA, is managed by the Cameron County Parks and Recreation Department and is considered public land. The NWR is managed by the USFWS and is considered public land. Portions of the VLA are located within Coastal Barrier Resources System Unit T-12 (see Section 3.11). The NHL, approximately 3 miles southwest of the VLA, is considered public land. Refer to Section 3.8 for more information on these public lands.

### 3.12.4 Environmental Consequences

The FAA has not established a significance threshold for land use, nor has the FAA identified specific factors to consider in making a significance determination for land use impacts. According to FAA Order 1050.1F, the determination that significant land use impacts exist is normally dependent on the significance of other impacts.

The Boca Chica Launch Site is currently a mixed-use, industrial facility. Impacts to land use from launch-related operations are not anticipated because the Proposed Action would not violate any local land use ordinances. Additionally, the planned uses under the Proposed Action are consistent with the current land uses. There are no land use plans or zoning ordinances that would be violated by the Proposed Action. The Proposed Action would not change dedicated land uses in the study area. The launch site is currently supporting launch-related tests and suborbital launches. That would not change under the Proposed Action. SpaceX's proposed expansion of the VLA and solar farm is within SpaceX's property boundaries.

SpaceX would install the proposed utility lines leading from the LLCC to the VLA underground in the SH 4 ROW. SpaceX would coordinate with USFWS and TxDOT to obtain the appropriate approvals and utility permits in accordance with the Utility Accommodation Policy found in TAC. The power line upgrades and the installation of underground utilities from the LLCC to the VLA would not adversely affect land use.

The Texas Natural Resources Code Section 61.132 permits TGLO and Cameron County to enter into a memorandum of agreement under the terms of which Boca Chica Beach may be closed temporarily for space launches. The MOA between Cameron County and TGLO (TGLO 2013)[40] delineates the circumstances under which the County is authorized to close the beach and beach access points for the limited purpose of protecting public health and safety during spaceflight activities.

As detailed in Section 2.1.3.5, SpaceX would establish an access restriction area prior to launch-related operations. The access restriction area is similar to the access restriction area developed during preparation of the 2014 EIS, which was developed in collaboration with public land-managing agencies to avoid adverse effects to public lands. The TxDOT has authorized a SpaceX Roadway Closure Traffic Control Plan to perform road access restrictions on SH 4. Public access to Boca Chica State Park, the NHL, the NWR, and Brazos Island State Park would be closed for safety and security reasons during launch operations, with advanced notice provided to the public for planning purposes. These access restrictions would be limited to up to 500 hours per year for nominal operations and up to an additional 300 hours per year to address anomalies. SpaceX has established a hotline for real time status and updates on access restrictions through a text message alert service. Subscribers can text "BEACH" to 1-866-3475 to receive updates and public notices will also be available on the Cameron County webpage.[41]

SpaceX's transport of Starship/Super Heavy, cargo, and payloads to the Boca Chica Launch Site would occur on SH 4, which is the only road leading to the launch site. If either stage landed in the Gulf of Mexico on a floating platform, SpaceX would deliver it by barge to the Port of Brownsville and transport it the remaining distance to the Boca Chica Launch Site over roadways. No landside infrastructure would be required in support of the Proposed Action. The transport of rocket components and payloads over this stretch of SH 4 is currently a common occurrence.

As discussed in the 2014 EIS, state-owned submerged lands are included in the water closure area. There are seven active leases offshore in the Gulf of Mexico near the project location (BOEM 2021). Impacts to these leases are anticipated to be minimal. SpaceX would notify and coordinate with the oil and gas operators prior to any launch (including landing). Gas wells and dry holes are present along SH 4, as previously described in the 2014 EIS. No new oil or gas wells appear to have been constructed onshore in the project vicinity since completion of the EIS (RRC 2021).

In summary, the Proposed Action is not expected to result in significant land use impacts because the Proposed Action is consistent with existing uses of land, would not change land use, and would occur according to existing plans and procedures in place (e.g., SpaceX Roadway Closure Traffic Control Plan; SpaceX Security Plan).

### 3.12.5 Mitigation and Monitoring

The FAA would ensure that SpaceX implements the following measures to minimize impacts related to land use.

[40] Texas General Land Office (September 1, 2013). Contract No. 13-447-000-7916 [Memorandum of Agreement].

[41] See: http://www.cameroncounty.us/space-x/.

1. SpaceX would notify and coordinate with the oil and gas operators prior to any launch (including landing).
2. The measures listed above in Section 3.8.5 would also mitigate land use impacts.

# 3.13 Hazardous Materials, Solid Waste, and Pollution Prevention

## 3.13.1 Definition of Resource and Regulatory Setting

Hazardous materials, solid waste, and pollution prevention as an impact category includes an evaluation of the following:

- waste streams that would be generated by a project, potential for the wastes to impact environmental resources, and the impacts on waste handling and disposal facilities that would likely receive the wastes;
- potential hazardous materials that could be used during operation of a project, and applicable pollution prevention procedures;
- potential to encounter existing hazardous materials at contaminated sites during operation and decommissioning of a project; and
- potential to interfere with any ongoing remediation of existing contaminated sites at the proposed project site or in the immediate vicinity of a project site.

The terms hazardous material, hazardous waste, and hazardous substance are often used interchangeably when used informally to refer to contaminants, industrial wastes, dangerous goods, and petroleum products. Each of these terms, however, has a specific technical meaning based on the relevant regulations.

***Solid waste*** is defined by the implementing regulations of the Resource Conservation and Recovery Act (RCRA) generally as any discarded material that meets specific regulatory requirements and can include such items as refuse and scrap metal, spent materials, chemical by-products, and sludge from industrial and municipal wastewater and water treatment plants.

***Hazardous waste*** is a type of solid waste defined under the implementing regulations of RCRA. A hazardous waste is a solid waste that possesses at least one of the following four characteristics: ignitibility, corrosivity, reactivity, or toxicity as defined in 40 CFR part 261 subpart C, or is listed in one of four lists in 40 CFR part 261 subpart D, which contains a list of specific types of waste that the EPA has deemed hazardous. RCRA imposes stringent requirements on the handling, management, and disposal of hazardous waste, especially in comparison to requirements for non- hazardous wastes.

***Hazardous substance*** is a term broadly defined under Section 101(14) of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Hazardous substances include:

- any element, compound, mixture, solution, or substance designated as hazardous under Section 102 of CERCLA;
- any hazardous substance designated under Section 311(b)(2)(A) or any toxic pollutant listed under Section 307(a) of the CWA;
- any hazardous waste under Section 3001 of RCRA;
- any hazardous air pollutant listed under Section 112 of the Clean Air Act; and
- any imminently hazardous chemical substance or mixture for which the EPA has "taken action under" Section 7 of the Toxic Substances Control Act.

***Hazardous material*** is any substance or material that has been determined to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce. The term hazardous materials includes both hazardous wastes and hazardous substances, as well as petroleum and natural gas substances and materials (see 49 CFR § 172.101).

***Pollution prevention*** describes methods used to avoid, prevent, or reduce pollutant discharges or emissions through strategies such as using fewer toxic inputs, redesigning products, altering manufacturing and maintenance processes, and conserving energy.

More information about hazardous materials, solid waste, and pollution prevention can be found in Chapter 7 of the FAA Order 1050.1F Desk Reference (FAA 2020d).

## 3.13.2 Study Area

The study area for hazardous materials, pollution prevention, and solid waste is the Boca Chica Launch Site and locations to which wastes are transported for disposal. Class 1 and Class 2 non-hazardous industrial waste is currently disposed of at the Seabreeze landfill in Angleton, Texas. Hazardous waste is currently transported to Tradebe Treatment and Recycling, LLC, in Memphis, Tennessee, for fuel blending or incineration.

## 3.13.3 Existing Conditions

SpaceX currently uses numerous types of hazardous materials at the Boca Chica Launch Site, including paint, industrial solvents, fuels, petroleum products, oils, lubricants, VOCs, corrosives, refrigerants, adhesives, sealants, epoxies, and propellants. SpaceX manages, controls, stores, and disposes all hazardous wastes at the launch site according to regulations found in 40 CFR Parts 260–282 and 30 TAC Chapters 330 and 335.

A review of CERCLA, RCRA, Toxic Release Inventory, Toxic Substances Control Act, and brownfields databases did not identify any hazardous materials use, release, or disposal sites in the vicinity of the launch site. The nearest Superfund site is the Falcon Refinery located in Ingleside, Texas, approximately 200 miles north of the launch site (EPA 2019a). A review of historical aerial photos of the VLA from 1950 to present did not indicate any history of development prior to development by SpaceX (Google Earth 2019). The 2014 EIS did not indicate any history of known releases, users, or generators of hazardous substances in the vicinity of the VLA.

Several hazardous waste treatment, storage, and disposal facilities are located in the State of Texas and could be used for the transport and disposal of hazardous wastes. SpaceX currently disposes hazardous wastes at Tradebe Treatment and Recycling, LLC, which is capable of handling 450 drums per day of hazardous waste and has an 80,000-gallon tank farm (Tradebe Treatment and Recycling 2020). SpaceX currently disposes of Class 1 and Class 2 non-hazardous wastes at the Seabreeze landfill in Angleton, Texas. In 2019, the Seabreeze landfill had approximately 18,444,409 remaining tons of capacity and had an estimated 17 remaining years (TCEQ 2020b).

## 3.13.4 Environmental Consequences

The FAA has not established a significance threshold for hazardous materials, solid waste, and pollution prevention. Factors to consider when assessing the significance of potential impacts include whether the action would have the potential to:

- violate applicable federal, state, tribal, or local laws or regulations regarding hazardous materials and/or solid waste management;
- involve contaminated sites;
- produce an appreciably different quantity or type of hazardous waste;
- generate an appreciably different quantity or type of solid waste or use a different method of collection or disposal and/or would exceed local capacity; or
- Adversely affect human health and the environment.

### 3.13.4.1 Hazardous Materials

Construction activities would use products containing hazardous materials, including paints, solvents, oils, lubricants, acids, batteries, surface coating, and cleaning compounds. Implementation of appropriate handling and management procedures for hazardous materials, hazardous wastes, and solid wastes would avoid or minimize the potential for impacts.

Processing launch vehicles at the Boca Chica Launch Site requires the use of hazardous materials and results in the production of hazardous wastes. Small quantities of hazardous waste would be generated during routine operations. Most of the hazardous materials would be consumed, so no substantial volumes of hazardous waste would require disposal. Launch vehicle maintenance, propellant and fuel storage and dispensing, and facility and grounds maintenance would generate very small quantities of hazardous wastes. The sources of hazardous waste include waste oils, spent solvents, paint waste, spill response materials, and used batteries. The battery infrastructure associated with the on-site solar array is subject to appropriate handling and management procedures. A potential hazardous material release associated with the solar array infrastructure, although unlikely, would be subject to the management procedures described in SpaceX's Anomaly Response Plan.

Starship may contain between 1 to 10 metric tons of $LCH_4$ upon landing depending on the specific mission characteristics. The residual LOX would be vented and $LCH_4$ would be recycled or vented. If vented, $LCH_4$ would evaporate within hours. This would cause some level of short-term flammable

environment; however, the potential for impacts would be limited through the implementation of appropriate handling and management procedures for hazardous materials.

Hazardous materials such as fuels, ordnance, chemicals, and payload components would be transported over public transportation routes to the appropriate facilities in accordance with DOT regulations. The transport and use of hazardous materials would have the potential to result in accidental spills that could adversely impact soil, surface water, and groundwater adjacent to transportation routes or downgradient from the operational areas. These types of potential impacts to water resources are discussed in Section 3.9. In the case of a reportable spill or the discovery of previously unknown contaminants that exceed a reportable threshold, SpaceX would stop work and contact the National Response Center. If the reportable spill occurs within tidal waters, SpaceX would also notify the TGLO. SpaceX would treat or remove soils that adversely affected by spills in accordance with applicable federal and state regulations.

SpaceX would store hazardous materials at the launch site in a manner consistent with applicable federal, state, and local environmental, public, and occupational health and safety regulations, which would prevent these materials from leaking, spilling, and potentially polluting soils, groundwater, and surface waters. SpaceX would adhere to the National Fire Protection Association guidelines regarding the location of cryogenic storage in relation to public access (National Fire Protection Association 55 2020). SpaceX would store hazardous materials on pallets under cover and with secondary containment. SpaceX would not store incompatible materials together. SpaceX would provide sufficient space between stored containers to allow for spill clean-up and emergency response access. Storage units would meet building and fire code requirements and would be located away from vehicle traffic. SpaceX would continue to post storage instructions and train employees in proper receiving, handling, and storage procedures. SpaceX would continue to provide Safety Data Sheets for all materials stored on the site to all site personnel.

A launch anomaly could result in debris and hazardous materials being distributed in the immediate area of the VLA or downrange landing site. Any anomalies in the landing event plan would cause a destruct signal to be sent to the vehicle over the ocean, causing the onboard ordnance to detonate. SpaceX would respond to all accidental releases of polluting substances quickly and implement appropriate clean-up measures in accordance with applicable laws to minimize impacts to the environment. Starship would have approximately 34 gallons of hydraulic fluid, and the booster would have approximately 74 gallons of hydraulic fluid. In the event of an anomaly, hydraulic fluid may remain contained in the vehicle, ignite, or be released. Remaining hazardous materials such as propellant, ordnance, or chemicals would be transported back to a processing facility in accordance with DOT regulations for transport of hazardous substances (Title 49 CFR 100- 199). Potential impacts on water resources from the release of hazardous materials are discussed in Section 3.9.

Large commercial vessels, such as the floating platform SpaceX would use for offshore landings, routinely discharge ballast water, gray and black water, bilge water, deck runoff, sewage, and a variety of other vessel discharges consistent with the International Convention for the Prevention of Pollution from Ships Annex IV and the CWA NPDES Program. SpaceX compliance with these requirements would result in minimal environmental impacts from using the floating platform.

In summary, SpaceX would comply with all applicable federal, state, and local rules and regulations pertaining to the proper storage, handling, and use of hazardous materials. SpaceX has appropriate plans in place to address accidental spills or releases of hazardous materials (e.g., SPCC Plan). Therefore, the Proposed Action is not expected to result in significant impacts related to hazardous materials.

### 3.13.4.2 Solid Waste

SpaceX would place solid wastes in covered receptacles until disposal to avoid or minimize accidental entry into coastal waters or contact with stormwater and to prevent offsite deposition from wind. SpaceX would salvage or recycle solid wastes to the maximum extent practicable and dispose of the remaining solid waste in appropriately permitted landfills.

In 2019, the Seabreeze landfill had approximately 18,444,409 remaining tons of capacity and had an estimated 17 remaining years (TCEQ 2020b). Thus, the landfills used by SpaceX have sufficient capacity to handle solid waste generated by the Proposed Action. Therefore, the Proposed Action would not result in significant solid waste impacts.

### 3.13.4.3 Pollution Prevention

SpaceX would prevent pollution via source reduction whenever feasible. SpaceX would recycle and/or treat polluting substances whose use cannot be avoided in accordance with applicable laws. SpaceX's disposal of all polluting substances would be employed only as a last resort and would be conducted in accordance with applicable laws. SpaceX would respond to all accidental releases of polluting substance quickly and implement appropriate clean-up measures in accordance with applicable laws and plans to minimize impacts to the environment. SpaceX would also implement its SWPPP and SPCC Plan throughout construction and operation of the Proposed Action, which would prevent potential spills from affecting surface water in the nearby areas.

SpaceX would collect, store, and dispose of hazardous materials, substances, and wastes used and generated as part of recovery operations using practices that minimize the potential for accidental releases or contact with storm or marine water and in accordance with the Anomaly Response Plan, SWPPP, and SPCC Plan. Starship/Super Heavy has been designed to perform pinpoint landings to avoid collisions with existing structures and to avoid release of hazardous materials and pollutants.

To further minimize the potential for groundwater contamination, SpaceX would assemble an emergency response team that would be responsible for responding to hazards and spills for all Starship/Super Heavy propellants. SpaceX would implement its Anomaly Response Plan to ensure that adequate and appropriate guidance, policies, and protocols regarding hazardous material incidents and associated emergency response are available to and followed by all personnel. Emergency response and clean-up procedures contained in the plan would reduce the magnitude and duration of any impacts both on and off site.

SpaceX currently stores sewage produced at the VLA in a septic tank, which is routinely hauled off-site for disposal. SpaceX would continue this practice under the Proposed Action.

The Proposed Action would not result in significant impacts regarding hazardous materials, solid waste, and pollution prevention because it would not 1) violate laws or regulations regarding hazardous

materials and/or solid waste management; 2) involve a contaminated site; 3) produce an appreciably different quantity or type of hazardous waste; 4) generate an appreciably different quantity or type of solid waste or use a different method of collection or disposal; 5) exceed local capacity; or 6) adversely affect human health and the environment.

### 3.13.5 Mitigation and Monitoring

SpaceX would implement the following measures to minimize impacts related to hazardous materials, solid waste, and pollution prevention.

1. SpaceX would handle any release of a hazardous material according to the management procedures described in its Anomaly Response Plan.
2. SpaceX would comply with all applicable federal, state, and local rules and regulations pertaining to the proper storage, handling, and use of hazardous materials.
3. SpaceX would implement its SPCC Plan to prevent and address accidental spills or releases of hazardous materials.
4. SpaceX would report any release of a hazardous material in the Gulf of Mexico through the USCG National Response Center; releases in tidal waters would also be reported to TGLO.
5. SpaceX would comply with the International Convention for the Prevention of Pollution from Ships Annex IV and the CWA NPDES Program regarding vessel discharge of large commercial vessels for offshore landings on platforms.
6. SpaceX would implement the appropriate handling and management procedures for hazardous materials when venting residual LOX and LCH4.
7. Hazardous materials such as fuels, ordnance, chemicals, and payload components would be transported over public transportation routes to the appropriate facilities in accordance with DOT regulations.
8. SpaceX would treat or remove any soils adversely affected by spills in accordance with applicable federal and state regulations.
9. In the event of an anomaly, SpaceX would respond to all accidental releases of polluting substances quickly and implement appropriate clean-up measures in accordance with applicable laws to minimize impacts to the environment.
10. SpaceX would store solid wastes in covered receptacles until disposal to avoid offsite deposition, recycle solid wastes to the extent practicable, and dispose of the remaining solid waste in appropriately permitted landfills.
11. SpaceX would collect, store, and dispose of hazardous materials, substances, and wastes used and generated as part of recovery operations using practices that minimize the potential for accidental releases or contact with storm or marine water and in accordance with the Hazardous Materials and Emergency Response Plan, SWPPP, and SPCC Plan, as well as RCRA and OSHA regulations.

12. SpaceX would assemble an emergency response team that would be responsible for responding to hazards and spills for all Starship/Super Heavy propellants.

# 3.14 Natural Resources and Energy Supply

## 3.14.1 Definition of Resource and Regulatory Setting

As an impact category, natural resources and energy supply provides an evaluation of a project's consumption of natural resources (such as water, asphalt, aggregate, wood, etc.) and use of energy supplies (such as coal for electricity; natural gas for heating; and fuel for commercial space launch vehicles, ground vehicles, or marine vessels). Consumption of natural resources and use of energy supplies might result from construction, operation, and/or maintenance of the project. More information about natural resources and energy supply can be found in Chapter 10 of the FAA Order 1050.1F Desk Reference (FAA 2020d).

## 3.14.2 Study Area

The study area for natural resources and energy supply is the Boca Chica Launch Site because that is the area where the project's consumption of natural resources and use of energy supplies would occur.

## 3.14.3 Existing Conditions

The natural resources required for the operation of the Boca Chica Launch Site include a water source for potable use, as well as for the deluge water system used during launches for noise suppression and cooling. There is currently no potable water supply at the VLA. The nearest municipal water supply is the City of Brownsville, with the closest connections approximately 15–20 miles west of the VLA. Based on the Texas Water Development Board projected municipal water use in Brownsville from 2020 through 2070, the actual municipal water use in 2018 was 20.8 million gallons per day (MGD) and projected municipal water use in 2030 will be 36.8 MGD (TWDB 2020b, 2020c). The total municipal capacity from the Rio Grande is 47.5 MGD.

Resources such as building materials and fuel supplies that are transported to the SpaceX launch facilities are provided by suppliers within the broader southern Texas region.

Resources required for the supply of energy include electricity and fuels. Electricity at the VLA is provided by solar power from the SpaceX solar panels near the LLCC. The solar energy farm currently supplies approximately 1 megawatt of power, and there is a 3.87 megawatt-hour battery for energy storage. Power is distributed from the solar farm underground along the SH 4 ROW to a transformer on the launch pad. The solar array currently provides for all of the power demands to run the day-to-day operations at the VLA.

Additionally, various propellant fuels and commodities are required for launches and static fire engine tests, as well as diesel and gasoline to fuel ground equipment. Launch vehicle propellants include LOX and $LCH_4$, and commodities include $LN_2$, water, gaseous oxygen, gaseous methane, gaseous nitrogen, helium, and hydraulic fluid. Propellants and commodities are generated through the air separation unit

or provided by regional or national suppliers and are transported to the VLA by truck. SpaceX would need approximately 400 trucks per launch.

## 3.14.4 Environmental Consequences

The FAA has not established a significance threshold for natural resources and energy supply. Factors to consider when assessing the significance of potential impacts include whether the action would have the potential to cause demand to exceed available or future supplies of these resources.

### 3.14.4.1 Energy Supply

Under the Proposed Action, SpaceX would power daily operations at the VLA primarily via solar power from the solar panels near the LLCC. The solar energy farm currently supplies approximately 1 MW of power. The proposed expansion of the solar farm would add an additional 750 kilowatts of power, for a total of 1.6 MWs of energy. SpaceX would install an additional battery system at the solar farm, with up to 8 MW-hours of storage.

Additionally, SpaceX would use various propellant fuels and commodities for launches and static fire engine tests, as well as diesel and gasoline to fuel ground equipment. Launch vehicle propellants include LOX and $LCH_4$, and commodities include $LN_2$, water, gaseous oxygen, gaseous methane, gaseous nitrogen, helium, and hydraulic fluid. Propellants would be generated through the air separation unit or provided by regional or national suppliers. Use of these propellants in support of the Proposed Action would not adversely impact local supply, as the ability for SpaceX to supply their own propellants would reduce the demand on the local supply. Similarly, SpaceX does not anticipate that the gasoline and diesel fuels required for operations would adversely impact local supply, as the Boca Chica Launch Site is located in the highly industrialized Rio Grande Basin. Therefore, the Proposed Action would not result in significant impacts related to energy supply.

### 3.14.4.2 Natural Resources

SpaceX uses groundwater for various operations and for personnel use at the facilities. Potable water would either be delivered by truck or pumped from an existing on-site well at the VLA. SpaceX would install water distribution lines to distribute the potable water from the water tower to the facilities to provide potable water to the area. The existing well at the VLA would draw water from the Gulf Coast Aquifer (the Chicot Aquifer).

Water required to support the VLA would be primarily generated from the existing well and generated from Cameron County. Groundwater in the study area is within the Gulf of Mexico aquifers designated as underground sources of drinking water.

Numerous operations may require the use of water. Groundwater would be extracted at an approximate rate of 40 gpm from the existing groundwater onsite.

As described previously, if used for sound and vibration suppression, SpaceX would store deluge water in the tanks at the VLA. During a launch-related activity, SpaceX would discharge up to 350,000 gallons of water per static fire or launch event. In addition, prepress (pressing vehicle tanks for static fire or launch) requires a minimum volume of 60,000 gallons of water. SpaceX would recycle water from

prepress and use it for other operations. Tank hydrostatic tests would also require large volumes of water, and exact volumes of water used would depend on the size of the tank or article being tested, but up to 10,000 gallons of water may be required for each hydroproof. SpaceX would also use water for fire suppression purposes in the case of an anomaly resulting in a fire. In these cases, SpaceX would use all water in storage until all available water is consumed and/or the fire was completely suppressed. Water use would be dependent on operations on would likely vary over time; the approximate rate of use would be 100,000 gallons per week. SpaceX would release water that is used during testing and launch operations on-site to percolate through the ground; the water would not leave the site boundaries. SpaceX would design retention ponds to prevent any deluge water from leaving the site.

Operations would result in an increase of permanent and temporary personnel. A maximum of 450 full-time SpaceX employees/contractors would be onsite. The potable water usage by the employees and contractors is projected to be 3.3 million gallons per year (MGY).

Groundwater in the Gulf Coast Aquifer at the location of the VLA has concentrations of TDS exceeding the National Secondary Drinking Water Regulations standard of 500 mg/L. TDS concentrations in the Chicot and Evangeline Aquifers in south central Cameron County has the highest TDS values, with concentrations greater than 10,000 mg/L (Choudhury and Mace 2007). Groundwater pumped for potable use from a well would likely require treatment to remove the TDS and reduce the salinity prior to potable use. SpaceX would treat this water according to the Safe Drinking Water Act and TCEQ requirements as a potable water source.

### Municipal Water Supply

The Texas Water Development Board, Groundwater Division's *GAM Run 17-025 MAG: Modeled Available Groundwater for the Gulf Coast Aquifer System in Groundwater Management Area 16* (TWDB 2017) projected that the area of Cameron County without a Groundwater Conservation District, where the proposed project is located, would have 2,179 MGY of groundwater available in 2020. The amount of available groundwater is projected to increase annually, growing to 3,888 MGY by 2060. The 5.86 MGY of groundwater required for the Proposed Action would create a negligible impact to groundwater supply in Cameron County.

Potable water for employees would be supplied from municipal sources. The municipal groundwater demand for Cameron County in 2020 is estimated using a population of 423,163 (USCB 2019a) and a conservative 75 gallons per capita per day with 20 percent of water use derived from groundwater in 2018 (TWDB 2020d). It is estimated that the municipal groundwater demand for Cameron County is 2300 MGY or 8.8 million cubic meters per year. SpaceX would need 3.3 MGY of potable municipal water to support employees on site. If 20 percent of the municipal water is drawn from groundwater sources, the potable water demands in support of the Proposed Action would increase groundwater demand by 660,000 gallons per year. The onsite staff needed to conduct operations in support of the Proposed Action would increase demand for municipal groundwater by 0.25 percent.

Water use at the launch pad for non-potable use would be 5.2 MGY.

### Aquifer Draw Down

In the 2014 EIS, aquifer drawdown from the operational activities was conservatively calculated assuming a transmissivity of 617 cubic meters/meter (49,500 gpd/feet) (Myers 1969), a storativity of 0.0001, and a single source well (FAA 2014a). It was estimated that the water production well screened in the discontinuous sand and clay beds of the Chicot aquifer would produce water at an average rate of approximately 9.9 gpm (0.04 cubic meters), based on the maximum projected water demand of 5.2 MGY for hydrostatic testing and deluge water, assuming a constant pumping rate. For this calculation, injection rate is subtracted from pumping rate.

Aquifer drawdown from the operational activities was conservatively calculated assuming a transmissivity of 49,500 gpd/feet and a storativity of 0.0001 (FAA 2014a). It is estimated that the water production well screened in the discontinuous sand and clay beds of the Chicot aquifer would produce water at an average rate of approximately 25 gpm, based on the maximum projected water demand of 13,000,000 gallons for the launch operations, assuming a constant pumping rate. Using the Theis equation to calculate drawdown, the maximum drawdown at one well would range up to 0.60 feet after 20 years of withdrawal. A properly constructed water supply well would have up to 50 feet of a water column in the well, which could accommodate a 0.60-feet drawdown.

In summary, the Proposed Action is not expected to result in significant impacts on natural resources.

# 3.15 Socioeconomics, Environmental Justice, and Children's Environmental Health and Safety Risks

## 3.15.1 Definition of Resource and Regulatory Setting

Socioeconomics is an umbrella term used to describe aspects of a project that are either social or economic in nature. A socioeconomic analysis evaluates how elements of the human environment such as population, employment, housing, and public services might be affected by the Proposed Action.

Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental, and commercial operations or policies. Meaningful Involvement means that people have an opportunity to participate in decisions about activities that may affect their environment and/or health; the public's contribution can influence the regulatory agency's decision; their concerns will be considered in the decision-making process; and the decision makers seek out and facilitate the involvement of those potentially affected.

EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*, directs each federal agency to "make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income

populations." Subsequent orders at the federal level, including DOT Order 5610.2(a), *Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, have reinforced the directives outlined in EO 12898. CEQ also developed guidelines (CEQ 1997) to assist federal agencies in incorporating the goals of EO 12898 into the NEPA process.

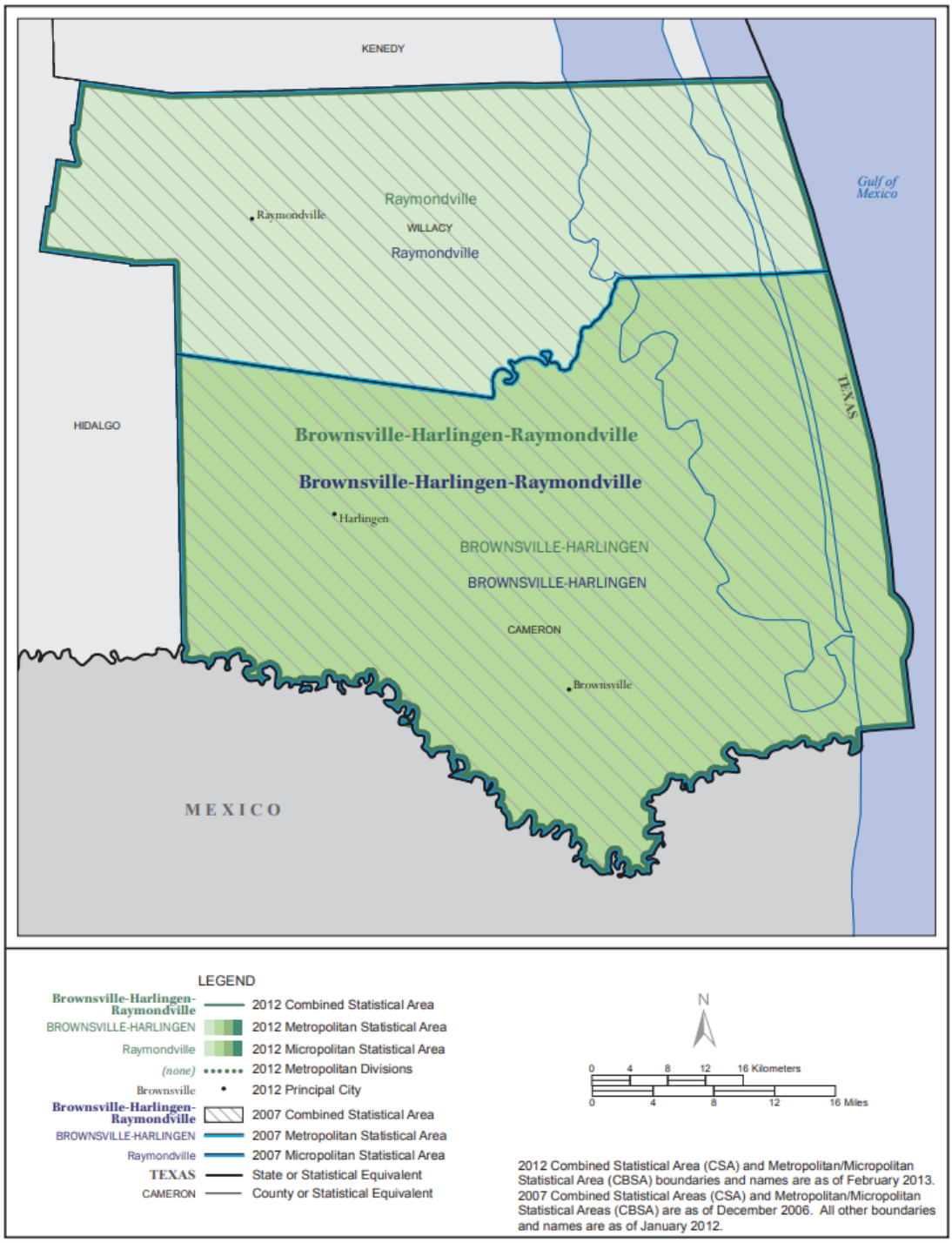
Impacts to children are considered separately in NEPA reviews because children may experience a different intensity of impact as compared to an adult exposed to the same event. EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, requires federal agencies to identify disproportionately high and adverse impacts on children. Children may suffer disproportionately more environmental health and safety risks than adults because they are still developing their neurological, digestive, immunological, and other bodily systems; they eat more food, drink more fluids, and breath more air in proportion to their body weight than adults; their behavior patterns may make them more susceptible to accidents because they are less able to protect themselves; and their size and weight may diminish their protection from standard safety features.

More information about socioeconomics, environmental justice, and children's environmental health and safety risk and regulations can be found in Chapter 12 of the FAA Order 1050.1F Desk Reference (FAA 2020d).

### 3.15.2 Study Area

The study area for socioeconomics, environmental justice, and children's environmental health and safety risks includes Cameron and Willacy counties, which comprise the Brownsville-Harlingen-Raymondville, TX Combined Statistical Area. Figure 3-8 shows the Brownsville-Harlingen-Raymondville, TX Combined Statistical Area (USCB 2012). The State of Texas serves as the geographic region for comparative analysis.

**Figure 3-8. Brownsville-Harlingen-Raymondville, TX Combined Statistical Area**



## 3.15.3 Existing Conditions

### 3.15.3.1 Socioeconomics

The U.S. Census Bureau estimates the 2018 total population within the study area to be 445,423 (as compared to the 2010 census reporting 428,315). Cameron County is estimated to have 456 persons per square mile and Willacy County has approximately 37.5 persons per square mile (USCB 2019a). Estimates for population growth rate in the study area was 1.6 percent (-2.8 in Willacy and +4.4 % in Cameron) from 2010 to 2018 (USCB 2019a). The growth rate for Texas was 14.1 percent during this time. Cameron County is estimated to have gained 17,793 residents, while Willacy County is estimated to have lost 621 residents between 2010 and 2018.

Cameron County's unemployment rate dropped 1 percent while Willacy County's rate dropped 2.3 percent between 2016 and 2017. During the same time, Texas's unemployment rate dropped 0.3 percent (USCB 2019b).

In 2018, the number of housing units in the study was estimated at 152,363 and 7,372 for Cameron and Willacy counties, respectively. Due to their coastal location, both Cameron and Willacy counties reportedly have a greater percentage of their vacant housing units comprised of vacant seasonal or recreational units (7.8 and 4.3 percent, respectively) compared to Texas (2.1 percent) (USCB 2012). The median value of owner-occupied housing between 2013 and 2017 was $82,500 and $49,100 for Cameron and Willacy counties, respectively, and considerably lower than the state of Texas, which reported $151,500.

### 3.15.3.2 Environmental Justice

The median household income for Cameron and Willacy counties was 50 percent of that reported for Texas for the years 2014–2018 (USCB 2019c). Median household income for Cameron County for 2014-2018 was $37,132. Median household income for Willacy County during that time period was $29,944. Poverty levels were meaningfully greater for Cameron (27.7%) and Willacy (35%) counties when compared to Texas (14.7%) and the nation (11.8%). Cameron and Willacy counties have a much higher percentage of families and individuals below the poverty level than the state of Texas.

For the purpose of this evaluation, minority refers to people who identified themselves in the Census as Black or African American, Asian or Pacific Islander, American Indian or Alaskan Native, other non-White races, or as being of Hispanic or Latino origin. Persons of Hispanic and Latino origin may be of any race (CEQ 1997). Per DOT Order 5610.2(a), a minority population is "any readily identifiable group of minority persons who live in geographic proximity, and if circumstances warrant, geographically dispersed/transient persons (such as migrant workers or Native Americans) who will be similarly affected by a proposed DOT program, policy or activity." The geographical unit for comparison in this analysis is the state of Texas.

In 2010 and in 2018, while the percentage of people who identified themselves as white was greater in Cameron and Willacy counties than for Texas, the percentage of people who identified themselves as of Hispanic or Latino origin was also much greater than in Texas. In 2018, minority representation in Cameron County was 89.8 percent and Willacy County was 88.4 percent.

The Boca Chica Launch Site is located in Census Block Group 480610127002, which has a population of 527 people. According to the EPA Environmental Justice Screening and Mapping Tool (EJSCREEN), within this Block Group, 90 percent of individuals list their racial status as a race other than white alone and/or list their ethnicity as Hispanic or Latino. 82 percent of individuals are in households where the household income is less than or equal to twice the federal poverty level (EPA 2021c). The demographic characteristics of the Block Group are consistent with the demographic characteristics of Cameron and Willacy counties in that the percentages of minority and low-income populations are substantially higher than the state of Texas.

### 3.15.3.3 Children's Environmental Health and Safety Risks

The Boca Chica Launch Site is bordered on the north, west, and south by mostly open land with little human population and to the east by the Gulf of Mexico. The nearest residential area is Boca Chica Village, located approximately 2 miles from the VLA. There are no children residing in Boca Chica Village. The nearest public school is Port Isabel Junior High, over 6 miles away in Port Isabel. The U.S. Census Bureau (2019a) reports that the population under 18 years in Cameron County is 30 percent, which is greater than in Texas (25.8%). Willacy County recorded 23.5 percent of the population under 18 years (UCSB 2019a).

## 3.15.4 Environmental Consequences

According to FAA Order 1050.1F, the FAA has not established significance thresholds for socioeconomics, environmental justice, or children's environmental health and safety risks. However, the FAA has identified factors to consider when assessing the significance of potential impacts. For socioeconomics, the factors to consider are whether the Proposed Action would have the potential to:

- Induce substantial economic growth in an area, either directly or indirectly (e.g., through establishing projects in an undeveloped area);
- Disrupt or divide the physical arrangement of an established community;
- Cause extensive relocation when sufficient replacement housing is unavailable;
- Cause extensive relocation of community businesses that would cause severe economic hardship for affected communities;
- Disrupt local traffic patterns and substantially reduce the levels of service of roads serving an airport and its surrounding communities; or
- Produce a substantial change in the community tax base.

For environmental justice, the factors to consider are whether the action would have the potential to lead to a disproportionately high and adverse impact on an environmental justice population (i.e., a low-income or minority population) due to significant impacts in other environmental impact categories or impacts on the physical or natural environment that affect an environmental justice population. Those impacts must be in a way that the FAA determines is unique to the environmental justice population and significant to that population.

For children's environmental health and safety risks, the factor to consider is whether the action would have the potential to lead to a disproportionate health and safety risk to children.

The Proposed Action does not involve activities anticipated to adversely affect existing economic activity, income, employment, population, housing, sustenance, public services, and social conditions. The launch operations may result in moderate economic benefits, including increased demand in the workforce, higher revenues, and increased per capita income in the local area. While the population under the poverty threshold may not directly benefit through employment and income, it may indirectly benefit as regional economic health is improved through the proposed increase in employment for commercial space exploration activity.

### 3.15.4.1 Socioeconomics

SpaceX anticipates personnel supporting the Proposed Action would reach up to 450 full-time workers. Increases in personnel are not anticipated to affect any existing employment positions since there are no existing commercial activities in the vicinity of the Boca Chica Launch Site. Assuming that all 450 permanent SpaceX personnel move to the area and using an average household size of about 3.4 persons for Cameron and Willacy counties (USCB 2019a), 1,530 people would move to the area. This would represent approximately 0.4 percent of the year 2018 population count for the study area (423,908). The salaries paid to the on-site SpaceX personnel would represent direct annual income, with some earnings paid to taxes, and some saved and invested, and most would be spent on housing, consumer goods, and services in the study area. Transient SpaceX workers would spend portions of their earnings within the study area during the launch events, particularly related to accommodations, food, and rental vehicles. This intermittent spending would “ripple” through the economy, which may generate additional indirect jobs and income in areas such as the accommodation, food services, and retail trade sectors, benefitting the economy in the study area. SpaceX expects these indirect, unspecialized positions would be filled by unemployed or underemployed local residents. No population in-migration to the study area would be expected as a result of indirect job growth.

All 450 full-time SpaceX employees/contractors would represent well under 1 percent of the 159,725 total study area housing units listed in the 2018 census (USCB 2019a). This minimal increase would not significantly change the housing purchase or rental markets. Therefore, the increase in personnel would not have significant impacts on the availability of houses within the study area housing market.

Operations at the VLA might not be considered desirable for the limited residential areas along SH 4 and could result in lowered property values for residential use. Property values are dynamic and influenced by a combination of factors, including market conditions, neighborhood characteristics, and individual real property characteristics (e.g., the age of the property, its size, and amenities). The degree to which a particular factor may affect property values is influenced by many other factors that fluctuate widely with time and market conditions. No definitive federal standards exist for quantifying the impact of launches and launch complexes, nor are there previous studies conducted for similar launch facilities. Given the dynamic nature of the real estate market and the varying degree to which any combination of factors may affect the value of a particular property, it would not be possible to quantify how the Proposed Action may affect nearby property values.

Just as potential impacts to property values can be qualitatively described, so can potential impacts to quality of life for nearby residents. The remaining residents in Boca Chica Village and occupants of the limited residences further west along SH 4 would be exposed to some changes from the Proposed Action, including changes to traffic, the noise environment, nighttime light emissions, road access

restrictions at SpaceX checkpoints on SH 4, and increased numbers of people in the vicinity. These changes could affect how residents experience their neighborhood. While some local residents might consider these changes a negative impact, there could be some residents who would enjoy the vibrancy and excitement associated with the proposed launches. Entrepreneurs could view the study area as a highly desirable area to establish businesses that would serve the needs of SpaceX personnel and tourists.

The annual population growth rate in the study area from 2013–2018 is 1.6 percent (USCB 2019c). The potential in-migration of 450 people to the study area, less than 0.1 percent of the existing population, would not be expected to strain the capacity or affect the quality of emergency response, medical, or public education services.

The expenditures associated with the Starship/Super Heavy launch program would increase tax revenue collections in the study area and Texas, including property tax, hotel occupancy tax, and gross receipts tax revenues. Taxes from local sales to workers would be collected, as would the income received by area businesses benefitting from the additional sale of goods and services. In addition, the Proposed Action would be expected to attract tourists who would travel to the area specifically to view a launch. According to the Valley Central NBC/CBS local news affiliate, existing operations are "already helping local businesses" (Valley Central 2020). Spending by these tourists would generate revenue for businesses within the study area, particularly in the hospitality industry.

Overall, the direct, economic impacts resulting from the Proposed Action are expected to be positive. The enhancements and the improved capabilities and longevity of SpaceX programs at the Boca Chica Launch Site would continue to provide beneficial impacts and labor income.

Purely social or economic effects are not required to be analyzed under NEPA. Even if NEPA recognizes socioeconomic impacts from re-routing aircraft due to commercial space operations, such impacts would be similar to re-rerouting aircraft for other reasons (e.g., weather issues, runway closures, wildfires, military exercises, and presidential flights). Potential socioeconomic impacts include additional airline operating costs for increased flight distances and times resulting from re-routing aircraft and increased passenger costs as a result of impacted passenger travel, including time lost from delayed flights, flight cancellations, and missed connections. Alternatively, restricting or preventing a launch event would have socioeconomic impacts on SpaceX, commercial payload providers, and consumers of payload services. SpaceX operations would not result in the closure of any public airport during the SpaceX operation, nor would it so severely restrict the use of the surrounding airspace as to prevent access to an airport for an extended period of time. Existing airspace closures for SpaceX operations are temporary and the FAA's previous analyses[42] related to the NAS have concluded minor or minimal impacts on the NAS from commercial space launches. The FAA does not expect airspace closures from the Proposed Action would result in significant socioeconomic impacts. Furthermore, local air traffic control facilities would coordinate with airports and aircraft operators to minimize the effect of the launch operations on airport traffic flows as well as traffic flows in en-route airspace.

[42] See: https://www.faa.gov/space/environmental/nepa_docs/media/Falcon_Program_EA_Appendices_508.pdf

### 3.15.4.2 Environmental Justice

The counties within the study area (see Figure 3-8), and the Census Block Group where the Boca Chica Launch Site is located, have substantially higher proportions of minority and low-income populations than Texas as a whole. Local residents have shown significant interest in the project, and have participated in the public comments, voicing concerns to the FAA. As an example, one overarching concern consistently raised by local residents was the frequency of access restrictions imposed on Boca Chica Beach, one of the area's free public beaches. Access to Boca Chica Beach would be temporarily restricted for Starship/Super Heavy operations and would occur on an intermittent basis, up to 500 hours per year for nominal operations, and would be temporary. As noted in Section 2.1.3.5, SpaceX would implement measures to limit access restrictions. Boca Chica Beach is within the unincorporated area of Cameron County and requires no fee for parking or access. Cameron County maintains free public beach access at several areas within Cameron County, including Boca Chica Beach, Access Point Number Four (4) (East and West), Access Point Number Five (5) West, and Access Point Number Three (3) and Six (6) (Cameron County 2018). Additionally, the city of South Padre Island provides free access to the beach and parking at several locations along Gulf Boulevard (City of South Padre Island, Texas 2021, and City of South Padre Island Shoreline Department 2021). The approximate driving time from the eastern most community in the city of Brownsville to Boca Chica Beach is approximately 20 minutes; the approximate driving time to the nearest public beach in South Padre Island is 30 minutes. As the access restrictions to Boca Chica Beach would be temporary and intermittent, and there are other cost-free public beach access locations within the vicinity of local communities, the Proposed Action would not result in disproportionate high and adverse impacts to minority and low-income populations.

The Proposed Action would have some unavoidable impacts to local residents that do not rise to a level of significance, from increased noise, traffic, lighting during nighttime operations, and intermittent and temporary access restrictions to Boca Chica Beach. These impacts would be minimized by following all appropriate FAA, OSHA, DOT, and state requirements and guidelines, as well as the mitigation measures identified in this document. Further, the FAA will continue providing Spanish translations of vital project-related documents and information, and oral interpretation services for public meetings, or by request, in the future.

Therefore, the Proposed Action would not result in significant impacts on environmental justice populations.

### 3.15.4.3 Children's Environmental Health Risks and Safety Risks

As described above, Cameron County has higher proportions of children under the age of 18 than the state of Texas. The Proposed Action is located in a sparsely populated area approximately 6 miles from the nearest public school. Boca Chica Village is the only residential area near the Proposed Action and has no children under the age of 18. The Proposed Action would not increase risks to children's environmental health or safety. Therefore, the Proposed Action would not result in significant impacts related to children's environmental health or safety.

### 3.15.5 Mitigation and Monitoring

The measures listed above Section 3.8.5, specifically item #9, would mitigate any potential impacts on an environmental justice population. Further, the FAA will continue providing Spanish translations of vital project-related documents and information, and oral interpretation services for public meetings, or by request, in the future.

# Chapter 4. List of Preparers and Independent Evaluators

## 4.1 List of Preparers

Brian Pownall, Transportation Engineer
Kimley Horn and Associates

Kelsey Condell, Environmental Engineer
SpaceX

Katy Groom, Environmental Engineer
SpaceX

Elyse Procopio, Environmental Engineer
SpaceX

## 4.2 List of Independent Evaluators

Stacey Zee, Manager, Operations Support Branch
FAA Office of Commercial Space Transportation

Chelsea Clarkson, Environmental Protection Specialist
FAA Office of Commercial Space Transportation

Amy Hanson, Environmental Protection Specialist
FAA Office of Commercial Space Transportation

# Chapter 5.
# List of Agencies and Persons Consulted

Federal Agencies

Advisory Council on Historic Preservation

National Aeronautics and Space Administration

National Park Service

U.S. Army Corps of Engineers

U.S. Coast Guard

U.S. Fish and Wildlife Service

State Agencies

Texas Parks and Wildlife Department

Texas Historical Commission

Tribes

Comanche Nation of Oklahoma

Kiowa Tribe of Oklahoma

Mescalero Apache Tribe

Tonkawa Tribe of Oklahoma

Carrizo Comecrudo Nation of Texas