Federal Aviation Administration

Draft Environmental Assessment for Issuing a License to LauncherOne, LLC for LauncherOne Launches at the Mojave Air and Space Port, Kern County, California

January 2017

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AGENCIES: Federal Aviation Administration (FAA), lead Federal agency; National Aeronautics and Space Administration, cooperating agency.

This Draft Environmental Assessment (EA) is submitted for review pursuant to section 102(2)(C) of the National Environmental Policy Act of 1969, as amended (NEPA; 42 United States Code 4321, et seq.), Council on Environmental Quality NEPA implementing regulations (40 Code of Federal Regulations Parts 1500 to 1508), and FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*.

DEPARTMENT OF TRANSPORTATION, FEDERAL AVIATION ADMINISTRATION: The FAA is evaluating LauncherOne, LLC's (L1's) proposal to launch the LauncherOne at the Mojave Air and Space Port in Kern County, California, for purposes of transporting small satellites into a variety of Low Earth Orbits. The launch system consists of the rocket (LauncherOne) and a carrier aircraft (Boeing 747). To operate LauncherOne at the Mojave Air and Space Port, L1 must obtain a launch license from the FAA. Issuing a license is considered a major Federal action subject to environmental review under NEPA. Under the Proposed Action, the FAA would issue a launch operator license to L1 that would allow L1 to operate LauncherOne from the Mojave Air and Space Port. L1 is proposing a maximum of 115 launches over the course of the 5-year launch license (expected 2017–2021). The maximum number of annual launches during this time period would be 40.

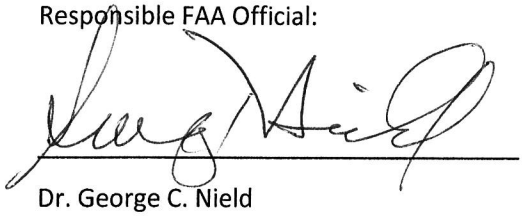
The Draft EA evaluates the potential environmental impacts from the Proposed Action and No Action Alternative on air quality; biological resources (including fish, wildlife, and plants); climate; Department of Transportation Act, Section 4(f); hazardous materials, solid waste, and pollution prevention; historical, architectural, archaeological, and cultural resources; land use; noise and noise-compatible land use; socioeconomics, environmental justice, and children's environmental health and safety risks; visual effects; and water resources (including wetlands, floodplains, surface waters, groundwater, and wild and scenic rivers). Potential cumulative impacts are also addressed in the Draft EA.

PUBLIC REVIEW PROCESS: In accordance with the applicable requirements, the FAA is initiating a public review and comment period for the Draft EA. The 30-day public comment period for the NEPA process begins with the publication of the Draft EA. Comments are due on February 13, or 30 days from the date of publication of the Notice of Availability in the *Federal Register*, whichever is later.

CONTACT INFORMATION: To submit comments on the Draft EA or ask questions, please contact Mr. Daniel Czelusniak, Environmental Protection Specialist, Federal Aviation Administration, 800 Independence Avenue, SW, Suite 325, Washington, DC 20591; email LauncherOneEA@icfi.com.

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

Responsible FAA Official:



Date: 12/22/16

Dr. George C. Nield

Associate Administrator for
Commercial Space Transportation

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ACRONYMS AND ABBREVIATIONS

AGL	Above Ground Level
AQMP	Air Quality Management Plan
ARTCC	Air Route Traffic Control Center
ATC	Air Traffic Control
CAA	Clean Air Act
CAAA	Clean Air Act Amendment
CAAQS	California Ambient Air Quality Standards
CARB	California Air Resource Board
CBNMS	Cordell Bank National Marine Sanctuary
CCA	California Coastal Act
CFR	Code of Federal Regulations
CH_4	Methane
CNEL	Community Noise Equivalent Level
CO	Carbon
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CWA	Clean Water Act
dB	Decibel(s)
dBA	A-Weighted Decibel(s)
DNL	Day-Night Level
EA	Environmental Assessment
EKAD	East Kern Airport District
EKAPCD	Eastern Kern Air Pollution Control District
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
ft	foot/feet
GFNMS	Greater Farallones National Marine Sanctuary
GHG	Greenhouse Gas(es)
kg	kilogram(s)
km	kilometer(s)
L1	LauncherOne, LLC
lb	pound(s)
lbm	pounds mass
L_{dn}	Day-Night Level
LEO	Low Earth Orbit
L_{eq}	Equivalent Sound Level
LOX	Liquid Oxygen
LTO	Landing and Take Off
m	meter(s)
MBTA	Migratory Bird Transit Act
mi	mile(s)
MMPA	Marine Mammal Protection Act
MSL	Mean Sea Level
MT	Metric Ton(s)
MtCO2e	Metric tons of CO2 equivalent
N_2O	Nitrous Oxide
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
No_2	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notice to Airmen
NPDES	National Pollutant Discharge Elimination System
NSR	New Source Review
O_3	Ozone
Pb	Lead
PEIS	Programmatic Environmental Impact Statement
PM_{10}	Particulate matter less than or equal to 10 microns
$PM_{2.5}$	Particulate matter less than or equal to 2.5 microns
ppm	parts per million
psf	pounds per square foot
RLV	Reusable Launch Vehicle
ROG	Reactive Organic Gas
ROI	Region of Influence
RP-1	Rocket Propellant 1
RWQCB	Regional Water Quality Control Board
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
SSO	Sun Synchronous Orbit
SWRCB	State Water Resources Control Board
Tg	Teragram(s)
Tg CO_2 Eq.	Teragrams of Carbon Dioxide Equivalent
TIM	Time in Mode
U.S.	United States
U.S.C.	United States Code
USDOT	U.S. Department of Transportation

CHAPTER 1 PURPOSE AND NEED

SECTION 1.1 INTRODUCTION

LauncherOne, LLC (L1) proposes to operate the LauncherOne and a Boeing 747 at the Mojave Air and Space Port to carry small satellites into a variety of Low Earth Orbits (LEOs). Both vehicles—LauncherOne and Boeing 747—make up the "launch system." When discussing the launch system's components separately in this EA, the LauncherOne is referenced as the "rocket" and the Boeing 747 is referenced as the "carrier vehicle." To operate LauncherOne at the Mojave Air and Space Port, L1 must obtain a launch license from the Federal Aviation Administration (FAA) Office of Commercial Space Transportation. Issuing launch licenses is considered a major Federal action subject to environmental review under the National Environmental Policy Act of 1969, as amended (NEPA; 42 United States Code [U.S.C.] 4321, et seq.). The FAA is the lead Federal agency and is preparing this Environmental Assessment (EA) in accordance with NEPA, Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations [CFR] parts 1500-1508), and FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*. This EA evaluates the potential environmental impacts of activities associated with the Proposed Action of issuing a launch license to operate LauncherOne at the Mojave Air and Space Port (see Section 2.1 for a more detailed description).

According to FAA Commercial Space Transportation Regulations (14 CFR part 400), an applicant must provide enough information for the FAA to analyze the potential environmental impacts associated with proposed launch activities. The information provided by an applicant must be sufficient to enable the FAA to comply with the requirements of NEPA. This EA is intended to fulfill NEPA requirements for analyzing the potential environmental impacts of issuing a launch license for the operation of LauncherOne and associated launch activities. The successful completion of the environmental review process does not guarantee that the FAA will issue a launch license to L1 to operate LauncherOne. The project also must meet all FAA safety, risk, and financial responsibility requirements per 14 CFR part 400. Additional environmental analyses would be required for future proposed activities not within the scope of activities addressed in this EA.

The September 2009 *Final Programmatic Environmental Impact Statement for Streamlining the Processing of Experimental Permit Applications* (2009 PEIS; FAA 2009) provides information and analyses common to all reusable suborbital rockets, and specifically evaluated the environmental impacts of vertical and horizontal rocket launches at the Mojave Air and Space Port over a five-year period, from 2009 to 2014. Relevant information from the FAA's 2009 PEIS is incorporated by reference and summarized in the description of the affected environment section of this EA (see Chapter 3). A copy of the 2009 PEIS can be found online at the following FAA website address: http://www.faa.gov/about/office_org/headquarters_offices/ast/environmental/nepa_docs/review/documents_completed/.

The East Kern Airport District (EKAD) obtained a launch site operator license in 2004 to operate the Mojave Air and Space Port as a commercial space launch site and offer the site to launch vehicle operators for suborbital reusable launch vehicle (RLV) missions. Prior to issuing the launch site operator license, the FAA prepared an EA and issued a Finding of No Significant Impact. EKAD's license was renewed in 2009 and 2014. In June 2014, the licensee changed from EKAD to Mojave Air and Space Port. The current launch site operator license expires on June 17, 2019. In addition to issuing a launch license to L1, the Proposed Action in this EA also includes adding "orbital" launch vehicle missions to the Mojave Air and Space Port's launch site operator license, since the LauncherOne would reach LEOs.

SECTION 1.2 FEDERAL AGENCY ROLES

As the lead Federal agency, the FAA is responsible for analyzing the potential environmental impacts of the Proposed Action. The issuance of an FAA launch license would allow the activities described in this EA to be conducted at the Mojave Air and Space Port. A launch license for RLV missions authorizes a licensee to launch and reenter, or otherwise land, one model or type of RLV from a launch site or other location that is approved for the mission, to a reentry site or other location approved for the mission. A launch license can authorize one or more flights and includes specifics of each flight of an RLV that is under the license. A licensee's authorization to conduct RLV missions terminates upon completion of all activities authorized by the license or the expiration date stated in the license, whichever occurs first.

As authorized by Executive Order (EO) 12465, *Commercial Expendable Launch Vehicle Activities* (49 *Federal Register* 7099, 3 CFR, 1984 Comp., p. 163), and the Commercial Space Launch Act of 2011 (51 U.S.C. Subtitle V, ch. 509, §§ 50901–50923), the FAA licenses and regulates U.S. commercial space launch and reentry activity, as well as the operation of non-Federal launch and reentry sites. The FAA's mission is to ensure public health and safety and the safety of property while protecting the national security and foreign policy interests of the United States during commercial launch and reentry operations. In addition, Congress directed the FAA to encourage, facilitate, and promote commercial space launches and reentries.

The FAA has the responsibility, under the Commercial Space Launch Act, to do the following:

- Promote economic growth and entrepreneurial activity through use of the space environment for peaceful purposes.
- Encourage the U.S. private sector to provide launch vehicles, reentry vehicles, and associated services by:
    - simplifying and expediting the issuance and transfer of commercial licenses, and
    - facilitating and encouraging the use of government-developed space technology.
- Ensure that the Secretary of Transportation provides oversight and coordinates the conduct of commercial launch and reentry operations, issue and transfer commercial licenses authorizing those operations, and protect the public health and safety, safety of property, and national security and foreign policy interests of the United States
- Facilitate the strengthening and expansion of the U.S. space transportation infrastructure, including the enhancement of U.S. launch sites and launch-site support facilities, and development of reentry sites, with Federal, State, and private sector involvement, to support the full range of U.S. space-related activities.

The FAA invited the National Aeronautics and Space Administration (NASA) to participate in the NEPA process as a cooperating agency.[1] NASA agreed to participate as a cooperating agency and provided technical review and input for this EA.

SECTION 1.3 PURPOSE AND NEED FOR THE PROPOSED ACTION

The purpose and need provides the foundation for identifying intended results or benefits and future conditions. In addition, the purpose and need defines the range of reasonable alternatives to a

[1] A cooperating agency is an agency that has jurisdiction by law or special expertise regarding any environmental impact resulting from a proposed action or reasonable alternative.

proposed action. According to FAA Order 1050.1F, Paragraph 6-2.1(c), the purpose and need presents the problem being addressed and describes what the FAA is trying to achieve with the Proposed Action.

1.3.1 THE FAA'S PURPOSE AND NEED

The purpose of the FAA's Proposed Action in connection with L1's proposal is to fulfill the FAA's responsibilities as authorized by EO 12465 and the Commercial Space Launch Act of 2011. Responsibilities include oversight of commercial space launch activities, including issuing site operator licenses for the operation of commercial space launch sites and launch licenses to operate expendable and reusable orbital and suborbital launch vehicles. The Proposed Action would be consistent with the objectives of the Commercial Space Launch Act.

The need for the FAA's action of issuing a launch operator license results from the statutory direction from Congress under the Commercial Space Launch Act, 51 U.S.C 50901(b) to, in part, "protect the public health and safety, safety of property, and national security and foreign policy interests of the United States" while "strengthening and [expanding] the United States space transportation infrastructure, including the enhancement of United States launch sites and launch-site support facilities, and development of reentry sites, with Government, State, and private sector involvement, to support the full range of United States space-related activities."

The FAA could receive multiple applications for launch licenses to operate LauncherOne. The FAA must review all applications and determine whether to issue a launch license, as appropriate. Actions described in any application for license to operate this vehicle that fall outside the scope of the analysis in this EA would require additional environmental review.

1.3.2 LAUNCHERONE LLC'S PURPOSE AND NEED

The purpose of L1's proposal is to create a way to put small satellites into orbit that is low cost, responsive, and evolvable. The space satellite launch environment is evolving from medium-and heavy-lift orbital launches to small commercial orbital satellite launches. The shift to smaller launches is largely due to the development of an emerging market for smaller commercially-used satellites, and a national security environment that demands quick launch capabilities. The need for L1's proposal is to fulfill the needs of clients in the small satellite commercial orbital and suborbital market. The space satellite industry is changing and leading to an interest in small, responsive, and commercially-focused vehicles that are low-cost solutions for private and government clients (FAA 2015).

SECTION 1.4 PUBLIC INVOLVEMENT

In accordance with NEPA, CEQ NEPA implementing regulations, and FAA Order 1050.1F, the FAA has initiated a 30-day public review and comment period for this Draft EA. Interested parties are invited to submit comments on the Draft EA, preferably in writing, on or before February 13, or 30 days from the date of publication of the Notice of Availability in the *Federal Register*, whichever is later. Before including your address, phone number, e-mail address, or other personal identifying information in your comment, be advised that your entire comment—including your personal identifying information—may be made publicly available at any time. While you can ask us in your comment to withhold from public review your personal identifying information, we cannot guarantee that we will be able to do so.

No public hearings will be held. An electronic version of the Draft EA is available on the FAA's website.[2]

The FAA will revise the Draft EA, as necessary, in response to internal and external comments received on the draft document, and a Final EA will be prepared. Although the FAA is not required to formally respond to public comments, the Final EA will reflect the FAA's consideration of comments and may present responses to substantive comments if warranted. Following review of the Final EA, the FAA will either issue a Finding of No Significant Impact or issue a notice of intent to prepare an Environmental Impact Statement.

SECTION 1.5 OTHER ENVIRONMENTAL REQUIREMENTS

In addition to NEPA, this EA addresses the following relevant special purpose laws, regulations, and EOs, including:

- Clean Air Act (CAA)
- Endangered Species Act (ESA) of 1973
- Marine Mammal Protection Act (MMPA) of 1972
- Migratory Bird Treaty Act (MBTA) of 1918
- National Marine Sanctuaries Act
- EO 13693, *Planning for Federal Sustainability in the Next Decade*
- California Coastal Act (CCA) of 1972
- Comprehensive Environmental Response, Compensation, and Liability Act, as amended by the Superfund Amendments and Reauthorization Act; the Toxic Substances Control Act; the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (Resource Conservation and Recovery Act; 42 U.S.C. 6901–6992)
- 36 CFR part 800, Protection of Historic Properties
- U.S. Department of Transportation (DOT) Act Section 4(f)
- Clean Water Act (CWA)

[2] http://www.faa.gov/about/office_org/headquarters_offices/ast/environmental/nepa_docs/review/documents_progress/

CHAPTER 2 DESCRIPTION OF PROPOSED ACTION AND NO ACTION ALTERNATIVE

SECTION 2.1 PROPOSED ACTION

The FAA's Proposed Action is to issue a launch operator license to L1 that would allow L1 to operate LauncherOne from the Mojave Air and Space Port. The Proposed Action also includes modifying the Mojave Air and Space Port's launch site operator license to include "orbital" RLV missions. L1 is proposing a maximum of 115 launches[3] over the course of the 5-year launch operator license (expected 2017–2021). The maximum number of annual launches during this time period would be 40.

The carrier vehicle and mated rocket would take off from the Mojave Air and Space Port and fly to the drop point, where the rocket would be released and travel to predetermined LEOs where it would release small satellites. There are three potential in-air drop points: a primary drop point off the central California coast (the southern drop point) and two other drop points off the northern California Coast (the northern drop points; see Section 2.1.1 below). At all drop points, many distinct trajectories could be utilized, each with a slightly different launch azimuth. The Mojave Air and Space Port's existing infrastructure, which consists of an airport traffic control tower, engineering facilities, a high bay building, and runways, would be used for takeoff and landing activities. The Proposed Action does not include any construction activities.

The following subsections provide a description of the project's location, the launch system, and proposed operations.

2.1.1 LOCATION

The Mojave Air and Space Port encompasses approximately 3,000 acres (1,214.1 hectares) and is located in Kern County, California, east of the unincorporated community of Mojave (Figure 2-1 and Figure 2-2). Aircraft operations at the Mojave Air and Space Port averaged 48 each day over a 12-month period ending May 24, 2016 (AirNav, 2016). The flight corridors from the Mojave Air and Space Port to and from the drop points described above are shown in Figure 2-3. The flight corridors include counties in central and western California, including portions of Kern, Ventura, and Santa Barbara, as well as part of the exclusive economic zone off of northern California. The flight corridor to and from the southern in-air launch point is approximately 342 miles (mi) (550.4 kilometers [km]). The flight corridor from the Mojave Air and Space Port to and from the northern in-air launch point is approximately 750 mi (1207 km). For the southern drop point for all three trajectories, LauncherOne would be released at an altitude of approximately 35,000–40,000 feet (ft) (10,668–12,192 meters [m]) and approximately 70 mi (112.7 km) off the California coast. The release point for the northern drop points would be at the same approximate altitude, but 50 mi (31.1 km) off the California coast for trajectories that have a more southerly azimuth at Northern Drop Point 1, and 15 mi (9.3 km) off the California Coast for the all other trajectories at Northern Drop Point 2. The elliptical holding patterns at each drop point are approximately 100 mi (160.9 km) around. For the purposes of the analysis, 75 percent of missions would utilize the southern drop point, and 25 percent of missions would utilize the northern drop points.

[3] For purposes of this EA, a launch includes takeoff and landing of the carrier vehicle and the flight of the rocket.

Figure 2-1: Regional Area Surrounding Mojave Air and Space Port

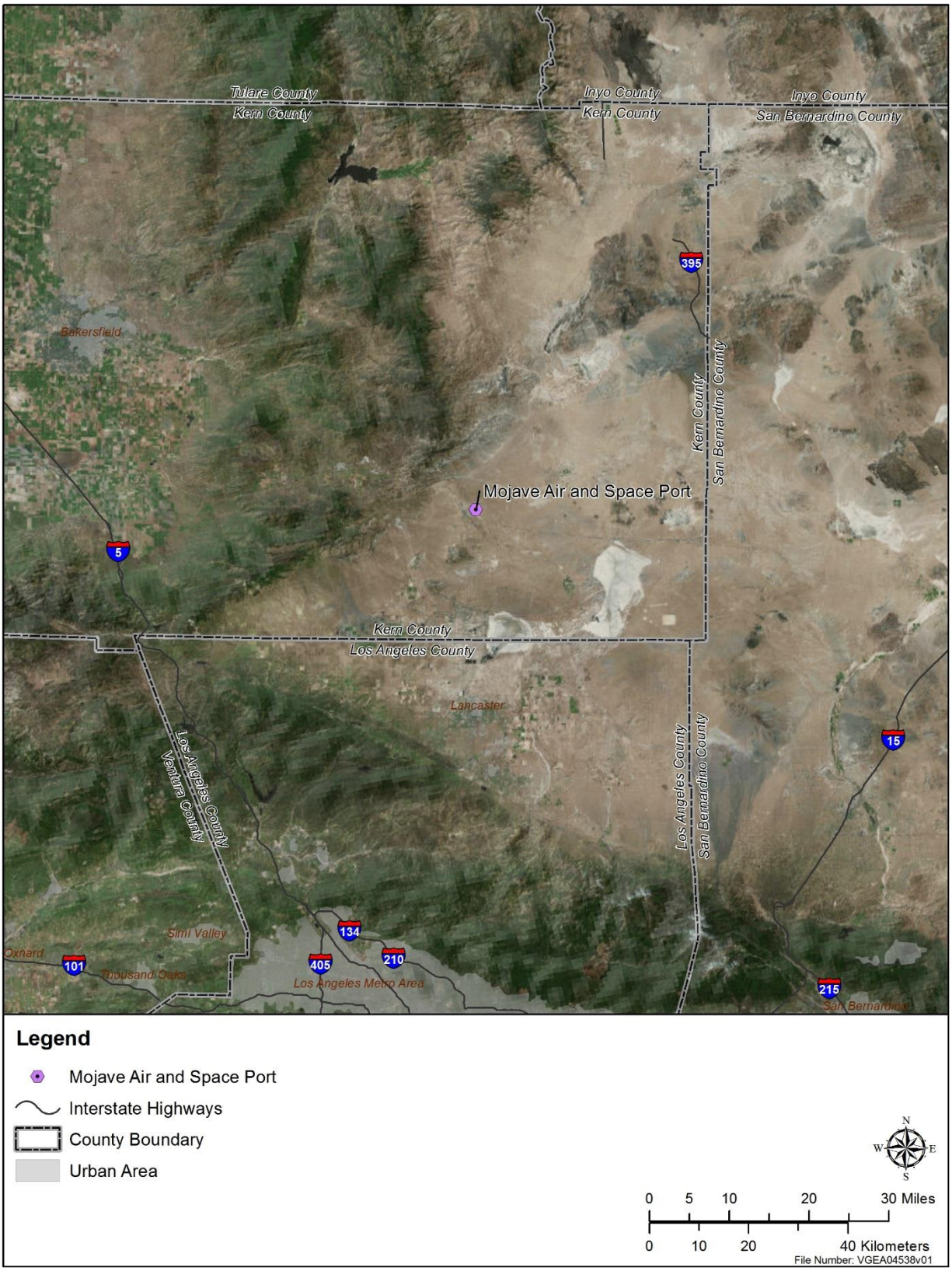

Figure 2-2: Local Area Surrounding Mojave Air and Space Port

Figure 2-3: Approximate Flight Paths for the North and South Drop Points

2.1.2 LAUNCH SYSTEM

2.1.2.1 Carrier Vehicle

The carrier vehicle, a Boeing 747-400, is a four-engine, wide-body vehicle, similar to other Boeing 747 aircraft that have been extensively used in commercial passenger and cargo transport for the last few decades (see Figure 2-4). The Boeing 747-400 has a non-stop range of over 8,055.5 mi (12,964 km) at almost maximum payload weight. The vehicle itself has the capability to carry over 100 metric tons (MT) of internal payload. To facilitate LauncherOne operations, the carrier vehicle would be modified such that it could carry a rocket at an interior wing position on the port side between the fuselage and inboard engine. The wing would be modified to carry both the rocket and a removable adapter, which houses the structural release mechanism, and quick release electrical and pneumatic connections to the carrier vehicle. The carrier vehicle provides electrical power, purge gasses, and monitoring and control of the rocket by a launch engineer onboard the carrier vehicle. For a round trip flight from the Mojave Air and Space Port to the southern drop point, the carrier vehicle would use approximately 50,000 pounds (lb) (22,679.6 kilograms [kg]) of fuel. For a round trip flight to the northern drop points, the carrier vehicle would use approximately 80,000 lb (36,287.4 kg) of fuel (Jet-A).

Figure 2-4: Carrier Vehicle with Rocket Attached

2.1.2.2 Rocket

The rocket is an expendable, air-launched two-stage rocket (Figure 2-5) that is designed to carry small satellites (approximately 661.4–1102.3 lb [300–500 kg] of payload) into a variety of LEOs. The rocket is a liquid oxygen/rocket propellant (LOX/RP-1) system comprised of a first stage with 29,215 pound mass (lbm) of LOX and 13,279 lbm of RP-1, and second stage with 3,642 lbm of LOX and 1,683 lbm of RP-1. The thrust of the first stage is 69,298 foot pounds.

Rather than launching from ground level, the rocket is carried to an altitude of approximately 35,000–40,000 ft (10,668–12,192 m) above mean sea level (MSL) by the carrier vehicle and released into a flight path angle of approximately 20 degrees. The rocket offers a large fairing with a payload adapter capable

of accommodating a variety of standard sizes for one or multiple spacecraft and a simple design that increases reliability while keeping costs low.

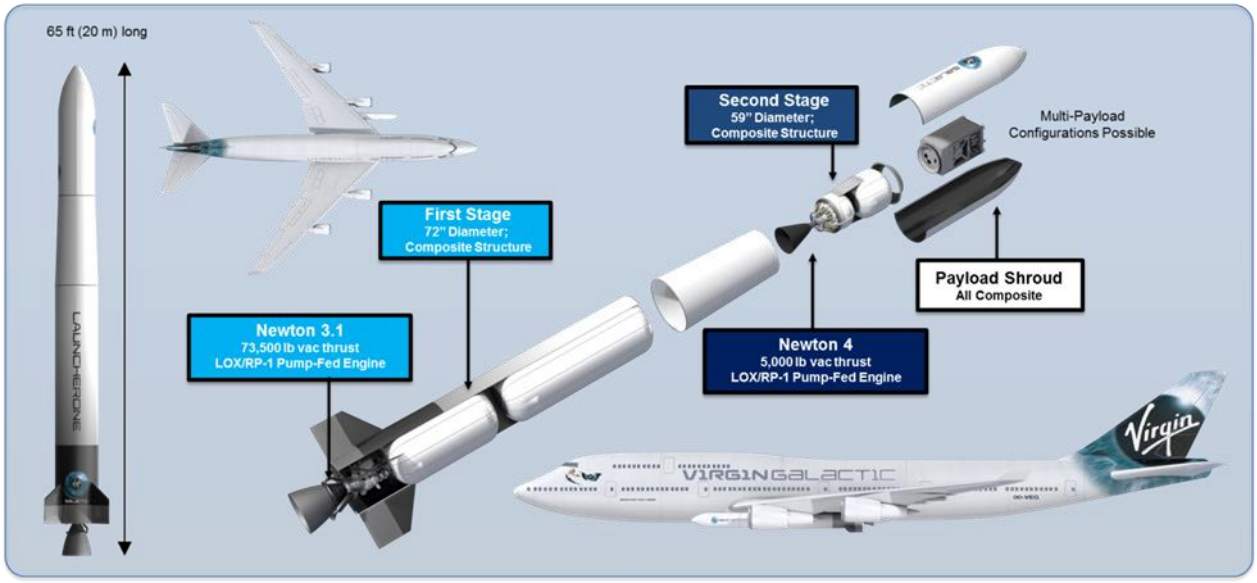

Figure 2-5: Rocket

2.1.3 Mission Profile

The carrier vehicle's takeoffs and landings from the Mojave Air and Space Port would occur at Runway 12-30. The carrier vehicle and mated rocket would take off from Mojave Air and Space Port and fly west to the designated launch point off the coast of California. The rocket would be carried to an altitude of approximately 35,000–40,000 ft (10,668-12,192 m) above MSL where it would be released, as depicted in Figure 2-6. With a drop flight path angle of approximately 20 degrees and an angle of attack of approximately 5 degrees, the rocket would maintain the flight angle required for vehicle safety through the 5-second drop, prior to ignition of the rocket's first stage. The carrier vehicle would then pull away and return to the Mojave Air and Space Port. Following ignition of the rocket's first stage, the rocket would be at supersonic speed (in excess of 768 miles per hour), and the engine would burn until all of the propellant is consumed. At that time, the rocket's first stage would detach and fall into the Pacific Ocean, and the rocket's second stage would ignite until reaching its desired LEO. Upon reaching the desired LEO, the rocket would coast while releasing the small satellites at predetermined LEO heights and then re-ignite its engine (or blow-down[4]) until all of the propellants are consumed. The rocket would be safed per FAA regulations (14 CFR §417.129). In the event the mission is aborted and the rocket is not released, the carrier vehicle and mated rocket would return to the Mojave Air and Space Port. However, in case of an emergency, the carrier vehicle would fly to the most appropriate contingency abort landing site (e.g., another airport or dry lake bed), as approved by the launch license. Once a launch license application is received, the FAA will re-evaluate the potential impacts of contingency abort landing locations included in the application, if any, and prepare additional analysis to the extent necessary and appropriate under NEPA (FAA Order 1050.1F, Paragraph 9-3).

[4] To deplete onboard energy sources after completion of mission.

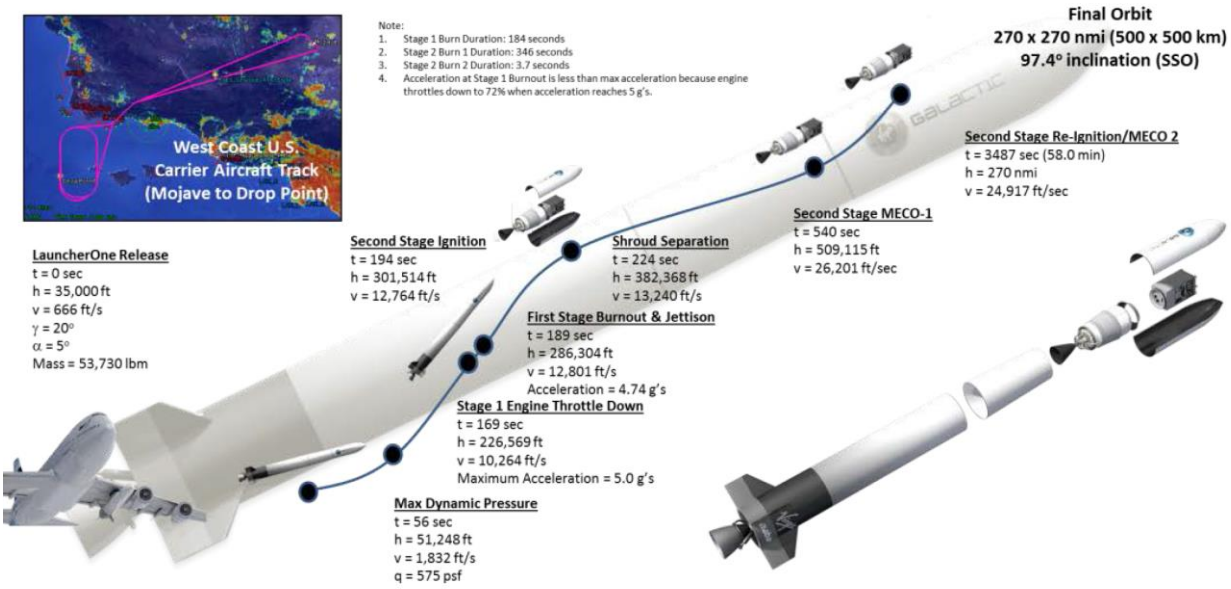

Figure 2-6: LauncherOne Mission Profile

2.1.4 Pre-Flight and Post-Flight Activities

2.1.4.1 Pre-Flight Activities

Pre-flight activities consist of preparing the carrier vehicle and rocket for takeoff and launch, mounting and loading propellants on LauncherOne, and support operations, such as gathering and distributing telemetry. In accordance with the Mojave Air and Space Port launch site operator license, all hazardous pre-flight ground operations would take place in a specified location that has established appropriate safety clear zones.

All launch operators are required to notify the Mojave Air and Space Port before a planned launch. The Mojave Air and Space Port coordinates operations with the Los Angeles Air Route Traffic Control Center (ARTCC)/Oakland ARTCC and Mojave Air Traffic Control (ATC). Specifically, the Mojave Air and Space Port would be required to obtain Letters of Agreement from the Los Angeles and/or Oakland ARTCC and Mojave ATC to allow operation of the carrier vehicle and rocket in the proposed airspace before any launches could commence. The Letters of Agreement would include notification requirements, including requirements for the issuance of Notices to Airmen (NOTAMs), which provide notice of unanticipated or temporary changes to components of, or hazards in, the National Airspace System (FAA Order JO 7930.2M, Air Traffic Organization Policy). The Mojave Air and Space Port launch site operator would notify L1 of other activities in the airport, resolve potential conflicts for commercial space launch site use, and notify other appropriate airspace scheduling agencies. Additionally, L1 would coordinate Local Notices to Mariners (LNMs) with the U.S. Coast Guard Eleventh District for defining the public ship avoidance areas for the specific mission trajectories. Missions would be rehearsed with all flight and ground support crews prior to each launch. Mission rehearsals entail fuel loading operations, flight to drop point, simulated abort, and fuel offloading.

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. Advance notice via NOTAMs and LNMs would assist general aviation

pilots and mariners in scheduling around any temporary disruption of flight or shipping activities in the area of operation.

2.1.4.2 Post-Flight Activities

For nominal launches, all of the oxidizer would be consumed during the rocket's powered flight. For a nominal launch, no hazardous post-flight ground operations would be required to return the carrier vehicle to safe conditions, so the carrier vehicle would be returned to the space port. For aborted flights, LOX and RP-1 would remain on-board the rocket for the return to the Mojave Air and Space Port. The LOX would be off-loaded upon return to the launch site. The RP-1 may stay on board if there is an intent to re-attempt launch and the time to perform a turn-around is no longer than a few days. The carrier vehicle would sit at the Mojave Air and Space Port during that time. In accordance with the Mojave Air and Space Port launch site operator license, any hazardous post-flight ground operations would take place in a specified location that has established appropriate safety clear zones.

SECTION 2.2 NO ACTION ALTERNATIVE

Under the No Action Alternative, the FAA would not issue a launch license for the operation of LauncherOne from the Mojave Air and Space Port. Also, the FAA would not modify Mojave Air and Space Port's launch site operator licenses to include "orbital" RLV missions. The Mojave Air and Space Port would continue its existing operations. This alternative provides the basis for comparing the environmental consequences of the Proposed Action.

CHAPTER 3 AFFECTED ENVIRONMENT

This chapter provides a description of the environmental impact categories that have the potential to be affected by the Proposed Action, as required by FAA Order 1050.1F. The environmental impact categories assessed in this EA include air quality; climate; noise and noise-compatible land use; water resources (including wetlands, floodplains, surface waters, groundwater, and wild and scenic rivers); biological resources (including fish, wildlife, and plants); hazardous materials, solid waste, and pollution prevention; historical, architectural, archeological, and cultural resources; land use; Department of Transportation Act, Section 4(f); socioeconomics, environmental justice, and children's environmental health and safety risks; and visual effects (including light emissions).

This EA examines three Regions of Influence (ROIs) that encompass the areas potentially affected by the Proposed Action (Figure 3-1). The first ROI, associated with takeoff and landing of the carrier vehicle, is the Mojave Air and Space Port and immediate airspace. The Mojave Air and Space Port is approximately 3,000 acres and is located in Kern County, California east of the unincorporated community of Mojave. In addition to being a general-use public airport, the Mojave Air and Space Port supports flight testing, commercial space industry development, and aircraft maintenance activities. Existing infrastructure at the Mojave Air and Space Port used to support launch activities consists of an air traffic control tower, rocket motor test stands, launch pads, engineering facilities, a high bay building, and Runway 12-30. More than 300 acres are zoned specifically for rocket motor testing and development (FAA 2012).

The other two ROIs include one each for the southern and northern drop points associated with the flight path, potential sonic boom region (which would not intersect with land at any of the launch points), and the location of the first stage splashdown. These ROIs are located off of the west coast of the United States in the Pacific Ocean and are geographically presented in Figure 3-1. Note that the potential splashdown regions (i.e., the rectangular boxes) shown in Figure 3-1 were estimated from the potential trajectories and anticipated descent rate of the first stage. For purposes of this analysis, there are three primary trajectories anticipated to be utilized at both the southern and northern drop points. The splashdown regions for each trajectory were merged into one polygon to be conservative.

As applicable, information from the 2009 PEIS is incorporated by reference and summarized in this chapter. Section 3.6 of the 2009 PEIS fully describes the existing general and on-site-specific environmental conditions for the Mojave Air and Space Port. Updates to these environmental conditions are provided in this EA, as applicable. In compliance with 40 CFR § 1502.15, 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 reasons stated:

- **Farmlands**: The Proposed Action does not involve construction activities and therefore will not impact farmlands, as defined by the Farmland Protection Policy Act.
- **Natural Resources and Energy Supply**: The Proposed Action would not result in any measurable effect on local supplies of energy or natural resources. The Proposed Action would not result in the development of new facilities or result in notable changes in local energy demands or consumption of other natural resources. The Proposed Action would not require additional sources of power or other public utilities.
- **Coastal Resources:** The Proposed Action would not occur within the coastal zone[5] or result in any impacts to the coastal zone or coastal resources.

[5] California's coastal zone generally extends 1,000 yards inland from the mean high tide line and extends seaward 3 nautical miles. https://coast.noaa.gov/czm/media/StateCZBoundaries.pdf.

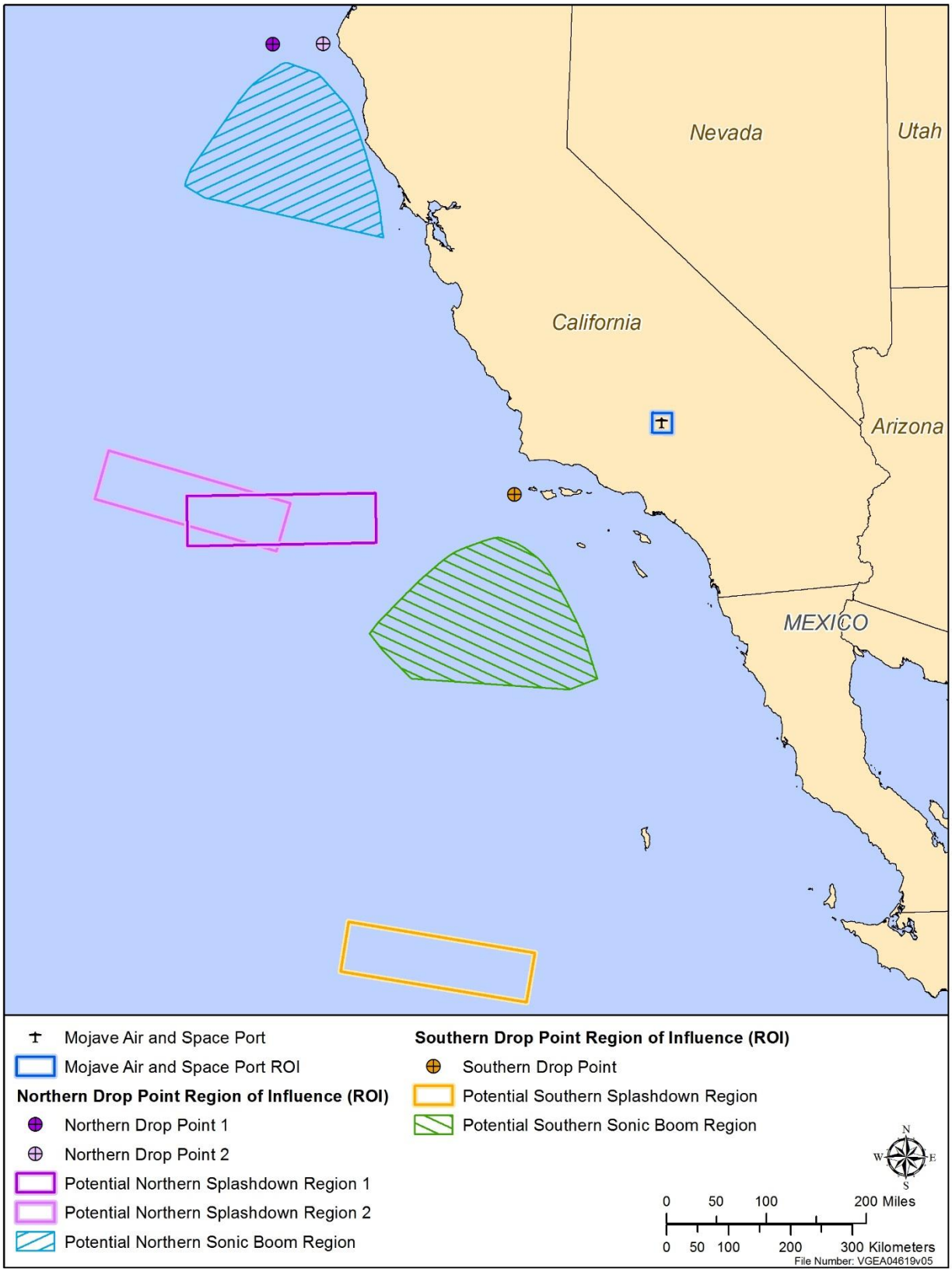

Figure 3-1: Proposed Action Regions of Influence

SECTION 3.1 AIR QUALITY

3.1.1 DEFINITION OF RESOURCE

Air quality is defined by ambient air concentrations of specific pollutants determined by the U.S. Environmental Protection Agency (EPA) to be of concern with respect to the health and welfare of the general public. Seven major pollutants of concern, called "criteria pollutants," are carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), suspended particulate matter less than or equal to 10 microns in diameter (PM_{10}), particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$), and lead. The U.S. EPA established the National Ambient Air Quality Standards (NAAQS), while the California Air Resources Board (CARB) established the State standards, known as the California Ambient Air Quality Standards (CAAQS). The U.S. EPA designates all areas of the United States as having air quality better than (attainment) or worse than (nonattainment) the NAAQS.

Ambient air quality refers to the atmospheric concentration of a specific compound (amount of pollutants in a specified volume of air) that occurs at a particular geographic location. The ambient air quality levels measured at a particular location are determined by the interactions of emissions, meteorology, and chemistry. Emission considerations include the types, amounts, and locations of pollutants emitted into the atmosphere. Meteorological considerations include wind and precipitation patterns affecting the distribution, dilution, and removal of pollutant emissions. Chemical reactions can transform pollutant emissions into other chemical substances. Ambient air quality data are generally reported as a mass per unit volume (e.g., micrograms per cubic meter of air) or as a volume fraction (e.g., parts per million [ppm] by volume).

Pollutant emissions typically refer to the amount of pollutants or pollutant precursors introduced into the atmosphere by a source or group of sources. Pollutant emissions contribute to the ambient air concentrations of criteria pollutants, either by directly affecting the pollutant concentrations measured in the ambient air or by interacting in the atmosphere to form criteria pollutants. Primary pollutants, such as CO, SO_2, lead, nitrogen oxides (NO_x), and some particulates, are emitted directly into the atmosphere from emission sources. Secondary pollutants, such as O_3, NO_2, and some particulates, are formed through atmospheric chemical reactions that are influenced by meteorology, ultraviolet light, and other atmospheric processes. PM_{10} and $PM_{2.5}$ are generated as primary pollutants by various mechanical processes (e.g., abrasion, erosion, mixing, or atomization) or combustion processes. However, PM_{10} and $PM_{2.5}$ can also be formed as secondary pollutants through chemical reactions or by gaseous pollutants condensing into fine aerosols. In general, emissions that are considered "precursors" to secondary pollutants in the atmosphere (such as reactive organic gases [ROG] and NO_x, which are considered precursors for O_3), are the pollutants for which emissions are evaluated to control the level of O_3 in the ambient air.

The State of California has identified four additional pollutants for ambient air quality standards: visibility reducing particles, sulfates, hydrogen sulfide, and vinyl chloride. The CARB has also established the more stringent CAAQS. Areas within California in which ambient air concentrations of a pollutant are higher than the State or Federal standard are considered to be nonattainment for that pollutant. Table 3-1 shows both the Federal and State ambient air quality standards. Toxic air pollutants, also called hazardous air pollutants, 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. The State of California has identified particulate emissions from diesel engines as a toxic air pollutant.

Table 3-1: Ambient Air Quality Standards

Pollutant	Averaging Time	NAAQS[1]		CAAQS[2]
		Primary[3]	Secondary[4]	Concentration[5]
O_3	1 hour	-	-	0.09 ppm
	8 hour	0.070 ppm	Same as primary	0.070 ppm
Respirable Particulate Matter (PM_{10})	24 hour	150 µg/m^3	Same as primary	50 µg/m^3
	Annual arithmetic mean	-	-	20 µg/m^3
Fine Particulate Matter ($PM_{2.5}$)	24 hour	35 µg/m^3	Same as primary	-
	Annual arithmetic average	12 µg/m^3	15 µg/m^3	12 µg/m^3
CO	1 hour	35 ppm	-	20 ppm
	8 hour	9 ppm	-	9 ppm
NO_2	1 hour	100 ppb	-	0.18 ppm
	Annual arithmetic average	53 ppb	Same as primary	0.030 ppm
SO_2	1 hour	75 ppb	-	0.25 ppm
	3 hour	-	0.5 ppm	-
	24 hour	-		0.04 ppm
Lead	30 day average	-	-	0.15 µg/m^3
	Rolling 3-month average	0.15 µg/m^3	Same as primary	-
Hydrogen Sulfide (HS)	1-Hour	No Federal Standards		0.03 ppm (42 µg/m^3)
Sulfates (SO_4)	24-Hour			25 µg/m^3
Visibility Reducing Particles	8-Hour (10 am to 6 pm, Pacific Standard Time)			In sufficient amount to produce an extinction coefficient of 0.23 per kilometer due to particles when the relative humidity is less than 70 percent.
Vinyl chloride[6]	24 Hour			0.01 ppm (26 µg/m^3)

[1]NAAQS (other than O3, particulate matter, and those based on annual averages or annual arithmetic mean) are not to be exceeded more than once a year. The O3 standard is attained when the fourth highest 8-hour concentration in a year, averaged over 3 years, is equal to or less than the standard. For PM10, the 24-hour standard is attained when 99 percent of the daily concentrations, averaged over 3 years, are equal to or less than the standard. For PM2.5, the 24-hour standard is attained when 98 percent of the daily concentrations, averaged over 3 years, are equal to or less than the standard. Contact the USEPA for further clarification and current Federal policies. [2]California Ambient Air Quality Standards for O3, CO (except Lake Tahoe), SO2 (1- and 24-hour), NO2, PM10, and visibility reducing particles, are values that are not to be exceeded. All others are not to be equaled or exceeded. [3]National Primary Standards: Provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. [4]National Secondary Standards: Provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.[5]Concentration expressed first in units in which it was promulgated. Ppm in this table refers to ppm by volume or micromoles of pollutant per mole of gas.[6]The CARB has identified lead and vinyl chloride as "toxic air contaminants" with no threshold level of exposure for adverse health effects determined. These actions allow for the implementation of control measures at levels below the ambient concentrations specified for these pollutants.

Notes: CO = carbon monoxide, ft = feet, NAAQS = national ambient air quality standards, CAAQS = California Ambient Air Quality Standards, NO_2 = nitrogen dioxide, O_3 = ozone, $PM_{2.5}$ = fine particulate matter less than or equal to 2.5 micrometers in diameter, PM_{10} = suspended particulate matter less than or equal to 10 micrometers in diameter, ppb = parts per billion, ppm = parts per million, µg/m^3 = micrograms per cubic meter
Source: California Air Resources Board 2015

3.1.2 Federal and State Requirements

The U.S. EPA is responsible for enforcing the CAA of 1970 and its 1977 and 1990 amendments (42 U.S.C. §7401, et seq.). The purpose of the CAA is to establish NAAQS, to classify areas as to their attainment status relative to the NAAQS, to develop schedules and strategies to meet the NAAQS, and to regulate emissions of criteria pollutants and air toxins to protect public health and welfare. Under the CAA, individual States are allowed to adopt ambient air quality standards and other regulations, provided they are at least as stringent as federal standards. The CARB is responsible for the coordination and administration of both Federal and State air pollution control programs within California, and implementation of the California CAA. The Clean Air Act Amendments (CAAA) (1990) established new deadlines for achievement of the NAAQS, dependent upon the severity of non-attainment.

The U.S. EPA requires each State to prepare a State Implementation Plan (SIP), which describes how that State will achieve compliance with the NAAQS. A SIP is a compilation of goals, strategies, schedules, and enforcement actions that will lead the State into compliance with all federal air quality standards.

The CAA also require that States develop an operating permit program that would require permits for all major sources of pollutants. The program would be designed to reduce stationary source emissions and control emissions of hazardous air pollutants through establishing control technology guidelines for various classes of emission sources.

New Source Review: A New Source Review (NSR) is required when a source has the potential to emit any pollutant regulated under the CAA in amounts equal to or exceeding specified major source thresholds (100 or 250 tons per year) which are predicated on a source's industrial category. Through the Eastern Kern Air Pollution Control District's (EKCAPCD's) permitting processes, all stationary sources are reviewed and are subject to an NSR process. It is not anticipated that the Proposed Action would require any stationary sources.

General Conformity: Under 40 CFR Part 93 and the provisions of Part 51, Subchapter C., Chapter I, Title 40, Appendix W of the CFR, of the CAA as amended, Federal agencies are required to demonstrate that federal actions conform to the applicable SIP. This means that projects using Federal funds or requiring Federal approval in nonattainment or maintenance areas must not (1) cause or contribute to any new violation of a NAAQS; (2) increase the frequency or severity of any existing violation; or (3) delay timely attainment of any standard, interim emission reduction, or other milestone. The General Conformity Rule applies to Federal actions affecting areas that are in nonattainment of a NAAQS and to designated maintenance areas (attainment areas that have been reclassified from a previous nonattainment status and which are required to prepare an Air Quality Maintenance Plan); the federally enforceable applicable SIP for California is compiled in 40 CFR part 52 Subpart F. A conformity review must be completed for every Federal action that generates air emissions in nonattainment or maintenance (former nonattainment) areas. Conformity determinations are required when the annual direct and indirect emissions from a Federal action exceed an applicable *de minimis* threshold. The conformity *de minimis* thresholds vary by pollutant and the severity of nonattainment conditions in the region where the Proposed Action would occur. EKAPCD Rule 210.7 implements the U.S. EPA General Conformity Rule.

3.1.3 Local Requirements

California is divided into 15 distinct air basins for monitoring and management purposes. The Mojave Air and Space Port ROI is within the Mojave Air Basin, which consists of the Antelope Valley Air Quality

Management District, Mojave Desert Air Quality Management District, and the EKCAPCD. The EKAPCD is responsible for regulating stationary sources of air emissions within Eastern Kern County and has prepared numerous air quality planning documents to meet State and Federal clean air mandates. The most important of these are the air quality management plans (AQMPs). These documents outline the EKAPCD's long-range strategy for providing clean, healthful air to the citizens and businesses of Eastern Kern County. The AQMPs are not one-time documents, but instead periodically get updated and revised in accordance with changes in governing law and air pollution control science and technology. Moreover, each successive AQMP builds on its predecessor. The last major Eastern Kern County document was the 2008 *Early Progress Plans Demonstrating Progress Toward Attaining the 8-hour National Air Quality Standard for Ozone* (Eastern Kern Air Pollution Control District 2008). It was prepared to satisfy requirements of the CAA for the 1997 Federal 8-hour ozone standard.

Central to AQMPs are stationary source control measures. Stationary source control measures are techniques and equipment for reducing ozone precursor emissions, reactive organic compounds (ROCs), and nitrogen oxides (NO_X) from stationary sources in the county. Examples of stationary source control measures include gasoline station vapor recovery systems, landfill gas recovery systems, and catalytic emission control systems on engines and various other combustion devices. Control measures for stationary sources proposed in the air quality plans and adopted by the EKAPCD are incorporated into the Rules and Regulations of the EKAPCD (Kern County Air Pollution Control District 2010).

The Western Regional Air Partnership Dust Emissions Joint Forum adopted a definition of fugitive dust on October 21, 2004 (Western Governors' Association 2006). Fugitive dust was defined as dust that could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening. Fugitive dust can be generated from agricultural tilling, construction, materials handling, paved travel surfaces, unpaved travel surfaces, minerals products industry, abrasive blasting, livestock husbandry, and wind erosion of exposed areas. Fugitive dust can become a contributor to nonattainment of the NAAQS for PM_{10} or $PM_{2.5}$.

3.1.4 Regional Setting

Presently, the EKAPCD attains all NAAQS except the ozone standard. Eastern Kern County is classified as an ozone nonattainment area (U.S. Environmental Protection Agency 2013a). The CARB also designates areas of the State that are in attainment or nonattainment of the CAAQS. Currently, the EKAPCD is in attainment of the CAAQS for all air pollutants except ozone and PM_{10} (Eastern Kern Air pollution Control District 2014). The most recent annual air emissions inventory data available for California (2012) are shown in Table 3-2.

Table 3-2: Annual Baseline (2012) Criteria and Precursor Air Pollutant Emissions for Mojave Air Basin and Eastern Kern County

Geographic Area	Criteria and Precursor Air Pollutant Emissions in Tons/Year					
	CO	NO_x	VOC/ROG	SO_x	PM_{10}	$PM_{2.5}$
Mojave Air Basin	112,858	63,437	23,907	2,810.5	47,888	13,176
Eastern Kern County (EKAPCD)	20,878	13,030	3,869	1,022	5,803	2,445

Notes: CO = carbon monoxide, NO_x = nitrogen oxides, SO_x = sulfur oxides, PM_{10} = suspended particulate matter less than or equal to 10 micrometers in diameter, $PM_{2.5}$ = fine particulate matter less than or equal to 2.5 micrometers in diameter, VOC = volatile organic compound.
Source: California Environmental Protection Agency 2015

3.1.5 Region of Influence

Identification of the ROI for air quality requires consideration of the type of pollutant(s), emission rates of the pollutant source(s), proximity to other emission sources, and local and regional meteorology. Ambient air quality is determined by the atmospheric concentrations of specific air pollutants at a particular time and location. The ambient air pollutant concentrations measured at a particular location are determined by the pollutant emissions rate, local meteorology, and atmospheric chemistry. Wind speed and direction and precipitation patterns affect the dispersal, dilution, and removal of air pollutant emissions.

For inert pollutants (all pollutants other than ozone and its precursors), the ROI is generally limited to a few miles downwind from the source. However, for photochemical pollutants such as ozone, the ROI may extend much farther downwind. Ozone is a secondary pollutant that is formed in the atmosphere by photochemical reactions of previously emitted pollutants, or precursors (ROG, NO_x, and PM_{10}). The maximum effect of precursors on ozone levels tends to occur several hours after the time of emission during periods of high solar radiation and may occur many miles from the source. Ozone and ozone precursors transported from other regions can also combine with local emissions to produce high local ozone concentrations. Emissions from the surface up to the mixing height (nominally 3,000 ft) are relevant for compliance with ambient air quality standards. Above this height, pollutants that are released generally do not mix with ground level emissions and do not have an effect on ground level concentrations in the local area. Accordingly, the ROI for air quality is the Mojave Air Basin, which includes portions of Kern County, San Bernardino County, Riverside County, and Los Angeles County.

SECTION 3.2 Climate

Climate change refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer. Global warming refers to the recent and ongoing rise in global average temperature near Earth's surface. Global warming causes climate patterns to change. However, global warming itself represents only one aspect of climate change (U.S. Environmental Protection Agency 2014). Global surface temperatures have increased by an average of about 1.3 degrees Fahrenheit during the last century (Solomon et al. 2007).

Global temperatures are moderated by naturally occurring atmospheric gases, including water vapor, carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), which are known as greenhouse gases (GHGs). These gases allow solar radiation (sunlight) into the Earth’s atmosphere, but prevent radiative heat from escaping, thus warming the Earth’s atmosphere. Gases that trap heat in the atmosphere are

often called GHGs, analogous to a greenhouse. GHGs are emitted by both natural processes and human activities.

3.2.1 Regulatory Framework

In August 2016, CEQ released final guidance regarding the consideration of GHGs in NEPA documents for federal actions (CEQ 2016). The 2016 guidance encourages agencies to draw from their experience and expertise to determine the appropriate level and type of analysis required to comply with NEPA; discusses methods to appropriately analyze reasonably foreseeable direct, indirect, and cumulative GHG emissions and climate effects; and recommends that agencies quantify a proposed action's projected direct and indirect GHG emissions, taking into account available data and GHG quantification tools.

3.2.2 Greenhouse Gas Emissions in the United States

GHG emissions occur from both natural processes and human activities. The primary long-lived GHGs directly emitted by human activities are CO_2, CH_4, N_2O, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Although CO_2, CH_4, and N_2O occur naturally in the atmosphere, their concentrations have increased by 38 percent, 149 percent, and 23 percent, respectively, from the preindustrial era (1750) to 2007–2008 (U.S. Environmental Protection Agency 2009).

To estimate total GHG emissions, each GHG is assigned a global warming potential; that is, the ability of a gas or aerosol to trap heat in the atmosphere. The global warming potential rating system is standardized to CO_2, which has a value of 1. For example, CH_4 has a global warming potential of 21, which means that it has a global warming effect 21 times greater than CO_2 on an equal-mass basis (Intergovernmental Panel on Climate Change 2013). To simplify GHG analyses, total GHG emissions from a source are often expressed as the CO_2 equivalent (CO_2e). The CO_2e is calculated by multiplying the emissions of each GHG by its global warming potential and adding the results together to produce a single, combined emission rate representing all GHG. While CH_4 and N_2O have much higher global warming potentials than CO_2, CO_2 is emitted in much higher quantities, so it is the overwhelming contributor to CO_2e from both natural processes and human activities. Global warming potential-weighted emissions are presented in terms of equivalent emissions of CO_2, using units of teragrams (Tg) (1 million metric tons, or 1 billion kilograms) of Tg CO_2e.

In 2011, the United States generated an estimated 6,702.3 Tg CO_2e (U.S. Environmental Protection Agency 2013b). The 2011 inventory data (U.S. Environmental Protection Agency 2013b) show that CO_2, CH_4, and N_2O contributed from fossil fuel combustion processes from mobile and stationary sources (all sectors) include approximately:

- 5,612.9 Tg CO_2,
- 587.23 Tg CH_4, and
- 356.9 Tg N_2O.

The 6,702.3 Tg CO_2e generated in 2011 is a decrease from the 6,810.3 Tg CO_2e generated in 2010 (U.S. Environmental Protection Agency 2013c). Among domestic transportation sources, light-duty vehicles (including passenger cars and light-duty trucks) represented 61 percent of CO_2 emissions, medium- and heavy-duty trucks 22 percent, commercial aircraft 7 percent, and other sources 11 percent. Across all categories of aviation, CO_2 emissions decreased by 20.8 percent (38.9 Tg) between 1990 and 2011.

While aviation in general represents a small percentage of fossil fuel use, it is important to note the unique impacts aviation emissions contribute because of their release at altitude. The majority of aircraft emissions occur high in the atmosphere, and the impact of burning fossil fuels at altitude is greater than burning the same fuels at ground level (particularly with regard to NO_x) (Intergovernmental Panel on Climate Change 1999). In addition, the mixture of exhaust gases discharged from aircraft perturbs radiative forcing directly through the heating effect and indirectly through affecting the microphysical processes of cirrus clouds formations. The total aviation radiation forcing, including the aviation-induced cirrus effect, is estimated to be 78 milliwatts per square meter, which represents 4.9 percent of total anthropogenic forcing (Lee et al. 2009).

SECTION 3.3 NOISE AND NOISE-COMPATIBLE LAND USE

Noise is considered any unwanted sound that interferes with normal activities or the natural environment. 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 takeoff noise and sonic booms are classified as short-duration events. The U.S. Congress has determined that aviation noise effects fall under the FAA's purview.

Statutes that are related to the consideration of noise impacts include:

- Airport and Airway Improvement Act of 1982 (49 U.S.C. §4701 et. seq.);
- Airport Noise and Capacity Act (49 U.S.C. §2101 et. seq.);
- Aviation Safety and Noise Abatement Act of 1979 (49 U.S.C. §47501–47507);
- The Control and Abatement of Aircraft Noise and Sonic Boom Act of 1968 (49 U.S.C. §47101); and
- The Noise Control Act of 1972 (49 U.S.C. §44715).

3.3.1 BASICS OF SOUND

3.3.1.1 Sound Metrics

Transient sound is defined as an "event having a beginning and an end where the sound temporarily rises above the background and then fades into it" (U.S. Army 2005). These types of sounds are associated with vehicles driving by, aircraft overflights, or impulse noise. A continually varying sound level over a given period can be described as a single "equivalent" sound level (L_{eq}) that contains an amount of sound energy equal to that of the actual sound level. As shown in the top panel of Figure 3-2, the sound level varies over time and increases during a sound "event" (in this case, an aircraft overflight). Thus, the L_{eq} is a measure of the average acoustic energy over a stated period, which includes both quiet periods and sound events. The L_{eq} is usually averaged over a 1-, 8-, or 24-hour period. An L_{eq} that is a 24-hour average can also be termed the Day-Night level (L_{dn} or DNL), with a caveat. The DNL is the average noise level over a 24-hour period (as shown in the bottom panel of Figure 3-2; this represents the average of 24 1-hour L_{eq} values). However, the noise levels between the hours of 10 p.m. and 7 a.m. are artificially increased by 10 decibels (dB). This noise is weighted to take into account people's increased sensitivity to noise at night. In many cases, the 10 dB addition also offsets the decrease in background ambient noise levels during nighttime hours (Figure 3-2).

The State of California also uses Community Noise Equivalent Level (CNEL). CNEL is essentially the same as DNL except in the CNEL, the 24-hour period is broken into three periods—day (7 a.m. to 7 p.m.), evening (7 p.m. to 10 p.m.), and night (10 p.m. to 7 a.m.)—with weightings of 5 A-weighted decibels (dBA) applied to the evening period and 10 dBA to the night period. FAA recognizes CNEL as an

acceptable alternative noise metric, requiring the use of either DNL or CNEL for noise analyses. Depending on the time-varying nature of the noise in question, the DNL and CNEL often produce very similar results.

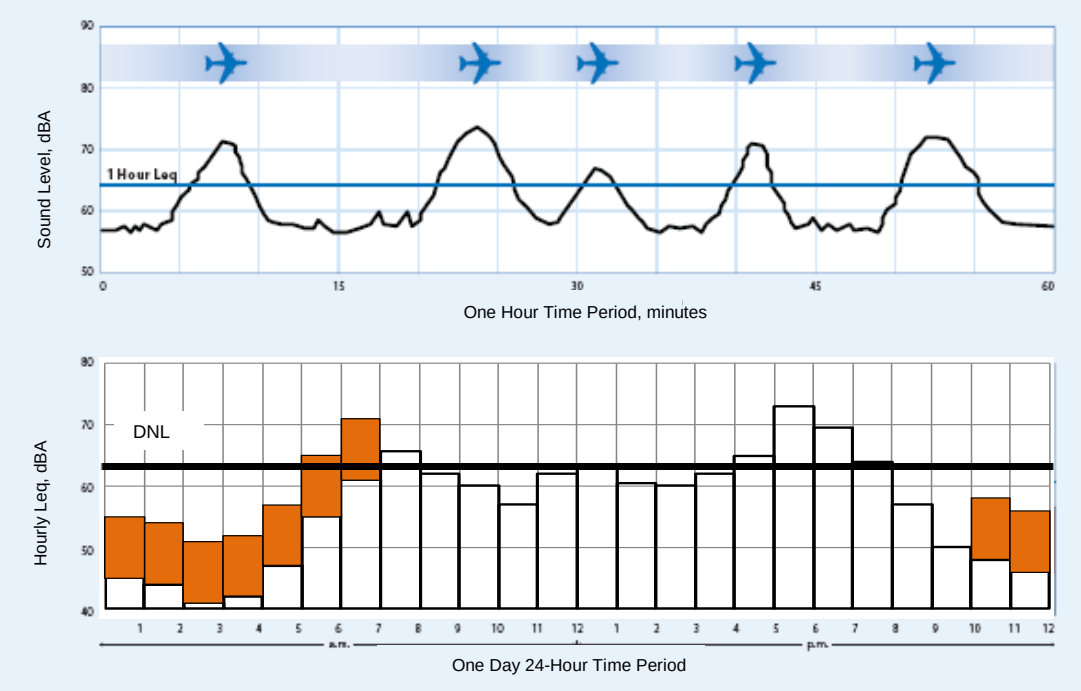

Figure 3-2: Relationship of Sound Level, L_{eq}, and Day-Night Average Sound Level

3.3.1.2 Sound Pressure Level and Perception

Sound pressure level is expressed in dB, a logarithmic scale that compares the sound pressure of an acoustical signal to a reference sound pressure. The logarithmic scale is used to compress an otherwise very large range of pressures to a more manageable range of decibels. A sound level of 0 dB is defined as the threshold of human hearing. The quietest environmental conditions yield sound levels of about 20 dBA. Typical nighttime sound levels in quiet residential areas have a sound level of about 35–45 dBA. Normal speech has a sound level of about 60 dBA at a distance of about 3 ft (1 m). A freight train passing by at about 49.2 ft (15 m) yields a sound level of about 85 dBA. The human pain threshold is about 120 dBA (Table 3-3).

A 1 dB change in the sound level is not perceptible to humans, a 3 dB change is barely perceptible, and a 5 dB change is clearly noticeable. A change in sound level of 10 dB represents more than a threefold change in sound pressure level. However, a 10 dB change is perceived by humans as a doubling or halving in loudness.

Table 3-3: Sound Levels of Selected Sound Sources and Environments

Source	Sound Level (dBA)	Human Perception of Loudness (relative to 70 dBA)
Military Jet Takeoff w/afterburner at 50 ft (15.2 m), Civil Defense Siren	130	**Above Threshold of Pain**
Commercial Jet Takeoff at 200 ft (61 m)	120	**Threshold of Pain** 32 times as loud
Pile Driver at 50 ft (15.2 m)	110	16 times as loud
Ambulance Siren at 100 ft (30.5 m) Power Lawn Mower at 3 ft (0.9 m)	100	**Very Loud** 8 times as loud
Motorcycle at 25 ft (7.6 m) Propeller Plane at 1,000 ft (304.8 m)	90	4 times as loud
Garbage Disposal at 3 ft (0.9 m) Passenger car, 65 mph at 25 ft (7.6 m)	80	2 times as loud
Vacuum Cleaner at 3 ft (0.9 m) Living Room Stereo at 15 ft (4.6 m)	70	**Moderately Loud** (Reference Loudness)
Normal Conversation at 5 ft (1.5 m)	60	1/2 as loud
Light Traffic at 100 ft (30.5 m)	50	1/4 as loud
Distant Bird Calls	40	**Quiet** 1/8 as loud
Soft Whisper at 5 ft (1.5 m)	30	1/16 as loud
N/A	0	**Threshold of Hearing**

Notes: dBA = decibels, A-weighted; ft = feet; m = meter(s), N/A = not applicable
Source: Federal Interagency Committee On Noise 1992

3.3.1.3 Time-Averaged Sound Levels

Concerns over sound include hearing loss, annoyance, speech interference, and sleep interference. Vehicular operation and flight preparation operations do not generate sound at intensities that could contribute to hearing loss in off-site public areas. However, potential effects would be conversation interruption, sleep interference, distraction, and annoyance during flight takeoffs and landing. Based on numerous sociological surveys, and recommendations of Federal interagency councils, the most common benchmark for assessing environmental sound impacts is a DNL of 65 dBA (Schomer 2005; Federal Interagency Committee on Noise 1992).

The DNL has been widely accepted as the best available method to describe aircraft noise exposure. The U.S. EPA identifies the DNL as the principal metric for airport noise analysis. The FAA requires DNL as the noise descriptor for use in aircraft noise exposure analysis and noise compatibility planning. DNL levels are commonly shown as lines of equal noise exposure (isopleths), similar to terrain contour maps.

3.3.2 Sensitive Receptors

Noise-sensitive areas are those areas where noise interferes with normal activities associated with its use. According to FAA Order 1050.1F, Paragraph 11-5(10), noise-sensitive areas include residential, educational, health, religious structures and sites, parks, recreational areas, areas with wilderness characteristics, wildlife refuges, and cultural and historical sites. In the context of facilities and equipment, noise-sensitive areas may include such sites in the immediate vicinity of operations, pursuant to the Noise Control Act of 1972. Users of designated recreational areas are considered

sensitive receptors. It is not expected that there are human sensitive receptors within the northern or southern ROIs.

The area to the north and east of the Mojave Air and Space Port is open and undeveloped land. Commercial and residential development lies immediately west and south of the space port (Kern County 2012), with numerous churches, parks, and health facilities. Local schools, operated by the Mojave Unified School District, are almost all located miles away from the main runway of the Mojave Air and Space Port. The two most proximate schools, Mojave Elementary and Mojave Junior/Senior High School, are immediately west of the boundary of the Mojave Air and Space Port property, but over 5,000 ft (1,524 km) from the major runway. Other schools (Douglas, Mountain View High School, and East Kern Community) are all located over 2 mi (approximately 3.2 km) from the major runway.

3.3.3 Ambient Noise Conditions

The ROI for noise is the Mojave Air and Space Port ROI, as sensitive noise receptors are not expected to be present in the offshore ROIs. The area within the Mojave Air and Space Port ROI consists mostly of open space. The most commonly occurring noise sources in the area include local vehicle traffic and noise associated with activities at the Mojave Air and Space Port. Traffic noise is generated by the local traffic along Highway 58 (Mojave-Barstow Highway) and Highway 14 (Aerospace Highway). Aircraft noise is generally associated with typical commercial aircraft flying over the area. Community noise levels in the area are presented in the Kern County Airport Land Use Compatibility Plan (2012), which show noise contours above DNL 65 dBA extending to the northwest and southeast past the boundaries of the space port. The configuration of the contours generally follow that of aircraft takeoff and landing routes. While these contours represent the 24-hour average sound level (i.e., DNL) a sensitive receptor might encounter, single event noise levels from aircraft activity are readily audible throughout the surrounding community (Kern County 2012).

SECTION 3.4 Water Resources (Including Wetlands, Floodplains, Surface Waters, Groundwater, and Wild and Scenic Rivers)

Water resources include wetlands, floodplains, surface waters, groundwater, and wild and scenic rivers. Under Section 404 of the CWA, wetlands are defined as areas that are “inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.” Surface water includes lakes, rivers, streams, wetlands, estuaries, and ocean waters, while groundwater refers to water below the surface. The CWA establishes the structure for regulating discharges of pollutants in Waters of the United States (Waters of the U.S.). The CWA mandates the National Pollutant Discharge Elimination System (NPDES) program, which requires a permit for the discharge of any pollutant to Waters of the U.S. from point and non-point sources. Point sources include wastewater from any discernible confined and discrete conveyances from which pollutants are or may be discharged. Non-point sources include stormwater runoff from industrial, municipal, and construction sites. The CWA and EPA regulations provide the authority and framework for State regulations. In California, the State Water Resources Control Board (SWRCB) administers the NPDES program through the Porter Cologne Water Quality Act/California Water Code. The SWRCB and the Regional Water Quality Control Board (RWQCB) administer the NPDES Program for industrial activities, municipalities, and construction activities through General Permits, although certain discharges require individual permits. The Mojave Air and Space Port maintains the water quality certification and upholds its requirements in compliance with the NPDES program. The Mojave Air and Space Port is in the jurisdiction of the Region 6V, Lahontan RWQCB.

Sections 3.6.12 and 3.6.13 of the 2009 PEIS provide a general description of water resources, including a description of the regulatory setting. These sections also provide a description of existing conditions for water resources at the Mojave Air and Space Port. There are no jurisdictional wetlands or surface waters at the Mojave Air and Space Port; therefore, CWA jurisdiction is not applicable, including certification under the NPDES Program. Accordingly, only waters of the open ocean are analyzed for impacts.

SECTION 3.5 BIOLOGICAL RESOURCES (INCLUDING FISH, WILDLIFE, AND PLANTS)

Per the FAA Order 1050.1F Desk Reference, biological resources are valued for their intrinsic, aesthetic, economic, and recreational qualities, and include fish, wildlife, 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);
- environmentally sensitive or critical habitats.

Section 7(a)(2) of the ESA (16 U.S.C. 1531 et seq.) requires that each Federal agency, in consultation with USFWS or National Oceanic and Atmospheric Administration (NOAA) 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 would be required to consult with the USFWS or NMFS if the Proposed Action may affect a federally listed species, or destroy or adversely modify critical habitat.

The MMPA of 1972 (16 U.S.C. 1361–1407) and its implementing regulations at 50 CFR Part 216 prohibit the "take" of marine mammals. Take includes injuring, killing, or harassing a marine mammal stock in the wild. The MMPA defines harassment as any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild, or has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering. Implementation of the MMPA is a joint effort between NMFS and USFWS. NMFS is responsible for the management and conservation of cetaceans (whales and dolphins) and pinnipeds (seals and sea lions), while USFWS is responsible for southern sea otters.

Under the National Marine Sanctuaries Act, NOAA established national marine sanctuaries for marine areas with special conservation, recreational, ecological, historical, cultural, archaeological, scientific, educational, or aesthetic qualities.

The Fishery Conservation and Management Act (16 U.S.C. 1801–1882), as amended and reauthorized by the Magnuson-Stevens Fishery Conservation and Management Act, provides NMFS legislative authority to regulate fisheries and protect important habitat through the creation of Essential Fish Habitat (EFH) as necessary habitat for fish spawning, breeding, feeding, and growth to maturity. Both the northern and southern splashdown regions are outside of EFH.

Because there is no potential to affect plants, plants are not discussed further in this EA. Since fish species spend essentially no time at the surface of the water, and exceptionally little energy from in-air noise is transmitted into water (Godin 2008), fish are is not considered further in this EA. The species

discussed in this section are limited to those potentially affected by acoustic impacts and expended debris resulting from the first stage splashdown in the Pacific Ocean. The northern sonic boom region overlaps federally designated critical habitat for the leatherback sea turtle (*Dermochelys coriacea*); however, there is no potential impact for any primary constituent elements (e.g., prey species) as a result of a sonic boom. Therefore, this critical habitat is not considered further in this EA.

3.5.1 Terrestrial Resources

The Mojave Air and Space Port is a largely developed and heavily impacted area located within the western portion of the Mojave Desert in California (Figure 2-2). The area surrounding the Mojave Air and Space Port, however, is generally undeveloped and biologically diverse as a result of its position near the confluence of the Transverse Ranges, the Sierra Nevada, the Mojave Desert, and the Great Basin. Wildlife in this area include variety of animals, including invertebrates, amphibians, reptiles, mammals, and birds.

Special status animal species within the Mojave Air and Space Port ROI are presented in Table 3-4. Of these, only the federally threatened desert tortoise (*Gopherus agassizii*) and State-threatened Mohave ground squirrel (*Xerospermophilus mahavensis*) have been recorded within the Mojave Air and Space Port facility in the past. However, due to large amounts of human activity and disturbance, there are no recent records, and the USFWS has previously concluded that the desert tortoise is not present within the boundaries of the facility (U.S. Fish and Wildlife Service 2007). Both the desert tortoise and Mohave ground squirrel occur in the area surrounding the Mojave Air and Space Port and therefore are within the ROI (California Department of Fish and Wildlife 2015; U.S. Fish and Wildlife Service 2015). The federally endangered California condor (*Gymnogyps californianus*) is observed on a rare basis in the ROI. There are also records of Townsend's big-eared bat (*Corynorhinus townsendii*), a candidate threatened species under the California ESA, in the surrounding area (California Department of Fish and Wildlife 2015). There is no designated critical habitat for any federally listed species at or near the Mojave Air and Space Port.

Table 3-4: Special Status Species Potentially Occurring in the Mojave Air and Space Port Region of Influence

Species	Conservation Status		Occurrence within the ROI
	Federal	State	
Desert tortoise *Gopherus agassizii*	FT	ST	Present
Mohave ground squirrel *Xerospermophilus mahavensis*	N/A	ST	Present
Townsend's big-eared bat *Corynorhinus townsendii*	N/A	SC	Present
California condor *Gymnogyps californianus*	FE	SE	Unlikely

Notes: FE = Federal Endangered Species, FT = Federal Threatened Species, SC = State Candidate Species, SE = State Endangered Species, ST = State Threatened Species
Sources: California Department of Fish and Wildlife 2015, U.S. Fish and Wildlife Service 2015

3.5.2 Marine Resources

3.5.2.1 Special Status Marine Species Potentially Occurring in the Northern and Southern Sonic Boom Regions

Marine animals found in the northern and southern sonic boom regions that may be sensitive to sonic booms include cetaceans (whales and dolphins), pinnipeds (seals and sea lions), sea turtles, and seabirds. Table 3-5 presents marine species that may occur in the northern and southern sonic boom regions.

Cetaceans, pinnipeds, and sea turtles occurrence and density data for the northern and southern sonic boom regions was determined by reviewing habitat-based density models (Becker et al. *in review*; U.S. Department of the Navy 2014) and stock assessments (Carretta et al. 2015). In total, five sea turtle species; six pinnipeds, including the ESA-listed Guadalupe fur seal; and 28 cetacean species/guilds, including six ESA-listed species, are potentially found within the northern and southern sonic boom regions (Table 3-4). The northern and southern sonic boom regions do not overlap any land and therefore do not include any pinniped haul outs or sea turtle nesting areas. The potential occurrence of seabirds within the northern and southern sonic boom regions was determined by performing an online query of USFWS's Information, Planning, and Conservation System (U.S. Fish and Wildlife Service 2016). The northern and southern sonic boom regions include 10 species of seabirds, including two currently listed under the ESA (Table 3-4). Since the northern and southern sonic boom regions do not overlap land, there is no overlap with nesting birds.

3.5.2.2 Sensitive Marine Habitats within the Northern and Southern Sonic Boom Regions

The sonic boom region associated with the northern drop points overlaps the Greater Farallones National Marine Sanctuary (GFNMS) and the Cordell Bank National Marine Sanctuary (CBNMS). The GFNMS provides haul outs and breeding locations for thousands of seals and sea lions at the Farallones Islands and the California shoreline. However, as noted above, the sonic boom footprint does not overlap any haul outs or breeding locations. The CBNMS is a region of nutrient-rich water that supports an important feeding ground for many marine mammals and seabirds. Upwelling of cold water during the spring and early summer causes a bloom of algae and invertebrates and attracts a vast array of fish and marine mammals for feeding.

Table 3-5. Special Status Species Potentially Occurring in the Sonic Boom Region of Influence

Species	Conservation Status		Occurrence within the ROI
	Federal	State	
Sea Turtles			
Green sea turtle *Chelonia mydas*	FT	N/A	Potential
Hawksbill sea turtle *Eretmochelys imbricata*	FE	N/A	Very Rare
Loggerhead sea turtle *Caretta*	FE[1]	N/A	Potential
Olive ridley sea turtle *Lepidochelys olivacea*	FE	N/A	Potential
Leatherback sea turtle *Dermochelys coriacea*	FE	N/A	Rare
Pinnipeds			
Pacific Harbor Seal *Phoca vitulina richardsi*	MMPA	N/A	Common
California Sea Lion *Zalophus californianus*	MMPA	N/A	Rare
Northern Elephant Seal *Mirounga angustirostris*	MMPA	SFP	Common
Steller Sea Lion *Eumetopias jubatus*	MMPA, FD	N/A	Rare
Northern Fur Seal *Callorhinus ursinus*	MMPA-D	N/A	Common
Guadalupe Fur Seal *Arctocephalus townsendi*	MMPA-D, FT	SFP	Rare
Cetaceans			
Humpback whale *Megaptera novaeangliae*	MMPA-D, FE	N/A	Common, Seasonal

Species	Conservation Status		Occurrence within the ROI
	Federal	State	
Blue whale *Balaenoptera musculus*	MMPA-D, FE	N/A	Common, Seasonal
Fin whale *Balaenoptera physalus*	MMPA-D, FE	N/A	Common
Sei whale *Balaenoptera borealis*	MMPA-D, FE	N/A	Rare
Bryde's whale *Balaenoptera brydei/edeni*	MMPA	N/A	Rare
Minke whale *Balaenoptera acutorostrata*	MMPA	N/A	Common
Gray whales *Eschrichtius robustus*	MMPA-D[2], FE[2]	N/A	Common, Seasonal
Sperm whale *Physeter microcephalus*	MMPA-D, FE	N/A	Rare
Dwarf sperm whale *Kogia sima*	MMPA	N/A	Potential
Killer whale *Orcinus orca*	MMPA	N/A	Rare
Short-finned pilot whales *Globicephala macrorhynchus*	MMPA	N/A	Rare
Long-beaked common dolphins *Delphinus capensis*	MMPA	N/A	Common
Short-beaked common dolphins *Delphinus delphis*	MMPA	N/A	Common
Common bottlenose dolphin *Tursiops truncates*	MMPA	N/A	Common
Striped dolphin *Stenella coeruleoalba*	MMPA	N/A	Rare
Pacific white-sided dolphin *Lagenorhynchus obliquidens*	MMPA	N/A	Common
Northern right whale dolphin *Lissodelphis borealis*	MMPA	N/A	Common
Risso's dolphin *Grampus griseus*	MMPA	N/A	Common
Harbor porpoise *Phocoena*	MMPA	N/A	Common
Dall's Porpoise *Phocoenoides dalli*	MMPA	N/A	Common, Seasonal
Cuvier's beaked whale *Ziphius cavirostris*	MMPA	N/A	Potential
Baird's beaked whale *Berardius bairdii*	MMPA	N/A	Rare
Blainville's beaked whale *Mesoplodon densirostris*	MMPA	N/A	Potential
Ginkgo-toothed beaked whale *Mesoplodon ginkgodens*	MMPA	N/A	Potential
Perrin's beaked whale *Mesoplodon perrini*	MMPA	N/A	Potential
Stejneger's beaked whale *Mesoplodon stejnegeri*	MMPA	N/A	Potential
Hubbs' beaked whale *Mesoplodon carlhubbsi*	MMPA	N/A	Potential
Pygmy beaked whale *Mesoplodon peruvianus*	MMPA	N/A	Potential
Birds			
Ashy storm-petrel *Oceanodroma homochroa*	MBTA	N/A	Rare, Seasonal

Species	Conservation Status		Occurrence within the ROI
	Federal	State	
Black-footed albatross *Pheobastria nigripes*	MBTA	N/A	Rare
Black-vented shearwater *Puffinus opisthomelas*	MBTA	N/A	Common
California brown pelican *Pelecanus occidentalis californicus*	FD	SD, SFP	Unlikely
Cassin's auklet *Ptychoramphus aleuticus*	MBTA	N/A	Common
Laysan albatross *Phoebastria immutabilis*	MBTA	N/A	Rare
Pink-footed shearwater *Puffinus creatopus*	MBTA	N/A	Rare
Short-tailed albatross *Phoebastria albatrus*	FE	N/A	Unlikely
Marbled murrelet *Brachyramphus marmoratus*	FT	SE	Rare
Scripps's murrelet *Synthliboramphus scrippsi*	FC	ST	Rare

[1] The only distinct population segment of loggerheads that occurs in the Study Area—the North Pacific Ocean distinct population segment—is listed as Federally endangered.
[2] Both populations of gray whale are protected under the MMPA; the western north pacific stock is listed as endangered under the ESA and depleted under the MMPA. Eastern gray whales are frequently observed in Southern California waters.
Notes: D = MMPA Depleted Strategic Stock, FC = Federal Candidate Species, FD = Federally de-listed, FE = Federal Endangered Species, FP = Federal Proposed Species, FT = Federal Threatened Species, MBTA = Migratory Bird Treaty Act, MMPA = Marine Mammal Protection Act, SC = State Candidate Species, SD = State de-listed, SFD = State Fully Protected Species, N/A = not applicable.
Sources: Sea Turtles – U.S. Department of the Navy 2014; Cetaceans and Pinnipeds - Carretta et al. 2015, U.S. Department of the Navy 2014; Sea Birds – U.S. Fish and Wildlife Service 2016.

SECTION 3.6 HAZARDOUS MATERIALS, SOLID WASTE, AND POLLUTION PREVENTION

Hazardous materials and wastes are those substances defined as hazardous by the Comprehensive Environmental Response, Compensation, and Liability Act, as amended by the Superfund Amendments and Reauthorization Act (42 U.S.C. 9601–9675); the Toxic Substances Control Act (15 U.S.C. 2601-2671); and the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (Resource Conservation and Recovery Act; 42 U.S.C. 6901–6992) and as defined in the State of California corresponding laws and regulations.

Section 3.1.5 of the 2009 PEIS provides a general description of hazardous materials, pollution prevention, and solid waste, including a description of the regulatory setting. The Mojave Air and Space Port uses hazardous materials for various institutional activities, which in turn generate hazardous waste. The hazardous materials at the Space Port mostly consist of airplane fuels and rocket propellants (oxidizers and fuels); however, other hazardous materials used and stored onsite include acetylene, paints, used motor and hydraulic oil, gear lubricant, and hydraulic fluid (FAA 2009, 2012). Section 3.6.5 of the 2009 PEIS provides a more detailed description of existing conditions for hazardous materials, solid waste, and pollution prevention at the Mojave Air and Space Port. Hazardous materials and waste are managed in accordance with applicable Federal, State, and local rules and regulations.

SECTION 3.7 HISTORICAL, ARCHITECTURAL, ARCHEOLOGICAL, AND CULTURAL RESOURCES

Historical, architectural, archeological, and cultural resources include tangible remains of past activities that show use or modification by people, including artifacts; features such as hearths, rock alignments, trails, rock art, roads, landscape alterations, or architecture; and aspects of the physical environment

that are part of traditional life ways and practices (FAA 2009). Section 106 of the NHPA is the principal statute concerning historical, architectural, archeological, and cultural resources.

Section 3.1.3 of the 2009 PEIS provides a general description of historical, architectural, archeological, and cultural resources, including a description of the regulatory setting. There are no recorded historical, architectural, archeological or cultural resources in the launch area and no sites at the Mojave Air and Space Port are listed on the National Register of Historic Places (FAA 2009). Section 3.6.3 of the 2009 PEIS provides a more detailed description of existing conditions for historical, architectural, archeological, and cultural resources at the Mojave Air and Space Port.

A recent search of the National Register of Historic Places found that there are 23 known sites in Kern County, California (U.S. Department of the Interior 2013). There are other known sites that may be eligible for listing, but are not yet listed in the National Register of Historic Places. These sites include ones that are identified as American Indian, archaeological, or Native American sites and California State Historical Landmarks.

There are no recorded cultural resources or sites listed or eligible to be listed on the National Register of Historic Places at the Mojave Air and Space Port or in the immediate vicinity (FAA 2012). Although Southern Paiute, Western Shoshone, Yokuts, and Mojave descendants reside in the surrounding region, there are no designated tribal lands located on or adjacent to the Mojave Air and Space Port property (U.S. Environmental Protection Agency 2016).

SECTION 3.8 LAND USE

Section 3.1.7 of the 2009 PEIS provides a general description of land use, including a description of the regulatory setting. Section 3.6.7 of the 2009 PEIS provides existing conditions for land use at the Mojave Air and Space Port. The Mojave Air and Space port is in an area that is zoned for industrial use. Land uses east of the Space Port are residential, commercial, industrial, resource management, public facilities, State, Federal, and undeveloped. No recreational land uses are designated at the space port (FAA 2009). Three major plans control the land use development of the Mojave community including:

1. County of Kern General Plan. A General Plan is the foundation and central feature of the local planning process. It governs the physical growth and change in the community. No land division, parcel map, conditional use permit, or rezoning can be approved unless it is found to be consistent with the adopted plan (Kern County Planning Department 2009).

2. County of Kern Airport Land Use Compatibility Plan. This plan was developed to establish procedures and criteria for Kern County and the incorporated cities to address compatibility issues when making planning decisions regarding airports and the land uses around them (Kern County 2011).

3. Mojave Specific Plan. The Mojave Specific Plan provides a detailed description of how to implement the goals, objectives, and policies of the General Plan in a manner appropriate to the smaller unincorporated areas of the County (Kern County 2003).

SECTION 3.9 DEPARTMENT OF TRANSPORTATION ACT, SECTION 4(F)

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) properties include:

- parks and recreational areas of national, State, or local significance that are both publicly owned and open to the public;
- publicly owned wildlife and waterfowl refuges of national, State, or local significance that are open to the public; and
- historic sites of national, State, or local significance in public or private ownership regardless of whether they are open to the public (U.S. DOT, 2012a).

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. Section 3.1.7 of the 2009 PEIS provides a general description of Section 4(f) resources, including a description of the regulatory setting.

The Mojave Air and Space Port is approximately 3,000 acres and is developed on 200 acres. It is in an area that is zoned for industrial use while the area to the east of the Space Port includes residential, commercial, industrial, resource management, public facilities, State, Federal, and undeveloped land uses. There are no recreational land uses designated at the space port. The closest Section 4(f) resources are U.S. Bureau of Land Management conservation areas: Middle Knob Conservation Area, Barstow Woolly Sunflower Conservation Area, North Edwards Conservation Area, and Alkali Mariposa Lily Conservation Area; all of which are several miles from the Mojave Air and Space Port (FAA 2009). There are no parks, recreational areas, wildlife refuges, or historic sites in or around the vicinity of the Mojave Air and Space Port. The carrier vehicle's overflight area includes Los Padres National Forest and the Channel Islands National Park. Section 3.6.7 of the 2009 PEIS provides a more detailed description of existing conditions for Section 4(f) resources at the Mojave Air and Space Port.

SECTION 3.10 SOCIOECONOMICS, ENVIRONMENTAL JUSTICE, AND CHILDREN'S ENVIRONMENTAL HEALTH AND SAFETY RISKS

The CEQ regulations for implementing NEPA state that the human environment "shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment" (40 CFR § 1508.14). This means that economic or social effects are not intended by themselves to require preparation of an environmental analysis; however, when economic, social, and natural or physical environment effects are interrelated, then the environmental analysis will discuss these effects on the human environment (40 CFR § 1508.14). Section 3.1.11 of the 2009 PEIS provides a general description of socioeconomics, environmental justice, and children's environmental health and safety risks, including a description of the regulatory setting.

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 (U.S. DOT 2012b), have reinforced the directives outlined in EO 12898. CEQ, which oversees the Federal government's compliance with EO 12898 and NEPA, also developed guidelines (CEQ 1997) to assist Federal agencies in incorporating the goals of EO 12898 into the NEPA process.

EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, requires Federal agencies to identify disproportionately high and adverse impacts to children. Children may suffer disproportionately more environmental health and safety risks than adults because of various factors such as: children have still-developing 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.

3.10.1 POPULATION

The U.S. Census Bureau estimates the population at Mojave to be 4,238 (U.S. Census Bureau 2016). People of African American descent make up approximately 16.2 percent of the population in Mojave, while Hispanic and Latino people make up 52.9 percent (U.S. Census Bureau, 2016). The median household income is $34,500 (U.S. Census Bureau, 2016). In 2015, the percentage of residents living below the poverty level was 31.5 percent (U.S. Census Bureau, 2016). Recent data reported that there are 358 companies in Mojave, California, and 72.3 percent of the population is a high school graduate or higher (U.S. Census Bureau 2016).

3.10.2 SCHOOLS

Two schools, the Mojave Elementary and Mojave Junior/Senior High School, are located less than 1,000 ft from the boundary of the Mojave Air and Space Port property, and over 5,000 ft from the major runway (FAA 2012). These schools enroll approximately 800 students (Public School Review 2015).

3.10.3 COMMUNITY SERVICES

Emergency response services at the Mojave Air and Space Port consist mainly of the Mojave Air and Space Aerospace Rescue Fire Fighting unit and the Kern County Fire Department. The firefighting crew is trained and qualified in fire and rescue techniques, and its response requirements follow the guidelines of the National Fire Protection Standard 402 and the U.S. Air Force Defense Logistics Agency Manual 8210.1. The Kern County Fire Department, located 0.25 mi (0.4 km) from the Mojave Air and Space Port, provides 24-hour support to the Mojave Air and Space Port Aerospace Rescue and Fire Fighting unit. Additionally, a Special Crash Rescue Vehicle is located at the Mojave Air and Space Port, which is specifically designed to respond to launch vehicle accidents. Hall Ambulance provides on-site, 24-hour, land-based emergency medical services, and Mercy Air provides on-site, 24-hour, air-based emergency medical services (FAA 2012).

SECTION 3.11 VISUAL EFFECTS (INCLUDING LIGHT EMISSIONS)

Visual effects are related to the extent to which the Proposed Action or alternatives would produce light emissions that create annoyance or interfere with activities; or the extent to which the Proposed Action or alternatives would detract from, or contrast with visual resources or the visual character of the existing environment. Section 3.1.8 of the 2009 PEIS provides a general description of visual resources, including a description of the regulatory setting.

The existing conditions at the Mojave Air and Space Port can be characterized as having low visual sensitivity because it is currently an industrialized area that supports air and spacecraft operations. There are numerous airplanes parked continuously at the Mojave Air and Space Port that can be seen from two highways. There are two railways that intersect in the community as well as other light

sources at the Mojave Air and Space Port, which are illuminated overnight. Section 3.6.8 of the 2009 PEIS provides a more detailed description of existing conditions for visual resources at the Mojave Air and Space Port.

Currently, more than 60 companies engage in flight development, light industrial to highly advanced aerospace design, flight test and research, and heavy rail industrial manufacturing at Mojave Air and Space Port (Witt 2015). There are numerous wind farm projects located in the area west of the Mojave Air and Space Port and several solar projects in the area surrounding the Mojave Air and Space Port. Current light sources at the Mojave Air and Space Port include security lighting on the grounds and safety lighting on the runways (FAA 2012).

CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

This chapter describes the potential environmental consequences of the Proposed Action and No Action Alternative, which were evaluated in accordance with all relevant statutory requirements, including the CEQ regulations and FAA Order 1050.1F.

SECTION 4.1 AIR QUALITY

This section describes the potential effects of the Proposed Action and the No Action Alternative on regional air quality under the mixing height (3,000 ft above ground level [AGL]). As discussed in more detail below, impacts associated with activities above the mixing level are not analyzed as they do not have an effect on ground level air pollutant concentrations.

4.1.1 SIGNIFICANCE THRESHOLD

Per FAA Order 1050.1F, significant air quality impacts would occur if the action would cause pollutant concentrations to exceed one or more of the NAAQS, as established by the U.S. EPA under the CAA, for any of the time periods analyzed, or to increase the frequency or severity of any such existing violations.

4.1.2 ENVIRONMENTAL CONSEQUENCES

4.1.2.1 Proposed Action

Air quality impacts from operations are considered only for activities below 3,000 ft AGL. Of primary importance in this evaluation is the mixing height. In general, the mixing height is defined as the vertical region of the atmosphere where pollutant mixing occurs. Above this height, pollutants that are released generally do not mix with ground level emissions and do not have an effect on ground level concentrations in the local area. Per FAA-AEE-00-01, DTS-34 (Consideration of Air Quality Impacts by Airplane Operations at or Above 3,000 ft [914 m] AGL), emissions above 3,000 ft (914 m) are not considered for local or regional air quality impacts.

4.1.2.1.1 Pre-Flight and Post-Flight Activities

Emissions can occur from support equipment used during ground fueling operations, including trucks and equipment. Trucks would be driven to the carrier vehicle and the rocket would be shut off during the loading process of LOX, RP-1, jet fuel (kerosene), and helium. Approximate travel time to the loading location is anticipated to be less than 10 minutes roundtrip. For each flight event, it is assumed that up to five trucks would be utilized. Given the small number of trucks used, and the short run-time of each truck, the total emissions from pre-flight and post-flight activities would be too small to lead to violations of the NAAQS or CAAQS. Five trucks operating for one hour each during 160 fueling operations (40 flights and up to 120 scrubbed flights) would create approximately 0.00215 tons of CO_2 per year, and proportionately less emissions of other pollutants. The air quality impacts would be insignificant and would not be distinguishable from the impacts of the other flight and ground operations at the Mojave Air and Space Port.

4.1.2.1.2 Carrier Vehicle Emissions

As described in Section 2.1, the Proposed Action would include a maximum of 115 flights of the carrier vehicle and subsequent launches of the mated rocket between 2017 and 2021. The maximum number of launches that would occur on an annual basis is 40, or approximately one flight every 9 days at most.

The pollutants emitted by an aircraft during takeoff and landing operations are dependent on the emission rates and the duration of these operations. The emission rates are dependent upon the type of engine and its size or power rating. An aircraft operational cycle, or Landing and Take Off (LTO) cycle, includes the landing and takeoff. An LTO cycle includes all normal operational modes performed by an aircraft between its descent from an altitude of about 3,000 ft (914 m) on landing and subsequent takeoff to reach the 3,000 ft (914 m) altitude. The 3,000 ft (914 m) limit is a reasonable approximation to the meteorological mixing height. The term "operation" is used by the FAA to describe either a landing or a takeoff cycle. Therefore, two operations make one LTO cycle.

The aircraft LTO cycle is divided into five segments or operational "modes" and categorized by

- Landing approach (descent from about 3,000 ft [914 m] to touch down)
- Taxi/idle-in
- Taxi/idle-out
- Takeoff, and
- Climb out (ascent from lift-off to about 3,000 ft [914 m])

The U.S. EPA's basic methodology for calculating aircraft emissions at any given airport in any given year can be summarized in six steps: (1) Determine airport activity in terms of the number of LTOs; (2) Determine the mixing height to be used to define an LTO cycle; (3) Define the fleet make-up at the airport; (4) Estimate time-in-mode (TIM); (5) Select emission factors; and (6) Calculate emissions based on the airport activity, TIM, and aircraft emission factors.

The emissions for the Proposed Action are based on the time of operation in each mode and the emission rates of the carrier vehicle engines. The time in the landing approach and climb-out modes are assumed to be 4.67 minutes and 3.0 minutes, respectively. The anticipated takeoff time is 0.5 minutes and represents the time for initial climb from ground level to about 500 ft (152 m). The time in taxi/idle mode has been estimated as 15 minutes for both taxi/idle in and taxi/idle-out (Virgin Galactic 2016).

Aircraft emissions for criteria pollutants were calculated by multiplying the TIM against respective emission factors and number of estimated flights. Table 4-1 lists estimated annual criteria and precursor air pollutant emissions for the Proposed Action and compares them to the General Conformity *de minimis* emission levels for each nonattainment pollutant to determine compliance with the SIP, and for each attainment pollutant as an indicator of potential impacts. The increases in carrier vehicle activities would result in a corresponding increase in criteria and precursor pollutant emissions. All would increase under the Proposed Action. Air pollutant emissions under the Proposed Action would not result in violations of Federal or State air quality standards because they would not have a measurable impact on air quality. As shown in Table 4-1, estimated emissions from the Proposed Action would account for less than 1 percent of the regional emissions.

Table 4-1: Annual Criteria and Precursor Air Pollutant Emissions for LTO cycle under the Proposed Action

Emissions Source	Criteria and Precursor Air Pollutant Emissions in Tons/Year				
	CO	NO_x	ROG	SO_4	PM
Proposed Action					
Carrier Vehicle LTOs (tons per LTO)	0.036	0.028	0.008	0.002	0.002
Carrier Vehicle LTOs (including 3 scrubbed launches per mission, and one rehearsal flight)	7.18	5.57	1.56	0.35	0.48
Summary and Comparison					
De minimis levels	100	100	50	100	100
Emissions as a percentage of the Mojave Air Basin baseline	**0.036%**	**0.028%**	**0.016%**	**0.002%**	**0.002%**
Emissions as a percentage of the Mojave Air Basin baseline for all potential flights	**7.18%**	**5.57%**	**3.12%**	**0.35%**	**0.48%**

Notes: CO = carbon monoxide, NO_x = nitrogen oxides, ROG = total hydrocarbons, LTO = landing and takeoff
Sources: International Civil Aviation Organization 2015, Aircraft Engine Emissions Databank
U.S. Air Force 2002, Aircraft/Auxiliary Power Units/Aerospace Ground Support Equipment Emissions Factors
U.S. Environmental Protection Agency 1999. Evaluation of Air Pollutant Emissions from Subsonic Commercial Jet Aircraft.

The U.S. EPA has listed 188 hazardous air pollutants regulated under Title III (Hazardous Air Pollutants), Section 112(g) of the CAA. Hazardous air pollutants are emitted by processes associated with the Proposed Action, including fuel combustion. The amounts of hazardous air pollutants emitted are small compared to the emissions of criteria pollutants; emission factors for most hazardous air pollutants from combustion sources are roughly three or more orders of magnitude lower than emission factors for criteria pollutants (California Air Resources Board 2007). Hazardous air pollutant emissions estimates were not calculated because of the small amounts that would be emitted.

Under the Proposed Action, hazardous pollutant emissions would increase, and the increases would be roughly proportional to the increases observed for the criteria air pollutants emitted (see Table 4-1). Hazardous air pollutants emissions would be intermittent and distributed over the ROI. Their concentrations would be further reduced by atmospheric mixing and other dispersion processes. After initial mixing, it is possible that hazardous pollutants would be measurable, but they would be in very low concentrations and would not affect the air quality in the air quality control regions. Therefore, no significant impacts to air quality would occur under the Proposed Action.

4.1.2.1.3 Rocket Emissions

Rocket activities would occur at altitudes above 30,000 ft (9,144 m) MSL. As stated above, pollutants that are released above 3,000 ft AGL generally do not mix with ground level emissions and do not have an effect on ground level concentrations in the local area. Additionally, per FAA-AEE-00-01, DTS-34, these activities are exempt from analysis for local and regional air quality. Accordingly, rocket activities would have no impact on regional air quality.

4.1.2.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch license for the operation of LauncherOne from the Mojave Air and Space Port. The Mojave Air and Space Port would continue its existing operations, which includes emissions associated with operating the air and space port. Under the No Action Alternative, there would be no new impacts related to air quality.

SECTION 4.2 CLIMATE

This section describes the potential climate-related effects of the Proposed Action and the No Action Alternative.

4.2.1 SIGNIFICANCE THRESHOLD

The FAA has not established a significance threshold for Climate. Although there are no Federal standards for aviation-related GHG emissions, it is well established that GHG emissions can affect climate. As noted by CEQ, "it is not currently useful for the NEPA analysis to attempt to link specific climatological changes, or the environmental impacts thereof, to the particular project or emissions; as such direct linkage is difficult to isolate and to understand" (CEQ 2010). Aviation has been calculated to contribute approximately 3 percent of global CO_2 emissions; this contribution may grow to 5 percent by 2050. Due to the uncertainties associated with various physical and chemical modeling, it is difficult to quantify the actual climate impact from the minimal GHG emissions from the Proposed Action.

4.2.2 ENVIRONMENTAL CONSEQUENCES

4.2.2.1 Proposed Action

The projected increase in GHG emissions from the Proposed Action is discussed in the context of national and global emissions from all sources. GHG emissions for ground activities were not calculated for the Proposed Action because of their minor usage time contributes only incrementally (approximately 1.95 kilograms of CO2 annually) when compared to the GHG emissions from the carrier vehicle and rocket.

Up to 40 launches are anticipated per year (with rehearsal flights preceding them), with the potential for three "scrubbed" missions per launch. A scrubbed mission would include an LTO cycle and transit to and from the drop point, but no launch of the rocket. For the purposes of the climate analysis, 75 percent of missions would utilize the southern drop point, and 25 percent of missions would utilize the northern drop point.

Actions within the EKCAPD are limited to LTO cycles (e.g., the carrier vehicle would leave the district boundary while still in climb-out phase) and as such, each flight would produce a maximum of 11.40 MT of CO2e (Table 4-2). The total GHG emissions for successful and scrubbed flights (160 total) within EKCAPD would be a maximum of 23,894 MT annually (Table 4-3).

Table 4-2. Proposed Action GHG Emissions per Activity in Tons

Scenario/Activity	Metric Tons Produced			
	CO_2	CH_4	N_2O	CO_2e
GHG Emissions of Carrier Vehicle Per LTO Cycle (< 3,000 ft)	11.28	0.000242	0.00363	11.401
GHG Emissions of Carrier Vehicle Per Flight to Southern Drop Point (> 3,000 ft)	89.41	N/A	0.00848	91.939
GHG Emissions of Carrier Vehicle Per Flight to Northern Drop Point (> 3,000 ft)	143.05	N/A	0.01358	147.105
GHG Emissions per Launch of Rocket	11.676	N/A	n/a	11.677
Total GHG Emissions for one Launch Event to the Southern Drop Zone	**112.375**	**0.000242**	**0.00885**	**115.02**
Total GHG Emissions for one Launch Event to the Northern Drop Zone	**166.021**	**0.000242**	**0.0139**	**170.18**

Scenario/Activity	Metric Tons Produced			
	CO_2	CH_4	N_2O	CO_2e

Notes: (1) CO_2e = (CO_2 * 1) + (CH4* 21) + (N2O * 298), N/A = not applicable
Sources: Climate Registry 2015. 2015 Climate Registry Default Emission Factors; U.S. Energy Information Administration, 2016. Carbon Dioxide Emissions Coefficients

Table 4-3 presents GHG emissions estimates for the Proposed Action (both with and without scrubbed missions, and rehearsal flights). GHG emissions would increase by 23,894 MT CO_2e annually, which is below the Federal threshold for reporting air emissions (for stationary sources, used here for a reference point) of 25,000 MT.

Table 4-3: Estimated Greenhouse Gas Emissions for Project Activities

Scenario	Greenhouse Gas Emissions (tons CO_2e)	Number of Activities	Annual Greenhouse Gas Emissions (tons CO_2e)
Southern Drop Point	115.02	30	3,451
Northern Drop Point	170.18	10	1,702
Total Annual GHG Emission (only successful launches)			**5,153**
Southern Drop Point	115.02	30	3,451
Southern Drop Point No Launch	103.34	120	12,401
Northern Drop Point	170.18	10	1,702
Northern Drop Point No Launch	158.51	40	6,340
Total Annual GHG Emission (including scrubbed launches and rehearsal flights)			**23,894**

Note: CO_2e = carbon dioxide equivalent; GHG = greenhouse gas

4.2.2.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch license for the operation of LauncherOne from the Mojave Air and Space Port. The Mojave Air and Space Port would continue its existing operations. Under the No Action Alternative, there would be no new climate-related impacts.

SECTION 4.3 NOISE AND NOISE-COMPATIBLE LAND USE

This section describes the potential noise effects of the Proposed Action and the No Action Alternative. Noise would be generated during carrier vehicle takeoffs and landings at the Mojave Air and Space Port, and during rocket flight in both the Northern and Southern Drop Point ROIs.

4.3.1 SIGNIFICANCE THRESHOLD

Per FAA Order 1050.1F, significant noise impacts would occur 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." Per the FAA Order 1050.1F Desk Reference, CNEL may be used in lieu of DNL for FAA actions needing approval in California.

4.3.2 Environmental Consequences

4.3.2.1 Proposed Action

4.3.2.1.1 Pre-Flight and Post-Flight Activities

Noise levels generated from pre-flight and post-flight activities (e.g., driving, fueling) would likely not propagate past the Mojave Air and Space Port's boundaries. Section 4.6.10 of the 2009 PEIS indicated that the addition of up to 400 jet-assisted launches per year at the Mojave Air and Space Port would not increase the DNL more than 1.5 dBA and concluded no significant impacts. Therefore, pre-flight and post-flight activities, which have noise levels far below those of launches, would not significantly impact the acoustic environment as a result of the Proposed Action.

4.3.2.1.2 Carrier Vehicle

Based on the 2012 Kern County Airport Land Use Compatibility Plan, the Mojave Air and Space Port currently supports approximately 17,575 flights annually, of which approximately 1,283 are military jet activities. The Mojave community currently experiences high noise levels from military jet takeoffs and landings and stationary rocket tests. Sensitive receptors in the Mojave community such as schools and residential areas already experience high-intensity noise levels above 90 dBA during a single aircraft takeoff event (Kern County 2012), and portions of the Mojave community underlie 24-hour noise contours in excess of 65 dBA CNEL.

Carrier vehicle noise levels would not differ substantially from other aircraft currently operating at the Mojave Air and Space Port. Additionally, because the Proposed Action would represent a small increase over the existing air traffic, it is unlikely that these activities would significantly contribute to the overall sound environment. Carrier vehicle takeoffs and landings are not expected to change the average day-night noise level (DNL) contours as reported in the 2012 Kern County Airport Land Use Compatibility Plan or elevate the day-night noise level more than 1.5 dB above the acceptable levels of 65 CNEL. Therefore, noise associated with operation of the carrier vehicle would not significantly impact the acoustic environment.

4.3.2.1.3 Rocket – Northern and Southern Drop Point ROIs

The carrier vehicle would take off from the Mojave Air and Space Port and fly either 70 mi (113 km) off the coast of California to the southern drop point, or 15 mi off the coast of California to the northern drop point. Once at the drop point, the rocket would be released at an altitude of approximately 35,000–40,000 ft (10,668–12,192 m) above MSL. Within 20 seconds releasing the rocket, the rocket would be flying at supersonic speeds.

For purposes of this analysis, there are three primary trajectories anticipated to be utilized at both the southern and northern drop points. To determine the potential for a sonic boom, the modeling program PCBOOM was used. Figure 4-1 and Figure 4-2 present the potential boom locations and intensities for each trajectory at the northern and southern drop points. Based on the modeling results, no sonic boom would intersect with land or human-sensitive receptors. The closest boom to the coast with a magnitude of 1.0 pound per square foot (psf) or greater is located near northern drop point 2, approximately 15 mi (23 km) offshore. As none of the sonic boom events that were modeled overlap with the coastal zone, terrestrial areas, sensitive marine habitats, or sensitive receptors, impacts related to sonic booms would be less than significant.

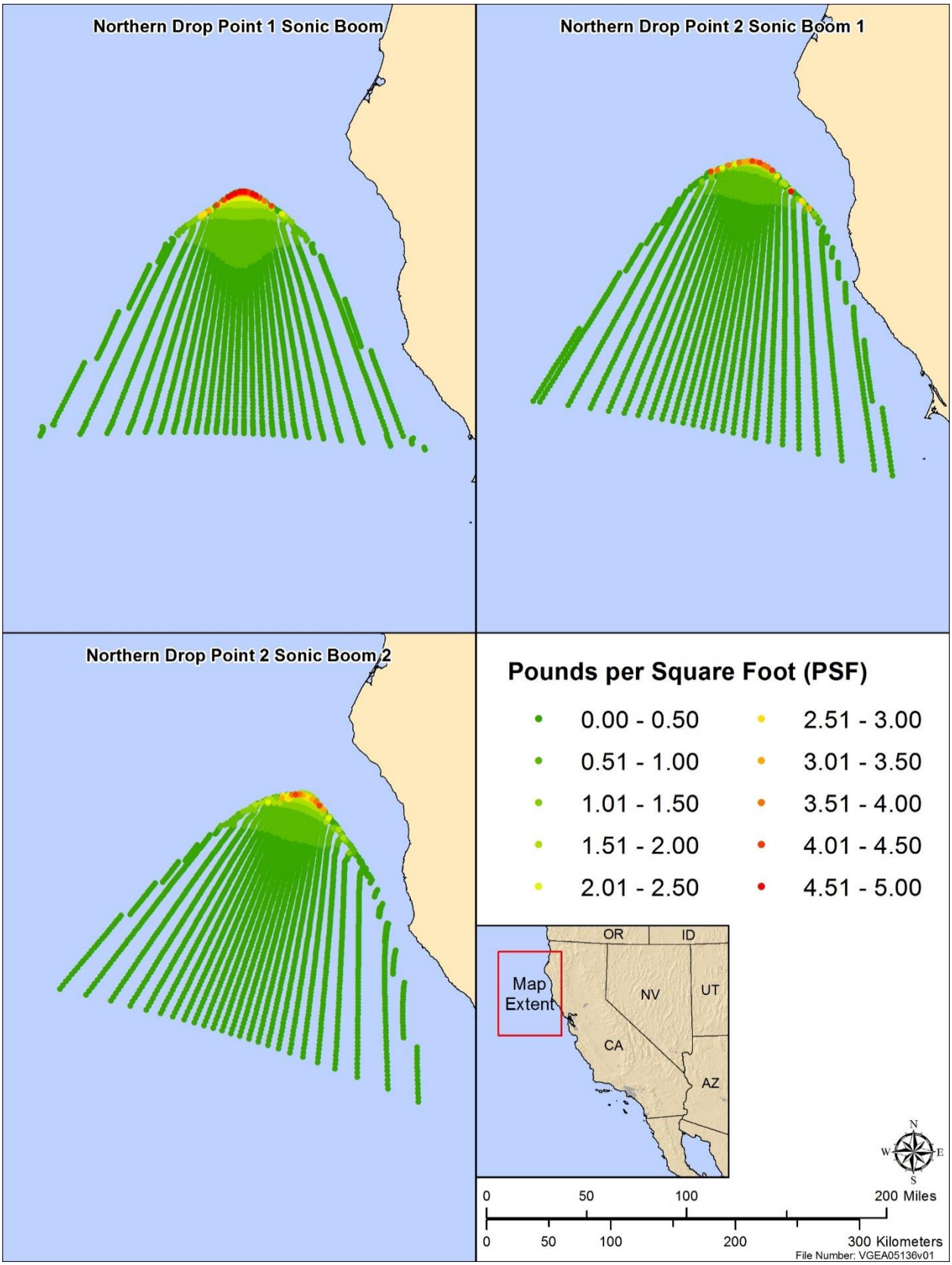

Figure 4-1: Examples of the Sonic Boom Impacts from the Northern Drop Points

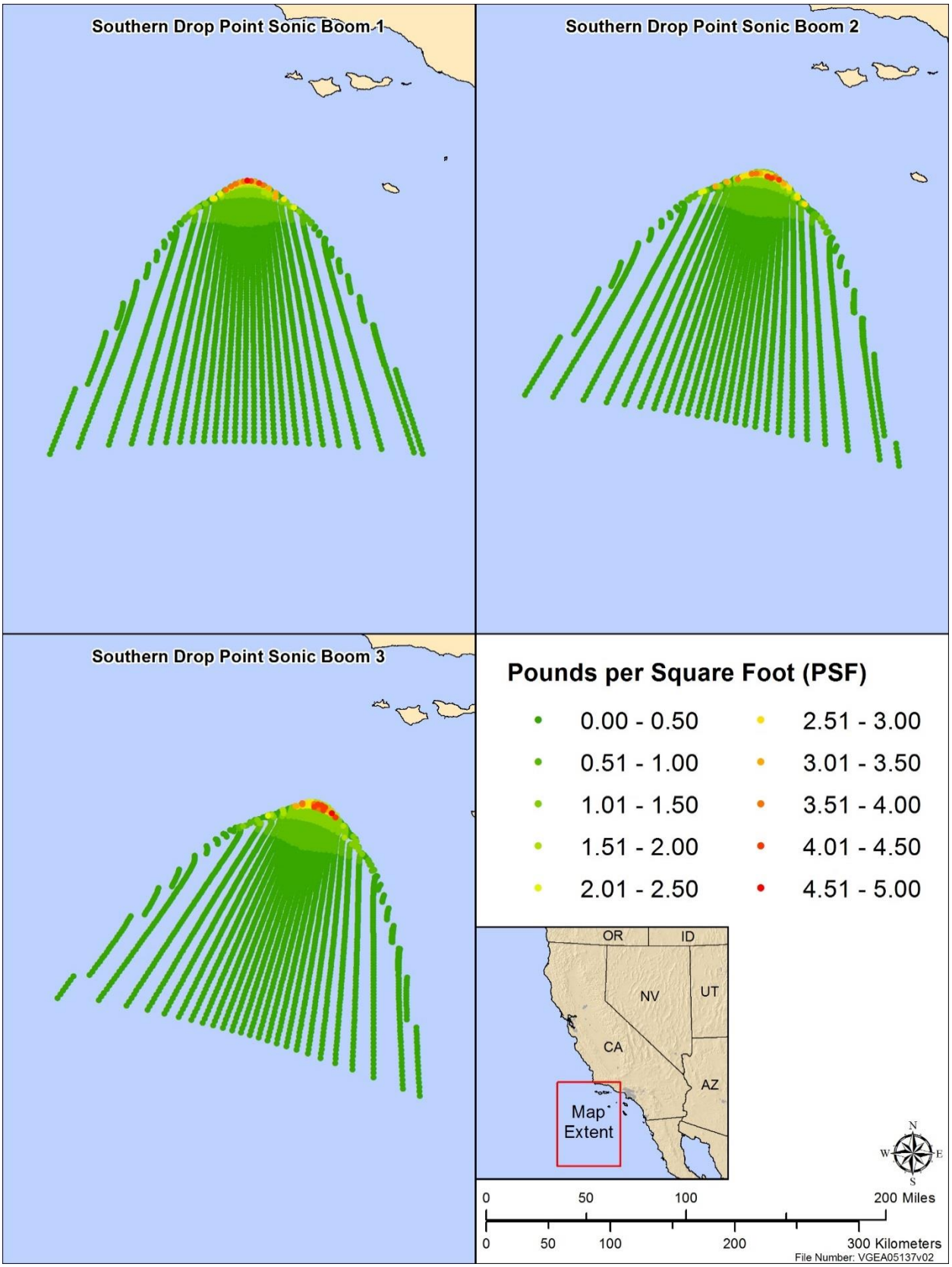

Figure 4-2: Examples of the Sonic Boom Impacts from the Southern Drop Points

4.3.2.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch license for the operation of LauncherOne from the Mojave Air and Space Port. The Mojave Air and Space Port would continue its existing operations, which includes noise generation from air and space port operations. Under the No Action Alternative, there would be no new noise-related impacts.

SECTION 4.4 WATER RESOURCES (INCLUDING WETLANDS, FLOODPLAINS, SURFACE WATERS, GROUNDWATER, AND WILD AND SCENIC RIVERS)

This section describes the potential effects of the Proposed Action and the No Action Alternative related to water resources.

4.4.1 SIGNIFICANCE THRESHOLD

As stated in Chapter 3, only waters of the open ocean would have the potential to be impacted by the Proposed Action. There are no surface waters at the Mojave Air and Space Port. Per FAA Order 1050.1F, significant impacts to surface waters would occur if the action would:

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

4.4.2 ENVIRONMENTAL CONSEQUENCES

4.4.2.1 Proposed Action

4.4.2.1.1 Pre-Flight and Post-Flight Activities

The Proposed Action does not involve construction activities that would potentially introduce non-point source pollution into drainage channels east and southwest of the runways at the Mojave Air and Space Port. Any accidental spills associated with pre-flight and post-flight activities would be addressed by emergency response procedures.

4.4.2.1.2 Carrier Vehicle

Operation of the carrier vehicle would not introduce non-point source pollution into drainage channels east and southwest of the runways.

4.4.2.1.3 Rocket Debris

Both stages of the rocket are expendable. First stage debris would fall into the Pacific Ocean within the Northern and Southern Drop Point ROIs, and second stage debris would expend into Earth's orbit. First stage debris, which is comprised of inert materials which are neither chemically or biologically reactive, is anticipated to sink relatively quickly. Accordingly, it would not affect water quality in the short term (while the debris is floating or descending through the water column) or in the long term (when the debris has settled into benthic habitats).

The propellant type used by LauncherOne is a mixture of a kerosene-based fuel (known as RP-1) and LOX. In the event of a launch failure, surface water quality in the ocean may be temporarily affected by the release of unconsumed RP-1. RP-1 is a Type 1 "Very Light Oil," which is characterized as being highly volatile and having low viscosity and low specific gravity (U.S. Fish and Wildlife Service 1998b). Due to its high volatility, RP-1 evaporates quickly when exposed to the air, and would completely dissipate within

1–2 days after a spill in the water. Cleanup following a spill of very light oil is usually not necessary or not possible, particularly with such a small quantity of oil that would enter the ocean in the event of an unsuccessful launch (U.S. Fish and Wildlife Service 1998b). Therefore, no attempt would be made to boom nor recover RP-1 fuel from the ocean. Although it would require 1–2 days for the RP-1 to completely dissipate, most of its mass would evaporate within the first few minutes. Swells and wave action would enable the remaining RP-1 to be volatized rapidly because of increased agitation and dissipation. Therefore, the Proposed Action would have insignificant impacts on water resources.

4.4.2.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch license for the operation of LauncherOne from the Mojave Air and Space Port. The Mojave Air and Space Port would continue its existing operations. Under the No Action Alternative, there would be no new impacts to water resources.

SECTION 4.5 BIOLOGICAL RESOURCES (INCLUDING FISH, WILDLIFE, AND PLANTS)

This section describes the potential effects of the Proposed Action and the No Action Alternative on biological resources as they relate to takeoff and landing activities within all three ROIs.

The potential impacts on biological resources from the Proposed Action are evaluated based on the extent to which the impacts could substantially degrade habitat, cause a special status species to drop below self-sustaining levels, or significantly reduce a population or restrict the range of an endangered, threatened, or rare species. For ESA-listed species, this is based on guidance contained in the *Endangered Species Consultation Handbook* (U.S. Fish and Wildlife Service 1998a), which uses the following effect determinations:

- "No effect" is the appropriate conclusion when a species will not be affected, either because the species will not be present or because the project does not have any elements with the potential to affect the species. "No effect" does not include a small effect or an effect that is unlikely to occur.
- "May affect, not likely to adversely affect" means that all effects are beneficial, insignificant, or discountable. Beneficial effects have concurrent positive effects without any adverse effects to the species or habitat (i.e., there cannot be balancing, wherein the benefits of the project would be expected to outweigh the adverse effects). Insignificant effects relate to the magnitude or extent of the impact (i.e., they must be small and would not rise to the level of a take of a species). Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.
- "May affect, likely to adversely affect" means that all adverse effects cannot be avoided. A combination of beneficial and adverse effects is still "likely to adversely affect," even if the net effect is neutral or positive. Adverse effects do not qualify as discountable simply because it is not certain they will occur. The probability of occurrence must be extremely small to achieve discountability. Likewise, adverse effects do not meet the definition of insignificant because they are less than major. If the adverse effect can be detected in any way or if it can be meaningfully articulated in a discussion of the results, then it is not insignificant; it is likely to adversely affect.

For marine mammals protected under the MMPA, impacts are determined based on the extent to which the Proposed Action has the potential to result in harassment of a marine mammal or marine mammal stock in the wild. "Level A Harassment" is the result of an activity that has the potential to injure or kill a marine mammal or marine mammal stock in the wild. "Level B Harassment" would result if an activity has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild. Depending on the level of harassment, and the length of the planned activities, either an Incidental Harassment Authorization (IHA) or a Letter of Authorization (LOA) issued by NMFS would be required to implement an action that has the potential to cause harassment of a marine mammal.

4.5.1 Significance Threshold

Per FAA Order 1050.1F, a significant impact on biological resources would occur if the USFWS or the NMFS determines that the action would be likely to jeopardize the continued existence of a federally listed threatened or endangered species, or would result in the destruction or adverse modification of federally designated critical habitat. The FAA has not established a significance threshold for unlisted species. However, FAA Order 1050.1F includes "factors to consider" when evaluating the context and intensity of potential environmental impacts to unlisted species, including the following:

- A long-term or permanent loss of unlisted plant or wildlife species, i.e., extirpation of the species from a large project area (e.g., a new commercial service airport);
- 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; and
- 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.

4.5.2 Environmental Consequences

4.5.2.1 Proposed Action

4.5.2.1.1 Pre-Flight and Post-Flight Activities

All hazardous pre- and post-flight ground activities would take place in a specified location that has established appropriate safety clear zones in accordance with the Mojave Air and Space Port's launch site operator license; therefore, vegetation and wildlife would not be impacted by pre-flight ground activities. During a nominal launch, all of the oxidizer would be consumed during rocket powered flight and no hazardous post-flight ground activities would be required to return the carrier vehicle to safe conditions. For aborted flights, the oxidizer would be released before landing, while the fuel would remain onboard and would be returned to the ground with the carrier vehicle. In the event the oxidizer is not completely consumed or released, the carrier vehicle and mated rocket would be moved to an area with an established safety clear zone, and the remaining oxidizer and fuel would be removed in accordance with the Mojave Air and Space Port's Explosive Site Plan.

It is unlikely that the increase in pre-flight and post-flight activities resulting from the Proposed Action would substantially contribute to the overall existing sound environment at the Mojave Air and Space Port. Wildlife found in the area are likely to be acclimated to the existing high level of noise disturbance.

Accordingly, pre-flight and post-flight activities are not expected to cause significant impacts to biological resources.

4.5.2.1.2 Carrier Vehicle – Mojave Air and Space Port ROI

Non-listed and Special Status Terrestrial Species

The Proposed Action would include a maximum of 115 launches between 2017 and 2021 (an annual maximum of 40 flights). Based on the 2012 Kern County Airport Land Use Compatibility Plan, the Mojave Air and Space Port currently supports approximately 17,575 flights annually, of which approximately 1,283 are military jet activities, which generate similar levels of sound during takeoff and landing as the carrier vehicle. The Mojave community and the surrounding area currently experiences high noise levels (up to 90 dBA) (Kern County 2012) from military jet takeoffs and landings and stationary rocket tests. The Proposed Action would result in an increase on average of one comparable takeoff and landing every 9 days, for an overall increase of less than 2 percent if compared to current military jet activities. Because of the volume of air traffic that utilizes this area already, it is unlikely that this increase would significantly contribute to the overall sound environment. Wildlife found in the area are likely to be acclimated to this level of noise disturbance; therefore, adding several minutes every other week of aircraft engine noise levels is not expected to cause significant impacts to wildlife. None of the "factors to consider" (listed above) when assessing the significance of impacts to unlisted species would occur. The Proposed Action would have "no effect" on the federally listed species potentially located within the Mojave Air and Space Port ROI: desert tortoise and California condor. Under section 7 of the Endangered Species Act, consultation with the U.S. Fish and Wildlife Service and/or National Marine Fisheries Service is not required when the action agency makes a "no effect" determination.

There is the potential for the carrier vehicle to strike wildlife on either takeoff or landing. The launch operator would comply with the requirements of the Mojave Air and Space Port's Wildlife Hazard Management Plan to minimize the potential for striking wildlife. A less than 2 percent increase of comparable aircraft flights would not cause a significant increase in Bird Aircraft Strike Hazard, which are hazards that could cause injury or mortality to bird species protected under the MTBA. The Proposed Action would not add any bird attractants to the Mojave Air and Space Port. In summary, operation of the carrier vehicle would have insignificant effects on biological resources.

4.5.2.1.3 Rocket and Rocket Debris – Northern and Southern Drop Point ROIs

Marine Resources

As described in Section 4.3.2.1.3, all rocket flights would create a sonic boom up to 5.0 psf that would impact the Pacific Ocean (see Figure 4-1 and Figure 4-2). Although a sonic boom up to 5.0 psf will impact the ocean's surface, the overall area of impact of a boom greater than 1.0 psf would be relatively small.

Both stages of the rocket are expendable. First stage debris would fall into the Pacific Ocean within the Northern and Southern Drop Point ROIs (Figure 3-1), and second stage debris would expend into Earth's orbit. As stated in Section 4.4, the first stage debris is comprised of inert materials which are neither chemically or biologically reactive and is anticipated to sink relatively quickly. The first stage is 72 inches in diameter, approximately 32.5 ft long, and is a made up of a composite structure.

Cetaceans and Pinnipeds

Cetaceans spend their entire lives in the water and most of their time (greater than 90 percent for most species) entirely submerged below the surface. Additionally, when at the surface, cetacean bodies are almost entirely below the water's surface, with only the blowhole exposed to allow breathing. This

minimizes in-air noise exposure, both natural and anthropogenic, essentially 100 percent of the time because their ears are nearly always below the water's surface. Similarly, when pinnipeds are at sea, they spend relatively little time at the water surface and are unlikely to be exposed to a brief in-air acoustic impact. Exceptionally little energy from in-air noise is transmitted into water (Godin 2008), and NMFS does not currently believe in-air noise is likely to result in behavioral harassment[6] of animals at sea (Carduner 2015). As a result, in-air noise caused by sonic boom would not have an effect on cetacean or pinniped species, and it is not necessary for L1 to seek MMPA authorization for incidental take of cetaceans and pinnipeds at sea as a result of in-air noise.

The areas that would be impacted by falling debris (the three potential splashdown regions shown in Figure 3-1) are approximately 9,460 square miles each. The debris would consist of the first stage of the rocket, which would impact the water surface (falling at any angle to impact the ocean with a length between 32.5 ft [in the case of a horizontal impact] and 72 inches [in the case of a vertical impact, where the impact area would be the first stage's diameter]). Other studies on potential strike of over 1,000 military expended materials (e.g., small, medium, and large-caliber projectiles, missiles, bombs, torpedoes, sonobuoys) annually from Navy training and testing activities in similar areas of Southern California waters concluded there would be less than one direct impact annually of any species of marine mammal under the worst case scenario in the Southern California area (U.S. Department of the Navy, 2013). Further, the potential splashdown areas are offshore where density of marine species decreases compared to coastal environments and upwelling areas. Given the small area of potential impact on the water surface (as compared to Navy training areas), and the anticipated lower densities of marine mammals, the likelihood of the first stage striking a marine mammal is very low.

The first stage is anticipated to sink quickly and is composed of inert materials that would not affect water quality or bottom substrate potentially used by marine mammals. The first stage is not so dense or large that benthic habitat would be degraded. Also, the area that would be impacted by a piece or pieces of sinking debris would only be as large as the object (32.5 ft long). As a result, the first stage would not have an effect on cetacean or pinniped species and it is not necessary for L1 to seek MMPA authorization for incidental take of cetaceans and pinnipeds at sea as a result of the first stage falling into the ocean.

Sea Turtles

A sonic boom would potentially affect sea turtle behavior if resting at the surface. The northern and southern sonic boom regions do not overlap land, and sea turtles spend very little time at the surface of the water. While all five sea turtle species in Table 3-4 have the potential to occur within the northern and southern sonic boom regions, four of these species (green, hawksbill, loggerhead, and olive Ridley) are unlikely or very rare within the Northern and Southern Drop Point ROIs. Additionally, while at-sea, during migration, foraging, and inter-nesting periods (the period of time between a successful nest and the next nesting attempt as sea turtles of all species lay several clutches of eggs during a nesting season), sea turtles spend a substantial amount of their time submerged (Southwood et al. 1999; James et al. 2006; Rice and Balazs 2008; Dodge et al. 2014; Hill 2014). Therefore, it would be extremely unlikely that any individuals of these species would be present within the sonic boom footprint and at the surface of the water during the brief moment (less than 1 second) of a sonic boom impact.

[6] The MMPA defines Level B harassment as any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to migration, breathing, nursing, breeding, feeding, or sheltering.

The leatherback sea turtle, which is able to tolerate colder water temperatures, forages in the area offshore of central and northern California. While able to tolerate the colder waters off northern California, this species is still uncommon in the northern and southern sonic boom regions, with a density estimate of approximately 0.003 individuals per square km (km^2) within the area that may be impacted by a sonic boom greater than 1.0 psf (U.S. Department of the Navy 2014). NMFS does not currently believe that in-air noise is likely to result in behavioral harassment to animals at sea (Carduner 2015). Leatherback sea turtles also spend the majority of their time at sea submerged (Southwood et al. 1999; James et al. 2006; Dodge et al. 2014). Therefore, it would be very unlikely that any individuals of this species would be at the surface of the water in the impact area during a brief sonic boom impact.

In summary, in-air noise caused by a sonic boom would have "no effect" on the five ESA-listed sea turtle species that have potential to occur within the Northern and Southern Drop Point ROIs: green sea turtle, hawksbill sea turtle, loggerhead sea turtle, olive Ridley sea turtle, and leatherback sea turtle.

The areas that would be impacted by falling debris (the three potential splashdown regions shown in Figure 3-1) are approximately 9,460 square miles each. Only one piece—the first stage of the rocket—would impact the water surface (falling at any angle to impact the ocean with a length between 32.5 ft [in the case of a horizontal impact] and 72 inches [in the case of a vertical impact, where the impact area would be the first stage's diameter]). Other studies on potential strike over 1,000 military expended materials (e.g., small, medium, and large-caliber projectiles, missiles, bombs, torpedoes, sonobuoys) annually from Navy training and testing activities in similar areas of Southern California waters concluded that there would be less than one direct impact annually of any species of sea turtle under the worst case scenario in the Southern California area (U.S. Department of the Navy, 2013). Further, the potential splashdown areas are offshore where density of marine species decreases compared to coastal environments and upwelling areas. Given the small area of potential impact on the water surface (as compared to Navy training areas), and the anticipated lower densities of sea turtles, the likelihood of the first stage striking a sea turtle is very low.

The first stage is anticipated to sink quickly and is composed of inert materials that would not affect water quality or bottom substrate potentially used by sea turtles. The first stage is not so dense or large that benthic habitat would be degraded. Also, the area that would be impacted by a piece or pieces of sinking debris is only 32.5 ft. As a result, the rocket debris caused by the first stage would not have an effect on sea turtles.

Seabirds

The potential impacts from a sonic boom on seabirds could range from behavioral disruption to injury, depending on the energy level of the boom that an individual may be exposed to. Behavioral reactions to noise can be dependent on relevance and association to other stimuli. A behavioral reaction may occur when an animal detects a noise above background levels, or possibly when an animal recognizes a biologically relevant sound. An animal's past experience with the sound-producing activity or similar acoustic stimuli can affect its choice of behavior. Competing and reinforcing stimuli may also affect its decision. Other stimuli present in the environment can influence an animal's behavior decision. These stimuli can be other acoustic stimuli not directly related to the sound-producing activity; visual, olfactory, or tactile stimuli; conspecifics or predators in the area; or the strong drive to engage in a natural behavior.

Competing stimuli tend to suppress behavioral reactions. For example, an animal involved in mating or foraging may not react with the same degree of severity to acoustic stimuli as it may have otherwise.

Reinforcing stimuli reinforce the behavioral reaction caused by acoustic stimuli. For example, awareness of a predator in the area coupled with the acoustic stimuli may elicit a stronger reaction than the acoustic stimuli itself otherwise would have. Since the rocket would be at significant altitude when a sonic boom impacts the earth's surface, there would be no visual stimuli coupled with the sonic boom. This would decrease the likelihood and severity of a behavioral response.

All launch trajectories are expected to produce sonic booms that would impact areas offshore of California (see Figure 4-1 and Figure 4-2). Booms greater than 1.0 psf created by trajectories at the northern drop points would impact within an area approximately 17–20 mi (27–113 km), with a concentration of sonic booms between 2.0 and 5.0 psf over a relatively small area 30–50 mi (48–80 km) offshore. For the southern drop point, sonic booms are expected to impact between 80 and 200 mi (129 and 322 km) from the mainland or between 40 and 80 mi (64 and 129 km) from the nearest islands. Seabirds (e.g., short-tailed albatross) are found at these distances offshore, but they occur at very low densities and are only very rarely observed. It would be highly unlikely that any seabirds would be present within the impact area during the brief moment (less than 1 second) of a sonic boom impact. Therefore, in-air noise caused by a sonic boom would not affect seabirds.

Since the area that would be impacted by falling debris is very small (at maximum 32.5 ft), the likelihood of a direct impact to seabirds is very low. Also, the first stage is anticipated to sink quickly and is composed of inert materials that would not affect water quality or surface waters potentially used by seabirds. Also, the area that would be impacted by a piece or pieces of sinking debris is only 32.5 ft. As a result, the rocket debris caused by the first stage would not have an effect on seabirds.

Sensitive Marine Habitats

A sonic boom with overpressures ranging from 0.1–0.3 psf would impact both the GFNMS and the CBNMS as a result of all three northern trajectories. This low-energy impact, roughly equivalent to a thunder clap, would be infrequent and brief (less than 1 second) and is not expected to result in significant degradation of habitats. Additionally, these sonic booms would not impact land; therefore there are no potential impacts to pinniped haul outs or bird nesting areas. As a result, in-air noise caused by sonic boom would not have a significant effect on National Marine Sanctuaries.

Since the area that would be impacted by falling debris is very small (at maximum 32.5 ft), the likelihood of adverse effects to sensitive marine habitats is very low. The first stage is anticipated to sink quickly and is composed of inert materials that would not affect water quality or bottom substrate of sensitive marine habitats. The first stage is not so dense or large that benthic habitat would be degraded. Also, the area that would be impacted by a piece or pieces of sinking debris is only 32.5 ft. As a result, the rocket debris caused by the first stage would not have an effect on sensitive marine habitats.

4.5.2.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch license for the operation of LauncherOne from the Mojave Air and Space Port. The Mojave Air and Space Port would continue its existing operations. Under the No Action Alternative, there would be no new biological resources-related impacts.

SECTION 4.6 HAZARDOUS MATERIALS, SOLID WASTE, AND POLLUTION PREVENTION

This section describes the potential effects of the Proposed Action and the No Action Alternative related to hazardous materials, solid waste, and pollution prevention in all three ROIs.

4.6.1 Significance Threshold

The FAA has not established a significance threshold for hazardous materials, solid waste, or pollution prevention. However, FAA Order 1050.1F includes factors to consider when evaluating the context and intensity of potential environmental impacts related to hazardous materials, solid waste, or pollution prevention. The factors to consider are 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 using a different method of collection or disposal and/or exceeding local capacity; or
- Adversely affect human health and the environment.

4.6.2 Environmental Consequences

4.6.2.1 Proposed Action

Under the Proposed Action, the amount of hazardous material, hazardous waste, and solid waste generated at the Mojave Air and Space Port would increase. Hazardous materials that would be used to support pre-flight and post-flight activities associated with the Proposed Action are similar to materials already handled at the Mojave Air and Space Port. Procedures are currently in place to accommodate additional fuel and other launch-related and maintenance-related hazardous materials, including paint, oils, lubricants, and solvents, and the Proposed Action would be conducted according to those procedures.

All hazardous pre- and post-flight activities, including propellant loading and unloading (if necessary), would take place in a specified location which has established appropriate safety clear zones in accordance with the Mojave Air and Space Port's launch site operator license. All fuels and other hazardous materials would be stored and used in compliance with the regulations applicable to their storage and use and already in place at Mojave Air and Space Port. In the event of a spill, East Kern Airport District would respond. Spill response kits, which include barrier pads, are located throughout the fuel storage tank farm. Because activities associated with the Proposed Action would comply with all relevant Federal, State, and local regulations related to hazardous materials and hazardous waste, no significant impacts are anticipated.

4.6.2.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a per mission launch license for the operation of LauncherOne from the Mojave Air and Space Port. The Mojave Air and Space Port would continue its existing operations. Under the No Action Alternative, there would be no new impacts related to hazardous materials, solid waste, or pollution prevention.

SECTION 4.7 Historical, Architectural, Archeological, and Cultural Resources

This section describes the potential effects of the Proposed Action and the No Action Alternative related to historical, architectural, archeological, and cultural resources.

4.7.1 Significance Threshold

The FAA has not established a significance threshold for historical, architectural, archeological, and cultural resources. However, FAA Order 1050.1F identifies a factor to consider when evaluating impacts, including, but not limited to, situations in which the Proposed Action would result in a "finding of adverse effect" through the Section 106 (National Historic Preservation Act) process.

4.7.2 Environmental Consequences

4.7.2.1 Proposed Action

As stated in Section 3.7, there are no recorded cultural resources or sites listed or eligible to be listed on the National Register of Historic Places at the Mojave Air and Space Port or in the immediate vicinity. The Proposed Action, known as an undertaking per Section 106 of NHPA, would not require any construction at, or modification of, the Mojave Air and Space Port. The Proposed Action would not result in any ground-disturbing activities, and there are no historic or tribal sites of significance in the ROIs. Because the rocket is air-launched over the open ocean, launch operations do not have the potential to affect historical, architectural, archaeological, and cultural resources. Therefore, the Proposed Action does not have the potential to affect architectural, archaeological, or other cultural resources, and the FAA has no further obligations under Section 106.

4.7.2.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch license for the operation of LauncherOne from the Mojave Air and Space Port. The Mojave Air and Space Port would continue its existing operations, which do not affect historical, architectural, archeological, and cultural resources. Under the No Action Alternative, there would be no impacts related to historical, architectural, archaeological, or cultural resources.

SECTION 4.8 Land Use

This section describes the potential effects of the Proposed Action and the No Action Alternative related to land use.

4.8.1 Significance Threshold

The FAA has not established a significance threshold for land use and there are no specific independent factors to consider. However, the determination of significant land use impacts is normally dependent on the significance of other impacts.

4.8.2 Environmental Consequences

4.8.2.1 Proposed Action

The Proposed Action would not result in any new types of ground operations and would not change the existing or planned land use of the Mojave Air and Space Port. The carrier vehicle would take off from existing infrastructure and release of the rocket would occur over the open ocean. Launch operations at the Mojave Air and Space Port would conform to the designated land uses. Therefore, there would be no land use impacts from the Proposed Action.

4.8.2.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch license for the operation of LauncherOne from the Mojave Air and Space Port. The Mojave Air and Space Port would continue its

existing operations. Therefore, under the No Action Alternative, there would be no land use-related impacts.

SECTION 4.9 DEPARTMENT OF TRANSPORTATION ACT, SECTION 4(F)

This section describes the potential effects of the Proposed Action and the No Action Alternative related to Section 4(f) properties.

4.9.1 SIGNIFICANCE THRESHOLD

Per FAA Order 1050.1F, a significant impact on Section 4(f) resources would occur if the action involves more than a minimal physical use[7] 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. Resources that are protected by Section 4(f) are publicly owned land from a public park, recreation area, or wildlife and waterfowl refuge of national, state, or local significance; and publicly or privately owned land from an historic site.

4.9.2 ENVIRONMENTAL CONSEQUENCES

4.9.2.1 Proposed Action

The Proposed Action would not require a transportation use of a property protected by Section 4(f), and therefore Section 4(f) does not apply. No construction is associated with the Proposed Action, so there is no physical use, such as permanent incorporation of land into a transportation facility. The Proposed Action would not require a temporary occupancy of a 4(f) resource, such as temporary easement or right of entry. The Proposed Action would not require a constructive use of a 4(f) property because there would be no impacts to a nearby 4(f) property. Additionally, no impacts to 4(f) properties would be so severe that the activities, features, or attributes are substantially impaired. For example, there are no significant noise impacts from the Proposed Action on a 4(f) property. Ignition of the rocket's engines would not occur until the rocket is released over the open ocean at an altitude of approximately 35,000 to 40,000 ft. This would take place well away from Section 4(f) resources – approximately 15 mi and 70 mi off of the California coastline for the northern and southern drop points, respectively.

As stated in Section 3.9, the carrier vehicle's overflight area includes the Los Padres National Forest and the Channel Islands National Park. Because the vehicle would be flying at an altitude above 30,000 ft MSL, it would not result in any impacts to the properties (i.e., there would be no physical or constructive use that would substantially impair a Section 4(f) property).

The Proposed Action would not result in a physical use, temporary use, or constructive use that would substantially impair Section 4(f) properties, and thus would not result in significant impacts.

4.9.2.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch license for the operation of LauncherOne from the Mojave Air and Space Port. The Mojave Air and Space Port would continue its existing operations, which do not affect 4(f) properties. Under the No Action Alternative, there would be no impacts on Section 4(f) properties.

[7] A "minimal physical use" is not the same as a *de minimis* impact determination established in Section 6009 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users.

SECTION 4.10 SOCIOECONOMICS, ENVIRONMENTAL JUSTICE, AND CHILDREN'S ENVIRONMENTAL HEALTH AND SAFETY RISKS

This section describes the potential effects of the Proposed Action and the No Action Alternative related to socioeconomics, environmental justice, and children's environmental health and safety risks.

4.10.1 SIGNIFICANCE THRESHOLD

The FAA has not established significance thresholds for socioeconomics, environmental justice, or children's environmental health and safety risks. However, FAA Order 1050.1F identifies factors to consider when evaluating 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 factor to consider is whether the Proposed Action would have the potential to lead to a disproportionately high and adverse impact to 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 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 Proposed Action would have the potential to lead to a disproportionate health and safety risk to children.

4.10.2 ENVIRONMENTAL CONSEQUENCES

4.10.2.1 Proposed Action

The Proposed Action does not involve construction or development; no new operations would occur on the ground; only existing personnel would be used to conduct launch activities; and the Proposed Action would not induce substantial population growth nor would it add or eliminate jobs at the Mojave Air and Space Port or in the nearby communities. Carrier vehicle takeoffs and landings would constitute approximately 0.2 percent of the daily operations at the Mojave Air and Space Port over a 12 month period and would be similar to existing operations (AirNav, 2016). Therefore, there would be no impacts that disproportionately adversely affect environmental justice populations. Additionally, no component of the Proposed Action would result in a disproportionate health and safety risk to children. Therefore, there would be no effects related to socioeconomics, environmental justice, or children's environmental health and safety risks.

4.10.2.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch license for the operation of LauncherOne from the Mojave Air and Space Port. The Mojave Air and Space Port would continue its existing operations. Under the No Action Alternative, there would be no new impacts related to socioeconomics, environmental justice, or children's environmental health and safety risks.

SECTION 4.11 VISUAL EFFECTS (INCLUDING LIGHT EMISSIONS)

4.11.1 SIGNIFICANCE THRESHOLD

The FAA has not established a significance threshold for visual effects. However, FAA Order 1050.1F identifies factors to consider when evaluating impacts related to visual effects. The factors to consider include but are not limited to:

- Light Emissions Effects
    - The degree to which the action would have the potential to create annoyance or interfere with normal activities from light emissions; and
    - The degree to which the action would have the potential to affect the visual character of the area due to the light emissions, including the importance, uniqueness, and aesthetic value of the affected visual resources.
- Visual Resources and Visual Character Effects
    - The degree to which the action would have the potential to affect the nature of the visual character of the area, including the importance, uniqueness, and aesthetic value of the affected visual resources;
    - The degree to which the action would have the potential to contrast with the visual resources and/or visual character in the study area; and
    - The degree to which the action would have the potential to block or obstruct the views of visual resources, including whether these resources would still be viewable from other locations.

4.11.2 ENVIRONMENTAL CONSEQUENCES

4.11.2.1 Proposed Action

The Mojave Air and Space Port already has existing operations that include airplanes in flight, advanced concept and experimental aircraft, and launch vehicles. The pre-flight and post-flight activities involved with the Proposed Action would not differ visually from those activities already occurring at the Mojave Air and Space Port. Operation of the carrier vehicle with mated rocket would not affect visual resources in any of the ROIs, as the contrails left by the carrier vehicle and rocket would be similar in visual impact to the contrails from existing operations at the Mojave Air and Space Port.

The Proposed Action would not substantially degrade the existing visual character or quality of the site and its surroundings and would have no adverse effect on a scenic vista or scenic resources. No new source of substantial light or glare would be created as a result of the Proposed Action to adversely affect day or nighttime views in the area. Therefore, the Proposed Action would not have significant visual effects.

4.11.2.2 No Action Alternative

Under the No Action Alternative, the FAA would not issue a launch license for the operation of LauncherOne from the Mojave Air and Space Port. The Mojave Air and Space Port would continue its existing operations. Under the No Action Alternative, there would be no new impacts related to visual effects.

CHAPTER 5 CUMULATIVE IMPACTS

Cumulative impacts are defined in the CEQ regulations (40 CFR §1508.7) as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions." The FAA analyzed the potential cumulative impacts in accordance with CEQ regulations and FAA Order 1050.1F.

For this EA, spatial and temporal boundaries were delineated to determine the area and projects the cumulative analysis would address. For this cumulative analysis, the spatial boundary is Kern County. The temporal boundary includes past actions that have occurred within the last three years, and reasonably foreseeable future actions include those that are planned to occur within the next five years. Because the carrier vehicle with mated rocket would be above 30,000 ft for most of its operations outside of Kern County, past, present, or reasonably foreseeable future projects in the areas of overflight and southern and northern drop points were not included in the cumulative impacts analysis. Past, present, and reasonably foreseeable actions at the Mojave Air and Space Port and the surrounding area include current and future aircraft operations at the airport, rocket launches, rocket engine testing, development in the local area related to activities at the Mojave Air and Space Port, and any other development that may occur as a result of economic growth in the area.

The projects identified in the following sections include those that had or have the potential to affect the environmental impact categories that are analyzed in this EA.

SECTION 5.1 PAST ACTIONS

Past projects and actions in Kern County are primarily tied to agriculture; renewable energy such as solar and wind; and space development.

Actions recently completed in or around the Mojave Air and Space Port and Kern County include:

- Multiple Wind and Solar Energy Projects
  - Desert Solar Projects by enXco
  - Kern Solar Ranch Project by Kern Solar, LLC
  - Monte Vista Solar Array by First Solar, Inc.
  - Nautilus Solar Energy Photovoltaic Project
  - Oro Verde Solar Project by Sun Edison, LLC
  - Twissleman Solar Project by SunEdison
  - Willow Springs Solar Array by First Solar, Inc.
  - High Desert Solar by Element Power
- Community Recycling and Resource Recovery, Inc. Project by Community Recycling and Resource Recovery, Inc.
- Grapevine Specific and Community Plan by Tejon Grapevine, LLC
- Indian Wells Valley Land Management Plan
- San Emidio Quarry Expansion Project
- Solari Sand and Gravel Project by Granite Construction Company

SECTION 5.2 PRESENT ACTIONS

Present actions in Kern County support economic development as well as agriculture, renewable energy such as solar and wind, oil and gas development, and space exploration. An aircraft designed to carry rockets high into the atmosphere to more easily put them into orbit, called the Stratolaunch, is currently being built by Vulcan Aerospace in a hanger in Mojave, CA (Wilhelm 2015). It will be a large twin-hulled plane made from carbon composites that will help people more quickly and cheaply get into orbit (Wilhelm 2015). In the future, the Vulcan Aerospace company hopes to use the Stratolaunch as a tool for deep space exploration (Wilhelm 2015).

Present actions in Kern County include:

- Operation of the Mojave Air and Space Port
- Valentine Solar Project by EDF Renewable Development Inc.
- Windhub Solar Project by Windhub Solar A, LLC and Windhub Solar B, LLC

SECTION 5.3 REASONABLY FORESEEABLE FUTURE ACTIONS

Future actions in Kern County include agricultural, renewable energy, oil and gas development, housing development, and air and space travel developments.

The following reasonably foreseeable future actions are planned in Kern County:

- Kern County Oil and Gas Permitting
- Zoning Ordinance Amendments
- Final Environmental Impact Report for Revisions to the Kern County Zoning Ordinance – 2015 C, focused on Oil and Gas Local Permitting
- Kern County 2015-2023 Housing Element Update
- The RENEWBIZ Grant Program

SECTION 5.4 ENVIRONMENTAL CONSEQUENCES

This EA uses information presented in Sections 5.0, 5.1, and 5.2 to determine potential cumulative impacts. The Proposed Action's impacts were analyzed for their potential to result in cumulative impacts when added to past, present, and reasonably foreseeable future actions.

As discussed in Chapter 4, implementation of the Proposed Action would result in no impact to the following impact categories: historical, architectural, archaeological, or cultural resources; land use; Department of Transportation Act, Section 4(f); socioeconomics, environmental justice, and children's environmental health and safety; and visual effects. Therefore, when combined with past, present, and reasonably foreseeable projects, the Proposed Action would not result in cumulative impacts to these impact categories.

Implementation of the Proposed Action would result in less than significant impacts related to air quality; climate; noise and noise-compatible land use; water resources; biological resources; and hazardous materials, solid waste, and pollution prevention. The potential cumulative impacts to those environmental impact categories are described in the following paragraphs.

Air quality: The past, present, and reasonably foreseeable future actions could result in increases or decreases to emissions as there are renewable energy alternatives being constructed, as well as oil and gas permitting, and other construction activities that have occurred, are occurring, and will occur.

The Proposed Action would have no significant impact on regional air quality. Launch activities occur at altitudes above 30,000 ft MSL. Pollutants that are released above 3,000 ft AGL generally do not mix with ground level emissions and do not have an effect on ground level concentrations in the local area. Additionally, per FAA-AEE-00-01, DTS-34, these activities are exempt from analysis for local and regional air quality. When combined with past, present, and reasonably foreseeable projects, the Proposed Action would not result in significant cumulative impacts to air quality.

Climate: The past, present, and reasonably foreseeable future actions could result in benefits or detriments to climate as there are renewable energy alternatives being constructed, as well as oil and gas permitting, and other construction activities that have occurred, are occurring, and will occur.

The Proposed Action's projected increase in GHG emissions is discussed in the context of national and global emissions from all sources. Each flight would produce a maximum of 10.34 MT of CO_2e. The total GHG emissions for successful and scrubbed flights (160 total) while within EKCAPD is a maximum of 1,654 MT annually, which is less than the EKCAPCD's significance threshold of 25,000 MT of CO_2e per year. Therefore, as the GHG emissions are less than the EKCAPCD's significance threshold, the Proposed Action would not result in significant cumulative impacts related to climate.

Noise and noise-compatible land use: The past, present, and reasonably foreseeable future actions are in broad categories of agriculture; renewable energy such as solar and wind; and space development. These actions could result in an increase in the overall noise in Kern County. However, the increase in noise would be variable temporally, spatially, and seasonally. Because the actions are not concentrated in a place that would drastically increase the overall noise environment of Kern County, there would be no significant cumulative impacts to noise and noise-compatible land use as a result of actions that have occurred, are occurring, and will occur. That is, the Proposed Action, when added to other past, present, and reasonably foreseeable future actions would not 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.

The Proposed Action would result in increased noise at and in the vicinity of the Mojave Air and Space Port during takeoffs and landings of the carrier vehicle. The increase in noise would be temporary, lasting only as long as takeoff and landing at Mojave Air and Space Port. When combined with past, present, and reasonably foreseeable projects, the Proposed Action would not result in significant cumulative impacts on noise and noise-compatible land use.

Water Resources: The past, present, and reasonably foreseeable future actions could result in temporary effects to water quality (freshwater) during construction. Contaminants could potentially be introduced by non-point source pollution into drainage channels or ground waters depending on the action. Because the Proposed Action would not affect groundwater or surface waters at the Mojave Air and Space Port, there would be no cumulative impacts to water quality.

The Proposed Action could potentially impact the open ocean waters. In the event of a launch failure, surface water quality in the ocean may be temporarily affected by the release of unconsumed RP-1. RP-1 is a Type 1 "Very Light Oil," which is characterized as being highly volatile and having low viscosity and

low specific gravity (U.S. Fish and Wildlife Service 1998b). Due to its high volatility, RP-1 evaporates quickly when exposed to the air, and would completely dissipate within 1–2 days after a spill in the water. As there are no surface waters at the Mojave Air and Space Port, the Proposed Action does not include construction activities, and the small quantity of light oil would dissipate completely within 1–2 days if spilled, the Proposed Action would not result in significant cumulative impacts to water resources.

Biological resources: The past, present, and reasonably foreseeable future actions could result in impacts to biological resources in Kern County. Actions such as development of agriculture, renewable energy such as solar and wind, oil drilling and exploration, and space development could impact biological resources in Kern County. However, because these impacts are not concentrated in one particular part of Kern County, they are not expected to significantly impact biological resources as a result of actions that have occurred, are occurring, and will occur.

The Proposed Action along with past, present, and reasonably foreseeable future actions could result in temporary behavioral impacts to biological resources in Kern County. However, impacts would be similar to ongoing activities at Kern County and would not significantly alter the current environment. Over the open ocean, the sonic boom produced by the Proposed Action would be considered a low energy impact, roughly equivalent to a thunder clap. It would be infrequent and brief (less than one second) and is not expected to result in significant behavioral disruptions to animals or create a degradation of ocean habitats; nor would it be heard over land in Kern County. In-air noise caused by the sonic boom will have no impact on terrestrial species, cetaceans, pinnipeds, sea turtles, seabirds and shorebirds, or any ESA-listed species.

Because activities associated with the Proposed Action would not overlap in time or space with past, present, and reasonably foreseeable future projects, and would comply with all relevant and applicable Federal, State, and local regulations related to biological resources, the Proposed Action would not result in significant cumulative impacts to biological resources.

Hazardous materials, solid waste, and pollution prevention: The past, present, and reasonably foreseeable future actions could result in impacts related to hazardous materials, solid waste, and pollution prevention. The past, present, and reasonably foreseeable future actions are expected to comply with all relevant Federal, State, and local regulations related to hazardous materials and hazardous waste. Therefore, they are not expected to result in significant impacts.

Under the Proposed Action, the amount of hazardous material, hazardous waste, and solid waste generated at the Mojave Air and Space Port would increase. Hazardous materials that would be used to support pre-flight and post-flight activities are similar to materials already handled at the Mojave Air and Space Port. Procedures are currently in place to accommodate additional fuel and other launch-related and maintenance-related hazardous materials, including paint, oils, lubricants, and solvents. Because activities associated with the Proposed Action would comply with all relevant Federal, State, and local regulations related to hazardous materials and hazardous waste, the Proposed Action would not result in significant cumulative impacts related to hazardous materials, solid waste, and pollution prevention.

In conclusion, the Proposed Action, when combined with past, present, and reasonably foreseeable future actions, would not result in significant cumulative impacts on the human environment.

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