Final

Supplemental Environmental Assessment

Launch, Boost-Back, and Landing of the Falcon 9

at

Vandenberg Air Force Base, California and Offshore Landing Contingency Options

31 January 2018

30th Space Wing, Installation Management Flight
1028 Iceland Avenue, Building 11146
Vandenberg Air Force Base, California 93437

FINDING OF NO SIGNIFICANT IMPACT
Launch, Boost-Back, and Landing of the Falcon 9 at Vandenberg Air Force Base, California, and Offshore Landing Contingency Options

This Finding of No Significant Impact (FONSI) hereby incorporates by reference and attaches hereto the *Final Supplemental Environmental Assessment* (SEA), *Launch, Boost-Back, and Landing of the Falcon 9 at Vandenberg Air Force Base* (VAFB), *California, and Offshore Landing Contingency Options*. This SEA supplements the following documents:

- *Falcon 9 and Falcon 9 Heavy Launch Vehicle Programs Environmental Assessment (EA) from SLC-4E, VAFB, California* (hereafter referred to as "Falcon 9 EA") (United States Air Force [USAF], 2011);
- *Final Environmental Assessment (EA) Boost-Back and Landing of the Falcon 9 Full Thrust First Stage at SLC-4 West at VAFB, California and Offshore Landing Contingency Option* (hereafter referred to as the "Falcon 9 Boost-Back EA") (USAF, 2016a); and,
- *SEA Boost-Back and Landing of the Falcon 9 First Stage at the Iridium Landing Area* (hereafter referred to as the "Falcon 9 Iridium SEA") (USAF, 2016b).

The SEA considered all potential environmental impacts of the Proposed Action (Alternative 1) and the No Action Alternative, including cumulative impacts, and identified management protective measures to avoid, prevent, or minimize environmental impacts.

PROPOSED ACTION (ALTERNATIVE 1)

The Proposed Action (Alternative 1) is Space Exploration Technologies Corporation's (SpaceX's) proposal to launch the Falcon 9 from VAFB and perform a boost-back maneuver (in-air) and landing of the Falcon 9 First Stage at either VAFB or one of two offshore contingency landing areas up to twelve times per year. In addition, launches would use up to 200,000 gallons of water in the flame duct to reduce vibration impacts from noise on payloads. A civil structure and retention basin would be constructed to divert and retain the portion of water expelled from the flame duct that would flow over land. Approximately 25,000 gallons of water would be expelled as steam and 25,000 gallons of water is expected to reach Spring Canyon. Vegetation in Spring Canyon would also be removed to minimize potential effects to nesting birds in the area impacted by the water release, and habitat enhancement would be conducted to mitigate for these permanent impacts to riparian vegetation. The Proposed Action was developed based on the purpose, need, and selection criteria discussed in Chapters 1 (Purpose of and Need for the Proposed Action) and 2 (Description of the Proposed Action and Alternatives) of the attached SEA.

NO ACTION ALTERNATIVE

The Council on Environmental Quality Regulations requires the assessment of the No Action Alternative (40 Code of Federal Regulations [C.F.R.] § 1502.14). Under the No Action Alternative, there would be no change to current Falcon 9 launches, boost-backs, and landings at VAFB. Although the No Action Alternative would meet the purpose of and need for the

Proposed Action, Alternative 1 is the Proposed Action because the increase tempo and multiple engine landing would better meet anticipated future commercial demands.

SUMMARY OF FINDINGS

The attached SEA analyzed the potential environmental consequences of activities associated with the Proposed Action and the No Action Alternative. Resources that are potentially affected by the changes to the Falcon 9 Program at VAFB are considered in more detail to determine whether additional analysis is required (40 C.F.R. § 1501.4[c]). Resources analyzed in the attached SEA include air quality, climate, noise, biological resources, water resources, cultural resources, geology and earth resources, coastal zone management, and Department of Transportation Section 4(f). VAFB does not anticipate that the proposed changes would alter the analysis for any additional resource that was described and assessed in the Falcon 9 EA (USAF, 2011), Falcon 9 Boost-Back EA (USAF, 2016a), or the Falcon 9 Iridium SEA (USAF 2016b). Potential adverse impacts were noted for the Proposed Action to the following resources, which are discussed below: air quality, noise, biological resources, water resources, and geology and earth resources.

Air Quality: Emissions from the Falcon 9 First Stage and support vessels would impact air quality. However, emissions from the Proposed Action would continue to be below the major source thresholds for all criteria pollutants, and the Proposed Action's impacts to air quality would not be significant.

Noise: The launch and landing of the Falcon 9 would produce continuous engine noise and sonic booms. This noise would primarily be heard in the vicinity of VAFB, over the North Channel Islands, and near the offshore landing areas. Construction vehicles and equipment would also produce noise. Given the short duration of these noises and the relatively low noise levels received at sensitive receptors, impacts from noise would be less than significant.

Biological Resources: The Proposed Action would affect terrestrial and marine species. Launch and landing noise, release of water and water vapor, and activities conducted during the installation of the diversion structure and vegetation clearing could result in temporary disturbances to wildlife resource. The USAF has determined, and the U.S. Fish and Wildlife Service (USFWS) concurred that the Proposed Action may affect and is likely to adversely affect the El Segundo blue butterfly (*Euphiloes battoides allyni*), California red-legged frog (*Rana draytonii*), California least tern (*Sternula antillarum browni*), and the western snowy plover (*Charadrius nivosus*; VAFB population) under the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. §§ 1531 et seq.). The USAF has also determined and the USFWS concurred that the Propose Action may affect, but is not likely to adversely affect the California condor (*Gymnogyps californianus*), marbled murrelet (*Brachyramphus marmoratus*), western snowy plover (*Charadrius nivosus*; North Channel Islands population), and southern sea otter (*Enhydra lutris nereis*) under the ESA.

Launch and landing impacts for pinnipeds at North Channel Islands would remain the same or substantially similar to those analyzed in the Falcon 9 EA (USAF, 2011), Falcon 9 Boost-back EA (USAF, 2016a), and Falcon 9 Iridium SEA (USAF, 2016b). Four pinnipeds may be present in the affected area at VAFB during boost-back and landing events: California sea lion (*Zalophus californianus*), Pacific harbor seal (*Phoca vitulina richardsi*), northern elephant seal (*Mirounga angustirostris*), and Steller sea lion (*Eumetopias jubatus*). VAFB has Letters of Authorization (LOA) that authorizes the take of marine mammals, by Level B harassment, for up to 50 launches per year, under the Marine Mammals Protection Act of 1972 (16 U.S.C. §§ 1361–1407), which includes launches by SpaceX at VAFB. SpaceX has also obtained an Incidental Harassment Authorization (IHA) to perform boost-back and landings at VAFB and the contingency land areas.

Water Resources: Implementation of the Proposed Action would affect water quantity, quality, and hydrology at Space Launch Complex-4 East (SLC-4E) and within Spring Canyon, which is an ephemeral surface water drainage south of SLC-4E. All launch operations would be conducted in accordance with the State National Pollutant Discharge Elimination System (NPDES) Industrial Storm Water Discharge General Permit and its associated Storm Water Pollution Prevention Plan (SWPPP). Wastewater discharges would follow the State NPDES General Permit for Discharges with Low Threat to Water Quality and the conditions for Enrollment in the General Waiver of Waste Discharge Requirements for SLC-4E Process Water Discharges. All construction activities would occur in previously disturbed areas and best management practices would be implemented to prevent contaminants from entering stormwater runoff per the NPDES Construction Storm Water Discharge General Permit and associated SWPPP. Removal of approximately 1.12 acres of willow riparian vegetation is regulated by the Regional Water Quality Control Board under the Central Coast Water Quality Control Plan and would be mitigated by the enhancement of 2.5 acres of degraded riparian habitat elsewhere within Spring Canyon. Therefore, impacts to water resources would be less than significant.

Geology and Earth Resources: Implementation of the Proposed Action would disturb up to 3 acres of soil. However, this area is largely previously disturbed from past construction activities and proposed soil disturbance is anticipated to be shallow. A SWPPP would be implemented during ground disturbance activities, which would include erosion and control measures. Therefore, the Proposed Action would not significantly affect geology and earth resources.

PUBLIC REVIEW AND COMMENT

The USAF made the Draft SEA available for public review and comment for 30 days following the publication of the Notice of Availability (NOA) in the *Lompoc Record* and *Santa Maria Times*. The USAF also distributed the Draft SEA and FONSI per a revised distribution list. Appendix H (Notice of Availability for Public Review, Proof of Delivery/Publication, Comments Received on Final Draft, and Responses) will contain a copy of the NOA, proofs of publication, proof of library deliveries, and VAFB's National Environmental Policy Act (NEPA) distribution list.

FINDING OF NO SIGNIFICANT IMPACT

Based on my review of the facts and analyses contained in the attached SEA, conducted per the NEPA, 42 U.S. Code 4321 et seq., implementing Council on Environmental Quality Regulations, 40 C.F.R. Parts 1500–1508, and 32 C.F.R. Part 989, *Environmental Impact Analysis Process*, I conclude that implementing the Proposed Action (chosen alternative), with incorporation of required environmental protection measures, will not have a significant effect on the human environment. Therefore, further analysis with an Environmental Impact Statement is not required, and a FONSI is appropriate.

31 JAN 18

MICHELLE A. LINN, GS-15, DAFC
Command Civil Engineer

Date

Attachment: Final Supplemental Environmental Assessment (2018) Launch, Boost-Back, and Landing of the Falcon 9 at Vandenberg Air Force Base, California, and Offshore Landing Contingency Options

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ACRONYMS AND ABBREVIATIONS

ºF	Degrees Fahrenheit
30 CES	30th Civil Engineer Squadron
30 CES/CEA	30th Civil Engineer Squadron, Asset Management Flight
30 CES/CEANQ	30th Civil Engineer Squadron, Asset Management Flight, Environmental Quality
30 CES/CEI	30th Civil Engineer Squadron, Installation Management Flight
30 CES/CEIEA	30th Civil Engineer Squadron, Installation Management Flight, Environmental Assets
30 SW	30th Space Wing
30 SW/SE	30th Space Wing, Office of the Chief of Safety
30 SW/SEW	30th Space Wing Weapons Safety Office
30 SWI	30th Space Wing Instruction
45 SW	45th Space Wing
ac.	acre(s)
AFI	Air Force Instruction
AFOSH	Air Force Occupational Safety and Health
AFSPCMAN	Air Force Space Command Manual
AGL	Above Ground Level
APCD	Air Pollution Control District
ASME	American Society of Mechanical Engineers
BO	Biological Opinion
BOEM	Bureau of Ocean and Energy ManagementBP Before Present
CAA	Clean Air Act
CAAQS	California Ambient Air Quality Standards
CARB	California Air Resources Board
CCC	California Coastal Commission
CCS	central coast scrub
CDFW	California Department of Fish and Wildlife
CEQ	Council on Environmental Quality
CetMap	Cetacean Density and Distribution Mapping Working Group
C.F.R.	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO2e	carbon dioxide equivalent
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
dB	decibel(s)
dBA	A-weighted decibels
dBP	peak, unweighted decibels
dB re µPa	decibel(s) referenced to micropascal(s)
DNL	Day-Night Average Sound Level
DoD	Department of Defense
EA	Environmental Assessment
EELV	Evolved Expendable Launch Vehicle
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EO	Executive Order
EPM	Environmental Protection Measure
ERP	Environmental Restoration Program
ESA	Endangered Species Act
ESBB	El Segundo Blue Butterfly
FAA	Federal Aviation Administration
FONPA	Finding of No Practicable Alternative
FONSI	Finding of No Significant Impact
FR	Federal Register
FSDP	Flight Safety Data Plan
ft.	foot/feet
FTS	Flight Termination System
GHG	greenhouse gas
GWP	global warming potential
ha	Hectare(s)
HSTT	Hawaii-Southern California Training and Testing
Hz	hertz
IHA	Incidental Harassment Authorization
IICEP	Interagency and Intergovernmental Coordination for Environmental Planning
kHz	kilohertz
km	kilometer(s)
km^2	square kilometer(s)
L_{eq}	equivalent sound level
lb	pound(s)
LF	Launch Facility
LOA	Letter of Authorization
LOX	liquid oxygen
m.	meter(s)
MMCG	Marine Mammal Consulting Group
MMPA	Marine Mammal Protection Act
MMRP	Military Munitions Response Program
mph	miles per hour
N_2O	Nitrous Oxide
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration

NCI	North Channel Islands
NFPA	National Fire Protection Association
NHPA	National Historic Preservation Act
NEPA	National Environmental Policy Act
nm	nautical mile(s)
NMFS	National Oceanic and Atmospheric Administration, National Marine Fisheries Service
NNG	non-native grassland
NO_2	nitrogen dioxide
NO_x	nitrogen oxide
NOAA	National Oceanic and Atmospheric Administration
NOT	Notice of Termination
NPDES	National Pollution Discharge and Elimination System
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
NSR	New Source Review
O_3	ozone
OEIS	Overseas Environmental Impact Statement
OSHA	Occupational Safety and Health Administration
PFDP	Preliminary Flight Data Package
Pb	lead
PBF	physical and biological feature
PERP	Portable Equipment Registration Program
$PM_{2.5}$	particulate matter less than 2.5 microns (fine particulate matter)
PM_{10}	particulate matter less than 10 microns
ppm	parts per million
psf	pound(s) per square foot
psi	pound(s) per square inch
RIMPAC	Rim of the Pacific
ROG	Reactive Organic Gas
ROI	region of influence
RP-1	rocket propellant
RWQCB	Regional Water Quality Control Board
SAIC	Science Applications International Corporation
SBCAPCD	Santa Barbara County Air Pollution Control District
SCAB	South Coast Air Basin
SCAQMD	South Coast Air Quality Management District
SCCAB	South Central Coast Air Basin
SEA	Supplemental Environmental Assessment
SEL	Sound Exposure Level
SIP	State Implementation Plan
SLC	Space Launch Complex
SLC-4E	Space Launch Complex 4 East
SLC-4W	Space Launch Complex 4 West
SO_2	sulfur dioxide
SOCAL	Southern California
SpaceX	Space Exploration Technologies Corporation
SWI	Space Wing Instruction
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board (California)
$\mu g/m^3$	microgram(s)
UPPR	Union Pacific Railroad
U.S.	United States
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Society
VAFB	Vandenberg Air Force Base
VOC	volatile organic compounds
WDID	Waste Discharge Identification Number

1 Purpose of and Need for the Proposed Action

1.1 Introduction

The USAF first assessed the operation of the Falcon 9 Launch Vehicle Program from SLC-4E in 2011. The *Final Environmental Assessment for Falcon 9 and Falcon 9 Heavy Launch Vehicle Programs from Space Launch Complex 4 East, Vandenberg Air Force Base, California* (hereinafter referred to as "Falcon 9 EA") evaluated the potential environmental consequences of operating the Falcon 9 and Falcon 9 Heavy launch vehicle programs from SLC-4E. This EA, which is hereby incorporated by reference, also evaluated the potential environmental consequences of required modifications and new construction at SLC-4E to accommodate these activities (USAF, 2011a).

In April 2016, the USAF issued a *Final Environmental Assessment for Boost-Back and Landing of the Falcon 9 Full Thrust First Stage at SLC-4 West at Vandenberg Air Force Base, California and Offshore Landing Contingency Option* (hereafter referred to as “Falcon 9 Boost-Back EA”), which is hereby incorporated by reference. This EA assessed the construction of a new concrete landing pad at SLC-4W and proposed boost-back maneuver (in-air), return flight, and landing of the Falcon 9 First Stage on the new SLC-4W pad up to six times per year. This action also included a conditional landing area on an autonomous barge located approximately 27 nm (50 km) offshore of VAFB (USAF, 2016a).

In September 2016, the USAF issued a *Final Supplemental Environmental Assessment for Boost-Back and Landing of the Falcon 9 Full Thrust First Stage at Iridium Landing Area, Vandenberg Air Force Base, California and Offshore Landing Contingency Option* (hereafter referred to as “Falcon 9 Iridium SEA”), which is hereby incorporated by reference. The Falcon 9 Iridium SEA assessed the proposed boost-back and landing of the Falcon 9 First Stage (up to six times per year) on a barge in the Iridium Landing Area (USAF, 2016b).

Subsequent to the completion of the Falcon 9 Launch and Boost-back EAs, SpaceX has proposed changes to the launch, boost-back, and landing of the Falcon 9 at VAFB. SpaceX proposes to launch the Falcon 9 from SLC-4E, followed by first stage boost-back and landing at SLC-4W up to 12 times per year. In addition, launches would use up to 200,000 gallons of water in the flame duct to reduce vibration impacts from noise on payloads. SpaceX proposes to construct a civil structure and retention basin to divert and retain a portion of the water expelled from the flame duct. Vegetation in Spring Canyon would also be removed to minimize potential effects to nesting birds in the area impacted by the water release, and habitat enhancement would be conducted to mitigate for these permanent impacts to riparian vegetation.

This SEA has been prepared per the National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code [U.S.C.] § 4321 et seq.); the White House Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provision of NEPA (40 Code of Federal Regulations [C.F.R.] Parts 1500–1508); 32 C.F.R. Part 989; and Federal Aviation Administration (FAA), Order 1050.1F, *Environmental Impacts: Policies and Procedures*. Per agreements between the United States (U.S.) Air Force (USAF) and the FAA, the USAF is the lead agency for the preparation and coordination of the NEPA documentation for the Proposed Action (40 C.F.R. § 1501.5), and the FAA and the National Aeronautics and Space Administration (NASA) are acting as cooperating agencies (40 C.F.R. § 1501.6).

1.2 Purpose and Need

The purpose of the Proposed Action is to substantially reduce the cost to the Government of reliable U.S. enterprise access to space, thus complying with the National Space Policy. The purpose of the Proposed Action is also to fulfill the FAA's responsibilities as authorized by Executive Order (EO) 12465, *Commercial Expendable Launch Vehicle Activities* (1984), and the Commercial Space Launch Act for oversight of commercial space launch activities.

The purpose of the Proposed Action is to reduce the risk of damage to payloads caused by acoustic vibrations. The noise generated from the rocket just prior to liftoff produces sound waves that reflect off of the ground and back onto the rocket. The noise vibrates the rocket and the payload, potentially damaging highly sensitive payloads. The Proposed Action would reduce this risk by using water to absorb the acoustic waves and significantly reducing the vibrations on the payload. The Proposed action would allow SpaceX to increase the type and number of potential customers that require low vibrations during flight.

The need for the Proposed Action results from the statutory direction from Congress under the Commercial Space Launch Act to protect the public health and safety, safety of property, and national security and foreign policy interests of the United States and to encourage, facilitate, and promote commercial space launch and reentry activities by the private sector to strengthen and expand U.S. space transportation infrastructure during commercial launch or reentry activities.

The Proposed Action is needed so that SpaceX can implement missions for the USAF and NASA (under the Space Act Agreement) and meet current and future commercial demands. In addition, the Proposed Action supports VAFB's vision of becoming the "world's most innovative space launch and landing team" (USAF, 2014a).

The Proposed Action is needed to be within the maximum predicted acoustic environment limits set by SpaceX that provide sufficient protection for highly sensitive payloads from acoustic vibrations during the launch of the Falcon 9 rocket. The action would encourage, facilitate, and promote commercial space launches by the private sector, and would facilitate the strengthening and expansion of the U.S. space transportation infrastructure, in accordance with the requirements of the Commercial Space Launch Act of 1984.

1.3 Project Location

VAFB occupies approximately 99,100 acres (ac.) (400 square kilometers [km^2]) of central Santa Barbara County, California, and is approximately halfway between San Diego and San Francisco. VAFB occurs in a transitional ecological region that includes the northern and southern distributional limits for many plant and animal species. The Santa Ynez River and State Highway 246 divide VAFB into two distinct parts: North Base and South Base. SLC-4 is located on South Base. Figure 1-1 and Figure 1-2 show the regional location of the project location and landing areas.

SLC-4E is the existing launch facility for the Falcon 9 program. SLC-4E is approximately 4.0 miles south of the Santa Ynez River and 0.9 miles east of the Pacific Ocean (USAF, 2011a).

SLC-4W is the existing landing facility for the Falcon 9 program. This facility is located approximately 715 feet (ft.) (218 meters [m]) west of SLC-4E and 0.5 miles (0.8 kilometers [km]) inland from the Pacific Ocean (USAF, 2016a).

Figure 1-1. Regional Location of Vandenberg Air Force Base

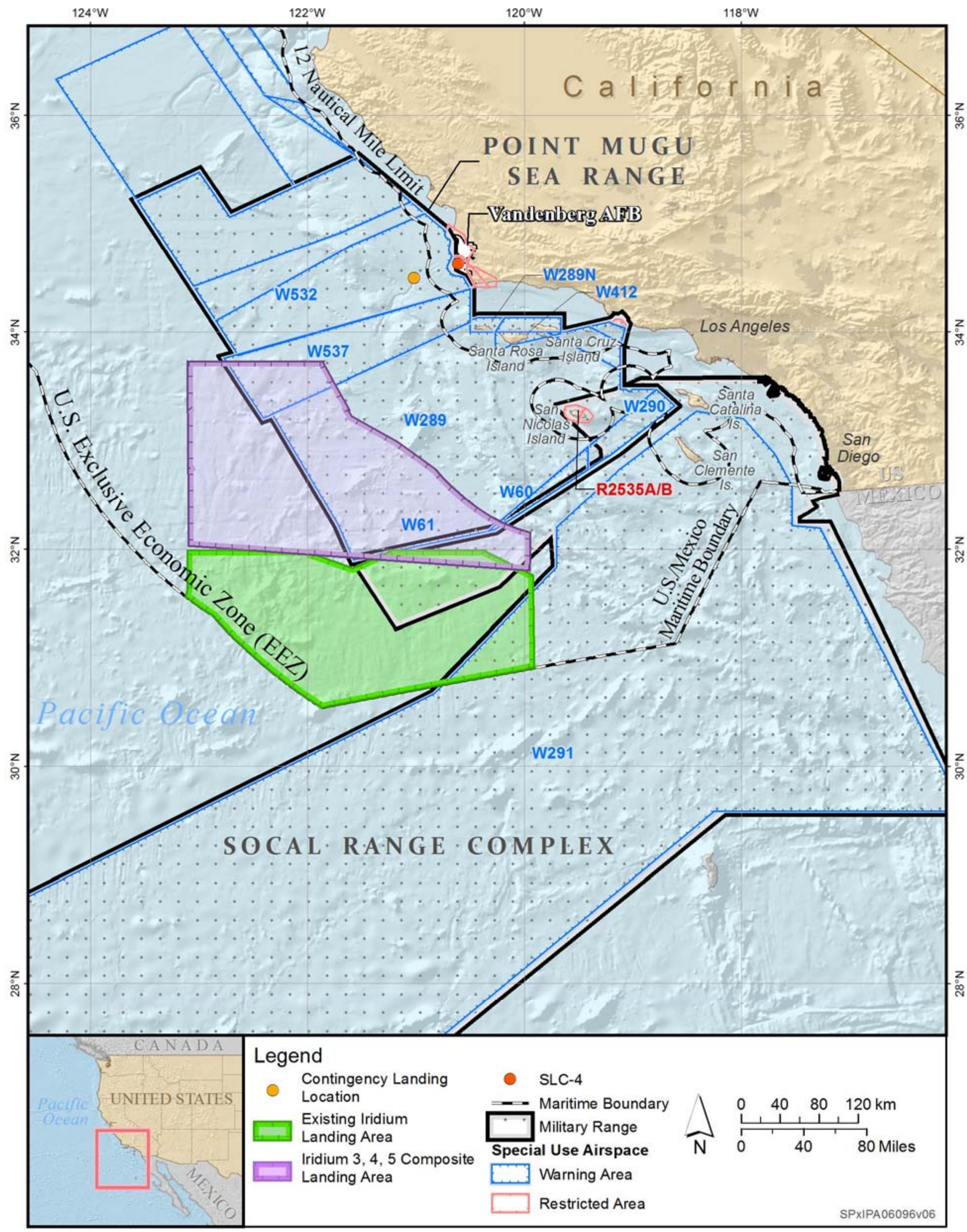


Figure 1-2. Existing Falcon 9 Landing Areas and Vicinity

The Contingency Landing Location is an existing contingency landing area for the Falcon 9. It is located approximately 27 nautical miles (nm) (50 km) offshore of VAFB (USAF, 2016a).

The Iridium Landing Area is a down-range contingency landing area for the Falcon 9 as shown in Figure 1-2. It is located southwest of San Nicolas Island and San Clemente Island coastal waters and may extend as far west as the U.S. Pacific Coast Region Exclusive Economic Zone. The Iridium Landing Area was previously analyzed in the Falcon 9 Iridium SEA (USAF, 2016b). The "Iridium 3, 4, 5 Composite Landing Area is an additional down-range contingency landing area previously analyzed and issued a Categorical Exclusion in 2017 (Figure 1-2; U.S. Air Force, 2017).

1.4 Scope of this Supplemental Environmental Assessment

This SEA is tiered from and is intended to supplement and update the Falcon 9 EA, the Falcon 9 Boost-Back EA, and the Falcon 9 Iridium SEA. Agencies are required to prepare SEAs when there is a substantial change to a proposed action that is relevant to environmental concerns, or if there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its environmental impacts (40 C.F.R. § 1502.9[c]). The USAF recently conducted a detailed review of the Falcon 9 Program at VAFB and concluded that a SEA was necessary in order to continue these operations. Resources that are potentially affected by these change are considered in more detail to determine whether additional analysis is required (40 C.F.R. § 1501.4[c]).

This SEA identifies, describes, and evaluates the potential environmental impacts that could result from the Proposed Action and the No Action Alternative, as well as possible cumulative impacts from other past, present, and reasonably foreseeable actions within the region of influence. The SEA identifies environmental permits relevant to the Proposed Action. The SEA describes, in terms of a regional overview or a site-specific description, the affected environment and environmental consequences of the action. Finally, the SEA identifies management measures to avoid, prevent, or minimize environmental impacts.

1.5 Interagency and Intergovernmental Coordination and Consultation

Under the Coastal Zone Management Act (CZMA) of 1972 (16 U.S.C. §§ 2452–24645), a federal action that may affect the coastal zone must be carried out in a manner that is consistent with state coastal zone management programs. On 31 August 2015, the California Coastal Commission (CCC) concurred with a negative determination (ND-0027-15) for recurring Falcon 9 first stage boost-back landings at SLC-4W or a barge approximately 27 nm (50 km) offshore of VAFB. The Executive Director determined that the proposed project would not adversely affect coastal resources.. The USAF determined that the proposed changes do not raise any new coastal resource issues not previously addressed and do not necessitate reinitiating consultation with the California Coastal Commission (CCC).

If, after reviewing this SEA, the FAA determines the Proposed Action would not individually or cumulatively result in significant impacts on the human environment, the FAA would issue its own Finding of No Significant Impact (FONSI) to support issuing a license to SpaceX. The FAA will draw its own conclusions from the analysis presented in this SEA and assume responsibility for its environmental decisions and any related mitigation measures. For the FAA to use this analysis to support its determination, the SEA must meet the requirements of FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures,* which contains the FAA's policies and procedures for compliance with NEPA, and its Desk Reference (FAA, 2015).

The Proposed Action is a federal undertaking subject to compliance with Section 106 of the National Historic Preservation Act (NHPA) of 1966 as amended (16 U.S.C. § 470 et seq.). VAFB has reinitiated consultation with California State Historic Preservation Office (SHPO) for the project under 36 C.F.R. Part 800. VAFB determined that the Proposed Action would have no adverse effect to any properties listed in or potentially listed in the National Register of Historic Places. The SHPO has concurred with VAFB's determination of no adverse effect to historic properties (Appendix A).

Native American traditional cultural properties are also protected by the NHPA. EO 13175, *Consultation and Coordination with Indian Tribal Governments*, directs Federal agencies to coordinate and consult with Native American tribal governments whose interests might be directly and substantially affected by activities on federally administered lands. VAFB initiated consultation with the Santa Ynez Band of Chumash Indians for the Proposed Action in 2017. Should any cultural material be discovered during the life of this project, the Santa Ynez Band of Chumash Indians Elders Council would be notified (Appendix D).

Under Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. § 1531 et seq.), federal agencies are required to assess the effect of projects authorized, funded by, or carried out by federal agencies on federally listed threatened or endangered species. Section 7 consultations with the U.S. Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS) are required for federal projects if such actions have the potential to directly or indirectly affect listed species or destroy or adversely modify critical habitat. The USAF reinitiated formal consultation with USFWS for the Proposed Action under ESA Section 7 and received concurrence that the proposed action was likely to adversely affect federally listed species (Appendix B). The USAF has determined that there is no need to re-initiate consultation with NMFS because the project would have no effect on threatened or endangered species under NMFS' jurisdiction.

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. The changes to the Proposed Action would not affect any EFH; therefore, further consultation under the Magnuson-Stevens Fishery Conservation and Management Act is not required for this action.

Per the Marine Mammal Protection Act of 1972 (MMPA; 16 U.S.C. § 1361 et seq.), NMFS previously issued regulations and Letters of Authorization (LOA) that authorized the take of marine mammals, by Level B harassment, incidental to launches of up to 50 rockets or missles per year from VAFB (79 Federal Register [FR] 10016). This LOA is effective from March 2014 to March 2019 and includes Falcon 9 launches at VAFB. SpaceX obtained an incidental harassment authorization (IHA) for pinniped species (marine mammals such as seals and sealions) for the boost-back and landing at SLC-4W and the contingency landing approximately 27 nm (50 km) offshore of VAFB in May 2016. This IHA expired on June 29, 2017. SpaceX has received a new IHA for pinniped species, by Level B harassment, for the Proposed Action, which is valid until December 1, 2018 (Appendix C).

2 Description of the Proposed Action and Alternatives

This chapter provides detailed descriptions of the Proposed Action (Alternative 1) and the No Action Alternative. It also describes selection criteria used to identify and select alternatives and summarizes alternatives that were considered but eliminated from further analysis.

2.1 Selection Criteria

A range of reasonable alternatives were identified by evaluating the ability of each alternative to meet the purpose of and need for the Proposed Action and their ability to meet the following selection criteria:

- Criterion 1: Provide sufficient acoustic vibration reductions that are within the maximum predicted environmental limits.
- Criterion 2: Does not jeopardize the integrity of the launch pad facilities, rocket, or payload.

CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 C.F.R. Parts 1500–1508) require federal agencies to use the NEPA process to identify and assess the reasonable alternatives to the Proposed Action that would avoid or minimize adverse effects of those actions on the quality of the human environment. The selection criterion that were used to identify suitable launch and landing locations was described in the Falcon 9 EA, Falcon 9 Boost-Back EA, and the Falcon 9 Iridium SEA (USAF, 2011a, 2016a, 2016b).

2.2 Alternative 1 (Proposed Action)

SpaceX proposes to launch the Falcon 9 from SLC-4E, followed by first stage boost-back andlanding at SLC-4W up to 12 times per year. In addition, launches would use up to 200,000 gallons of water in the flame duct to reduce vibration impacts from noise on payloads. SpaceX proposes to construct a civil structure and retention basin to divert and retain a portion of the water expelled from the flame duct. Vegetation in Spring Canyon would also be removed to minimize potential effects to nesting birds in the area impacted by the water release, and habitat enhancement would be conducted to mitigate for these permanent impacts to riparian vegetation.

Alternative 1 is carried forward for further evaluation because this alternative best met the selection criteria and the purpose and need. This alternative encourages, facilitates, and promotes commercial space launch and reentry activities by the private sector and strengthens and expands U.S. space transportation infrastructure during commercial launch and reentry activities. This alternative would also offer a cost-effective solution that would be anticipated to meet current and future demands for launch activities that require a sun-synchronous, polar, or near-polar orbit. Therefore, Alternative 1 is USAF's preferred alternative.

2.2.1 Launch and Landing Operations

Launches and landings would occur day or night, at any time during the year up to once per month, and under all but extreme weather conditions (i.e., would not occur during gale force winds, high wind shear, or extreme thunder and lightning conditions). The trajectory of the Falcon 9 would be either westward or southward from SLC-4 depending on the payload's orbital mission, with the first stage boost-back generally returning along the same trajectory. The total time from launch to landing would be approximately 10 to 20 minutes.

On a per-mission basis, launch campaigns (preparation for and the actual launch event) are expected to last from 2 to 8 weeks. During a launch campaign, up to 100 local and 100 transient employees would be present at SLC-4, including payload support personnel. Between launch campaigns, 50 to 80 employees would be present at the site.

Ground transportation support during a launch campaign would continue to be minimal. This presently consists of a truck to deliver the crane (if an external crane is required outside the Hangar or if the Hangar cranes are not yet complete) and four delivery trucks for delivery of the first stage, second stage, interstage, and payload. Trucks could be oversized, up to 140 ft. long and 16.5 ft. wide. In addition, fuel and helium trucks would continue to make weekly deliveries. Personal vehicles would be used by employees to commute locally on and off the site.

The First and Second Stages would continue to arrive separately, from Hawthorne, California, most likely via truck or rail, and would be placed in the Integration and Processing Hangar. Once at the Hangar, the stages and boosters are checked and prepared for mating. Upon completing any necessary primary payload processing, the payload would continue to be delivered to the Payload Processing Facility. The payload would then be mated to the launch vehicle.

After final systems checkout, there may be a mission rehearsal with propellants on the vehicle (wet) to verify full launch readiness. One to two dress rehearsals (usually within six days of launch) are typical in the launch preparation schedule to allow for team training and for coordination of activities between the SpaceX crew and VAFB personnel. Wet dress rehearsals require local closures or restricted access during the rehearsal. Under some circumstances, static fire tests of the first stage vehicle may be conducted at the launch site, where the vehicle is fully fueled and the engine ignited and run for up to seven seconds as a thorough test of all systems.

Once the first stage has landed and been secured, any remaining liquid oxygen and rocket propellant would be properly off-loaded and disposed or re-used. The landing pad was designed to contain all stormwater that comes in contact with it and route the water to an existing 100,000-gallon retention basis. This is achieved through a 1 percent slope that sends water to the northwest end of the pad. From there, a collection point routes all water to the 100,000-gallon retention basin. During landing operations, remotely controlled water cannons would be used to provide streams of water to help statically discharge the rocket in addition to being able to fight any fires that occur on the pad. Water volumes for normal operations average around 40,000 gallons. During storm events, the secondary containment structure is sized to handle water volumes from a 100-year storm event. Water collected in the retention pond would be pumped to an existing spray field for disposal. Nominal volumes of rocket propellant and liquid oxygen that would be offloaded post landing are 150 gallons and 300 gallons respectively. If spilled, liquid oxygen evaporates almost immediately after contact with ambient conditions. Rocket propellant would runoff into the retention basin. Any rocket propellant visibly floating on the surface of the water in the retention basin would be collected using floating absorbent pads and sampled per the Regional Water Quality Control Board (RWQCB) General Waiver enrollment conditions before discharge of water to the spray field. Therefore, in the event of a spill, no liquid oxygen or rocket propellant would be released outside of SLC-4.

Contingency Drone Ship Landing

As a Contingency Action to landing the Falcon 9 Full Thrust First Stage on the SLC-4W pad at VAFB, SpaceX would return the Falcon 9 Full Thrust First Stage to a drone ship in the Pacific

Ocean up to 12 times per year. This drone ship is specifically designed to be used as a landing platform for the First Stage.

The contingency action is necessary to provide for an alternative landing location if the Western Range deems that the first stage overflight of south VAFB is unacceptable due to potential impacts to critical assets or weather conditions or mission parameters do not permit for a successful landing attempt.

The maneuvering and landing process described above for a pad landing would be the same for a drone ship landing. Prior to a drone ship landing, a Notice to Mariners and a Notice to Airman for all pilots would be issued via the Range.

The following three vessels would be required for a drone ship landing:

1. Drone Ship/Landing Platform – approximately 300 ft. (91.4 m) long and 150 ft. (45.7 m) wide
2. Support Vessel – approximately 165 ft. (50.3 m) long research vessel
3. Ocean Tug – 120 ft. (36.6 m) open water commercial tug

The support vessels would originate from Long Beach Harbor to position for support for contingency landings. The tug and support vessel would be staged just outside of the landing location.

The drone ship, which is used as a landing platform, is a McDonough Marine Deck Barge with dimensions of 300 ft. (91.4 m) by 100 ft. (30.5 m). The barge has an operational displacement of 24,000,000 lb and is classified as an American Bureau of Shipping Class-A1 Ocean barge. The Barge was modified to accommodate the First Stage landing by increasing its width to 150 ft. (45.7 m) and installing a dynamic positioning system and a redundant communications and command and control system. Following barge modification, the drone ship was inspected by the U.S. Coast Guard, and SpaceX has obtained a Certificate of Inspection for its operation under the service of Research Vessel.

Engine Noise

Engine noise would be produced during Falcon 9 launch and landings. It is estimated that the Falcon 9 would produce engine noise of 110 A-weighted decibels (dBA) during launch operations in the vicinity of SLC-4E (Figure 2-1). Engine noise of up to 90 dBA may be heard off VAFB and at Santa Ynez River and Point Arguello. Previous engine noise footprints were computed using a single engine thrust landing. SpaceX proposes to use a three-engine thrust landing for some boost-back events, generating engine noises of up to 110 dBA. The engine noise would be primarily within the vicinity of SLC-4 and would attenuate below 80 dBA at approximately 8 miles (mi) (12.9 kilometer (km)) from SLC-4 (Figure 2-2). This model was used to estimate the engine noise at the Contingency Landing Location (Figure 2-3) and within the Iridium Landing Area.

Sonic Boom

During launch ascent, a sonic boom up to 3.0 psf may be generated at the northern Channel Islands (NCI). During boost-back and landing descent, a sonic boom would be generated while the first-stage booster is supersonic. Earlier sonic boom models predicted that first stage boost-back overpressures would be directed at the coastal area south of SLC-4 and would reach up to 2.0 psf

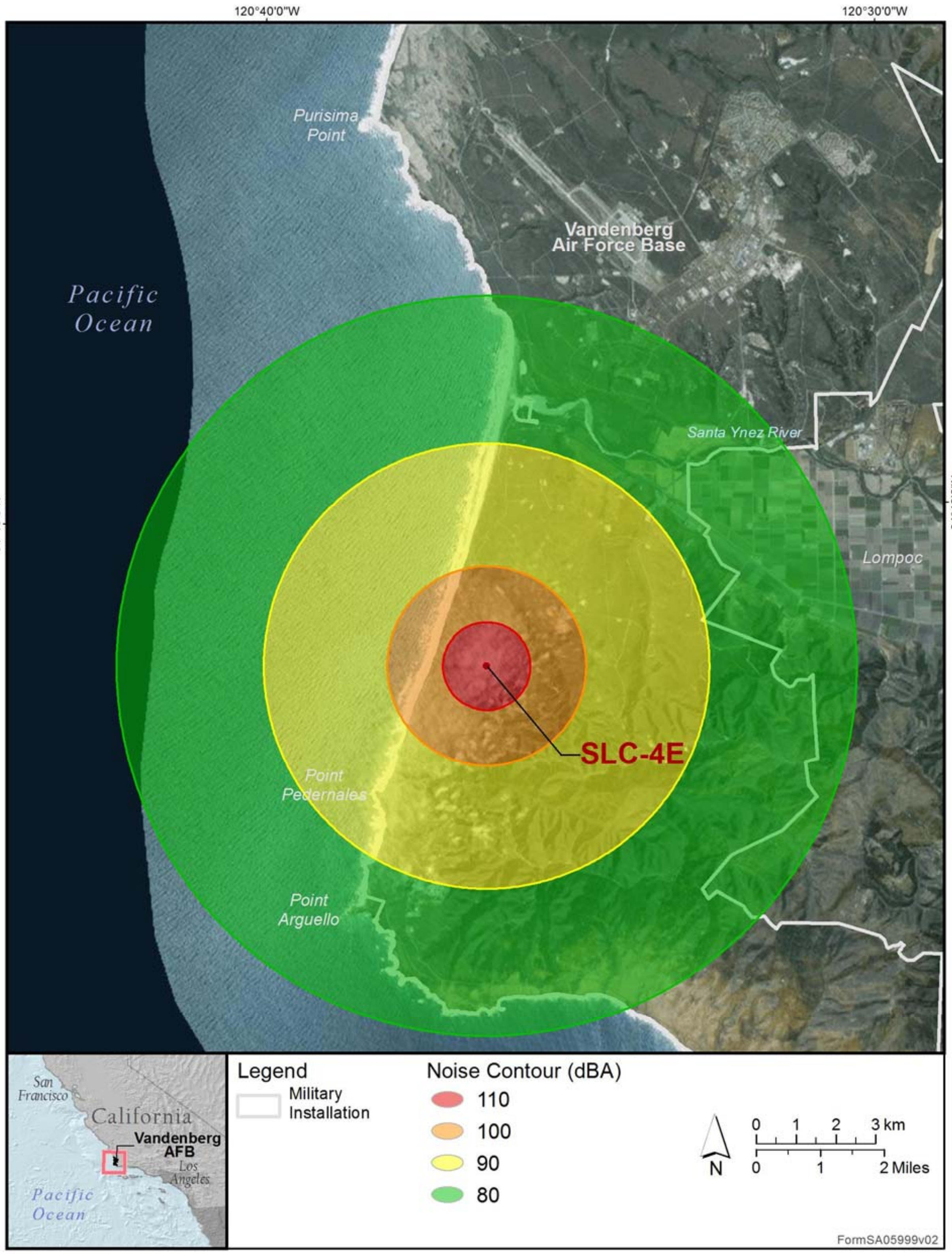


Figure 2-1. Estimated Launch Noise of Falcon 9 First Stage at SLC-4E

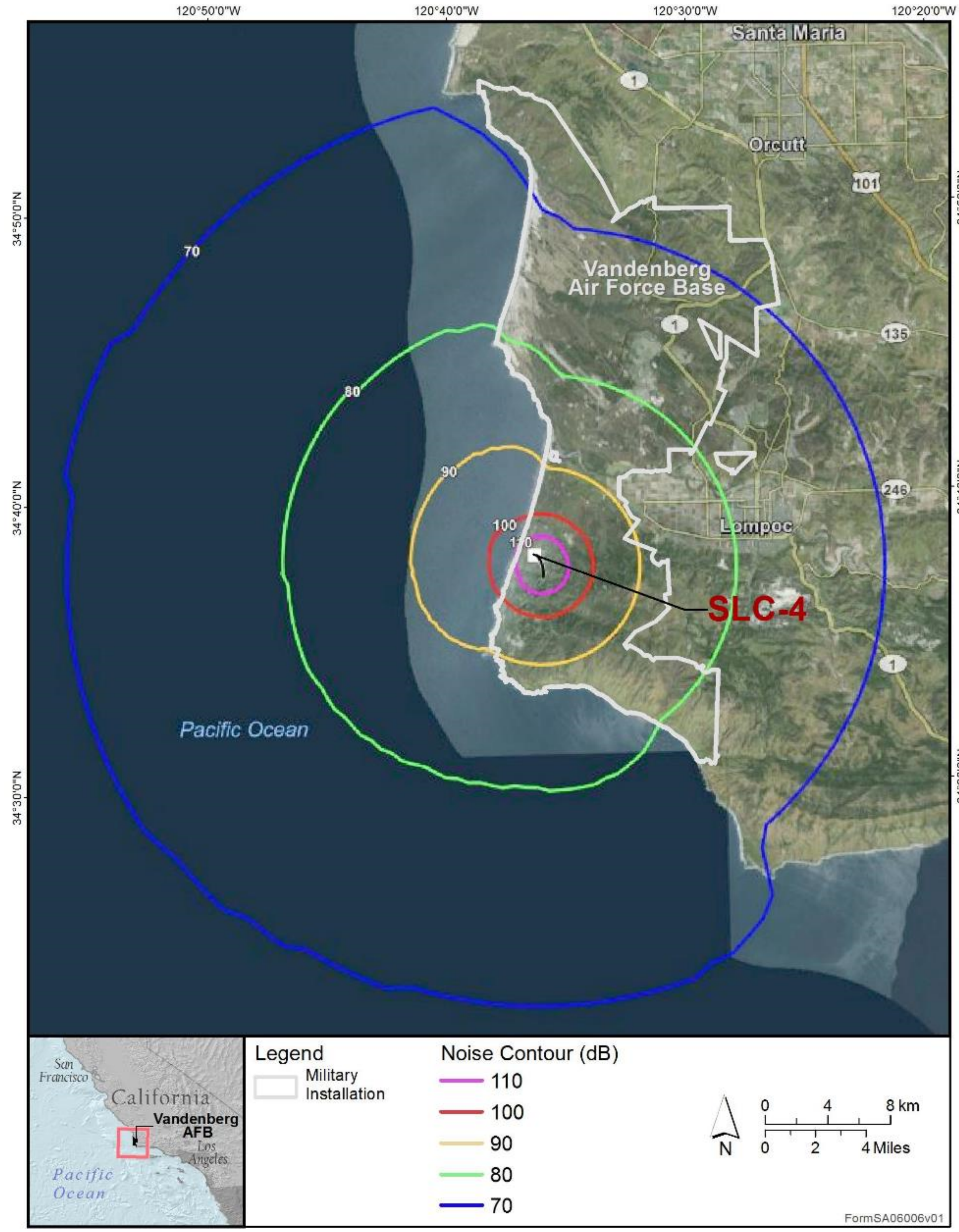


Figure 2-2. Estimated Landing Noise of Falcon 9 First Stage at SLC-4

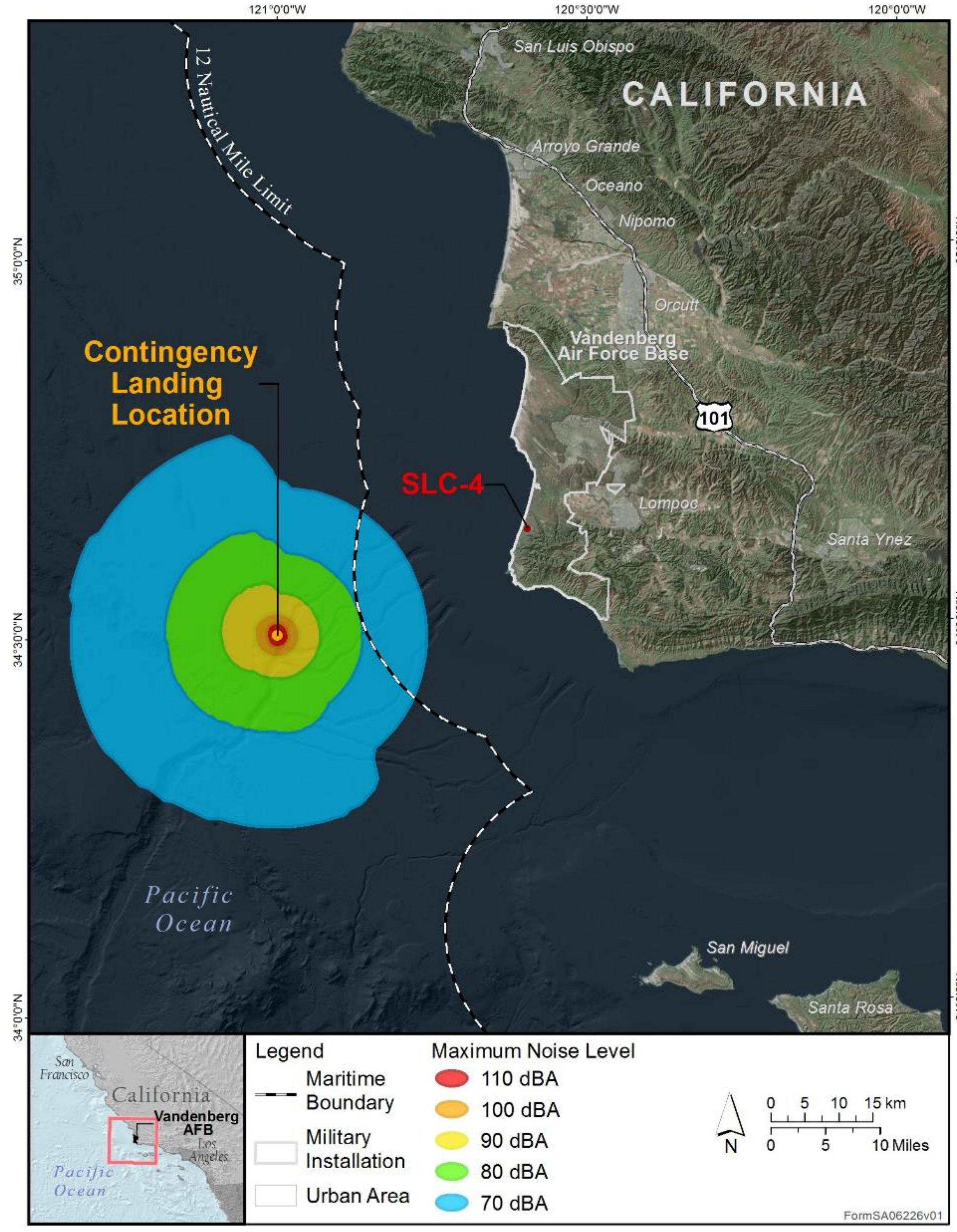


Figure 2-3. Estimated Landing Noise of Falcon 9 First Stage at the Contingency Landing Location

at SLC-4 and up to 3.1 psf at the NCI. Recent observations show that these early models underestimated the actual strength of these overpressures in the Near Field. The 45th Space Wing landing point, but the CRS-9 mission confirmed the 45th SW model to be the best predictor for Near Field sonic boom levels, which was validated by the CRS-9 data and acknowledged by the Eastern Range. Based on the NASA Technical Paper 1122, SpaceX optimized the model to match data from CRS-9 to predict sonic boom levels over a broader range.

The USAF now predicts overpressures as high as 8.5 psf [compared to approximately 146 dB (peak, unweighted)] at SLC-4W, which would attenuate to levels below 2.0 psf (134 dB) at approximately 5.5 mi (8.9 km) and below 1.0 psf at approximately 15.97 mi (25.7 km) from the landing area (Figure 2-4). These estimates are based, in part, on actual observations of Falcon 9 boost-backs and landings at Cape Canaveral and on autonomous droneships in the Pacific Ocean. In addition, the USAF is estimating that the NCI may be impacted by a sonic boom of up to 3.1 psf (137 dB) (Figure 2-5) during the return flight based on the higher of the two predictions between the model run by Wyle and Blue Ridge Research Consultation (James et al. 2017). The actual location of this overpressure may shift (e.g., offshore) as atmospheric conditions vary throughout the year. Depending on the distance from the landing pad, the sonic boom may be heard before or within a few seconds following the landing of the Falcon 9 first stage.

2.2.2 Flame Duct Water

Allowing standing water in the flame duct has proven to be the most effective method to reduce vibration impacts on payloads. Based on operations and experience at other launch complexes, SpaceX has determined that a maximum of 200,000 gallons of water would be required in the flame duct at SLC-4E to achieve vibration requirements for certain missions. During the Cassiope Mission in September 2014, when a similar amount of water was present in the flame duct, there was an unanticipated release of water into Spring Canyon. Upon evaluation of the flow path of the water, it was determined that a majority of this water flowed overland on its path to Spring Canyon. It was also determined that a much lesser quantity of water was ejected through the air directly into Spring Canyon.

In order to reduce impacts to Spring Canyon, a civil water diversion structure (see Section 2.2.3) would be constructed to capture and divert any water that would flow overland and potentially enter Spring Canyon. This water would be contained in a newly constructed 60,000-gallon capacity retention basin and subsequently pumped to an existing spray field for discharge with similar waters. Water containing prohibited chemical levels would be removed and hauled to an approved industrial wastewater treatment facility outside of VAFB. The ground cloud formed by the steam during a launch would not contain any hazardous materials.

Despite the civil structure, some liquid water is expected to reach Spring Canyon. It is difficult to evaluate exactly how much water would be discharged to Spring Canyon during launches. Based on the Cassiope Mission, it is estimated that of the 200,000 gallons of water placed in the flame duct, half of this volume would remain in the flame duct and half would be expelled as water and water vapor. Approximately 25,000 gallons of water would be expelled as steam, with the remaining 75,000 gallons expelled as liquid water. The maximum temperature of the water and water vapor is expected to be up to 130 ºF by the point at which it would reach Spring Canyon. The civil structure would be designed to capture the water that flows over land but some water would be discharged to Spring Canyon. To consider the worst-case scenario, it is assumed that up

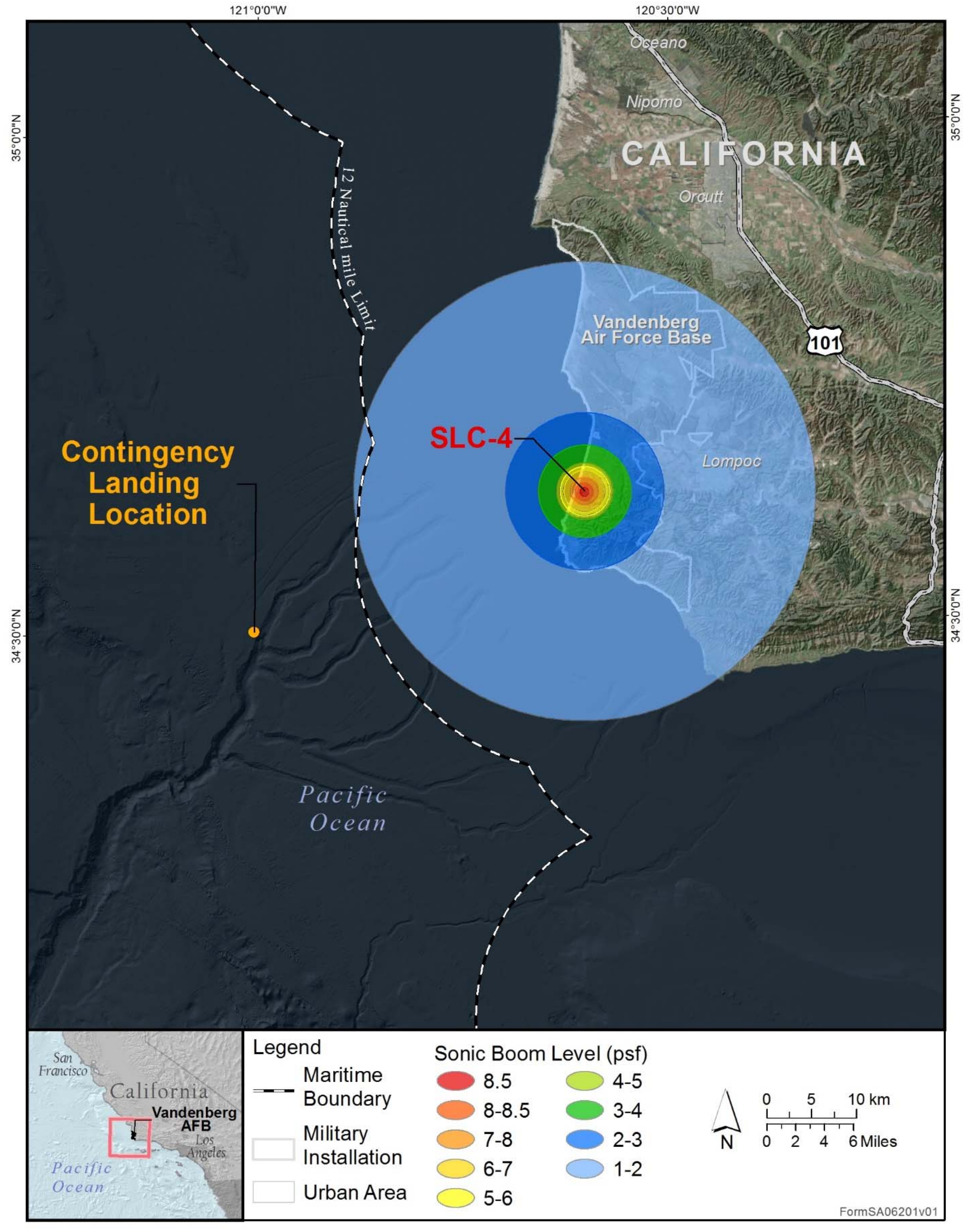


Figure 2-4. Estimated Sonic Boom Contours for Falcon 9 First Stage Landing at SLC-4W

Figure 2-5. Estimated Sonic Boom of Falcon 9 Landing First Stage at the NCI

to 25,000 gallons of liquid water could reach Spring Canyon during each launch event. Water discharged as part of this action would meet the thresholds and conditions identified by the RWQCB in the Statewide National Pollutant Discharge Elimination System (NPDES) General Permit for Discharges with a Low Threat to Water Quality.

Water collected in the retention basin would be pumped to the existing spray field via a 3-inch gas pump that has a strainer on the inlet with 1/8th inch holes. After launch operations, the water in the retention basin would be removed to below 4 inches in depth within 48 hours to reduce chances of attracting frogs and other animals.

2.2.3 Civil Water Diversion Structure

Under the Proposed Action, a civil water diversion structure would be constructed at SLC-4E in 2018. The slope from the end of the flame duct to the perimeter concrete area (perimeter apron) would be covered with gunite to reduce erosion (Figure 2-6 and Figure 2-7). Gunite (also known a shotcrete) is a mixture of concrete, sand, and water that is conveyed through a hose.

A 2-ft. tall stem walls would be placed at the western and eastern edges to anchor the structure (Figure 2-7). Minor grading of this area would be conducted to provide a constant slope. A 250-ft. (76.2-m.) perimeter wall would be constructed with concrete on top of the existing perimeter apron along the inside of the fence line (Figure 2-6 and Figure 2-8). This wall would serve to redirect water expelled from the flame duct and divert it down slope to a 60,000-gallon capacity retention basin to minimize water being discharged to Spring Canyon. The wall would be 4 ft. high with a 5-ft.-deep-by-4-ft.-wide footer. The footer would be excavated inside the fence line through the existing perimeter apron and the soil would be relocated to a stockpile onsite. The floor of the retention basin would utilize the existing concrete of the perimeter apron.

All equipment access to the construction area would be on existing roads or the existing apron. Concrete would be brought in with a concrete pump from the access road at the flame duct area. Valves would be installed on the existing stormwater drainage inlets to ensure that no water enters the inlets during launch operations (inlets would only be opened during storm events).

2.2.4 Spring Canyon Vegetation Removal

All vegetation would be removed to just above ground level within a 3.327-ac. (1.346-hectares [ha]) impact area of Spring Canyon (Figure 2-6) to avoid and minimize impacts to nesting migratory birds and erosion. Removal of the vegetation would be performed by mowers and hand equipment prior to nesting bird season and attempts would be made to reduce impacts to the drainage as much as possible. Additional vegetation removal (e.g., mowing) of the impact area would be performed outside of nesting bird season (15 February to 15 August) annually as needed to maintain low stature vegetation. Larger diameter vegetation (trees) will be removed from the drainage to prevent water quality impacts.

Figure 2-6. Civil Water Diversion Structure and Vegetation Removal Area (Impact Area) south of SLC-4 in Spring Canyon

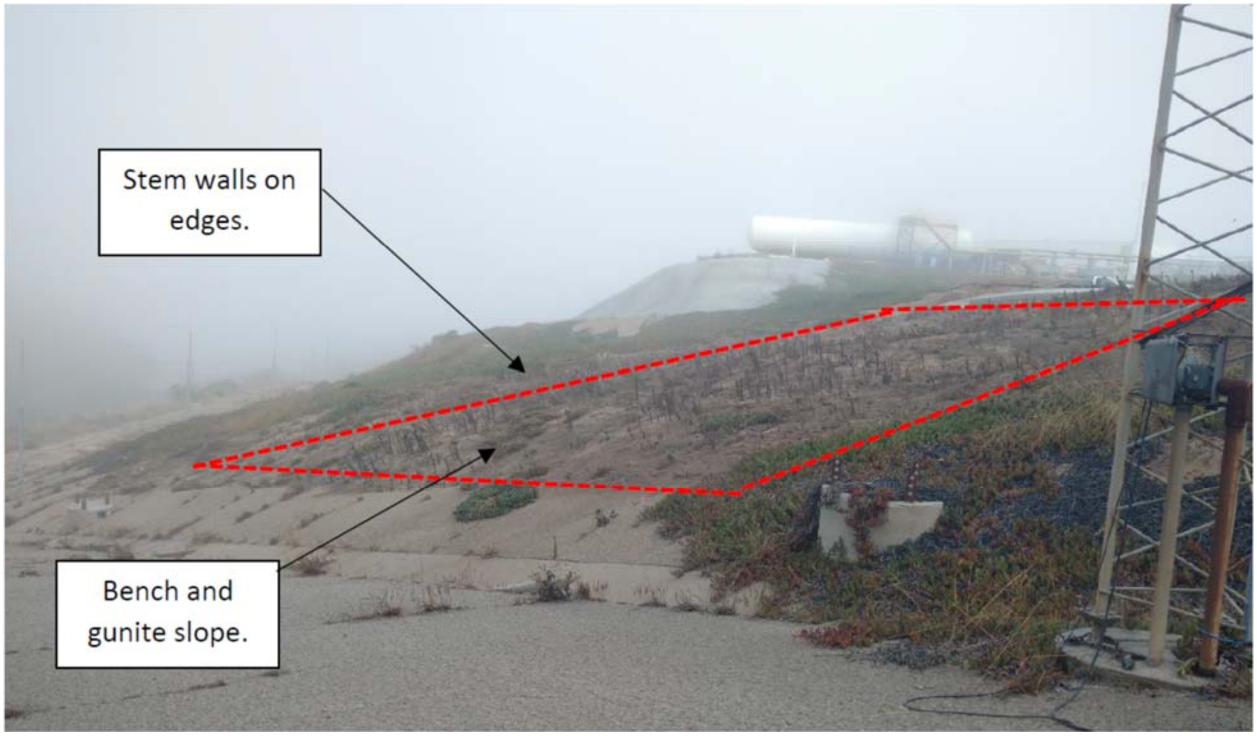


Figure 2-7. Proposed Gunite Application Area

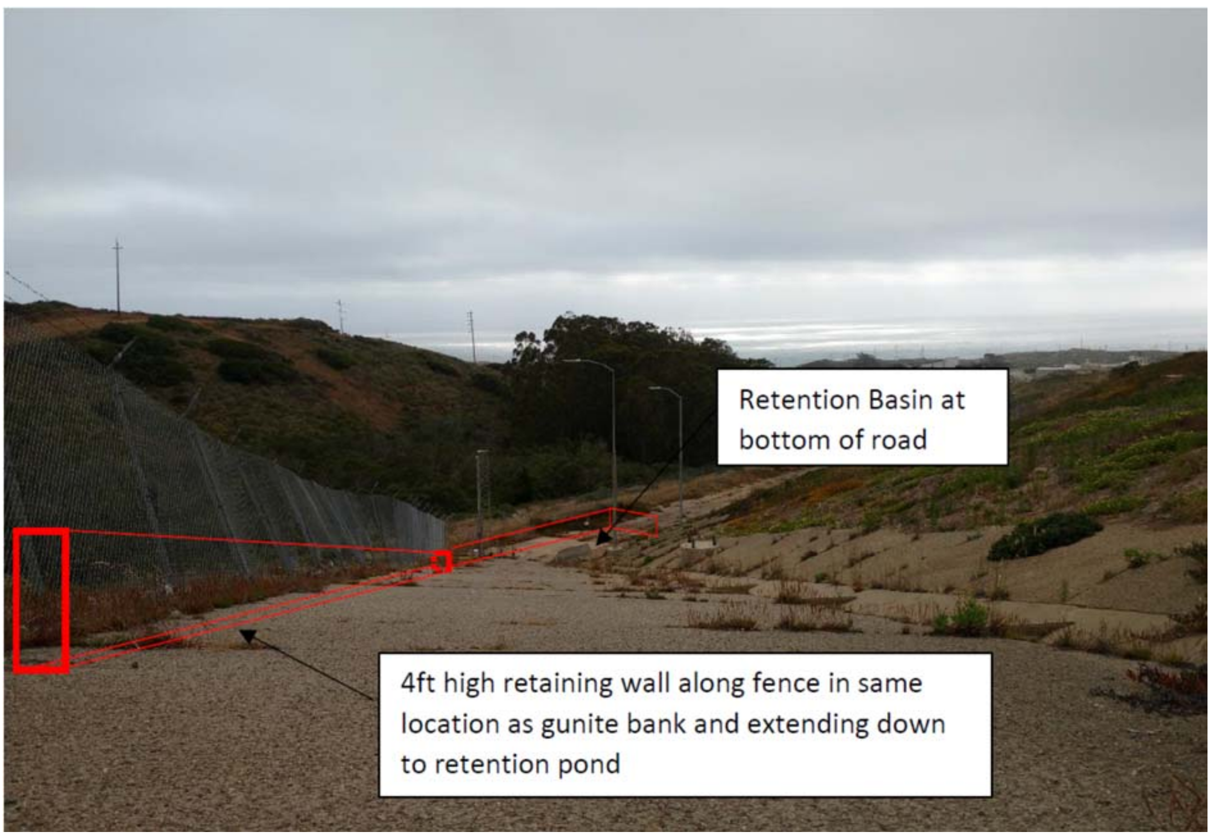


Figure 2-8. Mock-up of Proposed Perimeter Wall on Existing Concrete Apron

2.2.5 Spring Canyon Riparian Mitigation

The proposed project would result in an estimated 1.121 acres of permanent impacts (removal) to willow riparian habitat in Spring Canyon. To offset these impacts, the California State Water Resources Control Board would require mitigation at a 2:1 ratio (area of habitat enhanced through invasive species control to area of riparian woodland impacted). This mitigation would be accomplished by treating at least 2.25 acres of target invasive species within the Spring Canyon riparian area and within the Spring Canyon bed and bank area (from Coast Road to the west, beyond SLC-4). Target invasive species include Jubata grass (*Cortaderia jubata*), iceplant (*Carpobrotus edulis*), fennel (*Foeniculum vulgare*), poison hemlock (*Conium maculatum*), black mustard (*Brassica nigra*), and summer mustard (*Hirschfeldia incana*). Herbicide treatment would use a glyphosate-based herbicide formulation approved for aquatic use and would be applied to invasive plants up to the edge of surface water but not applied directly to any surface water. The Spring Canyon Riparian Mitigation Plan (Appendix G) contains additional details of the proposed habitat enhancement.

2.2.6 Environmental Protection Measures

The environmental protection measures (EPMs) described in the Falcon 9 EA and Falcon 9 Boost-Back EA would continue to be implemented (USAF, 2011a, 2106a, 2016b). Implementation of these EPMs would avoid or minimize potential adverse effects to various environmental resources. Mandatory EPMs (denoted by "shall" or "would") are part of the project design and would be implemented as part of Alternative 1 to avoid, minimize, reduce, or compensate for the anticipated potential environmental impacts. Discretionary measures (denoted by "may" or "could") may or may not be implemented to further reduce environmental impacts.

2.2.6.1 Air Quality – 1 (Air-1)

The following measures would be implemented to control fugitive dust emissions during ground-disturbing activities:

- A site-specific SWPPP has been prepared and implemented for SLC-4. Stormwater Best Management Practices are currently implemented following the latest California Stormwater Quality Association's Stormwater Best Management Practices Handbook.
- An Environmental Protection Plan, which includes dust control compliance measures, would be implemented prior to ground disturbance.
- Water trucks or sprinkler systems would be used to keep all areas of vehicle movement damp enough to prevent dust from leaving the site. At a minimum, this would include wetting down areas in the late morning and after work is completed for the day. Watering frequency would be increased when wind speeds exceed 15 miles per hour (mph). Whenever possible, reclaimed water would be used. The use of excessive amounts of water, which could cause runoff or erosion, would be avoided. Chlorinated water would not be allowed to run into any waterway.
- On-site vehicle speeds would be reduced to a maximum of 15 mph.
- Ground disturbance would be limited to the smallest practical area and to the least amount of time.
- After clearing, grading, earth moving, or excavation are completed, the disturbed area would be treated by watering, revegetating, or spreading soil binders until the area is replanted.

- If importation, exportation, and stockpiling of fill material are involved, soil stockpiled for more than 2 days would be covered, kept moist, or treated with soil binders to prevent dust generation. Trucks transporting fill material to and from the site would be tarped from the point of origin.
- Outbound trucks hauling construction debris (or any material that would generate visible fugitive dust beyond the property line) would utilize one of the following measures:
    a. Use properly secured tarps or cargo covering that covers the entire surface area of the load or use a container-type enclosures.
    b. Maintain a minimum of 6 inches of freeboard below the rim of the truck bed where the load touches the sides of the cargo area and ensure that the peak of the load does not extend above any part of the upper edge of the cargo area.
    c. Water or otherwise treat the bulk material to minimize loss of material to wind or spillage.
- Visbile roadway dust would be minimized by the use of any of the following track-out/carry-out and erosion control measures that apply to the project or operations: track-out grates of gravel beds at each egress point, wheel-washing at each egress point during muddy conditions, soil binders, chemical soil stabilizers, geotextiles, mulching, or seeding.
- Visible roadway dust would be removed at the conclusion of each work day when bulk material removal ceases, or every 24 hours for continuous operations. If a street sweeper is used to remove any track-out/carry-out, only a PM10-Efficient Street Sweeper would be used.
- A person or persons would be designated to monitor the dust control program and to order increased watering, as necessary, to prevent transporting dust off-site. The name and telephone number of the dust control monitor would be provided to the SBCAPCD prior to the issuance of grading/building permit issuance.

2.2.6.2 Air Quality – 2 (Air-2)

The following measures would be implemented to reduce nitrogen oxide (NO_x) and fine particulate matter (PM2.5) emissions from construction equipment:

- Before any modifications to SLC-4E or construction begins, portable equipment meeting the criteria for the California Air Resources Board Portable Equipment Registration Program would be registered in the program or have a valid SBCAPCD Permit to Operate.
- Whenever feasible, heavy-duty diesel-powered construction equipment manufactured after 1996 would be used. However, Tier 2 and up compliant vehicles that meet the California Air Resources Board's (CARB) In-Use Off-Road Diesel Vehicle Regulation are preferred.
- Construction equipment having the minimum practical engine size would be used.
- Construction equipment would be maintained per manufacturer's specifications.
- If available, construction equipment with diesel catalytic converters, diesel oxidation catalysts, and diesel particulate filters that are certified by the U.S. Environmental Protection Agency (USEPA) or CARB would be used.
- Idling of heavy-duty diesel trucks during loading and unloading would be limited to 5 minutes, with auxiliary power units used whenever possible.
- All applicable in-use heavy-duty diesel-fueled vehicles with a gross vehicle weight rating greater than 26,000 lb (e.g., trucks and buses) must meet particulate matter best available control technology and engine model year emission requirements as specified in the CARB

Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen and Other Criteria Pollutants from In-Use Heavy-Duty Diesel-Fueled Vehicles.

- Equipment usage and fuel consumption would be documented and reported to the 30th Civil Engineer Squadron, Asset Management Flight (30 CES/CEA) to facilitate tracking construction emissions for inclusion in the VAFB Air Emissions Inventory.

2.2.6.3 Biological Resources – 1 (Bio-1)

The following measures would be implemented to minimize potential impacts on native plant communities:

- The project footprint would minimize to the extent practicable to limit damage to native plant communities.
- When it is not practical to stage or operate project vehicles or equipment on paved or existing roadways and trails, vehicles and equipment would be staged and operated on nonnative vegetation to the maximum extent practicable.
- Native vegetation that is temporarily disturbed or removed during construction would be revegetated with local natives from VAFB's approved planting lists. Native species seeds would be purchased from a nursery with seed stock from a local source or collected in the vicinity of the disturbed area and used for revegetation either through planting of container plants, hydroseeding, or a combination of both.
- Non-native invasive plants such as jubata grass (*Cortaderia jubata*), fennel (*Foeniculum vulgare*), milk thistle (*Silybum marianum*), iceplant (*Carpobrotus* spp), etc. shall be controlled in restoration areas, including areas of cut vegetation when seasonally appropriate to prevent the introduction and spread of invasive plants into native plant communities. Non-native invasive plants shall be controlled as often during the year as necessary using manual and/or chemical means that is most effective and as often as strategically effective. Chemical application shall be adhere to herbicide application requirements by a certified herbicide applicator and shall avoid native plants..
- If a hydroseed mix is used, the hydroseed mix would be checked for the presence of potentially invasive species.
- In cases where short-term access is necessary, rubber-tired vehicles would be used to leave native vegetation intact and to minimize soil disturbance.
- In areas that are not required to be maintained as cleared areas, stumps would be left in place to facilitate regeneration. If complete clearing is necessary, the width and extent of cleared areas would be kept to a minimum. The number and footprint of access routes to a given area would also be minimized.
- Vehicles and equipment would be inspected and cleaned before use at a new site.
- Clothing would likewise be cleaned and inspected between sites.
- Weed-free materials, such as gravel, mulch, fill, and hay, would be used for construction and erosion control.

El Segundo Blue Butterfly (ESBB)

- The condition of seacliff buckwheat stands in the areas surrounding SLC-4 would be evaluated annually. Sites consistently supporting high numbers of mature seacliff buckwheat plants would be prioritized for ESBB surveys during the flight season.

- Historically occupied habitat on Avery Road, Bear Creek Road, and Coast Road would be surveyed at least once annually during the flight season.
- Monitoring would be conducted for at least 3 years. If ESBB are found in the area experiencing sonic boom in excess of 5.0 psf, or if occupancy is re-established and potential launch or landing related impacts are detected, additional monitoring may be conducted.
- Habitat enhancement would be performed within suitable but not known to be occupied habitat on Tranquillon Ridge along Honda Ridge Road adjacent to two existing ESBB restoration efforts on south VAFB. Habitat enhancement would consist of removing invasive plants and planting of seacliff buckwheat at a 2:1 ratio (area of habitat enhanced through invasive plant removal to area of potential El Segundo blue butterfly habitat impacted, and number of seacliff buckwheat planted to number of seacliff buckwheat impacted, by the flame duct action).
- Seacliff buckwheat would be propagated from seed sourced on south VAFB, would be grown without insecticides, and would be free of Argentine ants.
- Plantings would be conducted during the wet season (1 December – 15 March), and plants would be watered at the time of installation if rain is not forecasted with more than 60 percent certainty within 3 days of planting.
- The following measures would be implemented to reduce the risk of impacts to seacliff buckwheat and ESBB associated with habitat enhancement activities:
  - Individuals trained and proficient in seacliff buckwheat identification would conduct all herbicide applications;
  - Seacliff buckwheat would be avoided during herbicide application with plants covered to prevent drift if broad spectrum herbicide application is necessary adjacent to plants;
  - Herbicide treatments would occur under low wind conditions; and
  - Herbicide application would take place outside of the ESBB flight season (1 June – 15 September) when adults or larvae may be present.
- The following measures would be implemented to reduce the risk of impacts to seacliff buckwheat and ESBB associated with Spring Canyon riparian mitigation activities:
  - All individuals conducting herbicide application would be trained and demonstrate proficiency in the identification and avoidance of seacliff buckwheat.
  - Established roads, both paved and unpaved, would be used for vehicle access.
  - Herbicide would be applied in accordance with the pesticide label and Department of Defense (DoD) recommendations. The proposed herbicide formulation is currently DoD approved.
  - Herbicide mixing would occur in non-sensitive areas in accordance with the VAFB Integrated Pest Management Plan.
  - Herbicide treatments would only occur under low wind conditions to avoid drift to non-target species.
  - Seacliff buckwheat, although unlikely to occur in the riparian zone, would be avoided during all application of herbicides if encountered.
  - No broad scale herbicide application would take place in areas supporting seacliff buckwheat from 1 May through 30 September.

California Condor

- Movements of California condor would be monitored in the vicinity of VAFB, if present, via satellite telemetry during launch and landing events to determine whether launch and boost-back had an effect on movement patterns within the action area. Determination of presence would be coordinated with Ventana Wilderness Society and Service Condor Recovery Coordinator beginning two weeks in advance of each launch event at SLC-4.

Marbled Murrelet

- Annual population surveys would continue to be conducted at the current levels performed by the USAF to monitor the frequency and distribution of marbled murrelet within the ROI.

California Red-legged Frog

- A qualified biologist would conduct pre-activity surveys for California red-legged frog in Spring Canyon adjacent to SLC-4 and would conduct post-activity surveys to document any injured or killed individuals.
- If present within the area to be impacted by water and water vapor, adult California red-legged frogs would be captured when possible and relocated to the nearest suitable habitat within Spring Canyon, outside of the impact zone.
- One day prior to vegetation removal, a qualified biologist would conduct surveys for California red-legged frog within the area to be affected. Any California red-legged frogs present would be captured if possible and released at the nearest suitable habitat within Spring Canyon outside of the area to be affected by vegetation removal, as determined by the biologist. The biologist would also be present during vegetation removal to capture and relocate California red-legged frogs encountered to the extent that safety precautions allow. This biologist would also search for injured or dead California red-legged frogs after vegetation removal to document take.
- During construction of the civil water diversion structure, the following measures would be implemented:
    - All work would occur during daylight hours during periods when there is no rainfall.
    - A qualified biologist would monitor grading of the gunite application site.
    - Any open holes or trenches would be covered with plywood or metal sheets if left over night to minimize the risk of entrapment of California red-legged frogs.
    - A qualified biologist would survey the site, including any open holes or trenches, each day prior to initiation of work.
    - Any California red-legged frogs encountered during construction of the civil water diversion structure would be captured, if possible, and relocated out of harm's way to the nearest suitable habitat.
- The effects of sonic booms on California red-legged frogs breeding behavior in Cañada Honda Creek, and in upper Shuman Creek (as a "control" site) would be monitored using bioacoustics data loggers. Bioacoustic monitoring (one event) would be conducted during the first wet season launch/landing, between 30 November and 1 April. If no breeding California red-legged frogs are present during this launch, the monitoring would be attempted during the next wet season landing at SLC-4W.

- The USAF would continue to conduct baseline studies and population monitoring of California red-legged frog across the base, assess habitat, study the incidence of chytrid fungus, and assess other means of enhancing habitat across VAFB.
- The following measures would be implemented to reduce the risk of impacts to California red-legged frogs associated with Spring Canyon riparian mitigation activities:
    - All individuals conducting herbicide application would be trained and demonstrate proficiency in the identification and avoidance of special status species.
    - Established roads, both paved and unpaved, would be used for vehicle access.
    - Herbicide would be applied in accordance with the pesticide label and DoD recommendations. The proposed herbicide formulation is currently DoD approved.
    - Herbicide mixing would occur in non-sensitive areas in accordance with the VAFB Integrated Pest Management Plan.
    - Herbicide treatments would only occur under low wind conditions to avoid drift to non-target species.
    - Herbicide application would take place outside of the rainy season (15 October to 15 March).
    - No vehicle traffic would occur through surface water if present unless the route is pre-cleared by a qualified biologist.
    - All access for treatments would be restricted to daylight hours.
    - No glyphosate would be used in ephemeral aquatic habitats during the rainy season (15 October – 15 March).
    - No glyphosate would be used within 15 ft (4.6 m) of aquatic habitats when surface water or surface saturation of soils is present.
    - No glyphosate would be used in aquatic habitats 24 hours before or after a significant precipitation event (0.1 inches or more).

California Least Tern

- Monitoring of California least terns at the Santa Ynez River estuary would be conducted for landings events at SLC-4W to determine potential effects from the proposed activities, including mortality, injury, or changes to habitat use patterns or behavior. If California least terns are present at the Santa Ynez River estuary (typically 15 April to 15 August), a USFWS-approved biologist would conduct daily counts of California least terns beginning 3 days before the landing event through 3 days after. If practicable and not resulting in safety concerns to the monitor, visual and/or video monitoring of terns would be conducted during daytime launches.
- If active California least tern nests are present at the Purisima Point nesting colony, motion triggered video cameras would be placed at up to 10 percent of active nests to monitor potential impacts to the nest as a result of the launch and landing. Cameras would be placed in a manner to minimize disturbance to nesting terns; this would be determined in the field based on the best judgement of permitted tern monitors.
- Acoustic recording equipment would be deployed at or near the monitoring locations at the Santa Ynez River estuary and the Purisima Point nesting colony to document and quantify the level of the sonic boom.

Western Snowy Plover

- Monitoring of western snowy plovers would be conducted for landing events at SLC-4W between 1 March and 30 September. Nesting western snowy plovers nearest to SLC-4W, which will experience the highest sonic boom overpressures (e.g., 7-8 psf), would be monitored 3 days before and 3 days after the landing event to characterize potential impacts on reproductive success. This monitoring area is hereafter referred to as South Surf Beach to be consistent with the Monitoring and Minimization Plan (Appendix F).
- Up to 10 percent of active western snowy plover nests at South Surf Beach would be monitored with motion triggered video cameras for potential impacts to the nest as a result of the launch and landing. Cameras would be placed in a manner to minimize disturbance to nesting plovers; this would be determined in the field based on the best judgement of permitted plover monitors.
- Acoustic recording equipment would be deployed at or near the monitoring location to document and quantify sonic boom levels.
- The USAF would continue to perform annual management and monitoring of western snowy plover on Base, including habitat enhancement to expand potential breeding habitat, population monitoring, nest monitoring, and predator management. The USAF previously consulted with the USFWS and received a Biological Opinion on February 4, 2015, for the USAF's 2014-2018 Beach Management Plan and Water Rescue Training at VAFB. Restoration of western snowy plover habitat was proposed to compensate for the adverse effects caused by allowing recreational access in western snowy plover nesting habitat, and annual nest monitoring of all western snowy plovers throughout VAFB is a term and condition of the biological opinion.
- If western snowy plover eggs or chicks are abandoned or directly impacted and injured by launch activities, these animals would be transferred to the Santa Barbara Zoo for rehabilitation to the extent possible by USFWS-qualified individuals. During the nesting season, an incubator would be on standby operated by qualified individuals to receive abandoned eggs or chicks and safely transport them to the Santa Barbara Zoo for rehabilitation. This measure would be reviewed and adapted or eliminated if necessary depending on reviewing the number of eggs/chicks/adults requiring rehabilitation after the first year of activity.

Southern Sea Otter

- A USFWS-approved biologist would monitor southern sea otters for landing events at SLC-4W whenever a sonic boom of 2 psf or greater is predicted to be generated by the boost-back that would impact southern sea otter habitat. The monitoring location would be selected based on where pressure waves greater than 2 psf are predicted to impact and the relation of these locations to occupied sea otter habitat, which is commonly Sudden Flats on south VAFB. If otter counts by the United States Geological Survey (USGS), or other non-related survey efforts, show the establishment of new populations within the action area, new survey locations would be considered for boost-back and landing events.
- A USFWS-approved biologist would conduct daily counts of sea otters at the selected monitoring location beginning 3 days before and continuing 3 days after the boost-back and landing. The monitor would note any mortality, injury, or abnormal behavior observed during these counts. Weather permitting; the counts would be conducted between 09:00 AM and 12:00 PM when otters are most likely to be rafting to help maintain daily

consistency in detectability. Monitors would use both binoculars (10X) and a high-resolution 50–80X telescope to conduct counts.

- Acoustic recording equipment would be deployed at or near the monitoring location to document and quantify sonic boom levels.

2.2.6.4 Biological Resources – 3 (Bio-2)

The following measures would be implemented to minimize impacts on other non-federally listed special-status species (e.g., migratory birds):

- Removal of shrubs would also be avoided to the extent possible during the nesting period for non-raptor species of 15 February through 15 August. If removal of shrubs is necessary during this period, a nesting bird survey would be conducted in the impact areas to determine the presence of nesting native birds. If active nests are found, activities would not be conducted in that area until young have fledged.

2.2.6.5 Biological Resources – 4 (Bio-3)

The following measure would be implemented to mitigate impacts to pinnipeds:

- Unless constrained by other factors including human safety or national security concerns, launches must be scheduled to avoid boost-backs and landings during the harbor seal pupping season of March through June when practicable.

The following acoustic monitoring measures would be implemented to monitor potential impacts to offshore marine mammals and the offshore marine environment:

- To conduct monitoring of Falcon 9 First Stage recovery activities, SpaceX must designate qualified, on-site individuals approved in advance by NMFS;
- If sonic boom model results indicate that a peak overpressure of 1.0 psf or greater is likely to impact VAFB, then acoustic and biological monitoring at VAFB must be implemented;
- If sonic boom model results indicate that a peak overpressure of 1.0 psf or greater is predicted to impact the Channel Islands between March 1 and June 30, greater than 1.5 psf between July 1 and September 30, and greater than 2.0 psf between October 1 and February 28, monitoring of pinniped haulout sites on the Channel Islands must be implemented. Monitoring must be conducted at the haulout site closest to the predicted sonic boom impact area, when practicable;
- Monitoring must be conducted at the haulout site closest to the area predicted to experience the greatest sonic boom intensity, when practicable;
- If Falcon 9 First Stage recovery activities are scheduled during daylight, time-lapse photography or video recording must be used to document the behavior of marine mammals during Falcon 9 First Stage recovery activities;
- If Falcon 9 First Stage recovery activities are scheduled during nighttime, night vision binoculars must be used by monitors to observe pinniped behavior;
- Monitors must conduct hourly pinniped counts for 6 hours per day on the day of the Falcon 9 launch. Hourly pinniped counts will be centered around the launch time when events occur during daylight hours. For nighttime events, hourly pinniped counts will be conducted from daybreak to 6 hours after daybreak;

- Monitors must remain at the monitoring location until pinniped behavior is observed to return to normal, when practicable;
- Monitoring must be conducted for at least 72 hours prior to any planned Falcon 9 First Stage recovery and continue until at least 48 hours after the event;
- Monitoring must include multiple surveys each day that record the species, number of animals, general behavior, presence of pups, age class, gender and reaction to noise associated with Falcon 9 First Stage recovery, sonic booms or other natural or human caused disturbances, in addition to recording environmental conditions such as tide, wind speed, air temperature, and swell;
- For Falcon 9 First Stage recovery activities that occur from March through June, follow up surveys of harbor seal haulouts on VAFB will be conducted within two weeks of the Falcon 9 First Stage recovery;
- If sonic boom model results indicate a peak overpressure of 1.0 psf or greater is likely to impact VAFB during January or February, then acoustic and biological monitoring must be implemented at northern elephant seal rookeries at VAFB, when practicable;
- Acoustic measurements of the sonic boom created during boost-back at the monitoring location must be recorded to determine the overpressure level.

The following acoustic reporting measures would be implemented:

- Submit a report to the Office of Protected Resources, NMFS, and the West Coast Regional Administrator, NMFS, within 60 days after each Falcon 9 First Stage recovery action. This report must contain the following information:
    - Date(s) and time(s) of the Falcon 9 First Stage recovery action;
    - Design of the monitoring program; and
    - Results of the monitoring program, including, but not necessarily limited to:
        - Numbers of pinnipeds present on the haulout prior to the Falcon 9 First Stage recovery;
        - Numbers of pinnipeds that may have been harassed as a result of Falcon 9 First Stage recovery activities;
        - For pinnipeds estimated to have been harassed as a result of Falcon 9 First Stage recovery noise, the length of time pinnipeds remained off the haulout or rookery;
        - Any other observed behavioral modifications by pinnipeds that were likely the result of Falcon 9 First Stage recovery activities, including sonic boom; and
        - Results of acoustic monitoring including comparisons of modeled sonic booms with actual acoustic recordings of sonic booms.
- Submit an annual report on all monitoring conducted under the IHA. A draft of the annual report must be submitted within 90 calendar days of the expiration of the IHA, or, within 45 calendar days of the requested renewal of the IHA (if applicable). A final annual report must be prepared and submitted within 30 days following resolution of comments on the draft report from NMFS. The annual report will summarize the information from the 60-day post-activity reports, including but not necessarily limited to:
    - Date(s) and time(s) of the Falcon 9 First Stage recovery action;
    - Design of the monitoring program; and
    - Results of the monitoring program, including, but not necessarily limited to:

        - Numbers of pinnipeds present on the haulout prior to the Falcon 9 First Stage recovery;
        - Numbers of pinnipeds estimated to have been harassed as a result of Falcon 9 First Stage recovery activities at the monitoring location;
        - For pinnipeds estimated to have been harassed as a result of Falcon 9 First Stage recovery noise, the length of time pinnipeds remained off the haulout or rookery;
        - Any other observed behavioral modifications by pinnipeds that were likely the result of Falcon 9 First Stage recovery activities, including sonic boom;
        - Any cumulative impacts on marine mammals as a result of the activities, such as long term reductions in the number of pinnipeds at haulouts as a result of the activities; and
        - Results of acoustic monitoring including comparisons of modeled sonic booms with actual acoustic recordings of sonic booms.
- Reporting injured or dead marine mammals:
    - In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by the IHA (as determined by the lead marine mammal observer), such as an injury (Level A harassment), serious injury, or mortality, SpaceX will immediately cease the specified activities and report the incident to the NMFS Office of Protected Resources ((301) 427-8401) and the NMFS West Coast Region Stranding Coordinator ((562) 980-3230). The report must include the following information:
        - Time and date of the incident;
        - Description of the incident;
        - Status of all Falcon 9 First Stage recovery activities in the 48 hours preceding the incident;
        - Description of all marine mammal observations in the 48 hours preceding the incident;
        - Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility);
        - Species identification or description of the animal(s) involved;
        - Fate of the animal(s); and
        - Photographs or video footage of the animal(s).

Activities will not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with SpaceX to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. SpaceX may not resume their activities until notified by NMFS via letter, email, or telephone.

    - In the event that SpaceX discovers an injured or dead marine mammal, and the lead observer determines that the cause of the injury or death is unknown and the death is relatively recent (e.g., in less than a moderate state of decomposition), SpaceX will immediately report the incident to the NMFS Office of Protected Resources ((301) 427-8401) and the NMFS West Coast Region Stranding Coordinator ((562) 980-3230). The report must include the same information identified in 5(c)(1) of the IHA. Activities may continue while NMFS reviews the circumstances of the incident and makes a final determination on the cause of the reported injury or death. NMFS will work with SpaceX to determine whether additional mitigation measures or modifications to the activities are appropriate.

- In the event that SpaceX discovers an injured or dead marine mammal, and the lead observer determines that the injury or death is not associated with or related to the activities authorized in the IHA (e.g., previously wounded animal, carcass with moderate to advanced decomposition, scavenger damage), SpaceX will report the incident to the NMFS Office of Protected Resources ((301) 427-8401) and the NMFS West Coast Region Stranding Coordinator ((562) 980-3230), within 24 hours of the discovery. SpaceX will provide photographs or video footage or other documentation of the stranded animal sighting to NMFS. The cause of injury or death may be subject to review and a final determination by NMFS.

2.2.6.6 Cultural Resources

The following measures would be implemented to minimize impacts on sensitive archaeological resources:

- If cultural resources are encountered during project-related ground-disturbing activities, all excavation would be halted to avoid disturbing the site or any nearby area reasonably suspected to include cultural resources. 30th Civil Engineer Squadron, Installation Management Flight, Environmental Assets (30 CES/CEIEA) would be contacted so that the significance of the find can be assessed. If prehistoric Native American cultural materials are inadvertently discovered during project construction, then the SYBCI Tribal Elders Council will also be contacted.

2.2.6.7 Geology and Earth Resources

The following measures would be implemented to minimize erosion and impacts on stormwater quality during ground-disturbing activities:

- All entrances and exits to a construction site would be stabilized by, for example, using rumble plates, gravel beds, or other best available technology to reduce transport of sediment off-site. Any sediment or other materials tracked off-site would be removed within a reasonable time.
- Erosion and sediment control measures would be in place throughout grading and development of the site until all disturbed areas are permanently stabilized.
- Permanent roads shall be designed and constructed to prevent erosion and would require a gravel overlay or equivalent surface erosion control.

2.2.6.8 Human Health and Safety

The following measures would be implemented to minimize the potential for adverse impacts on human health and safety:

- All safety precautions for SLC-4 Operations and evacuation procedures for the project site area would be followed per Space Launch Vehicle Flight Hazard Zone requirements.
- SpaceX and subcontractors would comply with federal OSHA, AFOSH, and California's Division of Occupational Safety and Health (California OSHA) requirements.
- SpaceX would prepare and submit a health and safety plan to VAFB and would appoint a trained individual as safety officer.

- SpaceX would continue to implement Land Use Control Procedures, as documented in the VAFB General Plan (USAF, 2014a).
- To minimize potential adverse impacts from biological hazards (such as from snakes and poison oak) and physical hazards (such as from rocky and slippery surfaces), awareness training would be incorporated into the worker health and safety protocol.
- SpaceX would coordinate with 30th Space Wing Weapons Safety Office (30 SW/SEW) to insure VAFB policies on unexploded ordnance safety for construction work is incorporated into the site safety plan. The safety program would include coordination with the Air Force Civil Engineering Center, Environmental Center of Excellence Operations Military Munitions Response Program (MMRP) manager and contact with the weapons safety specialist for 30 SW/SEW.

2.2.6.9 Hazardous Materials and Waste

The following measures would be implemented to minimize impacts on hazardous materials and waste management:

- Measures would be taken to protect current wells related to remediation of groundwater around the site. There are three types of wells in the vicinity: monitoring wells, treatment wells, and extraction wells. Site activities would be conducted so as to protect wells that are in use and part of selected remedy as directed in the Final Record of Decision/Remedial Action Plan, VAFB Site 8c (USAF, 2013a).
- The fueling of vehicles and equipment would occur on impervious surfaces to the maximum extent practicable. Spill containment equipment would be present at all project sites where fuels or other hazardous substances are brought to the site. In addition, qualified personnel would conduct daily inspections of the equipment and the staging and maintenance areas for leaks of hazardous substances.

2.2.6.10 Solid Waste

Solid waste would be minimized by strict compliance with VAFB's Integrated Solid Waste Management Plan. Implementing the following measures would further minimize the potential for adverse impacts associated with solid waste:

- All materials that are disposed of off-base would be reported to the 30th Space Wing, Installation Management Flight (30 CES/CEI) Solid Waste Manager. Additionally, any materials recycled on-base by processes other than the base landfill, would be reported to the 30 CES/CEI Solid Waste Manager at least quarterly, with copies of weight tickets and receipts provided.

2.2.6.11 Water Resources

The following measures would be implemented to minimize impacts on water resources and stormwater:

- A mitigation and monitoring plan (MMP) has been prepared for the Falcon 9 program. Vegetation removal in Spring Canyon will result in an estimated 1.121 acres of permanent impacts to willow riparian habitat considered to be Waters of the State. To offset these impacts, the State Water Resources Control Board (SWRCB) requires mitigation at a 2:1 ratio: area of habitat enhanced through restoration and invasive species control to area of riparian woodland impacted. This mitigation would be accomplished with restoration of 2.5 acres of riparian habitat at the base of Spring Canyon drainage near Coast Road beyond SLC-4. Riparian restoration shall be implemented according to the plan and in accordance to any additional SWRCB requirements.

- A site-specific SWPPP has been prepared and implemented for SLC-4. Stormwater Best Management Practices are currently implemented following the latest California Stormwater Quality Association's Stormwater Best Management Practices Handbook.
- Geotextile fabrics, erosion control blankets, drainage diversion structures, or siltation basins would be used to reduce erosion and siltation into storm drains.
- All entrances and exits to a construction site would be stabilized by, for example, using rumble plates, gravel beds, or other best available technology to reduce transport of sediment off-site. Any sediment or other materials tracked off-site would be removed within a reasonable time.
- Wastewater in the retention basin shall be sampled per the General Waiver enrollment conditions and water containing prohibited chemical levels shall be properly disposed of per California regulations.

2.3 No Action Alternative

The CEQ regulations require the inclusion of a No-Action Alternative in an EA. The No-Action Alternative serves as a baseline against which the impacts of the Proposed Action can be evaluated.

Under the No Action Alternative, there would be no change to current launch and boost-back and landing activities. The potential impacts of the No Action Alternative have been previously analyzed in the Falcon 9 EA, the Falcon 9 Boost-Back EA, and the Falcon 9 Iridium SEA (USAF, 2011a, 2016a, 2016b). However, as described in Section 2.3, early models underestimated the nearfield magnitude of the sonic boom that would result from the boost-back and landings of the Falcon 9. The sonic boom from the First Stage would have the same sonic boom overpressures and characteristics as described in Section 2.3 for Alternative 1. The No Action Alternative would also continue to use a single engine for boost-backs and landings as described in the Falcon 9 EA.

Although the No Action Alternative would meet the purpose of and need for the Proposed Action, Alternative 1 is the Proposed Action because the increase tempo and multiple engine landing would better meet anticipated future commercial demands. The No Action Alternative would also not include the construction of a civil water diversion structure at SLC-4E, which would allow SpaceX to use more water in the flameduct at SLC-4E, which suppresses noise and vibration during launch events.

2.4 Other Alternatives Considered but Eliminated from Further Analysis

Other alternatives that were considered for this action but were determined to be unreasonable to meet the underlying purpose of and need for the Proposed Action were described in the Falcon 9 EA, Falcon 9 Boost-Back EA, and the Iridium SEA (USAF, 2011a, 2016a, 2016b).

The USAF also considered increasing Falcon 9 activities at Cape Canaveral, Kennedy Air Station, or both. This alternative was eliminated because rockets launched from Cape Canaveral and Kennedy Air Station typically launch east to achieve prograde orbits. Retrograde or polar orbit trajectories would not be reasonable at these locations because of landmass restrictions. Therefore, this alternative would not meet the purpose of or need for the Proposed Action.

The USAF considered the possibility of noise attenuation mechanisms, but there are no feasible methods of attenuating or redirecting the sonic boom of a super-sonic vehicle or landing noise. The only way to modify the sound would be to modify the source (rocket size, weight, profile, etc.) or modify the trajectory, such that the First Stage decelerates to subsonic speeds at a fairly high altitude. These modifications would limit payload possibilities or require more fuel and burn time to keep reducing speed. Neither of these modifications would meet the purpose of or need for the Proposed Action.

Adding water to the flame duct serves the purpose and need of reducing vibration during launch to protect cargo from damage. The USAF considered extending the flame duct to capture and divert the water release; however this was determined to be more impactful that the installation of a water diversion structure because of the significant amount of earthwork and concrete installation that would be required. There were no other feasible alternatives identified that would serve this purpose and need. The installation of a civil water diversion structure serves the purpose of capturing water release from the flame duct to minimize impacts to Spring Canyon. No other viable alternatives of capturing this water were identified.

Vegetation removal in Spring Canyon serves the purpose of avoiding impact to nesting migratory birds in the area impacted by release of water and steam from the flame duct during launch by eliminating nesting habitat in this area. Harassment mechanisms were considered, including the installation of laser arrays; however were determined to be more impactful on migratory birds than the elimination of habitat. The USAF also considered restricting launch operations that require water in the flame duct to outside of nesting season (15 February to 30 September); however, this alternative would not meet the purpose of or need for the Proposed Action.

Mitigation to offset impacts to riparian habitat within Spring Canyon are required by the Central Coast Regional Water Quality Control Board. Off-site mitigation options were considered; however, the Central Coast RWQCB strong prefers on-site mitigation options when available. The lower portion of Spring Canyon was the only feasible area identified for riparian mitigation within Spring Canyon due to hydrology, soils, and vegetation components.

3 Affected Environment

This chapter describes the existing environment near and within the project areas for Alternative 1 (Proposed Action) and the No Action Alternative. The area considered for most resources included the areas potentially impacted by overpressure, landing noise, and the overflight path of the Falcon 9 as well as the area potentially impacted from the construction of the civil water diversion structure. A wider regional area was evaluated for some environmental resources.

The resources identified for analysis in this SEA include air quality, climate, biological resources, water resources, cultural resources, geology and earth resources, coastal zone management, and U.S. Department of Transportation Act Section 4(f) Properties.

The following resources were considered but not analyzed in this SEA because the resource would not be affected or there would be no change from what was analyzed in the Falcon 9 EA, the Falcon 9 Boost-Back EA, or the Falcon 9 Iridium SEA (USAF, 2011a, 2016a, 2016b):

- ***Land Use and Aesthetics.*** The Proposed Action would not change land use or affect land use planning. Therefore, this resource was considered but not analyzed in this SEA.
- ***Environmental Justice.*** Per EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, the potential effects of the Proposed Action on minority communities and low-income communities were considered. Impacts to minority or low-income populations were not analyzed in this SEA because the Proposed Action and any potential effects, other than noise, would occur within VAFB boundaries, and it would not have disproportionately high and adverse human health or environmental effects on low income or minority populations within the region (Lompoc and Santa Maria Valleys).
- ***Children's Environmental Health and Safety Risks.*** Per EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks* (1997) (as amended by EO 13229 [2001] and EO 13296 [2003]), the potential effects of the Proposed Action on children were considered. The Proposed Action would neither affect nor disproportionately affect children within the region of influence (ROI). The Proposed Action would occur within an unpopulated area of VAFB, and potential environmental impacts with the exception of noise would not extend into populated areas. Therefore, this resource was not analyzed in this SEA, and it would not result in any health or safety risk that would disproportionately affect children.
- ***Socioeconomics.*** The Proposed Action would not include the creation or loss of jobs, nor would it change traffic patterns. Therefore, socioeconomic impacts were considered but not analyzed in this SEA.
- ***Floodplains.*** The Proposed Action would not impact regulated floodplains. Therefore, impacts to regulated floodplains was considered but not analyzed in this SEA.
- ***Hazardous Materials and Waste Management.*** The Proposed Action would not change the management of hazardous wastes and materials at SLC-4 as described in the Falcon 9 EA and Falcon 9 Boost-Back EA (USAF, 2011a, 2016a). Potential adverse impacts to the environment associated with hazardous materials and waste management would continue to be minimized through strict compliance with all applicable federal, state, and local laws

and regulations, local support plans and instructions including 30 SWP 32-7086, Hazardous Materials Management Plan; and 30 SWP 32-7043A, Hazardous Waste Management Plan, as well as those measures described in the Falcon 9 EA and Falcon 9 Boost-Back EA. Any infrastructure modifications and operations at SLC-4E and SLC-4W would accommodate on-going monitoring and remediation activities for Environmental Restoration Program (ERP) Site 8 cluster. Soils and groundwater (if encountered) would be observed for unusual odor or coloring. If irregularities are discovered, then construction would cease and the VAFB environmental office would be consulted. Therefore, the Proposed Action would not additionally affect hazardous materials and waste management, and this resource was considered but not analyzed in this SEA.

- ***Solid Waste Management.*** The Proposed Action would not change nor alter the management of solid waste as described in the Falcon 9 EA and Falcon 9 Boost-Back EA (USAF, 2011a, 2016a). Solid waste generated during construction activities would include packaging from materials (cardboard and plastic), scrap rebar, wood, pipes, wiring, asphalt, and concrete. These activities would result only in a negligible increase in the amount of solid waste generated locally. Contractors would be responsible for the disposal and recycling of all wastes generated during the scope of the project. SpaceX would manage construction and debris materials to the maximum extent possible. Therefore, the Proposed Action would not additionally affect solid waste management, and this resource was considered but not analyzed in this SEA.
- ***Human Health and Safety.*** There would be no additional conditions that could adversely impact human health and safety that were not analyzed in the Falcon 9 EA and Falcon 9 Boost-Back EA (USAF, 2011a, 2016a). All activities would continue to be subject to the requirements of the federal OSHA, AFOSH, and California OSHA regulations and procedures. In addition, missile/space launch, vehicle flight hazard zones, and explosive safety zones, as well as debris impact corridors, would continue to be utilized as described in the Falcon 9 EA and Falcon 9 Boost-Back EA. Therefore, the Proposed Action would not additionally affect human health and safety, and this resource was considered but not analyzed in this SEA.
- ***Transportation.*** The Proposed Action would not impact any primary or local roadway or increase traffic. Therefore, this resource was considered but not analyzed in this SEA. As discussed in the Falcon 9 Boost-Back EA (USAF, 2016a), VAFB would issue a Notice to Airmen and Notice to Mariners as required.
- ***Natural Resources and Energy Supply.*** The Proposed Action would not require the use of scarce or unusual materials and would not measurably increase demand on local supplies of energy or natural resources. Therefore, this resource was considered but not analyzed in this SEA.

3.1 Air Quality

Air quality is defined by ambient air concentrations of specific pollutants determined by the USEPA to be of concern with respect to the health and welfare of the general public. Six 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}), fine particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$), and lead (Pb). The USEPA has established National Ambient Air Quality Standards (NAAQS) for these pollutants. Areas that violate a federal air quality standard are designated as non-attainment areas.

The ambient air quality levels 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, 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 California Ambient Air Quality Standards (CAAQS). Areas within California in which ambient air concentrations of a pollutant are higher than the CAAQS or NAAQS are considered to be in non-attainment for that pollutant.

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.

3.1.1 Region of Influence

Specifically identifying the ROI for air quality requires knowledge of the type of pollutant, emission rates of the pollutant source, proximity to other emission sources, and local and regional meteorology. For inert pollutants (all pollutants other than O_3 and its precursors), the ROI is generally limited to a few miles downwind from the source. However, for photochemical pollutant such as O_3, the ROI may extend much farther downwind. O_3 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 O_3 levels tends to occur several hours after the time of emission during periods of high solar load and may occur many miles from the source. O_3 and O_3 precursors transported from other regions can also combine with local emissions to produce high local O_3 concentrations. The ROI for the Proposed Action includes the South Central Coast Air Basin (SCCAB) as well as the South Coast Air Basin (SCAB).

3.1.2 Regional Setting

VAFB is within Santa Barbara County and under the jurisdiction of the SBCAPCD. The SBCAPCD is the agency responsible for the administration of federal and state air quality laws, regulations, and policies in Santa Barbara County, which is within the SCCAB. The SCCAB includes San Luis Obispo, Santa Barbara, and Ventura Counties.

Support vessels would originate from Long Beach Harbor and transit to the contingency landing areas. Long Beach Harbor and adjacent coastal waters are within Los Angeles County and under the jurisdiction of the South Coast Air Quality Management District (SCAQMD), which is part of the SCAB. The SCAB includes Los Angeles County, Orange County, and Western San Bernardino County.

3.1.3 Federal Requirements

The USEPA is the agency responsible for enforcing the Clean Air Act (CAA) of 1970 and its 1977 and 1990 amendments. The purpose of the CAA is to establish NAAQS, classify areas as to their attainment status relative to the NAAQS, develop schedules and strategies to meet the NAAQS, and regulate emissions of criteria pollutants and air toxics 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 Clean Air Act Amendments (1990) established new deadlines for achievement of the NAAQS, dependent upon the severity of non-attainment.

The USEPA 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 mobile 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 SBCAPCD's permitting processes, all stationary sources are reviewed and are subject to an NSR process.

General Conformity: Under 40 C.F.R. Part 93 and the provisions of Part 51, Subchapter C., Chapter I, Title 40, Appendix W of the C.F.R., of the CAA as Amended, federal agencies are required to demonstrate that federal actions conform with the applicable SIP. The USEPA general conformity rule applies to federal actions occurring in non-attainment or maintenance areas. For projects that trigger the conformity rule by occurring in a non-attainment or maintenance area, a set of *de minimis* thresholds have been established to determine whether a federal action would have the potential to violate the state's SIP for the pollutant that is in non-attainment of NAAQS. If annual emissions produced from construction or operation activities exceed the *de minimis* thresholds, which are measured in tons per year, then the performing agency is required to consult with the corresponding air quality management district. A conformity determination is not required for activities that include major new or modified stationary sources that require a permit under the new source review program or the prevention of significant deterioration program.

3.1.4 Local Requirements

The ROI for this analysis includes Santa Barbara County, which is under the jurisdiction of the SBCAPCD as well as Long Beach Harbor and adjacent coastal waters, which are in the SCAB under the jurisdiction of the SCAQMD.

3.1.4.1 Santa Barbara County Air Pollution Control District

SBCAPCD regulations require that facilities building, altering, or replacing stationary equipment that may emit air pollutants obtain an Authority to Construct permit. Further, SBCAPCD regulations require a stationary source of air pollutants to obtain a Permit to Operate. The local air districts are responsible for the review of applications and for the approval and issuance of these permits. In addition, the SBCAPCD regulations require a stationary source that would emit 25 tons per year or more of any pollutant except CO in any calendar year during construction to obtain emission offsets.

Santa Barbara County is classified as an attainment/unclassified area for the NAAQS for all criteria pollutants. Santa Barbara County is a nonattainment area for the CAAQS for the O_3 8-hour and 1-hour averaging times and the PM_{10} 24-hour and annual arithmetic mean averaging times. Santa Barbara County is classified as an attainment/unclassified area for the CAAQS for all other criteria pollutants.

The CARB and SBCAPCD operate a network of ambient air monitoring stations throughout Santa Barbara County. The purpose of the monitoring stations is to measure ambient concentrations of the pollutants and determine whether the ambient air quality meets the CAAQS and the NAAQS. The nearest ambient monitoring stations to the project site are the VAFB STS Power site and the Lompoc S. H Street monitoring station. The VAFB monitoring station measures O_3, PM_{10}, CO, NO_2, and SO_2, but does not measure $PM_{2.5}$. The station ceased monitoring CO in 2012, as CO levels have been well below the state and federal standards. The Lompoc S. H Street monitoring station measures all criteria pollutants.

Table 3-1. Background Ambient Air Quality at VAFB (concentrations in ppm unless otherwise indicated)

Pollutant	Averaging Time	Sampling Method	Monitoring Station	2014	2015	2016	CAAQS (ppm)	CAAQS Designation	NAAQS (ppm)	NAAQS Designation
O_3	8 hour	National	Vandenberg	0.071 (May)	0.061	0.066	0.070	Nonattainment	0.070	Attainment
	1 hour	California	Vandenberg	0.078	0.069	0.072	0.09	Nonattainment	-	-
PM_{10}	Annual Arithmetic Mean	National	Vandenberg	21.4 µg/m^3	22.7 µg/m^3	25.1 µg/m^3	20 µg/m^3	Nonattainment	-	-
		California	Vandenberg	22.5 µg/m^3	-	-	20 µg/m^3	Nonattainment	-	-
	24 hour	National	Vandenberg	68.3 µg/m^3	58.0 µg/m^3	257.2 µg/m^3 (Nov)	50 µg/m^3	Nonattainment	150 µg/m^3	Attainment
		California	Vandenberg	71.1 µg/m^3 (Jan)	60.7 µg/m^3 (Apr)	173.6 µg/m^3 (Oct)	50 µg/m^3	Nonattainment	150 µg/m^3	Attainment
$PM_{2.5}$	Annual Arithmetic Mean	National	Lompoc	-	7.0 µg/m^3	7.0 µg/m^3	12 µg/m^3	Unclassified	12.0 µg/m^3	Attainment
		California	Lompoc	6.3 µg/m^3	-	-	12 µg/m^3	Unclassified	12.0 µg/m^3	Attainment
	24 hour	National	Lompoc	-	21.2 µg/m^3	30.9 µg/m^3	-	-	35 µg/m^3	Attainment
		California	Lompoc	16.7 µg/m^3	21.2 µg/m^3	30.9 µg/m^3	-	-	35 µg/m^3	Attainment
NO_2	Annual	-	Vandenberg	0.0	-	0.0	0.030	Attainment	0.053	Attainment
	1 hour	-	Vandenberg	0.038	0.008	0.007	0.18	Attainment	0.100	Attainment
CO	8 hour	-	Vandenberg	-	-	-	9.0	Attainment	9	Attainment
	1 hour	-	Vandenberg	1.500	0.400	0.500	-	-	-	-
SO_2	Annual	-	Vandenberg	-	-	-	-	-	0.030	Attainment
	24 hour	-	Vandenberg	-	-	-	0.04	Attainment	0.14	Attainment
	1 hour	-	Vandenberg	0.015	0.003	0.119	-	-	-	-

Source: www.arb.ca.gov

Notes: CAAQS = California Ambient Air Quality Standards, CO = Carbon Monoxide, NAAQS = National Ambient Air Quality Standards, NO_2 = Nitrogen Dioxide, $PM_{2.5}$ = Particulate Matter less than 2.5 microns, PM_{10} = Particulate Matter less than 10 microns, ppm = part(s) per million, µg/m^3 = microgram(s) per cubic meter

California averages reported for PM_{10}

Table 3-2. Background Ambient Air Quality at Long Beach Monitoring Stations (concentrations in ppm unless otherwise indicated)

Pollutant	Averaging Time	Sampling Method	Monitoring Station	2014	2015	2016	CAAQS (ppm)	CAAQS Designation	NAAQS (ppm)	NAAQS Designation
O_3	8 hour	National	Long Beach	0.072	0.066	0.059	0.070	Nonattainment	0.070	Nonattainment
	1 hour	California	Long Beach	0.087	0.087	0.079	0.09	Nonattainment	-	-
PM_{10}	Annual Arithmetic Mean	National	Long Beach	29.6 μg/m^3	31.5 μg/m^3	31.9 μg/m^3	20 μg/m^3	Nonattainment	-	-
		California	Long Beach	29.5 μg/m^3	31.3 μg/m^3	-	20 μg/m^3	Nonattainment	-	-
	24 hour	National	Long Beach	84.0 μg/m^3	80.0 μg/m^3	75.0 μg/m^3	50 μg/m^3	Nonattainment	150 μg/m^3	Nonattainment
		California	Long Beach	84.0 μg/m^3	79.0 μg/m^3	-	50 μg/m^3	Nonattainment	150 μg/m^3	Nonattainment
$PM_{2.5}$	Annual Arithmetic Mean	National	Long Beach	-	12.8 μg/m^3	11.9 μg/m^3	12 μg/m^3	Nonattainment	12.0 μg/m^3	Nonattainment
		California	Long Beach	-	12.9 μg/m^3	12.0 μg/m^3	12 μg/m^3	Nonattainment	12.0 μg/m^3	Nonattainment
	24 hour	National	Long Beach	-	48.8 μg/m^3	33.3 μg/m^3	-	-	35 μg/m^3	Nonattainment
		California	Long Beach	-	48.8 μg/m^3	33.3 μg/m^3	-	-	35 μg/m^3	Nonattainment
NO_2	Annual	-	Long Beach	-	0.011	0.010	0.030	Attainment	0.053	Maintenance
	1 hour	-	Long Beach	0.072	0.054	0.040	0.18	Attainment	0.100	Maintenance
CO	8 hour	-	Long Beach	-	-	-	9.0	Attainment	9	Maintenance
	1 hour	-	Long Beach	-	-	-	-	-	-	-
SO_2	Annual	-	Long Beach	-	-	-	-	-	0.030	Attainment
	24 hour	-	Long Beach	-	-	-	0.04	Attainment	0.14	Attainment
	1 hour	-	Long Beach	-	-	-	-	-	-	

Source: www.arb.ca.gov

Notes: CAAQS = California Ambient Air Quality Standards, CO = Carbon Monoxide, NAAQS = National Ambient Air Quality Standards, NO_2 = Nitrogen Dioxide, $PM_{2.5}$ = Particulate Matter less than 2.5 microns, PM_{10} = Particulate Matter less than 10 microns, ppm = part(s) per million, μg/m^3 = microgram(s) per cubic meter

California averages reported for PM_{10}

3.2 Climate

Climate change is a global phenomenon that can have local impacts. Scientific measurements show that Earth's climate is warming, with concurrent impacts including warmer air temperatures, increased sea level rise, increased storm activity, and an increased intensity in precipitation events. Research has shown there is a direct correlation between fuel combustion and greenhouse gas (GHG) emissions. GHGs are defined as including CO_2, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride (California Health and Safety Code Section 38505[g]). CO_2 is the most important anthropogenic GHG because it is a long-lived gas that remains in the atmosphere for up to 100 years.

GHGs have varying global warming potential (GWP). The GWP is the potential of a gas or aerosol to trap heat in the atmosphere; it is the "measure of the total energy that a gas absorbs over a particular period of time (usually 100 years), compared to CO_2" (USEPA, 2013). The reference gas for GWP is CO_2; therefore, CO_2 has a GWP of 1. The other main GHGs that have been attributed to human activity include CH4, which has a GWP of 21, and N_2O, which has a GWP of 310. CO_2, followed by CH_4 and N_2O, are the most common GHGs that result from human activity. CO_2, and to a lesser extent, CH_4 and N_2O, are products of combustion and are generated from stationary combustion sources as well as vehicles. High global warming potential gases include GHGs that are used in refrigeration/cooling systems such as chlorofluorocarbons and hydrofluorocarbons.

In August 2016, CEQ released final guidance regarding the consideration of GHGs in NEPA documents for federal actions (CEQ, 2016). CEQ withdrew this guidance effective April 5, 2017 (82 FR 16576).

3.3 Noise

Sound is a physical phenomenon consisting of pressure fluctuations that travel through a medium, such as air, and are sensed by the human ear. Noise is considered unwanted sound that can disturb routine activities (e.g., sleep, conversation, student learning) and can cause annoyance.

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 Region of Influence

This section addresses potential noise impacts on the human environment in the vicinity of VAFB from noise generated by activities identified in the alternatives, including the Proposed Action. For the purpose of this SEA, the ROI includes the SLC-4 complex and areas potentially overflown by the First Stage, areas that may be impacted by landing noise (Figure 2-2 and Figure 2-3), and areas that may be impacted by sonic booms from the Falcon 9 (Figure 2-4 and Figure 2-5).

3.3.2 Basics of Sound

3.3.2.1 Sound Characteristics

Sound results from vibrations, introduced into a medium such as air, that stimulate the auditory nerves of a receptor to produce the sensation of hearing. Sound is undesirable if it interferes with communication, is intense enough to damage hearing, or diminishes the quality of the environment. Undesirable sound is commonly referred to as "noise." Human responses to sound vary with the types and characteristics of the sound source, the distance between the source and receptor, receptor sensitivity, the background sound level, and other factors such as time of day. Sound may be intermittent or continuous, steady or impulsive, and may be generated by stationary sources such as industrial plants or transient noise sources such as cars and aircraft. Sound energy travels in waves. Its intensity at a receptor varies as a function of source intensity, the characteristics of the sound wave, the distance between source and receiver, and environmental conditions. Reflection, refraction, diffraction, and absorption are physical interactions between sound waves and surfaces or the medium through which the sound travels.

Most environments include near-constant, long-term sound sources that create a background sound level, and intermittent, intrusive sources that create sound peaks that are noticeably higher than the background levels. In remote areas far away from any human activities, the background sound level is determined by natural sources such as water (e.g., rain), and wind blowing through the vegetation. The extent to which an intrusive sound affects a given receptor in the environment depends upon the degree to which the intruding sound exceeds the background sound level. Both background and intrusive sound may affect the quality of life in a given environment. Cumulative, long-term exposure to excessive background sound is recognized as the primary cause of hearing loss. Intrusive sound, although not a cause of permanent hearing loss, can contribute to stress, irritability, loss of sleep, and impaired work efficiency.

Impulsive sound is short in duration, less than 1 second, and high in intensity. Impulsive sound has an abrupt onset and decays rapidly; it is characteristic of sonic booms, and is expressed in peak, unweighted decibels (defined in Section 3.3.2.2, Sound Spectrum) or pressure psf. Although impulsive sound is short in duration, it may be a source of discomfort for many people as the rapid onset of sound may produce a "startle" effect (U.S. Department of the Navy, 1978).

3.3.2.2 Sound Spectrum

Sound oscillates in waves, and the rates of oscillation (frequencies) are measured in cycles per second, or hertz (Hz). The human ear can detect sounds ranging in frequency from about 20 to 20,000 Hz, with the ear most sensitive to frequencies from 1,000 to 4,000 Hz (U.S. Army, 2005). Most environmental sounds consist not of a single frequency, but rather a broad band of frequencies that vary in intensity. Sound frequencies from military training activities vary greatly. Some examples of frequencies at peak sound energy include fixed-wing aircraft (2,000–4,000 Hz), small arms (approximately 500 Hz), explosives (approximately 31 Hz), street vehicles (approximately 60 Hz), and diesel trucks (approximately 250 Hz) (U.S. Department of the Navy, 1978; U.S. Army, 2005). The human ear is not equally sensitive to all sound frequencies within the frequency range of human hearing; the human ear cannot detect lower frequencies as well as it can detect higher frequencies. Thus, the "raw" sound intensity measured by mechanical devices is selectively weighted—or filtered—to simulate the non-linear response of the human ear. The two typical weighting networks are the C scale and the A scale (Figure 3-1).

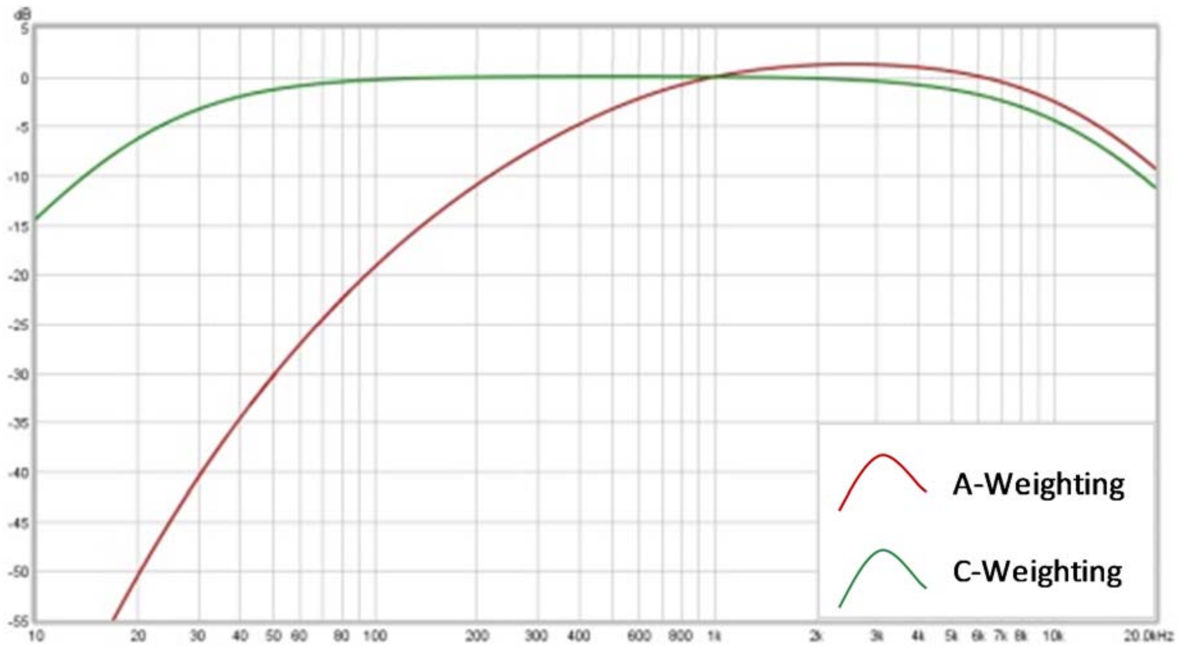


Figure 3-1. A and C Weighting Scales

Weighting networks are used in sound meters to adjust their frequency response to "raw" (unweighted) measured sounds. The A-weighting network is designed to duplicate the sensitivity of the human ear, heavily discounting sound energy at low frequencies and at very high frequencies and corresponding roughly to the average sensitivity of the human ear at low to moderate sound levels. In several studies, a person's judgment of the loudness of a sound has been shown to correlate well with the A-weighted values of those sounds (U.S. Department of the Navy, 1978). For this reason, the A scale is the most common weighting scheme for community sound measurements and standards, and is used for most environmental noise evaluations. These adjusted sound levels are termed "A-weighted" sound levels, denoted as dB(A) or simply dBA. The A-weighted scale is used internationally in sound standards and regulations. Therefore, dBA is the primary sound metric to be used in analyzing sound effects under environmental consequences because its characteristics are reflective of the human ear's frequency response.

3.3.2.3 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, measured in terms of Sound Exposure Level (SEL), are associated with vehicles driving by, aircraft overflights, or impulse noise. The SEL is based on two characteristics of transient sound, duration and intensity, where a long duration, low-intensity event can be as annoying as a high-intensity, shorter event. The SEL is the total acoustic energy in an event normalized to 1 second (U.S. Army, 2005). This number represents all of the acoustic energy for the event in a 1-second period.

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. Equivalent sound levels can represent any length of time, but typically are associated with some meaningful period, such as an 8-hour L_{eq} for an office, or a 1-hour L_{eq} for a classroom lecture (U.S. Army, 2005). The L_{eq} is often averaged over a 1-, 8-, or 24-hour period using the following formula:

$$Leq = 10\ log10\left\{\left[1/T\int_{t_1}^{t_2} p^2{}_A(t)dt\right]/p_o^2\right\}$$

Where $p^2A(t)$ is the square of the instantaneous A-weighted sound pressure, in pascals, as a function of time t for an averaging time interval T starting at t_1 and ending at t_2; p_o^2 is the square of the standard reference sound pressure of 20 micropascals.

The L_{eq} is often averaged over a 1-, 8-, or 24-hour period. The L_{eq} is used to describe continuous sound sources, and may be obtained by averaging sound levels over a selected period. This level is the estimation of the continuous sound level that would be equivalent to the fluctuating sound signal under consideration (U.S. Department of the Navy, 1978). A L_{eq} that is a 24-hour average can also be termed the Day-Night Average Sound Level (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 between the hours of 10 p.m. and 7 a.m. is artificially increased by decibels (dB). This noise is weighted to take into account the decrease in community background noise of 10 dB during this period (Figure 3-2).

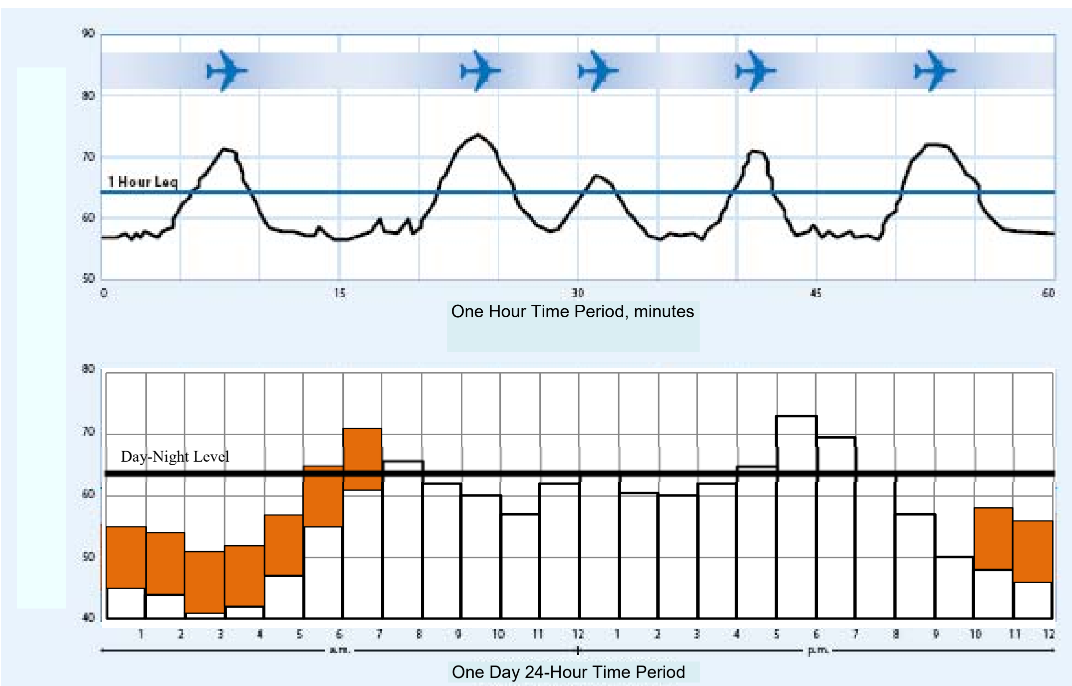


Figure 3-2. Relationship of Sound Level, Leq, and Day-Night Average Sound Level

3.3.2.4 Sound Intensity and Perception

Sound intensity is expressed in dB, a logarithmic scale that compares the power of an acoustical signal to a reference power level. 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 3.3 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 (typically measured between 120 and 140 dBA) (Table 3-3).

A 1 dB change in the sound level is not perceptible to humans (imperceptible change), a 3 dB change is barely perceptible, and a 5 dB change is clearly noticeable. A 10 dB change is perceived by the human ear 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 Falcon 9 Takeoff at 1,600 ft. (487m)	130	**Above Threshold of Pain**
Commercial Jet Takeoff at 200 ft. (61 m) Falcon 9 Takeoff at 2,500 ft. (762 m)	120	**Threshold of Pain** 32 times as loud
Pile Driver at 50 ft. (15.2 m) Falcon 9 takeoff at 1.5 miles (2.4 km)	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
	0	**Threshold of Hearing**

Notes: dBA = decibel(s), A-weighted; ft. = foot/feet; m = meter(s); mph = miles per hour

Sources: Federal Interagency Committee on Noise 1992, U.S. Army 2005, U.S. Air Force 2013b

3.3.2.5 Sound Propagation

Sound energy radiates outward from its source. This sound energy attenuates (decreases in intensity) as it moves away from its source because of geometric spreading of the sound energy, atmospheric absorption, ground attenuation, and shielding. Sound metrics for discrete sources are expressed in terms of a distance from the source (a typical reference distance is 50 ft. [15.2 m]).

Sound waves from point sources radiate in a spherical pattern, with the wave intensity attenuating due to geometric spreading by 6 dB per doubling of distance from the source (U.S. Army, 2005).

Line sources such as roads generate composite sound waves from numerous moving point sources that radiate outward in parallel planes; these waves attenuate due to geometric cylindrical spreading by only 3 dB per doubling of distance.

At substantial distances from the source, air absorption and ground attenuation can affect sound propagation. The efficiency of atmospheric absorption varies over the range of sound frequencies. At frequencies around 2,000 Hz, air absorption is about 20 dB per km. At 1,000 Hz, it is about 7 dB per km. At frequencies below 125 Hz, it is less than 1 dB per km. Factors for ground attenuation and barrier attenuation likewise vary by frequency. In practice, empirical determinations of sound attenuation (i.e., measuring the actual source in its proposed location) are best able to account for all possible factors.

3.3.2.6 Time-Averaged Sound Levels

Ambient sound standards regulate ambient sound levels through time-averaged sound L_{eq} limits. Sound standards for land use compatibility established by DoD and civilian jurisdictions are expressed in terms of the DNL. 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). Sound levels up to 65 dBA DNL are considered to be compatible with land uses such as residences, transient lodging, and medical facilities.

3.3.3 Sonic Boom

A sonic boom is the sound that results from a shock wave that is created when an object travels faster than the speed of sound. The crack of a bullwhip is an example of a sonic boom. When an object travels through the air, it creates pressure waves. As the speed of the object increases, the waves compress. At Mach 1 (approximately 1,225 km per hour [761 mph]), these waves merge into a single shockwave and a boom occurs because of the sudden change of pressure.

Sonic booms are generated continuously while an aircraft is supersonic. Aircrafts actually generate two sonic booms (one for the nose of the aircraft and another for the tail of the aircraft); however, an observer may only perceive a single sonic boom. The intensity of the sonic boom and the width of the area that could experience a sonic boom depend on the aircraft's speed, size, weight, altitude, and angle. For example, a larger, heavier aircraft creates a stronger, louder sonic boom than a smaller, lighter aircraft. In addition, generally, the higher the altitude of the aircraft, the farther the shockwaves must travel to reach ground level, which reduces the intensity of the sonic boom (Gibbs, 2017).

The pressure of a sonic boom is measured in pascals (i.e., one newton per square meter), psf, or pounds per square inch (psi). Supersonic aircraft typically generate peak overpressures between 1 and 10 psf. However, this pressure becomes amplified and focused when the vehicle maneuvers. Table 3-4 illustrates the typical overpressure of aircraft types (Gibbs, 2017).

Table 3-4. Typical Overpressures of Aircraft Types

Aircraft	Speed	Altitude	Overpressure (psf)
SR-71	Mach 3	80,000 ft.	0.9
Concord SST	Mach 2	52,000 ft.	1.94
F-104	Mach 1.93	48,000 ft.	0.8

Space Shuttle	Mach 1.5 (landing approach)	60,000 ft.	1.25

Source: Gibbs, 2017

A sonic boom with an overpressure of 0.2 to 0.3 psf could be heard by someone expecting it (Bradley, 2016a). Sonic booms of 1 psf are generally audible and may startle individuals. Eardrum ruptures are possible at pressures in excess of 5 psi (720 psf); lung injury is possible at 16 psi (2,304 psf); and lethality is possible at 30-42 psi (4,320-6,048 psf) (Burgess et al., 2010).

Although rare, minor damage to buildings or structures may occur with overpressures between 2 and 5 psf (Gibbs, 2017). Depending on the context, a sonic boom with overpressures greater than 2 psf could break weak glass or damage structures (Haber & Nakaki, 1989; Plotkin et al., 2012). However, "[b]ooms less than 11 psf should not damage 'building structures in good repair" (U.S. Army, 2005). Buildings can collapse when subject to pressures in excess of 10 psi (1,440 psf) (Burgess et al., 2010). Table 3-5 provides the maximum safe predicted thresholds for damages to buildings and materials (U.S. Army, 2005).

Table 3-5. Maximum Safe Predicted Thresholds for Buildings and Materials

Material	Peak Pressure (psf)		Peak Sound Level (dBP)[i]	
	Minor Damage[ii]	Major Damage[iii]	Minor Damage[ii]	Major Damage[iii]
Plaster on Wood	3.3	5.6	138.0	142.6
Plaster on Gyplath	7.5	16.0	145.1	151.7
Plaster on Expanded Metal Lath	16.0	16.0	151.7	151.7
Plaster on Concrete Block	16.0	16.0	151.7	151.7
Gyspum Board (new)	16.0	16.0	151.7	151.7
Gyspum Board (old)	4.5	16.0	140.7	151.7
Nail popping (new)	5.4	16.0	142.2	151.7
Bathroom Tile (old)	4.5	8.5	140.7	146.2
Damage Suspended Ceiling (new)	4.0	16.0	139.6	151.7
Stucco (new)	5.0	16.0	141.6	151.7

Source: U.S. Army, 2005

i. dBP is the peak sound levels that is unweighted

ii. Minor damage includes small (less than 3 inches) hairline crack extensions and pre-damaged paint chipping

iii. Major damage includes falling plaster and tile

When damage does occur, it nearly always involves a window breaking (U.S. Army, 2005). According to Hershey & Higgins (1976), there is a 0.013 percent chance of a glass window breaking when subject to a 1 psf overpressure, a 0.072 percent chance when subject to a 2 psf, a 0.316 percent chance when subject to a 4 psf overpressure, and a 2 percent chance when subject to 7 psf overpressures.

"Damage such as plaster cracking is very rare, but when it occurs it is always accompanied by window breakage and occurs almost simultaneously" (U.S. Army, 2005). According to Hershey & Higgins (1976), the probability that plaster would be damaged is .000001 percent for 1 psf, 0.1 percent for 2 psf, 0.2 percent for 4 psf, and between 0.3 percent and 9 percent for 7 psf. Table

3-5 summarizes the maximum safe predicted levels from the U.S. Army's Operational Noise Program. The U.S. Army defines "maximum safe level'" as "a 99.99 percent confidence that damage will not occur at these levels" (U.S. Army, 2005).

3.3.4 Sensitive Receptors

Noise sensitive areas are those areas where noise interferes with normal activities associated with its use. Normally, noise sensitive areas include residential, educational, health, and religious structures and sites; parks; recreational areas (including areas with wilderness characteristics); wildlife refuges; and cultural and historical sites. "Individual, isolated, residential structures may be considered compatible within the 65 dB DNL noise contour where the primary use of land is agricultural and adequate noise attenuation is provided" (FAA Order 10501.F). Also, transient residential use such as motels may be considered compatible within the 65 dB DNL noise contour where adequate noise attenuation is provided. Users of designated recreational areas are considered sensitive receptors.

Noise sensitive land uses on and near VAFB include residential areas, hospitals, schools, and libraries. These sensitive receptors are located in the Cantonment Area of VAFB, which is located over five miles (8 km) north of the project site. No sensitive receptors are located on or near the SLC-4 project site. There are numerous sensitive receptors in the City of Lompoc, including residential areas, hospitals, schools, parks, and libraries. In addition, the Channel Islands National Park is within the overflight path of the Falcon 9.

3.3.5 Ambient Noise Conditions

Existing noise levels on VAFB are generally quite low due to the large areas of undeveloped landscape and relatively sparse noise sources. Background noise levels are primarily driven by wind noise; however, louder noise levels can be found near industrial facilities and transportation routes. On VAFB, general ambient one-hour average sound level measurements have been found to range from around 35 to 60 dB (Thorson et al., 2001). Rocket launches and aircraft overflights create louder intermittent noise levels, which do not generally impact hourly noise levels offshore, while ambient in-air noise levels are driven primarily by wind and wave noise.

Noise levels in the adjacent city of Lompoc, are primarily driven by transportation noise and regional aircraft activities. Depending on regional airport activity, DNLs are typically between 55 and 65 dBA (City of Lompoc, 2014b).

3.4 Biological Resources

The following biological resources are present and within the affected environment for the Proposed Action: vegetation resources (including special status plant species and communities), wildlife resources, special status wildlife species in the terrestrial portion of the project area, special status species in the marine portion of the project area (including fish, sea turtles, birds, and marine mammals), and sensitive marine habitats.

Under Section 7 of the ESA of 1973, as amended (16 U.S.C. § 1531 et seq.), federal agencies are required to assess the effect of any project on species that are federally threatened, endangered, or proposed for listing based on the best scientific data available. Section 7 consultations with the USFWS and NMFS are required for federal projects if such actions have the potential to directly or indirectly affect listed species, or destroy or adversely modify critical habitat.

It is also USAF policy to consider species listed by state agencies, and other federal special status species when evaluating the impacts of a project. In California, these include “fully protected” wildlife species, which are protected by the California Department of Fish and Wildlife (CDFW), per the California Fish and Game Code Sections 3511, 4700, 5050, and 5515. Although not subject to the requirements of the California Endangered Species Act, as a goal of its Integrated Natural Resource Management Plan, VAFB also protects and conserves species considered sensitive by the state when not in direct conflict with the military mission.

The MMPA (16 U.S.C. §§ 1361–1407) restricts the taking of marine mammals, and its implementing regulations at 50 C.F.R. Part 216 prohibit the “taking” of any marine mammals. Taking 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.

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 EFH as necessary habitat for fish spawning, breeding, feeding and growth to maturity.

VAFB is also subject to the requirements of the Migratory Bird Treaty Act of 1918 (16 U.S.C. §§ 703-712) as amended, which protects native migratory birds, including their eggs, active nests, and young.

3.4.1 Region of Influence

The existing biological setting includes the regional setting of VAFB, SLC-4 and the surrounding landscape, the contingency landing area 31 mi. (50 km) offshore, and areas potentially impacted by sonic boom, landing noise, construction, vegetation clearing, water release, and habitat restoration activities. Biological resources on VAFB are abundant and diverse compared to other areas of California because VAFB is within an ecological transition zone where the northern and southern ranges of many species overlap, and because the majority of the land within the base boundaries has remained undeveloped. Biological resources offshore are also diverse, including EFH and Biologically Important Areas for cetaceans in the Western Region of the Pacific Coast (Calambokidis et al., 2015).

Responses to various aspects of the Proposed Action are dependent on the biology of the species and the overlap of their habitat use and occurrence with the potential impact and exposure zones of the expected environmental stressors (e.g., acoustic, visual, ground disturbance, etc.). Therefore, the ROIs for each biological resource will differ and are further defined in the subsections below.

3.4.2 Methodology

Impacts to biological resources were considered for all areas potentially impacted by construction, vegetation clearing, water release, habitat restoration activities, visual disturbance, direct impact, landing noise, and sonic boom. Prior special status species monitoring data, surveys, the California Natural Diversity Database, and Cetacean Density and Distribution Mapping Working Group (CetMap) records were consulted to assess the potential occurrence, distribution, and habitat use of special status species within the Action Area.

General biological surveys coupled with seacliff buckwheat (*Eriogonum parvifolium*) surveys and California red-legged frog habitat assessments were conducted at SLC-4 and Spring Canyon on 14 July 2017. To conduct surveys, a biologist walked meandering transects throughout the survey area and visually scanned for seacliff buckwheat and characterized vegetation types. Seacliff buckwheat stands were mapped using a Trimble Geo XT GPS unit. Vegetation types were mapped by hand using aerial photographs. A prior survey was conducted in 2013 to assess the potential impact area for California red-legged frogs (ManTech SRS Technologies, Inc., 2013).

3.4.3 Vegetation Resources

The ROI for vegetation resources are the areas impacted by construction, vegetation clearing, habitat restoration activities, and water release where ground-disturbing activities would take place. Non-native grassland (NNG), mixed central coast scrub (CCS), willow riparian forest, non-native forest, and "anthropogenic" habitat (areas already heavily impacted by prior construction and disturbance) occur within the area to be affected by proposed construction activities. Vegetation types are described in detail below. Where suitable, nomenclature follows classifications of VAFB vegetation communities completed in 2009 (USAF, 2009).

3.4.3.1 Central Coast Scrub

This vegetation type is characterized by shallow-rooted, mesophylic plant species that are often drought-deciduous and summer-dormant. Past disturbances have facilitated the establishment of many non-native species such as iceplant within this vegetation type. The dominant native species in this habitat are California sagebrush (*Artemisia californica*) and coyote brush (*Baccharis pilularis*). Within the area to be affected by proposed construction activities, this vegetation type is fragmented and heavily infested with non-native grassland species forming a mixed CCS and NNG community.

3.4.3.2 Central Coast Arroyo Willow Riparian Forest

The main canopy consists of arroyo willow (*Salix lasiolepis*). Within the willow riparian understory, ephemeral flow occurs supporting sporadic hydrophytic vegetation growing where intermittent standing water is found. The majority of the drainage consist of drier soils that are shaded by a canopy of arroyo willow. Species typical of the understory in this region include mugwort (*Artemisia douglasiana*), mulefat (*Baccharis salicifolia*), California blackberry (*Rubus ursinus*), western poison oak (*Toxicodendron diversilobum*), and stinging nettle (*Urtica dioca*).

3.4.3.3 Non-Native Grassland

This vegetation type occurs most commonly in areas that have been subjected to prior disturbance allowing weedy non-native species adapted to frequent disturbance to invade and dominate a site. Within the proposed construction area on SLC-4 this community consists of non-native forbs and grasses. Iceplant (*Carpobrotus edulis*) and veldt grass (*Ehrharta calycina*) are the dominant species present. The few native species also occurring include California-aster (*Corethrogyne* *filaginifolia*), deerweed (*Acmispon glaber*), and miniature lupine (*Lupinus bicolor*). Seacliff buckwheat is also present within this vegetation type.

3.4.3.4 Anthropogenic

In addition to areas dominated by plant cover, there are areas covered by pavement, unpaved roads, and structures within the SLC-4. Plant cover in these areas is very sparse to absent.

3.4.3.5 Special Status Plant Species and Sensitive Plant Communities

There were no special-status plant species documented during surveys. However, 153 seacliff buckwheat plants were documented during surveys conducted in 2017 within the area affected by construction and vegetation removal (Table 3-6; Figure 3-3). Seacliff buckwheat is the host plant for the federally endangered ESBB and the presence of seacliff buckwheat within and adjacent to the project site indicates the potential for ESBB to occur within the project site.

Table 3-6. Federal and State Special Status Plant Species with Potential to Occur in the Vicinity of the Proposed Construction Area and Sensitive Plant Communities Occurring within the Construction Area

Species	Status		Occurrence	Habitat	Bloom Period
	ESA	CDFW			
Seacliff buckwheat	NL	NL	118 plants	ESBB habitat	June–September

Notes: ESA = Endangered Species Act, CDFW = California Department of Fish and Wildlife, NL = Not listed

3.4.4 Wildlife Resources

The ROI for wildlife resources includes the areas impacted by construction, water release, and habitat restoration activities where ground-disturbing activities would take place and terrestrial areas that would potentially be affected by acoustic impacts. The diversity of vegetation types and communities present on VAFB provides valuable habitat for many common wildlife species, both within and adjacent to the project area.

Common birds likely to be found within and around the project area include house finch (*Carpodacus mexicanus*), Brewer's blackbird (*Euphagus cyanocephalus*), European starling (*Sturnus vulgaris*), cliff swallow (*Hirundo pyrrhonota*), barn swallow (*Hirundo rustica*), turkey vulture (*Cathartes aura*), red-tailed hawk (*Buteo jamaicensis*), white-throated swift (*Aeronautes saxatalis*), California quail (*Callipepla californica*), black phoebe (*Sayornis nigricans*), and California thrasher (*Toxostoma redivivum*). Nesting cliff swallows, house finches, black phoebes and European starlings have also been documented within SLC-4W (USAF, 2005a).

The project site may contain upland habitat for amphibians that inhabit Spring Canyon. California chorus frogs (*Pseudacris hypochondriaca*) are likely to be the most common amphibian species within the project area. Other wetland amphibian species, western toad (*Bufo boreas*), Monterey ensatina (*Ensatina eschscholtzii*) and arboreal salamander (*Aneides lugubris*) would also be expected to occur within the project area. Due to the ephemeral nature of the drainage, Spring Canyon is marginal habitat for the California red-legged frog since it has very little to no standing water during most years (ManTech SRS Technologies, Inc., 2013). The California red-legged frog is a federally threatened species as well as a California species of concern (see Section 3.4.5, Special Status Wildlife Species in the Terrestrial Portion of the Project Area).

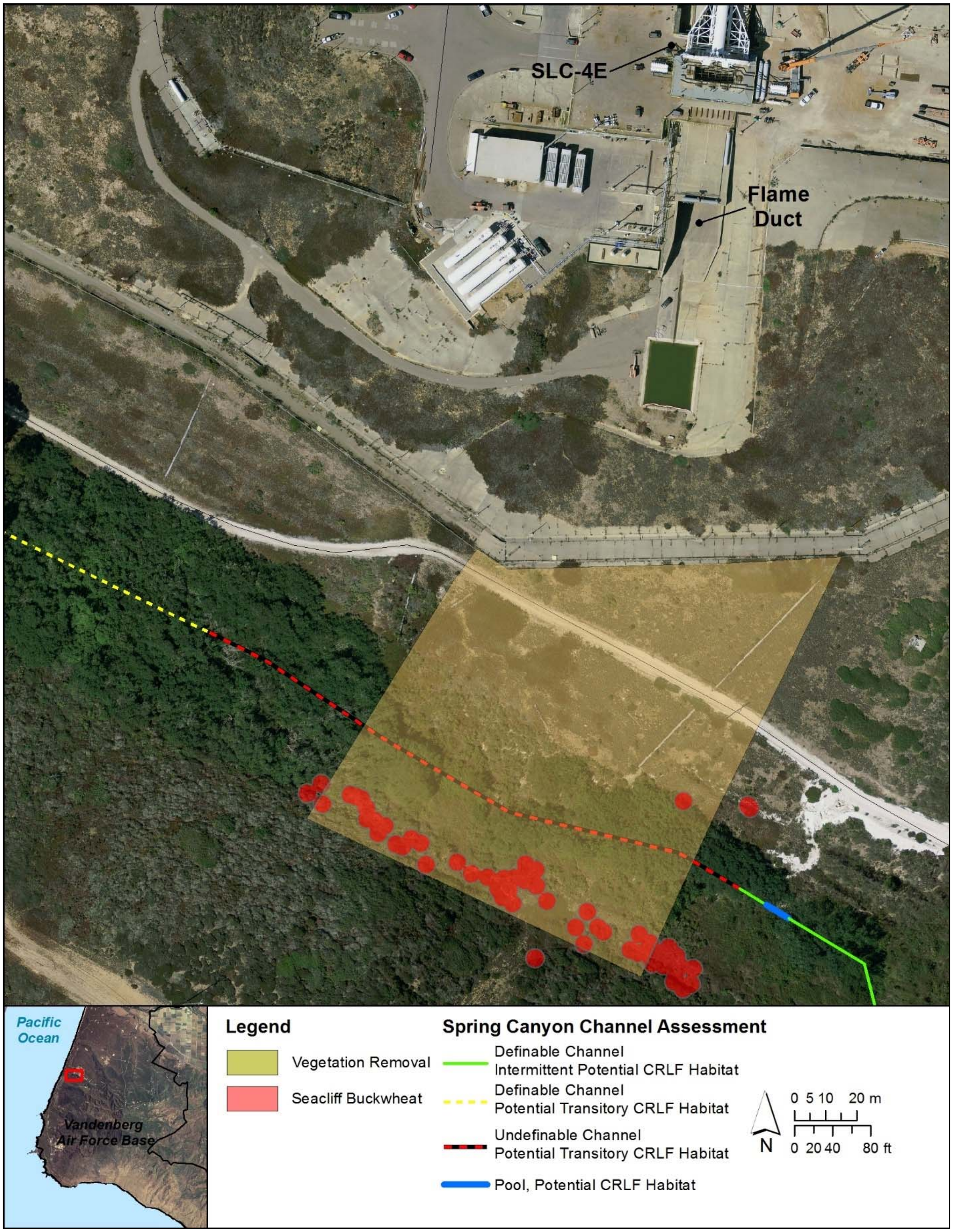


Figure 3-3. Seacliff Buckwheat Occurrence within Vegetation Clearing Area

Reptile species expected to occur within the project area include Western fence lizard (*Sceloporus occidentalis*), southern alligator lizard (*Elgaria multicarinata*), side-blotched lizard (*Uta stansburiana*), western skink (*Eumeces skiltonianus*), gopher snake (*Pituophis catenifer*), Pacific rattlesnake (*Crotalus helleri*), and coast horned lizard (*Phrynosoma blainvillii*). A variety of large and medium-sized mammal species are also expected to occur within the project area including coyote (*Canis latrans*), mule deer (*Odocoileus hemionus*), raccoon (*Procyon lotor*), bobcat (*Felis rufus*), brush rabbit (*Sylvilagus bachmani*), desert cottontail (*Sylvilagus audubonii*), and long-tailed weasel (*Mustela frenata*). Small mammals, including various species of mice (*Peromyscus* ssp.), and Botta's pocket gopher (*Thomomys bottae*) are also expected to occur.

3.4.5 Special Status Wildlife Species in the Terrestrial Portion of the Project Area

The ROI for special status wildlife species in the terrestrial portion of the project area includes the areas impacted by construction, vegetation clearing, water release, and habitat restoration activities and terrestrial areas that would potentially be affected by acoustic impacts and visual disturbance. Table 3-7 lists federal and state listed wildlife species and other special status species that occur or have the potential to occur within the terrestrial portion of the project area and its vicinity, as well as the launch vehicle's overflight path over land. Potential occurrence was determined based on past documentation of special status species within the vicinity of the Proposed Action Area and on suitability of habitat and occurrence within the region of a particular species.

The following are considered special-status biological resources:

- Plant and wildlife species that are federally listed, proposed for listing, or candidates for listing
- Plant and wildlife species that have been delisted
- Plant and wildlife species that are state listed or candidates for listing
- California fully protected species
- Wildlife species considered California Species of Special Concern by the CDFW
- Plant species listed as sensitive by the California Native Plant Society
- Golden eagles and bald eagles protected under the Bald and Golden Eagle Protection Act
- Federal Birds of Conservation Concern
- Winter roost locations for monarch butterflies protected under the Local Coastal Plan of Santa Barbara County
- Species protected under the MMPA

Within this SEA, detailed information is provided below for those special status species where potential impacts to these species may change as a result of changes to the Proposed Action. All species potentially affected by the Action are listed in Table 3-7, but for those species where impacts would not change, they are not discussed in further detail here. Refer to *Final Environmental Assessment Boost-Back and Landing of the Falcon 9 Full Thrust First Stage at SLC-4 West Vandenberg Air Force Base, California and Offshore Landing Contingency Option* (USAF, 2016a) for detailed occurrence and analysis of impacts for those species not discussed here.

Table 3-7. Special Status Species Occurring or Potentially Occurring within the Terrestrial Portion of the Project Area

Species	Conservation Status		Occurrence at SLC-4	Habitat	Notes
	Federal	CDFW			
Invertebrates					
El Segundo Blue Butterfly *Euphilotes battoides allyni*	FE	-	Potential	Occurrence is tied to host plant; seacliff buckwheat	Adult flight period June - September
Amphibians					
California Red-legged Frog *Rana draytonii*	FT	CSC	-	Chiefly associated with perennial ponds, streams	Common, but localized resident in wetlands
Reptiles					
Western Pond Turtle (*Antinemys pallida*)		CSC	-	Chiefly associated with perennial ponds, streams	Documented in Honda Creek
Blainville's Horned Lizard *Phrynosoma blainvillii*	-	CSC	Potential	Scrub, chaparral, and grassland with open shrub canopy and loose sandy or loamy soils	Documented in scrub and chaparral habitats on VAFB
Silvery Legless Lizard *Anniella pulchra*	-	CSC	Potential	Sparsely vegetated coastal scrub and chaparral with loose sandy or loamy soils	Documented in coastal dunes west of SLC-4
Two-striped Garter Snake *Thamnophis hammondii*	-	CSC	Potential	Generally found around pools, creeks, cattle tanks, and other water sources, often in rocky areas, in oak woodland, chaparral, and brushland.	Documented observations within three miles of SLC-4
Birds					
California Brown Pelican *Pelecanus occidentalis californicus*	FD	SD, FP	-	Coastal marine, estuaries	
Ferruginous Hawk *Buteo regalis*	BCC	-	-	Open grassland, prairie	Wintering birds hunt in fallow fields within the Proposed Action Area
Northern harrier *Circus cyaneus*	-	CSC	Potential	Prairie grasslands, marshes, wetlands	Nesting records near the Proposed Action Area
White-tailed Kite *Elanus leucurus*	-	CSC	Potential	Open grassland, prairie	Nesting records near SLC-4; numbers vary annually

Species	Conservation Status		Occurrence at SLC-4	Habitat	Notes
	Federal	CDFW			
Golden Eagle *Aquila chrysaetos*	BGEPA, BCC	FP	-	Grasslands, open woodland	
Bald Eagle *Haliaeetus leucocephalus*	BGEPA, FD	SE	-	Large lakes, wetlands	Rare winter migrant
American Peregrine Falcon *Falco peregrinus anatum*	FD, BCC	SD, FP	-	Open with proximity to water	
California Condor *Gymnogyps californianus*	FE	SE	Potential		One recent observation on VAFB
Western Snowy Plover *Charadrius nivosus*	FT, BCC	CSC	-	Beaches, barren ground	
Black Oystercatcher *Haematopus bachmani*	BCC	-	-	Intertidal	
Long-billed Curlew *Numenius americanus*	BCC	-	-	Intertidal	
California Least Tern *Sternula antillarum browni*	FE	SE	-	Coastal marine, estuaries	
Burrowing Owl *Athene cunicularia hypugea*	BCC	CSC	-	Grasslands	
Allen's Hummingbird *Selasphorus sasin*	BCC	-	Common	Coastal sage scrub, riparian shrubs	Resident riparian breeder Santa Ynez River
Nuttall's Woodpecker *Picoides nuttallii*	BCC	-	-	Deciduous riparian and adjacent oak woodland	Resident riparian breeder Santa Ynez River
Olive-sided Flycatcher *Contopus cooperi*	-	CSC	-	Coniferous woods	Summer resident, potential breeder in non-native woodland near Proposed Action Area
Loggerhead Shrike *Lanius ludovicianus*	BCC	-	-	Open grasslands	Resident central coast scrub breeder near the Proposed Action Area
Purple Martin *Progne subis*	-	CSC	-	Open areas, riparian	Fall/Spring transient at the Santa Ynez River mouth

Species	Conservation Status		Occurrence at SLC-4	Habitat	Notes
	Federal	CDFW			
Oak Titmouse *Baeolophus inornatus*	BCC	-	Potential	Dry oak, oak-pine woodlands	Resident riparian breeder Santa Ynez River
Yellow Warbler *Dendroica petechia brewsteri*	BCC	CSC	-	Riparian	Summer resident riparian breeder Santa Ynez River
Yellow-breasted Chat *Icteria virens*	-	CSC	-	Riparian	Summer resident riparian breeder Santa Ynez River
Black-Chinned Sparrow *Spizella atrogularis*	BCC	-	-	Chaparral, sage, scrub	
Belding's Savannah Sparrow *Posserculucs sandwhichensis beldingi*	-	SE	-	Coastal salt marsh	Localized resident breeder within wetlands on VAFB
Tricolored Blackbird *Agelaius tricolor*	BCC	CSC	-	Marsh, riparian, agricultural fields	Resident with historic breeding records on VAFB
Lawrence's Goldfinch *Spinus lawrencei*	BCC	-	-	Dry, open woodlands	Summer resident riparian breeder Santa Ynez River
Mammals					
Pallid Bat *Antrozous pallidus*	-	CSC	Potential	Rocky outcroppings, sparsely vegetated grasslands	Resident forager on VAFB
Townsend's Big-eared Bat *Corynorhinus townsendii*	-	SC	Potential	Pine forests, scrub	
Western Red Bat *Lasiurus blossevillii*	-	CSC	Potential	Forages in forests, woodlands from sea-level up	Resident breeder on VAFB at 13th Street Bridge
Southern Sea Otter *Enhydras lutris nereis*	FE	-		Common in coastal waters with numbers concentrated around kelp beds	May be hauled out within the Project Area
American Badger *Taxidea taxus*	-	CSC	Potential	Open plains, prairies, dry grasslands	
Pacific Harbor Seal[1] (*Phoca vitulina*)	-	-		Common in coastal waters	Rookery use of VAFB and may be hauled out within the Project Area
California Sea Lion[1]	-	-		Common in coastal waters	Sporadically hauled out within the Project Area

Species	Conservation Status		Occurrence at SLC-4	Habitat	Notes
	Federal	CDFW			
(*Zalophus californianus*)					
Northern Elephant Seal[1] (*Mirounga angustirostris*)	-	-		Common in coastal waters	Sporadically hauled out within the Project Area
Stellar Sea Lion[1] (*Eumetopias jubatus*)	-	-		Present in small numbers	Sporadically hauled out within the Project Area

[1] These species are discussed further under Section 3.4.6 (Marine Mammals).

Notes: FE = Federal Endangered Species, FT = Federal Threatened Species, FC = Federal Candidate Species, BCC = Federal Bird Species of Conservation Concern, BGEPA = Bald and Golden Eagle Protection Act, SE = State Endangered Species, CSC = California Species of Special Concern, SC = State Candidate Species, FP = California Fully Protected Species. Abundant = 15+ individuals per day of survey; Common = Over 15 per year of survey; Rare = 1–15 per year of survey; Very Rare = Less than 1 individual per year of survey; Absent = No records of occurrence.

3.4.5.1 El Segundo Blue Butterfly (*Euphilotes battoides allyni* [Federal Endangered Species])

ESBB were listed as federally endangered on 1 June 1976 (40 FR 48139 - 48140). Critical habitat was proposed for ESBB in 1977, but has yet to be designated. As a result, the project area is not within critical habitat and the Proposed Action would not affect critical habitat for this species.

The ESBB is a member of the Family Lycaenidae. ESBB adults range in size from 1.7 to 2.1 centimeters (Opler, 1999) and are typically active on VAFB from June to mid-August although larvae may be present into September. The dorsal wing color is blue in males and gray-brown in females. The ventral wing surface of both sexes is boldly spotted, with checkered margins and a bold orange aurora on the lower wings.

ESBB are closely associated with their host plant, seacliff buckwheat. Adult ESBB nectar and lay their eggs on buckwheat flowerheads. ESBB larvae feed within the flowerheads until maturation. Upon maturation, larvae burrow into the soil and pupate below the host plant within the root and debris zone (Mattoni, 1992). Pupae remain in diapause until at least the following June. The number that close in a given year is dependent on environmental conditions with the majority of the population remaining in diapause on any given year (Pratt and Ballmer, 1993).

Although seacliff buckwheat is found on much of VAFB, as of 2014, known ESBB populations on south VAFB are limited to ridgeline habitat along Arguello and Honda Ridge roads and the ridge extending from Tranquillon Peak to Oak Mountain. ESBB occurrence on coastal south VAFB is limited to the observation of a single individual in 2008 at the intersection of Bear Creek and Coast Roads. Five years of follow-up surveys at this location have not documented additional ESBB at this site; the lack of additional observations indicates that this was likely a transitory individual.

Initially, ESBB were thought to be restricted to remnant habitat patches from Playa del Rey to the Palos Verdes Peninsula in Los Angeles County, California (Arnold, 1978, 1981). *Euphilotes* were not discovered on VAFB until 2004 (ManTech SRS Technologies, Inc., 2008b). Identification of *Euphilotes* species is complex, but based on the morphological and life history traits shared by the VAFB and Los Angeles populations, and through consultation with other experts on the *Euphilotes* genus, the USFWS decided in 2006 that the VAFB *Euphilotes* would be treated as the ESBB barring evidence to the contrary.

As discussed in Section 3.4.3.5 (Special Status Plant Species and Sensitive Plant Communities), 153 seacliff buckwheat plants were documented during surveys conducted in 2017 within the area affected by construction and vegetation removal. The presence of seacliff buckwheat within and adjacent to the project site indicates the potential for ESBB to occur within the project site. The SLC-4W project site is approximately 1.5 miles (2.4 km) from the nearest known ESBB locality. This locality was recorded near the intersection of Coast and Bear Creek Roads and represents an isolated individual observed in 2008. Subsequent surveys in the area conducted in 2008, 2009, 2011, 2012, 2013, and 2014 failed to document additional ESBB (ManTech SRS Technologies, Inc., 2009a, 2014a). Additionally, on 14 July 2017, a qualified biologist surveyed the area to be impacted by water release from the flame duct for ESBB and seacliff buckwheat and found 153 plants within 0.2069 ac. (0.0837 ha) of potential habitat that would be removed or damaged by water release and vegetation removal in Spring Canyon (Figure 3-4). No ESBB were detected during this survey. The closest ESBB population to the proposed construction area is on Honda

Ridge approximately 3.3 miles (5.3 km) south-southeast of the project site (ManTech SRS Technologies, Inc., 2014a).

3.4.5.2 California Condor (*Gymnogyps californianus* [Federal Endangered Species])

The USFWS listed the California condor as endangered on 11 March 1967 (32 FR 4001) and completed a Recovery Plan for the species on 25 April 1996 (USFWS, 1996). In 1982, there were only 23 California condors in existence. To prevent the condor from going extinct, all remaining condors were placed into a captive breeding program in 1987. The USFWS and its partners began releasing condors back into the wild in 1992. The nearest release site to the ROI is Bitter Creek National Wildlife Refuge (USFWS, 2017b). Other release points include the Ventana Wilderness and Pinnacles National Park (Figure 3-5). Almost all condors released into Santa Barbara County have either died or were brought back into captivity, with the last nesting attempt occurring in 2001 (Lehman, 2016).

Condors nest in rock formations (e.g., ledges and crevices) and less frequently in giant sequoia trees (*Sequoiadendron giganteum*). They normally lay a single egg between late January and early April. Both parents incubate the egg and share responsibilities for feeding the nestlings after hatching. Condors require large remote areas and can range up to 150 miles (241 km) a day in search of food. Chicks usually take their first flight around 6 to 7 months from hatching. The cause of the California condor's decline is inconclusive, but experts believe that lead poisoning and hunting greatly contributed to their decline (USFWS, 1996).

The California condor's current range is not within the ROI. However, in March 2017, telemetry data indicated a California condor was ranging within VAFB. This condor (SB 760) was an immature, non-reproductive female hatched in captivity on May 22, 2014, and released at the Ventana Wilderness on November 9, 2016. The condor departed the VAFB area on April 12, 2017, and later died on approximately July 19, 2017. Other condors may occur on VAFB in the future.

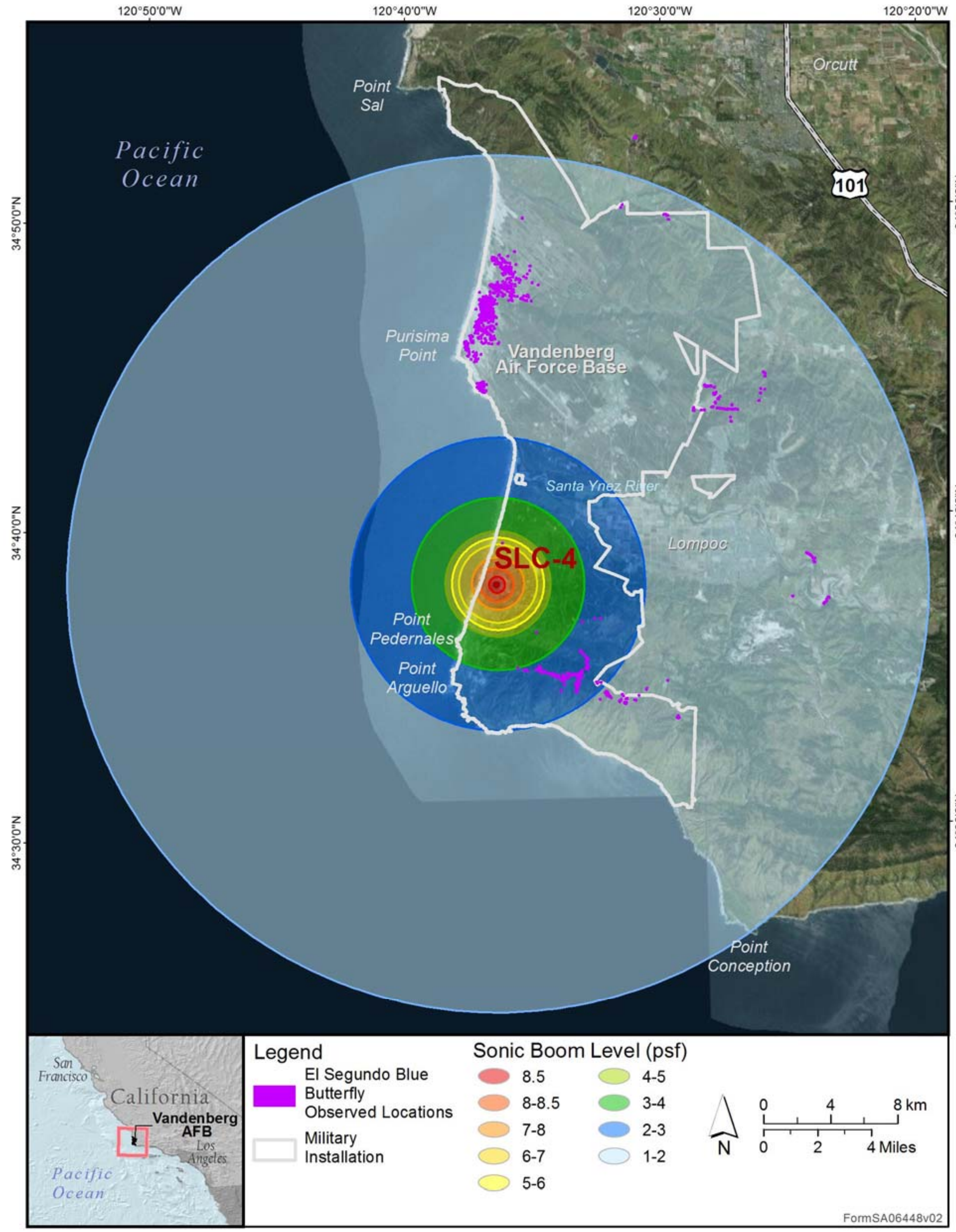
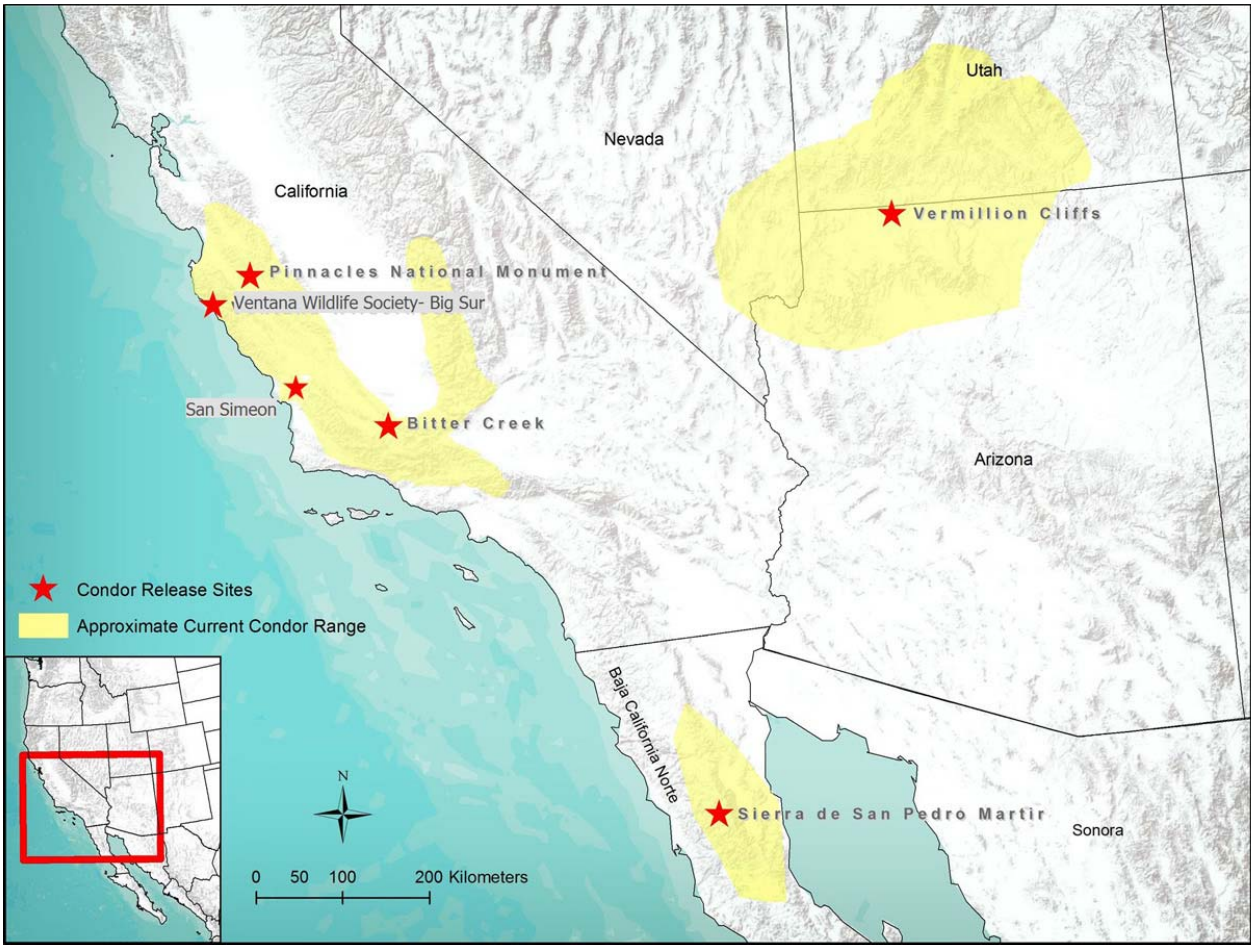


Figure 3-4. Current Known El Segundo Blue Butterfly Localities on VAFB



Source: USFWS, 2016

Figure 3-5. California Condor Release Sites and Approximate Range

3.4.5.3 California Red-legged Frog (*Rana draytonii* [Federal Threatened Species])

California red-legged frog were listed as federally threatened by the USFWS on 23 May 1996 (61 FR 25813-25833). In 2002, the USFWS issued a Recovery Plan to stabilize and restore California red-legged frog populations (USFWS, 2002). Critical habitat was designated on 17 March 2010 (50 FR 12816-12959); however, it does not include VAFB, since it was excluded under section 4(b)(2) of the ESA, for reasons including impacts on national security.

The California red-legged frog is a member of the family Ranidae and is California's largest native frog. To breed, California red-legged frog require water bodies with sufficient hydroperiods and compatible salinity levels to accommodate larval and egg development. Breeding typically takes place from November through April with most egg deposition occurring in March. Eggs require 6–14 days, depending on water temperature, to develop into tadpoles (Jennings, 1988). Tadpoles typically require 11–20 weeks to develop into terrestrial frogs (USFWS, 2002), although some individuals may overwinter in the tadpole stage (Fellers et al., 2001).

Adult California red-legged frog have been documented traveling distances of over 1 mile (1.6 km) during the wet season and spend considerable time in terrestrial riparian vegetation (USFWS, 2002). It is thought that riparian vegetation provides good foraging habitat, as well as good dispersal corridors, due to canopy cover and presence of moisture (USFWS, 2002).

Regular California red-legged frog surveys have occurred across VAFB since the early 1990s (Christopher, 1996, 2004; ManTech SRS Technologies, Inc., 2009b, 2014b, 2016a, 2016b) and have shown that California red-legged frog can potentially occur in virtually all known wetlands and bodies of water on VAFB (Figure 3-6). The Santa Ynez River and Bear Creek, to the north of SLC-4, have California red-legged frog populations and suitable breeding habitat (Christopher, 1996, 2004; SRS Technologies, 2001; ManTech SRS Technologies, Inc., 2009b). Spring Canyon is an ephemeral drainage located approximately 200 ft. south of SLC-4. Spring Canyon has no definable channel through the majority of the drainage and minimal evidence of potential pooling or flow of surface water (ManTech SRS Technologies, Inc., 2013; Figure 3-6. Depending on annual rainfall levels, several small areas of Spring Canyon may constitute suitable habitat for California red-legged frog during wet periods when adequate surface water is present; however, in July 2017, after an above average rain year, a USFWS-permitted biologist reassessed the drainage in support of this BA and found no significant changes from the habitat assessment conducted in 2013, including no suitable breeding habitat within the vegetation removal area or downstream (J. LaBonte, ManTech SRS Technologies, Inc.). It is therefore unlikely that California red-legged frog occupy this area on a regular basis, other than transitory habitat.

Approximately 2 miles (3.2 km) south of SLC-4, suitable California red-legged frog breeding habitat is found in Cañada Honda Creek, along with scattered California red-legged frog localities in minor wetlands and drainages, across south VAFB, including Bear Creek 1 mile (1.6 km) northeast of SLC-4 (Christopher, 1996, 2004; SRS Technologies, 2001; and ManTech SRS Technologies, Inc., 2009b, 2014b, 2016). Suitable upland dispersal habitat exists throughout VAFB between the various riparian zones and ponds on Base but, as noted above, dispersal into these upland habitats is not likely to be as extensive as has been observed in more mesic parts of the range of this species.

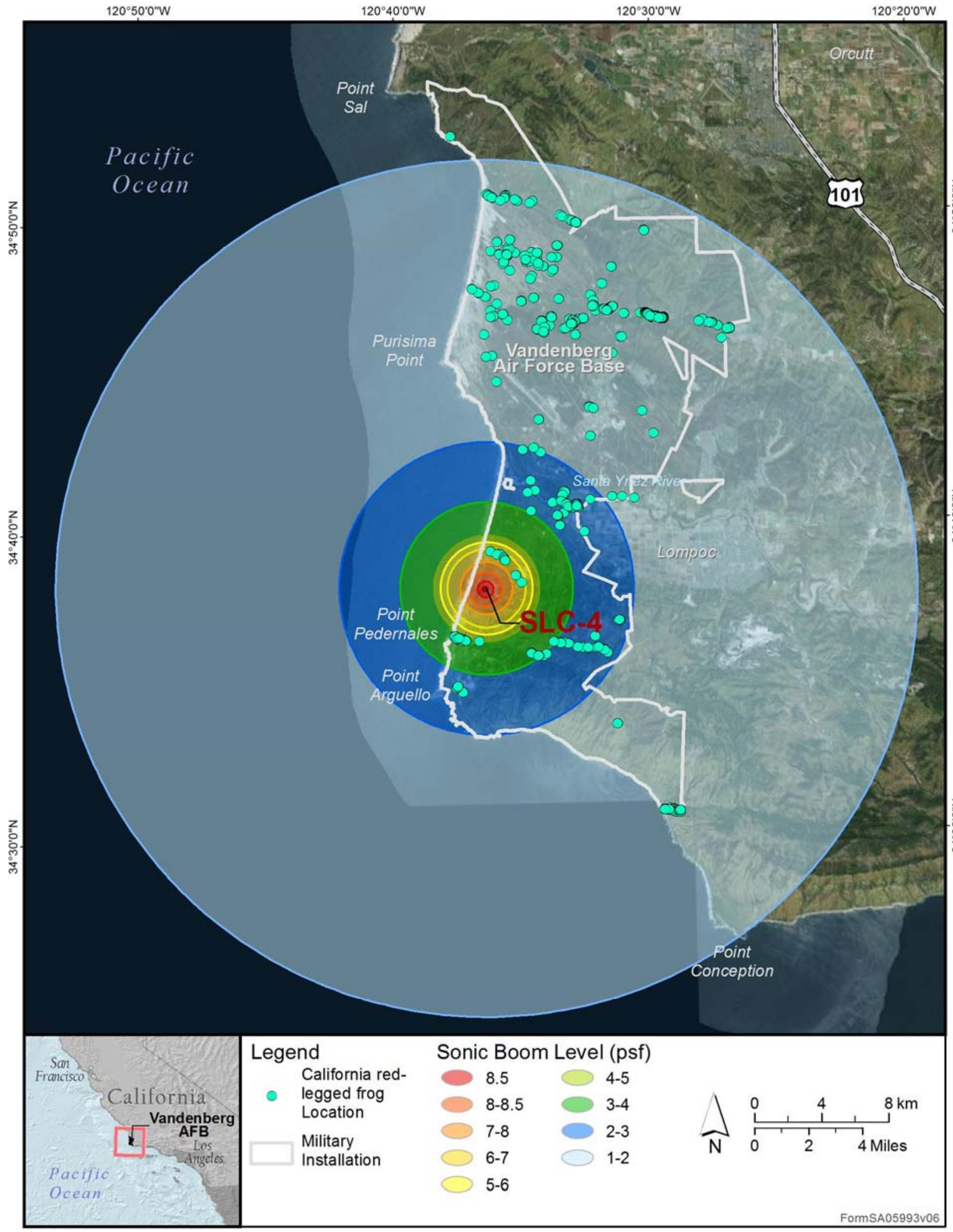


Figure 3-6. Known California Red-Legged Frog Localities on VAFB Critical Habitat

The USFWS issued a final rule revising the California red-legged frog's critical habitat on 16 March 2010 (75 FR 12816–12959) (Figure 3-7). Physical and biological features (PBFs) are used to identify the habitat characteristics essential for conservation of listed species. The following are the PBFs for critical habitat for the California red-legged frog:

(1) *Aquatic Breeding Habitat*: Standing bodies of fresh water (with salinities less than 4.5 parts per thousand), including natural and manmade (e.g., stock) ponds, slow-moving streams or pools within streams, and other ephemeral or permanent water bodies that typically become inundated during winter rains and hold water for a minimum of 20 weeks in all but the driest of years.

(2) *Aquatic Non-Breeding Habitat*: Freshwater pond and stream habitats, as described above, that may not hold water long enough for the species to complete its aquatic life cycle but which provide for shelter, foraging, predator avoidance, and aquatic dispersal of juvenile and adult California red-legged frogs. Other wetland habitats considered to meet these criteria include, but are not limited to: plunge pools within intermittent creeks, seeps, quiet water refugia within streams during high water flows, and springs of sufficient flow to withstand short-term dry periods.

(3) *Upland Habitat*: Upland areas adjacent to or surrounding breeding and non-breeding aquatic and riparian habitat up to a distance of 1 mile (1.6 km) in most cases (i.e., depending on surrounding landscape and dispersal barriers) including various vegetational types such as grassland, woodland, forest, wetland, or riparian areas that provide shelter, forage, and predator avoidance for the California red-legged frog. Upland features are also essential in that they are needed to maintain the hydrologic, geographic, topographic, ecological, and edaphic features that support and surround the aquatic, wetland, or riparian habitat. These upland features contribute to: (1) Filling of aquatic, wetland, or riparian habitats; (2) maintaining suitable periods of pool inundation for larval frogs and their food sources; and (3) providing nonbreeding, feeding, and sheltering habitat for juvenile and adult frogs (e.g., shelter, shade, moisture, cooler temperatures, a prey base, foraging opportunities, and areas for predator avoidance). Upland habitat should include structural features such as boulders, rocks and organic debris (e.g., downed trees, logs), small mammal burrows, or moist leaf litter.

(4) *Dispersal Habitat*: Accessible upland or riparian habitat within and between occupied or previously occupied sites that are located within 1 mile (1.6 km) of each other, and that support movement between such sites. Dispersal habitat includes various natural habitats, and altered habitats such as agricultural fields, that do not contain barriers (e.g., heavily traveled roads without bridges or culverts) to dispersal. Dispersal habitat does not include moderate- to high-density urban or industrial developments with large expanses of asphalt or concrete, nor does it include large lakes or reservoirs over 50 ac. (20 ha) in size, or other areas that do not contain those features identified in PBF 1, 2, or 3 as essential to the conservation of the species (75 FR 12836).

The USFWS excluded VAFB from California red-legged frog critical habitat designation pursuant to Section 4(a)(1) of the ESA. However, USFWS designated critical habitat for the species, within the ROI, along the northeastern and southeastern perimeters of VAFB (Figure 3-7). Unit STB-2 is along the northeaster perimeter. This unit is approximately 36,004 ac. (14,570 ha), 11,405.18

ac. (568.66 ha) of which are within the ROI. The USFWS considered this unit to be occupied critical habitat (75 FR 12852). Unit STB-4 is along the southeastern perimeter. Unit STB-4 is approximately 8,693 ac. (3517.93 ha) and is completely within the ROI. The USFWS also considers this unit to be occupied critical habitat (75 FR 12852).

3.4.5.4 Marbled Murrelet (*Brachyramphus marmoratus* [Federal Threatened Species])

The USFWS listed the marbled murrelet as threatened on 1 October 1992 (57 FR 45328), and published a Recovery Plan for the species in 1997 (USFWS, 1997). The USFWS completed a 5-year review of the species in 2009 (USFWS, 2009).

The marbled murrelet is a small seabird that breeds along the Pacific coast, foraging on nearshore prey, and flying inland to breed. The species requires nearshore marine habitats with abundant prey (fish and invertebrates). Among alcids, the species is unique because it uses old-growth coniferous forests and mature trees for nesting (USFWS, 1997). Marbled murrelets are wing-pursuit divers. Although little has been known about the marbled murrelet's movement and home range, more information is becoming available. The first marbled murrelet nest was not documented until 1974. Since then, the marbled murrelet's home range has been observed as 655 km^2 for non-nesters and 240 km^2 for nesters within California. In addition, at-sea resting areas have also been observed an average of 5.1 km from the mouths of drainages. The species spends nighttime hours resting in the ocean at these resting areas and commute to foraging areas during the day. Nests have been observed from sea level to 5,020 ft. (USFWS, 2009).

Marbled murrelets range from Alaska to California and may occur as far south as Baja California. Marbled murrelets are considered rare to very rare much of the year in Santa Barbara County; however, the species may be somewhat regular north of VAFB in the late summer and would be considered casual in the spring (Lehman 2016). Individuals have been observed infrequently on and around north VAFB at Lion's Head and at nearby Point Sal and the Santa Maria River. Individuals have also been observed off Point Conception and Point Pedernales, on south VAFB (Lehman 2016). As such, marbled murrelets may occur in the nearshore waters off VAFB, within the ROI, but it is not known to nest in the ROI.

The USFWS designated critical habitat for the marbled murrelet on 24 May 1996 (61 FR 26257) and revised this designation on 4 August 2016 (81 FR 51348–51370). There is no designated critical habitat for this species within or adjacent to the ROI and the nearest critical habitat is approximately 165 miles (265.54 km).

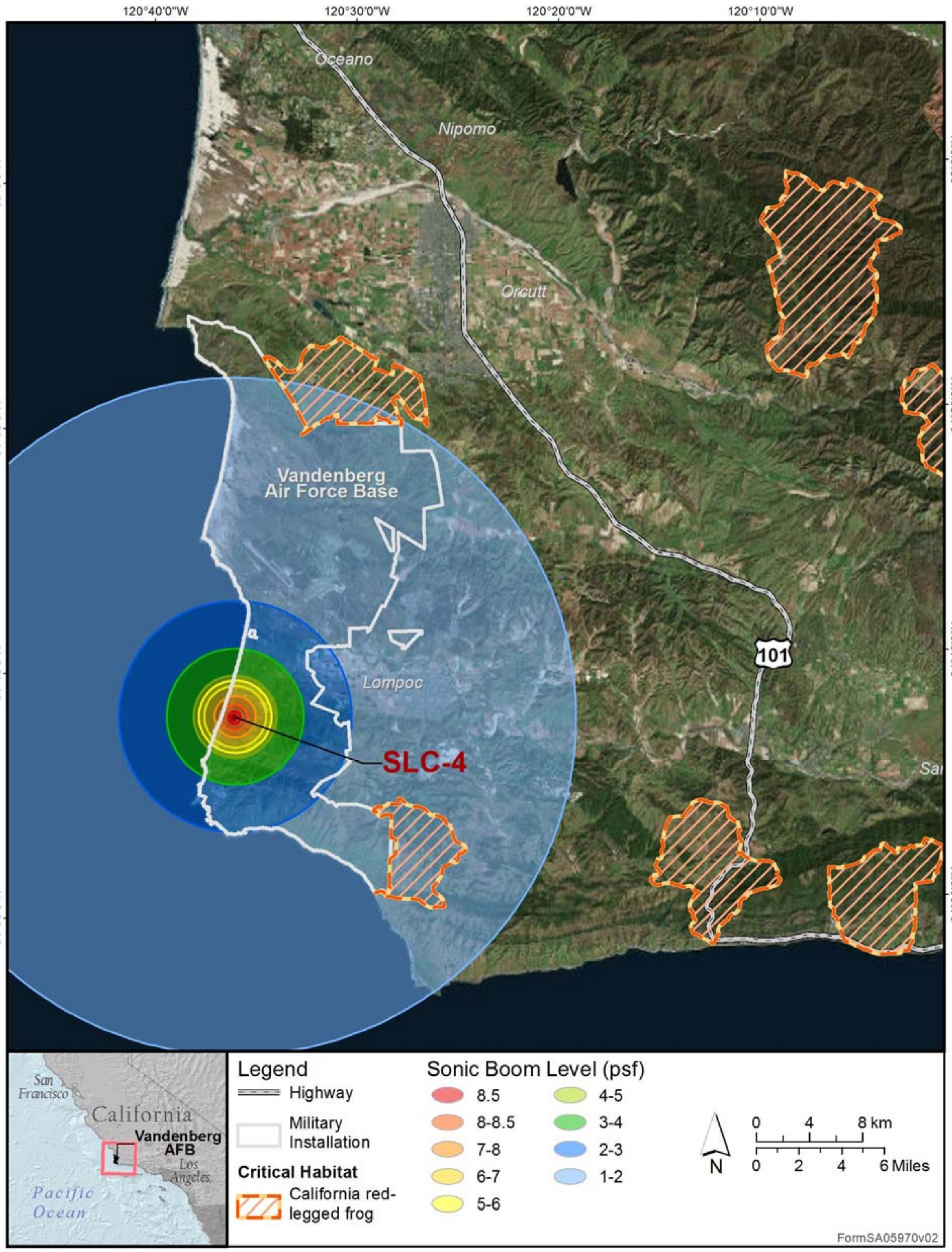


Figure 3-7. Designated Critical Habitat for the California Red-Legged Frog

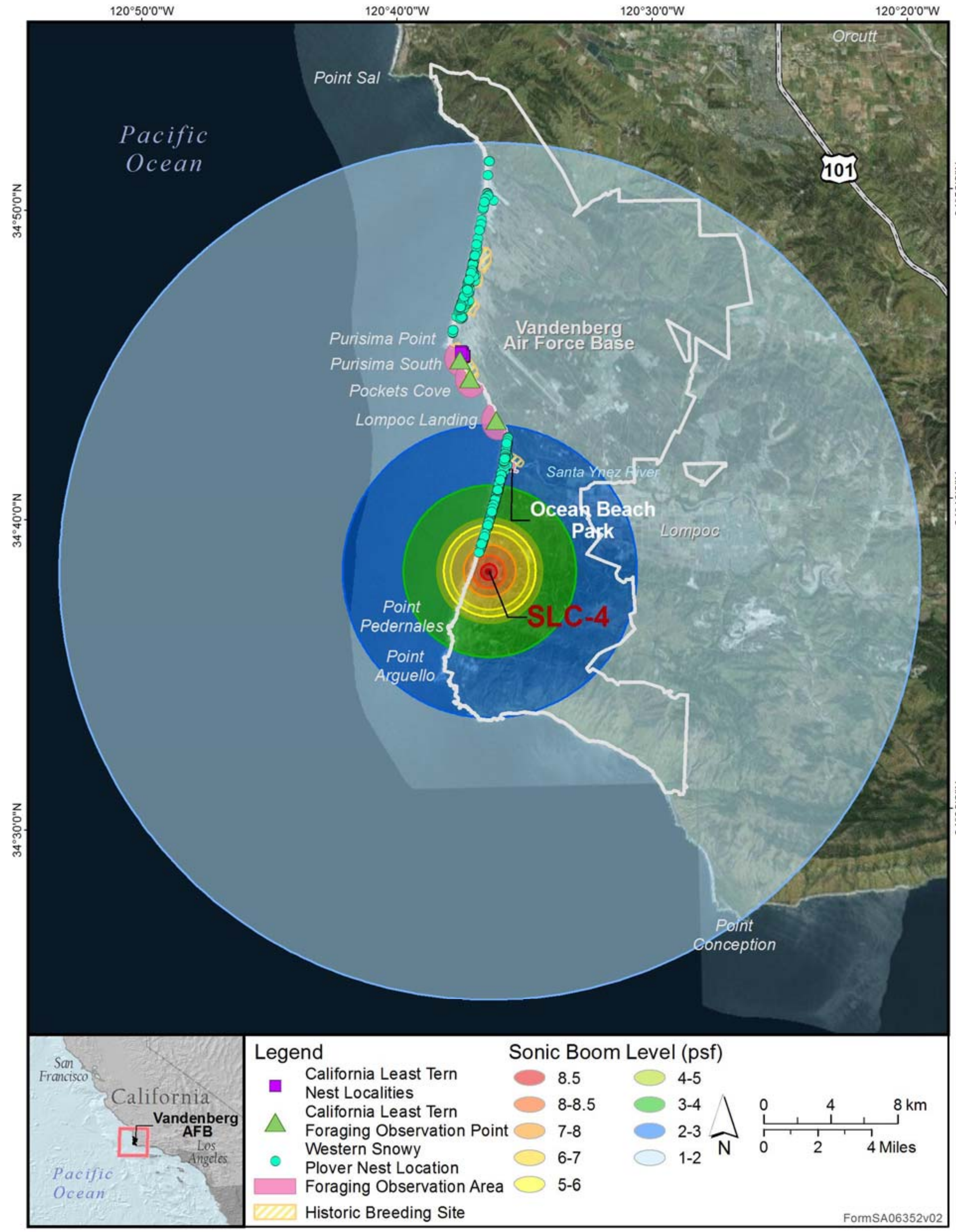


Figure 3-8. Current California Least Tern and Western Snowy Plover Nesting Localities and Tern Foraging Areas within the Region of Influence

3.4.5.5 California Least Tern (*Sternula antillarum browni* [Federal Endangered Species/State Endangered Species])

The USFWS listed the California least tern as federally endangered on 13 October 1970 (35 FR 16047-16048). Critical habitat for this species has not been designated. As a result, the Proposed Action would not affect critical habitat for this species.

The California least tern is the smallest of the North American terns and is found along the Pacific Coast of California, from San Francisco southward to Baja California. It has a distinctive black cap with stripes running across the eyes to the beak. The upperparts are gray and the underparts are white.

The California populations are localized and increasingly fragmented, due to coastal development resulting in habitat loss. California least terns are migratory and winter along the Pacific coast of southern Mexico and the Gulf of California. They usually arrive at breeding grounds by the last week of April and return to wintering grounds in August. This species nests in colonies on relatively open beaches kept free of vegetation by natural scouring from tidal or wind action.

Historically, California least terns nested in colonies in several locations along the coastal strand of the north VAFB coastline. Since 1998, with the exception of two nests established south of San Antonio Creek in 2002, California least terns have nested only at the primary colony site, in relatively undisturbed bluff top open dune habitat at Purisima Point. On VAFB, a California least terns breeding colony is found at Purisima Point and California least terns forage in the lagoons formed at the mouths of the Santa Ynez River and San Antonio Creek (Figure 3-8), and at other near-shore locations at VAFB. VAFB supports a very small percentage of California's breeding population of California least terns. However, as one of only three known breeding colonies between Monterey and Point Conception, the population on VAFB remains significant.

The total population of California least tern increased from less than 700 pairs circa 1985 to greater than 7,000 pairs circa 2006. The population has since declined and remains steady at 4,000 to 5,000 pairs since 2006. The majority of the population is south of Point Conception (Robinette et al, 2016). VAFB supports a small population of California least terns that represents a small percentage of all known breeding colonies. Robinette et al. (2016) estimated that VAFB supports a breeding population of 25 pairs of California least tern. Although this population is small, VAFB is one of only three breeding colonies that nest between Monterey and Point Conception. The Purisima Point breeding colony is considered important. This colony is approximately 8 mi. (12.9 km) north of SLC-4W (Figure 3-8). Adult California least terns forage in the Santa Ynez River lagoon and estuary, approximately 3.7 mi. (6.0 km) north of SLC-4W (Figure 3-8). After young have fledged in late summer, California least terns also disperse to this location to forage in the lagoon and roost on adjacent sandbars before migrating south for the winter (Robinette and Howar, 2010).

The action area for California least terns are those areas that would receive sonic boom overpressures of greater than 1 psf or engine noise in excess of 80 dBA, whichever is greater. A sonic boom of 1 psf could briefly affect foraging behavior of this species (USFWS, 2015b).

3.4.5.6 Western Snowy Plover (*Charadrius nivosus* [Federal Threatened Species/California Species of Special Concern])

The USFWS listed the Pacific coast population of the western snowy plover as federally threatened in March of 1993 (58 FR 12864-12874). The USFWS designated critical habitat for this species in 1999 and revised this designation on 29 September 2005 (70 FR 56969–57119). VAFB was exempted from critical habitat designation under section 4(a)(3) of the ESA. Critical habitat for this species overlaps the area potentially impacted by a sonic boom on Santa Rosa Island and parts of Ventura and Santa Barbara Counties.

The western snowy plover is a small shorebird with pale tan back, white underparts, and dark patches on the sides of the neck reaching around to the top of the chest. The Pacific coast population of snowy plovers is limited to individuals that nest adjacent to tidal waters. The population's range extends from southern Washington to Baja California, Mexico.

VAFB provides important breeding and wintering habitat for western snowy plover. Western snowy plover habitat on VAFB includes all sandy beaches and adjacent coastal dunes from the rocky headlands at the north end of Minuteman Beach to the pocket beaches and dune areas adjacent to Purisima Point on north VAFB (approximately 7.7 miles [12.4 km]). Also included are all sandy beaches and adjacent coastal dunes from the rocky headlands at the north end of Wall Beach south to the rock cliffs at the south end of Surf Beach on South VAFB (approximately 4.8 miles [7.7 km]). VAFB has consistently supported one of the largest populations of breeding western snowy plover along the west coast of the United States (Page & Persons, 1995). In 2014, VAFB supported an estimated 11 percent of California's breeding population (USFWS, 2014b).

Western snowy plovers nest and overwinter along the coast of VAFB (Figure 3-8). VAFB has performed annual monitoring of Western snowy plovers since 1993 (Robinette et al., 2016). In 2014, VAFB supported an estimated 11 percent of California's breeding population (USFWS, 2014b). The breeding population of Western snowy plovers on VAFB has been highly variable but relatively stable since 2007. The smallest population was recorded in 1999 (78 adults) (Robinette et al., 2016). The nearest observation of a Western snowy plover nest is approximately 0.9 mile (1.4 km) northwest of SLC-4 (Figure 3-8). The Western snowy plover is also considered a permanent resident of Santa Rosa Island and a summer resident of Santa Cruz Island. According to USFWS (2016a), only one individual has been observed at Santa Cruz Island since 2005. Although prior counts at San Miguel Island had yielded very few to no individuals 61 Western snowy plovers were observed in during 2016-2017 winter window survey (USFWS, 2017a).

3.4.6 Special Status Species in the Marine Portion of the Project Area

The ROI for special status wildlife species in the marine portion of the project area includes marine areas that would potentially be affected by impacts of the Proposed Action, primarily acoustic impacts. Fish, sea turtle, seabird species, and marine mammal species protected under the ESA or MMPA, and managed by NMFS have the potential to occur in the vicinity of the contingency landing location. However, as stated above, special status seabird species are highly unlikely to be present in the area affected during a contingency offshore landing event due to their extremely low densities. Therefore, they are not carried forward for analyses. Brief descriptions of the species and their potential for occurring in the project area are provided below. Table 3-8 lists non-mammal species potentially occurring within the marine portion of the project area. Table 3-9 lists protected marine mammal species potentially occurring with the marine portion of the project area. One species, the California least terns, was already discussed above in relevance to habitat and occurrence on land. It is again discussed below in relevance to occurrence in the marine portion of the project area as they also occur within the area affected by landing noise and sonic boom.

Within this SEA, detailed information is provided below for those special status marine species where potential impacts to these species may change as a result of changes to the Proposed Action. All species potentially affected by the action are listed in Table 3-8 and Table 3-9, but for those species where impacts would not change, they are not discussed in further detail. Refer to *Final Environmental Assessment Boost-Back and Landing of the Falcon 9 Full Thrust First Stage at SLC-4 West Vandenberg Air Force Base, California and Offshore Landing Contingency Option* (USAF, 2016a) for detailed occurrence and analysis of impacts for those species not discussed here. In addition, impacts to sea turtles, special status fish species, Essential Fish Habitat and seabirds would be similar to those described in the Falcon 9 Boost-back EA (USAF, 2016a), and Iridium SEA (USAF, 2016b) as well. These are therefore not carried forward for further analysis in this SEA.

Table 3-8. Special-Status Non-Mammal Species within the ROI for the Proposed Action

Species	Conservation Status	Occurrence within Region of Influence	Habitat	Notes
Fish				
Steelhead trout *Oncorhynchus mykiss*	FE	Common	The California Current and open ocean	Southern California distinct population segment[1]
Scalloped Hammerhead Shark *Sphyrna lewini*	FE	Common	Open ocean at depths of 1,000 meters, and coastal waters	Eastern Pacific distinct population segment[1]
Green sturgeon *Acipenser medirostris*	FT	Common	Coastal marine at depths of 20-70 meters	Southern distinct population segment[1]
Basking shark *Cetorhinus maximus*	SOC	Common	The California Current and open ocean	Eastern North Pacific population
Bocaccio *Sebastes paucispinis*	SOC	Common	The California Current and open ocean	Southern California distinct population segment[1]
Cowcod *Sebastes levis*	SOC	Common	The California Current and open ocean	Central Oregon to central Baja California and Guadalupe Island, Mexico evolutionarily significant unit[2]
Sea Turtles				
Green sea turtle *Chelonia mydas*	FT/FE[3]	Potential	Tropical and subtropical coastal and open ocean waters; as well as rocky ridges, channels, and floating kelp	
Hawksbill sea turtle *Eretmochelys imbricata*	FE	Very Rare	Tropical coastal and open ocean waters	No hawksbill sightings have been confirmed along the U.S. west coast in recent history[4]
Loggerhead sea turtle *Caretta*	FE[5]	Rare	Temperate to tropical regions with coastal estuaries to the open ocean	
Olive ridley sea turtle *Lepidochelys olivacea*	FT/FE[6]	Potential	Primarily open ocean in tropical and subtropical regions	
Leatherback sea turtle *Dermochelys coriacea*	FE	Potential	Tropical to subpolar oceans; open ocean and rarely coastal waters	

Seabirds				
California Brown Pelican *Pelecanus occidentalis californicus*	FD	Potential	Coastal marine, estuaries	
California Least Tern *Sternula antillarum browni*	FE	Potential	Coastal marine, estuaries	CLTE have not been found more than two miles off the coast

[1] A species with more than one distinct population segment can have more than one ESA listing status, as individual distinct population segments can be either not listed under the ESA or can be listed as endangered, threatened, or a candidate species.

[2] Evolutionarily significant unit is a population of organisms that is considered distinct for purposes of conservation.

[3] As a species, the green sea turtle is listed as Threatened. However, the Florida and Mexican Pacific Coast nesting populations are listed as Endangered. Green sea turtles found in the Study Area may include individuals from the Mexican Pacific Coast population.

[4] Eckert 1993; NOAA Fisheries and USFWS 2007b

[5] The only distinct population segment of loggerheads that occurs in the Study Area—the North Pacific Ocean distinct population segment—is listed as Endangered.

[6] NOAA Fisheries and USFWS only consider the breeding populations of Mexico's Pacific coast as Endangered. Other populations are listed as Threatened (USFWS & NMFS 1998).

Notes: SOC = Species of Concern, FD = Federally de-listed, FE = Federal Endangered Species, FT = Federal Threatened Species, FC = Federal Candidate Species, BCC = Federal Bird Species of Conservation Concern, SE = State Endangered Species, CSC = California Species of Special Concern, SC = State Candidate Species, FP = California Fully Protected Species, D = MMPA Depleted Strategic Stock, CLTE = California Least Tern

Table 3-9. Status of Protected Marine Mammal Species Potentially Offshore and within the Contingency Landing Area of Effect

Species	Conservation Status		Occurrence within Proposed Project Area	Habitat	Notes
	ESA	MMPA	Offshore drone ship/landing site		
Carnivores					
Southern Sea Otter *Enhydra lutris nereis*	FT	-	Unlikely	Nearshore waters, kelp beds,	The area between SLC-4 and Point Arguello is not regularly occupied and no otters have been detected at this location during the last three annual spring census counts from 2011 to 2014[1]
Pinnipeds					
Pacific Harbor Seal *Phoca vitulina richardsi*	NL	-	Common	Rocks and beach haul-outs, nearshore	
California Sea Lion *Zalophus californianus*	NL	-	Common	Rocks and beach haul-outs, nearshore	
Northern Elephant Seal *Mirounga angustirostris*	NL	-	Common	Rocks and beach haul-outs, nearshore	
Steller Sea Lion *Eumetopias jubatus*	FD	-	Unlikely	Rocks and beach haul-outs, nearshore	
Northern Fur Seal *Callorhinus ursinus*	NL	D/-[2]	Common	Rocks and beach haul-outs, nearshore	
Guadalupe Fur Seal *Arctocephalus townsendi*	FT	D	Rare	Open ocean	
Cetaceans					
Humpback whale *Megaptera novaeangliae*	FE	D	Common Seasonal	Open ocean and coastal waters	Summer feeding ground, peak occurrence is December through June[3]

Species	Conservation Status		Occurrence within Proposed Project Area	Habitat	Notes
	ESA	MMPA	Offshore drone ship/landing site		
Blue whale *Balaenoptera musculus*	FE	D	Common Seasonal	Open ocean and coastal waters	
Fin whale *Balaenoptera physalus*	FE	D	Common year-round	Offshore waters, open ocean	
Sei whale *Balaenoptera borealis*	FE	D	Rare	Offshore waters, open ocean	Primarily are encountered there during July to September and leave California waters by mid-October
Bryde's whale *Balaenoptera brydei/edeni*	NL	-	Rare	Open ocean	
Minke whale *Balaenoptera acutorostrata*	NL	-	Common	Nearshore and offshore	Less common in summer; small numbers around northern Channel Islands
Gray whales *Eschrichtius robustus*	FE/NL[4]	D/-4	Seasonal	Nearshore and offshore	
Sperm whale *Physeter microcephalus*	FE	D	Common year-round	Nearshore and offshore	Widely distributed year-round; More likely in waters > 1,000 m depth, most often > 2,000 m
Pygmy sperm whale *Kogia breviceps*	NL	-	Potential	Nearshore and open ocean	
Dwarf sperm whale *Kogia sima*	NL	-	Potential	Open ocean	
Killer whale *Orcinus orca*	NL	-	Uncommon	Nearshore and open ocean	
Short-finned pilot whales *Globicephala macrorhynchus*	NL	-	Uncommon	Offshore, open ocean	

Species	Conservation Status		Occurrence within Proposed Project Area	Habitat	Notes
	ESA	MMPA	Offshore drone ship/landing site		
Long-beaked common dolphins *Delphinus capensis*	NL	-	Common	Nearshore (within 57.5 mi. [92.5 km])	
Short-beaked common dolphins *Delphinus delphis*	NL	-	Common	Nearshore and open ocean	One of the most abundant CA dolphins; higher summer densities
Common bottlenose dolphin *Tursiops truncates*	NL	-	Common	Coastal and offshore	
Striped dolphin *Stenella coeruleoalba*	NL	-	Uncommon	Offshore	Warm water oceanic species
Rough-toothed dolphin *Steno bredanensis*	NL	-	Rare	Offshore and open ocean	
Pacific white-sided dolphin *Lagenorhynchus obliquidens*	NL	-	Common	Open ocean and offshore	year round cool water species; more abundant Nov-Apr
Northern right whale dolphin *Lissodelphis borealis*	NL	-	Common	Open ocean	year round cool water species; more abundant Nov-Apr
Risso's dolphin *Grampus griseus*	NL	-	Common	Nearshore and offshore	Higher densities Nov-Apr
Dall's Porpoise *Phocoenoides dalli*	NL	-	Common	Inshore/offshore	Higher densities Nov-Apr
Cuvier's beaked whale *Ziphius cavirostris*	NL	-	Potential	Open ocean	Possible year-round occurrence but difficult to detect due to diving behavior
Baird's beaked whale *Berardius bairdii*	NL	-	Potential	Open ocean	Primarily along continental slope from late spring to early fall

Species	Conservation Status		Occurrence within Proposed Project Area	Habitat	Notes
	ESA	MMPA	Offshore drone ship/landing site		
Blainville's beaked whale *Mesoplodon densirostris*	NL	-	Potential	Open ocean	Distributed throughout deep waters and continental slope regions; difficult to detect given diving behavior
Ginkgo-toothed beaked whale *Mesoplodon ginkgodens*	NL	-	Potential	Open ocean	Range generally includes California current system North Pacific Gyre
Perrin's beaked whale *Mesoplodon perrini*	NL	-	Potential	Open ocean	Range generally includes California current system North Pacific Gyre
Stejneger's beaked whale *Mesoplodon stejnegeri*	NL	-	Potential	Open ocean	Southern limit in the central Pacific is unknown but is likely to range between 50° N and 60° N, and 30° N[5]
Hubbs' beaked whale *Mesoplodon carlhubbsi*	NL	-	Potential	Open ocean	Speculated that the Hubbs' beaked whales' range includes the northernmost central California coastline[6]
Pygmy beaked whale *Mesoplodon peruvianus*	NL	-	Potential	Open ocean	Normally inhabit continental slope and deep oceanic waters and are only occasionally reported in waters over the continental shelf

[1] U.S. Geological Survey Western Ecological Resource Center 2014

[2] The eastern Pacific stock is listed as depleted under the MMPA, while the San Miguel Island stock is protected under the MMPA but is not considered depleted (Carretta et al. 2015).

[3] Calambokidis et al. 2001

[4] 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.

[5] Loughlin and Perez 1985; MacLeod et al. 2006

[6] Mead 1989 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 (Carretta et al. 2000, Forney et al. 1995, Henkel and Harvey 2008, Hobbs et al. 2004).

Notes: CA = California, m = meter(s), mi. = mile(s), km = kilometer(s), SOC = Species of Concern, FD = Federally de-listed, FE = Federal Endangered Species, FT = Federal Threatened Species, FC = Federal Candidate Species, D = MMPA Depleted Strategic Stock, NL = Not listed

3.4.6.1 Southern Sea Otter (*Enhydra lutris* [Federal Threatened Species])

The USFWS listed the Southern sea otter as federally threatened on 14 January 1977 (42 FR 2965) and published a Recovery Plan in 2003 (USFWS, 2003). The USWFS completed a 5-year review of the species in 2015 (USFWS, 2015b). Critical habitat for this species has not been designated.

The Southern sea otter is the smallest species of marine mammal in North America. It inhabits the nearshore marine environments of California from San Mateo County to Santa Barbara County with a small geographically isolated population around San Nicolas Island. On occasion, Southern sea otters have been observed beyond these limits and have been documented as far south as Baja, Mexico (USFWS, 2015b).

This species breeds and gives birth year-round and pups are dependent for 120–280 days (average 166 days; (Riedman and Estes, 1990). Sea otters are opportunistic foragers known to eat mostly abalones, sea urchins, crabs, and clams. They play a key ecological role in kelp bed communities by controlling sea urchin grazing.

Southern sea otters occur regularly off the coast of VAFB, with animals typically concentrated in the kelp beds offshore of Purisima Point on north VAFB, and offshore of Sudden Flats on south VAFB (Figure 3-9). Transitory otters occasionally traverse the coast between SLC-4 and Point Arguello. This area is, however, not regularly occupied and no otters have been detected at this location during the last three annual spring census counts from 2011 to 2016 (U.S. Geological Survey Western Ecological Resource Center 2014, 2016).

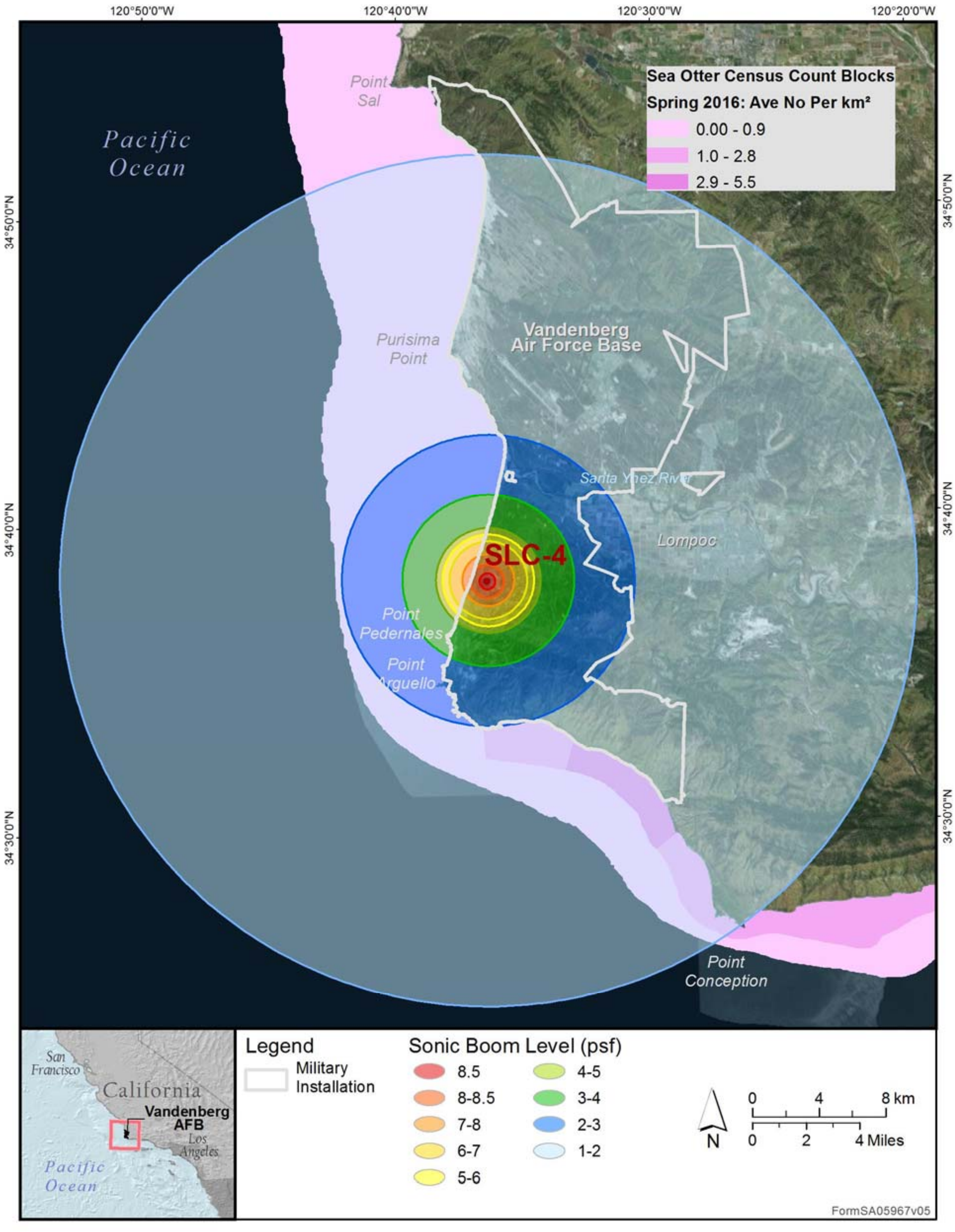


Figure 3-9. 2016 Southern Sea Otter Distribution within the Region of Influence

3.4.6.2 California Sea Lion (*Zalophus californianus*)

California sea lions are common offshore of VAFB and haul out sporadically on rocks and beaches along the coastline of VAFB. In 2014, counts of California sea lions at haulouts on VAFB increased substantially, ranging from 47 to 416 during monthly counts (ManTech SRS Technologies, Inc., 2015). However, California sea lions rarely pup on the VAFB coastline: no pups were observed in 2013 or 2014 (ManTech SRS Technologies, Inc., 2014c, 2015) and one pup was observed in 2015 (VAFB, unpubl. data). California sea lions are the most abundant pinniped species in the Channel Islands (Lowry et al., 2017b). San Miguel Island is the northern extent of the species breeding range; and, along with San Nicolas Island, it contains one of the largest breeding colonies of the species in the Channel Islands (Melin et al., 2010; Lowry et al., 2017a). Pupping occurs in large numbers on San Miguel Island at the rookeries found at Point Bennett on the west end of the island and at Cardwell Point on the east end of the island. During aerial surveys of the Northern Channel Islands conducted by NMFS in February 2010, 21,192 total California sea lions (14,802 pups) were observed at haulouts on San Miguel Island and 8,237 total (5,712 pups) at Santa Rosa Island (M. Lowry, NMFS, unpubl. data). During aerial surveys in July 2012, 65,660 total California sea lions (28,289 pups) were recorded at haulouts on San Miguel Island, 1,584 total (3 pups) at Santa Rosa Island, and 1,571 total (zero pups) at Santa Cruz Island (M. Lowry, NMFS, unpubl. data). The at-sea estimated density for California sea lions is assumed to be 0.0596 individuals per km^2 in the affected areas (U.S. Department of the Navy, 2016).

3.4.6.3 Pacific Harbor Seal (Phoca vitulina richardsi)

Pacific harbor seals congregate on multiple rocky haulout sites along the VAFB coastline. Most haulout sites are located between the Boat House and South Rocky Point, where most of the pupping on VAFB occurs. Pups are generally present in the region from March through July. Within the affected area on VAFB, up to 332 adults and 34 pups have been recorded in monthly counts from 2013 to 2015 (ManTech SRS Technologies, Inc., 2014c, 2015; VAFB, unpublished data). During aerial pinniped surveys of haulouts located in the Point Conception area by NMFS in May 2002 and May and June of 2004, between 488 to 516 harbor seals were recorded (M. Lowry, NMFS, unpubl. data). Data on pup numbers were not provided. Harbor seals also haul out, breed, and pup in isolated beaches and coves throughout the coast of San Miguel Island. During aerial surveys conducted by NMFS in May 2002 and May and June of 2004, between 521 and 1,004 harbors seals were recorded at San Miguel Island, between 605 and 972 at Santa Rosa Island, and between 599 and 1,102 Santa Cruz Island (M. Lowry, NMFS, unpubl. data). Again, data on pup numbers were not provided. Lowry et al. (2017b) counted 1,367 Pacific harbor seals at the Channel Islands in July 2015. The at-sea estimated density for harbor seals is assumed to be 0.0183 individuals per km^2 in the affected areas (U.S. Department of the Navy, 2016).

3.4.6.4 Northern Elephant Seal (*Mirounga angustirostris*)

Northern elephant seals haul-out sporadically on rocks and beaches along the coastline of VAFB and observations of young of the year seals from May through November have represented individuals dispersing later in the year from other parts of the California coastline where breeding and birthing occur. Pupping of this species was observed on south VAFB in January 2017, for the first time in more than 40 years. Eleven northern elephant seals were observed during aerial surveys of the Point Conception area by NMFS in February of 2010 (M. Lowry, NMFS, unpubl. data). Northern elephant seals breed and pup at the rookeries found at Point Bennett on the west end of San Miguel Island and at Cardwell Point on the east end of the island (Lowry, 2002). Northern elephant seals are abundant in the Channel Islands from December to March (Lowry et al., 2017b). During aerial surveys of the Northern Channel Islands conducted by NMFS in February 2010, 21,192 total northern elephant seals (14,802 pups) were recorded at haulouts on San Miguel Island and 8,237 total (5,712 pups) were observed at Santa Rosa Island (M. Lowry, NMFS, unpubl. data). None were observed at Santa Cruz Island (M. Lowry, NMFS, unpubl. data). Lowry (2017b) stated that aerial surveys found 16,208 pups in San Miguel Island, 10,882 pups at San Nicolas Island, and 5,946 pups at Santa Rosa Island. The at-sea estimated density for northern elephant seals is assumed to be 0.076 individuals per km^2 in the affected areas (U.S. Department of the Navy, 2016).

3.4.6.5 Steller Sea Lion (*Eumetopias jubatus*)

North Rocky Point was used in April and May 2012 by Steller sea lions (Marine Mammal Consulting Group and Science Applications International Corporation [MMCG and SAIC], 2012). This observation was the first time this species had been reported at VAFB during launch monitoring and monthly surveys conducted over the past two decades. Since 2012, Steller sea lions have been observed frequently in routine monthly surveys, with as many as 16 individuals recorded. In 2014, up to five Steller sea lions were observed in the affected area during monthly marine mammal counts (ManTech SRS Technologies, Inc., 2015) and a maximum of 12 individuals were observed during monthly counts in 2015 (VAFB, unpublished data). However, up to 16 individuals were observed in 2012 (MMCG and SAIC, 2012). Steller sea lions once had two small rookeries on San Miguel Island, but these were abandoned after the 1982-1983 El Niño event (DeLong and Melin, 2000; Lowry, 2002); however occasional juvenile and adult males have been detected since then. These rookeries were once the southernmost colonies of the eastern stock of this species. The Eastern Distinct Population Segment of this species, which includes the California coastline as part of its range, was de-listed from the federal Endangered Species Act in November 2013. The at-sea estimate density for Steller sea lion is assumed to be 0.0001 individuals per km^2 in the affected areas; however, the species is not expected to occur in the Iridium Landing Area (U.S. Department of the Navy, 2015; U.S. Department of the Navy, 2016).

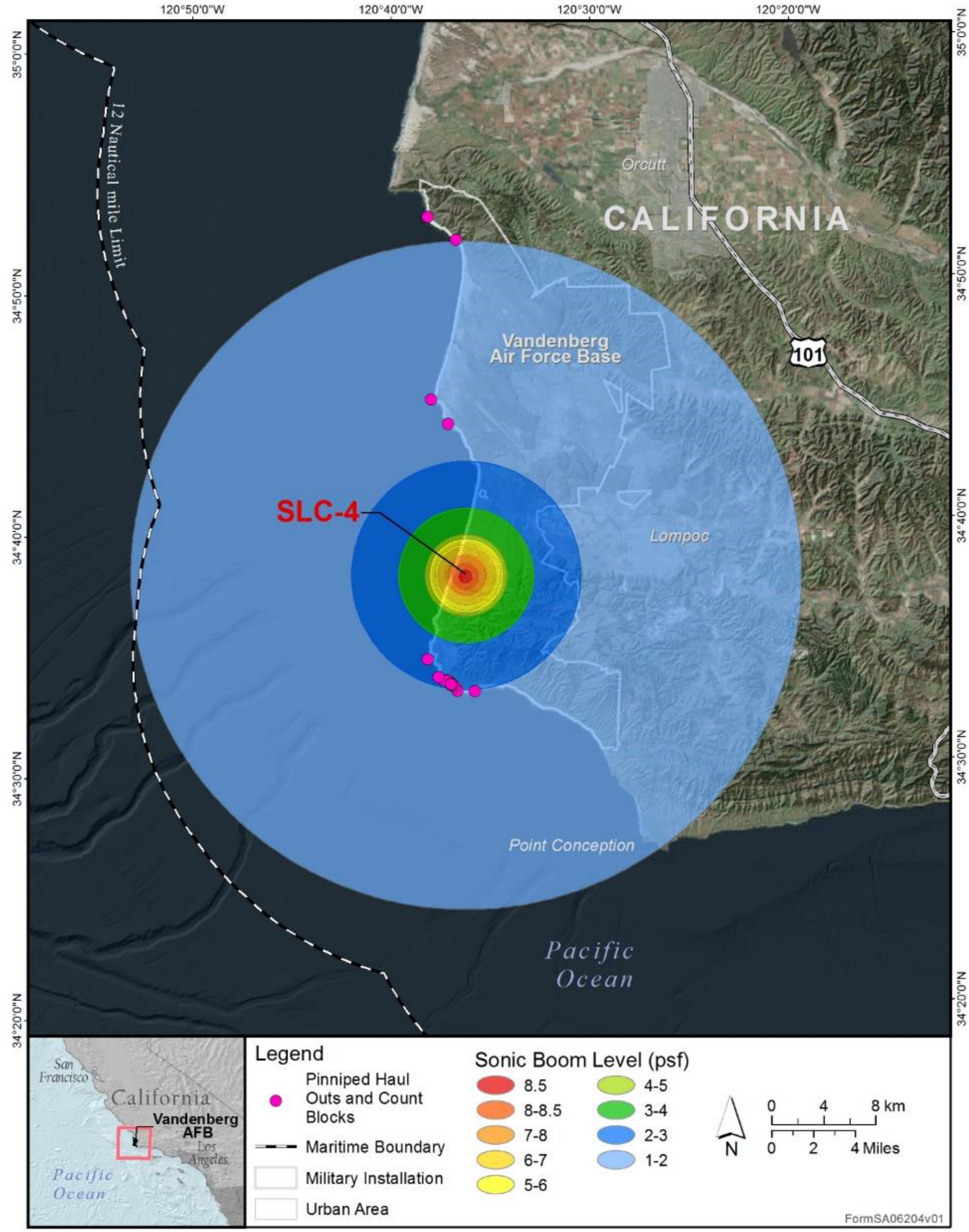


Figure 3-10. Marine Mammal Haulouts at VAFB and Sonic Boom Levels

3.5 Water Resources

Water resources include surface water, groundwater, and wetlands as well as their physical, chemical, and biological characteristics. Surface water includes lakes, rivers, streams, and wetlands. Groundwater refers to water below the surface of the Earth.

3.5.1 Region of Influence

The ROI for Water Resources include those areas where the Proposed Action may affect surface water and groundwater. This includes any potential construction area where ground-disturbing activities would take place as well as adjacent areas that may be impacted by construction, operation, and implementation of the Proposed Action. For surface water resources, the ROI includes Spring Canyon Creek and the Pacific Ocean. For groundwater resources, the ROI includes the Santa Ynez River groundwater basin/Lompoc Terrace sub-basin.

All of Southern California is within a semi-permanent, high-pressure zone of the Eastern Pacific Region. The coastal area is characterized by sparse rainfall, most of which occurs in the winter season, and hot dry summers, tempered by cooling sea breezes. In Santa Barbara County, the months of heaviest precipitation are November through April, averaging 14.66 inches (approximately 9 gallons per one square foot of soil) annually.

3.5.2 Surface Water

The Clean Water Act (CWA) is the primary federal statute that regulates the discharges of pollutants into waters of the United States (waters of the U.S.).

Section 404 of the CWA authorizes U.S. Army Corps of Engineers (USACE) to issue permits for the discharge of dredge or fill material into waters of U.S. and Section 401 requires that a water quality certificate be obtained that ensures that a project does not violate state water quality standards.

Waters of the U.S. is a legal term that describes the types of water bodies which are regulated under the Clean Water Act (and the Oil Pollution Act). Generally, waters of the U.S. includes traditional navigable waters, waters used in interstate commerce, interstate waters, intrastate waters when the use, degradation, or destruction could affect interstate or foreign commerce, tributaries of these water, the territorial seas, and wetlands adjacent to these waters (40 C.F.R. § 230.3[s]). Territorial waters, defined by the 1982 United Nations Convention on the Law of the Sea, extend 12 nautical miles (13.8 miles, 22.2 km) from the mean low-water mark of a coastal state. In 2006, The U.S. Supreme Court issued the *Rapanos* decision which restricted the definition of waters of the U.S. to only those waters that are relatively permanent, standing, or continuously flowing, and forming geographic features such as oceans, rivers, streams, and lakes. Drainage channels in which water flows intermittently or ephemerally are no longer regulated as waters of the U.S. Additionally, *Rapanos* required the USACE to determine a “significant nexus” on a case-by-case basis before asserting jurisdiction over isolated wetlands that are not adjacent to “relatively permanent waters”. Spring Canyon Creek is an ephemeral drainage that the USACE has determined to have no significant nexus to the navigable waters of the Pacific Ocean and therefore does not qualify as a water of the U.S. under the current definition.

Section 402 of the CWA establishes the 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. In California, the SWRCB administers the NPDES program through the Porter Cologne Water Quality Act/California Water Code.

The SWRCB and the RWQCB administer the NPDES Program for industrial activities, municipalities and construction activities through General Permits, although certain discharges are authorized and certain discharges require individual permits. VAFB is in the jurisdiction of the Region 3, Central Coast RWQCB. Space X currently has coverage under the NPDES General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities (Construction General Permit) and the NPDES General Permit for Storm Water Discharges Associated with Industrial Activities (Industrial General Permit).

The Porter-Cologne Water Quality Control Act/California Water Code regulates the discharge of waste that may affect the quality of "waters of the state," which is defined broadly as “any surface water or groundwater, including saline waters, within the boundaries of the state" (California Water Code 13050[e]) and includes waters of the U.S. This act also provides a framework for establishing beneficial uses of water resources and the development of local water quality objectives to protect these beneficial uses. The Central Coast Water Quality Control Plan (Basin Plan) assigns beneficial uses to water bodies and provides local water quality objectives to protect these beneficial uses (SWRCB, 2016). The California Ocean Plan provides water quality objectives to protect ocean water quality (SWRCB, 2015).

The SWRCB has not designated a beneficial use for Spring Canyon Creek (SWRCB, 2016). The Basin Plan provides the following designations for surface water bodies that do not have designated beneficial uses, which would apply to Spring Canyon Creek:

- Municipal and domestic water supply; and
- Protection of both recreation and aquatic life.

Process water discharges at SLC-4E are enrolled in the RWQCB General Waiver for Specific Types of Discharges which allows discharge to land via a spray field under certain conditions including no designated or hazardous levels of chemicals.

The Santa Ynez River is considered the dividing line between North and South VAFB. The following three major drainages occur on south VAFB: Bear Creek, Cañada Honda Creek, and Jalama Creek. There are also numerous unnamed minor drainage basins containing seasonal (intermittent) and ephemeral streams. Drainage from these basins is predominantly to the west, toward the Pacific Ocean. Surface water resources in the vicinity of SLC-4 include Spring Canyon Creek and the Pacific Ocean.

Figure 3-11. Lower Spring Canyon, 30 January 2006

Spring Canyon Creek originates approximately 1.4 miles inland and flows toward the Pacific Ocean. Lower Spring Canyon is an ephemeral stream. Although water seldom flows in the creek, there is often standing water upstream of Surf Road (VAFB, 2007). Surface flow percolates into the groundwater to pass beneath road embankments and eventually enters the Pacific Ocean (USAF, 1987). Scientific evidence demonstrates that stream channels and open waters that form river networks are connected to downstream waters and influence the integrity of downstream water. Although the evidence is less abundant than that of perennial and intermittent streams, there is compelling scientific evidence that ephemeral streams are connected and influence downstream water as well, particularly when there is physical connectivity and channelized flow that form and maintain a network of streams (USEPA, 2015).

Spring Canyon Creek is not listed as an impaired water body under Section 303(d) of the Clean Water Act. Lower Spring Canyon was sampled during the VAFB Ambient Monitoring Program from December 2005 to December 2006. Low flow and highly saturated soil conditions were causing anaerobic decomposition, suppressing the dissolved oxygen and pH levels, increasing metals concentration. There was also a large amount of leaf litter that appeared to be decomposing into a thick, orange substance (VAFB, 2007).

3.5.3 Ground Water

Groundwater is, generally, not within the scope of the CWA unless the groundwater is hydrologically connected with a water of the U.S. Although the USEPA sets standards for public drinking water in accordance with the Safe Drinking Water Act, groundwater is a waters of the State regulated under the Porter-Cologne Water Quality Control Act/California Water Code Division 7.

SLC-4 is composed predominantly of sandy soil (Marina Sand, 9 to 30 percent slope, and Oceano sand, 2 to 15 percent slope) with low to very low runoff and a high to very high saturated hydraulic conductivity (Ksat) rating (i.e., 92 micrometers per second). This rating refers to the ease in which pores in saturated soil transmit water (Natural Resources Conservation Service [NRCS], 2017). VAFB includes parts of two major groundwater basins, and at least two sub-basins. Most of the northern third of the Base is within the San Antonio Creek Basin, while most of the southern two thirds of the Base are within the Santa Ynez River Basin and associated Lompoc Terrace and Cañada Honda sub-basins. SLC-4 is located on the southern margin of the Santa Ynez River groundwater basin/Lompoc Terrace sub-basin.

Groundwater at SLC-4 is unconfined and restricted to the unconsolidated material immediately above Sisquoc Formation bedrock. An erosional paleomarine terrace of Sisquoc shale bedrock has been noted within Spring Canyon and at the launch pad area. The bedrock surface has been affected by interaction with groundwater resulting in a physical and chemical change from shale to clay. The weathered clay bedrock effectively forms an aquitard, thereby limiting the infiltration of groundwater into the underlying Sisquoc Formation. Groundwater is typically found approximately 50 to 140 ft. below ground surface. Predominant groundwater flow is toward the Pacific Ocean (USAF, 1988).

As described in the Falcon 9 EA (USAF, 2011a), the ERP Site 8 Cluster underlies SLC-4E (Site 8), SLC-4W (Site 9), and Spring Canyon Pond (Site 10). Trichloroethelene, used as a degreaser of missile components, leaked into the underlying vadose zone through cracks and joints in the deluge channel and retention basin concrete lining, eventually reaching groundwater at a depth of 120 ft. below ground surface. In addition, a low altitude launch failure in 1986 caused widespread deposition of ammonium perchlorate debris that is believed to have sourced perchlorate in the soil and groundwater. Perchlorate surface soil contamination was determined to be below concentrations at risk to human health (Tetra Tech Inc., 2009). As such, previous launch operations have resulted in the release of hazardous materials to the environment, which has resulted in volatile organic compounds (VOCs) and perchlorate contaminating the groundwater. The area is populated with multiple monitoring and injection wells. Groundwater monitoring of the Site 8 Cluster is ongoing and future remediation cannot be ruled out.

3.5.4 Wetlands

Section 404 of the CWA establishes a program that regulates the discharge of dredge or fill material into waters of the U.S., including jurisdictional wetlands. Non-jurisdictional wetlands are not protected by the CWA because they are not considered waters of the U.S. Jurisdictional 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.” The following factors are used to determine whether an area is a wetland under the CWA: hydrophilic vegetation, wetland hydrology, and hydric soils. An area that meets all three of these factors qualifies as a wetland under the CWA. In order for the wetland hydrology criterion to be met, a site must be inundated or saturated or exhibit features that show the area was inundated or saturated for the required period of time (i.e., 45 days).

Under Section 404, a discharge of dredged or fill material cannot be permitted if a practicable alternative exists that avoids or minimizes wetland impacts. The U.S. Government has historically had a policy, which was first adopted in 1989, that there be "no net loss" of wetland habitat. This "no net loss" policy requires that USACE offset unavoidable wetland impacts. In addition, jurisdictional and non-jurisdictional wetlands are protected under EO 11990, dated 24 May 1977 and amended by EO 12608 on 9 September 1987, which requires federal agencies to minimize the destruction, loss, or degradation of wetlands and to enhance the natural and beneficial values of wetlands.

The SWRCB recently issued a final draft revised rule for state wetlands (SWRCB, 2017). This definition is broader than the CWA definition and it establishes new permitting provisions for discharging fill into state waters. Unlike the CWA regulations, the state's definition for wetlands only requires inundation and hydric soils, and it includes artificial features. Artificial wetlands would not be considered waters of the state when they are used or maintained for industrial wastewater treatment or disposal; storm water detention, infiltration, or treatment; or fire suppression among other things (SWRCB, 2017).

VAFB maintains a minimum 30-foot buffer zone around all riparian areas and wetlands as a development constraint. Due to the absence of a continuous surface connection from the stream/riparian zone adjacent to SLC-4 and the Pacific Ocean, Spring Canyon Creek is not considered federal jurisdictional waters, however it is considered state waters. The National Wildlands Inventory has also designated this creek as a freshwater forested/shrub or freshwater emergent wetland, which is a biological delineation, not a jurisdictional delineation..

3.6 Cultural Resources

Cultural resources are districts, buildings, sites, structures, areas of traditional use, or objects with historical, architectural, archeological, cultural, or of scientific importance. They include archeological resources (both prehistoric and historic), historic architectural resources (physical properties, structures, or built items), and traditional cultural properties (those important to living Native Americans for religious, spiritual, ancestral, or traditional reasons).

Section 106 of the NHPA requires federal agencies to assess potential project related effects to historic properties that are listed or eligible for listing in the National Register of Historic Places (NRHP). Associated implementing regulations include 36 C.F.R. Part 800, Protection of Historic Properties.

3.6.1 Region of Influence

The ROI for Cultural Resources is in the vicinity of SLC-4 where ground-disturbing activities would take place. The prehistory of California's central coast spans the entire Holocene and may extend back to late Pleistocene times. Excavations on VAFB reveal occupations dating back 11,000 years (Lebow et al., 2014). These early occupants are thought to have lived in small groups that had a relatively egalitarian social organization and a forager-type land-use strategy (Erlandson, 1994; Glassow, 1996; Greenwood, 1972; Moratto, 1984). Human population density was low throughout the early and middle Holocene (Lebow et al. 2007). Cultural complexity appears to have increased around 3,000–2,500 years ago (King 1981, 1990). At VAFB, that interval also marks the beginning of increasing human population densities and appears to mark the shift from a foraging to a collecting land-use strategy (Lebow et al. 2006, 2007). Population densities reached their peak around 600–800 yars ago, corresponding to the full emergence of Chumash cultural complexity (Arnold, 1992). People living in the VAFB area prior to historic contact are grouped with the Purisima Chumash (Greenwood, 1978; King, 1984; Landberg, 1965), one of several linguistically related members of the Chumash culture. In the Santa Barbara Channel area, the Chumash people lived in large, densely populated villages and had a culture that "was as elaborate as that of any huntergatherer society on earth" (Moratto, 1984). Relatively little is known about the Chumash in the Vandenberg region. Explorers noted that villages were smaller and lacked the formal structure found in the channel area (Greenwood, 1978). About five ethnohistoric villages are identified by King (1984) on VAFB, along with another five villages in the general vicinity. Diseases introduced by early Euroamerican explorers, beginning with the maritime voyages of Cabrillo in A.D. 1542–1543, substantially impacted Chumash populations more than 200 years before Spanish occupation began (Erlandson & Bartoy 1995, 1996; Preston 1996). Drastic changes to Chumash lifeways resulted from the Spanish occupation that began with the Portolá expedition in A.D. 1769.

VAFB history is divided into the Mission, Rancho, Anglo-Mexican, Americanization, Regional Culture, and Suburban periods. The Mission Period began with the early Spanish explorers and continued until 1820. Mission La Purísima encompassed the Vandenberg area. Farming and ranching were the primary economic activities at the Mission. The Rancho Period began in 1820 and continued until 1845. Following secularization in 1834, the Alta California government granted former mission lands to Mexican citizens as ranchos. Cattle ranching was the primary economic activity during this period. The Bear Flag Revolt and the Mexican War marked the beginning of the Anglo-Mexican Period (1845–1880). Cattle ranching continued to flourish during the early part of this period, but severe droughts during the 1860s decimated cattle herds. The combination of drought and change in government from Mexican to the United States caused substantial changes in land ownership. Sheep ranching and grain farming replaced the old rancho system. Increased population densities characterize the Americanization Period (1880–1915).

Beginning in the late 1890s, the railroad provided a more efficient means of shipping and receiving goods and supplies, which in turn increased economic activity. Ranching and farming continued during the early part of the period of Regional Culture (1915–1945), until property was condemned for Camp Cooke (Palmer, 1999).

The Suburban Period (1945–1965) began with the end of World War II. In 1956, the army transferred 64,000 ac. of North Camp Cooke to the USAF, and it was renamed the Cooke Air Force Base. Construction of missile launch complexes began in 1957 and in 1958 the base had its first missile launch, the Thor, and was renamed VAFB (Palmer, 1999). The base played a very important role in the Cold War, with every ballistic missile in the United States arsenal ground- and flighttested at VAFB and thousands of military personnel receiving training under operational conditions. In addition, the base was the only place where military satellites could be safely launched into polar orbit and, thus, proved critical to the military space program during the Cold War (Nowlan et al., 1996).

3.6.2 Recorded Cultural Resources

Construction of SLC-4 began in 1961. Initially, the two launch pads (SLC-4E and SLC-4W) were designed to launch Atlas/Agena vehicles. The first launch occurred on July 12, 1963. Over time, the pads were modified to accommodate various Titan launch vehicles. SLC-4 has played an important role in the U.S. military space program, with many launches of classified reconnaissance satellite systems (Nowlan et al., 1996:109–111). Because they played a pivotal role during the Cold War, both SLC-4E and SLC-4W were recommended eligible for the NRHP under Cold War Criterion A (Nowlan et al., 1996:142). However, VAFB, in consultation with the SHPO, subsequently determined that SLC-4 was not eligible for the NRHP due to a substantial loss of historical integrity.

As described in Falcon 9 EA, an archaeological site record and literature search were completed for all sites within 0.25 miles of SLC-4E. This effort identified seven archaeological sites and one artifact within a 0.25 mile radius of SLC-4E. These include CA-SBA-537, -1127,-1815, -1816, -1940, -2305, -2427, and VAFB-ISO-300. Of those, only CA-SBA-537 and VAFB-ISO-300 are within or partially within SLC-4E. CA-SBA-1816, while recorded as a separate site, is within CA-SBA-537 and forms a complex designated as CA-SBA-537/1816 (USAF, 2011a). CA-SBA-537/1816 is a Late Period prehistoric archaeological site, which the SHPO has previously determined eligible for the NRHP under Criterion D (Smallwood & Ryan, 2017). Only a very small portion of the site complex extends into SLC-4E (USAF, 2011a).

Applied EarthWorks (2017) performed fieldwork (i.e., shovel pits) in the area of direct impact for the Proposed Action, which was completed on 11 and 12 October 2017. A Native American representative for the Tribal Elders Council at the Santa Ynez Band of Chumash Indians accompanied Applied Earthworks during fieldwork. No archaeological sites, features, artifacts, or cultural midden soils were encountered during the archaeological fieldwork carried out during this study. The study found that the area of potential effects is highly disturbed due to past construction of SLC-4E. Archaeological testing indicated that no subsurface deposits exist in close proximity to the area of potential effects, and the area of potential effects is unlikely to contain any intact archaeological deposits.

3.7 Geology and Earth Resources

Geological resources include the geology, soils, and seismicity of a particular area. The Farmland Protection Policy Act (7 U.S.C. § 4201) requires federal agencies to evaluate the adverse effects of their activities on farmland, which includes prime and unique farmland and farmland of statewide and local importance, and to consider alternative actions that could avoid adverse effects. Prime farmland is based on the chemical and physical characteristics of the soil. Land does not have to be currently used for cropland to be subject to the requirements of the Farmland Protection Policy Act.

3.7.1 Region of Influence

The ROI for Geology and Earth Resources is any area where ground-disturbing activities would take place. Here, this would be primarily in the vicinity of SLC-4E and within and adjacent to Spring Canyon Creek.

3.7.2 Geology

VAFB is located in a geologically complex area in the transition zone between the Southern Coast Range and Western Transverse Range Geomorphic Provinces. Marine sedimentary rocks of the Late Mesozoic age (140 to 70 million years Before Present [BP]) and Cenozoic age (70 million years BP to the present) underlie VAFB (Dibblee, 1950).

SLC-4E is primarily underlain by landslide debris, particularly Orcutt sand, which is tan to rusty brown, wind deposited sand with a pebbly base from the Pleistocene period. However, portions of Spring Canyon Creek is primarily valley and floodplain deposits of silt, sand, and gravel from the Holocene period. SLC-4W is primarily underlain by older dune sand deposits, in places with weekly consolidated from the Pleistocene period (Dibblee, 1988).

3.7.3 Soils

Shipman (1981) and NRCS (2017) identify the dominant soil types on VAFB. The predominant soil type at SLC-4E is Marina sand with a 9 to 30 percent slope. This soil is generally sandy with a low runoff class, but it has a moderately high to high capacity to transmit water (0.57 to 1.98 inches per hour). The soil also is not characterized as hydric, which are soils that are permanently or seasonally saturated by water for a long enough period to result in anaerobic conditions in its upper layer (NRCS, 2017). However, VAFB (2007) stated that the low flow of the Lower Canyon Creek was resulting in anaerobic decomposition.

The predominant soil type at SLC-4W is Oceana sand with 2 to 15 percent slope (NRCS, 2017). This soil is general sandy with a low runoff class but a high to very high capacity to transmit water (5.95 to 19.98 inches per hour). In addition, like Marina sand, Oceana sand is not hydric (NRCS, 2017).

The NRCS (2017) classified the land within Oceana soil association as farmland of statewide importance. This land is largely being used as a launch facility. In addition, the NRCS (2017) has classified land approximately 300 ft. southwest of SLC-4E within and adjacent to Spring Canyon as prime farmland if irrigated and either protected from flooding or not frequently flooded during the growing season (Elder sandy loam, 2 to 9 percent slopes, eroded).

3.7.4 Seismicity

VAFB is in Seismic Hazard Zone 4, as defined by the Uniform Building Code, which is the most severe seismic region and is characterized by areas likely to experience earthquakes of a magnitude of 7 or higher on the Modified Mercalli Scale and to consequently sustain major damage from earthquakes. Numerous onshore and offshore faults have been mapped in the vicinity of VAFB; most are inactive and incapable of surface fault rupture or are unlikely to generate earthquakes. Four major faults have been mapped on VAFB: the Lion's Head fault on north VAFB and the Hosgri, Santa Ynez River, and Honda Faults on south VAFB. Other geologic hazards at VAFB are the potential for surface erosion, landslides, seacliff retreat, streambank erosion, tsunamis, and liquefaction. No faults are located on or near the project site.

3.8 Coastal Zone Management

The CZMA (16 U.S.C. § 1451 et seq.) is the primary federal law regarding the management of coastal resources. Federal actions that have reasonably foreseeable effects on natural resources or land or water uses in the coastal zone, regardless of the project's location, are required to be consistent, to the maximum extent practicable, with the enforceable policies of federally approved state coastal management programs (16 U.S.C. § 1456; 15 C.F.R. Part 930). Federal agencies submit a consistency determination to the state coastal management program when an action could foreseeably affect coastal resources. If a federal action would not foreseeably affect the coastal zone or coastal resources, then the federal agency may prepare a negative determination for that action.

The ROI for coastal zone management extends to those coastal resources that may be affected by the Proposed Action, including natural resources (e.g., wildlife and plants), land uses, and water uses as well as public access to and recreation within the California Coastal Zone. The California Coastal Zone Management Program was formed through the California Coastal Act of 1972. National Oceanic and Atmospheric Administration (NOAA) approved California's Coastal Management Program in 1978. The California Coastal Zone extends, generally, 1,000 yards inland and up to 3 nm (5.5 km) seaward. However, the California Coastal Zone may extend up to 5 miles inland for significant coastal estuarine, habitat, and recreational areas and less than 1,000 yards inland in urban areas. SLC-4 is on VAFB and is not within the California Coastal Zone.

On 31 August 2015, the California Coastal Commission concurred with a negative determination (ND) (ND-0027-15) for recurring Falcon 9 first stage boost-back landings at SLC-4W or a barge approximately 27 nm (50 km) offshore of VAFB. In 2016, the USAF determined the proposed use of the Iridium Landing Area would not raise any new coastal resource issues not previously addressed and the California Coastal Commission concurred with this determination on August 11, 2016 (USAF, 2016b).

3.9 Department of Transportation Section 4(f)

Section 4(f) of the USDOT Act of 1966 (49 U.S.C. § 303) protects the following types of properties:

- 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 (FAA, 2015).

Section 4(f) only applies to USDOT agency (e.g., FAA) actions. A property must be a significant resource for Section 4(f) to apply. Per FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*, the FAA will not approve any program or project that requires the "use" of any Section 4(f) property determined by the officials having jurisdiction thereof, unless no feasible and prudent alternative exists to the use of such land and such program, and the project includes all possible planning to minimize harm (FAA, 2015).

The "use" of Section 4(f) properties includes physical use and constructive use. Physical use occurs when there is a physical taking of property through the purchase of land or a permanent easement, physical occupation of a portion or all of the property, or alteration of structures or facilities on the property. Generally, the temporary occupancy of a property would not constitute a use within the meaning of Section 4(f). Constructive use occurs when the project's impacts substantially impair the activities, features, or attributes that qualify a property for protection under Section 4(f) (FAA, 2015).

The following public parks and recreation areas are located near SLC-4 and could be considered properties subject to Section 4(f): Jalama Beach County Park, Surf Beach, County of Santa Barbara Ocean Beach Park, Wall Beach, Miguelito Park, Rancho Guadalupe Dunes County Park, Point Sal Beach State Park, and Gaviota Beach State Park (USAF, 2016a). The Channel Islands National Park could also be considered a USDOT Section 4(f) property.

4 Environmental Consequences

This chapter presents the results of the analysis of potential environmental effects of implementing Alternative 1 and the No Action Alternative as described in Chapter 2 (Description of the Proposed Action and Alternatives). For each environmental component, anticipated impacts are assessed considering short- and long-term effects.

4.1 Air Quality

This section analyzes Alternative 1 and the No Action Alternative's impacts on ambient air quality. An action would have a significant impact on air quality if the action would cause pollutant concentrations to exceed one or more of the NAAQS, for any of the time periods analyzed, or if it were to increase the frequency or severity of any such existing violations.

The General Conformity Rule (40 C.F.R. § 93.153) requires that agencies prepare an applicability analysis and a conformity determination to determine whether a proposed action's reasonably foreseeable emissions conform with the SIP for nonattainment or maintenance areas. Reasonably foreseeable emissions include direct and indirect emissions (see also SBCAPCD Rule 702). If the applicability analysis determines that reasonably foreseeable emissions meet or exceed *de minimis* thresholds, a conformity determination is required. If these emissions are below *de minimis* thresholds, then the conformity evaluation is complete. Appendix C provides the Air Quality Analysis for construction activities under Alternative 1 (Proposed Action). Previously reported values for launches, vehicle use, ground operations (VAFB, 2011) and landings and vessel use (VAFB, 2016) are used as No Action Alternative numbers and operational/emissions calculations are scaled accordingly to represented up to 12 launches per year under Alternative 1.

4.1.1 Alternative 1 (Proposed Action)

4.1.1.1 Launch and Landing Operations

This analysis follows the methodology that was used in the analysis conducted for the Falcon 9 EA (USAF, 2011) and the SpaceX Falcon 1 and 9 Launch Program at Cape Canaveral Air Force Station (USAF, 2007). Table 4-1 provides the estimated emissions for 12 launches, boost-backs, and landings per year that would be within the mixing layer, which is defined as the area below the mixing height, typically 3,000 ft. above ground level.

Table 4-1. Emissions for Launch, Boost-Back, and Landings below 3,000 feet (tons/year) for Alternative 1

	ROG	NOx	CO	SO_x	PM_{10}	$PM_{2.5}$
Launch Emissions per Event	0	1.2	0	0	0	0
Landing Emission per Event	0	1.2	0	0	0	0
Total	0	28.8	0	0	0	0
De Minimis Threshold	100	100	100	100	70	70
Exceed Threshold	No	No	No	No	No	No

Notes: CO = Carbon Monoxide, NO_x = Nitrogen Oxide, $PM_{2.5}$ = particulate matter less than 2.5 microns, PM_{10} = particulate matter less than 10 microns, ROG = reactive organic gases, SO_x = Sulfur Dioxide

As described in the Falcon 9 EA (USAF, 2011), each Falcon 9 launch is anticipated to produce up to 95.22 tons of CO and trace amounts of other pollutants. The maximum amount of Falcon 9 launches under Alternative 1 would be 12 per year, resulting in up to 1,142.64 tons per year of CO emissions. The 1,142 tons per year of CO emissions include emissions above 3,000 feet. These emissions are above the mixing level and are therefore not included in the conformity analysis. However, according to data cited in USAF (2007), emissions per launch within 3,000 ft. above ground level for a rocket propelled with LOX and RP-1 would be 1.2 tons of NO_x and insignificant amounts of other pollutants. Under Alternative 1, this would total 14.4 tons of NO_x annually. Only insignificant amounts of other criteria pollutants would be produced below 3,000 ft. Above Ground Level (AGL), and totals for those pollutants are reported as zero.

Emissions below 3,000 ft. AGL associated with the landing would result from combustion of RP-1 during the final single engine burn, which is estimated to take place over approximately 17 seconds. Minor emissions of ROG would be associated with offloading of the remaining RP-1 fuel from the Falcon 9 fuel tank. USAF (2011) estimated that each landing would result in 1.2 tons of NO_x and insignificant amounts of other pollutants, resulting in approximately 14.4 tons of NO_x annually under Alternative 1.

Alternative 1 includes emissions from drone ships and support vessels in the Pacific Ocean. These vessels would deploy from Long Beach Harbor and then head towards either the Contingency Landing Location or the Iridium Landing Area depending on the mission requirements.

For the Contingency Landing Location, the drone ship landing site would be located no closer than approximately 27 nm (50 km) from shore, and the vessels would be within the boundary of California Coastal Zone for approximately 43 hours of the total transit time (21.5 hours outbound and 21.5 hours inbound). USAF (2011) predicted that emissions from the operation of the three vessels for six landings per year would be below the major source threshold of 100 tons per year for all criteria pollutants. Increasing the number of landings to 12 per year would still be below this threshold (Table 4-2).

Table 4-2. Vessel Emissions for a Contingency Landing Location Within and Beyond California Coastal Zone (tons/year) for Alternative 1

Operations	ROG	NO_x	CO	SO_x	PM_{10}
Combined emissions for all three vessels per roundtrip transit (entire transit)	0.00010	0.00229	0.00070	0.00024	0.00011
Combined emissions for all three vessels per roundtrip transit (CA Coastal waters only)	0.000056	0.001290	0.000401	0.000134	0.000064
Total emissions for twelve roundtrip transits/year (entire transit)	0.0012	0.02478	0.0084	0.00288	0.00132
Total emissions for twelve roundtrip transits/year (CA Coastal waters only)	0.000672	0.01548	0.004812	0.00168	0.000768

Notes: CO = Carbon Monoxide, NO_x = Nitrogen Oxide, $PM_{2.5}$ = particulate matter less than 2.5 microns, PM_{10} = particulate matter less than 10 microns, ROG = reactive organic gases, SO_x = Sulfur Dioxide

As was stated in the Iridium SEA, the proposed Iridium Landing Area would be located approximately 122 nm (226 km) southwest of San Nicolas coastal waters and 133 nm (245 km) southwest of San Clemente Island coastal waters and would require approximately 40 hours transit time each way. The vessels would be within the boundary of California Coastal Zone for approximately two hours of the total transit time (one hour outbound and one hour inbound) (USAF, 2016b). Increasing the number of landings to 12 per year would still be below the major source threshold of 100 tons per year for all criteria pollutants (

Table 4-3).

Table 4-3. Vessel Emissions for a Contingency Drone Ship Landing in the Iridium Landing Area Within and Beyond California Coastal Zone (tons/year) for Alternative 1

Operations	ROG	NO_x	CO	SO_x	PM_{10}
Combined emissions for all three vessels per roundtrip transit (entire transit)	0.00011	0.00253	0.00078	0.00027	0.00012
Combined emissions for all three vessels per roundtrip transit (CA Coastal waters only)	0.000003	0.000060	0.000019	0.000006	0.000003
Total emissions for twelve roundtrip transits/year (entire transit)	0.00130	0.03035	0.00934	0.00319	0.00149
Total emissions for twelve roundtrip transits/year (CA Coastal waters only)	0.000003	0.000060	0.000019	0.000006	0.000003

Notes: CO = Carbon Monoxide, NO_x = Nitrogen Oxide, $PM_{2.5}$ = particulate matter less than 2.5 microns, PM_{10} = particulate matter less than 10 microns, ROG = reactive organic gases, SO_x = Sulfur Dioxide

In addition to emissions associated with launch activities, each launch activity would result in vehicle trips due to workers required to support launch activities, and heavy duty truck trips associated with delivery of components, fuel and propellants. These emissions as well as those of two generators are summarized in USAF (2011). Alternative 1 would not change these operational activities. However, Alternative 1 includes annual maintenance (i.e., mowing) of the area south of SLC-4E. Although these emissions would add to annual emissions, they would be negligible as this would only occur once per year around the launch site. Table 4-4 estimates the total ambient air quality emissions per year for SpaceX's operations of the Falcon 9 at VAFB. Although the SCAB is in extreme non-attainment for O_3, which would mean that the *de minimis* threshold for O_3 is 10, the majority of the emissions being produced by the Proposed Action would be released within the SCCAB. Emissions that would take place below 3,000 feet would be released in the SCCAB since the rocket would be above the 3,000-foot threshold before leaving the SCCAB. The only emissions being released in the SCAB would come from contingency vessels. A small number of support vehicles would be used within Long Beach Harbor during loading and unloading operations. Less than one ton of pollutants would be released annually by contingency vessels. These are small in comparison to both other aspects of the operation as well as the *de minimis* thresholds for the SCAB. Since the SCCAB is where almost all of the emissions will be released, the *de minimis* thresholds for that basin was used, which for the referenced pollutant is the moderate non-attainment threshold.

Table 4-4. Operational Emissions (tons/year) Resulting from Alternative 1

Operations	ROG	NO_x	CO	SO_x	PM_{10}	$PM_{2.5}$
Employee Vehicles[1]	0.948	1.764	16.788	0.012	0.096	0.096
Operations Deliveries[1]	0.036	0.576	0.168	0	0.024	0.024
Emergency Generators[1]	0.216	2.676	0.576	0.18	0.192	0.192
Launch	0	14.4	0	0	0	0
Landing	0	14.4	0	0	0	0
Contingency Vessels[2]	0.000672	0.01548	0.004812	0.00168	0.000768	0.000672
Total	1.2007	33.8315	17.5368	0.1937	0.3128	0.3127
De Minimis Threshold	100	100	100	100	70	70
Exceeds Threshold	No	No	No	No	No	No

Notes: CO = Carbon Monoxide, NO_x = Nitrogen Oxide, $PM_{2.5}$ = particulate matter less than 2.5 microns, PM_{10} = particulate matter less than 10 microns, ROG = reactive organic gases, SO_x = Sulfur Dioxide

[1] Values for vehicles, deliveries, and generators are from VAFB 2011, and scaled to 12 operations per year.
[2] Values are based on contingency landing locations for conservative estimate of annual emissions

4.1.1.2 Civil Water Diversion Structure

As discussed in Chapter 2 (Description of the Proposed Action and Alternatives), Alternative 1 includes construction of a civil water diversion structure at SLC-4E. Construction is anticipated to occur for up to 60 days. During 30 days of this construction, concrete would be curing and minimal construction activities would occur. Construction emissions that would be associated with Alternative 1 include fugitive dust emissions from grading, exhaust emissions from heavy construction equipment, and emissions from worker vehicles and trucks. Table 4-5 lists the equipment that would be used for construction of the civil water diversion structure.

Table 4-5. Emissions for Proposed Construction Activities (tons/year) for Alternative 1

	CO	VOCs	NOx	SO_x	PM_{10}	$PM_{2.5}$
Heavy Construction Equipment	0.38	0.86	0.5	0.001	0.04	0.03
Construction Worker Travel	0.005	0.0001	0.0004	0.00003	0.00003	0.00002
Fugitive Dust	-	-	-	-	0.002	0.0007
Total	0.4	0.9	0.5	0.001	0.04	0.03
De Minimis Threshold	100	100	100	100	70	70
Exceed Threshold	No	No	No	No	No	No

Notes: CO = Carbon Monoxide, NO_x = Nitrogen Oxide, $PM_{2.5}$ = particulate matter less than 2.5 microns, PM_{10} = particulate matter less than 10 microns, ROG = reactive organic gases, SO_x = Sulfur Dioxide

Since Santa Barbara County violates the CAAQS for PM_{10}, dust mitigation measures are required for all discretionary construction activities regardless of the significance of the fugitive dust impacts based on the policies in the 1979 Air Quality Attainment Plan. Furthermore, construction activities are required to comply with Santa Barbara County Air Pollution Control District Rule 345, *Control of Fugitive Dust from Construction and Demolition Activities* (Adopted 2010). Under Rule 345, construction, demolition, and/or earthmoving activities are prohibited from causing discharge of visible dust outside the property line; and must utilize standard best management practices to minimize dust from truck hauling, trackout/carry-out from active construction sites, and demolition activities.

Fine particulate emissions from diesel equipment exhaust are classified as carcinogenic by the State of California. Therefore, during project grading, construction, and hauling, construction contracts would specify that contractors shall adhere to state requirements to reduce emissions of O_3 precursors and fine particulate emissions from diesel exhaust.

All portable diesel-fired construction engines rated at 50 brake-horsepower or greater must have either statewide Portable Equipment Registration Program (PERP) certificates or Air Pollution Control District (APCD) permits prior to operation. Construction engines with PERP certificates are exempt from APCD permit, provided they will be on-site for less than 12 months.

At all times, idling of heavy-duty diesel trucks would be limited to five minutes; auxiliary power units should be used whenever feasible. State law requires that drivers of diesel-fueled commercial vehicles:

- would not idle the vehicle's primary diesel engine for greater than 5 minutes at any location

- would not idle a diesel-fueled auxiliary power system for more than 5 minutes to power a heater, air conditioner, or any ancillary equipment on the vehicle.

4.1.1.3 Summary

The majority of emissions under Alternative 1 would be released within the SCCAB. The only criteria pollutants for which this area is in non-attainment are O_3 and PM_{10}. The precursors for O_3, NO_x and VOCs, would be emitted from operational activities in annual quantities of 33.8 and 1.2 tons per year respectively, and PM_{10} would be released in annual quantities of 0.4 tons per year. These quantities fall well below the *de minimis* threshold of 100 (O_3 and NO_x) and 70 tons per year (PM_{10}) and would not be expected to affect the attainment status of the SCCAB. Construction activities that would occur within the SCCAB would produce less than one ton per year of any criteria pollutants and would not affect the ambient air quality. The criteria pollutants for which the area is in attainment would not be released in large quantities. CO would be the second largest pollutant with an annual emissions rate of 17.5 tons per year, which is well below the *de minimis* threshold and shows that Alternative 1 would not cause the SCCAB to go into nonattainment for other pollutants. Only a minimal amount of the emissions would be released in the SCAB and would not affect the ambient air quality to a discernable extent. Therefore, Alternative 1 would result in less than significant impacts to air quality. SBCAPCD Permit to Operate 13711-R1 is inclusive of all SpaceX operations.

4.1.2 No Action Alternative

Under the No Action Alternative, the current operations would continue and there would be no change to the existing number of Falcon 9 launches or landings (estimated at up to 6 per year). In addition, there would be no construction of a civil water diversion structure. As presented in the Falcon 9 Boost-Back EA (USAF, 2016a) and Iridium SEA (USAF, 2016b), emissions from the operation of the three vessels would not cause pollutant concentrations to exceed one or more of the NAAQS, for any of the time periods analyzed, or if it were to increase the frequency or severity of any such existing violations (Table 4-6). Therefore, the No Action Alternative would result in less than significant impacts to air quality.

Table 4-6. Operational Emissions (tons/year) Resulting from the No Action Alternative

Operations	ROG	NO_x	CO	SO_x	PM_{10}	$PM_{2.5}$
Employee Vehicles	0.79	1.47	13.99	0.01	0.08	0.08
Operations Deliveries	0.03	0.48	0.14	0.15	0.16	0.16
Emergency Generators	0.48	0.18	2.23	0.15	0.16	0.16
Launch	0	7.2	0	0	0	0
Landing	0	7.2	0	0	0	0
Contingency Vessels	0.000016	0.000360	0.000112	0.000037	0.000018	0.0000018
Total	1.3000	16.5304	16.3601	0.3100	0.4000	0.4000
De Minimis Threshold	100	100	100	100	70	70
Exceeds Threshold	No	No	No	No	No	No

Notes: CO = Carbon Monoxide, NO_x = Nitrogen Oxide, $PM_{2.5}$ = particulate matter less than 2.5 microns, PM_{10} = particulate matter less than 10 microns, ROG = reactive organic gases, SO_x = Sulfur Dioxide

4.2 Climate

FAA Oder 1050.1F does not identify significance thresholds or factors for climate impacts. CEQ withdrew its final guidance on analyzing GHG emissions on April 5, 2017 (82 FR 16576). CEQ's prior draft guidance, however, proposed a threshold of 25,000 metric tons of CO_2e emissions per year. Meanwhile, both the Santa Barbara County Air Quality Management District and the Santa Barbara County Air Pollution Control District have a screening threshold of 10,000 metric tons of CO_2e emissions per year for stationary sources, should state permits be mandated for CEQA compliance.

4.2.1 Alternative 1 (Proposed Action)

Under Alternative 1, launch and landing operations and the construction of the civil water diversion structure would release GHGs. Table 4-7 provides the anticipated GHGs that would result from Alternative 1. Emissions from launch and landing operations and construction of the civil water diversion structure would cause the overall program emissions to exceed the significance threshold of 10,000 metric tons of CO_2e per year. While overall program emissions exceed the Santa Barbara County APCD adopted CO_2e significance threshold, the program activities subject to APCD permitting requirements are well below the threshold.

Table 4-7. Greenhouse Gas Emissions Resulting from Alternative 1

Scenario/Activity	Total Metric Tons			
	CO_2	CH_4	N_2O	CO2e
Construction				
Civil Water Diversion	58.6	0.009	0	62.5
Operations				
Transit Employee vehicles[1]	948	0.12	0.156	997
Emergency Generators[1]	90	0	0	75
Operations Deliveries[1]	66	0	0.048	67
Launch Emissions[1]	7,906	1.212	0.732	10,756
Landing Emissions	511	0	0.0022	511.62
Vessel (drone ship, tug, and support) Emissions	1,805	0.019	0.099	1,834
TOTAL	11,384.60	1.36	1.04	14,303.12

Notes: CH_4 = methane, CO_2 = carbon dioxide, CO_2e = (CO2 * 1) + (CH_4* 21) + (N_2O * 298), N_2O = nitrous oxide

1 Values for vehicles, deliveries, and generators are from VAFB 2011, and scaled up to 12 operations per year

4.2.2 No Action Alternative

Under the No Action Alternative, the current operations would continue and there would be no change to the existing number of Falcon 9 launches or landings (estimated at up to 6 per year). In addition, there would be no construction of a civil water diversion structure under this alternative Table 4-8 provides the estimated GHG emissions for the No Action Alternative.

Table 4-8. Greenhouse Gas Emissions Resulting from the No Action Alternative

Scenario/Activity	Total Metric Tons			
	CO2	CH_4	N_2O	CO2e

Transit Employee vehicles	790	0.10	0.13	830
Emergency Generators[1]	75	0	0	75
Operations Deliveries[1]	55	0.00	0.04	67
Launch Emissions[1]	6588	1.01	0.07	6629
Landing Emissions[2]	255.48	0	0.0011	255.81
Vessel (drone ship, tug, and support) Emissions	901.52	0.009	0.047	915.86
TOTAL	7,763.48	1.11	0.2411	7,856.81

Notes: CH_4 = methane, CO_2 = carbon dioxide, CO_2e = (CO2 * 1) + (CH_4* 21) + (N_2O * 298), N_2O = nitrous oxide
1 VAFB 2011, 2 VAFB 2016

4.3 Noise

An action would be considered significant if "the action would increase noise by DNL 1.5 dB or more for a noise sensitive area that is exposed to noise at or above the DNL 65 dB noise exposure level, or that will be exposed at or above the DNL 65 dB level due to a DNL 1.5 dB or greater increase, when compared to the no action alternative for the same timeframe" (FAA Order 1050.1F). For example, an increase from DNL 65.5 dB to 67 dB is considered a significant impact, as is an increase from DNL 63.5 dB to 65 dB.

Special consideration is given to the evaluation of the significance of noise impacts on noise sensitive areas within Section 4(f) properties where the land use compatibility guidelines in 14 C.F.R. Part 150 are not relevant to the value, significance, and enjoyment of the area in question. For example, the DNL 65 dB threshold does not adequately address the impacts of noise on visitors to areas within a national park or national wildlife and waterfowl refuge where other noise is very low and a quiet setting is a generally recognized purpose and attribute.

4.3.1 Alternative 1 (Proposed Action)

The scope of this noise analysis is limited to the launch, boost-back, and landing of the Falcon 9 as well as the construction of a civil water diversion system at SLC-4E as described in Chapter 2.

There are three main noise components to Falcon 9 activities. The first is continuous noise created by the launch vehicle during ascent, which can last up to several minutes. The second is the impulsive sonic boom created by the returning first stage, which lasts less than one second. The final noise event is the continuous noise form the engines as the first stage lands, with engine noise occurring for approximately 60 seconds. Launch noise and landing noise is presented in units of dBA, and impacts to human sensitive receptors are measured in terms of dBA DNL. Sonic booms are presented in terms of psf (pounds per square foot) for the boom itself, and their contribution to community noise levels are done so using C-Weighted Day-Night Levels.

4.3.1.1 Launch and Landing Operations

Launch Noise

As described in Section 2.3.5 (Falcon 9 Launch Trajectories), it is estimated that the Falcon 9 would produce engine noise of 110 dBA during launch operations in the vicinity of the launch pad (Figure 2-1). Engine noise of up to 90 dBA may be heard off VAFB and at Santa Ynez River and

Point Arguello. Given the short duration (typically 2-3 minutes) of the launch noise and the relatively low received noise levels at sensitive receptors, the contribution of launch noise would be minimal and unlikely that DNL levels would be elevated above 65 dBA as a result of a single launch event. The Leq for the hour in which the launch occurs would increase based on the equation in Section 3.3.2.3. Conservatively speaking, if a 1-hour Leq without a rocket launch was 60 dBA (a typical daytime noise level in rural areas), a 60-second period of noise at 90 dBA (with another 120 seconds at 80 dBA as the rocket gained altitude and distance from the launch pad), that hour's Leq would rise to approximately 72 dBA. However, this 1-hour Leq would need to be integrated with the other 23 hourly Leq values from that day to determine the DNL. Assuming typical daytime Leqs of 60 dBA and nighttime Leqs of 40 dBA, it would be anticipated that the resultant DNL for a day with a rocket launch to approximately 61 dBA. Additionally, rocket launches have previously been analyzed as having less than significant impacts to the noise environment (USAF, 2011a).

Sonic Boom

The USAF predicts nearfield overpressures as high as 8.5 psf at the landing location, which would attenuate to levels below 2.0 psf at approximately 6.2 miles (10.0 km) from the location (Figure 2-6). When landing at SLC-4W, the 2.0 psf contour from the nearfield model would overlap the western portion of Lompoc. The overpressure would reach as high as 8.5 psf on VAFB and 3.1 psf on the Northern Channel Islands. Depending on the distance the observer is from the landing pad or drone ship, a sonic boom may be heard before or within a few seconds following the landing of the First Stage.

The boom contours from the far-field models are generally broad forward-facing crescents. Overpressures would occur on shore in two areas: VAFB and immediate vicinity; and in a crescent from the northern Channel Islands in the ocean extending to the northeast over portions of Santa Barbara, Ventura, and Kern Counties. Overpressures between 1.6 and 1.0 psf would extend off-base approximately 5 miles (8.1 km) to the east, impacting the western portion of Lompoc. The 1.0 psf footprint extends approximately 12 miles (19.3 km) beyond the VAFB boundary. Booms with overpressures of about 1 psf are generally audible and can startle people, but generally do not cause adverse effects such as damage to structures. Impacts to structures are typically considered at peak overpressures above 2.0 psf (Haber and Nakaki 1989; Plotkin et al. 2012).

One of the sonic boom overpressure crescents extends from the ocean to the northeast over portions of Santa Barbara, Ventura, and Kern Counties. While this crescent is extensive in distribution, the expected overpressure would be between 0.4 and 0.2 psf. A boom of that magnitude could be heard by someone who is expecting it and listening for it, but usually would not be noticed. The general threshold for significance is whether a sonic boom could cause damage to structures. While received overpressures (at nearby city and counties) are loud enough to be heard, they are not anticipated to cause damage, and are thus not significant.

Figure 2-10 and Figure 2-11, illustrate the sonic boom footprint that would be anticipated from a boost-back at the Contingency Landing Location. Figure 2-12 and Figure 2-13 illustrate the sonic boom footprint that would be anticipated from a boost-back within the Iridium Landing Area. One of the sonic boom overpressure crescents from sonic booms at the Contingency Landing Location extends from the ocean to the northeast over portions of Santa Barbara and San Luis Obispo Counties. While this crescent is extensive in distribution, the expected overpressure would be between 0.4 and 0.2 psf. Similar to sonic booms from landings at SLC-4, effects from the boost-back and landing at the Contingency Landing Location would be less than significant.

Landing Noise

Noise impacts would occur during landing of the Falcon 9 first stage booster at SLC-4W, which takes place below an altitude of about 12,000 ft. (3,658 m) for a period of approximately 60 seconds.

The western portion of Lompoc would be exposed to SLC-4 landing noise above 80 dBA but below 90 dBA, which is slightly lower than the noise of a passing motorcycle at 25 ft. (7.6 m) (Table 3-3). The remainder of the Lompoc area would be exposed to noise levels above 70 dBA but not above 80 dBA, which is comparable to a passenger car traveling at 65 mph at 25 ft. (7.6 m) (Table 3-3). Given the short duration (typically 60 seconds) of the landing noise and the relatively low received noise levels at sensitive receptors, the contribution of landing noise would be minimal and unlikely that DNL levels would be elevated as a result of a single landing event. Additionally, landing noise impacts would be less than the impacts from the launch of the vehicle, which have previously been analyzed as having less than significant impacts to the noise environment (USAF, 2011a).

Similar engine noise and noise impacts would occur during landing of the Falcon 9 first stage booster at the Contingency Landing Location (Figure 2-15) and within the Iridium Landing Area (Figure 2-16). Both would be focused on an area well offshore of California. When landing at the Contingency Landing Location, the landing noise would fall below 70 dB at 10 miles (6.1 km) from the landing site (Figure 2-15). The Iridium Landing Area is much further from shore than the Contingency Landing Location, and noise contours would not overlap land. Given that noise from landing activities would occur well offshore of sensitive receptors, there would be no significant impacts associated with implementation of the landings at the Contingency Landing Location or Iridium Landing Area.

4.3.1.2 Civil Water Diversion Structure

Construction activities would be a temporary source of local daytime sound. Given the distance from all construction locations to adjacent human sensitive receptors, noise levels from construction activities would not be audible above typical background noise levels. The noise-generating events from renovation activities would be intermittent; the contribution of renovation to the hourly sound levels (L_{eq}) is anticipated to be low (and thus, their contribution to the DNL). Sound levels up to 65 dBA DNL are considered to be compatible with land uses such as residences, transient lodging, and medical facilities. There are no human sensitive receptors impacted from sound as a result of construction activities under Alternative 1. Noise in excess of 65 dBA from construction activities would occur only on an intermittent basis, and only in areas immediately adjacent to the construction activities. Therefore, construction noise would not significantly affect the acoustic environment under Alternative 1.

Table 4-9. Typical Construction Noise Levels

Equipment	Typical Noise Level (dBA) 50 ft. (15.2 m) from source	Typical Noise Level (dBA) 500 ft. (152.4 m) from source	Approximate Noise Level (dBA) 0.5 mi. (804.6 m) from the source
Compactor	82	62	48

Equipment	Typical Noise Level (dBA) 50 ft. (15.2 m) from source	Typical Noise Level (dBA) 500 ft. (152.4 m) from source	Approximate Noise Level (dBA) 0.5 mi. (804.6 m) from the source
Concrete Mixer	85	65	51
Dozer	85	65	51
Excavator	81	61	47
Generator	81	61	47
Grader	85	65	51
Loader	85	65	51
Paver	89	69	55
Roller	74	54	40
Truck	88	68	54

Notes: dBA = decibel(s), A-weighted; ft. = foot/feet; m = meter(s)
Source: U.S. Department of Transportation 2006

4.3.2 No Action Alternative

Under the No Action Alternative, there would be no change to current launch and boost-back and landing activities. The No Action Alternative would also not include the construction of a civil water diversion structure at SLC-4E. The potential impacts of the No Action Alternative have been previously analyzed in the Falcon 9 EA, the Falcon 9 Boost-Back EA, and the Falcon 9 Iridium SEA (USAF, 2011a, 2016a, 2016b). However, as described in Section 2.3, early models underestimated the nearfield magnitude of the sonic boom that would result from the boost-back and landings of the Falcon 9. The sonic boom from the First Stage would have the same sonic boom overpressures and characteristics as described in Section 2.3 for Alternative 1. The No Action Alternative would also continue to use a single engine for boost-backs and landings as described in the Falcon 9 EA (See Figure 2-20, Figure 2-21, and Figure 2-22). Therefore, effects from the No Action Alternative would be less than significant.

4.4 Biological Resources

4.4.1 Alternative 1 (Proposed Action)

4.4.1.1 Vegetation Resources

All vegetation would be removed to just above ground level within a 3.33 ac. (1.35 ha) impact area of Spring Canyon. Removal of the vegetation would be performed by mowers and hand equipment prior to nesting bird season and attempts would be made to reduce impacts to the drainage as much as possible. Additional vegetation removal (e.g., mowing) of the impact area would be performed outside of nesting bird season (15 February to 15 August) annually as needed to maintain low stature vegetation.

Vegetation removal would result in an estimated 1.12 ac. (0.45 ha) of permanent impacts to willow riparian habitat. To offset these impacts, SpaceX would implement mitigation at a 2:1 ratio: area of habitat enhanced through invasive species control to area of riparian woodland impacted. This mitigation would be accomplished by treating at least 2.25 ac. (0.91 ha) of the target invasive species listed below within the bed and bank of the Spring Canyon drainage from Coast Road to the west, beyond SLC-4 and restoring 2.50 ac. (1.01 ha) of riparian habitat in Spring Canyon.

No federal or state-listed plant species were documented within the footprint of the construction area during the botanical surveys. However, seacliff buckwheat, the host plant of the federally endangered ESBB is present. There would be no effects to federal or state-listed plant species as a result of implementing the Proposed Action, but seacliff buckwheat plants would be disturbed, damaged or destroyed as a result of construction activities. The USAF completed Section 7 consultation with the USFWS for potential impacts to ESBB habitat (2017-F-0480] and would implement all applicable minimization, monitoring, and avoidance measures in this BO and the EPMs described in Section 2.2.6 (Appendix B). Potential effects to riparian and ESBB habitat would therefore be less than significant.

4.4.1.2 Wildlife Resources

Native plant communities within the Proposed Action Area are highly productive wildlife habitats. Temporary and permanent impacts to these habitat types during project implementation would have potential adverse effects on wildlife species. Launch and landing noise, release of water and water vapor, and activities conducted during the installation of the diversion structure and vegetation clearing could result in temporary disturbances to wildlife resources.

Temporary disturbances due to noise and human presence could disrupt foraging and roosting activities, or cause common bird and wildlife species to avoid the area. Temporary disturbances could also potentially result in the loss of wildlife species that are present during project activities. Nesting birds may be disturbed in Spring Canyon and abandon nests; however, adult birds would likely move to adjacent suitable habitat due to project related disturbances and removal of vegetation would be conducted in the area to be impacted by release of water and water vapor to minimize potential nesting opportunities in the impact area. Birds are therefore not anticipated to experience direct physical effects. In addition, qualified biologists would be present during vegetation removal and additional minimization measures designed to protect nesting birds and native wildlife would be implemented (Section 2.2.6). Impacts to wildlife resources would therefore be less than significant.

4.4.1.3 Special Status Terrestrial Species

4.4.1.3.1 El Segundo Blue Butterfly

Launch and Landing Operations

Little is understood about butterfly sensor mechanisms. Most species have good visual and chemical senses but the ability to hear or sense sounds is not a normal trait for butterflies (Yack et al., 2000). Hearing in butterflies has been described in the nocturnal superfamily Hedyloidea, likely as an adaptation to avoid predation by bats (Yack et al., 2000), and in the family Nymphalidae (Swihart, 1967; Yack et al., 2000; Lane et al., 2008; Lucas et al., 2009; Lucas et al., 2014). In Nymphalidae, many species possess a forewing structure, the Vogel's organ, which has been shown to function as an ear, similar to an insect tympanal ear (Lane et al., 2008). Adult Lycaenidae (including the ESBB) do not have a Vogel's organ nor are they known to have other structures that would function as ears and are presumed to be deaf (Rydell, et al. 2003; R. Arnold, pers. comm.). Lycaenid larvae and pupae are well known to produce vibrational signals, most likely directed to ant species that tend the pupae (Downey, 1966; DeVries, 1991, 1992; Heath and Claassens, 2003); however, have not been demonstrated to hear.

The sonic boom would cause a very slight vibration to terrain, structures (including vegetation), and individual ESBB. This vibration would be very brief (milliseconds) and not likely to disrupt behavior because it would be less than movement caused by ambient winds, which are regularly sustained at greater than 30 mph (48 km per hour) in this region of South VAFB. Additionally, given that ESBB are less than 1 square inch in surface area, the ESBB would not receive the full force of an overpressure but only a fraction (less than 1/144) of the psf level. For reference, an 8-psf overpressure is equivalent to 0.056 psi or roughly one ounce. Additionally, there are no documented localities within the area expected to receive a 6-psf sonic boom or greater, despite ongoing surveys of suitable habitat within this area since 2007. The nearest known ESBB localities are expected to receive a sonic boom of less than 6 psf, equivalent to 0.042 psi or roughly 0.67 ounces of pressure. As a result, the potential acoustic impacts from noise and vibration during launch and landing of the Falcon 9 at SLC-4 would have no effect on ESBB.

The USFWS and Los Angeles World Airports have previously determined that noise and vibration have no effect on the species (ESBB Recovery Plan – USFWS, 1998; Los Angeles International Airport Biological Assessment – Sapphos Environmental, Inc., 2003). Jet engine noise at the El Segundo sand dunes at Los Angeles International Airport is not known to affect ESBB (USFWS, 1998; Sapphos Environmental, Inc., 2003; R. Arnold, pers. comm.). The persistent population of ESBB at the Los Angeles International Airport sand dunes experience near constant noise impacts as high as an equivalent sound level (L_{eq}) of 93 dBA (Los Angeles City Controller, 2017) and an average sound level over a 24-hour period of 79 dBA (Los Angeles World Airports, 2017). This population has not been observed to experience negative impacts from this noise and vibration over the past 30 years (R. Arnold, pers. comm.).

Spring Canyon Vegetation Clearing and Flame Duct Water

Since the vegetation clearing activities would take place outside of bird nesting season (15 February through 15 August), these activities would also take place outside of the ESBB flight season; therefore, there would be no risk of direct impacts to adult ESBB from vegetation clearing activities. Direct impacts to ESBB larvae within the footprint of the area to be mowed include injury or mortality from inadvertent crushing by workers as they walk and operate mechanical equipment and during mowing of vegetation, including seacliff buckwheat. The release of water and water vapor during launches requiring water within the flame duct may cause direct injury or mortality to adult or larval ESBB if they are present within the impact area. The risk of impacts to ESBB are low because they have not been detected within SLC-4, the area to mowed, or nearby in the surrounding suitable habitat despite numerous past surveys. Therefore, the likelihood of occurrence within the area to be cleared is low. This risk would be reduced further by the removal of potential habitat (seacliff buckwheat) within the impact area.

Vegetation clearing would result in an estimated loss of 153 seacliff buckwheat within 0.2069 ac. (0.0837 ha) of potential habitat. Impacts to seacliff buckwheat habitat would be offset by habitat enhancement of suitable habitat on South VAFB by removing invasive plants and planting of buckwheat at a 2:1 ratio (area of habitat enhanced through invasive plant removal to area of potential ESBB habitat impacted). A USFWS-approved biologist would continue to survey for ESBB in the impact area annually during future flight seasons to monitor for the presence of the species.

Civil Water Diversion Structure

With the exception of the grading and application of gunite on the slope immediately south of the flame bucket, all construction would take place on existing paved surfaces. The slope is currently sparsely covered by iceplant and dead vegetation due to the heat created during ongoing launches. In addition, all vehicle and equipment access would occur on existing paved surfaces. As a result, there would be no potential habitat for the ESBB affected by the construction of the civil water diversion structure. Since the construction would occur prior outside of ESBB flight season, there would be no risk of injury to adult ESBB.

Spring Canyon Riparian Mitigation

Although few, if any, seacliff buckwheat are expected to be present in the mitigation area, the EPMs described in Section 2.2.6 would be implemented to avoid and minimize potential impacts to seacliff buckwheat and ESBB. These measures will substantially reduce the potential for adverse effects to ESBB.

Conclusion

Impacts to ESBB from launch and landing operations and construction of the civil water diversion structure are not anticipated. The loss of ESBB habitat during vegetation removal would be offset through habitat enhancement and a USFWS-approved biologist would continue to survey the area annually for ESBB. The USAF completed Section 7 consultation with the USFWS for potential impacts to ESBB (2017-F-0480) and would implement all applicable minimization, monitoring, and avoidance measures in this BO and the EPMs described in Section 2.2.6. Critical habitat for the ESBB does not occur within or near the Action Area. Therefore, the Proposed Action would have no effect on this species' critical habitat. Potential effects to ESBB would therefore be less than significant.

4.4.1.3.2 California Condor

The ROI is outside the normal range of the species and the species is not known to breed within the area. To date, there has been only one documented occurrence of this species foraging within the ROI (Rhys M. Evans, pers. comm., 27 March 2017). Satellite tracking data revealed that one condor arrived at VAFB approximately 12 March 2017 and was on South VAFB in the upper Honda Canyon area for about two nights and three days. After leaving Base for about two days, it returned to VAFB to North Base and was in the area between Bishop Road and Minuteman Beach on north VAFB for about 2.5 weeks. The condor roosted on VAFB for a total of about 15 nights. The overall likelihood of a California condor occurring within the ROI again during a launch or landing event is very low. However, given the exceptional rarity of the species, any substantial impact to an individual may be considered a population-level impact.

Behavioral responses are the most commonly used endpoints when studying the effects of noise on wildlife. This is largely based on practical considerations and the difficulty in measuring animal fitness or physiological and ecological endpoints. Common behavioral responses include alert behavior, startle response, flying or running away, and increased vocalizations (National Park Service, 1994; Bowles, 1995; Larkin et al., 1996). In some instances, behavioral responses could interfere with breeding, raising young, foraging, habitat use, and physiological energy budgets, particularly when an animal continues to respond to repeated exposures. While difficult to measure in the field, all behavioral responses are accompanied by some form of physiological response, such as increased heart rate or a startle response. In many cases, individuals would return to homeostasis or a stable equilibrium almost immediately after exposure. The individual's overall metabolism and energy budgets would not be affected assuming it had time to recover before being exposed again. If the individual does not recover before being exposed again, physiological responses could be cumulative and lead to reduced fitness. However, it is also possible that an individual would have an avoidance reaction (i.e., move away from the noise source) to repeated exposure or habituate to the noise when repeatedly exposed.

Noise types and levels that increase stress in humans would have a similar impact on birds but studies show that birds are much more resilient than humans or other mammals to hearing loss or other damage (Dooling and Popper, 2016). Both the current field and laboratory data indicate that many birds appear to habituate to noise through repeated exposure without long-term discernible negative effects. Loud sonic booms (80-89 dBA SEL) elicited a shorter duration of startle responses than to other disturbances, such as humans on foot, low-flying helicopters, or loud boats (Manci et al., 1988). A literature review of studies of aircraft and noise impacts on birds, which included various species of songbirds, upland game birds, waterfowl, seabirds, and raptors, showed that reactions vary boom to boom but birds "occasionally run, fly, or crowd" in response to a sonic boom (Manci et al., 1988).

It has been difficult to analyze the effect human disturbance could have on California condors. Generally, California condors are less tolerant to human disturbances near nesting sites than at roosting sites. The species is described as being "keenly aware of intruders" and may be alarmed by loud noises from distances greater than 1.6 miles (2.6 km). In addition, the greater the disturbance in either noise level or frequency, the less likely the condor would nest nearby. As such, USFWS typically requires isolating roosting and nesting sites from human intrusion (USFWS, 1996).

We do not know at this time if another unpaired California condor would return to forage within the area and become a regular occurrence. Other than telemetry data, there is very little information on what drew the bird into the area. Non-breeding birds tend to expand their home range farther than paired birds to encompass a larger availability of food resources and may explore new areas. Seasonal shifts do occur but, generally, these shifts are based on food availability. There are no known California condor nests within the ROI.

Any aircraft that surprises a bird may elicit a temporary startle response. In addition, close approaches by an aircraft may potentially drive birds out of an area but most of this research has been done on waterfowl (Bowles et al., 1991a). The accompaniment of engine noise (from the launch and landing) with the sonic boom and visual disturbance may temper any impact from the sonic boom because the species would likely already be alert.

Conclusion

Although launch noise, landing noise, visual disturbance, and sonic boom may cause a startle response and disrupt behavior if a condor is within the ROI during a launch and landing at SLC-4, the likelihood of a condor being present during these activities is extremely low and the effect of the proposed project on California condors would be discountable. The proposed activities may affect, but are not likely to adversely affect the California condor. The USAF completed Section 7 consultation with the USFWS for potential impacts to California condor (2017-F-0480) and would implement all applicable minimization, monitoring, and avoidance measures in this BO and the EPMs described in Section 2.2.6. Critical habitat for the California condor does not occur within or near the Action Area. Therefore, the Proposed Action would have no effect on this species' critical habitat. Potential effects to California condor would therefore be less than significant.

4.4.1.3.3 California Red-Legged Frog

Launch and Landing Operations

During landing of the Falcon 9 first stage, engine noise of approximately 80 to 100 dBA and sonic boom up to 6.0 psf is expected to overlap areas known to be occupied by California red-legged frog populations in the Santa Ynez River, Honda Creek, Bear Creek, and various isolated wetlands and ephemeral streams on south VAFB. If present in Spring Canyon or within adjacent upland dispersal habitat, California red-legged frogs would be subjected to a sonic boom with overpressures of up to 8.5 psf and engine noise between 100 and 110 dBA during the boost-back and landing of the Falcon 9. However, dispersal into upland habitat on VAFB is not likely to be as extensive as has been observed in more mesic parts of the range of this species.

All life stages of California red-legged frog can detect noise and vibrations (Lewis and Narins, 1985), and are assumed able to perceive the engine noise and sonic boom. There are no studies on the effects of noise on California red-legged frog, and few studies on the effects of noise disturbance on anurans in general. Those that have been conducted have tended to focus on the effects of sustained vehicle noise associated with roads near breeding ponds, which have been shown to have negative effects on individual frog's behavior and physiology and may have consequences for populations (see examples in Parris et al. [2009] and Tennessen, et al., [2014]). However, impacts from engine noise and sonic boom would be of short duration and infrequent, therefore are expected to have different effects on frogs than sustained noise. We could not locate any directly applicable studies examining anuran reactions to these types of stimuli. It is assumed that the sonic boom and engine noise would likely trigger a startle response in California red-legged frog, causing them to flee to water or attempt to hide in place; however, there are no data on what level of sonic boom or launch noise would cause this reaction. It is likely that any reaction would be dependent on the sensitivity of the individual, the behavior in which it is engaged when it experiences the overpressure, and the level of the sonic boom (e.g., higher stimuli would be more likely to trigger a response). Regardless, the reaction is expected to be the same–the frog's behavior would be disrupted and it may flee to cover in a similar reaction to that of a frog reacting to a predator (USFWS, 2015a). As a result, there could be a temporary disruption of California red-legged frog behaviors including foraging and calling and mating (during the breeding season). However, frogs tend to return to normal behavior quickly after being disturbed. Rodrıguez-Prieto & Fernandez-Juricic (2005) examined the responses in the Iberian frog (*Rana iberica*) to repeated human disturbance and found that the resumption of normal behavior after three repeated human approaches occurred after less than four minutes. Sun and Narins (2005) examined the effects of airplane and motorcycle noise on anuran calling in a mixed-species assemblage, including the sapgreen stream frog (*Rana nigrovittata*). Sun and Narins found that frogs reduced calling rate during the stimulus but the sapgreen stream frog increased calling rate immediately after cessation of the stimuli, likely in response to the subsequent lull in ambient sound levels. Similarly, qualified biologists working on VAFB and elsewhere in the range of the California red-legged frog have routinely observed a similar response in this species after disrupting individuals while conducting frog surveys (A. Abela, M. Ball, and J. LaBonte, pers. obs.). California red-legged frog would therefore be expected to resume normal activities quickly once the disturbance has ended and any behavioral response would be short term and discountable.

Since the engine noise caused by the boost-back and landing of the Falcon 9 First Stage would be of short duration (approximately 25–35 seconds) and of low magnitude, injury to California red-legged frog hearing is highly unlikely. Anuran vocalizations commonly reach 90 to 100 dB (Gerhardt, 1975); therefore, frogs and toads, in general, are likely to be adapted to tolerate relatively high sound pressure levels. Anurans are also able to regenerate their hearing after damage; therefore, any potential hearing loss would not be permanent. Although no studies have been conducted using California red-legged frogs, Simmons et al. (2014) found that consistent morphological damage of hair cells in the hearing structures of American bullfrogs (*Lithobates catesbeianus*), which is within the same Family as the California red-legged frog (Ranidae), was not observed until exposure of sound levels greater than 150 dB sound pressure levels, which is approximately equivalent to 13 psf. This is much higher than the highest overpressures that individuals may be exposed to as a result of the Proposed Action. Even after such hearing damage, bullfrogs showed full functional recovery within three to four days (Simmons et al., 2014). Any hearing damage is thus highly unlikely from the much lower levels of sound exposure that would be experienced by California red-legged frog within the Action Area. For these reasons, engine noise and sonic boom resulting from the Falcon 9 Program may affect, and is not likely to adversely affect, the California red-legged frog.

Spring Canyon Vegetation Clearing and Flame Duct Water

Direct impacts to California red-legged frogs within the footprint of the area to be mowed include injury or mortality from inadvertent crushing by workers as they walk and operate mechanical equipment and during mowing of vegetation. An assessment of Spring Canyon in 2013 (ManTech SRS Technologies, Inc., 2013) and in July 2017 found no potential breeding habitat or watered sections within Spring Canyon in or downstream of the impact area, therefore there no direct impact to breeding habitat are anticipated. The Spring Canyon drainage downstream of the impact area is a series of un-watered, undefined channel with thick vegetation, intermittent drainage with a definable channel, and subsurface flow with little to no potential for breeding habitat (ManTech SRS Technologies, Inc., 2013). The risk of impacts on California red-legged frog would be reduced because USFWS-approved biologists would capture and relocate all individuals detected within the Project Area to nearby suitable habitat prior to the onset of vegetation clearing activities. A USFWS-approved biologist would also be present to monitor vegetation-clearing activities to move any California red-legged frogs encountered out of harm's way. In addition, a USFWS-approved biologist would conduct pre-launch surveys for California red-legged frogs at SLC-4 and in adjacent Spring Canyon and, if present, relocate them to the nearest suitable habitat out of harm's way from the release of water. Regardless, frogs may be injured, or killed as a result of vegetation clearing activities and the release of water and water vapor during Falcon 9 launches. A USFWS-approved biologist would therefore search the impact area as soon as possible after post-launch safety closures are lifted for injured or killed California red-legged frogs within the impact area and downstream in Spring Canyon to document any take.

Civil Water Diversion Structure

With the exception of the grading and application of gunite on the slope immediately south of the flame bucket, all construction would take place on existing paved surfaces. In addition, all vehicle and equipment access would occur on existing paved surfaces. The slope where gunite would be applied is currently sparsely covered by iceplant and dead vegetation due to the heat created during ongoing launches. Occasional holes of burrowing rodents (e.g., gophers) are present on the slope but would be very marginal refugia for California red-legged frog dispersing through the area, given the lack of vegetative cover. A USFWS-approved biologist would monitor grading and application of gunite to the slope.

During construction, California red-legged frogs that may potentially disperse through the project area may become entrapped in any holes or trenches left open overnight. However, open holes and trenches would be covered overnight and would be surveyed each day prior to initiation of work to minimize risk of entrapment. Any California red-legged frogs encountered would be captured and relocated to suitable habitat out of harm's way.

Spring Canyon Riparian Mitigation

The proposed habitat enhancement activities in Spring Canyon may have direct effects on the California red-legged frog through trampling and/or crushing individuals resulting in their injury or mortality. Trampling and/or crushing may occur as a result of foot traffic, vehicle traffic, and construction activity. These effects may be magnified during the wet season, when the species is more active. These impacts would be avoided and minimized by implementing the measures specified within the Spring Canyon Riparian Mitigation Plan (Appendix G) and the EPMs described in Section 2.2.6. These measures will substantially reduce the potential for direct injury or mortality of California red-legged frogs, but some may still occur.

The proposed habitat enhancement activities in Spring Canyon may have direct and indirect effects on the California red-legged frog by contaminating habitat in the area with herbicides associated with invasive species control. These effects may be magnified during the wet season, when the species is more active. These impacts would be avoided and minimized by implementing the measures specified within the Spring Canyon Riparian Mitigation Plan (Appendix G) and the EPMs described in Section 2.2.6. These measures should reduce the potential for such impacts on habitat to affect California red-legged frogs.

Critical Habitat

The Action Area includes the following designated critical habitat units for the California red-legged frog: STB-2 and STB-4. The Proposed Action would have no ground disturbing activities or impacts to water quality within critical habitat therefore no measurable impacts to vegetation, hydrology, habitat structure, or any other physical features of habitat. Unit STB 4 would receive landing noises in excess of 70 dB and units STB-2 and STB-4 would potentially receive infrequent sonic booms of 1 to 2 psf, which would not be expected to appreciably diminish habitat quality, including vegetation, prey base, or degradation of habitat structure. Therefore, the Proposed Action would have no effect on critical habitat for this species.

Conclusion

Engine noise and sonic boom resulting from the Falcon 9 Program may cause behavioral disruptions to California red-legged frogs. However, the potential physical impacts as a result of water release and vegetation clearing in Spring Canyon, the loss of potential upland/transitory habitat, construction of a civil water diversion structure, and Spring Canyon riparian mitigation could result in injury to individuals or loss of habitat. The USAF completed Section 7 consultation with the USFWS for potential impacts to California red-legged frog (2017-F-0480) and would implement all applicable minimization, monitoring, and avoidance measures in this BO and the EPMs described in Section 2.2.6. The Proposed Action would have no effect on critical habitat for this species. Potential effects to California red-legged frog would therefore be less than significant.

4.4.1.3.4 California Least Tern

Launch and Landing Operations

California least terns nest and forage within the ROI. The nests at Purisima Point would experience overpressures between 1 and 2 psf from a sonic boom. These nests would also experience engine noise from the launches (between 70 and 70 dBA) and landing (between 80 and 90 dBA). Meanwhile, California least terns foraging at the Santa Ynez River mouth would be within the 2-3 psf sonic boom footprint of the boost-back and would experience louder engine noises than those at Purisima Point (between 80 to 90 dBA). Purisima Point and the Santa Ynez River are not within the overflight zone; therefore, no visual impacts are anticipated.

Human activity impacts birds if they are forced to flush or exhibit other signs of fear; however, the relationship between the tendency to flush and reproductive success is poorly understood (Bowles et al., 1991b). Austin et al. (1970) attributed a mass hatching failure of sooty tern (*Sterna fuscata*) in southern Florida to sonic booms from low flying military aircraft. The authors found 242 chicks instead of the normal 20,000 to 25,000 chicks at Dry Tortugas colony in southern Florida. The authors ruled out most other causes, except an overgrowth of vegetation and sonic booms. The authors had no evidence that the booms caused the hatching failure; however, the booms were described as almost a daily occurrence and were reportedly strong enough to shatter windows (Gladwin et al., 1988). Bowels et al. (1991b) were unable to duplicate the assumptions made by Austin et al. (1970). Bowles et al. attempted to duplicate this response by exposing chick eggs to sound pressure levels of 177.3 decibels referenced to 20 micropascals (dB re 20 uPa); mean community SEL of 139 dB, mean frequency of 60 Hz. They found that hatchling failures due to physical effect of sonic booms are highly unlikely (Bowles et al., 1991b). Today, Austin et al. (1970) is typically considered circumstantial evidence at best.

The available data on launches suggest that sonic booms may produce a startle response in wildlife (See NASA, 1978). At VAFB, monitoring of California least terns has been conducted for five Delta II launches from SLC-2 on north VAFB. SLC-2 is 0.4 miles (0.6 km) from the Purisima Point nesting colony and significantly closer than SLC-4, which is approximately 7.5 miles (12.1 km) from the Purisima Point nesting colony. California least tern response has been variable. Pre- and post-launch monitoring of non-breeding California least tern for the 7 June 2007 Delta II COSMO-1 launch, and monitoring of nesting California least tern during the 20 June 2008 Delta II OSTM and 10 June 2011 Delta II AQUARIUS launches did not document any mortality of adults, young, or eggs, or any abnormal behavior as a result of the launches (ManTech SRS Technologies, Inc., 2007, 2008b; 2011). The May and July 1997 Delta II launches, however, potentially caused the abandonment of up to five nests and the death of a chick due to exposure, although predation of adult California least tern by owls may have been responsible for some of the losses observed (BioResources, 1997). In addition, Delta II launches from SLC-2 in 2002 and 2005, when terns were arriving at the colony, may have caused temporary or permanent emigration from the colony because there was decreased attendance following the launches (Robinette et al., 2003, Robinette and Rogan, 2006). This data implies that the response to noise of California least terns is related to where individuals are in the nesting cycle. For instance, at the beginning of the nesting season when least terns are arriving at the breeding colony, the adults seem to be more disturbed, but once serious courtship and nest-tending begins, the adults are more tenacious. The sound profile for launch noise generated by the Delta II vehicle at SLC-2 was characterized at the Purisima Point nesting area during the 15 April 1999 launch (SRS Technologies, 1999). Sound reaching the recording site had an unweighted peak of 135.5 dB (roughly 2.3 psf). The A-weighted

SEL was 121.5 dB (SRS Technologies, 1999). These launch noises greatly exceed the launch and landing noises anticipated by the Falcon 9 First Stage.

Dooling & Popper (2016) provides threshold guidance for traffic noise and road construction on birds. They found that a single impulse of 140 dBA could result in hearing damage (which was based on small mammal studies); however, they state that there is no data available on temporary threshold shifts for birds from impulsive sound (e.g., like a sonic boom). They also found that a temporary threshold shift could occur from continuous noise of 93 dBA. However, they stated that any audible component of construction or traffic noise could cause a behavior response in birds.

Engine noise from the Falcon 9 boost-back and landing at SLC-4 would not reach the levels of the Delta II at SLC-2 (adjacent to the tern colony). Engine noise during landing is expected to be within the 80-dBA footprint at the Purisima Colony and between 80 and 90 dBA at the Santa Ynez River mouth. The Purisima Colony could experience overpressure between 1 and 2 psf. Least terns at the Santa Ynez River could experience overpressures from the sonic boom between 2.0 psf and 3.0 psf.

Conclusion

The audible components from this action (e.g., engine noise and sonic boom) could potentially cause the California least tern to respond behaviorally or physiologically to this sound. In particular, this stimulus could result in a startle reaction. USAF is of the opinion that the least tern's response to the action would be commensurate with those observed for Delta II rocket launches, particularly during certain periods of the nesting cycle. Based on this past anecdotal evidence, USAF has determined that a reasonable person would expect that the action would affect foraging activities at Santa Ynez River and potentially lead to temporary site or nest abandonment at the Purisima Colony. The USAF completed Section 7 consultation with the USFWS for potential impacts to California least tern (2017-F-0480) and would implement all applicable minimization, monitoring, and avoidance measures in this BO and the EPMs described in Section 2.2.6. The USFWS has not designated critical habitat for the California least tern. Therefore, the Proposed Action would have no effect on critical habitat for this species. Potential effects to California least tern would therefore be less than significant.

4.4.1.3.5 Marbled Murrelet

Point Pedernales, the nearest known locality for marbled murrelets in relation to SLC-4, would receive launch noise of 80-90 A-weighted decibels (dBA), landing noise up to 90 dBA, and a sonic boom overpressure up to 3 psf. It is unlikely that a marbled murrelet would be present within the ROI during a launch and landing event. If present, the action could cause a short-term startle response or other minor and temporary behavioral shift, but would not likely cause injury or substantially disrupt a marbled murrelet's normal behavior. Due to the low likelihood of occurrence during launch and landing activities plus the short-term nature of anticipated launch/landing noise and overpressure at no more than 3 psf, the effects of the Proposed Action on marbled murrelets would be insignificant and discountable. The proposed activities may affect, but are not likely to adversely affect the marbled murrelet. The USAF completed Section 7 consultation with the USFWS for potential impacts to marbled murrelet (2017-F-0480) and would implement all applicable minimization, monitoring, and avoidance measures in this BO and the EPMs described in Section 2.2.6. Critical habitat for the marbled murrelet does not occur within or near the Action Area. Therefore, the Proposed Action would have no effect on this species' critical habitat. Potential effects to marbled murrelet would therefore be less than significant.

4.4.1.3.6 Western Snowy Plover

Launch and Landing Operations

Western snowy plover monitoring for impacts related to launch-related engine noise and visual disturbance has been conducted during numerous past launches on VAFB, where they may experience landing noise in excess of 100 dBA. Direct observations of wintering birds were made during a Titan IV and Falcon 9 launch from SLC-4E (SRS Technologies, 2006a; Robinette and Ball, 2013). The Titan IV launches were louder (130 dBA) than the Falcon 9 First Stage landing noise (110 dBA). Western snowy plovers did not exhibit any adverse reactions to these launches (SRS Technologies, 2006a; Robinette and Ball, 2013). With the exception of one observation (see following), monitoring of western snowy plover during the breeding and non-breeding season for other launches has routinely demonstrated that Western snowy plover behavior is not adversely affected by launch noise or vibrations, and no incidents of injury or mortality to adults, young, or eggs have been clearly attributed to any of the launches (SRS Technologies, Inc. 2006a, 2006b, 2006c, 2006e, 2006f, 2006g, 2006h; ManTech SRS Technologies, Inc. 2007, 2008a, 2008b, 2009c). However, during a launch event of a Titan II from SLC-4W in 1998, monitoring of snowy plovers found the nest located closest to the launch facility had one of three eggs broken after the launch (Applegate and Schultz, 1998). The cause of the damaged egg was not determined. Landing noise from the Falcon 9 would be substantially less than the Titan II (119 dBA); therefore, the landing noise from the Falcon 9 would not likely adversely affect the snowy plover.

The western snowy plover could be exposed to a sonic boom of up to 8 psf at VAFB and up to 3 psf on the NCI. Launch events would occur during the breeding season. On VAFB, the magnitude of the boom, preceded by the launch noise, and coupled with landing noise as well as the visual impact of seeing the landing could provoke temporary or permanent emigration from nesting sites, trigger a startle response that alerts predators to nest locations, cause temporary abandonment of nests, mask biologically significant sounds (e.g. predators) that make abandoned eggs or young more vulnerable and reduce overall fitness.

On the NCI, the impacts to western snowy plover would be substantially less. There would not be any exposure to launch or landing noise or any associated visual stimuli, and the sonic booms during launch and landing are not expected to be greater than 3 psf. Due to the lower intensity and the short-term, transient nature of anticipated sonic boom noise, any behavioral reactions would likely be short term (minutes) and would be unlikely to cause long-term consequences for individuals or populations. Because of the short term, transient nature of the sonic boom and the relatively few numbers of individuals occurring on the NCI, the impacts would be insignificant and discountable.

Critical Habitat

The ROI includes the Santa Rosa Island, portions of which are designated critical habitat for the western snowy plover. These areas would potentially receive sonic booms up to 3 psf during launch and boost-back. The Proposed Action does not include any ground disturbance within critical habitat nor would it appreciably diminish the species' prey base or any other physical features of habitat. Therefore, the Proposed Action would have no effect on critical habitat for this species.

Conclusion

Noise impacts resulting from the Proposed Action may cause behavioral disruption to western snowy plovers, potentially including temporary nest abandonment and reduced fitness of young. The USAF completed Section 7 consultation with the USFWS for potential impacts to western snowy plover (2017-F-0480) and would implement all applicable minimization, monitoring, and avoidance measures in this BO and the EPMs described in Section 2.2.6. The Proposed Action would have no effect on critical habitat for this species. Potential effects to western snowy plover would therefore be less than significant.

4.4.1.4 Special Status Marine Species

4.4.1.4.1 Southern Sea Otter

Launch and Landing Operations

Otters in transit along the coast immediately west of SLC-4 may be affected by launch noise up to 100 dBA, landing noise up to 110 dBA, and a sonic boom as high as 8 psf; however, otters are highly unlikely to be present within these areas during the brief period when a sonic boom or landing noise would occur, therefore these effects would be discountable. At the kelp beds located along the coast south of SLC-4 and off of Purisima Point, where otters are regularly observed, they may experience launch and landing noise up to 80 dBA and sonic boom overpressure levels up to 2.0 psf.

Launch monitoring of sea otters on both north and south VAFB has been extensive, with pre- and post-launch counts and observations conducted at rafting sites immediately south of Purisima Point for numerous Delta II launches from SLC-2 and one Taurus launch from Launch Facility 576E and at the rafting sites off of Sudden Flats for two Delta IV launches from SLC-6. No abnormal behavior, mortality, or injury has ever been documented for sea otters as a result of launch-related disturbance (SRS Technologies 2006a,b,c,d,e; ManTech 2007a,b,c, 2008a,b). During the Delta IV launches, the number of sea otters observed after launch activities was similar to or greater than pre-launch counts.

Sonic booms would not cause more than a temporary startle-response, as monitoring sea otters during launch operations has indicated that launch noise is not a primary driver of sea otter behavior. While a 2-psf boom is approximately 135 dB (unweighted), it is likely that most of that acoustic energy is not heard by sea otters. Exceptionally little sound is transmitted between the air-water interface; thus, in-air sound would not have a significant effect on submerged animals (Godin 2008). In addition, Ghoul and Reichmuth (2014) analyzed aerial hearing thresholds in captive sea otters and found that otter hearing is most sensitive to sound frequencies between 2 and 26 kilohertz (kHz), whereas most of the sonic boom energy is less than 250 hertz (Hz), well below the sea otter’s region of hearing sensitivity. Due to the short-term, transient nature of anticipated boost-back and sonic boom noise, lack of overlap of hearing sensitivity with majority of sonic boom noise, and their lack of adverse responses to rocket launch noise, responses to landing noise and sonic boom would only be behavioral. Behavioral reactions would likely be short term (minutes) and would be unlikely to cause long-term consequences for individuals or populations.

Conclusion

Because no abnormal behavior, mortality, or injury of sea otters has been detected as a result of any launches, including those involving launch vehicles that produced louder noise than the boost-back landing is expected to produce; due to the short-term, transient nature of anticipated launch/landing noise and overpressure; and the lack of sea otter hearing sensitivity in the range of the sonic boom noise, the Proposed Action would not cause more than a temporary startle-response and activities may affect, but are not likely to adversely affect the southern sea otter. Therefore, impacts of the Proposed Action on the Southern sea otter would be insignificant and discountable. The USAF completed Section 7 consultation with the USFWS for potential impacts to southern sea otter (2017-F-0480) and would implement all applicable minimization, monitoring, and avoidance measures in this BO and the EPMs described in Section 2.2.6. Potential effects to southern sea otter would therefore be less than significant.

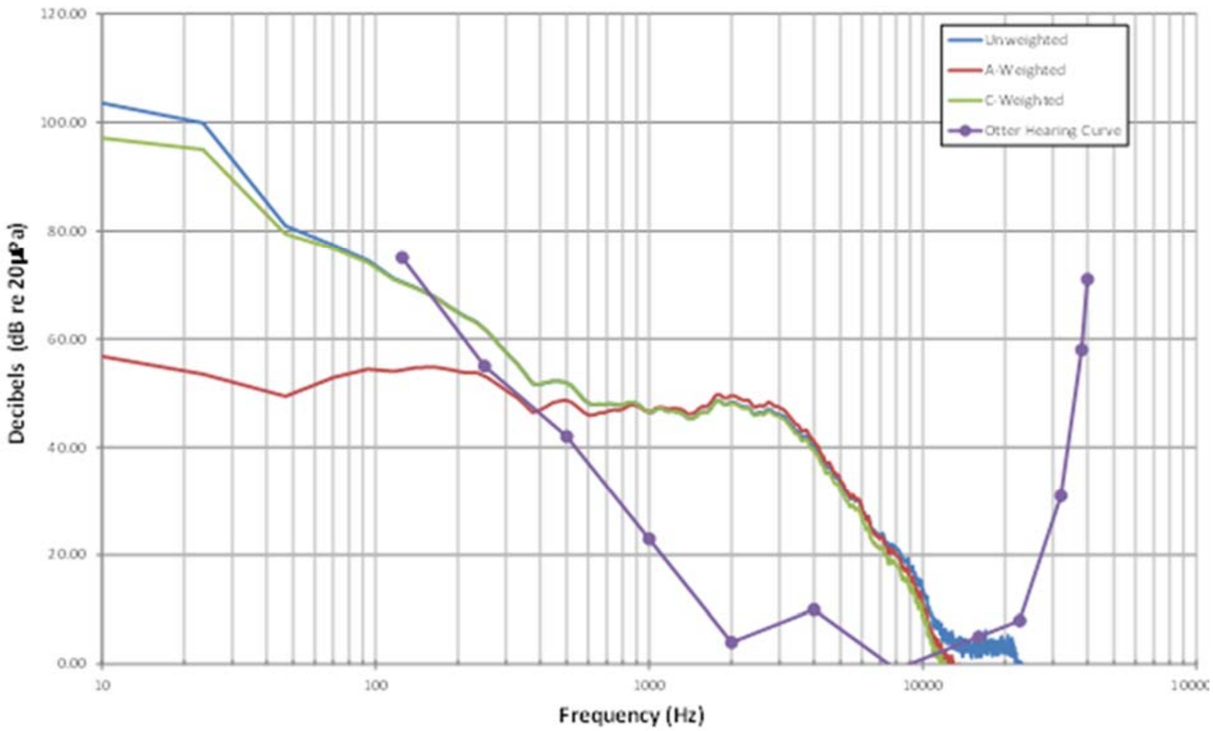


Figure 4-1. Sonic boom spectrum and sea otter hearing sensitivity curve

4.4.1.4.2 Pinnipeds

Pinnipeds at the Northern Channel Islands

Launch and landing impacts for pinnipeds at the NCI would remain the same or substantially similar to those analyzed in the Falcon 9 EA (USAF, 2011a), Falcon 9 Boost-back EA (USAF, 2016a), and Iridium SEA (USAF, 2016b), except that the number of events would increase to a maximum of 12 per year. This increase in launch frequency is not expected to significantly change the results of those analyses. NMFS previously issued regulations and LOA that authorizes the take of marine mammals, by Level B harassment, incidental to launches of up to 50 rockets per year from VAFB (79 FR 10016). This LOA is effective from March 2014 to March 2019 and includes Falcon 9 launches at VAFB. In addition, SpaceX has obtained an IHA from NMFS for impacts to marine mammals as a result of Falcon 9 boost-back and landing at SLC-4W and offshore contingency landings (Appendix D). The USAF and SpaceX would adhere to the conditions of the LOA and IHA; therefore, impacts from launch and landing activities would not have a significant impact on pinnipeds at the NCI.

Pinnipeds at Vandenberg Air Force Base

Four pinnipeds may be present in the affected area at VAFB during boost-back and landing events: California sea lion, Pacific harbor seal, northern elephant seal, and Steller sea lion. The following changes to the Proposed Action result in impacts that were either not previously analyzed or greater than those analyzed in the Falcon 9 EA (USAF, 2011a), Falcon 9 Boost-back EA (USAF, 2016a), and Iridium SEA (USAF, 2016b):

- Sonic booms up to 8.5 psf at the SLC-4W landing area.
- Increasing Falcon 9 boost-back and landings to up to 12 per year (up to one per month).
- Using three engines instead of one engine during landing.

Pinnipeds spend significant amounts of time out of the water during breeding, molting, and hauling out periods. In the water, pinnipeds spend varying amounts of time underwater. NMFS does not currently believe that in-air noise is likely to result in behavioral harassment of animals at sea (J. Carduner, NOAA Fisheries, pers. comm.). 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. NMFS believes the potential for such disruption, from in-air noise, is extremely unlikely for animals that are at sea. As such, it is not necessary for SpaceX to seek MMPA authorization for the incidental take of marine mammals at sea as a result of in-air noise. The Proposed Action, however, would create in-air noise that may impact marine mammals that are hauled out and these potential impacts are analyzed below.

Launch and Landing Operations

Sonic Boom

During boost-back and landing of the Falcon 9 First Stage, sonic booms would disturb pinnipeds that may be at the surface in the area of exposure, depending on the strength of the overpressure. This impulsive in-air noise is expected to cause variable levels of disturbance to pinnipeds that may be hauled out within the area of exposure depending on the species exposed and the level of the sonic boom. The USAF has monitored pinnipeds during launch-related sonic booms on the NCI during numerous launches over the past two decades and determined that there are generally no significant behavioral disruptions caused to pinnipeds by sonic booms less than 1.0 psf. Furthermore, past pinniped monitoring of sonic booms on San Miguel Island by the USAF has shown that certain species, including northern elephant seal, tend not to respond or respond only mildly (e.g., head raise alert) to any sonic booms, whereas harbor seal, California sea lion, and Steller sea lion tend to be more reactive.

For a SLC-4W landing, haulouts at Point Arguello, Point Conception, and VAFB would be impacted by a sonic boom (Figure 3-10). Pinnipeds would be taken only by incidental Level B harassment from noise or visual disturbances associated with the boost-back and landing of the Falcon 9 First Stage. Sonic booms generated during the return flight of the Falcon 9 First Stage may elicit an alerting, avoidance, or other short-term behavioral reaction, including diving or fleeing to the water if hauled out.

In addition, behavioral reactions to noise can depend on relevance and association to other stimuli. A behavioral decision is made when an animal detects increased background noise, 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; they can be visual, olfactory, or tactile stimuli; the stimuli can be conspecifics or predators in the area; or the stimuli can be 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 illicit a stronger reaction than the acoustic stimuli itself otherwise would have. The visual stimulus of the Falcon 9 First Stage would not be coupled with the sonic boom, since the First Stage would be at significant altitude when the overpressure is produced. This would decrease the likelihood and severity of a behavioral response. It is difficult to separate the stimulus of the sound from the stimulus of source creating the sound. The sound may act as a cue, or as one stimulus of many that the animal is considering when deciding how to react.

In addition, data from launch monitoring by the USAF on the NCI has shown that pinniped's reaction to sonic booms is correlated to the level of the sonic boom. Low energy sonic booms (< 1.0 psf) have resulted in little to no behavioral responses, including head raising and briefly alerting but returning to normal behavior shortly after the stimulus. Sonic booms that are more powerful have flushed animals from haulouts but not resulted in any mortality or sustained decreased in numbers after the stimulus. Additionally, the sonic boom events would be infrequent (up to twelve times annually) and therefore unlikely to result in any permanent avoidance of the area. Finally, since the sonic boom is decoupled from biologically relevant stimuli there would likely be less reaction, or no reaction, to the sonic boom, depending on intensity.

Landing Noise

The Falcon 9 First Stage would generate non-pulse engine noise up to 110 dB re 20 uPa while landing on the landing pad at SLC-4W. This landing noise event would be of short duration (approximately 17 seconds). Although, during a landing event at SLC-4W, landing noises between 70 and 90 dB would overlap pinniped haulout areas at and near Point Arguello and Purisima Point, no pinniped haulouts would experience landing noises of 90 dB or greater.

In addition, the trajectory of the return flight includes a nearly vertical descent, as such, there would be no significant visual disturbance to marine mammals. The First Stage would either be shielded by coastal bluffs or too far away to cause significant stimuli to marine mammals. Therefore, landing noise and visual disturbance associated with the Falcon 9 First Stage boost-back would not result in Level B harassment of marine mammals.

Conclusion

Pinnipeds on VAFB would be impacted by a sonic boom up to 8.5 psf that would result in behavioral disturbance (Level B Harassment). The USAF was issued an LOA from NMFS for take by Level B harassment of marine mammals during launch of the Falcon 9 and SpaceX has obtained an IHA from NMFS for impacts to marine mammals as a result of Falcon 9 boost-back and landing at SLC-4W. VAFB and SpaceX would implement all applicable minimization, monitoring, and avoidance measures required by the LOA and IHA and the EPMs described in Section 2.2.6. Potential effects to pinnipeds would therefore be less than significant.

4.4.2 No Action Alternative

Under the No Action Alternative, operational activities would continue as described in the Falcon 9 EA, Falcon 9 Boost-Back EA, and the Falcon 9 Iridium SEA. However, landing would be conducted at the SLC-4W pad at VAFB, with a contingency option of landing at the autonomous drone ship landing area approximately 27 nm (50 km) off the coast of Point Arguello, as discussed in Section 2.3 of the Falcon 9 Boost-Back EA (USAF, 2016a).

Analysis of effects on biological resources in the Falcon 9 Boost-Back EA (USAF, 2016a) concluded that the program could potentially affect seven federally listed marine mammal species, five federally listed turtles, three federally listed fish species, and marine mammal species protected under the MMPA due to debris impact, acoustic impacts, and expended materials. The USAF received concurrence from NMFS with its assessment that the activities associated with Falcon 9 Boost-Back project (No Action Alternative herein) may affect, but was not likely to adversely affect these ESA-listed species. NMFS also issued an IHA to SpaceX for Level B harassment of marine mammals as a result of boost-back and landing of the Falcon 9 First Stage at SLC-4W of the contingency landing area offshore of VAFB. In response to the USAF's analysis of potential impacts to EFH, NMFS concluded that the project could have an adverse effect on EFH over time as a result of the cumulative addition of marine debris to the sea floor. The USAF and SpaceX coordinated with NMFS to contribute to a marine debris removal program to offset these impacts.

4.5 Water Resources

Significance depends on whether the water resource is surface water, groundwater, or wetland. For both surface water and groundwater, a significant impact would occur when the action would:

1. Exceed water quality standards established by Federal, state, local, and tribal regulatory agencies; or
2. Contaminate or draw down the public drinking water supply such that public health may be adversely affected or water supplies are not able to meet need.

Factors that were considered include whether the action would

- Adversely affect natural and beneficial water resource values to a degree that substantially diminishes or destroys such values;
- Adversely affect surface waters such that the beneficial uses and values of such waters are appreciably diminished or can no longer be maintained and such impairment cannot be avoided or satisfactorily mitigated; or
- Present difficulties based on water quality impacts when obtaining a permit or authorization.

These factors are not thresholds for significance. If these factors exist, they must be considered in light of the context and intensity of the action.

For wetlands, a significant impact would occur when the action would

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

Steps can be taken to avoid or minimize impacts to wetlands. If these measures are not sufficient, then compensatory mitigation may be necessary, including wetland mitigation banking.

4.5.1 Alternative 1 (Proposed Action)

4.5.1.1 Surface Water

Activities during modification of SLC-4E as well as during launch operations would include the use of hazardous materials and generation of wastewater that could result in an adverse impact to water resources if not properly controlled and managed. As required by the NPDES Construction and Industrial General Permits, best management practices would be implemented to properly manage materials, and to reduce or eliminate project-associated runoff, which further reduces the potential for adverse effects, especially during the rainy season (1 October to 15 April). Wastewater discharges would follow the State NPDES General Permit for Discharges with Low Threat to Water Quality and conditions of the 2013 RWQCB letter for Enrollment in the General Waiver of Waste Discharge Requirements for SLC-4E Process Water Discharges to eliminate potential adverse effects to water quality.

Launch and Landing Operations

Alternative 1 includes adding 200,000 gallons of water to the flame duct during each launch. This additional usage would not impact the total usage capabilities or allotments that VAFB currently has and would help improve water quality on south VAFB (R. Munns, American Water, pers. comm.). Alternative 1 also includes the construction of a civil water diversion structure to capture and divert water flowing over land from entering Spring Canyon Creek during launch operations at SLC-4E. This water would be contained in a newly constructed 60,000-gallon capacity retention basin and subsequently pumped to the existing spray field for discharge of similar waters. Water containing prohibited chemical levels would be removed and hauled to an approved industrial wastewater treatment facility outside of VAFB.

It is assumed that approximately 25,000 gallons of water could reach Spring Canyon Creek during each launch event (300,000 gallons per year). Wastewater discharges would follow the State NPDES General Permit for Discharges with Low Threat to Water Quality to eliminate potential adverse effects to water quality. As this is an intermittent waterway, implementation of Alternative 1 would directly impact water quantity and hydrology within Spring Canyon Creek. Adding water into the creek may reduce the anaerobic decomposition that was previously reported however there would be the added decomposition of cut vegetation (VAFB, 2007).

As was described in the Falcon 9 EA (USAF, 2011a), surface waters near SLC-4E could be affected by the exhaust cloud that would form near the launch pad at lift-off as a result of the exhaust plume and evaporation and subsequent condensation of deluge water. Because the Falcon 9 uses only LOX and RP-1 propellants, the exhaust cloud would consist of steam only and would not contain any hazardous materials. As the volume of water expected to condense from the exhaust cloud is expected to be minimal, the exhaust cloud would generate less than significant impacts on surface water quality near SLC-4E.

The use of gunite would bind the soil, which increases water flow but reduces the potential for sedimentation and erosion from entering water systems. Mowing and trimming vegetation along the embankment of Spring Canyon Creek would increase stormwater runoff and sedimentation entering the creek. However, Alternative 1 does not include removing any root system, which would minimize erosion potential. In addition, low growing vegetation would replace the vegetation that would be mowed and trimmed and stabilize soils to protect from erosion.

Stormwater from the entire SLC-4E launch pad drains into the retention basin. Stormwater would be analyzed before any discharge takes place to determine if residues from the launch pad have contaminated stormwater and treatment is required.

All launch operations would continue to be conducted in accordance with the NPDES Industrial Storm Water General Permit Order 2014-0057-DWQ (Industrial General Permit) for SLC-4 and its associated SWPPP. The Industrial General Permit requires the implementation of management measures that would achieve the performance standard of best available technology economically achievable and best conventional pollutant control technology.

Alternative 1 includes increasing landing events on drone ships in the Pacific Ocean. SpaceX would continue to use the proper management of materials and wastes as described in Sections 4.8, Hazardous Materials and Waste Management; and 4.9, Solid Waste Management, of the Falcon 9 Boost-Back EA (USAF, 2016a). These procedures would reduce or eliminate the potential for accidental spills or runoff of contaminants, which could directly impact water quality.

Alternative 1 construction activities would continue to be covered under the NPDES General Permit for Construction Activities (Construction General Permit). The SWPPP would be amended and submitted online to the SWRCB. During modification activities, best management practices would be implemented to prevent contaminants from entering stormwater runoff. Exposed soils would be permanently stabilized to prevent erosion due to wind and rain. Once all permit termination requirements are met, a NOT would be submitted to the RWQCB. With the implementation of these procedures and requirements, adverse effects to water resources from stormwater would be less than significant.

As previously discussed, excavating, grading, and the creating impervious surfaces, could alter the existing hydrology at SLC-4E. All construction activities would occur in areas that have been previously disturbed, where normal drainage patterns no longer exist. Any post-construction storm water requirements for new or replaced impervious area would be addressed through the Construction General Permit. The Energy and Independence Secuity Act Section 438 design objective for storm water volume may be used. Therefore, adverse impacts to natural drainages from increased storm water runoff are not anticipated.

4.5.1.2 Ground Water

Groundwater is unlikely to be encountered during excavation activities, because the depth of excavation would not exceed 16 ft. below ground surface. The greatest threat to groundwater is contamination from hazardous materials or waste releases during modifications to SLC-4E and operational activities that could infiltrate an aquifer. This potential would be greatest during the rainy season. Proper management of hazardous materials and wastes during SLC-4E modifications and operational activities would reduce or eliminate the potential for contaminated infiltration.

Wastewater discharges that may occur during project activities, including accumulated stormwater and non-stormwater discharges, would be managed in accordance with the State NPDES General Permit for Discharges with Low Threat to Water Quality and the RWQCB letter for Enrollment in the General Waiver of Waste Discharge Requirements for SLC-4E Process Water Discharges and the and NPDES General Industrial Permit. After a launch, approximately 9,000 gallons of deluge water per Falcon 9 launch would remain in the existing retention basin after evaporation. The proposed new retention basin would capture an additional 60,000 gallons of deluge water. Samples of the deluge water would be collected and analyzed. If the water is clean enough to go to grade, it would be discharged from the retention basin via the spray field. It would then percolate into the groundwater system and flow down gradient into Spring Canyon Creek. With adherence to federal, state, and local laws and regulations, impacts to groundwater would be less than significant. Infrastructure modifications and operations at SLC-4E are required to accommodate the Environmental Restoration Program's groundwater monitoring and remediation activities.

4.5.1.3 Wetlands

Larger diameter vegetation (trees) would require removal from Spring Canyon to prevent water quality impacts from discharge of nutrients and lower dissolved oxygen from decomposition. The removal of vegetation would result in an estimated 1.121 ac. of permanent impacts to willow riparian habitat. To offset these impacts, the SWRCB requires mitigation at a 2:1 ratio: area of habitat enhanced through invasive species control to area of riparian woodland impacted. This mitigation would be accomplished by treating at least 2.5 ac. of the riparian restoration area at the base of Spring Canyon drainage near Coast Road beyond SLC-4 (Figure 4-1). This area is herein referred to as the Spring Canyon Restoration Area.

Within the 2.5 ac. Spring Canyon Restoration Area the following invasive plant species would be treated: jubata grass (*Cortaderia jubata*), iceplant (*Carpobrotus edulis*), fennel (*Foeniculum vulgare*), poison hemlock (*Conium maculatum*), black mustard (*Brassica nigra*), and summer mustard (*Hirschfeldia incana*). Appendix H includes the Spring Canyon Restoration Plan. Prior surveys of the area in 2017 showed these species to be prevalent in this area and interspersed into riparian woodland habitat to varying degrees. These target species would be treated using a glyphosate-based herbicide solution that is approved for aquatic use and would be applied to invasive plants up to the edge of surface water; however, would not be applied directly to any surface water.

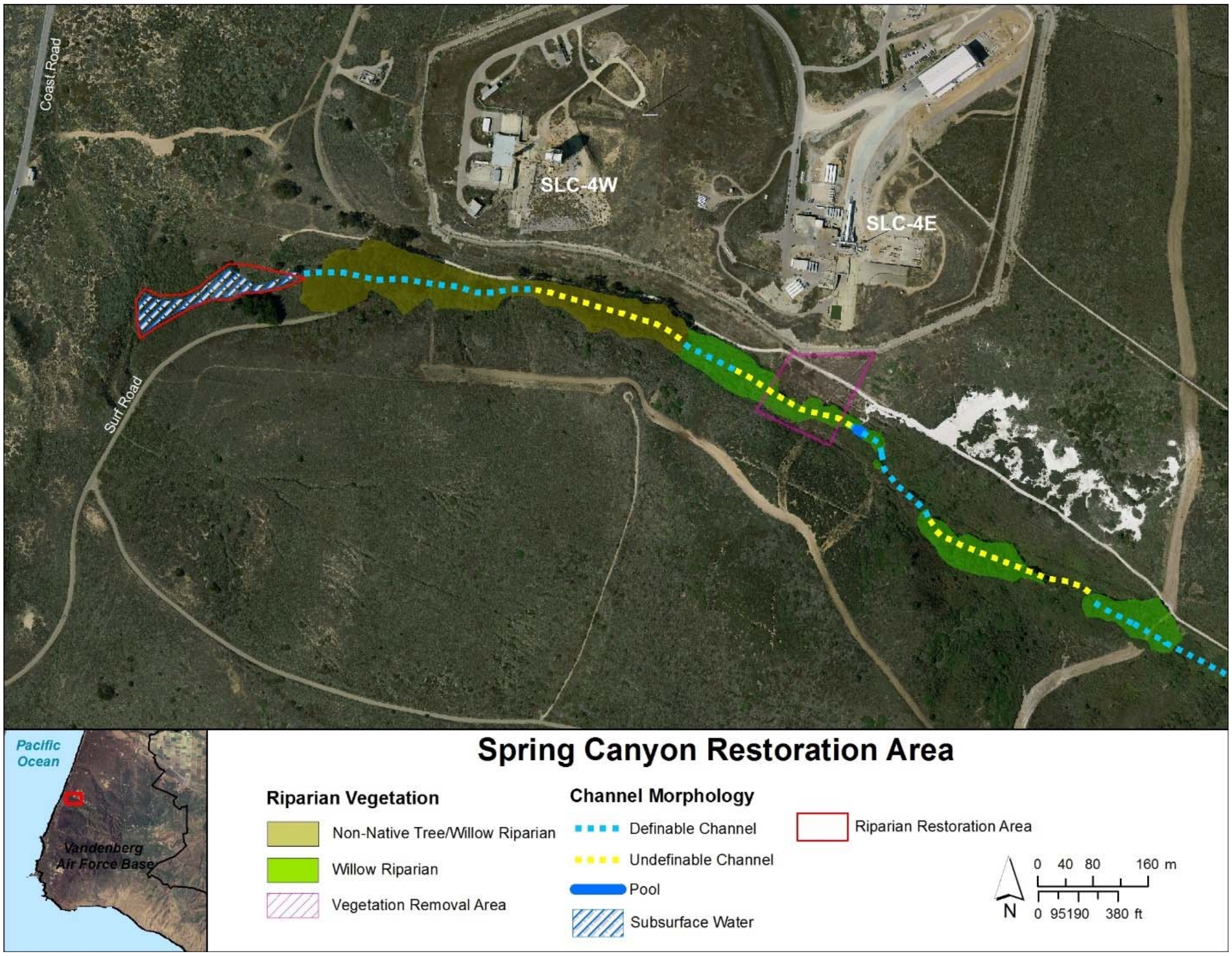


Figure 4-2. Spring Canyon Restoration Area.

4.5.1.4 Conclusion

Alternative 1 would include the implementation of best management practices that would protect surface and ground water from further exceeding any water quality standards established by Federal, state, or local regulatory agencies. In addition, Alternative 1 would not alter a public drinking water supply, adversely affecting public health. Removal of approximately 1.12 acres of willow riparian vegetation is regulated by the Regional Water Quality Control Board under the Central Coast Water Quality Control Plan and would be mitigated by the enhancement of 2.5 acres of degraded riparian habitat elsewhere within Spring Canyon. Therefore, Alternative 1 would not significantly impact water resources.

4.5.2 No Action Alternative

Under the No Action Alternative, operational activities would continue as described in the Falcon 9 EA, Falcon 9 Boost-Back EA, and the Falcon 9 Iridium SEA. The No Action Alternative would not result in any direct or indirect impacts to water quality that was not previously analyzed in these documents. Unlike Alternative 1, this alternative would not include the construction of a civil water diversion structure and 200,000 gallons of water would not be added to the flame duct. As described in the Falcon 9 EA, the deluge system would discharge approximately 30,000 gallons of water, which would be captured in the existing retention basin and analyzed to determine if it meets the standards that would allow it to be discharged to grade. Water containing prohibited chemical levels would continue to be removed and hauled to an approved industrial wastewater treatment facility outside of VAFB. The ground cloud formed by the steam during a launch would not contain any hazardous materials. The No Action Alternative would not result in the exceedance of any water quality standards established by federal, state, or local regulatory agencies. In addition, the No Action Alternative would not alter a public drinking water supply, adversely affecting public health. Therefore, the No Action Alternative would not significantly impact water resources.

4.6 Cultural Resources

U.S. Air Force actions are subject to compliance with all relevant authorities governing cultural resources, including Section 106 of the NHPA and AFI 32-7065, *Cultural Resources Management*. Section 106 of the NHPA requires federal agencies to consider the effects of proposed federal undertakings on historic properties that are listed in or eligible for listing in the NRHP (a.k.a. historic properties). Part of compliance with Section 106 requires the federal agency to determine either that the undertaking would have no effect to historic properties, no adverse effect to historic properties, or an adverse effect to historic properties (which would then require resolving). The Section 106 implementing regulations [36 C.F.R. Part 800] prescribe the process for making these determinations.

Compliance with Section 106 of the NHPA also satisfies federal agencies responsibilities for considering potential project related effects to historic properties under the NEPA. Whether the action would result in a finding of Adverse Effect through the NHPA Section 106 process is a factor for determining whether an action would significantly impact cultural resources. However, an Adverse Effect finding under Section 106 does not automatically trigger preparation of an environmental impact statement (EIS) (i.e., a significant impact) and would depend on the context and intensity of the action.

4.6.1 Alternative 1 (Proposed Action)

Lebow (2010) surveyed the area proposed for gunite application and the location where the perimeter wall and retention basin would be located as part of efforts to make SLC-4E operational for the Falcon 9 and Falcon Heavy Launch Programs. This area as well as the area slated for vegetation removal was surveyed as part of this SEA effort in October 2017 (Smallwood & Ryan, 2017).

According to Lebow (2010), archaeological site complex CA-SBA-537/1816 extends slightly into SLC-4E and isolated artifact VAFB-ISO-300 is recorded within the launch complex. The exact recorded location of VAFB-ISO-300 is unknown; its plotted location is within the substantially modified part of SLC-4E, which is outside the area of direct impacts. CA-SBA-537 and -1816 were formerly determined eligible for the NRHP by USAF in consultation with SHPO in June 1987 as part of efforts to construct a security fence around SLC-4E. The northern edge of CA-SBA-537 abuts the southern security fence at SLC-4E. Both CA-SBA-537 and -1816 are outside the area of direct impacts for Alternative 1. Smallwood & Ryan (2017) found that the area of potential effects is highly disturbed due to past construction of SLC-4E. Archaeological testing by Applied Earthworks indicated that no subsurface deposits exist in close proximity to the area of potential effects, and the area of potential effects is unlikely to contain any intact archaeological deposits (Smallwood & Ryan, 2017).

VAFB has determined that no historic properties would be affected by the Proposed Action. Consultation with the California SHPO and the Santa Ynez Band of Chumash Indians was carried out in accordance with Section 106 of the NHPA for this action and has concluded (see Appendices A and D). The EPMs described in Section 2.2.6 would be implemented for this action. Therefore, implementation of Alternative 1 would not significantly impact cultural resources.

4.6.2 No Action Alternative

Under the No-Action Alternative, the modifications to SLC-4E and to the operation of the Falcon 9 would not be implemented and no consequences for cultural resources would result. Therefore, the No Action Alternative would not significantly impact cultural resources.

4.7 Geology and Earth Resources

Factors for significance includes whether the project would result in substantially increased erosion, landslides, soil creep, mudslides, or unstable slopes. Additional factors include whether the project would increase the likelihood of or result in exposure to earthquake damage, slope failure, foundation instability, land subsidence, or other severe geologic hazards. The conversion of important farmlands to non-agricultural use is also a factor for significance. A total combined scored on Form AD-1006, *Farmland Conversion Impact Rating* of between 200 and 260 points would be considered a significant impact under FAA Order 1050.1F.

4.7.1 Alternative 1 (Proposed Action)

Alternative 1 would increase the extent of impervious areas at SLC-4, with the intent of increasing the efficiency of drainage patterns. Activities with the potential to impact geology and soils would largely be associated with the construction of the Civil Water Diversion Structure and the application of gunite. However, this area is largely previously disturbed from past construction activities and proposed soil disturbance is anticipated to be shallow. Vegetation would also be removed in the area around Spring Canyon Creek to avoid impacting migratory birds; however, root systems would remain intact within this area, which would reduce the potential for erosion and sediment to enter Spring Canyon. In all, project activities could disturb up to 3 ac. of land. Coverage under the NPDES Construction General Permit is required and the USAF would prepare a SWPPP in accordance with this permit. The SWPPP would include erosion control measures. Best management practices would also be implemented during ground-disturbing activities and the EPMs detailed in Section 2.2.6 would be implemented. Project construction (i.e. constructing a civil water diversion structure) would be designed to comply with seismic design standards as specified in AFSPCMAN 91-710, *Range Safety Requirements*. Implementation of Alternative 1 would have no bearing on liquefaction. Thus, potential hazards due to liquefaction are not anticipated. Alternative 1 would also not convert land categorized as prime or unique farmland or farmland of statewide importance. As a result, no long-term or significant impacts on geological resources from Alternative 1 are anticipated.

4.7.2 No Action Alternative

Under the Alternative Action, no construction or alteration at SLC-4E would occur. Therefore, the No Action Alternative would not significantly impact geological resources.

4.8 Coastal Zone Management

The California Coastal Commission reviews federal agency actions for consistency with the policies of the California Coastal Management Program. The following factors are used to determine whether a project would have significant impacts on coastal resources:

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

4.8.1 Alternative 1 (Proposed Action)

As stated in the Falcon 9 Boost-Back EA (USAF, 2016a), the following California Coastal Act policies apply for this project:

- Providing for maximum public access to the coast;
- Protecting marine and land resources, including environmentally sensitive habitat areas, such as wetlands, riparian corridors and creeks, rare and endangered species habitat, and marine habitat, such as tide pools;
- Protecting the scenic beauty of the coastal landscape;
- Maintaining productive coastal agricultural lands;
- Recreational boating use; and
- Oil and hazardous substance spill prevention, preparedness, and response in the marine environment.

4.8.1.1 Launch and Landing Operations

Alternative 1 would increase the number of Falcon 9 launches to up to 12 per year. Coastal access would be restricted at Surf Beach, Wall Beach, County of Santa Barbara Ocean Beach Park, Miguelito Park, and Jalama Beach County Park during each launch event for up to 5 to 8 hours per event for purposes of public safety. Under the federal consistency regulations, a negative determination can be submitted for an activity "which is the same as or similar to activities for which consistency determinations have been prepared in the past." The California Coastal Commission previously concurred that the Falcon 9 and Falcon Heavy Programs at SLC-4E would have similar impacts as those described for launch activities at SLC-3E (CD-049-98) and for relocating the Falcon 1 launch vehicles to SLC 4W (ND-088-08) (USAF, 2011a). Increasing the number of launches would have similar impacts as described in prior consultations.

Alternative 1 would increase the number of boost-backs and landings to up to 12 per year at one of three landing locations. The California Coastal Commission concurred that boost-back and landings of the Falcon 9 at SLC-4W and on a barge 30 mi (48 km) offshore of VAFB would not adversely affect coastal resources. The California Coastal Commission concurred that landing on a barge 140 miles (225 km) southwest of San Nicolas Island did not raise any new coastal resource issues. Although the sonic boom is more intense than previously estimated, the USAF has determined that increasing the number of Falcon 9 landings would have similar impacts as described in prior consultations.

The construction of the Civil Water Diversion Structure would occur within VAFB at SLC-4E. This construction would not affect the scenic or visual qualities of any coastal area nor would it affect the public's ability to access the coastal zone.

The U.S. Air Force has determined that Alternative 1 would result in similar impacts to coastal resources as currently occurring at SLC-4. Therefore, these activities would not significantly impact coastal resources and further consultation with the California Coastal Commission is not required.

4.8.2 No Action Alternative

Under the No-Action Alternative, the modifications to SLC-4E and modifications to the operation of the Falcon 9 would not be implemented. Current Falcon 9 operations at SLC-4 were assessed in prior assessments (USAF 2011a, 2016a, 2016b) and consultations where it was determined these activities would not significantly impact coastal resources.

4.9 Department of Transportation Section 4(f) Properties

A significant impact on Section 4(f) property would occur if the action involves more than a minimum physical use[1] of a Section 4(f) property or constitutes a constructive use based on an FAA determination that the project would substantially impair the Section 4(f) property (FAA, 2015).

4.9.1 Alternative 1 (Proposed Action)

Alternative 1 does not includes any construction activities within or actual physical taking of a Section 4(f) property through the purchase of land or a permanent easement, physical occupation of a portion or all of Section 4(f) property, or alteration of structures or facilities on Section 4(f) property.

Impacts to Surf Beach, Wall Beach, County of Santa Barbara Ocean Beach Park, Miguelito Park, and Jalama Beach County Park would result from their closure to the public during launch/landing events, because these parks fall within the debris impact corridor. Although the parks are not directly over flown by the launch vehicle, a launch anomaly could impact them. Therefore, for the safety of park visitors, the County Parks Department and the County Sheriff would close the parks upon request from VAFB. Since 1979, an evacuation and closure agreement has been in place between USAF and Santa Barbara County. This agreement includes closing Surf Beach, Ocean Beach, Miguelito Park, and Jalama Beach County Parks in the event of launch activities, including commercial launches. Under this agreement, USAF must provide notice of a launch at least 72 hours prior to the closure, and the closure is not to exceed 48 hours.

Under Alternative 1, closure of the parks would have the potential to occur up to 12 times per year. These closures would only last as long as necessary to assure the public is safe during a launch/landing, with coastal access restricted for a short period of time (5 to 8 hours). There would be no additional closures when landings would occur at the contingency landing sites.

[1] 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. See FAA Order 1050.1F (2015).

Alternative 1 would not substantially diminish the protected activities, features, or attributes of Surf Beach, Wall Beach, County of Santa Barbara Ocean Beach Park, Miguelito Park, and Jalama Beach County Park, and therefore would not result in substantial impairment of the properties, because there would be a maximum of 12 landings per year and the closures would be of short duration. In addition, although the launch trajectory could overfly the Channel Islands National Park, impacts would not be so severe that the activities, features, or attributes that qualify the Channel Island National Park for protection under Section 4(f) are substantially impaired. Therefore, Alternative 1would not be considered a constructive use of these Section 4(f) properties and thus would not invoke Section 4(f) of the USDOT Act. This means that the FAA does not need to undertake a Section 4(f) Evaluation or determine whether the impacts are *de minimis.*

4.9.2 No Action Alternative

Under the No Action Alternative, there would be no additional use or impacts to Section 4(f) properties as described in the Falcon 9 EA and Flacon 9 Boost-Back EA (USAF, 2011a, 2016a). Closures of Surf Beach, Wall Beach, County of Santa Barbara Ocean Beach Park, Miguelito Park, and Jalama Beach County Park would continue to occur up to 10 times per year for Falcon 9 and Falcon 9 Heavy.

4.10 Cumulative Impacts

The effects of Alternative 1 (Proposed Action) in combination with the effects of other relevant past, present, and reasonably foreseeable future projects are evaluated in this cumulative effects analysis. The depth of this analysis is commensurate with the potential for significant impacts, and this analysis focuses only on impacts that are truly meaningful to decision-makers. The No Action Alternative is not analyzed in this section because this alternative would have no cumulative effects on the environment (i.e., there would be no change to the current Falcon 9 Program at SLC-4).

4.10.1 Past, Present, and Reasonably Foreseeable Future Actions in the Region of Influence

The ROI is defined as the area over which effects of the Proposed Action could contribute to cumulative impacts on the environment. Therefore, the ROI includes the SLC-4W, SLC-4E, the contingency landing location, Iridium landing area, and vicinity as described in Section 2.3.

Table 4-10 lists the past, present, and reasonably foreseeable future actions that may contribute to cumulative effects of the Proposed Action. Future large projects that are currently projected in the ROI for the next several years and have the greatest potential to result in cumulative impacts are likely military activities, U.S. Coast Guard operations, oil and gas development, transportation, and recreational and commercial fishing.

Table 4-10: Past, Present, and Reasonably Foreseeable Federal and Non-Federal Projects within the Region of Influence

Federal Activities	Status
Taurus Standard Small Launch Vehicle	Past
Repairs and Replacement of Overhead Electrical Lines, Feeders K1 and K7	Past
Replacement of N5, N9, and N10 Powerlines on South VAFB	Past
Replacement of N1, N3, N6 Powerlines on South VAFB	Past
13th Street Bridge Replacement at the Santa Ynez River Crossing	Past
Evolved Expendable Launch Vehicle Program	Past, present, and future
Demolition and Abandonment of Atlas and Titan Facilities	Past, present, and future
East Housing Area Solar Energy Project	Past, present, and future
Snowy Plover Habitat Restoration	Past, present, and future
Beach Management for the Western Snowy Plover	Past, present, and future
Hawaii and Southern California Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement (HSTT EIS/OEIS) (Southern California Range Complex)	Past, present, and future
Rim of the Pacific Exercise	Past, present, and future (June–August [biennially])
At-Sea Law Enforcement	Past, present, and future
Programmatic BO on Routine Mission Operations and Maintenance Activities, Vandenberg Air Force Base, Santa Barbara County, California (8-8-13-F-49R)	Past, present, and future
Oil and Gas Development: Official Protraction Diagram Blocks (NH10-03; NH10-02, NH11-01; NI10-12; and NI11-10)	Future
Narlon Bridge Replacement on San Antonio Creek	Future
Non-Federal Projects	**Status**
City of Lompoc, North Avenue Bridge Preventative Maintenance Project	Past
Other Environmental Considerations	**Status**
Maritime Traffic	Past, present, and future
Commercial and Recreational Fishing	Past, present, and future

Federal activities (e.g., VAFB projects, military activities, and U.S. Coast Guard operations) contain environmental contract specifications and are individually evaluated for their environmental impacts. Based on the environmental impacts associated with each specific project, environmental protection measures and requirements are included in the project activities to reduce adverse environmental effects. Thus, individually implemented measures provide cumulative protection, potentially reducing overall adverse effects on VAFB environmental resources. This section considers these actions cumulatively, based on the expected timeframe of their execution compared to the Proposed Action. Brief descriptions of each project and the resources impacted are provided below.

4.10.1.1 Federal Activities

Taurus Standard Small Launch Vehicle Program

This action included the Taurus Standard Small Launch Vehicle program and modifications to Facility 576E, including construction of a launch pad area, guard shacks, and security fencing. It assessed potential environmental effects for Air Quality, hydrology and water quality, geology and soils, biological resources, visual resources, population, land use, community facilities and services, transportation, economy, waste management, health and safety, noise, and cultural resources (USAF, 1992).

The action was determined to have no significant effect on geology and soils, visual resources, population, land use, community facilities and services, transportation, economy, waste management, and health and safety. Potentially significant impacts to air quality, water quality, biological resources, noise, and cultural resources were identified. These impacts were avoided or reduced to insignificant levels through the implementation of mitigation measures and project procedures. A FONSI was issued in 1992.

Repairs and Replacement of Overhead Electrical Lines, Feeders K1 and K7

This project included demolition and replacement of approximately 21 miles (34 km) of existing electrical lines and construction of new overhead electrical lines and permanent access roads on South VAFB. An EA was completed in 2012 (USAF, 2012).

Potential adverse impacts were analyzed for air quality, biological resources, cultural resources, geology and earth resources, land use and coastal zone resources, noise, public health and safety, transportation, and water resources. Portions of the proposed Feeder Line K7 were located within the Santa Ynez River floodplain; therefore, the USAF analyzed potential impacts to floodplains and issued a Finding of No Practicable Alternative (FONPA) in 2012. Based on the EA, this project was not determined to have an individual or cumulatively significant impact on these resources. A FONSI/FONPA was issued in 2012 (USAF, 2012). The project is complete.

Replacement of N5, N9, and N10 Powerlines on South VAFB

This action involves demolishing existing electrical lines and constructing new overhead electrical lines. The new electrical lines would be established along a new route located east of the existing route, along two parallel sets of power poles between "Substation N" and SLC-6 for approximately 1.5 miles (2.4 km). A 15 ft. (4.6 m) gravel road would be established between the two sets of power poles to allow for future maintenance of the lines.

An EA is was prepared for this action and has concluded that by implementing environmental protection measures, no significant adverse effects would result to the following resources: air quality, biological resources, cultural resources, geology and earth resources, hazardous materials and hazardous management, human health and safety, land use and coastal zone resources, noise, solid waste, transportation, utilities, visual resources, and water resources. In addition, no significant adverse cumulative impacts would result from this action or the alternatives when considered with past, present, or reasonably foreseeable future projects at VAFB.

Repairs and Replacement of Overhead Electrical Line, Feeders N1, N3, and N6

VAFB proposed demolishing approximately 20 miles (32 km) of existing overhead electrical lines on South VAFB and replacing them with approximately 11 miles (18 km) of new overhead lines.

An EA (USAF, 2011b) concluded that by implementing environmental protection measures, no significant adverse effect would result to the following resources: air quality, GHGs, biological resources, geology and earth resources, land use and coastal zone resources, noise, public health and safety, transportation, visual resources, and water resources. No significant cumulative impacts were anticipated to these resources. The EA determined that the action would not affect environmental justice, socioeconomics, public services and utilities, and recreation. Adverse direct and cumulative impacts were anticipated to cultural resources. Therefore, the USAF implemented Alternative B, which realigned the powerline route to avoid impacts to these resources. A FONSI was issued in 2011.

13th Street Bridge Replacement at the Santa Ynez River

This project has the following main components: construction of a new bridge on 13th Street over the Santa Ynez River and corresponding approach roads; demolition and removal of the existing 13th Street Bridge and existing approach roads; installation of a fiber optic communication cable under the Santa Ynez River; restoration of areas temporarily disturbed by construction and demolition activities; and establishment of a Wetland Mitigation Area at the Santa Ynez River Estuary to offset any potential project-related impacts to wetlands that cannot be restored within the main project area. The action would occur in two project areas within the lower Santa Ynez River area, referred to as the Wetland Mitigation Area and the 13th Street Bridge Project Area. The 13th Street Bridge Project Area included the site of the new bridge construction, the demolition of the existing bridge, the installation of the fiber optic cable under the Santa Ynez River, and the restoration of temporary impacts from construction and demolition. Construction of the new bridge and demolition of the existing bridge began in 2016 and lasted approximately 12–20 months. An EA was completed in 2014, and a FONPA was issued in 2014 (USAF, 2014b).

The EA determined that the project would not result in individual or cumulatively significant impacts to any resources. However, potential adverse impacts were noted for the following resources: air quality, biological resources, cultural resources, earth resources, hazardous materials and waste management, human health and safety (noise), land use and aesthetics, solid waste management, transportation, and water resources. Some aspects of the project were noted as potentially beneficial to biological resources and water resources.

Evolved Expendable Launch Vehicle Program

The Evolved Expendable Launch Vehicle (EELV) system was designed to be modular with only flight-worthy components being delivered to the launch base, including VAFB. This approach reduces manufacturing costs and allows the government to leverage off the commercial market to reduce overall launch costs.

An EIS (USAF, 1998) was prepared to analyze potential impacts on 15 separate environmental resource areas as a result of implementing the action. These resource areas included local community, land use and aesthetics (including coastal zone management), transportation, utilities, hazardous materials and hazardous waste management, health and safety, geology and soils, water resources, air quality (lower atmosphere), air quality (upper atmosphere), noise, orbital debris, biological resources, cultural resources, and environmental justice. Resource areas identified as having potentially significant impacts included those associated with coastal zone management, hazardous materials and hazardous waste management, geology and soils, water resources, air quality (lower atmosphere), air quality (upper atmosphere), noise, orbital debris, biological resources, and cultural resources. A Record of Decision was issued in 1998 to permit the continued development and deployment of the EELV.

Demolition and Abandonment of Atlas and Titan Facilities

This action was to demolish or abandon Atlas and Titan Heritage launch program buildings no longer required to sustain either current or foreseeable VAFB missions. Buildings that were proposed for demolition or abandonment were located throughout VAFB: 28 buildings on North VAFB and 35 buildings on South VAFB. The action entailed the total above-grade demolition, complete abandonment, or partial demolition and partial abandonment of specific structures at each of the buildings.

A Programmatic EA (USAF, 2006a) concluded that with implementation of the project and monitoring measures described, no significant effects should result to cultural resources, hazardous materials and hazardous waste management, human health and safety, solid waste management, transportation, and water resources. The Programmatic EA found that this action could result in less than significant impacts to air quality, biological resources, cultural resources, land use and aesthetics, and water quality. No cumulative adverse impacts would result from the action when considered in conjunction with recent past and future projects. A FONSI was issued for the action in 2006, and the project is underway.

East Housing Solar Energy Project

VAFB proposed leasing land to and entering into a Power Purchase Agreement with a private developer who would design, construct, operate, and maintain an unmanned photovoltaic solar energy facility at the former East Housing Area on and for the benefit of VAFB. The portion of the East Housing Area selected for the project was approximately 182 ac. (0.74 km^2) in size and had few environmental constraints. The East Housing Area had topographic and other locational characteristics needed for cost-effective renewable energy generation, including existing on-site presence of key infrastructure (e.g., roads, power lines, water). The Project is projected to provide almost 25 percent of VAFB's electrical energy. The Project is designed to have a useful life of 20–30 years, although the life span could be extended by upgrades and refurbishments. An EA was completed in 2014, and a FONSI was issued in 2014 (USAF, 2014c). The Project became operational in 2016.

Based on the EA, this project would not result in individual or cumulatively significant impacts to any resources. However, adverse impacts were noted for the action during construction or operation to the following resources: air quality, biological resources, noise, transportation, visual resources, and water resources. Beneficial impacts were noted for air quality as a result of future use of a renewable energy source at VAFB.

Snowy Plover Habitat Restoration

The western snowy plover habitat restoration project consists of implementing habitat restoration for the benefit of the snowy plover and the coastal dune ecosystem on VAFB, and includes the removal of invasive, non-native species and revegetation with native dune species where appropriate. Eradication methods for targeted invasive species include manual and mechanical removal, and fire and chemical treatment. Active restoration began in 2008 and is ongoing. An EA was prepared in 2008 (USAF, 2008). The EA determined that, with the implementation of environmental protection and monitoring measures, no adverse effects would result to hazardous materials and waste management, human health and safety, land use and aesthetics, and water resources.

Three resources evaluated in the EA were determined to potentially have less than significant impacts: air quality, biological resources, and cultural resources. No cumulative adverse impacts were expected. A FONSI was issued in 2008.

Beach Management for the Western Snowy Plover

The USAF VAFB Beach Management Plan includes public and military access to the beaches on VAFB; enforcement; predator management; management of the California least tern colony; and beach restoration activities, water rescue training, and coastline familiarization.

An EA was originally prepared in 2006 (USAF, 2006b) to analyze potential impacts to biological resources, cultural resources, human health and safety, land use and aesthetics, and environmental justice. The USAF determined that the action would not result in significant individual or cumulative impacts to resources, and a FONSI was issued in 2006.

Hawaii and Southern California Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement

The Navy prepared a Hawaii-Southern California Training and Testing (HSTT) EIS/Overseas Environmental Impact Statement (OEIS) in 2013 (U.S. Department of the Navy, 2013). A warning area (W-291) and tactical maneuvering area that are part of the Southern California (SOCAL) Range Complex are near the location of the Iridium Landing Area. The two primary components of the SOCAL Range Complex are the ocean operating areas and the special use airspace (U.S. Department of the Navy, 2013). Appendix A of the HSTT EIS/OEIS includes a list of potential testing and training activities that the Navy may perform within these areas. The Navy is currently preparing an update to the HSTT EIS/OEIS, which is scheduled for 2018. Resources analyzed in the EIS/OEIS include air quality, sediments and water quality, vegetation, invertebrates, habitats, fishes, marine mammals, reptiles, birds, cultural resources, socioeconomics, and public health and safety. Resources that may overlap with the ROI in this SEA include fishes, marine mammals, reptiles, and birds.

Rim of the Pacific Exercise

The biennial Rim of the Pacific Exercise (RIMPAC) exercise, which occurs off the coasts of Hawaii and Southern California and includes over 29 nations has been occurring since 1968 (U.S. Department of the Navy, 2002). RIMPAC 2016 is the 25th version of this exercise. It occurred from 30 June to 4 August 2016 and is “the world's largest international maritime exercise” (Commander Naval Surface Force, 2016). Resources to consider for cumulative impacts as a result of the RIMPAC exercise include air quality, sediments and water quality, biological resources, and public health and safety.

Programmatic Biological Opinion on Routine Mission Operations and Maintenance Activities, Vandenberg Air Force Base, Santa Barbara County, California (8-8-13-F-49R)

The Programmatic BO on Routine Mission Operations and Maintenance Activities, Vandenberg Air Force Base, Santa Barbara County, California from 2015 supersedes the existing consultations that contained similar actions to those that were analyzed in the document. The superseded documents include: Titan Space Launch Program at SLC-4 (biological opinion number 1-8-96-F/C-29), Delta II/SLC-2 Space Launch Rate Increase (1-8-96-F-53R), Theater Missile Targets

Program (1-8-98-F-24), Delta II/SLC-2 and Taurus LF-576-E Launch Programs (1-8-98-F-25R), Atlas Launch Program (1-8-99-F/C-79), Landfill Operations and Cell Closure (1-8-06-F-2), IRP Site 32 Cluster Project (1-8-06-F-26), Small Missile Launch Site LF-06 (1-8-06-F-17), Firebreaks and Access Roads (1-8-06-F-43), MMRP (1-8-07-F-54, 8-8-09-F-39R, 8-8-10-F-27R), Reinitiation of the Atlas Launch Program at SLC-3E (1-8-08-F-6R), Closure of Solid Waste Disposal Cell at the VAFB Landfill (1-8-06-F-2). The Programmatic BO addresses actions proposed by the Air Force that consist of the five core programs (Mission Operations, Infrastructure Support, Infrastructure Development, Environmental Management, and Fire Management). The consultation document addresses the five categories and launch-related, construction, and maintenance activities that would occur in accordance with these five programs and their impact on threatened and endangered species (USFWS, 2015a).

At-Sea Law Enforcement

U.S. Coast Guard operates within the U.S. economic exclusion zone. The U.S. Coast Guard has the following 11 statutory missions (U.S. Coast Guard, 2014):

- Ports, waterways, and coastal security
- Drug interdiction
- Aids to navigation
- Search and rescue
- Living marine resources
- Marine safety
- Defense readiness
- Migrant interdiction
- Marine environmental protection
- Ice operations
- Other law enforcement

Living marine resources includes conducting operations to enforce all applicable laws and regulations that safeguard fisheries and marine protected resources. The U.S. Coast Guard provides a consistent at-sea law enforcement presence and assists natural resource agencies with responding to events such as strandings and entanglements (U.S. Coast Guard, 2016). In addition, U.S. Coast Guard also often trains with the Navy at sea (Commander, U.S. Third Fleet, 2016), which includes participating in the biennial RIMPAC exercise. Resources to consider for cumulative impacts as a result of at-sea law enforcement include air quality, sediments and water quality, biological resources, and public health and safety.

Official Protraction Diagram Blocks (NH10-03; NH10-02, NH11-01; NI10-12; and NI11-10)

Offshore oil and gas production, which is administered by the Bureau of Ocean and Energy Management (BOEM), is listed as another dominant use in the area (National Ocean Service, 2016). BOEM has gridded the ocean into Official Protraction Diagram blocks. The landing area is located within NH10-03 (Valero Basin) block, and the sonic boom may be heard within the NH10-02, NH11-01 (Bushnell Knoll), NI10-12 (Patton Ridge), and NI11-10 (San Clemente Island) blocks. There are no active or proposed oil and gas leases within these blocks. In May 2016, BOEM completed a programmatic EA to use well stimulation treatment on the Pacific outer continental shelf; however, this activity was limited to existing facilities, therefore cumulative impacts in the ROI would not occur as a result of current offshore oil and gas production (Argonne National Laboratory, 2016).

Narlon Bridge Replacement on San Antonio Creek

The Union Pacific Railroad (UPRR) needs to replace the antiquated Narlon Bridge over San Antonio Creek, which is located inside UPRR right-of-way, within the boundaries of north VAFB. To accomplish the bridge replacement, UPRR would encroach on VAFB (federal) property for the purposes of accessing the project site and temporary staging of equipment during construction. Because federal property would be accessed, the bridge replacement project is subject to environmental evaluation under federal law, in compliance with NEPA. An EA is being prepared that evaluates environmental impacts that could occur on both VAFB and UPRR property for the entire bridge replacement project.

The resources analyzed included air quality, biological resources and wetlands, cultural resources, socioeconomics, water resources, geology and earth resources, public health and safety, transportation, and cumulative impacts. It was determined that the project would not impact or have a negligible impact on environmental justice, land use and coastal resources, public utilities, noise, recreation, and visual resources. Construction is expected to begin in the summer of 2019.

4.10.1.2 Non-Federal Projects

City of Lompoc, North Avenue Bridge Preventative Maintenance Project

The City of Lompoc proposed repairing the North Avenue Bridge at the San Miguelito Creek crossing. This project includes applying a bridge deck seal, repairing minor spalls in concrete bridge support columns, controlling traffic, controlling water pollution, removing traffic striping and markings, and installing traffic striping and markings. The construction impact area included 0.4 ac. (1,618 square meters) of un-vegetated paved road surface, concrete, and compacted dirt. It was determined that the project did not encroach on or impact the floodplain.

The following resources were determined to be potentially affected by the project: biological resources, air quality, hazards and hazardous materials, and noise. The project was determined to have no effect on land use and planning, population and housing, geology and soils, cultural resources, agricultural resources, aesthetics, utilities, public services, and recreation. The project was determined to have less than significant impacts on noise and transportation. With mitigation incorporated, the project was determined to have less than significant impacts on water quality, air quality, biological resources, and hazards and hazardous materials. A Mitigated Negative Declaration was issued in 2014 (City of Lompoc, 2014a). A Categorical Exclusion from the requirements to issue an EA under NEPA was issued in 2014 (City of Lompoc, 2014b).

4.10.1.3 Other Environmental Considerations

Maritime Traffic

Maritime traffic includes pleasure crafts, cargo shipping, cruise ships/marine tourism, and other vessels at sea. A Notice to Mariners would be issued before landings would occur in the Pacific Ocean, thus avoiding cumulative impacts to air quality, sediments and water quality, biological resources, socioeconomics, and public health and safety.

Commercial and Recreational Fishing

There are 11 ports in Southern California that commercial and commercial passenger fishing vessels use in the open ocean areas of the SOCAL range complex (U.S. Department of the Navy, 2009). Thirty-nine fisheries in Southern California include groundfishes (e.g., flatfishes, skates, some sharks, and rockfishes), highly migratory species (e.g., tuna, billfish, some sharks, dolphinfish, and swordfish), coastal pelagic species (anchovies, mackerel, and sardines), and invertebrates (California spiny lobster, several crab species), and market squid are harvested and sold commercially. The NMFS issues fishing vessel, dealer, and commercial operator permits and fishing authorizations as required under the various Federal Fishery Regulations.

Recreational fishing is also significant in southern California, where over 3.3 million angler days were recorded in 2013 (NMFS, 2015). More than 200 for-hire fishing vessels operate from 15 separate ports between Point Conception and the U.S.–Mexico border (California Marine Life Protection Act Initiative, 2009). Commercial fishing can adversely affect fish populations, non-target species, and habitats.

4.10.2 Alternative 1 (Proposed Action)

4.10.2.1 Air Quality and Climate

Air emissions from other projects listed in Table 4-10 would be localized and short term in nature, except for the HSTT EIS/OEIS, which is anticipated to continue at the rates given in the 2013 EIS/OEIS until it is renewed in 2018, and the basewide Demolition project, which is anticipated to continue over the course of 15 years, contingent on funding. Long-term emissions from the projects are not anticipated to increase. Cumulative emissions from Alternative 1 combined with other concurrent projects and activities would not exceed the significance thresholds and would not produce any significant cumulative air quality impacts.

4.10.2.2 Climate

The incremental contribution of Alternative 1 to GHG emissions is extremely small relative to global emissions and therefore would not have a significant impact to cumulative GHG emissions or climate change. This determination was made by reviewing the total emission impact of this project with the cumulative emissions from all planned concurrent projects (Table 4-10). Therefore, implementation of Alternative 1 in conjunction with other past, present, or reasonably foreseeable projects would not result in cumulative impacts to air quality or climate change.

4.10.2.3 Noise

Construction activities at the site of Alternative 1 and for other projects listed in Table 4-10 would result in temporary, intermittent impacts localized to the project site. Construction projects are typically temporary in duration and the noise impact from the construction of the civil water diversion structure at SLC-4E would not be a significant contributor to the noise setting on VAFB.

There are about eight launches a year at VAFB (space and missile launches). Noise effects associated with each of these launches is relatively short (no more than five minutes). When required, appropriate environmental analysis is conducted for these activities. Noise associated with the boost-back is anticipated to be short (about two minutes) and would not create a significant cumulative impact when compared to other launch related activities. The anticipated sonic boom events would be infrequent (up to 12 events per year) and each event would last less than two minutes. Therefore, implementation of Alternative 1 in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative noise impacts.

4.10.2.4 Biological Resources

Alternative 1 and other construction and launch projects that involve ground-disturbing activities and related noise and traffic impacts could have temporary and localized effects on biological resources. Cumulative adverse impacts could result if concurrent projects, along with Alternative 1, cause disturbances to special-status species or their habitats. Construction of the civil water diversion structure at SLC-4 E would be limited to a small area within SLC-4E. Loss of non-native vegetation communities is not considered adverse due to the abundance of vegetation communities in the project vicinity. Additionally, boost-back and landing is a short and infrequent operation (up to 12 events per year) and would not be expected to have residual effects past each operation.

Although Alternative 1 and other concurrent projects may disturb wildlife, the disturbance would be temporary and wildlife would continue to use habitat in the periphery of the projects. Compliance with a project-specific BO and implementation of EPMs would minimize impacts to special-status species as described in Section 2.2.6 would minimize impacts to special-status species. Therefore, implementation of Alternative 1 in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative impacts to biological resources.

4.10.2.5 Water Resources

Cumulative impacts to water resources could occur if concurrent projects were to inadequately address water resources in the ROI. However, projects on VAFB, including Alternative 1, are required to utilize site-specific BMPs to control runoff and conduct site restoration, as necessary, to minimize impacts to water quality. Impacts tend to be localized and temporary during construction activities. In addition, all VAFB cumulative projects, as shown in Table 4-10, would follow the conditions of the CWA Section 404 Permit and 401 Water Quality Certification, the SWPPP prepared for the NPDES Construction General Permit, Post Construction Storm Water Standards, or Energy Independence and Security Act of 2007 Section 438, as applicable. Compliance with all state and Federal regulations and implementation of proper management of materials and wastes (as described in Sections 4.8, Hazardous Materials and Waste Management; and 4.9, Solid Waste Management, of the Falcon 9 Boost-Back EA [USAF, 2016]) would minimize impacts to water resources as a result of Alternative 1.

All activities under Alternative 1 would be subject to all requirements contained in the SWRCB Construction General Permit (WDID Number: 3 42W000312). Implementation of measures described in Section 2.2.6 (Water Resources) of this SEA, identified in environmental documents completed for other projects, to be incorporated in environmental documents for future projects, as well as identified and established by VAFB for Operations and Maintenance projects, should avoid or minimize any potential adverse effects.

Erosion and contamination caused by construction activities are not anticipated as a result of Alternative 1. Therefore, implementation of Alternative 1 in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative impacts to water resources.

4.10.2.6 Cultural Resources

Activities that disturb intact, native soils or demolish structures over 50 years of age could result in impacts to cultural resources. Cumulative impacts would result if construction activities resulted in major ground disturbances in areas of high paleontological sensitivity (subsurface prehistoric or historic archaeological resources). SHPO has concurred with VAFB findings (Appendix A).

In addition, EPMs would be implemented to minimize impacts on sensitive archaeological resources. Vehicular access would be prohibited within known cultural sites. While some areas within the landing site at SLC-4E have been previously disturbed, the potential remains for currently buried, unknown cultural resources to be uncovered during ground-disturbing activities, as well as in those areas that are as of yet undisturbed. However, if such resources were uncovered during the course of project development, construction would be suspended until a qualified archaeologist could determine the significance of the encountered resource(s). Therefore, implementation of Alternative 1 in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative impacts to cultural resources.

4.10.2.7 Geology and Earth Resources

Cumulative projects at VAFB that involve grading, excavations, construction or demolition could result in erosion-induced sedimentation of adjacent drainages and water bodies. The soils in the ROI have been altered over time and some of the project site is permanently disturbed with existing infrastructure and paved surfaces. Potential cumulative effects would include an increase in soil disturbance associated with construction, substantially increased erosion, landslides, soil creep, mudslides, and unstable slopes. These impacts would be minimized by the use of BMPs and site restoration to minimize soil erosion and reduce fugitive dust. Erosion-induced sedimentation of surface drainages could occur as a result of cumulative projects at VAFB.

All projects located in the region are subject to seismically induced ground shaking due to an earthquake on a local or regional fault. By incorporating modern construction engineering and safety standards, all adverse seismic-related impacts at the project site, as well as the projects in the region should be avoided. Therefore, implementation of Alternative 1 in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative impacts to geology and earth resources.

4.10.2.8 Coastal Zone Management

Alternative 1 would not adversely affect the Coastal Zone, CZMA, or CCA policies. The cumulative projects identified in Table 4-10 that may impact coastal zone resources include the HSTT EIS/OEIS and future oil and gas development. Compliance with all state and Federal regulations and the submittal of a negative determination for the boost-back and landing within the Iridium Landing Area to the California Coastal Commission would show that Alternative 1 would have minimal impacts to coastal zone resources. Therefore, implementation of Alternative 1 in conjunction with other past, present, or reasonably foreseeable projects would not result in cumulative impacts to coastal zone resources.

4.10.2.9 Department of Transportation Section 4(F) Properties

Construction of the civil water structure and construction from other projects in the ROI would not result in restricted access to any Section 4(f) property. Noise levels from construction activities would not be audible above typical ambient noise levels at the closest noise sensitive areas, including the Section 4(f) properties in the vicinity of SLC-4E. Therefore, implementation of Alternative 1 in conjunction with other past, present, or reasonably foreseeable projects would not result in cumulative impacts to Section 4(f) properties.

4.10.2.10 Summary and Conclusion

To ensure that no significant cumulative impacts result from projects on VAFB that occur either concurrently or sequentially with Alternative 1, VAFB includes environmental contract specifications and protective measures, when necessary, in all projects. Preventive measures are identified and defined by resource managers and actions are taken by project proponents and VAFB during the planning process to ensure adverse impacts are minimized, or avoided all together, as projects are reviewed under NEPA. Prior projects are also considered to ensure no levels of acceptable impacts are exceeded.

All projects on VAFB are designed and implemented to be in full compliance with applicable statutes and regulations. VAFB develops environmental protection measures in coordination with appropriate regulatory agencies throughout the NEPA process. With these practices in place, the activities included under Alternative 1, in conjunction with other foreseeable projects in the ROI, would not result in significant cumulative impacts.

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APPENDIX A: State Historic Preservation Office Consultation

DEPARTMENT OF THE AIR FORCE
30TH SPACE WING (AFSPC)

OCT 17 2017

Lieutenant Colonel Jason M. Aftanas
Commander, 30th Civil Engineer Squadron
1172 Iceland Ave
Vandenberg AFB CA 93437-6011

Ms. Julianne Polanco
State Historic Preservation Officer
Department of Parks and Recreation
Office of Historic Preservation
P.O. Box 942896
Sacramento CA 94296-0001

COPY

Dear Ms. Polanco

The 30th Space Wing of the United States Air Force, Vandenberg Air Force Base (VAFB), in coordination with Space Exploration Technologies Corporation (SpaceX), proposes construction of a flame trench catchment area at Space Launch Complex (SLC)-4 East in the South Base area of VAFB in Santa Barbara County, California. VAFB determined the *SLC-4 East Flame Trench Catchment Area Project* is an undertaking subject to compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, and will comply with Section 106 using the implementing regulations [36 CFR Part 800]. With this letter and its attachment, VAFB is initiating consultation with you. Additionally, VAFB is requesting expedited review by the SHPO.

VAFB conducted cultural resources studies and background research on the Project Area of Potential Effects (APE) in September–October, 2017 in support of this project. Details of the investigation are provided in the attachment. VAFB presents the following federal agency determinations for concurrence from the State Historic Preservation Officer:

1. The APE for the *SLC-4 East Flame Trench Catchment Area* Project is adequately delineated; and

2. There are no historic properties within the Project APE.

Pending concurrence with our above determinations, VAFB has reached a Section 106 finding of *no historic properties affected* for this undertaking. If you do not object to this finding, VAFB has fulfilled its Section 106 responsibilities for this undertaking and no further consultation is required. If project implementation results in a discovery during construction, VAFB would re-open Section 106 consultation.

If you have any questions or require additional information, please contact Christopher Ryan, Cultural Resources Management, 30 CES/CEIEA, 1028 Iceland Avenue, Building 11146, Vandenberg AFB; phone: 805-605-0748; e-mail: Christopher.ryan.7@us.af.mil. Thank you for your assistance with this undertaking.

Sincerely

JASON M. AFTANAS, Lt Col, USAF
Commander

Attachment:
Identification of Historic Properties, Space Launch Complex (SLC)-4 East Flame Trench Catchment Area Project

COPY

State of California • Natural Resources Agency Edmund G. Brown Jr., *Governor*

DEPARTMENT OF PARKS AND RECREATION
OFFICE OF HISTORIC PRESERVATION
Lisa Ann L. Mangat, *Director*

Julianne Polanco, State Historic Preservation Officer
1725 23rd Street, Suite 100, Sacramento, CA 95816-7100
Telephone: (916) 445-7000 FAX: (916) 445-7053
calshpo.ohp@parks.ca.gov www.ohp.parks.ca.gov

November 07, 2017

Reply in Reference To: USAF_2017_1023_001

Lieutenant Colonel Jason M. Aftanas
Commander, 30th Civil Engineer Squadron
1172 Iceland Avenue
Vandenberg AFB, CA 93437-6011

Re: Section 106 Consultation for Construction of a Flame Trench Catchment Area at Space Launch Complex-4 East, Vandenberg AFB (your letter of October 17, 2017)

Dear LtCol Aftanas:

The United States Air Force's (USAF) is initiating consultation with the State Historic Preservation Officer (SHPO) on the above-cited undertaking in accordance with Section 106 of the National Historic Preservation Act of 1966 (54 U.S.C. § 306108), as amended, and its implementing regulation found at 36 CFR Part 800.

USAF is proposing to construct a flame trench catchment area at Space Launch Complex-4 East, Vandenberg Air Force Base, which will consist of 350 feet long by 4 feet tall concrete diversion wall, a 140 feet wide by 90 feet long benched and sloped embankment, and a 60,000 gallon retention pond equipped with a slide gate and drain valve. Based on previous surveys, USAF knew that CA-SBA-537/1816 is located approximately 300 feet west of the area of potential effects (APE) for this proposed undertaking. USAF and SHPO have consulted previously and agreed that this site is eligible for listing on the National Register of Historic Places under Criterion D (USAF870302A and USAF880104A). USAF wanted to ascertain if the site extended into the APE and contracted with Applied Earthworks, Inc. (Æ) to conduct a testing program to determine if the site extended into the APE. Æ personnel and Charley Centeno (Native American monitor, Santa Ynez Band of Chumash Indians) conducted fieldwork on October 11 and 12, 2017. The testing included 12 shovel test pits and 4 auger borings that ranged in depth between 40 and 280 centimeters. The testing also included pedestrian surveys of areas that had been burned recently by wildfires, which resulted in excellent surface visibility. As a result of the testing program, USAF has determined that CA-SBA-537/1816 does not extend into the APE and that there are no cultural resources located within the APE.

USAF consulted with Freddie Romero of the Santa Ynez Band of Chumash Indians in regards to this proposed undertaking. He responded that the Tribe had no concerns about this proposed undertaking, they did request that they be notified if any cultural material was discovered during the project.

After reviewing the information submitted by USAF, SHPO has the following comments:

1) SHPO has no objections to your identification and delineation of area of potential effect pursuant to 36 CFR Parts 800.4 (a)(1) and 800.16(d); and
2) SHPO does not object to your Finding of No Historic Properties Affected and agreed that it is appropriate for this proposed undertaking

Be advised that under certain circumstances, such as an unanticipated discovery or a change in project description, the Board may have additional future responsibilities for this undertaking under 36 CFR Part 800. Should cultural artifacts be encountered during ground disturbing activities, please halt all work until a qualified archaeologist can be consulted on the nature and significance of such artifacts.

If you have any questions or concerns, please contact Ed Carroll of my staff at (916) 445-7006 or Ed.Carroll@parks.ca.gov.

Sincerely,

Julianne Polanco
State Historic Preservation Officer

APPENDIX B: United States Fish & Wildife Service Consultation

DEPARTMENT OF THE AIR FORCE
30TH SPACE WING (AFSPC)

Beatrice L. Kephart
30 CES/CEI
1028 Iceland Avenue
Vandenberg AFB CA 93437-6010

13 June 2017

Stephen P. Henry
U.S. Fish and Wildlife Service
2493 Portola Road, Suite B
Ventura CA 93003

Dear Mr. Henry

In accordance with section 7 of the Endangered Species Act of 1973, Vandenberg Air Force Base (VAFB) requests the initiation of formal consultation for "Launch, Boost-Back and Landing of the Falcon 9 First Stage at SLC-4 West." Space Exploration Technologies Corporation ("SpaceX") proposes to return the first stage of the Falcon 9 rocket to Space Launch Complex 4-West (SLC-4W) for potential reuse up to 12 times per year. The potential impacts of noise from both launch and landing activities are comprehensively discussed within the attached Biological Assessment (BA). All physical/structural modifications to SLC-4 required to support these activities have been authorized under separate consultations.

We request "take" as a result of our determination that this project "may affect, and is likely to adversely affect" the following Threatened and Endangered Species: California red-legged frog (Rana draytonii), Western snowy plover (Charadrius nivosus) and California least tern (Sternula antillarum browni). Extensive avoidance and monitoring measures will minimize disturbance to these species. We are also requesting concurrence on our "may effect, but not likely to adversely affect" determinations to the California condor, Marbled murrelet and Southern sea otter for this activity. The actions discussed in the BA will not affect designated Critical Habitat for any species (note that critical habitat has not been designated for some of the species listed above).

Enclosed is our biological assessment with the project description and effects of project activities. As always, we would appreciate the opportunity to review the draft Biological Opinion for this project before your office finalizes it. Additionally, due to the critical timeline which we have developed for this project, we request formal notification that all necessary materials and information have been received in support of a 135-day consultation. With that written confirmation that consultation has been initiated, we formally request an estimated date of completion for the required Biological Opinion.

Thank you for your assistance. Please contact me at (805) 605-7924 or Darryl York at (805) 605-8684 if you have any questions.

Sincerely

BEATRICE L. KEPHART
Chief, Installation Management Flight

Attachment:
Biological Assessment

Biological Assessment for Launch, Boost-Back and Landing of the Falcon 9 First Stage at SLC-4, Vandenberg Air Force Base, California

July 2017

Prepared for

Space Exploration Technologies Corporation
1 Rocket Road
Hawthorne, CA 92050

and

30th Space Wing, Installation Management Flight
1028 Iceland Avenue, Bldg. 11146
Vandenberg Air Force Base, California 93437

Prepared by

ManTech SRS Technologies, Inc.

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ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
ac.	acre(s)
AFB	Air Force Base
BA	Biological Assessment
BO	Biological Opinion
dB	decibels unweighted
dBA	A-weighted decibel(s)
C.F.R.	Code of Federal Regulations
E	East
ESA	Endangered Species Act
ESBB	El Segundo blue butterfly
FAA	Federal Aviation Administration
FR	Federal Register
ha	hectare(s)
IPAC	Information for Planning and Conservation
kHz	kilohertz
km	kilometer(s)
km^2	square kilometers
LOX	liquid oxygen
mi.	mile(s)
NASA	National Aeronautics and Space Administration
NCI	Northern Channel Islands
PBF	Physical and biological features
psf	pounds per square foot
psi	pounds per square inch
RP-1	rocket propellant
SEL	Sound Exposure Level
SLC	Space Launch Complex
SpaceX	Space Exploration Technologies Corporation
SW	Space Wing
U.S.	United States
USAF	U.S. Air Force
USFWS	U.S. Fish and Wildlife Service
VAFB	Vandenberg Air Force Base
W	West

1 Introduction

The purpose of this Biological Assessment (BA) is to address the effects of the Space Exploration Technologies Corporation's (SpaceX's) Falcon 9 Launch and Landing Program at Space Launch Complex (SLC) 4, on federally listed (endangered and threatened) species and their critical habitat as required by Section 7 of the Endangered Species Act (ESA) of 1973 (16 United States Code § 1536).

SLC-4 is located at Vandenberg Air Force Base (VAFB). The U.S. Air Force (USAF) is the lead agency for the Falcon 9 program for purposes of this BA. The Federal Aviation Administration (FAA) issues a reentry license for the Falcon 9 Program. Both the FAA and the National Aeronautics and Space Administration are cooperating agencies for the Falcon 9 program at SLC-4.

VAFB consulted with the United States (U.S.) Fish and Wildlife Service (USFWS) per Section 7 of the ESA on the modification and use of SLC-4 East (E) to support the Falcon 9 and Falcon 9 Heavy Programs in 2011 (U.S. Fish and Wildlife Service, 2011a). VAFB completed a second consultation in 2014 that included an operational check, abort test, a onetime test of a new technology in recovering rocket boosters, referred to as "boost-back landing," and infrastructure improvements at SLC-4 West (W) (8-8-14-F-41) (Tetra Tech Inc., 2014; U.S. Fish and Wildlife Service, 2014b). In addition, VAFB received concurrence from USFWS on 29 August 2014 that launch noise and light as a result of Falcon 9 launches may affect, but is not likely to adversely affect, California red-legged frogs (*Rana draytonii*) potentially occurring in Spring Canyon. VAFB completed a subsequent consultation in 2015 that included incorporating the boost-back and landing at VAFB as a standard component of future launch operations (U.S. Fish and Wildlife Service, 2015c; ManTech SRS Technologies, Inc., 2015a, 2015b).

In 2011, USFWS completed a Programmatic Biological Opinion (BO) (8-8-09-F-10, now 8-8-13-F-49R) for routine mission operations and maintenance activities at VAFB. This Programmatic BO expressly excluded the modification and operation of SLC-4E (8-8-10-F-38) from its coverage (U.S. Fish and Wildlife Service, 2011b). USFWS completed a re-initiation of the Programmatic BO in 2015, which continued to exclude the operation of SLC-4E (U.S. Fish and Wildlife Service, 2015a). SpaceX operates the Falcon 9 Program at SLC-4. As of 6 April 2017, SpaceX has performed three Falcon 9 launches at VAFB. SpaceX has yet to perform a boost-back and landing maneuver onshore at VAFB; however, has performed one successful and one failed autonomous drone ship landings in the Pacific. SpaceX has successfully performed four first stage land landings at Cape Canaveral and on an autonomous droneship in the Atlantic Ocean five times. A total of five droneship landing attempts have been unsuccessful due to varying reasons. Failures have been restricted to the early "learning curve" and there have not been any landing failures since 15 June 2016.

The USAF identified the following changes to the Falcon 9 Program at VAFB since receiving USFWS's concurrence:

1. Increasing Falcon 9 boost-back and landings at VAFB from 10 to 12 per year (up to once per month);
2. Changes to the predicted sonic boom levels and footprint for launch and boost-back;
3. Observation of California condor (*Gymnogyps californianus*) on VAFB;

4. Changes to Falcon 9's landing noise because they will be using three engines instead of one engine; and
5. The release of water and water vapor into Spring Canyon as a result of adding up to 200,000 gallons of water to the flame duct to reduce vibration during launches.

This BA examines the potential effects of the Falcon 9 Program on the El Segundo blue butterfly (ESBB; *Euphilotes battoides allyni*), California red-legged frog, California condor, California least tern (*Sternula antillarum browni*), marbled murrelet (*Brachyramphus marmoratus*), Western snowy plover (*Charadrius nivosus*), Southern sea otter (*Enhydra lutris nereis*), and critical habitat for these species, if designated. Since launch noise has been covered in previous consultations for the California red-legged frog, California least tern, Western snowy plover on VAFB, and Southern sea otter, this potential stressor is only analyzed for potential affects to California condor, Western snowy plover on the Northern Channel Islands (NCI), and marbled murrelet here.

2 Project Description

2.1 Proposed Action

SpaceX proposes to launch and land the Falcon 9 at SLC-4 for potential reuse up to 12 times per year. Launches and landings would occur day or night. Launches would not occur during extreme weather conditions such as gale force winds, high wind shear, or extreme thunder and lightning conditions. The Falcon 9 first stage is 12 feet (ft.) in diameter and 160 ft. in height. Figure 2-1 provides a graphical depiction of the boost-back and landing sequence, which remains unchanged from prior consultations. The total time from launch to landing is approximately 10 to 20 minutes.

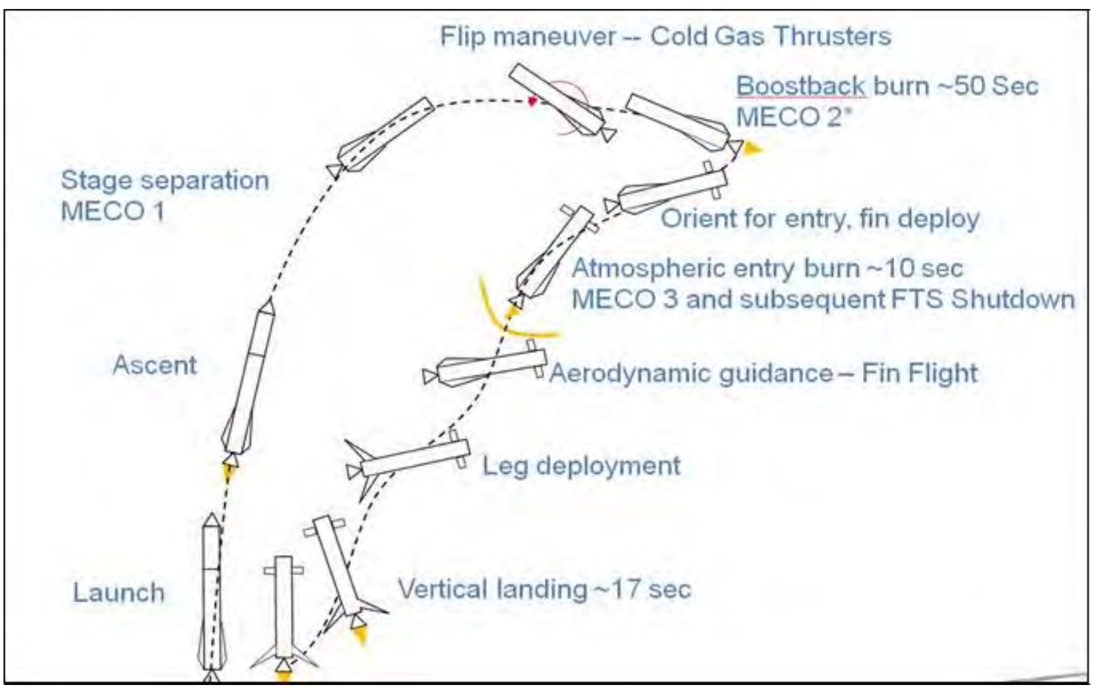

Figure 2-1. Stages of Falcon 9 Boost- Back and Propulsive Landing

2.1.1 Flame Duct Water

Allowing standing water in the flame duct has proven to be the most effective method to reduce vibration impacts on payloads. Based on operations and experience at other launch sites, SpaceX has determined that a maximum of 200,000 gallons of water would be required in the flame duct to achieve vibration requirements for certain missions. During the Cassiope Mission in September 2014, when a similar amount of water was present in the flame duct, there was an unanticipated release of water into Spring Canyon. Upon evaluation of the flow path of the water, it was determined that a majority of this water flowed overland on its path to Spring Canyon. It was also determined that a much lesser quantity of water was ejected through the air directly into Spring Canyon. In order to reduce impacts to Spring Canyon, SpaceX would install a civil structure (see Section 2.1.2, Civil Water Diversion Structure) to help capture and divert any water that would flow overland and potentially enter Spring Canyon. This water would be contained in a newly constructed 60,000-gallon capacity retention basin and subsequently pumped to the existing spray field for discharge of similar waters.

Even despite the civil structure, some liquid water may reach Spring Canyon. It is difficult to evaluate exactly how much water would be discharged to Spring Canyon due to this action. Based on the Cassiope Mission, it is estimated that of the 200,000 gallons of water placed in the flame duct, half of this volume would remain in the flame duct and half would be expelled as water and water vapor. Approximately 25,000 gallons of water would be expelled as steam, with the remaining 75,000 gallons expelled as liquid water. The civil structure would be designed to capture the majority of the water to the extent possible, but some water would be discharged to Spring Canyon. To consider the worst-case scenario it is assumed that up to 25,000 gallons of liquid water could reach Spring Canyon. Water discharged as part of this action would meet the thresholds identified by the Regional Water Quality Control Board in the statewide low threat discharge to surface waters permit.

The maximum temperature of the water and water vapor is expected to be up to 130 degrees Fahrenheit (ºF) by the point at which it would reach Spring Canyon. SpaceX plans to remove all vegetation to just above ground level within a 3.327-acres (ac.) (1.346-hectares [ha]) impact area of Spring Canyon (Figure 2-2) to avoid and minimize impacts to nesting migratory birds. Removal of the vegetation would be performed by mowers and hand equipment prior to nesting bird season and attempts would be made to reduce impacts to the drainage as much as possible. Additional vegetation removal (e.g., mowing) of the impact area would be performed outside of nesting bird season annually as needed to maintain low stature vegetation.

2.1.2 Civil Water Diversion Structure

Construction of a civil water diversion structure would occur between October 2017 and April 2018. The slope from the end of the flame duct to the perimeter concrete area (perimeter apron) would be covered with gunite to reduce erosion (Figure 2-2 and Figure 2-3). A 2-ft. tall stem walls would be placed at the western and eastern edges to anchor the structure (Figure 2-3). Minor grading of this area would be conducted to provide a constant slope. A 250-ft. (76.2-meters) perimeter wall would be constructed with concrete on top of the existing perimeter apron along the inside of the fence line (Figure 2-2 and Figure 2-4). This wall would serve to redirect water expelled from the flame duct and divert it down slope to a 60,000-gallon capacity retention basin to minimize water being discharged to Spring Canyon. The wall would be 4 ft. high with a 5 ft. deep by 4 ft. wide footer. The footer would be excavated inside the fence line through the existing perimeter apron and the soil would be relocated to a stockpile onsite. The floor of the retention basin would utilize the existing concrete of the perimeter apron.

Figure 2-2. Civil Water Diversion Structure and Vegetation Removal Area (Impact Area) south of SLC-4 in Spring Canyon

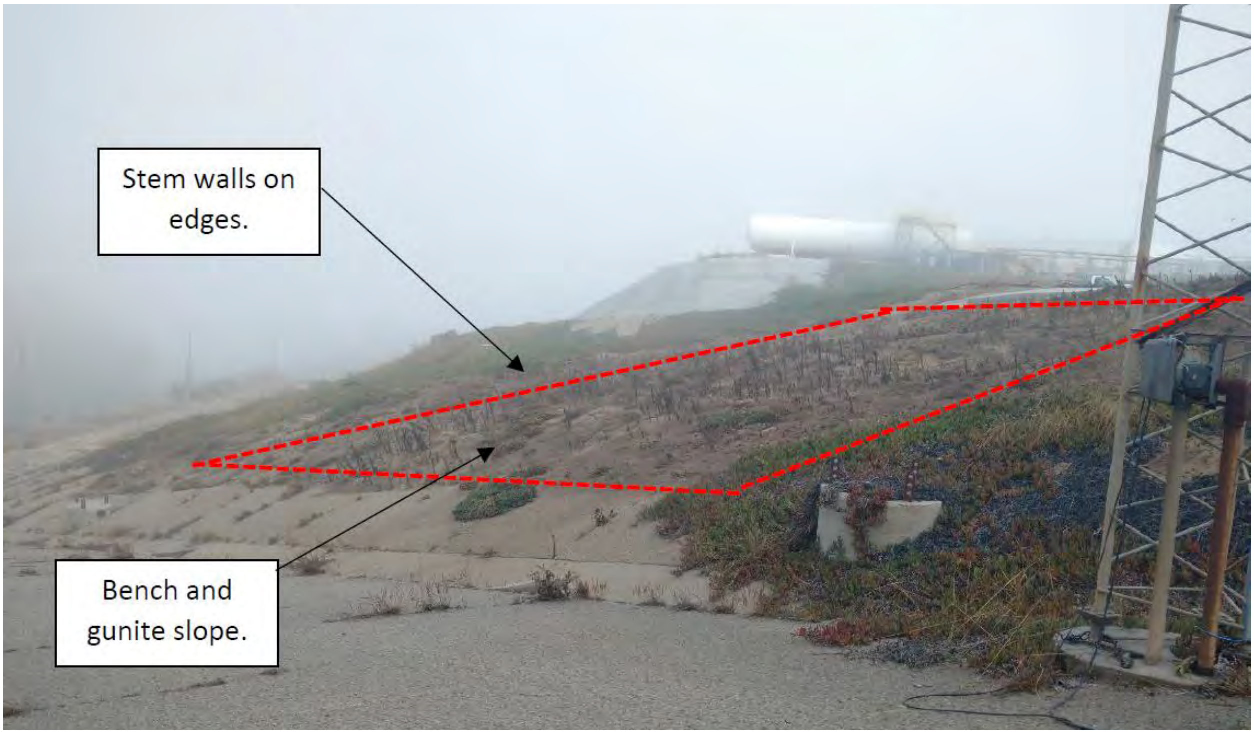

Figure 2-3. Gunite Application Area

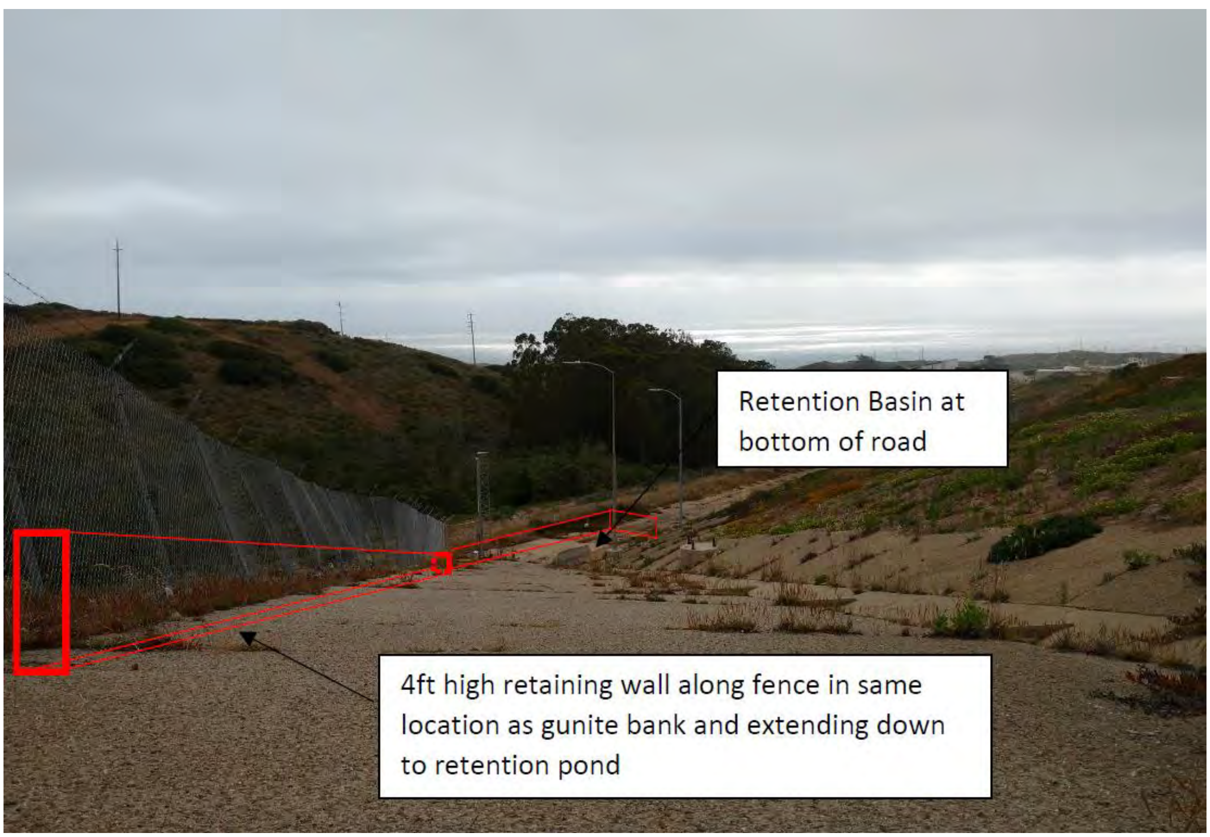

Figure 2-4. Mock-up of Perimeter Wall Design on Existing Concrete Apron

All equipment access to the construction area would be on existing road or the existing apron. Concrete would be brought in with a concrete pump from the access road at the flame duct area. Valves will be installed on the existing stormwater drainage inlets to ensure that no water enters the inlets during launch operations (inlets would only be opened during storm events). Water collected in the retention basin would be pumped to the existing spray field via a 3-inch gas pump that has a strainer on the inlet with 1/8th inch holes. After launch operations, the water in the retention basin would be removed to below 4 inches in depth within 48 hours to reduce chances of attracting frogs and other animals.

2.1.3 Sonic Boom and Engine Noise

The trajectory of the Falcon 9 first stage would continue to be either westward or southward from SLC-4 depending on the payload's orbital mission. During ascent, a sonic boom (overpressure of high-energy impulsive sound) up to 3.0 pounds per square foot (psf) may be generated at the NCI. After the first stage engine cutoff, exoatmospheric cold gas thrusters would be triggered to flip the first stage into position for retrograde burn. Three of the nine first stage Merlin engines would be restarted to conduct the retrograde burn to reduce the velocity of the first stage and to place the first stage in the correct angle to land. Once the first stage is in position and approaching its landing target, the three engines would be cut off to end the boost-back burn. The first stage would then perform a controlled descent using atmospheric resistance to slow the stage down and guide it to the landing pad target. The first stage is outfitted with grid fins that allow cross range corrections as needed. The landing legs on the first stage would then deploy in preparation for a final single engine burn that would slow the first stage to a velocity of zero before landing on the landing pad at SLC-4W. The detailed sequence of events for first stage landing along with trajectory data would be provided in the final Flight Safety Data Plan.

During descent, a sonic boom would be generated while the first-stage booster is supersonic. Earlier sonic boom models predicted these overpressures would be directed at the coastal area south of SLC-4 and would reach up to 2.0 psf at SLC-4 and up to 3.1 psf at the NCI. Recent observations show that these early models underestimated the actual strength of these overpressures in the Near Field. The 45th Space Wing (SW) performed modeling based on National Aeronautics and Space Administration (NASA) Technical Paper 1122, but optimized by the 45th SW to match maximum overpressure from the CRS-9 mission. The 45th SW has stated that their model is less accurate the further away from landing point, but the CRS-9 mission confirmed the 45th SW model to be the best predictor for Near Field sonic boom levels, which was validated by the CRS-9 data and acknowledged by the Eastern Range. Based on the NASA Technical Paper 1122, SpaceX optimized the model to match data from CRS-9 to predict sonic boom levels over a broader range.

The USAF now predicts overpressures as high as 8.5 psf at SLC-4W, which would attenuate to levels below 2.0 psf at approximately 5.5 miles (mi.) (8.9 kilometers [km]) and below 1.0 psf at approximately 15.97 mi. (25.7 km) from the landing area (Figure 2-5). This estimate is based, in part, on actual observations of Falcon 9 boost-backs and landings at Cape Canaveral and on autonomous droneships in the Pacific Ocean. In addition, the USAF is estimating that the NCI may be impacted by a sonic boom of up to 3.1 psf during the return flight based on the higher of the two predictions between the model run by Wyle and Blue Ridge Research Consultation (James et al., 2017) (Figure 2-6). Note that modelling results predict a 3.1 psf sonic boom would impact offshore of the NCI. Since atmospheric conditions vary throughout the year, the actual location of this overpressure may shift. As a result, the USAF

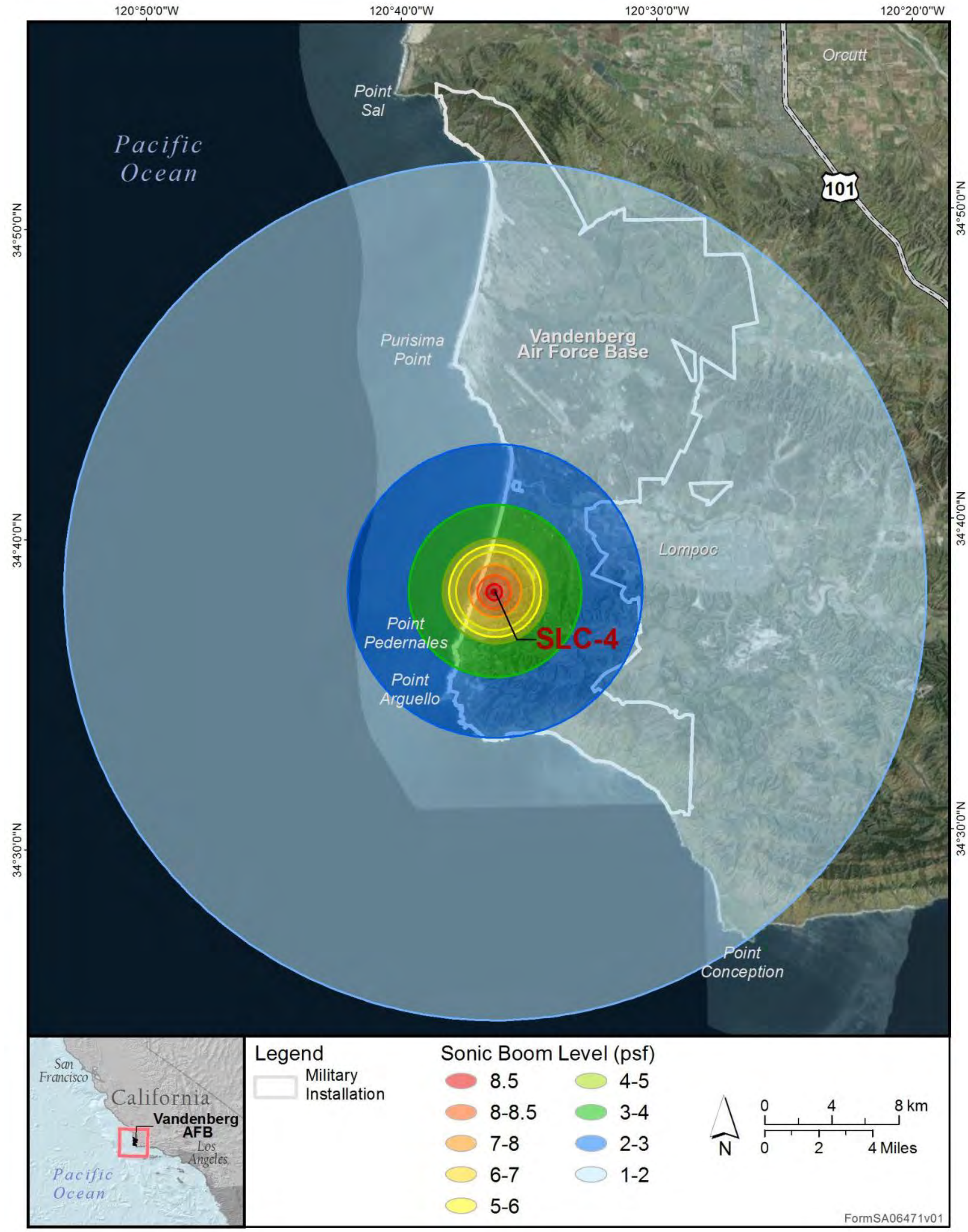

Figure 2-5. Estimated Sonic Boom of Falcon 9 Landing First Stage at SLC-4W

Figure 2-6. Estimated Sonic Boom of Falcon 9 Landing First Stage at the NCI

Sources: Wyle; James, Salton, & Downing, 2017 is conservatively assuming that a sonic boom would overlap the NCI, using the greater of the two model results.

Depending on the distance that the observer is from the landing pad, the sonic boom may be heard before or within a few seconds following the landing of the Falcon 9 first stage. Table 2-1 presents comparative noise levels for sonic booms against real-world examples. For comparative purposes of in-air decibels (dB) (peak, unweighted) and psf levels, the following conversion formula is used: $psf = [10^{(dB)}/20] * 0.0002 / 47.88$.

Table 2-1: Comparative Noise Levels

<table>
<tr><th>PSF</th><th>dB (unweighted peak)</th><th>Equivalent Noise Source</th><th>Description</th></tr>
<tr><td>1</td><td>127.6</td><td>Balloon Pop</td><td>1 meter from receiver</td></tr>
<tr><td>2</td><td>133.6</td><td>Rifle, .22 mm (rimfire)</td><td>Level at shooter’s ear</td></tr>
<tr><td>3</td><td>137.1</td><td rowspan="2">Rifle, .22 mm</td><td rowspan="2">Level at shooter’s ear</td></tr>
<tr><td>4</td><td>139.6</td></tr>
<tr><td>5</td><td>141.6</td><td>Rifle, .22 mm (high velocity)</td><td>Level at shooter’s ear</td></tr>
<tr><td>6</td><td>143.2</td><td rowspan="3">Shotgun (12 gauge)</td><td rowspan="3">Level at shooter’s ear</td></tr>
<tr><td>7</td><td>144.5</td></tr>
<tr><td>8</td><td>145.6</td></tr>
<tr><td>13</td><td>150</td><td>Jet engine take-off</td><td>Level at 25 meters</td></tr>
</table>

Unweighted dB measurements take no account of how sound power is distributed with respect to frequency. Because the sensitivity of human hearing to sound varies with frequency, an additional scale called A-weighted decibels (dBA) has been devised that yields measurement values that are more intuitively aligned with human perception of sound loudness. dBA measurements assign different weights to the sound in different frequency bands, with the highest weighting being in bands where humans are most sensitive and lower weightings in lower- and higher-frequency bands where human sensitivity diminishes. In general, you cannot convert between dB (unweighted peak) and dBA measurements unless you know how the sound power is distributed with respect to frequency. For example, a sound might have a very high dB but a very low dBA if most of the sound power is below the frequency range that humans hear well. Unless you have the original frequency information, you cannot convert from dB to dBA or dBA to dB. Therefore, converting psf of a sonic boom to dBA without the frequency range is not possible.

Engine noise would also be produced during Falcon 9 launch and landings (Figure 2-7 and Figure 2-8). Previous engine noise footprints were computed using a single engine thrust landing. SpaceX proposes to use a three-engine thrust landing for some boost-back events. According to Bradley (2016), a three-engine thrust landing would generate engine noises of up to 110 A-weighted decibels (dBA). The engine noise would be primarily within the vicinity of SLC-4 and would attenuate below 80 dBA at approximately 8 mi. (12.9 km) from SLC-4 (Bradley, 2016; Figure 2-8).

Once the first stage has landed and been secured, any remaining LOX and RP-1 would be properly off-loaded and disposed or re-used. LZ-4, located at SLC-4W, is the designated landing location for all boost-back actions at SLC-4W. LZ-4 was designed to contain all stormwater that comes in contact with it and route the water to an existing 100,000-gallon retention basis. This is achieved through a 1 percent slope that sends water to the northwest end of the pad. From here, there is a collection point that routes all water to a 100,000-gallon retention basin. During landing operations, remotely controlled water cannons will be used to provide streams of water to help statically discharge the rocket in addition to being able to fight any fires that occurred on the pad. Normal water volumes for

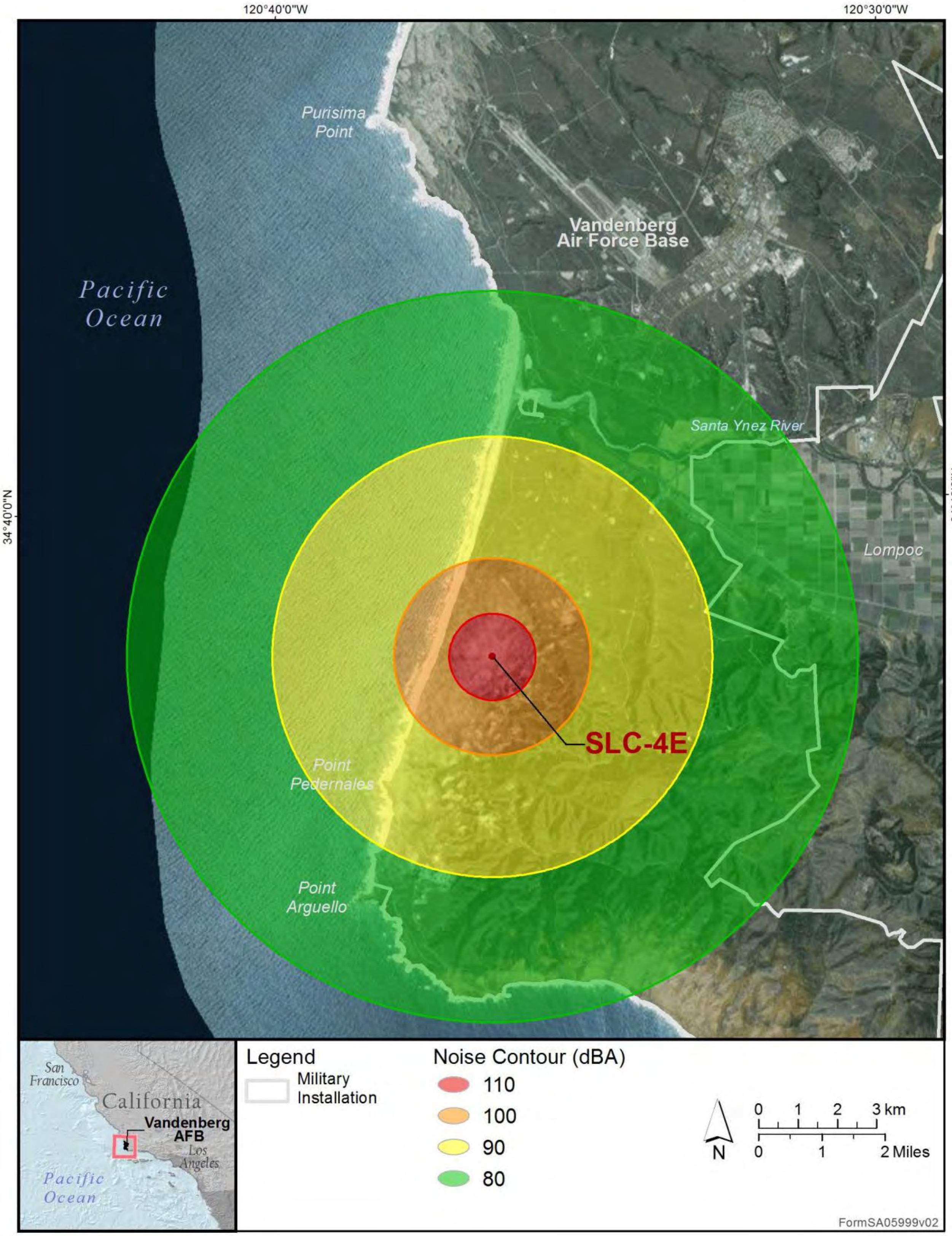

Figure 2-7. Estimated Launch Noise of Falcon 9 First Stage at SLC-4

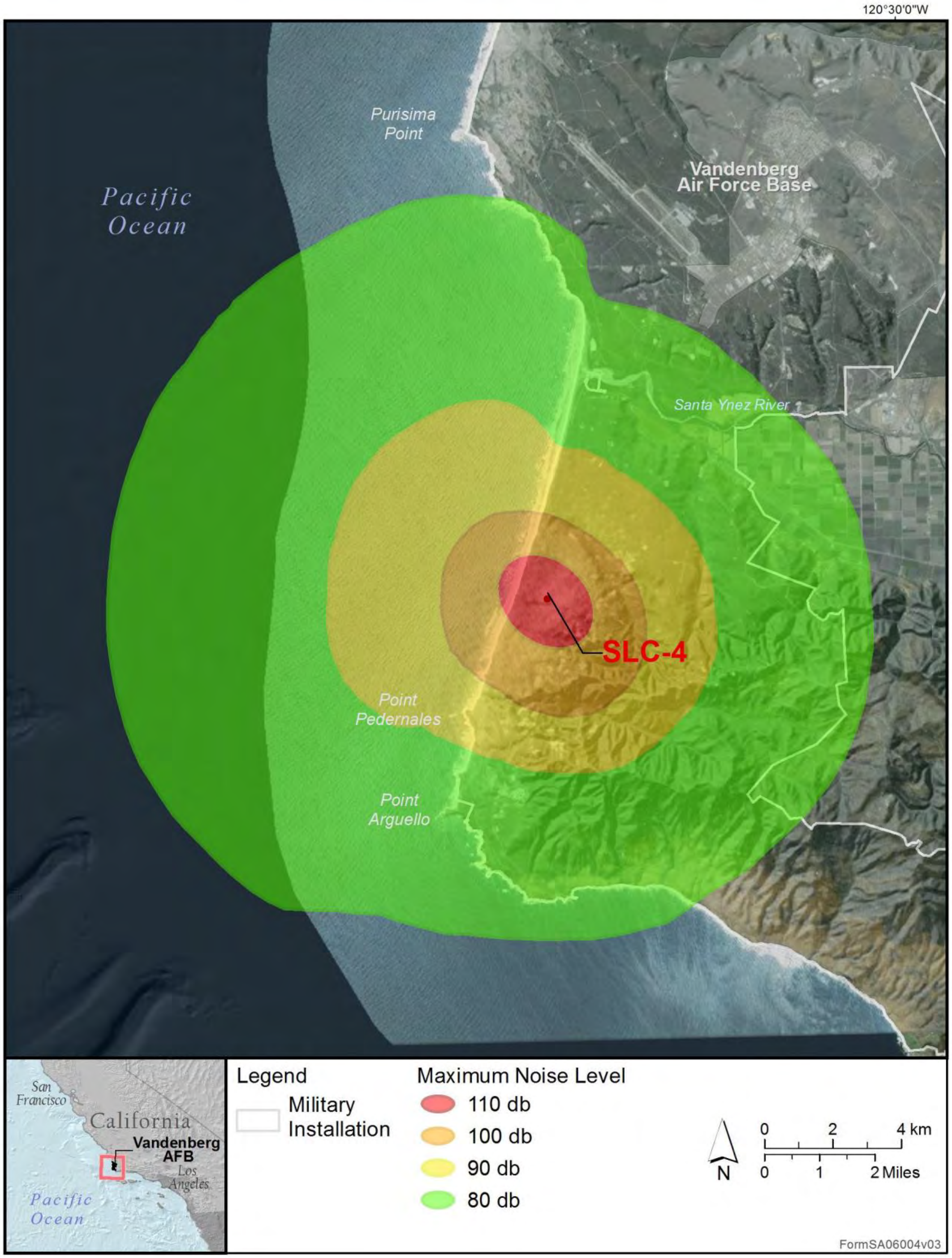

Figure 2-8. Estimated Landing Noise of Falcon 9 First Stage at SLC-4W

Source: Bradley, 2016

operations average around 40,000 gallons. During storm events, the secondary containment structure was sized to handle water volumes from a 100-year storm event. Water collected in the retention pond will be pumped to an existing spray field for disposal. Nominal volumes of RP-1 and LOX that will be offloaded post landing are 150 gallons and 300 gallons respectively. If spilled, LOX evaporates almost immediately after contact with ambient conditions. RP-1 would runoff into the retention basin. Any RP-1 visibly floating on the surface of the water in the retention basin would be collected using floating absorbent pads before discharge to the spray field. Therefore, in the event of a spill, no LOX or RP-1 would be released outside of SLC-4.

2.2 Avoidance, Minimization, and Monitoring Measures

The minimization and monitoring measures listed below would be implemented to avoid, minimize, or characterize the effects of the Falcon 9 Program on the El Segundo blue butterfly, California condor, California red-legged frog, California least tern, Western snowy plover, and Southern sea otter. There are no minimization or monitoring measures proposed for the marbled murrelet. There is also no feasible methods to minimize the intensity of the sonic boom or engine noise.

2.2.1 El Segundo Blue Butterfly

- The USAF would continue to monitor for the presence of ESBB at SLC-4, Spring Canyon, and the surrounding area through annual flight season surveys of suitable habitat.
- Habitat enhancement would be performed within suitable habitat on South VAFB by removing invasive plants and planting of seacliff buckwheat at a 2:1 ratio (area of habitat enhanced through invasive plant removal to area of potential ESBB habitat impacted).

2.2.2 California Condor

- Movements of California condor would be monitored in the vicinity of VAFB, if present, via satellite telemetry during launch and landing events to determine whether launch and boost-back had an effect on movement patterns within the Action Area. Determination of presence will be coordinated with Ventana Wildlife Society and USFWS personnel prior to launch.

2.2.3 California Red-legged Frog

- A qualified biologist would conduct pre-activity surveys for California red-legged frog in Spring Canyon adjacent to SLC-4 and would conduct post-activity surveys to document any injured or killed individuals.
    - If present within the area to be impacted by water and water vapor, adult California red-legged frogs would be captured when possible and released at the nearest suitable habitat within Spring Canyon, outside of the impact zone.
    - If not present in Spring Canyon, surveys would be conducted at the nearest known locality as determined from the most recent survey data in an area that is reasonably accessible. California red-legged frogs at this monitoring location would not be relocated, but would be monitored for any evidence of abnormal behavior, injury, or mortality that may be a result of launch and landing activities.
- One day prior to vegetation removal, a qualified biologist would conduct surveys for California red-legged frog within the area to be mowed. Any California red-legged frogs present would be captured if possible and released at the nearest suitable habitat within

Spring Canyon outside of the area to be mowed, as determined by a USFWS-approved biologist. Because ground conditions change depending on rainfall and season, this location cannot be identified in advance. The monitor would also be present during mowing to capture and relocate California red-legged frogs that are encountered during the mowing activities to the extent that safety precautions allow. This monitor would also search for injured or dead California red-legged frogs after mowing to document take.

- During construction of the civil water diversion structure, the following measures will be implemented:
    - All work will occur during daylight hours during periods where there is no rainfall.
    - A USFWS-approved biologist will monitor grading of the gunite application site.
    - Any open holes or trenches will be covered with plywood or metal sheets if left over night to minimize the risk of entrapment of California red-legged frogs.
    - A USFWS-approved biologist will survey the site, including any open holes or trenches, each day prior to initiation of work.
    - Any California red-legged frogs encountered during construction of the civil water diversion structure will be captured and relocated out of harm's way to the nearest suitable habitat.
- VAFB would continue to conduct baseline studies and population monitoring of California red-legged frog across Base, assess habitat, study the incidence of chytrid fungus, and assess other means of enhancing habitat across VAFB.

2.2.4 California Least Tern

- Monitoring of breeding California least terns at the Santa Ynez River estuary would be conducted, for boost-back and landings at SLC-4W that occur when California least terns are present (typically 15 April to 15 August), to characterize any potential impacts from landing noise and sonic boom.
    - A USFWS-approved biologist would conduct daily counts of California least terns at the Santa Ynez River estuary (when terns are present) beginning three days before the boost-back and landing event through three days after. This data would be used to determine if the Proposed Action had an effect on habitat use patterns within the impact area or caused any mortality, injury, or abnormal behavior.
    - Motion triggered video cameras would also be placed at up to 10 percent of active nests to monitor potential impacts to the nest as a result of the launch and landing.
- If practicable and not within a safety closure zone, California least terns at the Santa Ynez River, if present, would be visually or video monitored during boost-back landing for daytime launches. Monitoring would be conducted by a USFWS-approved biologist.
- Acoustic recording equipment would be deployed at or near the monitoring location to document and quantify noise levels.
- VAFB will continue to perform proactive annual management and monitoring of California least terns on Base, including population monitoring, nest monitoring, maintenance of a predator deterrent electric fence at the Purisima colony, and predator management.

2.2.5 Western Snowy Plover

- Between 1 March and 30 September, monitoring of nesting western snowy plovers would be conducted within the predicted impact area on VAFB during boost-back and landing events to characterize potential impacts on western snowy plover reproductive success.
- Up to 10 percent of active western snowy plover nests would be monitored with motion triggered video cameras for potential impacts to the nest as a result of the launch and landing.
- Acoustic recording equipment would be deployed at or near the monitoring location to document and quantify noise levels.
- VAFB will continue to perform proactive annual management and monitoring of Western snowy plover on Base, including habitat enhancement to expand potential breeding habitat, population monitoring, nest monitoring, and predator management.

2.2.6 Southern Sea Otter

- A USFWS-approved biologist would monitor Southern sea otters for boost back and landing events whenever a sonic boom of 2 psf or greater is predicted to be generated by the boost-back that would impact Southern sea otter habitat. The monitoring location would be selected based on where pressure waves greater than 2 psf are predicted to impact and the relation of these locations to occupied sea otter habitat, which is commonly Sudden Flats on South VAFB.
- A USFWS-approved biologist would conduct daily counts of sea otters at the selected monitoring location beginning three days before and continuing three days after the boost-back and landing. The monitor would note any mortality, injury, or abnormal behavior observed during these counts. Weather permitting, the counts would be conducted between 09:00 AM and 12:00 PM when otters are most likely to be rafting (Estes, Underwood, & Karman, 1986). This would maintain daily consistency in detectability. Monitors would use both binoculars (10X) and a high-resolution 50–80X telescope to conduct counts.
- Acoustic recording equipment would be deployed at or near the monitoring location to document and quantify noise levels.

2.2.7 General Environmental Protection Measures

The USAF and SpaceX are already implementing the following general environmental protection measures at SLC-4. These measures avoid and minimize the risk of impacts to federally listed species in the event of accidental spills.

- A site-specific Stormwater Pollution Prevention Plan has been prepared and implemented for SLC-4. Stormwater Best Management Practices are currently implemented following the latest California Stormwater Quality Association's Stormwater Best Management Practices Handbook.
- As discussed above, LZ-4 was designed to contain all stormwater that comes in contact with it and route it to a 100,000-gallon retention basis. If there is a fuel spill, LOX would evaporate and RP-1 would end up in in the retention basin. Any RP-1 visibly seen floating on the surface of water in the retention basin would be collected using floating absorbent pads before discharge to the spray field.

- Emergency response procedures for hazardous materials spills are established in VAFB's Hazardous Materials Emergency Response Plan (U.S. Air Force, 2010). These procedures would be fully implemented in the event of a hazardous materials spill.

3 Methods and Action Area

The USFWS's regulations define the "Action Area" as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 Code of Federal Regulations [C.F.R.] § 402.02). Impacts to listed species were considered for all areas potentially impacted by the release of water and water vapor, the installation of the civil water diversion structure, and the visual disturbance, launch noise, landing noise, and sonic boom associated with launch and landing operations. The Action Areas for species were determined by considering species sensitivity and prior data and studies on effects of noise impacts. The primary stressors caused by the Proposed Action are noise impacts, which may startle and alert individuals, physical impacts caused the release of water and water vapor into Spring Canyon, physical impacts as a result of vegetation removal in Spring Canyon, and loss of habitat. Responses to noise vary largely upon individual circumstances and psychological factors unrelated to the intensity of the sound. It is, therefore, difficult to generalize the anticipated behavioral reactions to various noise levels across species. Available studies and data as well as personal observations by qualified biologists in the field were used as the basis for determining what levels were likely to produce a significant behavioral response or damage to hearing sensitivity. In most cases, however, no directly applicable studies exist. Therefore, reasonable conclusions were deduced from similar species as proxy to the extent possible and by examining evidence of impacts from other types of noise (e.g., aircraft noise, space vehicle launch noise).

Information Planning and Conservation (IPAC) reports were run in March 2017 for Santa Barbara County and for the Action Area. IPAC identified twenty listed species with the potential to occur within the Action Area (14 endangered and 6 threatened species). Of these twenty species, the El Segundo Blue Butterfly (ESBB), California least tern, Western snowy plover, Southern sea otter, California red-legged frog, California condor, and marbled murrelet may be affected by the Proposed Action. Prior special status species monitoring data, surveys, and California Natural Diversity Database records were also consulted to assess the potential occurrence, distribution, and habitat use of listed species within the Action Area. Additionally, a biologist permitted by USFWS for work with the California red-legged frog and ESBB conducted a site visit and survey of Spring Canyon on 9 July 2017 (J. LaBonte, ManTech SRS Technologies, Inc.). During the survey, seacliff buckwheat within the vegetation removal area in Spring Canyon were mapped and quantified. The Spring Canyon drainage was also reassessed for California red-legged frog habitat quality within the vegetation removal area and downstream. Spring Canyon had previously been assessed for California red-legged frog habitat quality in 2013 (ManTech SRS Technologies, Inc. 2014); however, 2013 was a poor rain year compared to the above average rain received in 2017 and therefore warranted re-evaluating the drainage.

4 Status of the Species

4.1 El Segundo Blue Butterfly [Federal Endangered Species]

4.1.1 Status

USFWS listed the ESBB endangered on 1 June 1976 (41 FR 22044). ESBB were formerly thought to be restricted to the El Segundo dunes in Los Angeles County; however, invertebrate surveys conducted in 2004 and 2005 at VAFB documented butterflies morphologically, temporally, and behaviorally consistent with ESBB (Pratt, 2006). USFWS subsequently determined that these butterflies were ESBB.

4.1.2 Life History

A member of the Lycaenid family, this butterfly has blue upperwings and boldly spotted lower wings, checkered wing margins and a bold orange aurora. It ranges in size from 17 to 21 mm (Opler, 1999).

The taxonomy of the genus *Euphilotes* is complex, with species converging on the same hosts, and occurring in similar climatic conditions often exhibiting convergent morphology to the degree that they appear superficially to be more similar to one another than to more closely related species and subspecies occupying different niches (Mattoni, 1992; Pratt, 2006). Coastal populations of *E. bernardino,* another member of the *E. battoides* complex, and *E. battoides*, demonstrate convergence of phenotypes when occupying similar habitats (Mattoni, 1992) as have populations of *E. enoptes* (Pratt, 2006). Pratt recommended molecular studies to clarify the taxonomic status of VAFB butterflies (Pratt, 2006); preliminary studies concluded in 2008 were largely inconclusive.

ESBB adults on VAFB may be on wing from mid-June through August and are closely associated with their host plant, seacliff buckwheat (*Eriogonum parvifolium*). Eggs are deposited on buckwheat flowerheads where the larvae feed until maturation. Upon maturation, larvae burrow into the soil and pupate below the host plant. Most pupation occurs within the root and debris zone of the host plant (Mattoni, 1992). Pupae remain in diapause until the following June. The number that eclose on a given year is dependent on environmental conditions with the majority of the population remaining in diapause on any given year (Pratt, pers. com.).

4.1.3 Occurrence within the Action Area

Suitable habitat for ESBB, defined by the presence of its host plant seacliff buckwheat, is found throughout South VAFB and within and surrounding SLC-4. Flight season surveys for ESBB have been conducted within suitable habitat at SLC-4 and the surrounding area in 2007, 2009, 2011, 2014, 2016, and 2017 without documenting any ESBB. The nearest ESBB record to SLC-4 is one individual observed in 2008 approximately 1.7 mi. (2.7 km) north at the intersection of Bear Creek Road and Coast Road (ManTech SRS Technologies, Inc., 2009b; Figure 4-1). Despite intensive follow-up surveys during 2008 and annual surveys during almost every flight season since 2008, there have been no other ESBB documented at this locality. The next nearest ESBB record to SLC-4 was one individual observed in 2016 approximately 2.0 mi. (3.2 km) southeast on Avery Road (ManTech SRS Technologies, Inc., 2017; Figure 4-1).

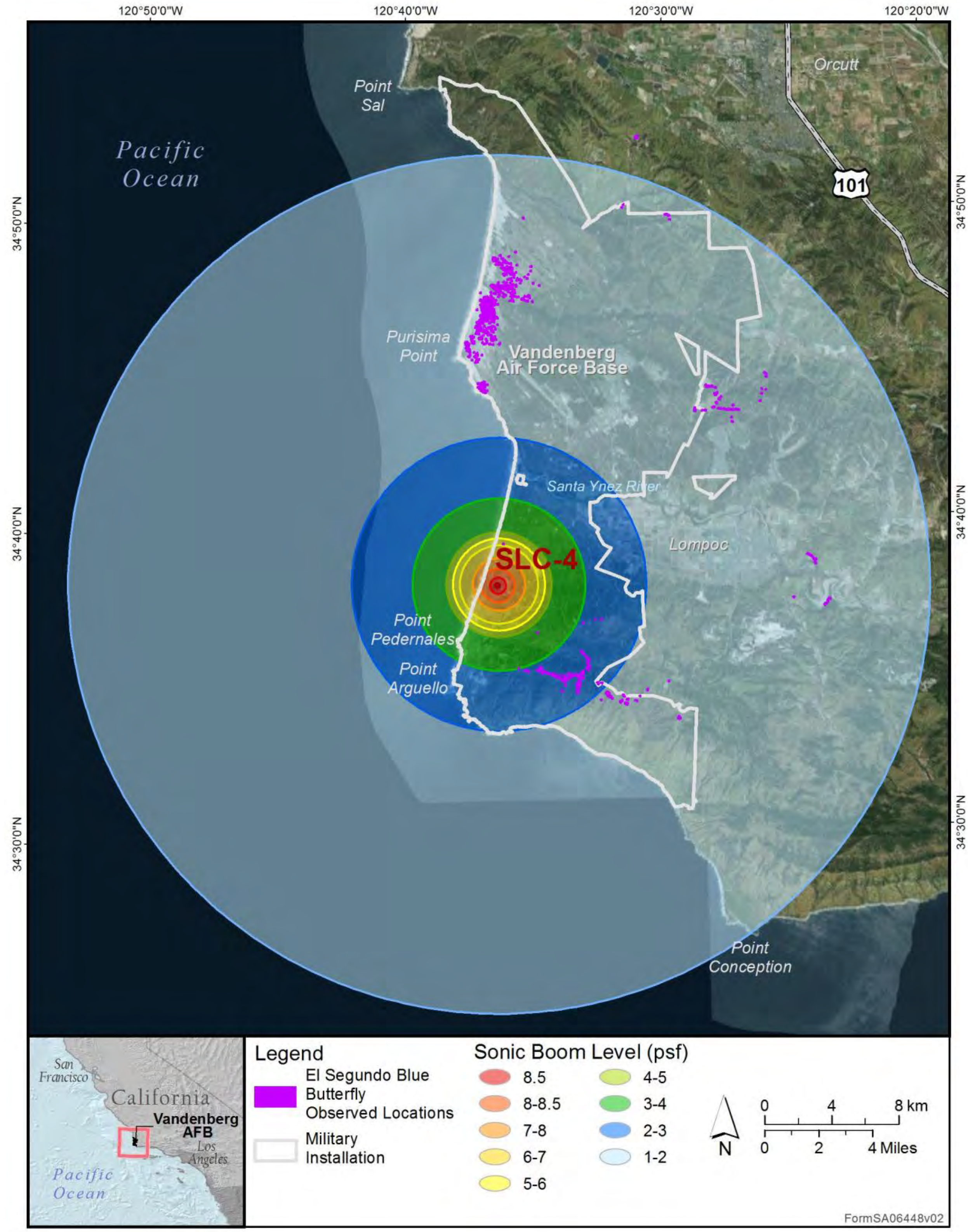

Figure 4-1. Current Known El Segundo Blue Butterfly Localities on VAFB

On 14 July 2017, a qualified biologist surveyed the area to be impacted by water release from the flame duct for ESBB and seacliff buckwheat and found 153 plants within 0.2069 ac. (0.0837 ha) of potential habitat that would be removed or damaged by water release and vegetation removal in Spring Canyon (

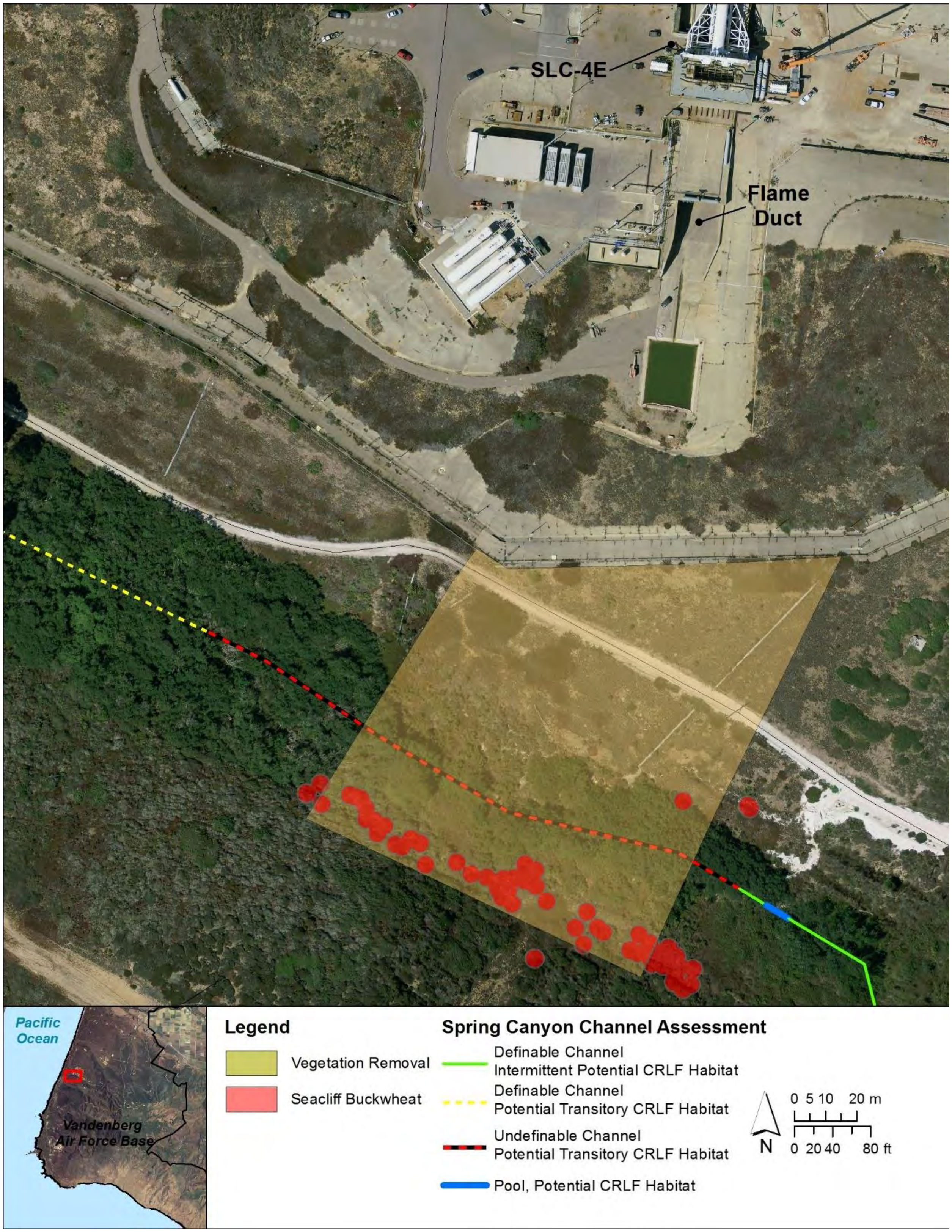

Figure **4-2**). No ESBB were detected during this survey.

4.1.4 Critical Habitat

The USFWS designated critical habitat for the ESBB on 8 February 1977 (42 FR 7292). However, ESBBs were not known to occur in Central California at that time. Therefore, USFWS did not designate critical habitat in this region and the proposed project is not within critical habitat. In addition, VAFB would likely be excluded from this designation under either section 4(a)(3) or section 4(b)(2) of the ESA.

4.2 California Condor [Federal Endangered Species]

4.2.1 Status

The USFWS listed the California condor as endangered on 11 March 1967 (32 FR 4001) and completed a Recovery Plan for the species on 25 April 1996 (U.S. Fish and Wildlife Service, 1996). In 1982, there were only 23 California condors in existence. To prevent the condor from going extinct, all remaining condors were placed into a captive breeding program in 1987. The USFWS and its partners began releasing condors back into the wild in 1992. The nearest release site to the Action Area is Bitter Creek National Wildlife Refuge (U.S. Fish and Wildlife Service, 2017b). Other release points include the Ventana Wilderness and Pinnacles National Park (Figure 4-3). Almost all condors released into Santa Barbara County have either died or were brought back into captivity, with the last nesting attempt occurring in 2001 (Lehman, 2016).

4.2.2 Life History

Condors nest in rock formations (e.g., ledges and crevices) and less frequently in giant sequoia trees (*Sequoiadendron giganteum*). They normally lay a single egg between late January and early April. Both parents incubate the egg and share responsibilities for feeding the nestlings after hatching. Condors require large remote areas and can range up to 150 mi. (241 km) a day in search of food. Chicks usually take their first flight around 6 to 7 months from hatching. The cause of the California condor's decline is inconclusive, but experts believe that lead poisoning, and hunting greatly contributed to their decline (U.S. Fish and Wildlife Service, 1996).

4.2.3 Diet

California condors are opportunistic scavengers and primarily feed on dead carcasses (U.S. Fish and Wildlife Service, 1996).

4.2.4 Occurrence within the Action Area

The California condor's current range is not within the Action Area. However, in March 2017, the USAF learned that telemetry data from USFWS showed there was a California condor ranging within VAFB. This condor is SB 760 (“VooDoo”), an immature, non-reproductive female (USFWS, personal communication, 27 March 2017). SB 760 is an unpaired, female California condor that hatched in captivity on 22 May 2014. She was released at the Ventana Wilderness on 9 November 2016 (Ventana Wildlife Society, 2017). This condor is reported to have departed the VAFB area on or about 22 April 2017, however she may return in the future, or other condors may also “explore” the VAFB area.

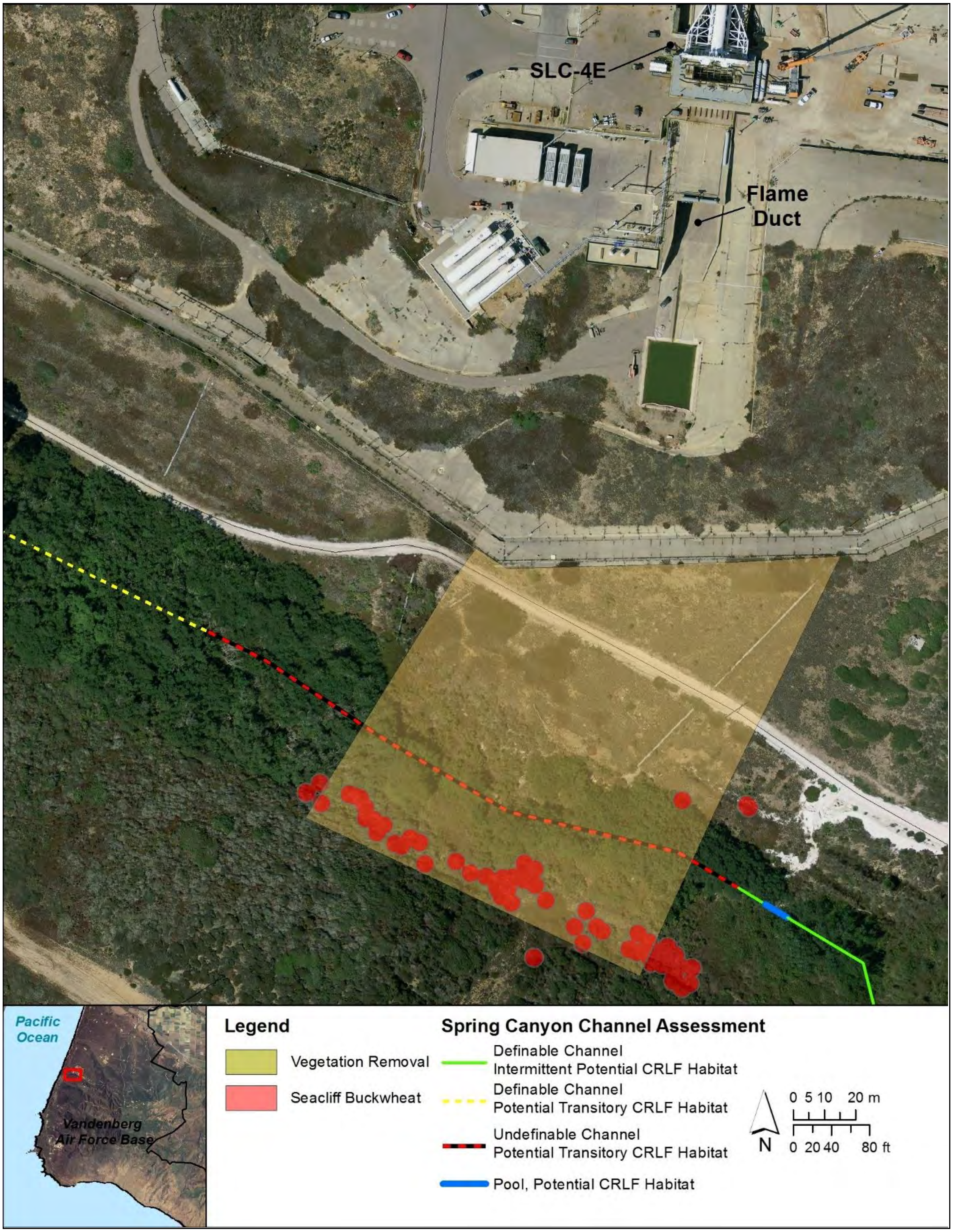

Figure 4-2. Potential ESBB and California Red-Legged Frog Habitat at Vegetation Removal Area in Spring Canyon

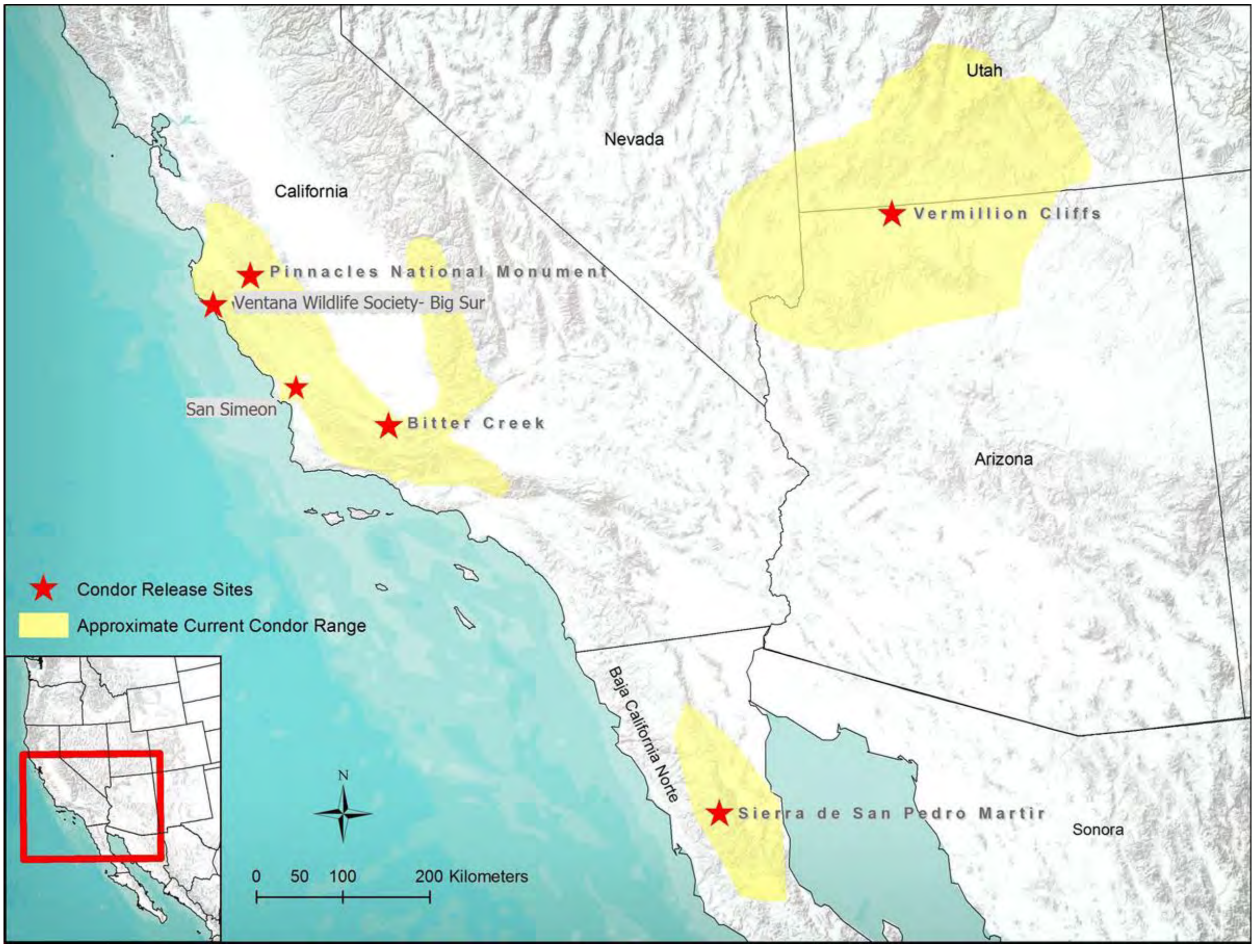

Figure 4-3. California Condor Release Sites and Approximate Range

Source: U.S. Fish and Wildlife Service, 2016

4.2.5 Critical Habitat

The USFWS designated critical habitat for the California condor in 1976 and revised it in 1977 (42 FR 47840). The nearest designated critical habitat for the California condor is near San Luis Obispo, approximately 26 mi. (41.84 km) from the Action Area. There is no critical habitat within or adjacent to the Action Area. (Note: Pinnacles National Monument was designated a National Park in 2013).

4.3 California Red-Legged Frog [Federal Threatened Species]

4.3.1 Status

The UFSWS listed the California red-legged frog as threatened on 23 May 1996 (61 Federal Register [FR] 25813-25833). In 2002, USFWS issued a Recovery Plan to stabilize and restore California red-legged frog populations (U.S. Fish and Wildlife Service, 2002c).

4.3.2 Life History

The California red-legged frog is a member of the family Ranidae and is California's largest native frog. To breed, California red-legged frogs require water bodies with sufficient hydroperiods and compatible salinity levels to accommodate larval and egg development. Breeding typically takes place from November through April with most egg deposition occurring in March. Eggs require 6–14 days, depending on water temperature, to develop into tadpoles (Jennings, 1988). Tadpoles typically require 11–20 weeks to develop into terrestrial frogs (U.S. Fish and Wildlife Service, 2002c), although some individuals may overwinter in the tadpole stage (Fellers et al., 2001).

Adult California red-legged frogs have been documented migrating to breeding ponds over distances of up to 2 mi. (3.22 km) during the wet season in Santa Cruz County where regular high flow events make much of the perennial stream habitat in the area unsuitable for breeding (Bulger, Scott, & Seymour, 2003). However, these migrations may be unique to mesic habitats and have not been documented in other more xeric habitats where suitable breeding habitat is not limited by frequent high-flow and scour events (Tatarian, 2008). Tatarian (2008) found that California red-legged frogs in Contra Costa County move much shorter distances away from aquatic habitat and tended to move to breeding sites through aquatic habitat, rather than through terrestrial habitat, but still spend considerable time in terrestrial riparian vegetation. Experts think that riparian vegetation provides good foraging habitat, as well as good dispersal corridors, due to canopy cover and presence of moisture (U.S. Fish and Wildlife Service, 2002c). Santa Barbara County tends to receive significantly less rainfall than Santa Cruz County. It also has fewer scouring flows and may be more similar to Contra Costa County in these regards. On VAFB, California red-legged frogs that were radio-tracked moved much shorter distances into upland habitat than those observed in Santa Cruz County (S. Christopher, pers. comm.).

Habitat loss and degradation from stream alteration, ground water depletion, loss of wetland, and expanding urbanization were, and continue to be, important factors in the decline of California red-legged frog from the early-to-mid-1900s to present (Jennings & Hayes, 1994). Diseases, competition and predation from non-native species, including the bullfrog (*Lithobates catesbeiana*), catfish (*Ictalurus* spp.), bass (*Micropterus* spp.), mosquitofish (*Gambusia affinis*), and exotic crayfish (e.g., *Procambarus clarkia*), have also had significant impacts on California red-legged frog populations (Jennings & Hayes, 1994). Several studies on VAFB have shown that *Batrachochytrium dendrobatidis* infection across VAFB is widespread, but there is variability in infection rate and load (ManTech SRS Technologies, Inc., 2009a, 2014, 2016a, 2016b).

4.3.3 Diet

Experts believe larvae graze on algae. Adults primarily eat invertebrates, but they may eat small vertebrates as well (U.S. Fish and Wildlife Service, 2002).

4.3.4 Occurrence within the Action Area

Regular California red-legged frog surveys have occurred across VAFB since the early 1990s (Christopher, 1996; Christopher, 2004; ManTech SRS Technologies, Inc., 2009a, 2014, 2016a, 2016b) and have shown that California red-legged frog can potentially occur in virtually all known wetlands and bodies of water on VAFB (Figure 4-4). The Santa Ynez River and Bear Creek, to the north of SLC-4, have California red-legged frog populations and suitable breeding habitat (Christopher, 1996, 2004; SRS Technologies, 2001; ManTech SRS Technologies, Inc., 2009a). Spring Canyon is an ephemeral drainage located approximately 200 ft. south of SLC-4. Spring Canyon has no definable channel through the majority of the drainage and minimal evidence of potential pooling or flow of surface water (ManTech SRS Technologies, Inc., 2014;

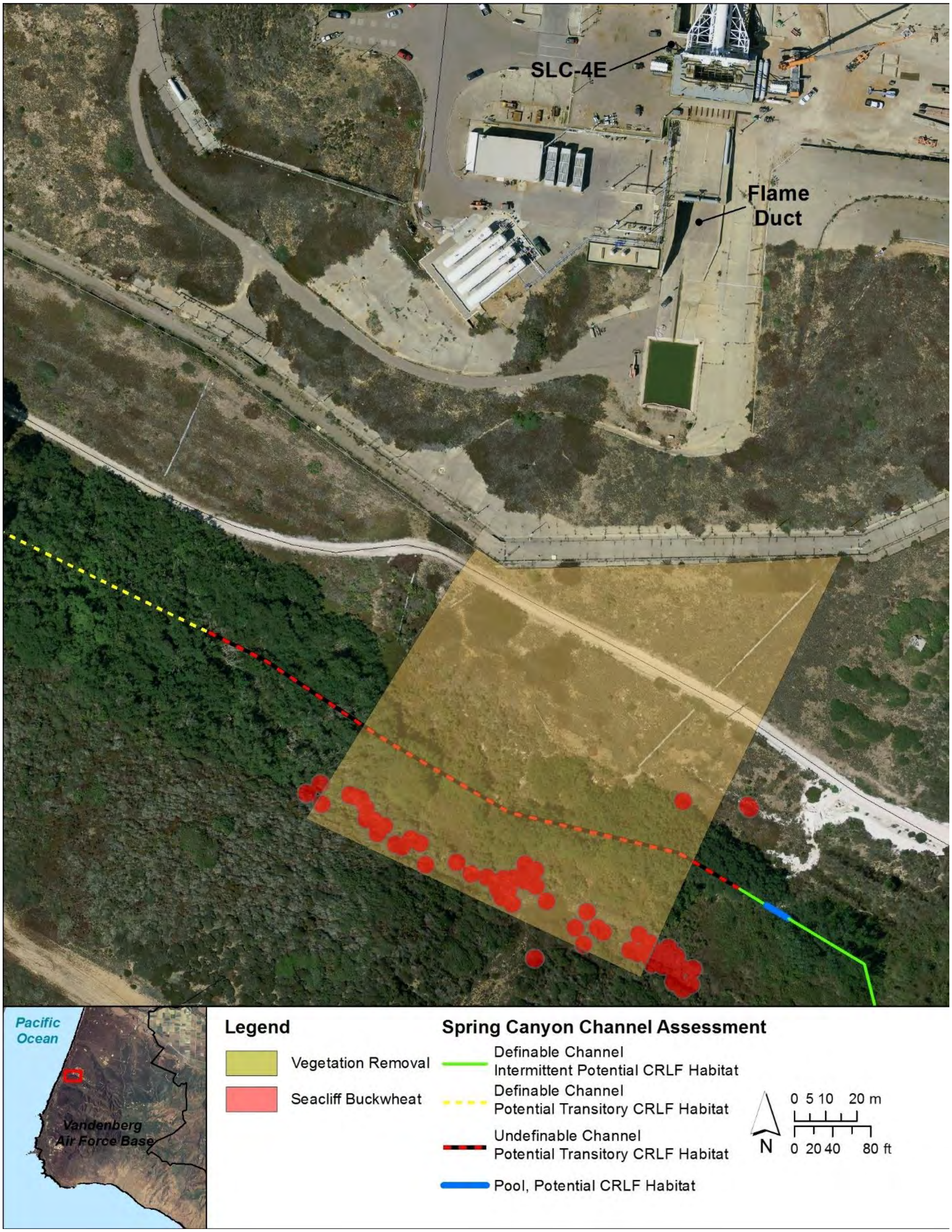

Figure **4-2**). Depending on annual rainfall levels, several small areas of Spring Canyon may constitute suitable habitat for California red-legged frog during wet periods when adequate surface water is present; however, in July 2017, after an above average rain year, a USFWS-permitted biologist reassessed

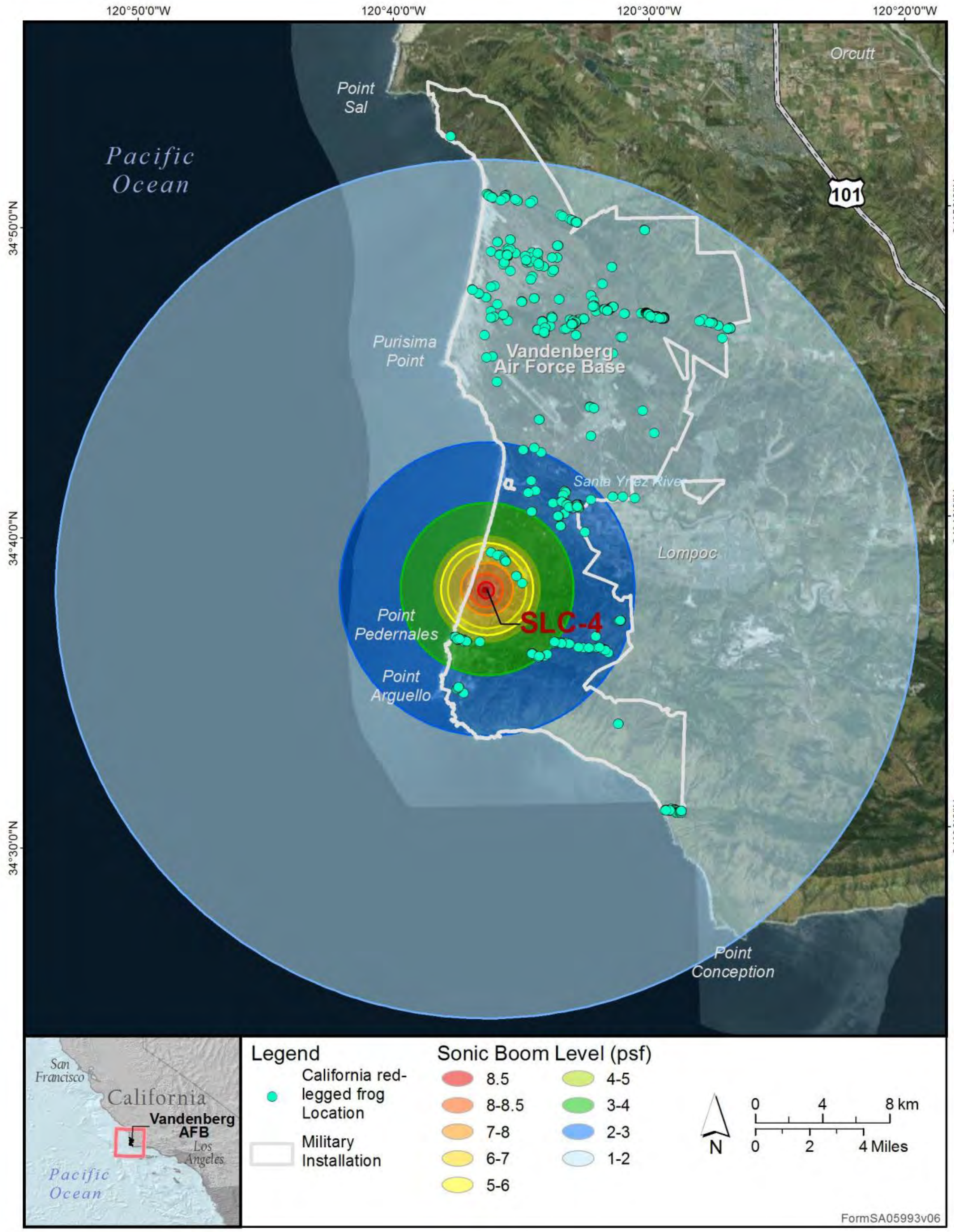

Figure 4-4. Known California Red-Legged Frog Localities on VAFB

the drainage in support of this BA and found no significant changes from the habitat assessment conducted in 2013, including no suitable breeding habitat within the vegetation removal area or downstream (J. LaBonte, ManTech SRS Technologies, Inc.). It is therefore unlikely that California red-legged frog occupy this area on a regular basis, other than transitory habitat.

Approximately 2 mi. (3.2 km) south of SLC-4, suitable California red-legged frog breeding habitat is found in Cañada Honda Creek, along with scattered California red-legged frog localities in minor wetlands and drainages, across south VAFB, including Bear Creek 1 mi. (1.6 km) northeast of SLC-4 (Christopher, 1996, 2004; SRS Technologies, 2001; and ManTech SRS Technologies, Inc., 2009a, 2014, 2016a, 2016b). Suitable upland dispersal habitat exists throughout VAFB between the various riparian zones and ponds on Base, but as noted above, dispersal into these upland habitats is not likely to be as extensive as has been observed in more mesic parts of the range of this species.

The action area for California red-legged frog are those areas that would receive sonic boom overpressures of 1 psf and greater.

4.3.5 Critical Habitat

The USFWS issued a final rule revising the California red-legged frog's critical habitat on 16 March 2010 (75 FR 12816–12959) (Figure 4-5). Physical and biological features (PBFs) are used to identify the habitat characteristics essential for conservation of listed species. The following are the PBFs for critical habitat for the California red-legged frog:

> (1) *Aquatic Breeding Habitat*: Standing bodies of fresh water (with salinities less than 4.5 parts per thousand), including natural and manmade (e.g., stock) ponds, slow-moving streams or pools within streams, and other ephemeral or permanent water bodies that typically become inundated during winter rains and hold water for a minimum of 20 weeks in all but the driest of years.
>
> (2) *Aquatic Non-Breeding Habitat*: Freshwater pond and stream habitats, as described above, that may not hold water long enough for the species to complete its aquatic life cycle but which provide for shelter, foraging, predator avoidance, and aquatic dispersal of juvenile and adult California red-legged frogs. Other wetland habitats considered to meet these criteria include, but are not limited to: plunge pools within intermittent creeks, seeps, quiet water refugia within streams during high water flows, and springs of sufficient flow to withstand short-term dry periods.
>
> (3) *Upland Habitat*: Upland areas adjacent to or surrounding breeding and non-breeding aquatic and riparian habitat up to a distance of 1 mi (1.6 km) in most cases (i.e., depending on surrounding landscape and dispersal barriers) including various vegetational types such as grassland, woodland, forest, wetland, or riparian areas that provide shelter, forage, and predator avoidance for the California red-legged frog. Upland features are also essential in that they are needed to maintain the hydrologic, geographic, topographic, ecological, and edaphic features that support and surround the aquatic, wetland, or riparian habitat. These upland features contribute to: (1) Filling of aquatic, wetland, or riparian habitats; (2) maintaining suitable periods of pool inundation for larval frogs and their food sources; and (3) providing nonbreeding,

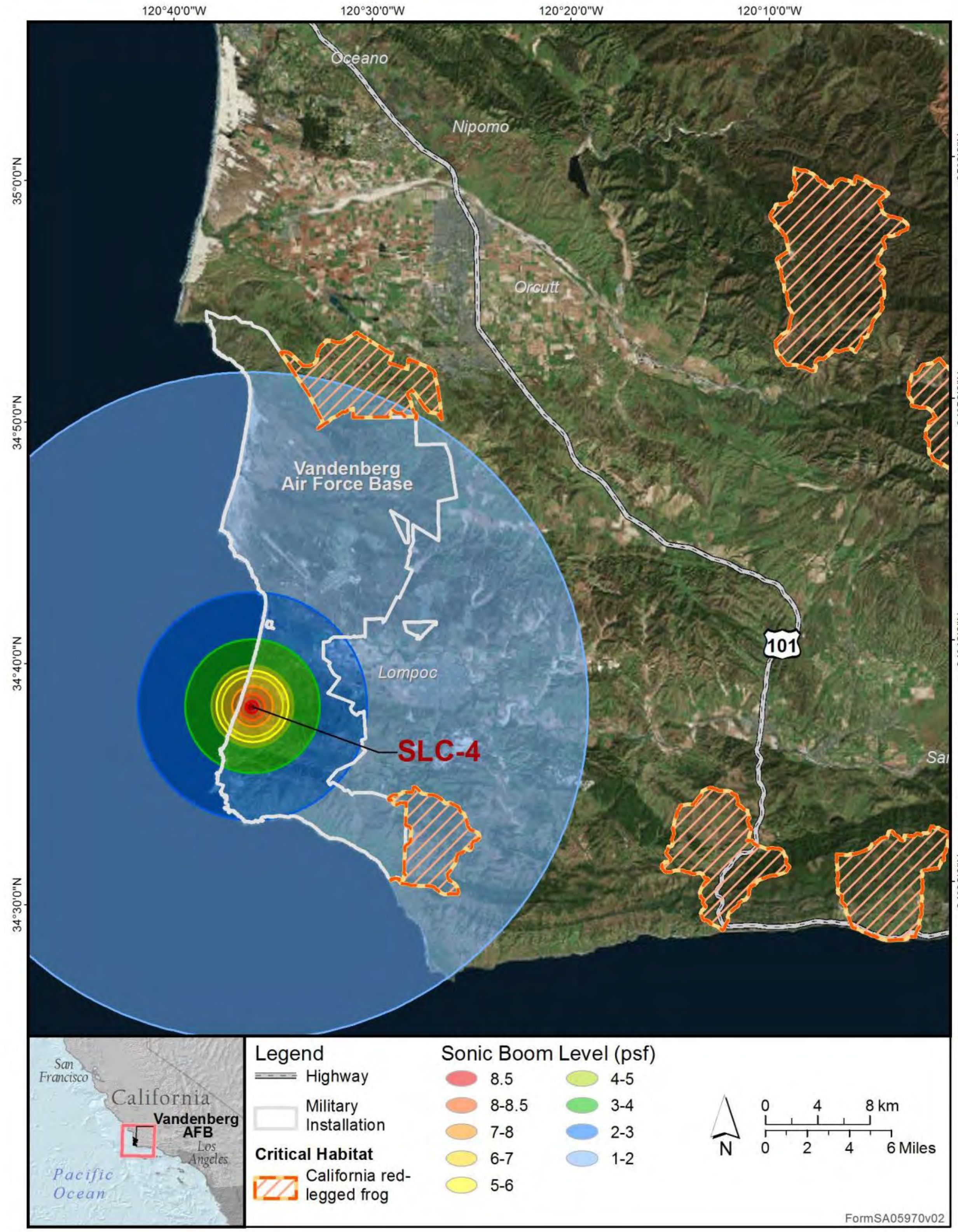

Figure 4-5. Designated Critical Habitat for the California Red-Legged Frog

feeding, and sheltering habitat for juvenile and adult frogs (e.g., shelter, shade, moisture, cooler temperatures, a prey base, foraging opportunities, and areas for predator avoidance). Upland habitat should include structural features such as boulders, rocks and organic debris (e.g., downed trees, logs), small mammal burrows, or moist leaf litter.

(4) *Dispersal Habitat*: Accessible upland or riparian habitat within and between occupied or previously occupied sites that are located within 1 mi (1.6 km) of each other, and that support movement between such sites. Dispersal habitat includes various natural habitats, and altered habitats such as agricultural fields, that do not contain barriers (e.g., heavily traveled roads without bridges or culverts) to dispersal. Dispersal habitat does not include moderate- to high-density urban or industrial developments with large expanses of asphalt or concrete, nor does it include large lakes or reservoirs over 50 ac. (20 ha) in size, or other areas that do not contain those features identified in PBF 1, 2, or 3 as essential to the conservation of the species (75 FR 12836).

The USFWS excluded VAFB from California red-legged frog critical habitat designation pursuant to Section 4(a)(1) of the ESA. However, USFWS designated critical habitat for the species, within the Action Area, along the northeastern and southeastern perimeters of VAFB (Figure 4-5). Unit STB-2 is along the northeaster perimeter. This unit is approximately 36,004 ac. (14,570 ha), 11,405.18 ac. (568.66 ha) of which are within the Action Area. The USFWS considered this unit to be occupied critical habitat (75 FR 12852). Unit STB-4 is along the southeastern perimeter. Unit STB-4 is approximately 8,693 ac. (3517.93 ha) and is completely within the Action Area. The USFWS also considers this unit to be occupied critical habitat (75 FR 12852).

4.4 California Least Tern [Federal Endangered Species]

4.4.1 Status

The USFWS listed the California least tern as federally endangered on 13 October 1970 (35 FR 16047–16048). The USFWS published a Recovery Plan for the species in 1985 (U.S. Fish and Wildlife Service, 1985).

4.4.2 Life History

The California least tern is the smallest of the North American terns and is found along the Pacific Coast of California, from San Francisco southward to Baja California. It has a distinctive black cap with stripes running across the eyes to the beak. The upperparts are gray and the underparts are white.

The California populations are localized and increasingly fragmented, due to coastal development resulting in habitat loss. California least terns are migratory and winter along the Pacific coast of Southern Mexico and the Gulf of California. They usually arrive at breeding grounds by the last week of April and return to wintering grounds in August. This species nests in colonies on relatively open beaches kept free of vegetation by natural scouring from tidal or wind action.

Historically, California least tern nested in colonies in several locations along the coastal strand of the north VAFB coastline. Since 1998, with the exception of two nests established south of San Antonio Creek in 2002, California least tern have nested only at the primary colony site, in relatively undisturbed bluff-top open dune habitat at Purisima Point; this area is not within the Action Area.

4.4.3 Diet

California least tern eat small fish, typically younger than 1 year old (U.S. Fish and Wildlife Service, 1985). For California least terns on VAFB, Robinette, Miller, & Howar (2016) found rockfish to be an abundant part of their diet.

4.4.4 Occurrence within the Action Area

The total population of California least tern increased from less than 700 pairs circa 1985 to greater than 7,000 pairs circa 2006. The population has since declined and remains steady at 4,000 to 5,000 pairs since 2006. The majority of the population is south of Point Conception (Robinette et al, 2016). VAFB supports a small population of California least terns that represents a small percentage of all known breeding colonies. Robinette et al. (2016) estimated that VAFB supports a breeding population of 25 pairs of California least tern. Although this population is small, VAFB is one of only three breeding colonies that nest between Monterey and Point Conception. The Purisima Point breeding colony is considered important. This colony is approximately 8 mi. (12.9 km) north of SLC-4W (Figure 4-6). Adult California least terns forage in the Santa Ynez River lagoon and estuary, approximately 3.7 mi. (6.0 km) north of SLC-4W (Figure 4-6). After young have fledged in late summer, California least terns also disperse to this location to forage in the lagoon and roost on adjacent sandbars before migrating south for the winter (Robinette & Howar, 2010).

The action area for California least terns are those areas that would receive sonic boom overpressures of greater than 1 psf or engine noise in excess of 80 dBA, whichever is greater. A sonic boom of 1 psf could briefly affect foraging behavior of this species (U.S. Fish and Wildlife Service, 2015c).

4.4.5 Critical Habitat

The USFWS has not designated critical habitat for the California least tern.

4.5 Marbled Murrelet [Federally Threatened Species]

4.5.1 Status

The USFWS listed the marbled murrelet as threatened on 1 October 1992 (57 FR 45328), and published a Recovery Plan for the species in 1997 (U.S. Fish and Wildlife Service, 1997). The USFWS completed a 5-year review of the species in 2009 (U.S. Fish and Wildlife Service, 2009).

4.5.2 Life History

The marbled murrelet is a small seabird that breeds along the Pacific coast, foraging on nearshore prey, and flying inland to breed. The species requires nearshore marine habitats with abundant prey (fish and invertebrates). Among alcids, the species is unique because it uses old-growth coniferous forests and mature trees for nesting (U.S. Fish and Wildlife Service, 1997). Marbled murrelets are wing-pursuit divers. Although little has been known about the marbled murrelet's movement and home range, more information is becoming available. The first marbled murrelet nest was not documented until 1974. Since then, the marbled murrelet's home range has been observed as 655 square kilometers (km^2) for non-nesters and 240 km^2 for nesters within California. In addition, at-sea resting areas have also been observed an average of 5.1 km from the mouths of

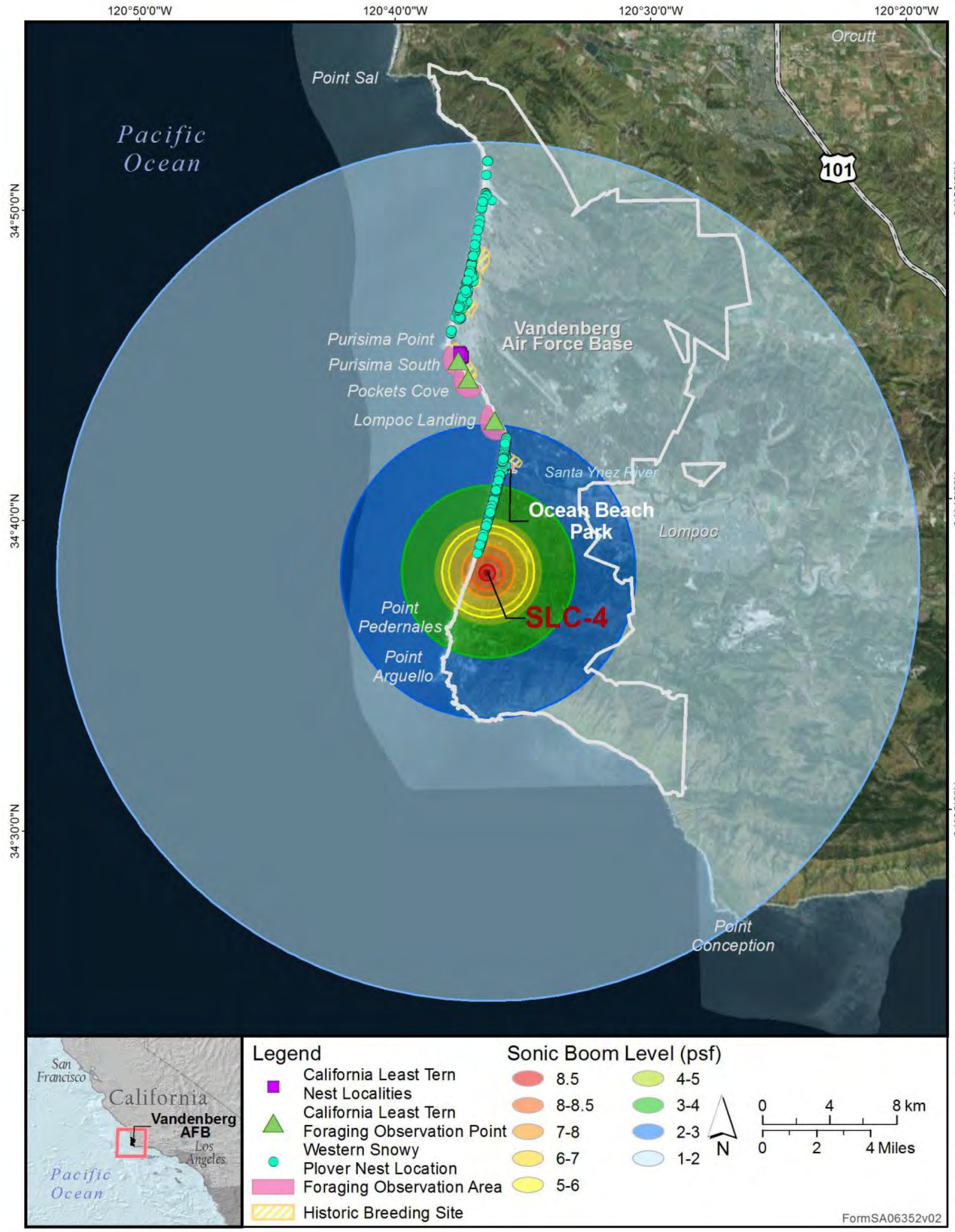

Figure 4-6. Current California Least Tern and Western Snowy Plover Nesting Localities and Tern Foraging Areas within the Action Area

drainages. The species spends nighttime hours resting in the ocean at these resting areas and commute to foraging areas during the day. Nests have been observed from sea level to 5,020 ft. (U.S. Fish and Wildlife Service, 2009).

4.5.3 Diet

Marbled murrelets eat small fish and invertebrates (U.S. Fish and Wildlife Service, 1997).

4.5.4 Occurrence within the Action Area

Marbled murrelets range from Alaska to California and may occur as far south as Baja California. The species is considered rare to very rare much of the year in Santa Barbara County. However, the species may be somewhat regular north of VAFB in the late summer and would be considered casual in the spring (Lehman, 2016). Individuals have been observed infrequently on and around north VAFB at Lion's Head and at nearby Point Sal and the Santa Maria River. Individuals have also been observed off Point Conception and Point Pedernales, on south VAFB (Lehman, 2016). As such, the species may occur in the nearshore waters off VAFB, within the Action Area, but it is not known to nest in the Action Area.

4.5.5 Critical Habitat

The USFWS designated critical habitat for the marbled murrelet on 24 May 1996 (61 FR 26257) and revised this designation on 4 August 2016 (81 FR 51348–51370). There is no designated critical habitat for this species within or adjacent to the Action Area and the nearest critical habitat is approximately 165 mi. (265.54 km).

4.6 Western Snowy Plover [Federal Threatened Species]

4.6.1 Status

The USFWS listed the Pacific coast population of the Western snowy plover as federally threatened in March of 1993 (58 FR 12864–12874).

4.6.2 Life History

The Western snowy plover is a small shorebird with pale tan back, white underparts, and dark patches on the sides of the neck reaching around to the top of the chest. The Pacific coast population of snowy plovers is limited to individuals that nest adjacent to tidal waters. The population's range extends from Southern Washington to Baja California, Mexico.

VAFB provides important breeding and wintering habitat for Western snowy plover, which includes all sandy beaches and adjacent coastal dunes from the rocky headlands at the north end of Minuteman Beach to the pocket beaches and dune areas adjacent to Purisima Point on north VAFB (approximately 7.7 mi. [12.4 km]). Also included are all sandy beaches and adjacent coastal dunes from the rocky headlands at the north end of Wall Beach south to the rock cliffs at the south end of Surf Beach on South VAFB (approximately 4.8 mi. [7.7 km]). VAFB has consistently supported one of the largest populations of breeding Western snowy plover along the west coast of the United States (Robinette et al., 2016).

4.6.3 Diet

Western snowy plover diet consists of aquatic and terrestrial insects (U.S. Fish and Wildlife Service, 2007).

4.6.4 Occurrence within the Action Area

Western snowy plovers nest and overwinter along the coast of VAFB (Figure 4-6). VAFB has performed annual monitoring of Western snowy plovers since 1993 (Robinette et al., 2016). In 2014, VAFB supported an estimated 11 percent of California's breeding population (U.S. Fish and Wildlife Service, 2014a). The breeding population of Western snowy plovers on VAFB has been highly variable but relatively stable since 2007. The smallest population was recorded in 1999 (78 adults) (Robinette et al., 2016). The nearest observation of a Western snowy plover nest is approximately 0.9 mi. (1.4 km) northwest of SLC-4 (Figure 4-6). The Western snowy plover is also considered a permanent resident of Santa Rosa Island and a summer resident of Santa Cruz Island. According to USFWS (2016a), only one individual has been observed at Santa Cruz Island since 2005. Although prior counts at San Miguel Island had yielded very few to no individuals 61 Western snowy plovers were observed in during 2016-2017 winter window survey (U.S. Fish and Wildlife Service, 2017a).

4.6.5 Critical Habitat

The USFWS designated critical habitat for this species in 1999 and revised this designation on 29 September 2005 (70 FR 56969–57119) and on 19 June 2012 (77 FR 36727). VAFB was exempted from critical habitat designation under Section 4(a)(3) of the ESA. Santa Rosa Island includes critical habitat for this species (Figure 4-7). This habitat was occupied at the time of listing and is currently occupied habitat. This unit includes areas of sandy beaches above and below the high tide line with surf-cast wrack that is generally barren but supports small invertebrates. The PBFs for Western snowy plover include the following:

> Sandy beaches, dune systems immediately inland of an active beach face, salt flats, mud flats, seasonally exposed gravel bars, artificial salt ponds and adjoining levees, and dredge spoil sites, with:
>
> (1) Areas that are below heavily vegetated areas or developed areas and above the daily high tides;
>
> (2) Shoreline habitat areas for feeding, with no or very sparse vegetation, that are between the annual low tide or low water flow and annual high tide or high water flow, subject to inundation but not constantly under water, that support small invertebrates, such as crabs, worms, flies, beetles, spiders, sand hoppers, clams and ostracods, that are essential food sources;
>
> (3) Surf- or water-deposited organic debris, such as seaweed (including kelp and eelgrass) or driftwood located on open substrates that supports and attracts small invertebrates described in PBF 2 for food, and provides cover or shelter from predators and weather, and assists in avoiding detection (crypsis) for nests, chicks, and incubating adults; and
>
> (4) Minimal disturbance from the presence of humans, pets, vehicles, or human-attracted predators, which provide relatively undisturbed areas for individual and population growth and for normal behavior.

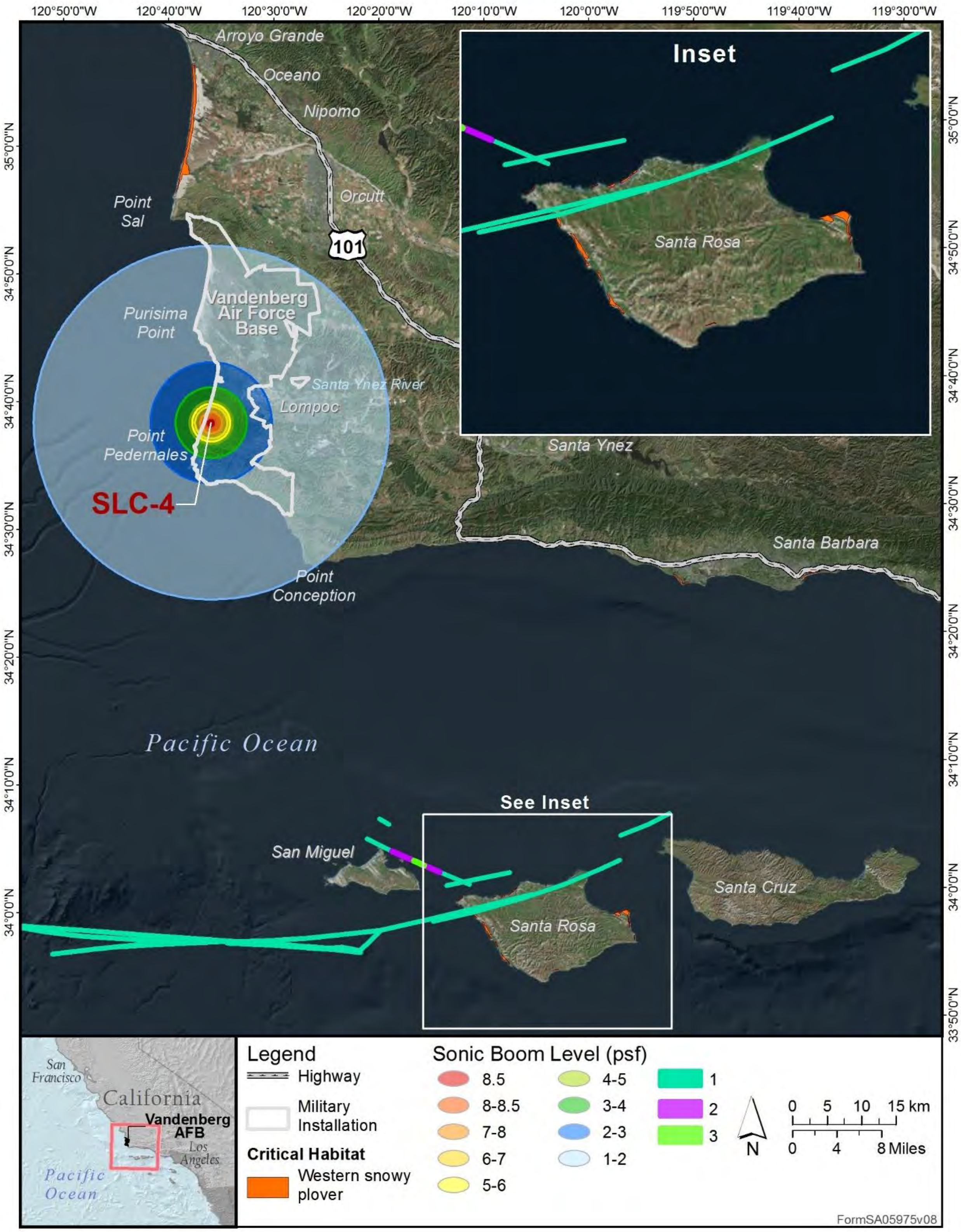

Figure 4-7. Designated Critical Habitat for the Western Snowy Plover

4.7 Southern Sea Otter [Federal Threatened Species]

4.7.1 Status

The USFWS listed the Southern sea otter as federally threatened on 14 January 1977 (42 FR 2965) and published a Recovery Plan in 2003 (U.S. Fish and Wildlife Service, 2003). The USWFS completed a 5-year review of the species in 2015 (U.S. Fish and Wildlife Service, 2015b).

4.7.2 Life History

The Southern sea otter is the smallest species of marine mammal in North America. It inhabits the nearshore marine environments of California from San Mateo County to Santa Barbara County with a small geographically isolated population around San Nicolas Island. On occasion, Southern sea otters have been observed beyond these limits and have been documented as far south as Baja, Mexico (U.S. Fish and Wildlife Service, 2015b).

This species breeds and gives birth year-round and pups are dependent for 120–280 days (average 166 days; (Riedman & Estes, 1990). Sea otters are opportunistic foragers known to eat mostly abalones, sea urchins, crabs, and clams. They play a key ecological role in kelp bed communities by controlling sea urchin grazing.

Sea otters inhabit the waters along VAFB. Annual U.S. Geological Survey (USGS) surveys have documented persistent populations in nearshore waters off Sudden Flats and Purisima Point (U.S. Geological Survey Western Ecological Resource Center, 2014). As many as 55 adult otters have been documented in the Sudden Flats area at one time (SRS Technologies, 2006b), and as many as 18 adult otters have been documented in the Purisima Point area at one time (SRS Technologies, 2002).

4.7.3 Diet

Although individuals have a high variation of diets, Southern sea otter eat numerous species of invertebrates. In Alaska, they are also known to eat fish (U.S. Fish and Wildlife Service, 2003).

4.7.4 Occurrence within the Action Area

Southern sea otters occur regularly off the coast of VAFB, with animals typically concentrated in the kelp beds offshore of Purisima Point on north VAFB, and offshore of Sudden Flats on south VAFB (Figure 4-8). Transitory otters occasionally traverse the coast between SLC-4 and Point Arguello. This area is, however, not regularly occupied and no otters have been detected at this location during the last three annual spring census counts from 2011 to 2016 (U.S. Geological Survey Western Ecological Resource Center, 2014, 2016).

4.7.5 Critical Habitat

Critical habitat for this species has not been designated.

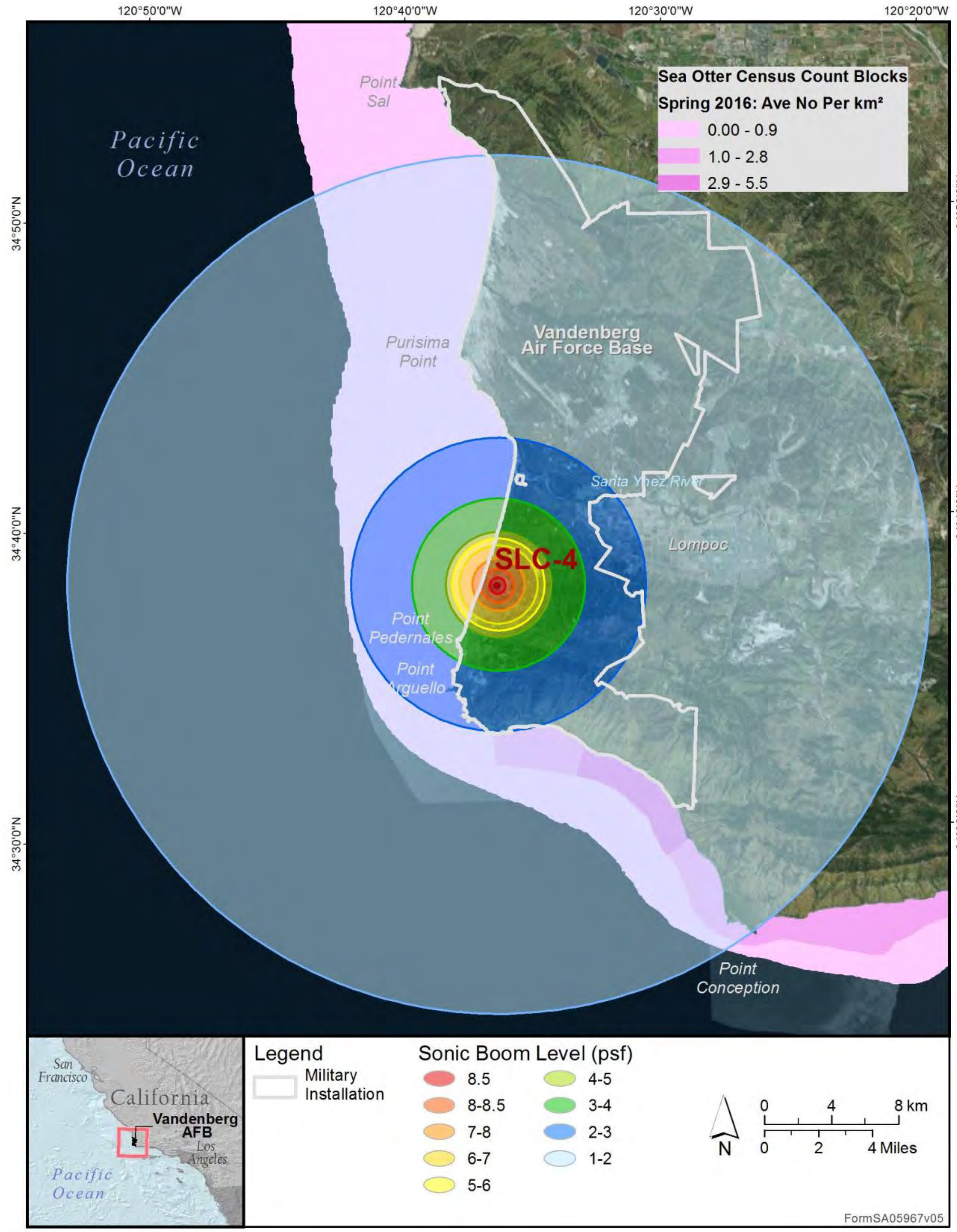

Figure 4-8. 2016 Southern Sea Otter Distribution within the Action Area

5 Analysis of Effects of the Proposed Action

5.1 Direct and Indirect Effects on Species

Effects of an action include direct and indirect effects. Direct effects are those effects that would be caused by or result from the proposed action and occur contemporaneously with the proposed action (U.S. Fish and Wildlife Service and National Marine Fisheries Service, 1998). USFWS regulations define indirect effects as "those that are caused by the proposed action and are later in time, but still are reasonably certain to occur" (50 C.F.R. § 402.02).

5.1.1 El Segundo Blue Butterfly

5.1.1.1 Noise and Vibration

Little is understood about butterfly sensor mechanisms. Most species have good visual and chemical senses but the ability to hear or sense sounds is not a normal trait for butterflies (Yack, Otero, Dawson, Surlykke, & Fullard, 2000). Hearing in butterflies has been described in the nocturnal superfamily Hedyloidea, likely as an adaptation to avoid predation by bats (Yack et al. 2006), and in the family Nymphalidae (Swihart, 1967; Yack et al., 2000; Lane, Lucas, & Yack, 2008; Lucas, Windmill, Robert, & Yack, 2009; Lucas, Mongrain, Windmill, Robert, & Yack, 2014). In Nymphalidae, many species possess a forewing structure, the Vogel's organ, which has been shown to function as an ear, similar to an insect tympanal ear (Lane et al., 2008). Adult Lycaenidae (including the ESBB) do not have a Vogel's organ nor are they known to have other structures that would function as ears and are presumed to be deaf (Rydell, Kaerma, Hedelin, & Skals, 2003; R. Arnold, pers. comm.). Lycaenid larvae and pupae are well known to produce vibrational signals, most likely directed to ant species that tend the pupae (Downey, 1966; DeVries, 1991, 1992; Heath & Claassens, 2003); however, have not been demonstrated to hear.

The sonic boom would cause a very slight vibration to terrain, structures (including vegetation), and individual ESBB. This vibration would be very brief (milliseconds) and not likely to disrupt behavior because it would be less than movement caused by ambient winds, which are regularly sustained at greater than 30 mi. per hour (48 km per hour) in this region of South VAFB. Additionally, given that ESBB are less than 1 square inch in surface area, the ESBB would not receive the full force of an overpressure but only a fraction (less than 1/144) of the psf level. For reference, an 8-psf overpressure is equivalent to 0.056 pounds per square inch (psi) or roughly one ounce. Additionally, there are no documented localities within the area expected to receive a 6-psf sonic boom or greater (Figure 4-1), despite ongoing surveys of suitable habitat within this area since 2007. The nearest known ESBB localities are expected to receive a sonic boom of less than 6 psf, equivalent to 0.042 psi or roughly 0.67 ounces of pressure. As a result, the potential acoustic impacts from noise and vibration during launch and landing of the Falcon 9 at SLC-4 are discountable and would have no effect on ESBB.

The USFWS and Los Angeles World Airports have previously determined that noise and vibration have no effect on the species (ESBB Recovery Plan – U.S. Fish and Wildlife Service, 1998; Los Angeles International Airport Biological Assessment – Saphos Environmental, Inc., 2003). Jet engine noise at the El Segundo sand dunes at Los Angeles International Airport is not known to affect ESBB (U.S. Fish and Wildlife Service, 1998; Saphos Environmental, Inc., 2003; R. Arnold, pers. comm.). The persistent population of ESBB at the Los Angeles International Airport sand dunes experience near constant noise impacts as high as an equivalent sound level (L_{eq}) of 93 dBA (Los Angeles City Controller, 2017) and an average sound level over a 24-hour period of 79 dBA

(Los Angeles World Airports, 2017). This population has not been observed to experience negative impacts from this noise and vibration over the past 30 years (R. Arnold, pers. comm.).

5.1.1.2 Vegetation Clearing and Water Release

Since the vegetation clearing activities would take place outside of bird nesting season (1 March through 30 September), these activities will also take place outside of the ESBB flight season; therefore, there would be no risk of direct impacts to adult ESBB from vegetation clearing activities. Direct impacts to ESBB larvae within the footprint of the area to be mowed include injury or mortality from inadvertent crushing by workers as they walk and operate mechanical equipment and during mowing of vegetation, including seacliff buckwheat. The release of water and water vapor during launches requiring water within the flame duct may cause direct injury or mortality to adult or larval ESBB if they are present within the impact area. The risk of impacts to ESBB are low because they have not been detected within SLC-4, the area to mowed, or nearby in the surrounding suitable habitat despite numerous past surveys. Therefore, the likelihood of occurrence within the area to be cleared is low. This risk will be reduced further by the removal of potential habitat (seacliff buckwheat) within the impact area (Figure 4-1).

Vegetation clearing would result in an estimated loss of 153 seacliff buckwheat within 0.2069 ac. (0.0837 ha) of potential habitat. Impacts to seacliff buckwheat habitat would be offset by habitat enhancement of suitable habitat on South VAFB by removing invasive plants and planting of buckwheat at a 2:1 ratio (area of habitat enhanced through invasive plant removal to area of potential ESBB habitat impacted). A USFWS-approved biologists would continue to survey for ESBB in the impact area annually during future flight seasons to monitor for the presence of the species.

5.1.1.3 Construction of Civil Water Diversion Structure

With the exception of the grading and application of gunite on the slope immediately south of the flame bucket (Figure 2-2), all construction will take place on existing paved surfaces. The slope is currently sparsely covered by iceplant and dead vegetation due to the heat created during ongoing launches. In addition, all vehicle and equipment access would occur on existing paved surfaces. As a result, there would be no potential habitat for the ESBB affected by the construction of the civil water diversion structure. Since the construction would occur prior outside of ESBB flight season, there would be no risk of injury to adult ESBB.

5.1.1.4 Conclusion

Therefore, the potential physical impacts from water release and vegetation clearing in Spring Canyon may affect and is likely to adversely affect the ESBB. These effects are unavoidable but would be minimized through the implementation of habitat enhancement and monitoring measures.

5.1.2 California Condor

The Action Area is outside the normal range of the species and the species is not known to breed within the Action Area. To date, there has been only one documented occurrence of this species foraging within the Action Area (Rhys M. Evans, pers. comm., 27 March 2017). Satellite tracking data revealed that one condor arrived at VAFB approximately 12 March and was on South VAFB in the upper Honda Canyon area for about two nights and three days. After leaving Base for about two days, it returned to VAFB to North Base and was in the area between Bishop Road and

Minuteman Beach on north VAFB for about 2.5 weeks. The condor roosted on VAFB for a total of about 15 nights.

The overall likelihood of a California condor occurring within the Action Area again during a launch or landing event is very low. However, given the exceptional rarity of the species, any substantial impact to an individual may be considered a population-level impact. Since the condor had not been considered in prior consultations for the Falcon 9 program, the potential impacts of launch noise, landing noise, visual disturbance, and sonic boom are analyzed in this BA.

Behavioral responses are the most commonly used endpoints when studying the effects of noise on wildlife. This is largely based on practical considerations and the difficulty in measuring animal fitness or physiological and ecological endpoints. Common behavioral responses include alert behavior, startle response, flying or running away, and increased vocalizations (National Park Service, 1994; Bowles, 1995; Larkin, Pater, & Tazik, 1996). In some instances, behavioral responses could interfere with breeding, raising young, foraging, habitat use, and physiological energy budgets, particularly when an animal continues to respond to repeated exposures. While difficult to measure in the field, all behavioral responses are accompanied by some form of physiological response, such as increased heart rate or a startle response. In many cases, individuals would return to homeostasis or a stable equilibrium almost immediately after exposure. The individual's overall metabolism and energy budgets would not be affected assuming it had time to recover before being exposed again. If the individual does not recover before being exposed again, physiological responses could be cumulative and lead to reduced fitness. However, it is also possible that an individual would have an avoidance reaction (i.e., move away from the noise source) to repeated exposure or habituate to the noise when repeatedly exposed.

Noise types and levels that increase stress in humans would have a similar impact on birds but studies show that birds are much more resilient than humans or other mammals to hearing loss or other damage (Dooling & Popper, 2016). Both the current field and laboratory data indicate that many birds appear to habituate to noise through repeated exposure without long-term discernible negative effects. Loud sonic booms (80-89 dBA Sound Exposure Level [SEL]) elicited a shorter duration of startle responses than to other disturbances, such as humans on foot, low-flying helicopters, or loud boats (Manci, Gladwin, Villella, & Cavendish, 1988). A literature review of studies of aircraft and noise impacts on birds, which included various species of songbirds, upland game birds, waterfowl, seabirds, and raptors, showed that reactions vary boom to boom but birds "occasionally run, fly, or crowd" in response to a sonic boom (Manci et al., 1988).

It has been difficult to analyze the effect human disturbance could have on California condors. Generally, California condors are less tolerant to human disturbances near nesting sites than at roosting sites. The species is described as being "keenly aware of intruders" and may be alarmed by loud noises from distances greater than 1.6 mi. (2.6 km). In addition, the greater the disturbance in either noise level or frequency, the less likely the condor would nest nearby. As such, USFWS typically requires isolating roosting and nesting sites from human intrusion (USFWS, 1996).

We do not know at this time if the unpaired California condor that was recently sighted on VAFB would return to forage within the area and become a regular occurrence. Other than telemetry data, there is very little information on what drew the bird into the area. Non-breeding birds tend to expand their home range farther than paired birds to encompass a larger availability of food resources and may explore new areas. Seasonal shifts do occur but, generally, these shifts are based on food availability. There are no known California condor nests within the Action Area.

Any aircraft that surprises a bird may elicit a temporary startle response. In addition, close approaches by an aircraft may potentially drive birds out of an area but most of this research has been done on waterfowl (Bowles, Tabachnick, & Fidell, 1991). The accompaniment of engine noise (from the launch and landing) with the sonic boom and visual disturbance may temper any impact from the sonic boom because the species would likely already be alert.

Although launch noise, landing noise, visual disturbance, and sonic boom may cause a startle response and disrupt behavior if a condor is within the Action Area during a launch and landing at SLC-4, the likelihood of a condor being present during these activities is extremely low and therefore the effect of the Proposed Action would be negligible. Therefore, launch noise, landing noise, visual disturbance, sonic boom, and the release of water and water vapor produced by the Falcon 9 First Stage may affect, but is not likely to adversely affect, the California condor; it is "discountable."

5.1.3 California Red-Legged Frog

5.1.3.1 Noise

During landing of the Falcon 9 first stage, engine noise of approximately 80 to 100 dBA and sonic boom up to 6.0 psf is expected to overlap areas known to be occupied by California red-legged frog populations in the Santa Ynez River, Honda Creek, Bear Creek, and various isolated wetlands and ephemeral streams on south VAFB (Figure 4-4). If present in Spring Canyon or within adjacent upland dispersal habitat, California red-legged frogs would be subjected to a sonic boom with overpressures of up to 8.5 psf and engine noise between 100 and 110 dBA during the boost-back and landing of the Falcon 9 (Figure 4-4). However, as noted in Section 4.2.2, dispersal into upland habitat on VAFB is not likely to be as extensive as has been observed in more mesic parts of the range of this species.

All life stages of California red-legged frog can detect noise and vibrations (Lewis & Narins, 1985), and are assumed able to perceive the engine noise and sonic boom. There are no studies on the effects of noise on California red-legged frog, and few studies on the effects of noise disturbance on anurans in general. Those that have been conducted have tended to focus on the effects of sustained vehicle noise associated with roads near breeding ponds, which have been shown to have negative effects on individual frog's behavior and physiology and may have consequences for populations (see examples in Parris, Velik-Lord, & North [2009] and Tennessen, Parks, & Langkilde [2014]). However, impacts from engine noise and sonic boom would be of short duration and infrequent, therefore are expected to have different effects on frogs than sustained noise. We could not locate any directly applicable studies examining anuran reactions to these types of stimuli. It is assumed that the sonic boom and engine noise would likely trigger a startle response in California red-legged frog, causing them to flee to water or attempt to hide in place; however, there are no data on what level of sonic boom or launch noise would cause this reaction. It is likely that any reaction would be dependent on the sensitivity of the individual, the behavior in which it is engaged when it experiences the overpressure, and the level of the sonic boom (e.g., higher stimuli would be more likely to trigger a response). Regardless, the reaction is expected to be the same – the frog's behavior would be disrupted and it may flee to cover in a similar reaction to that of a frog reacting to a predator (U.S. Fish and Wildlife Service, 2015a). As a result, there could be a temporary disruption of California red-legged frog behaviors including foraging and calling and mating (during the breeding season). However, frogs tend to return to normal behavior quickly after being disturbed. Rodrıguez-Prieto & Fernandez-Juricic (2005) examined the responses in the Iberian frog (*Rana iberica*) to repeated human disturbance and found that the resumption of normal behavior after three repeated human approaches occurred after less than four minutes. Sun & Narins (2005) examined the effects of airplane and motorcycle noise on anuran calling in a mixed-species assemblage, including the sapgreen stream frog (*Rana nigrovittata*). Sun & Narins found that frogs reduced calling rate during the stimulus but the sapgreen stream frog increased calling rate immediately after cessation of the stimuli, likely in response to the subsequent lull in ambient sound levels. Similarly, qualified biologists working on VAFB and elsewhere in the range of the California red-legged frog have routinely observed a similar response in this species after disrupting individuals while conducting frog surveys (A. Abela, M. Ball, and J. LaBonte, pers. obs.). California red-legged frog would therefore be expected to resume normal activities quickly once the disturbance has ended and any behavioral response would be short term and discountable.

Since the engine noise caused by the boost-back and landing of the Falcon 9 First Stage would be of short duration (approximately 25–35 seconds) and of low magnitude, injury to California red-legged frog hearing is highly unlikely. Anuran vocalizations commonly reach 90 to 100 dB (Gerhardt, 1975), therefore frogs and toads, in general, are likely to be adapted to tolerate relatively high sound pressure levels. Anurans are also able to regenerate their hearing after damage; therefore, any potential hearing loss would not be permanent. Although no studies have been conducted using California red-legged frogs, Simmons et al. (2014) found that consistent morphological damage of hair cells in the hearing structures of American bullfrogs (*Lithobates catesbeianus*), which is within the same Family as the California red-legged frog (*Ranidae*), was not observed until exposure of sound levels greater than 150 dB sound pressure levels, which is approximately equivalent to 13 psf. This is much higher than the highest overpressures that individuals may be exposed to as a result of the Proposed Action. Even after such hearing damage, bullfrogs showed full functional recovery within three to four days (Simmons et al., 2014). Any hearing damage is thus highly unlikely from the much lower levels of sound exposure that would be experienced by California red-legged frog within the Action Area. For these reasons, engine noise and sonic boom resulting from the Falcon 9 Program may affect, and is not likely to adversely affect, the California red-legged frog.

5.1.3.2 Vegetation Clearing and Water Release

Direct impacts to post-metamorphic California red-legged frogs within the footprint of the area to be mowed include injury or mortality from inadvertent crushing by workers as they walk and operate mechanical equipment and during mowing of vegetation. An assessment of Spring Canyon in 2013 (ManTech SRS Technologies, Inc., 2014) and in July 2017 found no potential breeding habitat or watered sections within Spring Canyon in or downstream of the impact area, therefore there no direct impact to breeding habitat are anticipated. The Spring Canyon drainage downstream of the impact area is a series of un-watered, undefined channel with thick vegetation, intermittent drainage with a definable channel, and subsurface flow with little to no potential for breeding habitat (ManTech SRS Technologies, Inc., 2014). The risk of impacts on California red-legged frog will be reduced because USFWS-approved biologists will capture and relocate all individuals detected within the Project Area to nearby suitable habitat prior to the onset of vegetation clearing activities. A USFWS-approved biologist would also be present to monitor vegetation-clearing activities to move any California red-legged frogs encountered out of harm's way. In addition, a USFWS-approved biologist would conduct pre-launch surveys for California red-legged frogs at SLC-4 and in adjacent Spring Canyon and, if present, relocate them to the nearest suitable habitat out of harm's way from the release of water. Regardless, post-metamorphic frogs may be injured, or killed as a result of vegetation clearing activities and the release of water and water vapor during Falcon 9 launches. A USFWS-approved biologist would therefore search the impact area as soon as possible after post-launch safety closures are lifted for injured or killed California red-legged frogs within the impact area and downstream in Spring Canyon to document any take.

5.1.3.3 Construction of Civil Water Diversion Structure

With the exception of the grading and application of gunite on the slope immediately south of the flame bucket Figure 2-2), all construction will take place on existing paved surfaces. In addition, all vehicle and equipment access would occur on existing paved surfaces. The slope where gunite will be applied is currently sparsely covered by iceplant and dead vegetation due to the heat created during ongoing launches. Occasional holes of burrowing rodents (e.g., gophers) are present on the slope but would be very marginal refugia for California red-legged frog dispersing through the area, given the lack of vegetative cover. A USFWS-approved biologist would monitor grading and application of gunite to the slope.

During construction, California red-legged frogs that may potentially disperse through the project area may become entrapped in any holes or trenches left open overnight. However, open holes and trenches would be covered overnight and would be surveyed each day prior to initiation of work to minimize risk of entrapment. Any California red-legged frogs encountered would be captured and relocated to suitable habitat out of harm's way.

5.1.3.4 Conclusion

Engine noise and sonic boom resulting from the Falcon 9 Program may affect, and is not likely to adversely affect, the California red-legged frog. However, the potential physical impacts as a result of water release and vegetation clearing in Spring Canyon, the loss of potential upland/transitory habitat, and the construction of a civil water diversion structure, may affect, and are likely to adversely affect the California red-legged frog, but the effect will be minimized through the implementation of minimization and monitoring measures.

5.1.4 California Least Tern

California least terns nest and forage within the Action Area. The nests at Purisima Point would experience overpressures between 1 and 2 psf from a sonic boom. These nests would also experience engine noise from the launches (between 70 and 70 dBA) and landing (between 80 and 90 dBA). Meanwhile, California least terns foraging at the Santa Ynez River mouth would be within the 2-3 psf sonic boom footprint of the boost-back (Figure 4-6) and would experience louder engine noises than those at Purisima Point (between 80 to 90 dBA) (Figure 4-6). Purisima Point and the Santa Ynez River are not within the overflight zone; therefore, no visual impacts are anticipated.

Human activity impacts birds if they are forced to flush or exhibit other signs of fear; however, the relationship between the tendency to flush and reproductive success is poorly understood (Bowles Tabachnick, & Jehl, 1991). Austin et al. (1970) attributed a mass hatching failure of sooty tern (*Sterna fuscata*) in southern Florida to sonic booms from low flying military aircraft. The authors found 242 chicks instead of the normal 20,000 to 25,000 chicks at Dry Tortugas colony in southern Florida. The authors ruled out most other causes, except an overgrowth of vegetation and sonic booms. The authors had no evidence that the booms caused the hatching failure; however, the booms were described as almost a daily occurrence and were reportedly strong enough to shatter windows (Gladwin, Manci, & Villella, 1988). Bowels, Awbrey, & Jehl (1991) were unable to duplicate the assumptions made by Austin et al. (1970). Bowles et al. attempted to duplicate this response by exposing chick eggs to sound pressure levels of 177.3 dB re 20 uPa; mean community SEL of 139 dB, mean frequency of 60 hertz (Hz). They found that hatchling failures due to physical effect of sonic booms are highly unlikely (Bowles, Awbrey, & Jehl, 1991). Today, Austin et al. (1970) is typically considered circumstantial evidence at best.

The available data on launches suggest that sonic booms may produce a startle response in wildlife (See National Aeronautics and Space Administration, 1978). At VAFB, monitoring of California least terns has been conducted for five Delta II launches from SLC-2 on north VAFB. SLC-2 is 0.4 mi. (0.6 km) from the Purisima Point nesting colony and significantly closer than SLC-4, which is approximately 7.5 mi. (12.1 km) from the Purisima Point nesting colony (Figure 4-6). California least tern response has been variable. Pre- and post-launch monitoring of non-breeding California least tern for the 7 June 2007 Delta II COSMO-1 launch, and monitoring of nesting California least tern during the 20 June 2008 Delta II OSTM and 10 June 2011 Delta II AQUARIUS launches did not document any mortality of adults, young, or eggs, or any abnormal behavior as a result of the launches (ManTech SRS Technologies, Inc., 2007a., 2008b; 2011a). The May and July 1997 Delta II launches, however, potentially caused the abandonment of up to five nests and the death of a chick due to exposure, although predation of adult California least tern by owls may have been responsible for some of the losses observed (BioResources, 1997). In addition, Delta II launches from SLC-2 in 2002 and 2005, when terns were arriving at the colony, may have caused temporary or permanent emigration from the colony because there was decreased attendance following the launches (Robinette et al., 2003, Robinette & Rogan, 2006). This data implies that the response to noise of California least terns is related to where individuals are in the nesting cycle. For instance, at the beginning of the nesting season when least terns are arriving at the breeding colony, the adults seem to be more disturbed, but once serious courtship and nest-tending begins, the adults are more tenacious. The sound profile for launch noise generated by the Delta II vehicle at SLC-2 was characterized at the Purisima Point nesting area during the 15 April 1999 launch (SRS Technologies, 1999). Sound reaching the recording site had an unweighted peak of 135.5 dB (roughly 2.3 psf). The A-weighted SEL was 121.5 dB (SRS Technologies, 1999). These launch noises greatly exceed the launch and landing noises anticipated by the Falcon 9 First Stage (Figures 2-7 and 2-8).

Dooling & Popper (2016) provides threshold guidance for traffic noise and road construction on birds. They found that a single impulse of 140 dBA could result in hearing damage (which was based on small mammal studies); however, they state that there is no data available on temporary threshold shifts for birds from impulsive sound (e.g., like a sonic boom). They also found that a temporary threshold shift could occur from continuous noise of 93 dBA. However, they stated that any audible component of construction or traffic noise could cause a behavior response in birds.

As evidenced in Figures 2-7 and 2-8, engine noise from the Falcon 9 boost-back and landing at SLC-4 would not reach the levels of the Delta II at SLC-2 (adjacent to the tern colony). Engine noise during landing is expected to be within the 80-dBA footprint at the Purisima Colony and between 80 and 90 dBA at the Santa Ynez River mouth (Figure 2-8). The Purisima Colony could experience overpressure between 1 and 2 psf. Least terns at the Santa Ynez River could experience overpressures from the sonic boom between 2.0 psf and 3.0 psf.

5.1.4.1 Conclusion

The audible components from this action (e.g., engine noise and sonic boom) could potentially cause the California least tern to respond behaviorally or physiologically to this sound. In particular, this stimulus could result in a startle reaction. USAF is of the opinion that the least tern's response to the action would be commensurate with those observed for Delta II rocket launches, particularly during certain periods of the nesting cycle. Based on this past anecdotal evidence, USAF has determined that a reasonable person would expect that the action would affect foraging activities at Santa Ynez River and potentially lead to temporary site or nest abandonment at the Purisima Colony. Therefore, the USAF has determined that the action may affect, and is likely to adversely affect, the California least tern. As stated in Section 2.2.2, California Least Tern, a USFWS-approved biologist would monitor any impact on the species, including mortality, injury, or other abnormal behavior following each event.

5.1.5 Marbled Murrelet

The marbled murrelet is infrequently observed in the summer in the north VAFB area and occasionally observed in the spring (Lehman, 2016). Since the marbled murrelet had not been considered in prior consultations for the Falcon 9 program, the potential impacts of launch noise, landing noise, visual disturbance, and sonic boom are analyzed in this BA. Individuals have been observed infrequently on and around north VAFB at Lion's Head and at nearby Point Sal and Santa Maria River. Individuals have also been observed off Point Conception and off Point Pedernales. Of these areas, the Point Pedernales would receive the greatest sonic boom, up to 3 psf, launch noise of 80-90 dBA, and landing noise up to 90 dB. There are no known nesting areas within the Action Area and the species is unlikely to be within the Action Area during a launch event. Birds react very similarly to aircraft noise and observations have shown that shorebirds are more affected by habitat availability than low-level military overflights (Wyle, 2014). These birds are more likely to flush in response to human presence than subsonic overflights (Wyle, 2014). Generally, there would be no permanent impact. In the unlikely event that a marbled murrelet were present within the Action Area during a launch and landing event, the species would likely be foraging and the action could cause a short-term startle response or other minor and temporary behavioral shift. The Falcon 9 Program would not likely injure an individual marbled murrelet or substantially disrupt its normal behavior.

5.1.5.1 Conclusion

Because the marbled murrelet is very unlikely to be within the Action Area during a launch and landing of the Falcon 9, the effects of the Proposed Action would be negligible and discountable. Therefore, the Falcon 9 Program may affect, but is not likely to adversely affect, the marbled murrelet.

5.1.6 Western Snowy Plover

Western snowy plover monitoring for impacts related to launch-related engine noise and visual disturbance has been conducted during numerous past launches on VAFB, where they may experience landing noise in excess of 100 dBA. Direct observations of wintering birds were made during a Titan IV and Falcon 9 launch from SLC-4E (SRS Technologies, 2006a; Robinette & Ball, 2013). The Titan IV launches were louder (130 dBA) than the Falcon 9 First Stage landing noise (110 dBA). Western snowy plovers did not exhibit any adverse reactions to these launches (SRS Technologies, 2006a; Robinette & Ball, 2013). With the exception of one observation (see following), monitoring of Western snowy plover during the breeding and non-breeding season for other launches has routinely demonstrated that Western snowy plover behavior is not adversely affected by launch noise or vibrations, and no incidents of injury or mortality to adults, young, or eggs have been clearly attributed to any of the launches (SRS Technologies, Inc. 2006a, 2006b, 2006c, 2006e, 2006f, 2006g, 2006h; ManTech SRS Technologies, Inc. 2007a, 2008a, 2008b, 2009b). However, during a launch event of a Titan II from SLC-4W in 1998, monitoring of snowy plovers found the nest located closest to the launch facility had one of three eggs broken after the launch (Applegate & Schultz, 1998). The cause of the damaged egg was not determined. Landing noise from the Falcon 9 would be substantially less than the Titan II (119 dBA); therefore, the landing noise from the Falcon 9 would not likely adversely affect the snowy plover.

The Western snowy plover could be exposed to a sonic boom of up to 8 psf at VAFB and up to 3 psf on the NCI (Figure 4-7). Launch events would occur during the breeding season. On VAFB, the magnitude of the boom, preceded by the launch noise, and coupled with landing noise as well as the visual impact of seeing the landing could provoke temporary or permanent emigration from nesting sites, trigger a startle response that alerts predators to nest locations, cause temporary abandonment of nests, mask biologically significant sounds (e.g. predators) that make abandoned eggs or young more vulnerable and reduce overall fitness. Therefore, the Falcon 9 Program may affect, and is likely to adversely affect, the Western snowy plover occurring at VAFB. The proposed monitoring measures (see Section 2) would continue to be in place to monitor any impact following an event.

On the NCI, the impacts to Western snowy plover would be substantially less. There would not be any exposure to launch or landing noise or any associated visual stimuli, and the sonic booms during launch and landing are not expected to be greater than 3 psf. Due to the lower intensity and the short-term, transient nature of anticipated sonic boom noise, any behavioral reactions would likely be short term (minutes) and would be unlikely to cause long-term consequences for individuals or populations. Because of the short term, transient nature of the sonic boom and the relatively few numbers of individuals occurring on the NCI, the impacts would be insignificant and discountable. Therefore, the Proposed Action may affect but is not likely to adversely affect Western snowy plover on the NCI.

5.1.6.1 Conclusion

The Falcon 9 Program may affect, and is likely to adversely affect, the Western snowy plover occurring at VAFB and may affect but is not likely to adversely affect Western snowy plover on the NCI.

5.1.7 Southern Sea Otter

Otters in transit along the coast immediately west of SLC-4 may be impacted by landing noises of up to 110 dBA and a sonic boom as high as 8 psf (Figure 4-8). However, otters are highly unlikely to be present within these areas during the brief period of when a sonic boom or landing noise would occur, therefore these impacts would be negligible.

At the kelp beds located along the coast south of SLC-4 and off of Purisima Point, where otters are regularly observed, they may experience overpressure levels comparable to those projected during the initial consultation (primarily less than 2.0 psf; Figure 4-8). For aquatic and marine species, the ear is adapted to the aquatic environment (Wyle, 2014). California sea lions and harbor seals that are exposed to aircraft noise and sonic booms between 80–89 dB are more likely to startle (Bowles, Tabachnick, & Fidell, 1991). Bowles et al. (1991) stated that the zone of influence is 50 dB greater than ambient to drive species out of habitat. Narrowband or impulsive noise would require even higher noise ratios (i.e., 60 to 80 dB above ambient) (Bowles, Tabachnick, & Fidell, 1991).

Exceptionally little sound is transmitted between the air-water interface; thus, in-air sound would not have a significant effect on submerged animals (Godin, 2008). In addition, according to Ghoul & Reichmuth (2014), "Under water, hearing sensitivity [of sea otters] was significantly reduced when compared to sea lions and other pinniped species, demonstrating that sea otter hearing is primarily adapted to receive airborne sounds." This study suggested that sea otters are less efficient than other marine carnivores at extracting noise from ambient noise, especially at frequencies below 2 kilohertz (kHz) (Ghoul & Reichmuth, 2014).

Davis, Williams, & Awbrey (1988) conducted a study of Southern sea otter's reactions to various underwater and in-air acoustic stimuli. The purpose of the study was to identify a means to move sea otters away from a location in the event of an oil spill. Anthropogenic sound sources used in this behavioral response study included truck air horns and an acoustic harassment device (10–20 kHz at 190 dB) designed to keep dolphins and pinnipeds from being caught in fishing nets. The authors found that the sea otters often remained undisturbed and quickly became tolerant of the various sounds. When a fleeing response occurred as a result of the harassing sound, they generally moved only a short distance (100–200 meters) before resuming normal activity (Davis et al., 1988).

Permanent threshold shift and temporary threshold shifts have not been determined for the sea otter. Because of biological similarities, we assume that the thresholds developed by the National Marine Fisheries Service for pinnipeds (National Marine Fisheries Service, 2016) would be similar to those for otters. A sonic boom may cause temporary physiological or behavioral disturbances to sea otters. Disturbance responses could range from mild, such as an increase in heart rate, to more damaging effects on metabolism and hormone balance. These disturbances would be short in duration and would vary by species.

Launch monitoring of sea otters on both north and south VAFB has been extensive, with pre- and post-launch counts and observations conducted at rafting sites immediately south of Purisima Point for numerous Delta II launches from SLC-2 and one Taurus launch from Launch Facility (LF)-576E and at the rafting sites off of Sudden Flats for two Delta IV launches from SLC-6. No abnormal behavior, mortality, or injury has ever been documented for sea otter as a result of launch-related disturbance (SRS Technologies, 2006a, 2006b, 2006c, 2006d, 2006e, 2006g; ManTech SRS Technologies, 2007a, 2007b, 2007c, 2008a, 2010). During the Delta IV launches, the number of sea otters observed after launch activities was similar to or greater than pre-launch counts.

We do not expect sonic booms to cause more than a temporary startle-response, as monitoring sea otters during launch operations has indicated that launch noise is not a primary driver of sea otter behavior. While a 2-psf boom is approximately 135 dB (unweighted), it is likely that most of that acoustic energy is not heard by sea otters anyway.

Figure 5-1 illustrates the frequency spectrum of a 1.5-psf sonic boom (recorded at San Nicolas Island on 12 December 2014) as well as the hearing curve of a sea otter (Ghoul & Reichmuth, 2014). Most of the sonic boom energy is less than 250 Hz, well below the region of best sensitivity of the sea otter (2–22.6 kHz; Figure 5-1). While the sea otter would likely hear the sonic boom, it would only be responding to acoustic energy that is above 250 Hz and total sound levels much less than 135 dB. As the sonic boom increases in pressure, it is likely that more energy would be detected by the sea otter, most notably in frequencies higher than 250 Hz.

5.1.7.1 Conclusion

Due to the short-term, transient nature of anticipated boost-back and sonic boom noise, lack of overlap of hearing sensitivity with majority of sonic boom noise, and their lack of adverse responses to rocket launch noise, we anticipate that responses to landing noise and sonic boom would only be behavioral. Behavioral reactions would likely be short term (minutes) and would be unlikely to cause long-term consequences for individuals or populations. Therefore, the proposed action may affect but is not likely to adversely affect the Southern sea otter because it is insignificant and discountable.

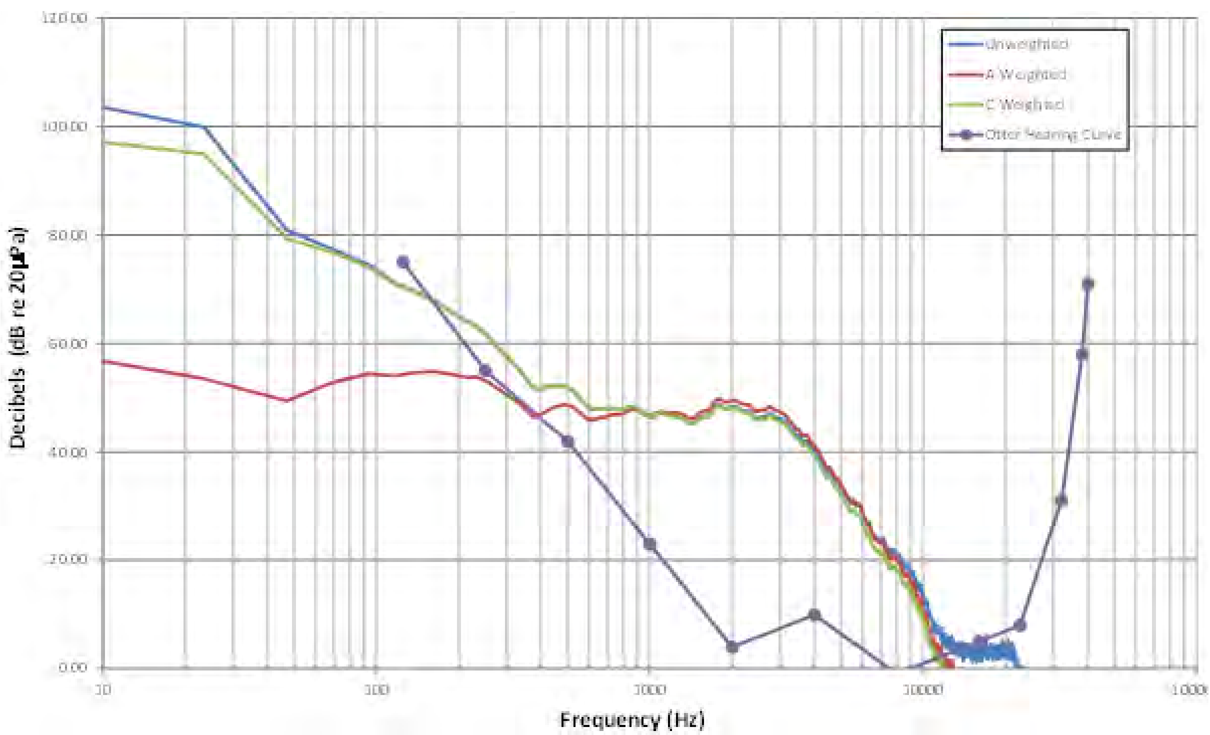

Figure 5-1. Sonic boom spectrum and sea otter hearing sensitivity curve

5.2 Direct and Indirect Effects on Critical Habitat

5.2.1 El Segundo Blue Butterfly

Critical habitat for the ESBB does not occur within or near the Action Area. Therefore, the Proposed Action would have no effect on this species' critical habitat.

5.2.2 California Condor

Critical habitat for the California condor does not occur within or near the Action Area. Therefore, the Proposed Action would have no effect on this species' critical habitat.

5.2.3 California Red-Legged Frog

The Action Area includes the following designated critical habitat units for the California red-legged frog: STB-2 and STB-4. The Proposed Action would have no ground disturbing activities or impacts to water quality within critical habitat therefore no measurable impacts to vegetation, hydrology, habitat structure, or any other physical features of habitat. Unit STB 4 would receive landing noises in excess of 70 dB and units STB-2 and STB-4 would potentially receive infrequent sonic booms of 1 to 2 psf, which would not be expected to appreciably diminish habitat quality, including vegetation, prey base, or degradation of habitat structure. Therefore, the Proposed Action would have no effect on critical habitat for this species.

5.2.4 California Least Tern

The USFWS has not designated critical habitat for the California least tern. Therefore, the Proposed Action would have no effect on critical habitat for this species.

5.2.5 Marbled Murrelet

Critical habitat for the marbled murrelet does not occur within or near the Action Area. Therefore, the Proposed Action would have no effect on this species' critical habitat.

5.2.6 Western Snowy Plover

The Action Area includes the Santa Rosa Island, portions of which are designated critical habitat for the Western snowy plover. These areas would potentially receive sonic booms up to 3 psf during launch and boost-back. The Proposed Action does not include any ground disturbance within critical habitat nor would it appreciably diminish the species' prey base or any other physical features of habitat. Therefore, the Proposed Action would have no effect on critical habitat for this species.

5.2.7 Southern Sea Otter

The USFWS has not designated critical habitat for the Southern sea otter. Therefore, the Proposed Action would have no effect on critical habitat for this species.

5.3 Cumulative Effects

Cumulative effects are defined in 50 C.F.R. § 402.02 as "those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the Action Area of the Federal action subject to consultation." Reasonable foreseeable future federal actions and potential future federal actions that are unrelated to the Proposed Action are not considered in the analysis of cumulative effects because they would require separate consultation pursuant to Section 7 of the ESA. There are no known cumulative effects related to the actions planned at SLC-4.

5.4 Interrelated and Interdependent Effects

Under USFWS's regulations, interrelated actions are "those that are part of a larger action and depend on the larger action for their justification." Interdependent actions are "those that have no independent utility apart from the action under consideration" (50 C.F.R. § 402.02).

The boost-back and landing of the Falcon 9 first stage is directly related to the Falcon 9 Launch Program. All first stage return flights (boost-back and landing) would occur with a Falcon 9 launch. In June 2011, USFWS concurred with the USAF assessment that Falcon 9 launch noise was likely to affect, but not likely to adversely affect, California red-legged frog, California least tern, Western snowy plover, and Southern sea otter (8-8-11-F-32R).

6 Conclusion

SpaceX proposes to perform up to 12 boost-back and landings of the Falcon 9 first stage at SLC-4. The Falcon 9 first stage would temporarily increase airborne noise during launches and landings within the Action Area. Based on actual observations from Cape Canaveral, the landing of the Falcon 9 first stage would also create a sonic boom with overpressures of up to 8.5 psf. As such, the Falcon 9 Program may affect listed species in a manner and to an extent not previously considered in prior consultations. Therefore, USAF is required to re-initiate consultation with USFWS under Section 7 of the ESA (50 C.F.R. § 402.16).

After reviewing the Falcon 9 Program, including its existing avoidance, minimization, and monitoring measures (Section 2.2), the USAF has determined that the Proposed Action may affect, but is not likely to adversely affect, the California condor, California red-legged frog, the marbled murrelet, and the Southern sea otter. In addition, the Proposed Action may affect, and is likely to adversely affect, the ESBB, California least tern, and the Western snowy plover. Table 6-1 summarizes the USAF's effect determinations for these species.

6.1.1 El Segundo Blue Butterfly

The Proposed Action may affect, and is likely to adversely affect, the ESBB, but would have no effect on this species' critical habitat.

6.1.2 California Condor

The Proposed Action may affect, but is not likely to adversely affect, the California condor, and would have no effect on this species' critical habitat.

6.1.3 California Red-Legged Frog

The Proposed Action may affect, and is not likely to adversely affect, the California red-legged frog, and would have no effect on this species' critical habitat.

6.1.4 California Least Tern

The Proposed Action may affect, and is likely to adversely affect, the California least tern. Critical habitat has not been designated for this species.

6.1.5 Marbled Murrelet

The Proposed Action may affect, but is not likely to adversely affect, the marbled murrelet, and would have no effect on this species' critical habitat.

6.1.6 Western Snowy Plover

The Proposed Action may affect, and is likely to adversely affect, the Western snowy plover at VAFB, and may affect but is not likely to adversely affect the Western snowy plover on NCI. The action would have no effect on this species' critical habitat.

6.1.7 Southern Sea Otter

The Proposed Action may affect, but is not likely to adversely affect, the Southern sea otter, and critical habitat has not been designated for this species.

Table 6-1. Federally Listed Species with Potential to Occur in Santa Barbara County and Summary of Effects Determinations

Common Name	Scientific Name	Federal Listing	Critical Habitat	General Habitat	Effects Determinations
El Segundo Blue Butterfly	*Euphiloes battoides allyni*	Endangered	Designated	Small dunes and bluffs with coast (seacliff) buckwheat	May affect, and is likely to adversely affect. No effect on critical habitat.
California Condor	*Gymnogyps californianus*	Endangered	Designated	Large remote areas; roost on large trees and isolated rocky outcrops; forage in open grasslands that support large mammals	May affect, but is not likely to adversely affect. No effect on critical habitat.
California Red-legged Frog	*Rana draytonii*	Threatened	Designated	Coastal drainages of central California with aquatic breeding areas (ponds, creeks, marshes, springs, etc.) and upland habitat	May affect, and is not likely to adversely affect. No effect on critical habitat.
California Least Tern	*Sternula antillarum browni*	Endangered	None	Coastal areas, nesting on open beaches free of vegetation	May affect, and is likely to adversely affect. No critical habitat designated.
Marbled Murrelet	*Brachyramphus marmoratus*	Threatened	Designated	Coastal species, nests in high trees within coastal forests	May affect, but is not likely to adversely affect. No effect on critical habitat.
Western Snowy Plover	*Charadrius nivosus*	Threatened	Designated	Coastal beaches, breeds above the high tide but may also breed in salt ponds and dredged material sites	VAFB: May affect, and is likely to adversely affect. NCI: May affect, but is not likely to adversely affect. No effect on critical habitat.

Common Name	Scientific Name	Federal Listing	Critical Habitat	General Habitat	Effects Determinations
Southern Sea Otter	*Enhydra lutris nereis*	Threatened	None	Shallow coastal waters with kelp beds	May affect, but is not likely to adversely affect No critical habitat designated.

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ventura Fish and Wildlife Office
2493 Portola Road, Suite B
Ventura, California 93003

IN REPLY REFER TO:
08EVEN00-2017-F-0480

December 12, 2017

Beatrice L. Kephart
30 CES/CEI
1028 Iceland Avenue
Vandenberg Air Force Base, California 93437

Subject: Biological Opinion on the Launch, Boost-Back and Landing of the Falcon 9 First Stage at SLC-4 at Vandenberg Air Force Base, Santa Barbara County, California (2017-F-0480)

Dear Ms. Kephart:

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion based on our review of the proposed launch, boost-back, and landing of the Falcon 9 first stage at Space Launch Complex 4 (SLC-4) on Vandenberg Air Force Base (VAFB), and its effects on the federally endangered El Segundo blue butterfly (*Euphilotes battoides allyni)* and California least tern (*Sterna antillarum browni*), and the federally threatened California red-legged frog (*Rana draytonii*) and western snowy plover (*Charadrius nivosus nivosus*). We received your August 8, 2017, request to initiate formal consultation on August 14, 2017. You also requested our concurrence that the launch, boost-back, and landing of the Falcon 9 first stage at SLC-4 may affect, but is not likely to adversely affect the federally endangered California condor (*Gymnogyps californianus*) and the federally threatened marbled murrelet (*Brachyramphus marmoratus*) and southern sea otter (*Enhydra lutris nereis*). The Air Force has determined that the proposed project will not affect designated critical habitat for any species. Your request and our response are in accordance with section 7 of the Endangered Species Act of 1973, as amended (Act) (16 U.S.C. 1531 et seq.).

We have based this biological opinion on information that accompanied your August 8, 2017, request for consultation, including the biological assessment (BA; ManTech SRS Technologies, Inc. (ManTech) 2017a), additional information regarding the project received via emails, and information in our files. We can make a record of this consultation available at the Ventura Fish and Wildlife Office.

Determination for the California Condor

In March 2017, telemetry data indicated a California condor was ranging within VAFB. This condor (SB 760) was an immature, non-reproductive female hatched in captivity on May 22, 2014, and released at the Ventana Wilderness on November 9, 2016. The condor departed the

VAFB area on April 12, 2017, and later died on approximately July 19, 2017. Other condors may occur on VAFB in the future. The Air Force has committed to incorporating the following monitoring measure into the project description:

> Movements of California condor would be monitored in the vicinity of VAFB, if present, via satellite telemetry during launch and landing events to determine whether launch and boost-back had an effect on movement patterns within the action area. Determination of presence would be coordinated with Ventana Wilderness Society and Service Condor Recovery Coordinator beginning two weeks in advance of each launch event at SLC-4.

Although launch noise, landing noise, visual disturbance, and sonic boom may cause a startle response and disrupt behavior if a condor is within the action area during a launch and landing at SLC-4, the Air Force anticipates that the likelihood of a condor being present during these activities is extremely low and that the effect of the proposed project on California condors would be discountable. We concur with your determination that the proposed activities may affect, but are not likely to adversely affect the California condor, and we are not discussing this species further in this biological opinion.

Determination for the Marbled Murrelet

Marbled murrelets are considered rare to very rare much of the year in Santa Barbara County; however, the species may be somewhat regular north of VAFB in the late summer and would be considered casual in the spring (Lehman 2016). Individuals have been observed infrequently on and around north VAFB at Lion's Head and at nearby Point Sal and the Santa Maria River. Individuals have also been observed off Point Conception and Point Pedernales, on south VAFB (Lehman 2016). As such, marbled murrelets may occur in the nearshore waters off VAFB, within the action area, but it is not known to nest in the action area. The Air Force has committed to incorporate the following monitoring measure into the project description:

> Annual population surveys would continue to be conducted at the current levels performed by the Air Force to monitor the frequency and distribution of marbled murrelet within the action area.

Point Pedernales, the nearest known locality for marbled murrelets in relation to SLC-4, would receive launch noise of 80-90 A-weighted decibels (dBA), landing noise up to 90 dBA, and a sonic boom overpressure up to 3 pounds per square foot (psf). The Air Force anticipates it is unlikely that a marbled murrelet would be present within the action area during a launch and landing event. If present, the action could cause a short-term startle response or other minor and temporary behavioral shift, but would not likely cause injury or substantially disrupt a marbled murrelet's normal behavior. Due to the low likelihood of occurrence during launch and landing activities plus the short-term nature of anticipated launch/landing noise and overpressure at no more than 3 psf, the Air Force expects the effects of the proposed project on marbled murrelets would be insignificant and discountable. We concur with your determination that the proposed activities may affect, but are not likely to adversely affect the marbled murrelet, and we are not discussing this species further in this biological opinion.

Determination for the Southern Sea Otter

Southern sea otters occur regularly off the coast of VAFB, with animals typically concentrated in the kelp beds offshore of Purisima Point on north VAFB, and offshore of Sudden Flats on south VAFB. Transitory otters occasionally traverse the coast between SLC-4 and Point Arguello. This area is, however, not regularly occupied and no otters have been detected at this location during the last three annual spring census counts from 2011 to 2016 (U.S. Geological Survey Western Ecological Resource Center 2014, 2016). Otters in transit along the coast immediately west of SLC-4 may be affected by launch noise up to 100 dBA, landing noise up to 110 dBA, and a sonic boom as high as 8 psf; however, the Air Force anticipates that otters are highly unlikely to be present within these areas during the brief period when a sonic boom or landing noise would occur, therefore these effects would be discountable. At the kelp beds located along the coast south of SLC-4 and off of Purisima Point, where otters are regularly observed, they may experience launch and landing noise up to 80 dBA and sonic boom overpressure levels up to 2.0 psf [Note: We previously consulted with the Air Force on impacts to otters at similar but slightly lower levels (Service 2015a); see Consultation History below].

Launch monitoring of sea otters on both north and south VAFB has been extensive, with pre- and post-launch counts and observations conducted at rafting sites immediately south of Purisima Point for numerous Delta II launches from SLC-2 and one Taurus launch from Launch Facility 576E and at the rafting sites off of Sudden Flats for two Delta IV launches from SLC-6. No abnormal behavior, mortality, or injury has ever been documented for sea otters as a result of launch-related disturbance (SRS Technologies 2006a,b,c,d,e; ManTech 2007a,b,c, 2008a,b). During the Delta IV launches, the number of sea otters observed after launch activities was similar to or greater than pre-launch counts.

The Air Force anticipates that sonic booms would not cause more than a temporary startle-response, as monitoring sea otters during launch operations has indicated that launch noise is not a primary driver of sea otter behavior. While a 2-psf boom is approximately 135 dB (unweighted), the Air Force states that it is likely that most of that acoustic energy is not heard by sea otters. Exceptionally little sound is transmitted between the air-water interface; thus, in-air sound would not have a significant effect on submerged animals (Godin 2008). In addition, Ghoul and Reichmuth (2014) analyzed aerial hearing thresholds in captive sea otters and found that otter hearing is most sensitive to sound frequencies between 2 and 26 kilohertz (kHz), whereas most of the sonic boom energy is less than 250 hertz (Hz), well below the sea otter's region of hearing sensitivity. Due to the short-term, transient nature of anticipated boost-back and sonic boom noise, lack of overlap of hearing sensitivity with majority of sonic boom noise, and their lack of adverse responses to rocket launch noise, the Air Force anticipates that responses to landing noise and sonic boom would only be behavioral. Behavioral reactions would likely be short term (minutes) and would be unlikely to cause long-term consequences for individuals or populations. The Air Force has committed to incorporate the following monitoring measures into the project description:

1. A Service-approved biologist would monitor southern sea otters for landing events at SLC-4W whenever a sonic boom of 2 psf or greater is predicted to be generated by the boost-back that would impact southern sea otter habitat. The monitoring location would be selected based on where pressure waves greater than 2 psf are predicted to impact and the relation of these locations to occupied sea otter habitat, which is commonly Sudden Flats on south VAFB. However, no monitors are allowed within the "Impact Limit Line" during launch or boostback. If otter counts by the United States Geological Survey, or other non-related survey efforts, show the establishment of new populations within the action area, new survey locations would be considered for boost-back and landing events;
    a. A Service-approved biologist would conduct daily counts of sea otters at the selected monitoring location beginning 3 days before and continuing 3 days after the boost-back and landing. The monitor would note any mortality, injury, or abnormal behavior observed during these counts. Weather permitting; the counts would be conducted between 09:00 AM and 12:00 PM when otters are most likely to be rafting to help maintain daily consistency in detectability. Monitors would use both binoculars (10X) and a high-resolution 50–80X telescope to conduct counts; and
2. Acoustic recording equipment would be deployed at or near the monitoring location to document and quantify sonic boom levels.

Because (1) the Air Force has not detected any abnormal behavior, mortality, or injury of sea otters as a result of any launches, including those involving launch vehicles that produced louder noise than the boost-back landing is expected to produce, and (2) due to the short-term, transient nature of anticipated launch/landing noise and overpressure, and (3) the lack of sea otter hearing sensitivity in the range of the sonic boom noise, the Air Force does not expect the proposed project would cause more than a temporary startle-response. We concur with your determination that the proposed activities may affect, but are not likely to adversely affect the southern sea otter, and we are not discussing this species further in this biological opinion.

Consultation History

Space Exploration Technologies Corporation (SpaceX) is a commercial space transport services company currently operating the Falcon Launch Vehicle Program at SLC-4 at VAFB. We previously completed three biological opinions (Service 2010b, 2011a, 2014b) and two concurrence letters (Service 2014a, 2015a) regarding the effects of operations performed to support this launch program at SLC-4.

In our biological opinion dated December 10, 2010 (Service 2010b), we consulted on the modification and operation of SLC-4 East (SLC-4E) for the new Falcon 9 and Falcon 9 Heavy Space Vehicle Program. We concurred that launch noise and visual disturbance from space vehicle launches from this facility may affect, but were not likely to adversely affect the California least tern, western snowy plover, or southern sea otter. We authorized incidental take of El Segundo blue butterflies resulting from landscape maintenance actions and launch-related fires.

On May 25, 2011, the Air Force requested reinitiation of that consultation due to a change in the effects determination for the California red-legged frog, from "no effect" to "may affect, not likely to adversely affect." In our biological opinion dated June 24, 2011, we concurred that launch noise and visual disturbance from space vehicle launches from this facility may affect, but were not likely to adversely affect the California red-legged frog, the California least tern, western snowy plover, or southern sea otter, and re-authorized incidental take of El Segundo blue butterflies resulting from landscape maintenance actions and launch-related fires (Service 2011a).

On October 10, 2013, the Air Force informed us of potential unauthorized impacts to El Segundo blue butterflies and California red-legged frogs resulting from the discharge of water into Spring Canyon during the launch of a Falcon 9 rocket on September 29, 2013. Approximately 125,000 gallons of water had been placed in the flame bucket, resulting in approximately 25,000 to 50,000 gallons being injected into Spring Canyon during the launch. Completed mitigation for the unanticipated impacts consisted of habitat restoration (planting of seacliff buckwheat, treatment of invasive plants) and removal of bullfrogs (*Lithobates catesbeianus*) in San Antonio Creek. The Air Force stated that all future launches from SLC-4E would be conducted with a dry flame duct to prevent discharge to Spring Canyon. In a letter dated August 29, 2014, we concurred that launch activities at SLC-4E may affect, but were not likely to adversely affect California red-legged frogs that may occur in suitable habitat in Spring Canyon (Service 2014a).

In our biological opinion dated December 22, 2014 (Service 2014b), we consulted on the proposed in-flight abort test and improvements at SLC-4 West (SLC-4W) which included construction a 300-foot (ft) diameter concrete pad to accommodate future landings of Falcon 9 first stage, two new access roads, and a new "FireX" fire control system. We concurred that the proposed activities may affect, but were not likely to adversely affect the California least tern, western snowy plover, or southern sea otter. We authorized incidental take of El Segundo blue butterflies and California red-legged frogs resulting from site improvements and, for frogs, capture and relocation.

On July 2, 2015, we consulted on Falcon 9 boost-back landing operations, which would occur up to 10 times per year at SLC-4W or at sea. The anticipated engine noise at landing would be less than the noise generated during launch, and the anticipated sonic boom overpressure would be up to a maximum of 2.0 psf. We concurred that boost-back landings of the Falcon 9 first stage as described at SLC-4W may affect, but were not likely to adversely affect the California red-legged frog, the California least tern, western snowy plover, or southern sea otter (Service 2015a).

As part of our programmatic biological opinion for routine operations and maintenance activities at VAFB (Service 2011b, 2015b), we analyzed the impacts of maintaining the firebreaks surrounding both SLC-4E and SLC-4W.

On June 14, 2017, we received the Air Force's initial request for formal consultation, including a BA, for proposed launch, boost-back, and landing of the Falcon 9 first stage, not including the use of flame duct water during launch. This request included determinations for the species named above with the exception of El Segundo blue butterfly. We requested additional information in a letter to you dated July 14, 2017.

We received a revised BA (ManTech 2017a) on August 14, 2017, with your August 8, 2017, request, which included a new project scope regarding SLC-4E flame duct water and impacts to Spring Canyon. As a result of this change, the Air Force made revised determinations that the proposed project may affect, and is likely to adversely affect the El Segundo blue butterfly and the California red-legged frog. The determinations that the proposed project is likely to adversely affect the California least tern and western snowy plover, and may affect but is not likely to adversely affect the California condor, marbled murrelet, and southern sea otter, were not changed. The Air Force provided additional and clarifying information regarding species and habitat occurrence data and impacts to California red-legged frogs and western snowy plovers via email and access to Air Force geographic information system data.

On November 20, 2017, we received the Air Force's revisions to the project description consisting of the Spring Canyon Riparian Mitigation Plan (mitigation required by the Central Coast Water Control Board; ManTech 2017b) and the project's Monitoring and Minimization Plan (ManTech 2017c) for federally listed species. Where monitoring or minimization measures differ between the BA and the Monitoring and Minimization Plan, the Air Force has confirmed that the latter represents the most up-to-date information and we have incorporated these in the Description of the Proposed Action below. Additional clarifications of monitoring measures were provided by the Air Force on November 28, 2017, at which time the Air Force also removed a minimization measure for California least terns from the project description.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

SpaceX proposes to launch the Falcon 9 from SLC-4E, followed by first stage boost-back and landing at SLC-4W up to 12 times per year. In addition, launches would use up to 200,000 gallons of water in the flame duct to reduce vibration impacts from noise on payloads. SpaceX proposes to construct a civil structure and retention basin to divert and retain a portion of the water expelled from the flame duct. Vegetation in Spring Canyon would also be removed to minimize potential effects to nesting birds in the area impacted by the water release, and habitat enhancement would be conducted to mitigate for these permanent impacts to riparian vegetation.

Launch and Landing Operations

Launches and landings would occur day or night, at any time during the year up to once per month, and under all but extreme weather conditions (i.e., would not occur during gale force winds, high wind shear, or extreme thunder and lightning conditions). The trajectory of the Falcon 9 would be either westward or southward from SLC-4 depending on the payload's orbital mission, with the first stage boost-back generally returning along the same trajectory. The total time from launch to landing would be approximately 10 to 20 minutes.

Engine noise would be produced during Falcon 9 launch and landings. Previous engine noise footprints were computed using a single engine thrust landing. SpaceX proposes to use a three-engine thrust landing for some boost-back events, generating engine noises of up to 110 dBA. The engine noise would be primarily within the vicinity of SLC-4 and would attenuate below 80 dBA at approximately 8 miles (mi) (12.9 kilometer (km)) from SLC-4.

During launch ascent, a sonic boom up to 3.0 psf may be generated at the northern Channel Islands (NCI). During boost-back and landing descent, a sonic boom would be generated while the first-stage booster is supersonic. Earlier sonic boom models predicted that first stage boost-back overpressures would be directed at the coastal area south of SLC-4 and would reach up to 2.0 psf at SLC-4 and up to 3.1 psf at the NCI. Recent observations show that these early models underestimated the actual strength of these overpressures in the Near Field. The 45th Space Wing (SW) performed modeling based on National Aeronautics and Space Administration (NASA) Technical Paper 1122, but optimized by the 45th SW to match maximum overpressure from the CRS-9 mission. The 45th SW has stated that their model is less accurate the further away from landing point, but the CRS-9 mission confirmed the 45th SW model to be the best predictor for Near Field sonic boom levels, which was validated by the CRS-9 data and acknowledged by the Eastern Range. Based on the NASA Technical Paper 1122, SpaceX optimized the model to match data from CRS-9 to predict sonic boom levels over a broader range.

The Air Force now predicts overpressures as high as 8.5 psf [compared to approximately 146 dB (peak, unweighted)] at SLC-4W, which would attenuate to levels below 2.0 psf (134 dB) at approximately 5.5 mi (8.9 km) and below 1.0 psf at approximately 15.97 mi (25.7 km) from the landing area. These psf estimates are based, in part, on actual observations of Falcon 9 boost-backs and landings at Cape Canaveral and on autonomous droneships in the Pacific Ocean. In addition, the Air Force is estimating that the NCI may be impacted by a sonic boom of up to 3.1 psf (137 dB) during the return flight based on the higher of the two predictions between the model run by Wyle and Blue Ridge Research Consultation (James et al. 2017). The actual location of this overpressure may shift (e.g., offshore) as atmospheric conditions vary throughout the year. Depending on the distance from the landing pad, the sonic boom may be heard before or within a few seconds following the landing of the Falcon 9 first stage.

Once the first stage has landed and been secured, any remaining liquid oxygen and rocket propellant would be properly off-loaded and disposed or re-used. LZ-4, located at SLC-4W, is the designated landing location for all boost-back actions at SLC-4W. LZ-4 was designed to contain all stormwater that comes in contact with it and route the water to an existing 100,000-gallon retention basin. This is achieved through a 1 percent slope that sends water to the northwest end of the pad. From there, a collection point routes all water to the 100,000-gallon retention basin. During landing operations, remotely controlled water cannons would be used to provide streams of water to help statically discharge the rocket in addition to being able to fight any fires that occur on the pad. Water volumes for normal operations average around 40,000 gallons. During storm events, the secondary containment structure is sized to handle water volumes from a 100-year storm event. Water collected in the retention pond would be pumped to an existing spray field for disposal. Nominal volumes of rocket propellant and liquid oxygen that would be offloaded post landing are 150 gallons and 300 gallons respectively. If spilled, liquid oxygen evaporates almost immediately after contact with ambient conditions. Rocket propellant would runoff into the retention basin. Any rocket propellant visibly floating on the surface of the water in the retention basin would be collected using floating absorbent pads before discharge to the spray field. Therefore, in the event of a spill, no liquid oxygen or rocket propellant would be released outside of SLC-4.

Flame Duct Water Release

Based on the September 29, 2013, Falcon 9 launch at SLC-4, the Air Force estimates that, of the 200,000 gallons of water placed in the flame duct, half would remain in the flame duct and half would be expelled as water vapor (approximately 25,000 gallons) and liquid water (approximately 75,000 gallons). Although the proposed civil structure would be designed to capture the majority of the water to the extent possible, up to 25,000 gallons liquid water would be discharged to Spring Canyon. Water discharged as part of this action would meet the thresholds identified by the Regional Water Quality Control Board in the statewide low threat discharge to surface waters permit. The maximum temperature of the water and water vapor is expected to be up to 130 degrees Fahrenheit by the point at which it would reach Spring Canyon.

Civil Water Diversion Structure and Retention Basin

SpaceX would construct a civil water diversion structure and retention basin to help divert and retain flame bucket water on-site and reduce discharge to Spring Canyon. The slope from the end of the flame duct to the perimeter concrete area (perimeter apron) would be covered with gunite to reduce erosion. SpaceX would place 2-ft tall stem walls at the western and eastern edges to anchor the structure, and would conduct some minor grading of this area to provide a constant slope. A 250-ft (76.2-meter (m)) perimeter wall would be constructed with concrete on top of the existing perimeter apron along the inside of the fence line. This wall would serve to redirect water expelled from the flame duct and divert it down slope to a to-be-constructed 60,000-gallon capacity retention basin to minimize water being discharged to Spring Canyon. The wall would be 4 ft high with a 5 ft deep by 4 ft wide footer. The footer would be excavated inside the fence line through the existing perimeter apron and the soil would be relocated to a stockpile onsite. The floor of the retention basin would utilize the existing concrete of the perimeter apron.

All equipment access to the construction area would be via existing roads or the existing apron. Concrete would be brought in with a concrete pump from the access road at the flame duct area. Valves would be installed on the existing stormwater drainage inlets to ensure that no water enters the inlets during launch operations (inlets would only be opened during storm events). Water collected in the retention basin would be pumped to the existing spray field via a 3-inch gas pump that has a strainer on the inlet with 1/8th inch holes. After launch operations, the water in the retention basin would be removed to below 4 inches in depth within 48 hours to reduce chances of attracting frogs and other animals.

Spring Canyon Vegetation Removal

SpaceX plans to remove all vegetation to just above ground level within a 3.327-acre impact area of Spring Canyon, to include areas affected by liquid and water vapor expelled from the flame duct, to avoid and minimize direct impacts to migratory birds by removing habitat in which they might normally nest. Removal of the vegetation would be performed by mowers and hand equipment outside of bird nesting season (Feb 15 – Aug 15), and attempts would be made to reduce impacts to the drainage as much as possible. Additional vegetation removal (e.g., mowing) of the impact area would also be performed outside of bird nesting season annually as needed to maintain low stature vegetation.

Spring Canyon Riparian Mitigation

The proposed project would result in an estimated 1.121 acres of permanent impacts (removal) to willow riparian habitat in Spring Canyon. To offset these impacts, the California State Water Resources Control Board would require mitigation at a 2:1 ratio (area of habitat enhanced through invasive species control to area of riparian woodland impacted). This mitigation would be accomplished by treating at least 2.25 acres of target invasive species within the Spring Canyon riparian area and within the Spring Canyon bed and bank area (from Coast Road to the west, beyond SLC-4). Target invasive species – Jubata grass (*Cortaderia jubata*), iceplant (*Carpobrotus edulis*), fennel (*Foeniculum vulgare*), poison hemlock (*Conium maculatum*), black mustard (*Brassica nigra*), and summer mustard (*Hirschfeldia incana*) – would be treated using a glyphosate-based herbicide formulation approved for aquatic use. Herbicide would be applied to invasive plants up to the edge of surface water but not applied directly to any surface water. The Spring Canyon Riparian Mitigation Plan (ManTech 2017b) contains additional details of the proposed habitat enhancement.

Minimization and Monitoring Measures

The Air Force will implement the following measures to minimize adverse effects to, and monitor effects of the proposed project on, El Segundo blue butterflies, California red-legged frogs, California least terns, and western snowy plovers. The Monitoring and Minimization Plan (ManTech 2017c) contains additional details of the following proposed measures.

El Segundo Blue Butterfly

1. The condition of seacliff buckwheat stands in the areas surrounding SLC-4 will be evaluated annually. Sites consistently supporting high numbers of mature seacliff buckwheat plants will be prioritized for El Segundo blue butterfly surveys during the flight season.

2. The nearest known occupied habitat based upon recurring annual surveys will be monitored at least once annually during the flight season. This has been Avery Road or near the intersection of Coast and Bear Creek Roads; however, additional sites may be identified.

3. Monitoring will be conducted for at least 3 years. If El Segundo blue butterflies are found in the area experiencing sonic boom in excess of 5.0 psf, or if occupancy is re-established and potential launch or landing related impacts are detected, additional monitoring may be conducted.

4. Habitat enhancement will be performed within suitable but not known to be occupied habitat on Tranquillon Ridge along Honda Ridge Road adjacent to two existing El Segundo blue butterfly restoration efforts on south VAFB. Habitat enhancement will consist of removing invasive plants and planting of seacliff buckwheat at a 2:1 ratio (area of habitat enhanced through invasive plant removal to area of potential El Segundo blue butterfly habitat impacted, and number of seacliff buckwheat planted to number of seacliff buckwheat impacted, by the flame duct action).

5. Seacliff buckwheat will be propagated from seed sourced on VAFB, will be grown without insecticides, and will be free of Argentine ants.

6. Plantings will be conducted during the wet season (December 1 – March 15), and plants will be watered at the time of installation if rain is not forecasted with more than 60 percent certainty within 3 days of planting.

7. The following measures will be implemented to reduce the risk of impacts to seacliff buckwheat and El Segundo blue butterflies associated with El Segundo blue butterfly habitat enhancement activities:

    a. Individuals trained and proficient in seacliff buckwheat identification will conduct all herbicide applications;

    b. Seacliff buckwheat will be avoided during herbicide application with plants covered to prevent drift if broad spectrum herbicide application is necessary adjacent to plants; alternatively, herbicide application devices that can direct microapplication, by wand or drip, without risk to nearby plants can be used.

    c. Herbicide treatments will occur under low wind conditions; and

    d. Herbicide application will take place outside of the El Segundo blue butterfly flight season (June 1 – September 15) when adults or larvae may be present.

8. The following measures will be implemented to reduce the risk of impacts to seacliff buckwheat and El Segundo blue butterflies associated with Spring Canyon riparian mitigation activities:

    a. All individuals conducting herbicide application will be trained and demonstrate proficiency in the identification and avoidance of seacliff buckwheat;

    b. Established roads, both paved and unpaved, will be used for vehicle access;

    c. Herbicide will be applied in accordance with the pesticide label and Department of Defense (DoD) recommendations. The proposed herbicide formulation is currently DoD approved;

    d. Herbicide mixing will occur in non-sensitive areas in accordance with the VAFB Integrated Pest Management Plan;

    e. Herbicide treatments will only occur under low wind conditions to avoid drift to non-target species;

    f. Seacliff buckwheat, although unlikely to occur in the riparian zone, will be avoided during all application of herbicides if encountered; and

    g. No broad scale herbicide application will take place in areas supporting seacliff buckwheat from May 1 through September 30.

California Red-legged Frog

1. A qualified biologist will conduct pre-activity surveys for California red-legged frog in Spring Canyon adjacent to SLC-4 and will conduct post-activity surveys to document any injured or killed individuals.

2. If present within the area to be impacted by water and water vapor, adult California red-legged frogs will be captured when possible and relocated to the nearest suitable habitat within Spring Canyon, outside of the impact zone.

3. One day prior to vegetation removal, a qualified biologist will conduct surveys for California red-legged frog within the area to be affected. Any California red-legged frogs present will be captured if possible and released at the nearest suitable habitat within Spring Canyon outside of the area to be affected by vegetation removal, as determined by the biologist. The biologist will also be present during vegetation removal to capture and relocate California red-legged frogs encountered to the extent that safety precautions allow. This biologist will also search for injured or dead California red-legged frogs after vegetation removal to document take.

4. During construction of the civil water diversion structure, the following measures will be implemented:

    a. All work will occur during daylight hours during periods when there is no rainfall;

    b. A qualified biologist will monitor grading of the gunite application site;

    c. Any open holes or trenches will be covered with plywood or metal sheets if left over night to minimize the risk of entrapment of California red-legged frogs;

    d. A qualified biologist will survey the site, including any open holes or trenches, each day prior to initiation of work; and

    e. Any California red-legged frogs encountered during construction of the civil water diversion structure will be captured, if possible, and relocated out of harm's way to the nearest suitable habitat.

5. The effects of sonic booms on California red-legged frogs breeding behavior in Cañada Honda Creek, and in upper Shuman Creek (as a "control" site) will be monitored using bioacoustics data loggers. Bioacoustic monitoring (one event) will be conducted during the first wet season launch/landing, between November 30 and April 1. If no breeding California red-legged frogs are present during this launch, the monitoring will be attempted during the next wet season landing at SLC-4W.

6. The Air Force will continue to conduct baseline studies and population monitoring of California red-legged frog across the base, assess habitat, study the incidence of chytrid fungus, and assess other means of enhancing habitat across VAFB.

7. The following measures will be implemented to reduce the risk of impacts to California red-legged frogs associated with Spring Canyon riparian mitigation activities:

    a. All individuals conducting herbicide application will be trained and demonstrate proficiency in the identification and avoidance of special status species;

    b. Established roads, both paved and unpaved, will be used for vehicle access;

    c. Herbicide will be applied in accordance with the pesticide label and DoD recommendations. The proposed herbicide formulation is currently DoD approved;

    d. Herbicide mixing will occur in non-sensitive areas in accordance with the VAFB Integrated Pest Management Plan;

    e. Herbicide treatments will only occur under low wind conditions to avoid drift to non-target species;

    f. Herbicide application will take place outside of the rainy season (October 15 to March 15);

    g. No vehicle traffic will occur through surface water if present unless the route is pre-cleared by a qualified biologist;

    h. All access for treatments will be restricted to daylight hours;

    i. No glyphosate will be used in ephemeral aquatic habitats during the rainy season (October 15 – March 15);

    j. No glyphosate will be used within 15 ft. (4.6 m) of aquatic habitats when surface water or surface saturation of soils is present; and

    k. No glyphosate will be used in aquatic habitats 24 hours before or after a significant precipitation event (0.1 inches or more).

California Least Tern

1. Monitoring of California least terns at the Santa Ynez River estuary will be conducted for landings events at SLC-4W to determine potential effects from the proposed activities, including mortality, injury, or changes to habitat use patterns or behavior. If California least terns are present at the Santa Ynez River estuary (typically April 15 to August 15), a Service-approved biologist will conduct daily counts of California least terns beginning 3 days before the landing event through 3 days after. If practicable and not resulting in safety concerns to the monitor, visual and/or video monitoring of terns will be conducted during daytime launches.

2. If active California least tern nests are present at the Purisima Point nesting colony, motion triggered video cameras will be placed at up to 10 percent of active nests to monitor potential impacts to the nest as a result of the launch and landing. Cameras will be placed in a manner to minimize disturbance to nesting terns; this will be determined in the field based on the best judgement of permitted tern monitors.

3. Acoustic monitoring will be conducted when terns are present at the Purisima Point Colony or Santa Ynez River estuary throughout a range of varying conditions. Discussions between the Air Force and the Service after a minimum of four landing events at SLC-4W will be conducted to reach consensus on removal of this requirement.

Western Snowy Plover

1. Monitoring of western snowy plovers will be conducted for landing events at SLC-4W between March 1 and September 30. Nesting western snowy plovers nearest to SLC-4W, which will experience the highest sonic boom overpressures (e.g., 7-8 psf), will be monitored 3 days before and 3 days after the landing event to characterize potential impacts on reproductive success. This monitoring area is hereafter referred to as South Surf Beach to be consistent with the Monitoring and Minimization Plan (ManTech 2017c).

2. Up to 10 percent of active western snowy plover nests at South Surf Beach will be monitored with motion triggered video cameras for potential impacts to the nest as a result of the launch and landing. Cameras will be placed in a manner to minimize disturbance to nesting plovers; this will be determined in the field based on the best judgement of permitted plover monitors.

3. Acoustic monitoring will be conducted during the western snowy plover breeding season at South Surf Beach, throughout a range of varying conditions. Discussions between the Air Force and the Service after a minimum of four landing events will be conducted to reach consensus on removal of this requirement.

4. The Air Force will continue to perform annual management and monitoring of western snowy plover on Base, including habitat enhancement to expand potential breeding habitat, population monitoring, nest monitoring, and predator management. These activities were previously consulted on in our biological opinion dated February 4, 2015, for the Air Force's 2014-2018 Beach Management Plan and Water Rescue Training at VAFB. Restoration of western snowy plover habitat was proposed to compensate for the adverse effects caused by allowing recreational access in western snowy plover nesting habitat, and annual nest monitoring of all western snowy plovers throughout VAFB is a term and condition of the biological opinion.

5. If western snowy plover eggs or chicks are abandoned or directly impacted and injured by launch activities, these animals will be transferred to the Santa Barbara Zoo for rehabilitation to the extent possible by Service-qualified individuals. During the nesting season, an incubator will be on standby operated by qualified individuals to receive abandoned eggs or chicks and safely transport them to the Santa Barbara Zoo for rehabilitation. This measure will be reviewed and adapted or eliminated if necessary depending on reviewing the number of eggs/chicks/adults requiring rehabilitation after the first year of activity.

General Environmental Protection Measures

The Air Force and SpaceX are already implementing the following general environmental protection measures at SLC-4. These measures avoid and minimize the risk of impacts to federally listed species in the event of accidental spills. A site-specific Stormwater Pollution Prevention Plan has been prepared and implemented for SLC-4. Stormwater Best Management Practices are currently implemented following the latest California Stormwater Quality Association's Stormwater Best Management Practices Handbook. As discussed above, LZ-4 was designed to contain all stormwater that comes in contact with it and route it to a 100,000-gallon retention basis. If there is a fuel spill, liquid oxygen would evaporate and rocket propellant would end up in in the retention basin. Any rocket propellant visibly seen floating on the surface of water in the retention basin will be collected using floating absorbent pads before discharge to the spray field. Emergency response procedures for hazardous materials spills are established in VAFB's Hazardous Materials Emergency Response Plan (Air Force 2010). These procedures will be fully implemented in the event of a hazardous materials spill.

ANALYTICAL FRAMEWORK FOR THE JEOPARDY DETERMINATION

Section 7(a)(2) of the Endangered Species Act requires that Federal agencies ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of listed species. "Jeopardize the continued existence of" means "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02).

The jeopardy analysis in this biological opinion relies on four components: (1) the Status of the Species, which describes the range-wide condition of the El Segundo blue butterfly, California red-legged frog, California least tern and western snowy plover, the factors responsible for that condition, and survival and recovery needs; (2) the Environmental Baseline, which analyzes the condition of the El Segundo blue butterfly, California red-legged frog, California least tern and western snowy plover in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the El Segundo blue butterfly, California red-legged frog, California least tern and western snowy plover; (3) the Effects of the Action, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the El Segundo blue butterfly, California red-legged frog, California least tern and western snowy plover; and (4) the Cumulative Effects, which evaluates the effects of future, non-Federal activities, that are reasonably certain to occur in the action area, on the El Segundo blue butterfly, California red-legged frog, California least tern and western snowy plover.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the current status of the El Segundo blue butterfly, California red-legged frog, California least tern and western snowy plover, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to reduce appreciably the likelihood of both the survival and recovery of these species in the wild by reducing the reproduction, numbers, and distribution of that species.

STATUS OF THE SPECIES

El Segundo Blue Butterfly

Legal Status

The El Segundo blue butterfly was federally listed as endangered on June 1, 1976 (41 Federal Register (FR) 22041). We have not designated critical habitat for the subspecies. We issued a recovery plan for the El Segundo blue butterfly on September 28, 1998 (Service 1998), and completed a 5-year status review for the subspecies in 2008 (Service 2008).

Natural History

The El Segundo blue butterfly is in the family Lycaenidae. It is one of five subspecies comprising the polytypic species, the square-spotted blue butterfly (*Euphilotes battoides*). Like all species in the genus *Euphilotes*, the El Segundo blue butterfly spends its entire life cycle in intimate association with a species of buckwheat, in this case seacliff buckwheat (*Eriogonum parvifolium*); however, the nearly complete association of all life stages with a single plant is unique among North American butterflies. El Segundo blue butterfly adults mate, nectar, lay eggs, perch, and in most cases probably die on buckwheat flowerheads (Mattoni 1990).

The adult stage of the El Segundo blue butterfly generally begins in early June and concludes in early to mid-September. The onset of this stage is closely synchronized with the beginning of the flowering season for seacliff buckwheat (Mattoni 1990; Pratt and Bailmer 1993). Adult females fly to seacliff buckwheat flower heads where they mate with males that are constantly moving among flower heads (Service 1998). The El Segundo blue butterfly lays eggs in seacliff buckwheat flower heads, and the eggs hatch within 3 to 5 days. The larvae then undergo four instars to complete growth, a process that takes 18 to 25 days (Service 1998). Larvae remain concealed within flower heads and initially feed on pollen, then switch to feeding on seeds sometime during the first and second instar (G. Pratt, pers. comm. 2006a).

At the end of the fourth instar, larvae disperse from the flowerheads, fall or crawl to the ground, and pupate in the soil. This typically occurs by September, by which time seacliff buckwheat plants have generally senesced. Larvae may find a suitable site directly underneath seacliff buckwheat plants or migrate (wander) away from the plant to a more suitable site. This wandering stage is short (likely 1 day or less). Larvae may travel up to approximately 25 ft (7.6 m) from the nearest seacliff buckwheat plant, but we expect that most larvae remain within the immediate vicinity of a seacliff buckwheat plant (R. Arnold, pers. comm. 2013a,b). Larvae pupate in sandy soils, clay soils, shale, sandstone, and even cracks and softer portions of road, and seem to prefer softer soils compared to harder substrates (Arnold, pers. comm. 2013a,b). Once they find a suitable site, larvae burrow into the ground and remain there until at least 0.5 inch (1.3 centimeters (cm)) of rain penetrates the soil to accumulate enough moisture for the pupae to develop into an adult (Pratt, pers. comm. 2006a).

The adult butterfly emerges the following June; however, some pupae may remain in diapause for 2 or more years (Service 1998), and may remain in diapause for up to 6 years (Pratt, pers. comm. 2013). Some pupae at every site likely remain in diapause every year (some pupae stay in diapause each year even in good years) (Arnold, pers. comm. 2013a,b).

The population dynamics of the El Segundo blue butterfly are closely allied with the seacliff buckwheat. Although individual plants may live 20 years or more, young plants generally do not flower until their second year of growth (Arnold and Goins 1987). Younger and older plants do not produce as many flowers as middle-aged buckwheat plants, which support the most butterflies (Arnold and Goins 1987). Field observations suggest that most solitary buckwheat plants less than about 5 years of age do not produce enough flowers for larvae to effectively utilize them (Arnold 1983). Thus, survival of the El Segundo blue butterfly is dependent upon maintenance of middle-aged buckwheat plants, plus recruitment of younger plants to replace older individual plants that senesce.

Arnold (1986) conducted capture-recapture studies in Los Angeles County and reported that the majority of El Segundo blue butterflies moved 100 ft (31 m) or less between captures. Approximately 93 percent of females and males moved 200 ft (61 m) or less between captures. We note that Arnold derived the 200-ft (61-m) buffer from studies at the Chevron Refinery (Chevron) in El Segundo. The Chevron site is approximately 1.5 acres and is surrounded by urban areas. The area contains high concentrations of seacliff buckwheat plants that grow in close proximity to one another. Therefore, adult El Segundo blue butterflies would not have to disperse very far to locate suitable seacliff buckwheat flowerheads. In contrast, the preserve at the Los Angeles International Airport (LAX) is 200 acres and contains widely scattered seacliff buckwheat plants. At the LAX site, El Segundo blue butterflies were detected dispersing up to 1.36 mi (2.18 km), and the average movement of individuals at LAX was more than twice that of individuals at the Chevron location (Arnold 1986). Additionally, adult El Segundo blue butterflies routinely dispersed up to 0.5 mi (0.8 km) from occupied locations to colonize restoration sites in Los Angeles and Redondo Beach. Because biologists have documented El Segundo blue butterflies dispersing farther distances in larger areas that contain more widely scattered plants, the 200-ft (61-m) buffer may represent the lower end of the dispersal distance capability of the El Segundo blue butterfly. Based on the habitat and area at VAFB, we expect that dispersal distance would be greater in Santa Barbara County where the seacliff buckwheat plants are much less dense than at Chevron, as it was at the LAX site compared to the Chevron site; however, we do not know, through actual measurement, the minimum, average, or maximum dispersal distances of the El Segundo blue butterfly in Santa Barbara County.

Rangewide Status

For the years following the subspecies' recognition as a new taxon (Shields 1975), researchers presumed the El Segundo blue butterfly was endemic to southwestern Los Angeles County in coastal southern California. Museum records reveal that the El Segundo blue butterfly was once widespread on the El Segundo sand dunes and specimens were collected at El Segundo, Redondo Beach, Manhattan Beach, and at several locations on the Palos Verdes peninsula (Donahue 1975). Currently, the El Segundo blue butterfly occurs at four locations in Los Angeles County: the Ballona Wetlands, the Airport Dunes, the Chevron Preserve, and Malaga Cove.

Seacliff buckwheat occurs over a larger range than the known range of the El Segundo blue butterfly; seacliff buckwheat occurs from San Diego County to the northern end of Monterey County (Pratt, pers. comm. 2006b; Jepson 2012; CalFlora 2013). The southern extent of the El Segundo blue butterfly's known distribution is Malaga Cove in Los Angeles County and before it was discovered in Santa Barbara County in 2005, the northern extent of its known distribution was the Ballona Wetlands in Los Angeles County. The El Segundo blue butterfly appears further limited to areas with high sand content (Service 1998).

The El Segundo blue butterfly was reported to occur at VAFB in 2005 by Dr. Gordon Pratt and by Dr. Pratt and Dr. Richard Arnold in 2007 (Pratt, pers. comm. 2006a; L. Bell, pers. comm. 2007). Questions arose whether the butterflies observed at VAFB are actually the El Segundo blue butterfly or a morphologically similar species. The genus *Euphilotes* is complex and diverse. Mattoni (1988) reported cases of cryptic speciation in the genus (i.e., some distantly related species are very similar morphologically). Entomologists typically use wing characters to identify butterflies; however, they are not as useful in *Euphilotes* (as a genus) because these characters can vary between individuals within the same taxon (and particularly in the *E. battoides* complex). In these instances, additional information and other characters are necessary for a definitive identification such as larval host plant, genitalia morphology, flight season, location, and genetics (G. Ballmer, pers. comm. 2006).

Because butterflies in the genus *Euphilotes* can be very similar morphologically yet substantially different genetically (Mattoni 1990; Pratt 1994), individual male butterflies were collected to compare the genetic signatures among the butterflies from VAFB with known El Segundo blue butterflies from Los Angeles County (Pratt and Stouthamer 2008). We have reviewed the results of the genetic study and determined that the resulting information was not conclusive enough to make a determination that the butterfly in question is not the El Segundo blue butterfly.

Given that the geographic separation between the known occurrences of El Segundo blue butterfly in Santa Barbara County and Los Angeles County is approximately 120 mi, and considering the relatively limited dispersal capability of the El Segundo blue butterfly, the butterflies observed at VAFB may not be El Segundo blue butterflies, but rather an undescribed, cryptic species with the same morphology, larval food plant, flight season, and genitalia. On the contrary, a continuous distribution between Santa Barbara and Los Angeles Counties may have existed, but was separated over time either naturally or by anthropogenic causes. The distribution of seacliff buckwheat, the butterfly's limited dispersal capabilities, and the increasing fragmentation of native habitat in this region support this concept.

A third possibility is that the butterflies currently have a continuous distribution between Santa Barbara and Los Angeles Counties, but have not yet been documented in the intervening areas; however, no areas with El Segundo blue butterfly occurrences have been documented between the populations in Santa Barbara and Los Angeles Counties. Another possibility is that El Segundo blue butterflies do not occupy the areas between Santa Barbara and Los Angeles Counties, but have dispersed from one area to another. A long-distance dispersal event is more likely to occur during one dispersal event rather than multiple events in a stepping-stone fashion because the probability of a single longer dispersal event is greater than the combined probability of two (or more) consecutive shorter dispersal events (Gillespie et al. 2012, Crisp et al. 2011). Strong wind events (e.g., Santa Ana winds, hurricanes) are a widely recognized mechanism for successful long distance dispersal events and have been determined to be the vector for the successful colonization of remote islands by plants, animals (e.g., butterflies), and arthropods, which are generally less dispersive (Gillespie et al. 2012, Zimmerman 1948).

Based on wing morphology, flight period, genitalia, and host plant association, the individuals on VAFB were determined to be more similar to El Segundo blue butterfly than to any other known *Euphilotes* species or *E. battoides* subtaxon (Ballmer, pers. comm. 2006; Pratt, pers. comm. 2006b). Therefore, we consider this species to be El Segundo blue butterfly until we receive definitive information demonstrating otherwise.

Threats

Urbanization and land conversion have fragmented the historical range of the El Segundo blue butterfly such that extant populations now operate as independent units rather than parts of a metapopulation or a single, cohesive, wide-ranging population (Service 2008). Small populations have higher probabilities of extinction than larger populations because their low abundance renders them susceptible to inbreeding, loss of genetic variation, high variability in age and sex ratios, demographic stochasticity, and other random, naturally occurring events such as droughts or disease epidemics (Soulé 1987). Additionally, isolated populations are more susceptible to elimination by stochastic events because the likelihood of recolonization following such events is negatively correlated with the extent of isolation (Wilcox and Murphy 1985). Given the low dispersal potential of El Segundo blue butterflies, the likelihood that this subspecies would naturally recolonize a site decreases as the distance between the occupied sites increases. Therefore, if El Segundo blue butterflies are extirpated from a site that is a greater distance from an occupied site than the subspecies' dispersal distance, the site may not be recolonized.

Habitat fragmentation is detrimental to small, isolated populations and produces edge effects that facilitate the introduction of invasive nonnative plant species that may outcompete and displace seacliff buckwheat. Relatively fast-growing invasive nonnative plants such as acacia (*Acacia* spp.), iceplant, other buckwheat species (*Eriogonum* spp.), and nonnative grasses such as veldt grass (*Ehrharta calycina*) compete with seacliff buckwheat and decrease the likelihood that seacliff buckwheat will sprout and mature (Mattoni 1990).

Furthermore, Pratt (1987) observed numerous insects living in seacliff buckwheat inflorescences along with El Segundo blue butterfly larvae, including lepidopterous larvae in the families of Cochylidae, Gelechiidae, Geometridae, Riodinidae, and even other Lycaenidae. Parasitoids (e.g., Branchoid wasp (*Cortesia* spp.)) and small predators may also affect El Segundo blue butterflies (Mattoni 1990).

In general, the El Segundo blue butterfly is threatened by competition, predation, and parasitism by other insects utilizing seacliff buckwheat; loss of habitat and habitat fragmentation due to development; and loss of habitat due to displacement of seacliff buckwheat by nonnative vegetation.

Recovery

The recovery plan for the El Segundo blue butterfly identifies four recovery units (Ballona, Airport, El Segundo, and Torrance) to conserve and maintain the species' distribution and its genetic diversity throughout its present range (Service 1998). At least one population is needed in each of the four units to reduce the risk of extinction from random events that may affect any one local area. We wrote the recovery plan for the El Segundo blue butterfly prior to the discovery of the species on VAFB, so the plan does not consider the Base.

The recovery of the El Segundo blue butterfly is dependent on protection of occupied and potential habitat. Occupied habitat contains individuals of the subspecies and associated habitat used for breeding, feeding, shelter, and/or as a dispersal corridor. Areas that contain El Segundo sand dune and are not currently occupied by El Segundo blue butterflies, but could be managed and restored, constitute potential habitat for the subspecies. Colonization of potential areas by El Segundo blue butterflies would result in increased numbers of individuals, ultimately expanding the number and size of populations until the subspecies reaches the point where it can be downlisted to threatened. According to the recovery plan (Service 1998), the El Segundo blue butterfly can be considered for downlisting to threatened status when:

1. At least one secure population in each of the four RUs is permanently protected. The Airport Dunes located in the Airport recovery unit contains the largest population of the butterfly and is the most likely one that can survive disease, predators, parasites, and other perturbations. The Airport Dunes must be one of the protected populations.

2. Each of the four populations are managed to maintain coastal dune habitat dominated by local native species including coast [seacliff] buckwheat.

3. As determined by a scientifically credible monitoring plan, each of the four populations must exhibit a statistically significant upward trend (based on transect counts) for at least 10 years (approximately 10 butterfly generations). Population management in each RU must ensure that discrete population growth rates are maintained at or above 1.0, indicating a stable or increasing population.

4. A program is initiated to inform the public about the El Segundo blue butterfly and its habitat.

<u>5-Year Review</u>

Biologists discovered the El Segundo blue butterfly on the Palos Verdes Peninsula near Point Vicente in Los Angeles County (RBF Consulting 2001; Pratt 2006 in Service 2008) and at VAFB in Santa Barbara County subsequent to the subspecies' listing and prior to the 2008 5-year status review. Thus, the original listing document and the recovery plan did not consider these areas. The 5-year review for the El Segundo blue butterfly states that the subspecies continues to be threatened by habitat degradation; habitat fragmentation; introduction of parasitic, competing and predatory insect species; and stochastic extinction. In consideration of its limited and fragmented distribution, overall small population size, and continued threats as discussed, we determined that the El Segundo blue butterfly remains in danger of extinction throughout all or a significant portion of its range (Service 2008); however, because of the recent success of habitat restoration efforts along Torrance, Redondo, and Dockweiler Beaches (Los Angeles County) in 2007, we conclude that this subspecies can respond positively to management of its habitat and its recovery potential has improved.

California Red-legged Frog

Legal Status

The California red-legged frog was federally listed as threatened on May 23, 1996 (61 Federal Register (FR) 25813, Service 1996). The Service designated revised critical habitat for the California red-legged frog on March 17, 2010 (75 FR 12816, Service 2010a). We issued a recovery plan for the species on May 28, 2002 (Service 2002).

Natural History

The California red-legged frog uses a variety of habitat types, including various aquatic systems, riparian, and upland habitats. They have been found at elevations ranging from sea level to approximately 5,000 ft. California red-legged frogs use the environment in a variety of ways, and in many cases they may complete their entire life cycle in a particular area without using other components (i.e., a pond is suitable for each life stage and use of upland habitat or a riparian corridor is not necessary). Populations appear to persist where a mosaic of habitat elements exists, embedded within a matrix of dispersal habitat. Adults are often associated with dense, shrubby riparian or emergent vegetation and areas with deep (greater than 1.6 ft) still or slow-moving water; the largest summer densities of California red-legged frogs are associated with deep-water pools with dense stands of overhanging willows (*Salix* spp.) and an intermixed fringe of cattails (*Typha latifolia*) (Hayes and Jennings 1988).

California red-legged frog breed in aquatic habitats; larvae, juveniles, and adult frogs have been collected from streams, creeks, ponds, marshes, deep pools and backwaters within streams and creeks, dune ponds, lagoons, and estuaries. They frequently breed in artificial impoundments such as stock ponds, given the proper management of hydro-period, pond structure, vegetative cover, and control of exotic predators. While frogs successfully breed in streams and riparian systems, high spring flows and cold temperatures in streams often make these sites risky egg and tadpole environments. An important factor influencing the suitability of aquatic breeding sites is the general lack of introduced aquatic predators. Accessibility to sheltering habitat is essential for the survival of California red-legged frogs within a watershed, and can be a factor limiting population numbers and distribution. Hayes and Tennant (1985) found juveniles to seek prey diurnally and nocturnally, whereas adults were largely nocturnal.

During periods of wet weather, starting with the first rains of fall, some individual California red-legged frogs may make long-distance overland excursions through upland habitats to reach breeding sites. In Santa Cruz County, Bulger et al. (2003) found marked California red-legged frogs moving up to 1.7 mi through upland habitats, via point-to-point, straight-line migrations without apparent regard to topography, rather than following riparian corridors. Most of these overland movements occurred at night and took up to 2 months. Similarly, in San Luis Obispo County, Rathbun and Schneider (2001) documented the movement of a male California red-legged frog between two ponds that were 1.78 mi apart in less than 32 days; however, most California red-legged frogs in the Bulger et al. (2003) study were non-migrating frogs and always remained within 426 ft of their aquatic site of residence (half of the frogs always stayed within 82 ft of water). Rathbun et al. (1993) radio-tracked three California red-legged frogs near the coast in San Luis Obispo County at various times between July and January; these frogs also stayed rather close to water and never strayed more than 85 ft into upland vegetation. Scott (2002) radio-tracked nine California red-legged frogs in East Las Virgenes Creek in Ventura County from January to June 2001, which remained relatively sedentary as well; the longest within-channel movement was 280 ft and the farthest movement away from the stream was 30 ft.

After breeding, California red-legged frogs often disperse from their breeding habitat to forage and seek suitable dry-season habitat. Cover within dry-season aquatic habitat could include boulders, downed trees, and logs; agricultural features such as drains, watering troughs, spring boxes, abandoned sheds, or hay-ricks, and industrial debris. California red-legged frogs use small mammal burrows and moist leaf litter (Rathbun et al. 1993; Jennings and Hayes 1994); incised stream channels with portions narrower and deeper than 18 inches may also provide habitat (61 FR 25814). This type of dispersal and habitat use, however, is not observed in all California red-legged frogs and is most likely dependent on the year-to-year variations in climate and habitat suitability and varying requisites per life stage.

Although the presence of California red-legged frogs is correlated with still water deeper than approximately 1.6 ft, riparian shrubbery, and emergent vegetation (Jennings and Hayes 1994), California red-legged frogs appear to be absent from numerous locations in the species' historical range where these elements are well represented. The cause of local extirpations does not appear to be restricted solely to loss of aquatic habitat. The most likely causes of local extirpation are thought to be changes in faunal composition of aquatic ecosystems (i.e., the introduction of non-native predators and competitors) and landscape-scale disturbances that disrupt California red-legged frog population processes, such as dispersal and colonization. The introduction of contaminants or changes in water temperature may also play a role in local extirpations. These changes may also promote the spread of predators, competitors, parasites, and diseases.

<u>Rangewide Status</u>

The historical range of the California red-legged frog extended coastally from southern Mendocino County and inland from the vicinity of Redding, California, southward to northwestern Baja California, Mexico (Storer 1925, Jennings and Hayes 1985; Shaffer et al. 2004). The California red-legged frog has sustained a 70 percent reduction in its geographic range because of several factors acting singly or in combination (Davidson et al. 2001). Over-harvesting, habitat loss, non-native species introduction, and urban encroachment are the primary factors that have negatively affected the California red-legged frog throughout its range (Jennings and Hayes 1985, Hayes and Jennings 1988). Habitat loss and degradation, combined with over-exploitation and introduction of exotic predators, were important factors in the decline of the California red-legged frog in the early to mid-1900s.

Continuing threats to the California red-legged frog include direct habitat loss due to stream alteration and loss of aquatic habitat, indirect effects of expanding urbanization, competition or predation from non-native species including the bullfrog, catfish (*Ictalurus* spp.), bass (*Micropterus* spp.), mosquito fish (*Gambusia affinis*), red swamp crayfish (*Procambarus clarkii*), and signal crayfish (*Pacifastacus leniusculus*). Chytrid fungus (*Batrachochytrium dendrobatidis*) is a waterborne fungus that can decimate amphibian populations, and is considered a threat to California red-legged frog populations.

A 5-year review of the status of the California red-legged frog was initiated in May 2011, but has not yet been completed.

<u>Recovery</u>

The final recovery plan for the California red-legged frog (Service 2002) states that the goal of recovery efforts is to reduce threats and improve the population status of the California red-legged frog sufficiently to warrant delisting. The recovery plan describes a strategy for delisting, which includes: (1) protecting known populations and reestablishing historical populations; (2) protecting suitable habitat, corridors, and core areas; (3) developing and implementing management plans for preserved habitat, occupied watersheds, and core areas; (4) developing land use guidelines; (5) gathering biological and ecological data necessary for conservation of the species; (6) monitoring existing populations and conducting surveys for new populations; and (7) establishing an outreach program. The California red-legged frog would be considered for delisting when:

1. Suitable habitats within all core areas are protected and/or managed for California red-legged frogs in perpetuity, and the ecological integrity of these areas is not threatened by adverse anthropogenic habitat modification (including indirect effects of upstream/downstream land uses).

2. Existing populations throughout the range are stable (i.e., reproductive rates allow for long-term viability without human intervention). Population status will be documented through establishment and implementation of a scientifically acceptable population monitoring program for at least a 15-year period, which is approximately 4 to 5 generations of the California red-legged frog. This 15-year period should coincide with an average precipitation cycle.

3. Populations are geographically distributed in a manner that allows for the continued existence of viable metapopulations despite fluctuations in the status of individual populations (i.e., when populations are stable or increasing at each core area).

4. The species is successfully reestablished in portions of its historical range such that at least one reestablished population is stable/increasing at each core area where California red-legged frog are currently absent.

5. The amount of additional habitat needed for population connectivity, recolonization, and dispersal has been determined, protected, and managed for California red-legged frogs.

The recovery plan identifies eight recovery units based on the assumption that various regional areas of the species' range are essential to its survival and recovery. The recovery status of the California red-legged frog is considered within the smaller scale of recovery units as opposed to the overall range. These recovery units correspond to major watershed boundaries as defined by U.S. Geological Survey hydrologic units and the limits of the range of the California red-legged frog. The goal of the recovery plan is to protect the long-term viability of all extant populations within each recovery unit.

Within each recovery unit, core areas have been delineated and represent contiguous areas of moderate to high California red-legged frog densities that are relatively free of exotic species such as bullfrogs. The goal of designating core areas is to protect metapopulations that, combined with suitable dispersal habitat, will support long-term viability within existing populations. This management strategy allows for the recolonization of habitat within and adjacent to core areas that are naturally subjected to periodic localized extinctions, thus assuring the long-term survival and recovery of the California red-legged frog.

California Least Tern

Legal Status

The Service listed the California least tern as endangered on June 2, 1970 (35 FR 8491 8498), and is a fully protected species under California law (California Fish and Game Code, Section 3511). We issued a revised recovery plan for the species in 1985 (Service 1985). The Service has not designated critical habitat for the California least tern.

Natural History

California least terns forage in nearshore oceans, harbors, marina channels, tidal estuarine channels, and sheltered shallow bays (Atwood and Kelly 1984). Adults forage mostly within 2 mi of breeding colonies, and at many sites foraging is primarily in nearshore ocean waters less than 60 ft deep (Service 1985). They feed on small fish that they catch by plunging into the water from flight. In a study of fish dropped by California least tern at 10 nesting areas, researchers found 49 species of fish, all individuals less than 1 year old. Northern anchovy (*Engraulis mordax*) and silverside species (Atherinidae) represented 67 percent of the total sample (Atwood and Kelly 1984).

California least terns are migratory colonial nesters, usually arriving in breeding areas by late April and departing again in August (Massey 1974). After the initial nesting period that begins on their arrival in April, a second wave of nesting may occur from mid-June to early August. These are mainly re-nests after initial failures and second-year birds nesting for the first time (Massey and Atwood 1981).

Nesting California least terns usually occupy a sand-shell beach relatively free of plant growth (Massey 1974). The nest is typically a shallow, round depression, constructed by a bird sitting and kicking its feet backwards while rotating its body. This may occur several times before an egg is laid (Massey 1974; Wolk 1974). Terns may use "sideways building" after scrape construction, which consists of the sitting bird reaching out with its bill to pick up additional nest material, such as small shells and shell fragments, and depositing them into the nest (Wolk 1974).

Early in the breeding season, California least terns display night roosting behavior. Prior to incubation, terns will sleep at night at varying distances from the nesting sites. Once incubation begins, birds roost at night on the nest. Terns use roosting sites away from breeding colonies prior to egg laying, apparently for predator avoidance. By not sleeping within the colony until eggs are laid, the terns may delay the colony being discovered by a nocturnal predator by 2 to 3 weeks (Service 1985).

California least terns begin incubation after laying the first egg. Both parents participate in incubation, which lasts 20 to 25 days (Massey 1974). Clutch size ranges from one to three eggs, with two eggs being most common (Massey 1974; Ehrlich et al. 1988).
Least tern chicks are semi-precocial (capable of a high degree of independent activity from birth) and are fed small fish by parents within hours of hatching (Massey 1974; Ehrlich et al. 1988). Chicks will begin leaving the nest in one to two days (Massey 1974) and fledge at approximately 20 days. Juveniles and adults will fish, loaf, preen, and roost together for several weeks after fledging; adults will continue to feed juveniles during this period (Massey 1974).

California least terns leave nesting areas by August to spend winter months along the west coast of Baja California, the west coast of Mexico, and further south, possibly from the Gulf of California to Guatemala (American Ornithologists' Union (AOU) 1957; Service 1985; Thompson et al. 1997).

Rangewide Status

The historical breeding range of the California least tern extends along the Pacific coast from central California (Moss Landing) to southern Baja California (San Jose del Cabo). Potentially vagrant birds have been documented further north in Alameda County, California (AOU 1957; Grinnell and Miller 1944). Since 1970, nesting sites have been recorded from San Francisco Bay to Bahia de San Quintin, Baja California. The nesting range in California has been discontinuous, with the majority of birds nesting in southern California from Santa Barbara County south through San Diego County (Service 1985).

In 1969 and 1970, Craig (1971) conducted breeding surveys in San Mateo, Orange, and San Diego Counties. Craig estimated 300 pairs at 15 sites in the three counties and made recommendations to prevent the extirpation of the California least tern in California, principally to protect existing sites from human disturbance and create new sites in areas that could be protected from disturbance and development (Craig 1971). In 1980, 1981, 1982, and 1983, the

California least tern breeding population in California was approximately 890-1,215; 963-1,171; 1,015-1,245; and 1,180-1,299 pairs, respectively (Service 1985). Fluctuations in the number of breeding pairs and productivity have been attributed to the El Niño Southern Oscillation, which results in limited food availability (Caffrey 1995; Massey et al. 1992; Robinette et al. 2015). The effects on California least terns after a severe El Niño event may last several years (Massey et al. 1992).

Surveys have become more standardized and frequent since the 1990s (Frost 2017). Frost reported 3,989-4,661 breeding pairs across 42 nesting sites in California over the 2016 breeding season (Frost 2017). The majority of breeding activity in California during the 2016 season was concentrated at a few sites: Camp Pendleton, Naval Base Coronado, Batiquitos, Point Mugu, Huntington, and Alameda Point (Frost 2017), a trend consistently observed in previous years (Frost 2016, 2017). These five sites in conjunction with Hayward, Los Angeles Harbor, Huntington, Bolsa Chica, and Oceano Dunes, contributed 88 percent of California's fledgling production. The California Department of Fish and Wildlife provides annual reports of nesting California least terns in California; reports include numbers of breeding pairs, nesting sites, and fledgling to breeding pair ratios. Table 1 compiles nesting pair and breeding site data from 1969 to 1974, and 1990 to 2016.

Table 1. Numbers of California least tern breeding pairs and nesting sites across California; data compiled from California Department of Fish and Wildlife Reports (Craig, 1971; Bender 1974a, 1974b; Johnson and Obst 1992; Obst and Johnson 1992; Caffrey 1993, 1994, 1995, 1997, 1998; Keane 1998, 1999, 2001; Patton 2002; Marschalek 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012; Frost 2013, 2015, 2016, 2017).

Year	*Approximate Number of Breeding Pairs*	*Number of Nesting Sites*
2016	3,989-4,661	42
2015	4,202-5,295	41
2014	4,232-5,786	41
2012	4,293-6,421	41
2011	4,826-6,108	40
2010	6,437-6,699	41
2009	7,130-7,352	41
2008	8,223-8,226	36
2007	6,744-6,989	35
2006	7,006-7,293	31
2005	6,865-7,341	28
2004	6,354-6,805	32
2000	4,521-4,790	37
1999	3,451-3,674	36
1998	4,141-4,182	30
1997	4,017	38
1996	3,330-3,392	35
1995	2,585-2,611	37
1994	2,792	36
1993	2,400	35
1992	2,106	38
1991	1,830	26
1990	1,706	28
1974	582	20
1973	624	19
1969-1970	300	15

<u>Recovery and Threats</u>

The primary goals outlined in the 1985 recovery plan are to prevent extinction and return the California least tern population to a stable, non-endangered status. We state that reclassification to threatened status may be considered if 1,200 breeding pairs in California occur in 15 secure management areas with a 3-year mean reproduction rate of 1.0 (one fledgling per breeding pair) (Service 1985). We also state that delisting may be considered if the population reaches 1,200 breeding pairs distributed in at least 20 of 23 coastal management areas with the following provisions:

1) Sufficient habitat to support at least one viable colony (consisting of a minimum of 20 breeding pairs with a 5-year mean reproductive rate of at least 1.0 young fledged per year, per breeding pair) at each of the 20 coastal management areas that are managed to conserve least terns (which must include San Francisco Bay, Mission Bay, and San Diego Bay); and

2) Assured land ownership and management objectives for future habitat management for the benefit of California least terns, and the security and status of Baja California colonies are assessed for incorporation into recovery objectives (Service 1985).

In the 2006 5-year status review, we indicate that the recovery criteria outlined in the recovery plan do not reflect the best available and most up-to date information on the biology and habitat of the California least tern. Specifically, we state that the recovery plan does not consider the following factors: (1) new information about reproductive rates that suggests that the recovery plan criteria of no less than one fledge per tern pair may not be necessary for stable or increasing populations; (2) information about the location of additional nesting sites; (3) new modeling efforts regarding population viability analyses; (4) new predators and the effectiveness of predator control efforts; and (5) increased human populations along the California coastline and their impacts on habitat. At the time of listing in 1970, the Service did not complete a five-factor analysis; this analysis is provided in the 5-year status review (Service 2006a).

In the 5-year status review, we include a 5-factor analysis of threats, conservation measures, and regulatory mechanisms. To summarize, degraded habitat throughout the range with competing human activities continue to threaten California least tern, and colonies continue to require intensive management. Within these managed sites, the California least tern remains vulnerable to predation, invasive non-native plants, and human-related disturbance. Without continued intensive management, we anticipate that the threats of habitat loss and predation would diminish population gains seen since listing (Service 2006a).

Our recommendation in the 5-year status review is that the California least tern be reclassified from endangered to threated due to some reduction of impacts of threats and increase in population, recognizing that threats had not been reduced to the point that California least terns would be secure without intensive, site-specific management. We also recommend revisiting the recovery plan, continued management and monitoring of nesting sites, creation of new sites, and expansion of existing sites (Service 2006a).

Additionally, since the issuance of the 5-year status review, studies and observations continue to see the effects of lower forage fish supply and reduced numbers of breeding pairs and productivity due to El Niño Southern Oscillation Events. With larger storms and tides, loss of breeding areas and washed out nests are likely increase in the future.

Western Snowy Plover

Legal Status

The Service listed the Pacific coast population of the western snowy plover as threatened on March 5, 1993 (58 FR 12864). We designated critical habitat in 1999 (64 FR 68508 68544) and re-designated it in 2005 (70 FR 56970 57119). In 2012, we issued a revised critical habitat designation which included a change in taxonomic nomenclature (77 FR 36727 36869). We completed a 5-year status review in 2006 (Service 2006b), and issued a recovery plan in September 2007 (Service 2007).

Natural History

The western snowy plover is a small shorebird in the family Charadriidae, a subspecies of the snowy plover (*Charadrius nivosus*). It is pale gray-brown above and white below, with a white collar on the hind neck and dark patches on the lateral breast, forehead, and behind the eyes. The bill and legs are black.

Western snowy plovers are primarily visual foragers, using the run-stop-peck method of feeding typical of most plover species. They forage on invertebrates in the wet sand and amongst surf-cast kelp within the intertidal zone, in dry sand areas above the high tide, on saltpans, on spoil sites, and along the edges of salt marshes, salt ponds, and lagoons. They sometimes probe for prey in the sand and pick insects from low-growing plants (Service 2007).

The Pacific coast population of the western snowy plover breeds primarily on coastal beaches from southern Washington to southern Baja California, Mexico. The main coastal habitats for nesting include sand spits, dune-backed beaches, beaches at creek and river mouths, and saltpans at lagoons and estuaries (Page and Stenzel 1981; Wilson 1980). Western snowy plovers nest less commonly on bluff-backed beaches, dredged material disposal sites, salt pond levees, dry salt ponds, and gravel river bars (Wilson 1980; Page and Stenzel 1981; Powell et al. 2002; Tuttle et al. 1997).

Their nests consist of a shallow scrape or depression, sometimes lined with beach debris (e.g., small pebbles, shell fragments, plant debris, and mud chips). As incubation progresses, western snowy plovers may add to and increase the nest lining. Driftwood, kelp, and dune plants provide cover for chicks that crouch near objects to hide from predators. Because invertebrates are often found near debris, driftwood and kelp are also important for harboring snowy plover food sources (Page et al. 2009).

Along the west coast of the United States, the nesting season of the western snowy plover extends from early March through late September. Generally, the breeding season may be 2 to 4 weeks earlier in southern California than in Oregon and Washington. Fledging (reaching flying age) of late-season broods may extend into the third week of September throughout the breeding range (Service 2007).

The approximate periods required for snowy plover nesting events are: 3 days to more than a month for scrape construction (in conjunction with courtship and mating), usually 4 to 5 days for egg laying, and incubation averaging 28.4 days in the early season (before May 8) to 26.9 days in the late season (Warriner et al. 1986). The usual clutch size is three eggs with a range from two to six (Page et al. 2009). Both sexes incubate the eggs, with the female tending to incubate during the day and the male at night (Warriner et al. 1986). Adult western snowy plovers frequently will attempt to lure people and predators from hatching eggs and chicks with alarm calls and distraction displays.

Western snowy plover chicks are precocial, leaving the nest with their parents within hours after hatching (Service 2007). They are not able to fly for approximately 1 month after hatching; fledging requires 29 to 33 days (Warriner et al. 1986). Broods rarely remain in the nesting area until fledging (Warriner et al. 1986; Lauten et al. 2010). Casler et al. (1993) reported broods would generally remain within a 1-mi radius of their nesting area; however, in some cases would travel as far as 4 mi.

In winter, western snowy plovers are found on many of the beaches used for nesting, as well as beaches where they do not nest. They also occur in man-made salt ponds and on estuarine sand and mud flats. In California, the majority of wintering western snowy plovers concentrate on sand spits and dune-backed beaches. Some also occur on urban and bluff-backed beaches, which they rarely use for nesting (Page et al. 1986; Page and Stenzel 1981). South of San Mateo County, California, wintering western snowy plovers also use pocket beaches at the mouths of creeks and rivers on otherwise rocky (Page et al. 1986). Snowy plovers forage in loose flocks. Roosting snowy plovers will sit in depressions in the sand made by footprints and vehicle tracks, or in the lee of kelp, driftwood, or low dunes in wide areas of beaches. (Page et al. 2009). Sitting behind debris or in depressions provides some shelter from the wind and may make the birds more difficult for predators to detect.

Rangewide Status

Historical records indicate that nesting western snowy plovers were once more widely distributed and abundant in coastal Washington, Oregon, and California (Service 2007). In Washington, western snowy plovers formerly nested at five coastal locations (Washington Department of Fish and Wildlife 1995) and at over 20 sites on the coast of Oregon (Service 2007). In California, by the late 1970s, nesting western snowy plovers were absent from 33 of 53 locations with breeding records prior to 1970 (Page and Stenzel 1981).

The first quantitative data on the abundance of western snowy plovers along the California coast came from window surveys conducted during the 1977 to 1980 breeding seasons by Point Reyes Bird Observatory (Page and Stenzel 1981). Observers recorded an estimated 1,593 adult western snowy plovers during these pioneering surveys. The results of the surveys suggested that the western snowy plover had disappeared from significant parts of its coastal California breeding range by 1980 (Service 2007).

Breeding season and winter window survey data from 2005 to 2017 includes approximately 250 sites in Washington, Oregon, and California, with the majority of the sites located in California. In California, 1,807 western snowy plovers were counted during the 2016 breeding window survey, and 3,802[1] western snowy plovers were counted during the 2016-2017 winter window survey (Service 2016, 2017). Across the Pacific coast range, the 2016 breeding window survey estimated 2,284 western snowy plovers, and the 2016-2017 winter window survey estimated 4,214 western snowy plovers in Washington, Oregon and California (Service 2016, 2017). These numbers demonstrate that a large percentage of all western snowy plovers in the Pacific coast range were counted in California during both winter and breeding window surveys. In a 2014 western snowy plover population viability analysis, Hudgens et al. (2014) suggest that sites south of Point Reyes National Sea Shore in California are expected to be population sources for sites in the higher latitudes of the Pacific coast range.

Threats

The reasons for decline and degree of threats for the western snowy plover vary by geographic location; however, the primary threat was, and remains, habitat destruction and degradation. Habitat loss and degradation can be primarily attributed to human disturbance, urban development, introduced beachgrass (*Ammophila* spp.), and expanding predator populations (Service 2007). Natural factors, such as inclement weather, have also affected the quality and quantity of western snowy plover habitat (58 FR 12865).

Recovery

The primary objective of the recovery plan (Service 2007) is to remove the Pacific coast population of the western snowy plover from the list of endangered and threatened wildlife and plants by:

1. Increasing population numbers distributed across the range of the Pacific coast population of the western snowy plover;

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[1] This number likely includes wintering inland birds that are not part of the listed Pacific coast population

2. Conducting intensive ongoing management for the species and its habitat and developing mechanisms to ensure management in perpetuity; and

3. Monitoring western snowy plover populations and threats to determine success of recovery actions and refine management actions.

The Pacific coast population of the western snowy plover would be considered for delisting when the following criteria have been met (Service 2007):

1. An average of 3,000 breeding adults has been maintained for 10 years, distributed among 6 recovery units as follows: Washington and Oregon, 250 breeding adults; Del Norte to Mendocino Counties, California, 150 breeding adults; San Francisco Bay, California, 500 breeding adults; Sonoma to Monterey Counties, California, 400 breeding adults; San Luis Obispo to Ventura Counties, California, 1,200 breeding adults; and Los Angeles to San Diego Counties, California, 500 breeding adults. This criterion also includes implementing monitoring of site-specific threats, incorporation of management activities into management plans to ameliorate or eliminate those threats, completion of research necessary to modify management and monitoring actions, and development of a post-delisting monitoring plan.

2. A yearly average productivity of at least one (1.0) fledged chick per male has been maintained in each recovery unit in the last 5 years prior to delisting.

3. Mechanisms have been developed and implemented to assure long-term protection and management of breeding, wintering, and migration areas to maintain the subpopulation sizes and average productivity specified in Criteria 1 and 2. These mechanisms include establishment of recovery unit working groups, development and implementation of participation plans, development and implementation of management plans for Federal and State lands, protection and management of private lands, and public outreach and education.

ENVIRONMENTAL BASELINE

Action Area

The implementing regulations for section 7(a)(2) of the Act define the "action area" as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 Code of Federal Regulations 402.02). The action area for this biological opinion includes areas where a sonic boom of 1 psf or greater is predicted; this includes areas on and adjacent to VAFB as shown in Figure 2-2 of the BA (ManTech 2017a) and all of San Miguel Island, Santa Rosa Island, and Santa Cruz Island (together referred to as the NCI).

Status of the Species in the Action Area

El-Segundo Blue Butterfly

The Air Force, along with biological consultants, first documented the El Segundo blue butterfly at two general locations on VAFB in Santa Barbara County (Tranquillon Mountain and San Antonio Terrace). Surveys in subsequent years indicate that the majority of occupied habitat occurs on north VAFB on sandy coastal habitat in the vicinity of San Antonio Terrace. El Segundo blue butterflies have also been observed on north VAFB near Lompoc-Casmalia Road, northeast of the Vandenberg tracking station, and in the Santa Lucia area. The upper Honda Ridge Road/Tranquillon Peak area remains the most extensive tract of occupied habitat on south VAFB, and El Segundo blue butterflies have also been reported along the ridgeline between Tranquillon Peak and Oak Mountain, along Arguello Ridge, and near the intersections of Bear Creek and Coast Road. Off VAFB, El Segundo blue butterflies have been reported along Black Road north of VAFB; on and adjacent to the Burton Mesa Ecological Reserve on the north side of Vandenberg Village and along Harris Grade Road; along San Miguelito Canyon Road east of Tranquillon Peak; along Sweeney and Santa Rosa Roads east of Lompoc; and even further east near Drum Canyon Road.

Based on 2016 flight season surveys, known occupied habitat on VAFB was estimated to be 1,557 acres, with approximately 1,199 acres on north VAFB and approximately 358 acres on south VAFB, and approximately 209 acres off VAFB (ManTech 2017d). Preliminary data from 2017 surveys indicate known occupied habitat has increased to approximately 1,799 acres on VAFB and approximately 226 acres off VAFB (R. Evans, pers. comm. 2017). Suitable but not known to be occupied habitat for the El Segundo blue butterfly is also found throughout VAFB and surrounding areas. Suitable but not known to be occupied habitat is defined by the presence of the host plant seacliff buckwheat, but where surveys have not been conducted or have not yet detected El Segundo blue butterflies. For suitable habitat to be considered unoccupied, at least five surveys must be conducted under appropriate conditions with negative results; the area would then be considered unoccupied for the remainder of the season. Due to the level of effort this entails, the five protocol surveys are rarely conducted and habitat is instead considered "not known to be occupied." On VAFB, the Air Force estimated that approximately 17,500 acres of suitable habitat is within 1 mi (1.6 km) of the known occupied habitat, and that seacliff buckwheat occurs over at least 60,000 acres of the Base. The amount of suitable but not known to be occupied habitat off VAFB has not been mapped or estimated.

Surveys conducted in Santa Barbara County (including at VAFB) reported 436 adult El Segundo blue butterflies in 2016, 213 individuals in 2015, 580 individuals in 2014, 274 individuals in 2013, 127 individuals in 2012, 247 individuals in 2011, 403 individuals in 2010, and 379 individuals in 2009. Variations in El Segundo blue butterfly observations are in part reflective of areas surveyed, survey strategy employed, survey effort, and environmental conditions, all of which may have differed between years. Lower numbers of adult El Segundo blue butterflies observed can be partially attributed to variation in precipitation (i.e., drought), which can result in dead or poor quality seacliff buckwheat plants.

El Segundo blue butterflies are known to occur in scattered locations throughout the action area, both on and off VAFB, including all of the localities described above with the exception of Black Road north of VAFB (Figure 1). The largest known concentrations of El Segundo blue butterflies in the action area occur in the sandy coastal habitat in the vicinity of San Antonio Terrace, north of Purisima Point and approximately 8 mi north of SLC-4. The next largest concentrations occur along upper Honda Ridge Road/Tranquillon Mountain Road slightly over 3 mi southeast of SLC-4, and on the Burton Mesa Ecological Reserve approximately 10 mi northeast of SLC-4. The nearest El Segundo blue butterfly record to SLC-4 is one individual observed in 2008 approximately 1.7 mi (2.7 km) north at the intersection of Bear Creek Road and Coast Road (ManTech 2009b). Despite intensive follow-up surveys during 2008 and annual surveys during almost every flight season since 2008, no other El Segundo blue butterflies have been documented at this locality. The next nearest El Segundo blue butterfly record to SLC-4 was one individual observed in 2016 approximately 2.0 mi (3.2 km) southeast on Avery Road (ManTech 2017d). Flight season surveys for El Segundo blue butterflies conducted within suitable habitat at SLC-4 and the surrounding area in 2007, 2009, 2011, 2014, 2016, and 2017 were negative.

On July 14, 2017, the area of Spring Canyon to be impacted by vegetation removal and flame duct water release was surveyed for El Segundo blue butterflies and seacliff buckwheat. No El Segundo blue butterflies were detected during the survey but 153 seacliff buckwheat plants were found within approximately 0.21 acres, as stated in the BA; however, the Monitoring and Minimization Plan (ManTech 2017c) states that site surveys in 2017 resulted in an estimate that a total of 258 seacliff buckwheat would be removed during vegetation removal activities in Spring Canyon related to flame bucket water use. The Spring Canyon Fire, caused when materials ejected from the SLC-4E flame bucket during a pre-launch engine test, occurred on August 19, 2017; 29 of these plants were destroyed, leaving 229 remaining buckwheat plants in the vegetation removal area.

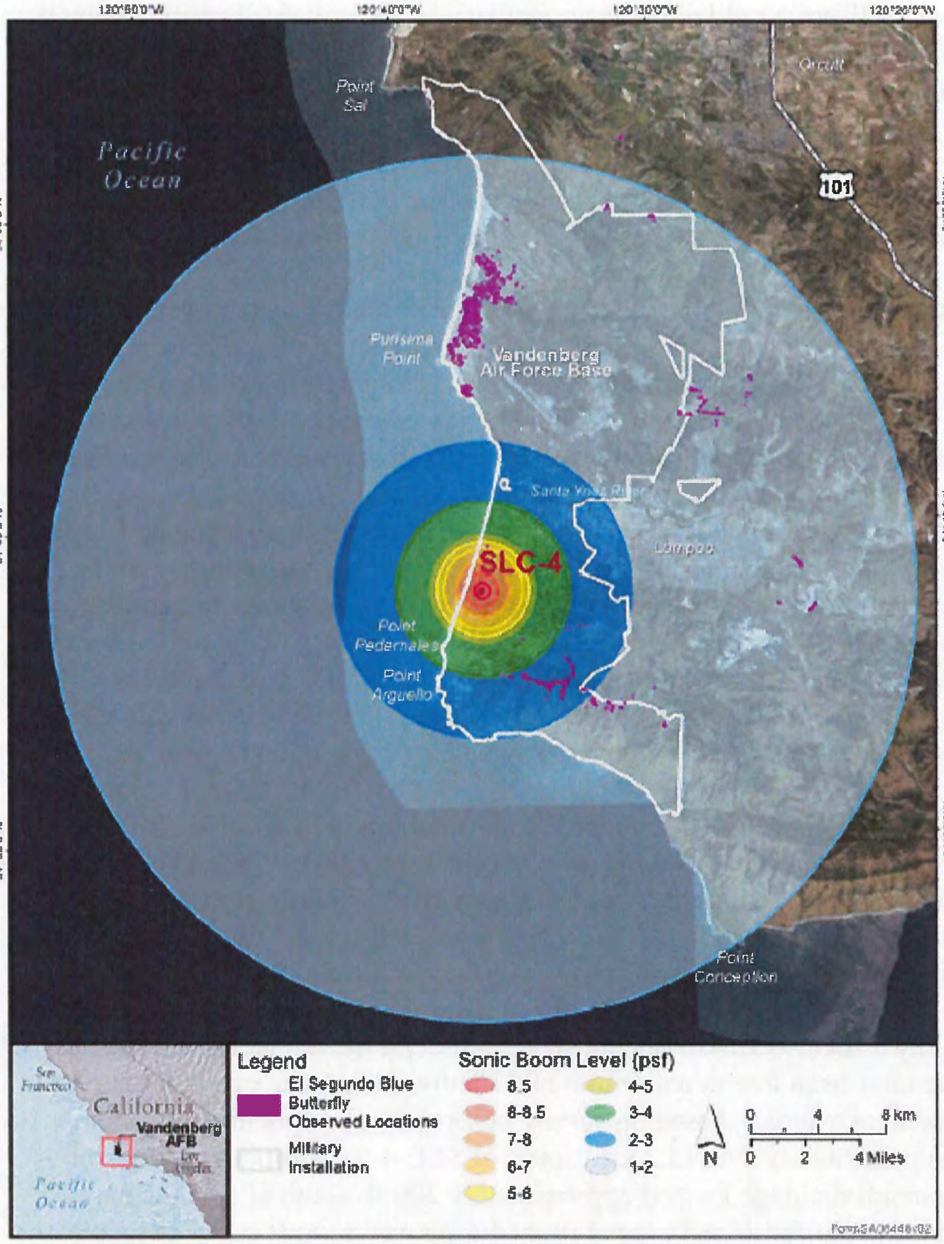

Figure 1. Current known El Segundo blue butterfly localities within the action area.

<u>California Red-legged Frog</u>

California red-legged frog surveys have been recorded across VAFB since the early 1990s and have shown that California red-legged frogs can potentially occur in all known wetlands and bodies of water on VAFB (Figure 2; Christopher 1996, 2002; ManTech 2009a, 2014, 2016). Of 109 ephemeral, wetland, and riparian sites surveyed, only 11 sites did not have any life stage of the California red-legged frog (Christopher 2002). On VAFB, Shuman Creek, Barka Slough, San Antonio Creek, the Santa Ynez River, Bear Creek, Cañada Honda Creek, Jalama Creek, and

Santa Lucia Canyon have California red-legged frog populations and suitable breeding habitat (Christopher 1996, 2002; SRS Technologies 2001; ManTech 2009a). The highest observed concentrations of California red-legged frogs are in San Antonio Creek and permanent ponds. In addition, adults have been observed in minor wetlands and drainages, small and large vernal pools, SLC-6 wastewater ponds, cattle troughs, ditches, borrow pits, created ponds, in the dune swale ponds of San Antonio Terrace, and in the cantonment area. Suitable upland dispersal habitat exists throughout VAFB between the various riparian zones and ponds on Base.

The Air Force previously determined that there are 19 permanent ponds encompassing approximately 40 acres and another 340 ponds covering approximately 515 acres, for a total of approximately 555 acres of suitable habitat for the California red-legged frog to breed, shelter, and overwinter on VAFB. They determined this baseline by reviewing aerial photos and reviewing multiple years of field data collected during the wet and dry seasons. The Air Force estimated that the 19 permanent ponds could support between 30 and 90 individuals, and the other 340 ponds could each support 20 individuals on average, resulting in an estimated population of 7,400 to 8,500 California red-legged frogs on base. While the accuracy of this estimate is unknown, we assume that VAFB supports a substantial population of California red-legged frogs because they have observed large numbers of the species in San Antonio Creek during multi-year surveys associated with creek bank stabilization efforts (e.g., a total of 1,681 individuals during their 2012-2013 surveys; ManTech 2013); however, there is not enough existing data to accurately estimate the California red-legged frog population on VAFB.

Based on habitat use on VAFB, California red-legged frogs are thought to occur in suitable habitat throughout the action area, both on VAFB (at all of the locations identified above; Figure 2) and off Base. Regular or widespread surveys for California red-legged frogs have not been conducted off VAFB; however, scattered locations of California red-legged frogs are known within the action area, including Burton Mesa Ecological Reserve and Salsipuedes Creek (southeast of Lompoc). The closest known population of California red-legged frogs to SLC-4 is Bear Creek, approximately 1 mi (1.6 km) to the northeast, although the number of observed frogs during surveys of the area has been low (a maximum of 11 individuals, seen in a night survey). The next closest (and apparently larger, based on survey observations) population occurs in Cañada Honda Creek, approximately 2 mi (3.2 km) south of SLC-4. In addition, portions of Spring Canyon (an ephemeral drainage located approximately 200 ft. south of SLC-4) may constitute suitable habitat for California red-legged frogs during wet periods when adequate surface water is present. Spring Canyon has no definable channel through the majority of the drainage and minimal evidence of potential pooling or flow of surface water (ManTech 2014). In July 2017, after an above average rain year, a Service-permitted biologist reassessed the drainage and found no significant changes from a habitat assessment conducted of the area in 2013, including no suitable breeding habitat within the vegetation removal area or downstream. Although breeding season surveys of Spring Canyon have not been conducted, this recent habitat assessment suggests it is unlikely that California red-legged frogs occupy this area on a regular basis, other than during dispersal events.

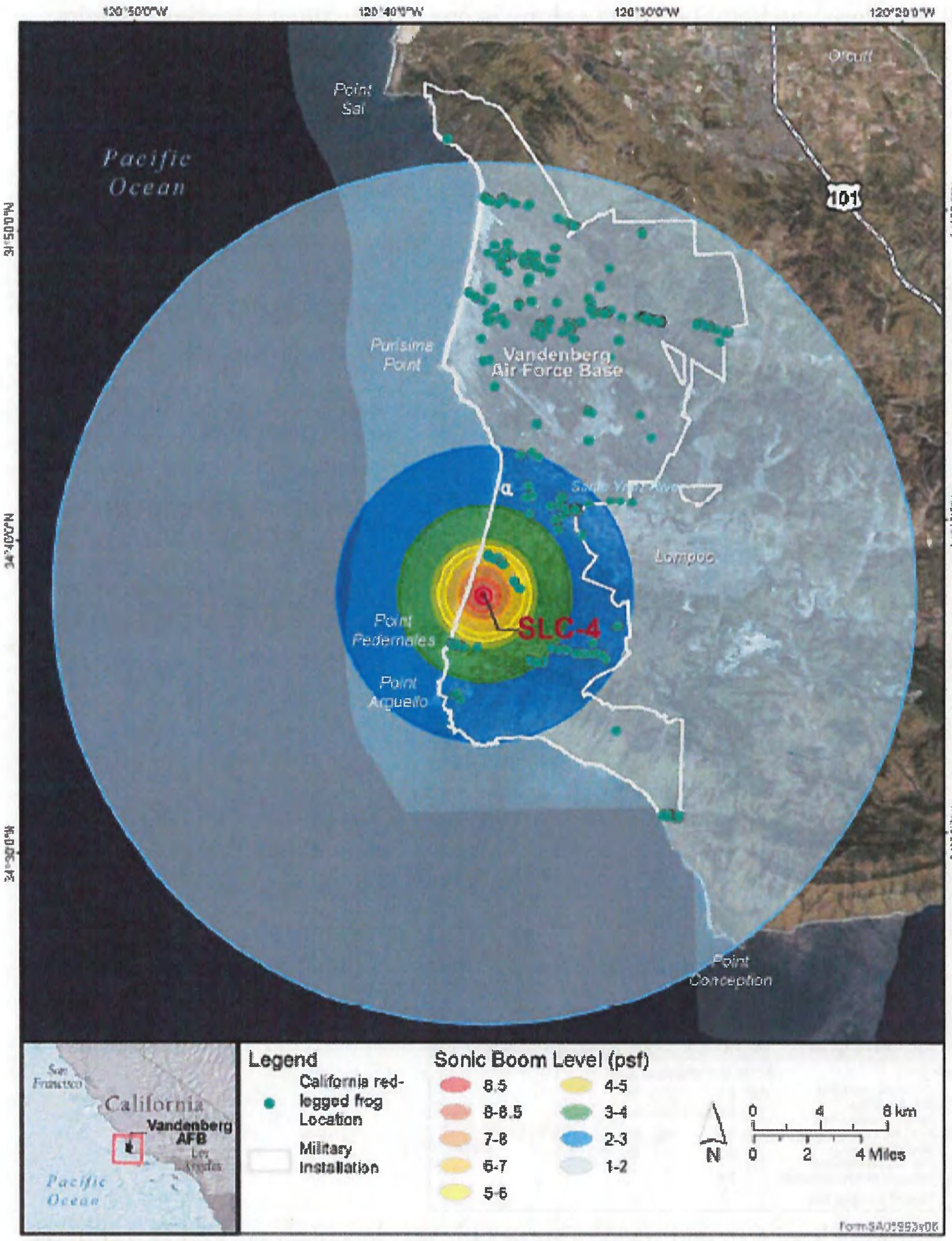

Figure 2. Known California red-legged frog localities on VAFB within the action area.

<u>California Least Tern</u>

Within the action area, California least terns are found primarily at Purisima Point and the Santa Ynez lagoon and estuary (Figure 3). VAFB supports a small population of California least terns that represents a small percentage of all known California least tern breeding colonies. Robinette et al. (2016) estimated that VAFB supports a breeding population of 25 pairs of California least tern, which nest at Purisima Point, approximately 8 mi (12.9 km) north of SLC-4. Although this population is small, the Purisima Point breeding colony is one of only three breeding colonies that occur between Monterey and Point Conception, and thus is considered important. Adult California least terns forage south of Purisima Point in the Santa Ynez River lagoon and estuary, approximately 3.7 mi (6.0 km) north of SLC-4. After young have fledged in late summer, California least terns also disperse to this location to forage in the lagoon and roost on adjacent sandbars before migrating south for the winter (Robinette & Howar 2010).

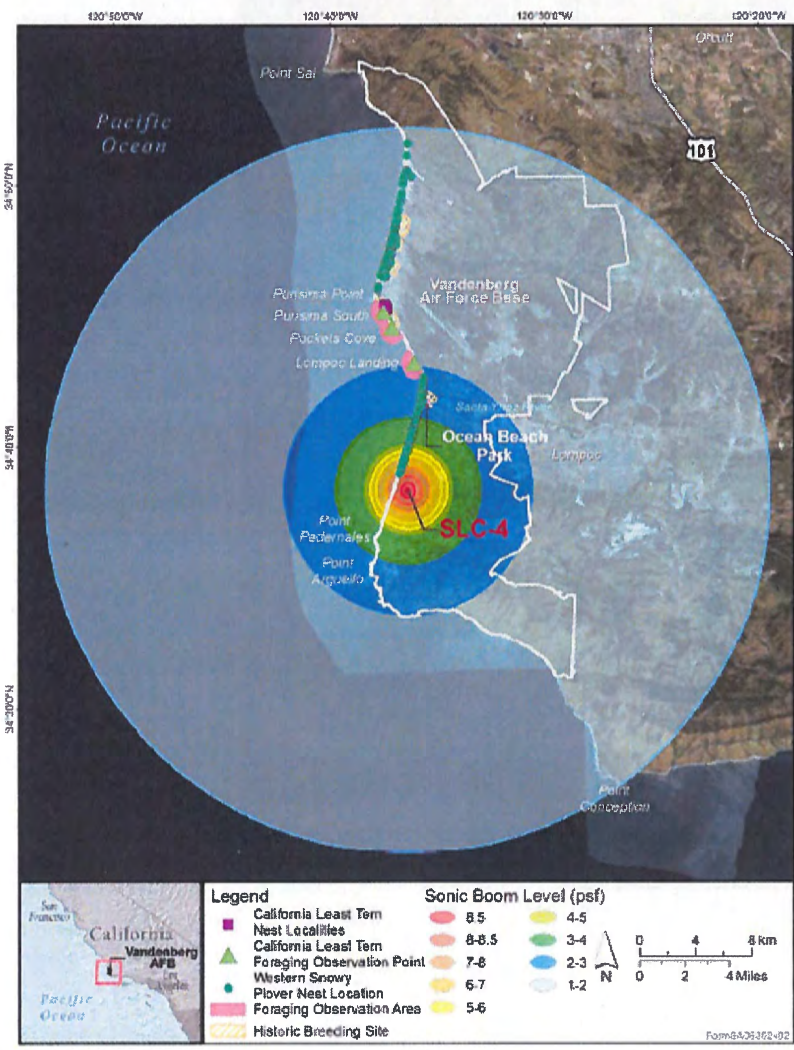

Figure 3. Known California least tern and western snowy plovers localities on VAFB within the action area.

Based on nesting data from 2001-2016 (Table 3; Air Force, unpubl. data 2017a), a total of 522 California least tern nests were established at Purisima Point on VAFB, with a yearly average of approximately 33 nests. Terns at VAFB laid an average of 1.73 eggs per nest, for a total of 830 eggs over this 16-year period. Average apparent nest success has been high during this time – 93 percent of nests have hatched at least one egg – resulting in a total of 572 confirmed chicks hatched between 2001 and 2016.

Table 3. California least tern nesting data from the Purisima Point colony on VAFB, 2001-2016. Data obtained or calculated from geographic information system files provided by the Air Force on August 18, 2017 (Air Force, unpubl. data 2017a).

Year	*No. of Nests*	*No. of Eggs*	*Average No. Eggs/Nest*	*No. of Chicks Hatched (Confirmed)*	*Average No. of Chicks Hatched/Nest*	*Apparent Nest success*
2001	47	96	2.04	78	1.66	0.94
2002	73	115	1.58	92	1.26	0.79
2003	118	103	0.87	72	0.61	0.49
2004	1	1	1.00	0	0.00	1.00
2005	44	74	1.68	30	0.68	1.00
2006	2	4	2.00	0	0.00	1.00
2007	18	29	1.61	20	1.11	1.00
2008	18	35	1.94	33	1.83	1.00
2009	31	63	2.03	43	1.39	1.00
2010	35	65	1.86	42	1.20	0.97
2011	32	46	1.44	36	1.13	0.75
2012	18	32	1.78	20	1.11	1.00
2013	15	30	2.00	18	1.20	1.00
2014	21	41	1.95	23	1.10	1.00
2015	22	47	2.14	36	1.64	1.00
2016	27	49	1.81	29	1.07	1.00
16-year totals	**522**	**830**	**--**	**572**	**--**	**--**
16-year averages	**32.6**	**51.9**	**1.73**	**35.8**	**1.06**	**0.93**

Western Snowy Plover

Western snowy plovers nest and overwinter along the entire coast of VAFB (Figure 3). The Air Force has performed annual monitoring of western snowy plovers since 1993 (Robinette et al. 2016). In 2014, VAFB supported an estimated 11 percent of California's breeding population (Service 2016). The breeding population of western snowy plovers on VAFB has been highly variable but relatively stable since 2007. The smallest population was recorded in 1999 (78 adults; Robinette et al. 2016).

Based on nesting data from 2012-2016 (Table 4; Air Force, unpubl. data 2017a), a total of 1,899 western snowy plover nests were established on VAFB during this 5-year period, with a yearly average of approximately 380 nests spread along the coastline north of SLC-4. The nearest observation of a western snowy plover nest to SLC-4 is approximately 0.9 mi (1.4 km) to the northwest. Western snowy plovers at VAFB typically lay between 1-3 (but sometimes up to 4) eggs per nest. Average apparent nest success (nests having at least one egg hatched) from 2012-2016 was approximately 48 percent. During this time, a total of 2,413 chicks are confirmed to have hatched (an average of approximately 483 chicks per year), and 937 of these are confirmed to have fledged (an average of approximately 187 chicks per year; average apparent fledging success was 38 percent). Most nests failed due to depredation, and most depredation was by coyotes.

Table 4. Western snowy plover nesting data from VAFB, 2012-2016. Data obtained or calculated from geographic information system files provided by the Air Force on August 18, 2017 (Air Force, unpubl. data 2017a).

Year	*No. of Nests*	*Apparent Nest Success*	*No. of Chicks Hatched (Confirmed)*	*No. of Chicks Fledged (Confirmed)*	*Apparent Fledging Success*
2012	341	0.43	382	92	0.24
2013	308	0.56	458	205	0.45
2014	428	0.38	428	159	0.37
2015	437	0.59	680	302	0.44
2016	385	0.45	465	179	0.38
5-year totals	**1899**	--	**2413**	**937**	--
5-year averages	**379.8**	**0.48**	**482.6**	**187.4**	**0.38**

On the NCI, the western snowy plover occurs in various locations on San Miguel, Santa Rosa, and Santa Cruz Islands (all within the action area). Although prior counts at San Miguel Island had yielded very few to no individuals, 61 western snowy plovers were observed during 2016-2017 winter window survey (Service 2017), and 129 plovers were incidentally observed in late September, 2017, at numerous sites around the island (including Point Bennett, south-facing beaches, and the east end of the island; J. Harris, pers. comm. 2017). The western snowy plover is considered a permanent resident of Santa Rosa Island. Since 2005, up to 37 western snowy plovers have been observed on Santa Rosa Island during the annual summer window survey, although this has decreased to an average of approximately 7 birds since 2008 (Service 2016). Incidental observations on Santa Rosa Island include approximately 100 western snowy plovers during winter, and approximately 12 plovers during the breeding season; most of these birds were observed at Skunk Point on the east side of the island, with about half as many on the south side of the island (S. Whitaker, pers. comm. 2017). The western snowy plover is considered a summer resident of Santa Cruz Island; only one individual has been observed at Santa Cruz Island since 2005 (Service 2016). Nesting western snowy plovers are not monitored on the NCI.

EFFECTS OF THE ACTION

El Segundo Blue Butterfly

<u>Effects of Flame Duct Water Use</u>

Of the proposed activities associated with use of water in the SLC-4E flame duct during launches, only vegetation removal will affect the El Segundo blue butterfly. Construction of the proposed civil water diversion structure and retention basin will not affect the butterfly because no suitable habitat (i.e., seacliff buckwheat plants) occurs in areas affected by the construction. Similarly, water release should not affect El Segundo blue butterflies because, after vegetation removal, no suitable habitat will occur in areas expected to be affected by the release of water or water vapor. Once the seacliff buckwheat plants are removed during initial vegetation removal actions, the area will be routinely mowed. Any seacliff buckwheat plants that may emerge between mowing events are not expected to grow large enough to provide habitat for El Segundo blue butterflies.

Pre-launch vegetation removal (initial vegetation removal and annual mowing) would reduce habitat for El Segundo blue butterflies, and all life stages of the subspecies associated with their host plant could be affected by the removal of seacliff buckwheat plants. SpaceX plans to remove all vegetation to just above ground level within a 3.327-acre impact area of Spring Canyon, to include areas affected by liquid and water vapor expelled from the flame duct. The Monitoring and Minimization Plan (ManTech 2017c) states that 229 seacliff buckwheat plants are present in the vegetation removal area. Currently, we consider seacliff buckwheat plants in the vegetation removal area to comprise habitat that is suitable but not known to be occupied by El Segundo blue butterflies, and therefore we assume that butterflies may be present. We assume that when host plants are removed, individual El Segundo blue butterfly larvae could be killed or injured as the plant is damaged or removed. Although the seacliff buckwheat plants will be removed by mowing and not disturb the soil beneath the plants, we expect all El Segundo blue butterfly pupae diapausing in the soil could be injured or killed through crushing by the mowing equipment. If El Segundo blue butterflies were present, and diapausing pupae were not injured or killed by mowing equipment, emerging adults would potentially have the opportunity to disperse to nearby seacliff buckwheat plants. We expect that adult butterflies, if present, would be able to move out of harm's way to suitable habitat available nearby.

To compensate for the removal of seacliff buckwheat associated with the proposed flame duct water release, the Air Force proposes to perform habitat enhancement within suitable but not known to be occupied habitat on Tranquillon Ridge along Honda Ridge Road adjacent to two existing El Segundo blue butterfly restoration efforts on south VAFB (ManTech 2017c). Habitat enhancement would consist of removing invasive plants and planting of seacliff buckwheat at a 2:1 ratio (area of habitat enhanced through invasive plant removal to area of potential El Segundo blue butterfly habitat impacted, and number of seacliff buckwheat planted to number of seacliff buckwheat impacted, by the flame duct action). Invasive plants would be treated with herbicides (Milestone VM, glyphosate-based herbicide, or Clethodim), and the following measures would be implemented to avoid and minimize potential impacts to seacliff buckwheat and El Segundo blue butterflies: (1) Individuals trained and proficient in seacliff buckwheat identification would conduct all herbicide applications; (2) Seacliff buckwheat would be avoided during herbicide application with plants covered to prevent drift if broad spectrum herbicide application is necessary adjacent to plants; (3) Herbicide treatments would occur under low wind conditions; and (4) Herbicide application would take place outside of the El Segundo blue butterfly flight season (June 1 – September 15) when adults or larvae may be present. In addition, all planted seacliff buckwheat would be (1) propagated from seed sourced on VAFB; (2) grown without insecticides; (3) free of Argentine ants; and (4) installed outside of the El

Segundo blue butterfly flight season. We expect that these measures will substantially reduce the potential for adverse effects to El Segundo blue butterflies. Furthermore, because the subspecies is negatively affected by its host plants' competition with non-native vegetation, the proposed habitat enhancement should improve and add to the available habitat for El Segundo blue butterflies on VAFB.

Effects of Launch and Landing Operations

Adults of the family Lycaenidae (including El Segundo blue butterflies) do not have structures that would function as ears and are presumed to be deaf (Rydell et al. 2003). Lycaenid larvae and pupae are well known to produce vibrational signals, most likely directed to ant species that tend the pupae (Downey 1966; DeVries 1991, 1992; Heath and Claassens 2003); however, they have not been demonstrated to hear. Thus, engine noise during launch and landing is not expected to affect the subspecies.

A sonic boom imparts an overpressure on an observer typically perceived as an audible impulse noise. Because El Segundo blue butterflies do not hear, only the magnitude of the overpressure would potentially impart an effect. The Air Force expects that a sonic boom is not likely to disrupt behavior of El Segundo blue butterflies because it would exert less pressure than ambient wind (ManTech 2017a). While a mathematical correlation between wind speed and overpressure is not well founded (T. Naughton, pers. comm. 2017a), ambient conditions may still be considered by estimating the amount of pressure exerted by wind. The conversion of wind speed to pressure depends on the wind's speed and density, and the object's shape. Online conversion tools are available which use calculations based on certain assumptions, such as "normal" velocities, relatively flat surfaces, and normal air densities and temperatures (https://sciencing.com/convert-wind-speed-pressure-5814125.html); these assumptions are considered appropriate to approximate pressure for the purposes of this analysis. To evaluate ambient wind-related pressure, we first analyzed wind speed data from the weather towers at SLC-4 (tower 300) and on Perry Road (tower 79) in the vicinity of occupied El Segundo blue butterfly habitat on south VAFB. We evaluated wind speeds measured at 4 m (i.e., the lowest height at which wind speed measurements were available) during the El Segundo blue butterfly flight season (June 1 – Sep 15) from 2012 through 2016 (Table 5; Air Force, unpubl. data 2017b). Based on these data, the area near SLC-4 experiences maximum wind gusts[2] of approximately 34 miles per hour during the flight season, and occupied habitat near Perry Road experiences maximum wind gusts of approximately 61 miles per hour. Using online conversion tools, we estimate that ambient wind exerts a pressure of up to approximately 3.1 psf in the vicinity of SLC-4, and up to approximately 10.0 psf in the vicinity of occupied habitat near Perry Road, during the El Segundo blue butterfly flight season. Thus, El Segundo blue butterflies occur in areas which experience ambient wind pressures greater than predicted overpressures resulting from landings at SLC-4W.

Table 5. Average and maximum wind speeds at weather tower 300 and 79 on south VAFB (Air Force, unpubl. data 2017b).

[2] Wind gust speed is measured as the highest instantaneous wind speed recorded during each one minute interval.

Speed (mph)	Tower 300 (SLC-4) June	July	Aug	Sep	Flight Season Avg	Tower 79 (Perry Rd) June	July	Aug	Sep	Flight Season Avg
Avg wind	6.1	5.5	6.0	5.3	**5.7**	15.0	11.0	14.5	9.8	**12.6**
Avg max wind	12.8	11.5	11.4	10.7	**11.6**	28.1	22.3	26.6	20.7	**24.4**
Max wind	23.7	19.2	18.0	16.6	**19.4**	46.0	39.1	36.2	33.4	**38.7**
Average gust	9.2	8.1	8.7	7.7	**8.4**	22.7	16.5	21.7	15.2	**19.0**
Avg max gust	18.9	16.7	16.9	16.1	**17.1**	41.1	31.2	37.9	29.0	**34.8**
Max gust	34.1	28.4	27.5	45.7	**33.9**	78.9	62.8	54.5	49.3	**61.4**

In addition, the potential effects of vibrations resulting from sonic boom overpressures on El Segundo blue butterflies and seacliff buckwheat are expected to be negligible due to the short duration and nature of the sonic boom. The effect of the sonic boom overpressure/vibration on El Segundo blue butterflies and seacliff buckwheat plants has been described as follows (Naughton, pers. comm. 2017b):

> "Due to the short duration of a sonic boom (typically less than a second), it cannot produce sustained vibrations. When a shock front passes, there is no longer a driving force for subsequent vibrations and the tendency is for restoration to the previous equilibrium conditions. The force or single vibration produced by a sonic boom will depend on several factors including: the location of interest relative to the position of the object transgressing the sound barrier, the atmospheric conditions, the geometry of the object transgressing the sound barrier, the rate at which the object accelerates through the sound barrier, etc. Although the individual vibration can be rather alarming due to the lack of warning, the shock vibration itself with a duration that is typically much less than one second is quite harmless (like a crack of thunder) relative to other naturally occurring vibrations such as wind turbulence that tends to produce relentless vibrations, especially during stormy conditions."

Therefore, due to the short duration of the vibration associated with a sonic boom, in conjunction with the existing ambient conditions under which El Segundo blue butterflies occur, we do not expect sonic booms to adversely affect the subspecies.

<u>Effects of Spring Canyon Riparian Mitigation</u>

To mitigate for permanent impacts to riparian habitat in Spring Canyon, SpaceX will be performing habitat enhancement to satisfy requirements by the California State Water Resources Control Board. Habitat enhancement will consist of invasive species treatments using a glyphosate-based herbicide within at least 2.25 acres of the Spring Canyon riparian corridor and bed and bank area. Although few, if any, seacliff buckwheat are expected to be present in the mitigation area, the following measures would be implemented to avoid and minimize potential impacts to seacliff buckwheat and El Segundo blue butterflies: (1) All individuals conducting herbicide application would be trained and demonstrate proficiency in the identification and avoidance of seacliff buckwheat; (2) Established roads, both paved and unpaved, would be used for vehicle access; (3) The proposed herbicide formulation is currently DoD-approved and would be applied in accordance with the label and DoD recommendations; (4) Herbicide mixing would occur in non-sensitive areas in accordance with the VAFB Integrated Pest Management Plan; (5) Herbicide treatments would only occur under low wind conditions to avoid drift to non-target species; (6) Seacliff buckwheat, although unlikely to occur in the riparian zone, would be avoided during all application of herbicides if encountered; and (7) No broad scale herbicide application would take place in areas supporting seacliff buckwheat from May 1 through September 30. We expect that these measures will substantially reduce the potential for adverse effects to El Segundo blue butterflies.

Effects of Monitoring

The project Monitoring and Minimization Plan (ManTech 2017c) includes annual habitat assessments and flight season surveys for the El Segundo blue butterfly in areas surrounding SLC-4. Flight season surveys are conducted on foot and consist of four visits during which El Segundo blue butterfly adults and/or larvae are counted. Currently, there are no known adverse effects of walking transects on diapausing pupae; however, human activity may affect adult El Segundo blue butterflies by disrupting normal behavioral patterns, and larvae could be harmed if seacliff buckwheat flowerheads are mishandled. Because only qualified biologists will be used to conduct these surveys, we expect that the potential for adverse effects to El Segundo blue butterflies (i.e., harassment of adults, injury or mortality of larvae due to mishandling) would be greatly reduced.

Effects on Recovery

The recovery plan for the El Segundo blue butterfly did not contemplate the role of VAFB in the subspecies' recovery because we finalized the plan prior to the observations of this subspecies in Santa Barbara County. Similarly, the 2008 5-year review does not specify the recovery function of VAFB for the El Segundo blue butterfly.

The Integrated Natural Resources Management Plan for VAFB considers the subspecies and includes measures to conserve the El Segundo blue butterfly and its host plants. The positive conservation measures for El Segundo blue butterfly the Air Force has implemented at VAFB so far include: (1) surveys to further delineate the subspecies' occurrence on, and off, the Base; (2) removal of invasive plants from potentially suitable habitat; (3) cooperation with research through U.C. Riverside and U.C. Santa Barbara; (4) public outreach; and (5) funding research such as commensal relationships between El Segundo blue butterfly and harvester ants (*Messor* spp., *Pogonomyrmex* spp.). Therefore, although the recovery plan for El Segundo blue butterfly did not consider the potential presence of the subspecies at VAFB, nor does the 2008 5-year review specify a recovery function of the Base, the Air Force has made a positive effort to conserve the El Segundo blue butterfly on VAFB, which would be consistent with other recovery efforts.

In summary, we expect adverse effects to El Segundo blue butterflies are likely to occur due to vegetation removal in Spring Canyon. Adverse effects would consist of loss of habitat (229 seacliff buckwheat) and may include injury or mortality of El Segundo blue butterfly larvae and/or diapausing pupae if present. We do not expect adverse effects to the subspecies as a result of other launch/landing operations, and we do not expect adverse effects to occur during habitat enhancement or monitoring activities due to the implementation of minimization measures described above. Although adverse effects are likely to occur as a result of the proposed action, we do not anticipate they will diminish the contribution the population at VAFB makes to the recovery of the El Segundo blue butterfly.

California Red-legged Frog

Effects of Flame Duct Water Use

Construction of the proposed civil water diversion structure and retention basin may have direct effects on the California red-legged frog through trampling and/or crushing individuals resulting in their injury or mortality. Trampling and/or crushing may occur as a result of foot traffic, vehicle traffic, and construction activity. These effects may be magnified during the wet season, when the species is more active. SpaceX would avoid and minimize these impacts by implementing the following measures, summarized from the Monitoring and Minimization Plan (ManTech 2017c): (1) A qualified biologist would survey the site each day prior to the initiation of work; (2) A qualified biologist would capture and relocate any California red-legged frogs found out of harm's way to the nearest suitable habitat; (3) Construction activities would occur only during daylight hours; (4) Construction activities would occur only during periods when there is no rainfall; (5) SpaceX would cover any open holes or trenches left open overnight to avoid entrapment of California red-legged frogs; and (6) A qualified biologist would monitor grading of the gunite application site. We expect that these measures will substantially reduce the potential for direct injury or mortality of California red-legged frogs, but some may still occur.

Construction of the proposed civil water diversion structure and retention basin could reduce habitat quality in the area for California red-legged frogs. Project activities may introduce contaminants such as construction materials, fuels, and lubricants to the Spring Creek area. Other project activities (particularly installation of the gunite slope) may alter the hydrological regime in the area and increase sedimentation of Spring Creek. Direct effects of contaminants and hydrological changes on the California red-legged frog (i.e., injury, mortality due to exposure) would be more likely during the wet season, when the species is more active and flows are available to convey contaminants downstream. SpaceX would avoid and minimize these impacts by implementing the following measures, summarized from the project description in the BA and the Monitoring and Minimization Plan (ManTech 2017c): (1) Construction activities would occur only during periods when there is no rainfall; (3) A qualified biologist would monitor grading of the gunite application site; (4) SpaceX would follow the site-specific Stormwater Pollution Prevention Plan already implemented for SLC-4; (5) SpaceX would implement the Best Management Practices within the latest California Stormwater Quality Association's Stormwater Best Management Practices Handbook; and (6) SpaceX would fully implement the procedures in VAFB's Hazardous Materials Emergency Response Plan in the event of a hazardous materials spill. We conclude that these measures will be effective at reducing the potential for injury or mortality of California red-legged frogs due to changes in habitat quality.

Capture and relocation of California red-legged frogs during pre-activity surveys and monitoring for construction of the proposed civil water diversion structure and retention basin may result in their injury or mortality during handling. SpaceX would avoid and minimize these impacts by having only qualified biologists capture and relocate California red-legged frogs. The potential for injury or mortality due to mishandling would be greatly reduced by having only experienced biologists engage in the activity.

Pre-launch vegetation removal (initial vegetation removal and annual mowing) associated with flame bucket use may cause injury or mortality of California red-legged frogs through trampling and/or crushing. Trampling and/or crushing may result from foot traffic, vehicle traffic, and vegetation removal activities. These effects would be magnified by vegetation removal during the wet season, when the species is more active. SpaceX would avoid and minimize these impacts by implementing the following measures, summarized from the Monitoring and Minimization Plan (ManTech 2017c): (1) A qualified biologist would conduct pre-activity surveys for California red-legged frog in the vegetation removal area; (2) A qualified biologist would capture and relocate California red-legged frogs found in the vegetation removal area out of the impact area; (3) A qualified biologist would monitor during vegetation removal activities to the extent that safety would allow; and (4) A qualified biologist would survey after vegetation removal to detect any injured or killed California red-legged frogs within the impact area. If implemented as proposed, these measures would be effective at reducing the potential for injury or mortality of California red-legged frogs during vegetation removal.

Pre-launch vegetation removal may reduce habitat quality and availability for California red-legged frogs in the Spring Creek area. Vegetation would be removed over a 3.327-acre area near Spring Creek, potentially used as cover by California red-legged frogs. Equipment use in the area may also reduce habitat quality by introducing contaminants, such as fuels and lubricants. Removal of vegetation in the area may also alter the hydrological regime in the area and increase sedimentation in Spring Creek due to erosion. The effects of vegetation removal would be magnified during the wet season when California red-legged frogs are active and more likely to come into contact with contaminants or be affected by sedimentation. SpaceX would avoid and minimize these impacts by implementing the following measures, summarized from the project description in the BA: (1) SpaceX would follow the site-specific Stormwater Pollution Prevention Plan already implemented for SLC-4; (2) SpaceX would implement the Best Management Practices within the latest California Stormwater Quality Association's Stormwater Best Management Practices Handbook; and (3) SpaceX would fully implement the procedures in VAFB's Hazardous Materials Emergency Response Plan in the event of a hazardous materials spill. Provided the various plans and practices to control contaminants and sedimentation are effective, these measures should reduce the potential for such impacts on habitat to affect California red-legged frogs.

Capture and relocation of California red-legged frogs in the area prior to vegetation removal may result in their injury or mortality during handling. SpaceX would avoid and minimize these impacts by using only qualified biologists to capture and relocate California red-legged frogs. The potential for injury or mortality due to mishandling would be greatly reduced by having only experienced biologists engage in the activity.

Water releases associated with flame bucket use may cause injury or mortality of California red-legged frogs through scalding and/or drowning individuals in the Spring Creek area. These effects would be magnified during the wet season, when California red-legged frogs are more active and are more likely to be present in Spring Canyon. SpaceX would avoid and minimize these impacts by implementing the following measures, summarized from the Monitoring and Minimization Plan (ManTech 2017): (1) A qualified biologist would conduct pre-activity surveys for California red-legged frog in the water release area; (2) A qualified biologist would capture and relocate California red-legged frogs found in these areas out of harm's way; and (3) A qualified biologist would survey after a water release to detect any injured or killed California red-legged frogs within the impact area. These measures should reduce the potential for California red-legged frogs to be killed or injured by the water releases; however, some individuals may not be detected during pre-activity surveys and could be killed or injured. We expect such effects would occur infrequently.

Water release activities may reduce habitat quality in the area for the California red-legged frog by altering the hydrologic regime and increasing sedimentation of Spring Creek. Water releases may also convey contaminants. These effects would be magnified during the wet season, when California red-legged frogs are more active and flows are available to convey contaminants downstream. SpaceX would avoid and minimize these effects by implementing the following measures, summarized from the project description in the BA: (1) SpaceX would construct a civil diversion structure and retention basin to minimize the amount of water entering Spring Creek from water release activities; (2) SpaceX would follow the site-specific Stormwater Pollution Prevention Plan already implemented for SLC-4; (3) SpaceX would implement the Best Management Practices within the latest California Stormwater Quality Association's Stormwater Best Management Practices Handbook; (4) SpaceX would collect any rocket propellant seen floating in the retention basin using absorbent pads prior to discharge to the spray field; and (5) SpaceX would fully implement the procedures in VAFB's Hazardous Materials Emergency Response Plan in the event of a hazardous materials spill. The civil diversion structure and collection of fuel with absorbent pads should reduce the potential for effects to California red-legged frogs. Provided the various plans and practices to control contaminants and sedimentation are effective, these measures should also reduce the potential for such impacts on habitat to affect California red-legged frogs. Given the uncertainty of how well the water release activities and related contaminants can be controlled, some injury or mortality of California red-legged frogs may still occur.

Capture and relocation of California red-legged frogs in the area prior to water release may result in their injury or mortality during handling. SpaceX would avoid and minimize these impacts by using only qualified biologists to capture and relocate California red-legged frogs. The potential for injury or mortality due to mishandling would be greatly reduced by having only experienced biologists engage in the activity.

Effects of Launch and Landing Operations

As discussed under Consultation History, above, on both June 24, 2011, and August 29, 2014, we concurred with the Air Force's determination that Falcon 9 launch activities at SLC-4E would not likely adversely affect California red-legged frogs. In addition, on July 2, 2015, we concurred that boost-back landings of the Falcon 9 first stage at SLC-4W (with launch/landing noise up to 110 dB and predicted sonic boom overpressures up to 2 psf) would not likely adversely affect California red-legged frogs. The maximum engine noise level (110 dB) during the proposed launch/landing operations is unchanged from the previous consultation. We have no evidence that the short duration of engine noise and/or light exposure during launch events causes adverse effects to amphibians beyond a short-term startle response (SRS Technologies Inc. 2001), and we do not expect engine noise or visual disturbance during launch and landings to adversely affect California red-legged frogs. Additionally, based on previous monitoring data (SRS Technologies Inc. 2001, 2006f), water quality is not anticipated to be affected by launch operations.

Based on revised modeling and Falcon 9 landing data from Cape Canaveral and drone ships in the Pacific Ocean, the Air Force now predicts sonic boom overpressures up to 8.5 psf (comparative to approximately 146 dB as described in Table 2-1 of the BA). We have no data on the response of California red-legged frogs to sonic booms. Accordingly, the effects of sonic booms resulting from landings at SLC-4W on California red-legged frogs is uncertain. Simmons et al. (2014) examined damage from exposure to high levels of noise and pressure in the hearing structures of American bullfrogs (*Lithobates catesbeianus*), using individuals of similar size to adult California red-legged frogs, and did not detect damage to these hearing structures until exposure to sound levels greater than 150 dB (13 psf). Simmons et al. (2014) found that such hearing-damaged individuals showed full functional recovery within three to four days. Therefore, we do not expect sonic booms resulting from project activities to cause physical damage to California red-legged frogs that would rise to the level of injury or mortality.

Sonic booms may induce behavioral responses in California red-legged frogs ranging from momentary startling or freezing by individual frogs to population-level emigration away from areas nearest to sonic booms. The impact of these behavioral responses may be magnified during the wet season, when California red-legged frogs are more active, by altering breeding behaviors such as migration and calling. Based on the BA (ManTech 2017a) and conversations with species experts (S. Sweet, pers. comm. 2017; Padre Associates, Inc., pers. comm. 2017) we do not expect project-related sonic booms to induce a behavioral response greater than momentary startling or freezing by individual frogs. Thus, we base our analysis of the effects of project-related sonic booms on the assumption that California red-legged frogs would have only a momentary behavioral response such as startling or freezing in response to sonic booms.

The noise from sonic booms resulting from repeated landing events at SLC-4W may directly and indirectly affect all California red-legged frogs in the action area by altering their behaviors. California red-legged frogs near SLC-4 may be exposed to sonic boom-related noise with a magnitude up to approximately 146 dB (8.5 psf). California red-legged frogs in or near Bear Creek approximately 1 mile northeast of SLC-4 may be exposed to sonic boom-related noise with a magnitude of up to 144.5 dB (7 psf). California red-legged frogs in or near Cañada Honda approximately 2 miles from SLC-4 may be exposed to sonic boom-related noise with a magnitude of up to 139.6 dB (4 psf). As stated above, the effects on California red-legged frogs are likely to be limited to momentary changes in behavior, such as freezing or startling. We do not expect the sonic booms to result in injury or mortality of individuals.

Similarly, overpressure associated with sonic booms may directly and indirectly impact all California red-legged frogs in the action area by altering their behaviors. California red-legged frogs near SLC-4 may be exposed to overpressures up to 8.5 psf. California red-legged frogs in or near Bear Creek may be exposed to overpressures up to 7 psf. California red-legged frogs in or near Cañada Honda may be exposed to overpressures up to 4 psf. As discussed in relation to the noise from sonic booms, the effects on California red-legged frogs due to overpressure are likely to be limited to momentary changes in behavior, such as freezing or startling. We do not expect the overpressure to result in injury or mortality of individuals.

Effects of Spring Canyon Riparian Mitigation

The proposed habitat enhancement activities in Spring Canyon may have direct effects on the California red-legged frog through trampling and/or crushing individuals resulting in their injury or mortality. Trampling and/or crushing may occur as a result of foot traffic, vehicle traffic, and construction activity. These effects may be magnified during the wet season, when the species is more active. SpaceX would avoid and minimize these impacts by implementing the following measures specified for other project activities, summarized from SpaceX's Spring Canyon Riparian Mitigation Plan (ManTech 2017b): (1) SpaceX would train individuals conducting herbicide application in the identification and avoidance of special status species to the point where these individuals demonstrate proficiency; (2) SpaceX would use established roads for vehicle access; (3) SpaceX would pre-clear routes for vehicle traffic using a qualified biologist if surface water is present; and (4) SpaceX would restrict all access for treatments to daylight hours. We expect that these measures will substantially reduce the potential for direct injury or mortality of California red-legged frogs, but some may still occur.
The proposed habitat enhancement activities in Spring Canyon may have direct and indirect effects on the California red-legged frog by contaminating habitat in the area with herbicides associated with invasive species control. These effects may be magnified during the wet season, when the species is more active. SpaceX would avoid and minimize these impacts by implementing the following measures specified for other project activities, summarized from

SpaceX's Spring Canyon Riparian Mitigation Plan (ManTech 2017b): (1) SpaceX would train individuals conducting herbicide application in the identification and avoidance of special status species to the point where these individuals demonstrate proficiency; (2) SpaceX would use established roads for vehicle access; (3) SpaceX would apply herbicide in accordance with the herbicide label and Department of Defense (DoD) recommendations; (4) SpaceX would mix herbicides in non-sensitive areas in accordance with the VAFB Integrated Pest management Plan; (5) SpaceX would perform herbicide treatments only under low wind conditions to avoid drift to non-target species; (6) SpaceX would apply herbicides outside of the rainy season (15 October to 15 March); (7) SpaceX would pre-clear routes for vehicle traffic using a qualified biologist if surface water is present; (8) SpaceX would restrict all access for treatments to daylight hours; (9) SpaceX would not use glyphosate in ephemeral aquatic habitats during the rainy season (October 15 to March 15); (10) SpaceX would not use glyphosate within 15 ft (4.6 m) of aquatic habitats when surface water or surface saturation of soils is present; and (11) SpaceX would not use glyphosate in aquatic habitats 24 hours before or after a significant rain precipitation event (0.1 inches or more). We expect that these measures should reduce the potential for such impacts on habitat to affect California red-legged frogs.

Effects of El Segundo Blue Butterfly Habitat Enhancement

The proposed El Segundo blue butterfly habitat enhancement activities_may have direct and indirect effects on the California red-legged frog by contaminating habitat in the area with herbicides associated with invasive species control. These effects may be magnified during the wet season, when the species is more active. SpaceX would avoid and minimize this impact by conducting herbicide treatments under low wind conditions to minimize drift (Monitoring and Minimization Plan; ManTech 2017c). We do not expect this contamination to cause injury or mortality because of the limited scope (approximately 800 square meters) and duration of potential herbicide application.

Effects of Bioacoustic Monitoring

Bioacoustic monitoring activities proposed by SpaceX may cause direct impacts to the California red-legged frog through trampling and/or crushing individuals resulting in their injury or mortality. These effects are magnified by occurring during the wet season when the species is more active. Nevertheless, we do not expect this activity to cause injury or mortality because it would only occur once during the course of the project and would be restricted to a small area.

Effects on Recovery

The proposed activities would not interfere with the recovery goals for Core Area 24 (Santa Maria-Santa Ynez River) given in the Service's 2002 recovery plan for the species. Direct and indirect effects from civil water diversion structure and retention basin construction, as well as flame duct use, would impact approximately 3.327 acres, a relatively small amount (less than 0.00001%) of the approximately 673,288 acres within Core Area 24. The noise and overpressure associated with sonic booms is not expected to result in effects on California red-legged frogs beyond short-term behavioral responses by individual California red-legged frogs.

In summary, we expect adverse effects are likely to occur to California red-legged frogs. Construction activities, vegetation removal, water release, riparian mitigation activities, and capture and relocation efforts may cause injury or mortality; however, based on the proposed minimization measures, we expect take of California red-legged frogs will be low. Although adverse effects are likely to occur as a result of the proposed action, we do not anticipate they will diminish the contribution the population at VAFB makes to the recovery of the California red-legged frog.

California Least Tern

Effects of Launch and Landing Operations

The California least tern nests at Purisima Point would be subjected to overpressures between 1 and 2 psf from a sonic boom. These nests would also experience engine noise from the landing between 80 and 90 dBA. California least terns foraging at the Santa Ynez River mouth would be within the 2 to 3 psf sonic boom footprint of the boost-back and would experience louder engine noises than those at Purisima Point (between 80 to 90 dBA).

If launch and landing occur during the breeding season (approximately April to August), California least terns nesting and foraging in the action area are likely to be disturbed by noise and overpressures from launch and landing activities. These disturbances may startle California least terns or could disrupt foraging or courtship activities. Brooding birds may flush and leave eggs or chicks unattended. Unattended eggs and chicks are vulnerable to the effects of exposure and predation. Exposure can cause eggs and chicks to become too cold or hot, or buried by sand in high winds. Prolonged exposure to these disturbances may reduce the numbers of nesting adults or productivity of California least terns in the action area over time.

Effects of Monitoring

Human activity within the California least tern breeding colony and at the Santa Ynez River estuary can cause birds to flush and become agitated. Monitoring activities may temporarily disrupt foraging activities. People entering the breeding area to install motion-activated cameras are likely to cause some disturbance to birds. These disturbances may startle California least terns or disrupt foraging or courtship activities. Brooding birds may flush and leave eggs or chicks unattended. Unattended eggs and chicks are vulnerable to the effects of exposure and predation; they may also become susceptible to injury if people enter the colony and step on chicks or nests that are not detected. Additionally, installation of cameras in the colony may provide a visual cue to attract predators. Because cameras will be placed in a manner to minimize disturbance to nesting terns, and monitoring activities would be conducted by a

Service-approved biologist familiar with the biology and potential risks to California least terns, we expect that the potential for adverse effects to California least terns from monitoring activities would be greatly reduced.

Effects on Recovery

The 1985 recovery plan outlines goals for both downlisting and delisting; however, in the 2006 5-year status review, we acknowledge the recovery goals did not reflect the best available and most up-to date information on the biology and habitat of the California least tern. Degraded habitat throughout the range and competing human activities continue to threaten the California least tern, and colonies continue to require intensive management. In the 5-year status review, we recommend continued management and monitoring of nesting sites, creation of new sites, and expansion of existing sites (Service 2006a).

In the 5-year status review, we explain that most extant colonies are on small patches of degraded habitat surrounded by human activity, and larger tern colonies are found on military lands (Service 2006a). We further discuss that while military bases are not devoid of threats, provisions under the Sikes Act (1 6 U.S.C. 670) continue to provide protection of California least terns and nesting habitat on Department of Defense lands (Service 2006a).

At the time the recovery plan was issued, 10 or 12 pairs of California least terns were known to have nested at the Santa Ynez River mouth. Some fledglings were observed, but no census was taken. The recovery plan stated that enhancing nesting in the area should be investigated. Being a relatively unknown occurrence, VAFB was not identified as a Coastal Management Area in the 1985 recovery plan (Service 1985); however, nesting on VAFB has been reported consistently since the early 1990s (Obst and Johnson 1992). Although relatively small, the Purisima Point breeding colony on VAFB can be a productive site for California least terns. For example, the 2016 California least tern breeding season comprised a total of 4,746 nests with a fledgling per pair ratio of 0.35 to 0.50; 27 of those nests were found on VAFB with a fledgling per pair ratio of 0.72 to 0.86 (Frost 2017). In addition, in 2015, VAFB had the highest fledgling per pair ratio in California, at 1.32 fledglings per pair (Frost 2016).

In summary, we expect adverse effects are likely to occur due to the proposed action; however, the severity of immediate and long-term impacts are uncertain, pending monitoring results. At minimum, we anticipate launches and landings would cause short-term effects to California least terns during the breeding season, such as startle responses, flushing, and interruptions to foraging, courtship, and breeding activities, with the potential for reduced numbers of nesting adults and/or productivity from repeated exposure to disturbances in the action area over time. Based on location of nesting California least terns on VAFB in relation to the range of predicted exposures to sonic boom noise and overpressure, we expect the effects to nesting terns to be temporary and minimal.

Although adverse effects are likely to occur as a result of the proposed action, we do not anticipate they will diminish the contribution the population at VAFB makes to the recovery of the California least tern.

Western Snowy Plover

Effects of Launch and Landing Operations

Western snowy plovers are present on VAFB year-round, both wintering and breeding. Launch and landing events are proposed to occur during both breeding and non-breeding season, day or night, and in proximity to breeding areas. Western snowy plovers could be exposed to sonic boom overpressures of up to 8 psf on VAFB and up to 3 psf on the NCI. Western snowy plovers would also experience engine noise from launch (80 to 100 dBA) and landing (80 to 110 dBA) at VAFB, and may also be exposed to visual disturbances from launch and landing activities.

Table 6 outlines 5-year averages (2012 to 2016) of western snowy plover nests, average nest success (number of nests with at least one egg hatched/number of total nests), and average fledging success (number of confirmed fledged chicks/number of confirmed hatched eggs) in areas that will be exposed to overpressures. These data describe the level of nesting that occurs in areas expected to be affected by overpressure, and the levels of potential psf.

Table 6. 2012-2016 averages of number of western snowy plover nests, and apparent nest success and fledging success, in each range of predicted sonic boom overpressures (psf) (Air Force, unpubl. data 2017a).

psf	***1-2***	***2-3***	***3-4***	***4-5***	***5-6***	***6-7***	***7-8***
Average # of nests	155	123	59	7.8	8.2	21	7.5
Average nest success	0.49	0.52	0.45	0.51	0.39	0.48	0.28
Average fledging success	0.37	0.38	0.38	0.55	0.35	0.29	0.31

Western snowy plovers nesting, roosting, and foraging in the action area on VAFB are likely to be distressed by visual disturbance, noise, and overpressures from launch and landing activities. These disturbances may startle western snowy plovers, or disrupt foraging or breeding activities. If launch and landing occur during the breeding season (approximately March through September), brooding birds may flush and leave eggs or chicks unattended. Unattended eggs and chicks may become vulnerable to exposure or predation. Furthermore, western snowy plovers may be killed or injured if overpressures are large enough to cause physical damage to eggs, chicks, or adults in areas of greatest impact, or if brooding adults abandon nests. Some effects to individuals may be reduced with implementation of rescue and rehabilitation of physically damaged chicks and adults or abandoned eggs.

Sound and overpressure may cause effects that are not immediately evident. Repeated exposure to these disturbances may cause reduced numbers of nesting adults or reduced productivity of western snowy plovers in the action area over time.

We anticipate effects to western snowy plovers on the NCI would be substantially less than on VAFB. Sonic booms during launch and landing are not expected to be greater than 3 psf, and there would not be any exposure to launch or landing noise or associated visual stimuli. Western snowy plovers on the NCI may startle or flush due to overpressures.

Effects of Monitoring

Human activity within the western snowy plover breeding areas can cause birds to flush and become agitated. People entering the South Surf Beach breeding area to install motion activated cameras and to conduct monitoring are likely to cause some disturbance to the birds. These disturbances may startle western snowy plovers or disrupt foraging or breeding activities. Brooding birds may flush and leave eggs or chicks unattended. Unattended eggs and chicks may become vulnerable to exposure or predation; they may also become susceptible to injury if people enter the colony and step on chicks or nests that are not detected. Additionally, installation of cameras in the colony may provide a visual cue to attract predators. Because cameras will be placed in a manner to minimize disturbance to nesting plovers, and monitoring activities would be conducted by a Service-approved biologist familiar with the biology and potential risks to western snowy plover, we expect that the potential for adverse effects to western snowy plovers from monitoring activities would be greatly reduced.

Effects on Recovery

In the recovery plan for western snowy plover, we designated six recovery units across the range. VAFB is located within Recovery Unit 5, which includes San Luis Obispo, Santa Barbara, and Ventura Counties. Recovery Unit 5 supports the greatest number of western snowy plovers in the range (approximately half of the U.S. population), and has the greatest amount of available suitable habitat (Service 2007).

To be considered for delisting, recovery criterion 1 states that an average of 3,000 breeding adults must be maintained for 10 years, distributed among six recovery units. Recovery Unit 5 would need to maintain 1,200 of the 3,000. To meet recovery criterion 2, a yearly average productivity of at least one fledged chick per male must be maintained in each recovery unit in the last 5 years prior to delisting (Service 2007).

Table 7 outlines average numbers of western snowy plovers counted during breeding season window surveys over a 12-year period. Percentages illustrate the numbers of breeding western snowy plovers at VAFB relative to numbers rangewide, across California, and within Recovery Unit 5. The 12-year average of breeding western snowy plovers at VAFB is 207.7, accounting for 11.1 percent of the overall range, 12.8 percent of California, and 26.0 percent of Recovery Unit 5.

Table 7. 2005-2016 breeding window survey averages for the Pacific Coast range of western snowy plover, California, Recovery Unit 5, and at Vandenberg Air Force Base with relative percentages (Service 2016).

Area Surveyed	*12-year Average*	*Percent of Range*	*Percent of CA*	*Percent of RU5*
Rangewide (California, Oregon, Washington)	1,858.5	100	-	
California Only	1,627.1	87.5	100	-
Recovery Unit (RU) 5	799.8	43.0	49.1	100
Vandenberg Air Force Base	207.7	11.1	12.8	26.0

From 2012 to 2016, western snowy plovers initiated an average of 379.8 nests at VAFB, with a 5-year average nest success of 48 percent (at least one egg hatched), and an average of 187.4 fledglings per year (Table 4). In the 2016 breeding season, the fledglings per male ratio was 1.19 (Kaisersatt, pers. comm. 2016); this is above the recovery criterion of 1 fledgling per male.

As mentioned in the Status of the Species section, the western snowy plover population viability analysis (PVA; Hudgens et al. 2014) suggests that sites south of Point Reyes National Sea Shore in California are expected to be population sources for sites in the higher latitudes of the Pacific coast range. The PVA identified latitudinal gradients of survival and fecundity across the Pacific coast range, with southern populations experiencing greater longevity and productivity than western snowy plovers from northern populations. Immigration probabilities show banded western snowy plovers from VAFB disperse to numerous breeding sites from San Diego County to Mendocino County (Hudgens et al. 2014).

In summary, we expect adverse effects to western snowy plovers are likely to occur as a result of the proposed action; however, the severity of immediate and long-term impacts are uncertain, pending monitoring results. At minimum, we anticipate launches and landings would cause short-term effects to western snowy plovers during breeding and non-breeding seasons. Short-term effects would likely include startle responses, flushing, and interruptions to foraging, courtship, and breeding activities, with the potential for reduced numbers of nesting adults and/or productivity from prolonged exposure to disturbances in the action area over time. If substantial effects to individuals or losses of the western snowy plover breeding population at VAFB occur due to project activities, we anticipate those would have cascading negative effects to recovery rangewide.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. We do not consider future Federal actions that are unrelated to the proposed action in this section because they require separate consultation pursuant to section 7 of the Act. Much of the action area is within VAFB, a Federal installation, and we are not aware of any non-Federal actions that are reasonably certain to occur in the portion of the action area outside VAFB.

CONCLUSION

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to the reproduction, numbers, and distribution of the species. In that context, the following paragraphs summarize the effects of the proposed project on the El Segundo blue butterfly, California red-legged frog, California least tern, and western snowy plover.

El Segundo Blue Butterfly

Reproduction

The proposed project would result in the loss of 229 seacliff buckwheat in suitable but not known to be occupied habitat on VAFB; however, the total amount of suitable habitat (i.e., 229 buckwheat plants, each buffered by 1 m) is relatively small and there is suitable habitat located nearby. SpaceX will compensate for these impacts by performing habitat enhancement, consisting of seacliff buckwheat plantings and invasive plant control at a 2:1 ratio, in suitable but not known to be occupied habitat located directly adjacent to known occupied habitat and existing habitat restoration areas. This habitat enhancement is expected to result in additional breeding habitat for the El Segundo blue butterfly on VAFB. In addition, based on the avoidance and minimization measures the Air Force has proposed, no project activities beyond the vegetation removal are expected to affect breeding El Segundo blue butterflies. Therefore, we conclude that the proposed project would not reduce El Segundo blue butterfly reproduction in the action area or rangewide.

Numbers

We currently consider seacliff buckwheat plants in the vegetation removal area in Spring Canyon to comprise habitat that is suitable but not known to be occupied by El Segundo blue butterflies, and therefore we assume that butterflies may be present. However, we are unable to determine the number of El Segundo blue butterflies that may be present in the area at the time of the vegetation removal because the numbers and location of individuals in the action area can vary from year to year. Vegetation removal activities could directly affect individual El Segundo blue butterfly larvae and diapausing pupae to the point of injury or death; however, we expect that adult butterflies would be able to move out of harm's way to suitable habitat nearby. In addition, based on the avoidance and minimization measures the Air Force has proposed, no project activities beyond the vegetation removal are expected to cause injury or mortality, or otherwise reduce the number of El Segundo blue butterflies in the action area. The number of El Segundo blue butterflies we expect to be affected by the vegetation removal activities is small relative to populations within the action area and those in the entirety of the subspecies' range. Therefore, we conclude that the proposed project would not reduce the number of El Segundo blue butterfly in the action area or rangewide.

Distribution

The proposed project could displace El Segundo blue butterflies from a portion of the action area in Spring Canyon, and could cause injury or mortality; however, as described above, the total amount of area affected is small and there is suitable habitat nearby within Spring Canyon. Based on the avoidance and minimization measures the Air Force has proposed, no project activities beyond the vegetation removal are expected to affect the distribution of El Segundo blue butterfly in the action area. In addition, the proposed El Segundo blue butterfly habitat enhancement may result in a slight increase in distribution of the subspecies on VAFB. Therefore, we conclude that the effects of the proposed project would not reduce the distribution of the El Segundo blue butterfly in the action area or rangewide.

Recovery

The recovery plan for the El Segundo blue butterfly did not contemplate the role of VAFB in the subspecies' recovery because we finalized the plan prior to the observations of this subspecies in Santa Barbara County. Regardless, the proposed action would not result in any appreciable change in reproduction, population numbers, or distribution of the El Segundo blue butterfly and thus would not preclude the Service's ability to implement any of the measures identified in the recovery plan for the subspecies. Therefore, we conclude that the proposed action would not appreciably reduce the likelihood of recovery of the El Segundo blue butterfly rangewide.

After reviewing the current status of the El Segundo blue butterfly, the environmental baseline for the action area, the effects of the proposed project, and the cumulative effects, it is the Service's biological opinion that the Air Force's proposal to conduct SpaceX Falcon 9 launch and landing operations (and related activities described herein) at SLC-4 on VAFB is not likely to jeopardize the continued existence of the El Segundo blue butterfly. We have determined that the reproduction, numbers, and distribution of the subspecies would not be reduced, and thus the proposed project would not appreciably reduce the likelihood of the survival and recovery of the El Segundo blue butterfly.

California Red-legged Frog

Reproduction

The proposed project would not result in a loss of California red-legged frog breeding habitat, and launch and landing operations are not expected to adversely affect breeding behavior or effort. In addition, the Air Force would implement measures to minimize the risk of adverse effects to riparian habitat in Spring Canyon, which California red-legged frogs may use for dispersal during the breeding season or during above-average wet conditions. Therefore, we do not expect breeding California red-legged frogs would be affected by the proposed activities and conclude that the proposed project would not reduce California red-legged frog reproduction in the action area, in the Central Coast Recovery Unit, or rangewide.

Numbers

We are unable to determine the number of California red-legged frogs that could occur in the action area and may be affected by proposed project because existing survey data are insufficient to estimate population numbers, and the numbers of individuals in the action area likely vary from year to year. The proposed activities could directly and indirectly affect individual California red-legged frogs to the point of injury or death, although we expect injury or mortality to be minimal based on the avoidance and minimization measures the Air Force has proposed. The number of California red-legged frogs we expect to be affected by the proposed activities is very small relative to VAFB populations and those in the entirety of the species' range. Therefore, we conclude that the proposed project will not reduce the number of California red-legged frog in the action area, in the Central Coast Recovery Unit, or rangewide.

Distribution

The proposed project could temporarily displace California red-legged frogs from portions of the action area and could cause injury or mortality; however, the Air Force would implement measures to minimize the risk of adverse effects on California red-legged frogs. Project activities could reduce habitat quality and availability in Spring Canyon and result in localized change is the distribution of California red-legged frogs that may occur there; however, the best available information indicates that the species is likely to occupy this area only infrequently, during dispersal events or above average rain years. Therefore, we conclude that the effects of the proposed project would not reduce the distribution of the California red-legged frog in the action area, in the Central Coast Recovery Unit, or rangewide.

Recovery

The action area lies within the Central Coast Recovery Unit. The proposed action would not result in any appreciable change in reproduction, population numbers, or distribution of the California red-legged frog and would not preclude the Service's ability to implement any of the measures identified in the recovery plan for the species. Therefore, we conclude that the proposed action would not appreciably reduce the likelihood of recovery of the California red-legged frog in the Central Coast Recovery Unit or rangewide.

After reviewing the current status of the California red-legged frog, the environmental baseline for the action area, the effects of the proposed project, and the cumulative effects, it is the Service's biological opinion that the Air Force's proposal to conduct SpaceX Falcon 9 launch and landing operations (and related activities described herein) at SLC-4 on VAFB is not likely to jeopardize the continued existence of the California red-legged frog. We have determined that the reproduction, numbers, and distribution of the species would not be reduced, and thus the proposed project would not appreciably reduce the likelihood of the survival and recovery of the California red-legged frog.

California Least Tern

Reproduction

When launch and landing operations occur during the breeding season (approximately April to August), breeding California least terns would likely be disturbed by noise and overpressures. At a minimum, we expect this may result in short-term effects including interruption of courtship or breeding activities, or flushing from nests. Repeated disturbance of breeding terns could result in reduced reproductive effort or productivity over time. The severity of immediate and long-term impacts are uncertain, pending monitoring results. Monitoring activities may also cause temporary disturbance to breeding California least terns; however, based on the minimization measures the Air Force has proposed (i.e., using only Service-approved biologists and placing cameras in a manner to minimize disturbance of nesting terns), monitoring activities are not expected to result in take. While it is possible that California least tern reproduction could be somewhat reduced within the action area, the Purisima Point breeding colony represents a small portion of the rangewide breeding effort (i.e., 27 nests, or approximately 0.5 percent, of the 4,746 nests found rangewide in 2016). Therefore, due to the small percentage of the breeding population affected, we conclude that the proposed project could potentially reduce California least tern reproduction within the action area but would not reduce reproduction of the subspecies rangewide.

Numbers

We are unable to determine the precise number of California least terns that could occur in the action area and may be affected by proposed project because the numbers of individuals in the action area likely vary from year to year. The proposed activities could directly affect individual California least terns to the point of injury or death, although we expect injury or mortality to be rare. The number of California least terns we expect to be affected by the proposed activities is small relative to populations in the entirety of the subspecies' range. Therefore, we conclude that the proposed project will not reduce the number of California least tern in the action area or rangewide.

Distribution

The proposed project could temporarily displace California least terns from portions of the action area and could cause injury or mortality. Repeated disturbance from sonic booms could potentially cause terns to avoid areas currently used for nesting or foraging, resulting in a change in distribution of the subspecies within the action area; however, we consider this to be a severe response and do not expect it to occur based on locations of California least terns on VAFB in relation to the range of predicted exposures to sonic boom noise and overpressure. It is more likely that any such change in distribution will be localized and temporary, rather than complete avoidance of the area by the subspecies. Therefore, we conclude that the effects of the proposed project would not reduce the distribution of the California least tern in the action area or rangewide.

Recovery

Although adverse effects are likely to occur as a result of the proposed action, we do not anticipate they will diminish the contribution the population at VAFB makes to the recovery of the California least tern. The proposed action would not result in any appreciable change in reproduction, population numbers, or distribution of the California least tern and thus would not preclude the Service's ability to implement any of the measures identified in the recovery plan for the subspecies. Therefore, we conclude that the proposed action would not appreciably reduce the likelihood of recovery of the California least tern rangewide.

After reviewing the current status of the California least tern, the environmental baseline for the action area, the effects of the proposed project, and the cumulative effects, it is the Service's biological opinion that the Air Force's proposal to conduct SpaceX Falcon 9 launch and landing operations (and related activities described herein) at SLC-4 on VAFB is not likely to jeopardize the continued existence of the California least tern. We have determined that the reproduction, numbers, and distribution of the subspecies would not be appreciably reduced, and thus the proposed project would not appreciably reduce the likelihood of the survival and recovery of the California least tern.

Western Snowy Plover

Reproduction

When launch and landing operations occur during the breeding season (approximately March through September), breeding western snowy plovers would likely be disturbed by noise and overpressures. At a minimum, we expect this may result in short-term effects including interruption of courtship or breeding activities, or flushing from nests. Repeated disturbance of breeding western snowy plovers could result in reduced reproductive effort or productivity over time. The severity of immediate and long-term impacts are uncertain, pending monitoring results. Monitoring activities may also cause temporary disturbance to breeding western snowy plovers; however, based on the minimization measures the Air Force has proposed (i.e., using only Service-approved biologists and placing cameras in a manner to minimize disturbance of nesting plovers), monitoring activities are not expected to result in take. Due to the close proximity of nesting western snowy plovers to SLC-4W, we expect reproduction within the action area would be at least somewhat reduced due to effects from sonic boom noise and overpressure. We conclude that while the proposed project has the potential to reduce western snowy plover reproduction in the action area, we further conclude that the activities would not reduce reproduction rangewide.

Numbers

We are unable to determine the precise number of western snowy plovers that could occur in the action area and may be affected by proposed project because the numbers of individuals in the action area likely vary from year to year, and the exact effects of the proposed action are not well-documented. The proposed activities could directly affect individual western snowy plovers to the point of injury or death, although we expect injury or mortality to be minimal. While we expect some decline in the number of western snowy plovers on VAFB due to the proposed activities, the uncertainty of the severity of effects leads us to conclude that the proposed project would not reduce the numbers rangewide.

Distribution

The proposed project could temporarily displace western snowy plovers from portions of the action area and could cause injury or mortality. Repeated disturbance from sonic booms could potentially cause plovers to avoid areas currently used for nesting or foraging, resulting in a change in distribution of the subspecies within the action area. This is more likely to occur in those areas closest to SLC-4W (i.e., South Surf Beach) but is not expected to happen basewide. Therefore, we conclude that the effects of the proposed project have the potential to reduce the distribution of the western snowy plover in the action area, but would not reduce distribution of the subspecies rangewide.

Recovery

The proposed action could potentially result in changes in reproduction, population numbers, and distribution of the western snowy plover in the action area. The severity of immediate and long-term impacts on these factors are uncertain, pending monitoring results. If substantial effects to individuals or losses of the western snowy plover breeding population at VAFB occur due to project activities, we anticipate those would have cascading negative effects to recovery rangewide. Existing and proposed monitoring measures would help determine if the severity of immediate and long-term impacts to reproduction, population numbers, and distribution are having a rangewide effect; however, based on the best information currently available, we conclude that the proposed action would not appreciably reduce the likelihood of recovery of the western snowy plover rangewide.

After reviewing the current status of the western snowy plover, the environmental baseline for the action area, the effects of the proposed project, and the cumulative effects, it is the Service's biological opinion that the Air Force's proposal to conduct SpaceX Falcon 9 launch and landing operations (and related activities described herein) at SLC-4 on VAFB is not likely to jeopardize the continued existence of the western snowy plover. Due to the uncertainty surrounding the severity of effects, further information may reveal rangewide impacts we could not predict with the currently available information, and we will revisit the activities if such rangewide changes in the western snowy plover's status become evident. Because monitoring will be conducted to reduce this uncertainty and measure the actual effects, we have determined that the proposed project would not appreciably reduce the likelihood of the survival and recovery of the western snowy plover.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened wildlife species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

In June 2015, the Service finalized new regulations implementing the incidental take provisions of section 7(a)(2) of the Act. The new regulations also clarify the standard regarding when the Service formulates an Incidental Take Statement [50 CFR 402.14(g)(7)], from "…if such take may occur" to "…if such take is reasonably certain to occur." This is not a new standard, but merely a clarification and codification of the applicable standard that the Service has been using and is consistent with case law. The standard does not require a guarantee that take will result; only that the Service establishes a rational basis for a finding of take. The Service continues to rely on the best available scientific and commercial data, as well as professional judgment, in reaching these determinations and resolving uncertainties or information gaps.

El Segundo Blue Butterfly

We anticipate that El Segundo blue butterflies could be subject to take in the form of harm, injury, and mortality. Removing seacliff buckwheat plants could result in injury or mortality of individual butterflies because this subspecies spends the vast majority of its life in close association with its host plant. Because of their cryptic nature and because evidence of dead or injured individuals would likely be destroyed by equipment used during the project, detecting dead or injured El Segundo blue butterflies would be extremely difficult; however, if El Segundo blue butterflies are occupying the plants to be removed, the take of El Segundo blue butterflies can be anticipated by destruction of habitat containing seacliff buckwheat.

We are unable to determine the number of El Segundo blue butterflies that may be present in the area at the time of the vegetation removal because the numbers and location of individuals in the action area can vary from year to year. In addition, we cannot quantify the precise numbers of El Segundo blue butterflies that may be killed or injured as a result of the proposed removal of 229 seacliff buckwheat because the number of individuals associated with any single plant or pupating underground varies. Consequently, we are unable to reasonably anticipate the actual number of El Segundo blue butterflies that would be taken by the proposed project.

The use of seacliff buckwheat plants as a surrogate for the take of individual butterflies is appropriate because reliance on finding injured or dead individuals would likely underestimate the actual effects of the action; i.e., the number of individual butterflies found dead or injured is going to be lower than what actually occurs. By using the habitat to determine the level of take we anticipate, we have a measurable accurate estimation of the actual impact.

The Environmental Baseline, Effects Analysis, and Conclusion sections of this biological opinion indicate that adverse effects to El Segundo blue butterflies would likely be minor given the nature of the proposed activities and the habitat currently recognized as suitable but not known to be occupied. We anticipate that any El Segundo blue butterflies occupying the 229 seacliff buckwheat plants that would be removed during vegetation removal activities associated with flame duct water use will be taken through injury or mortality. Therefore, if the number of seacliff buckwheat plants removed or destroyed in Spring Canyon as a result of vegetation removal activities associated with flame duct water use exceeds 110 percent of the current estimate (229 seacliff buckwheat plants), the Air Force must contact our office immediately to reinitiate formal consultation with the Service.

California Red-legged Frog

California red-legged frogs may be taken by capture, injury, and mortality in the course of project activities. All California red-legged frogs within project construction or restoration areas may be taken by capture. California red-legged frogs within the vicinity of the flame duct may be taken by injury or mortality resulting from civil diversion structure construction, vegetation removal, and/or flame duct use. California red-legged frogs within the vicinity of project restoration areas may be taken by injury or mortality resulting from restoration activities. Some proportion of captured California red-legged frogs may suffer injury or mortality in the course of handling for relocation or monitoring activities. Based on the proposed activities, the status of the species in the action area, and the proposed avoidance and minimization measures we expect take to be low.

Therefore, if 3 California red-legged frogs of any life stage are found injured or killed by activities associated with civil diversion structure construction, vegetation removal, flame duct use, and/or restoration activities, or if 10% of captured red-legged frogs are injured or killed during handling, the Air Force must contact us immediately to reinitiate formal consultation. Project activities that are likely to cause additional take should cease during this review period because the exemption provided under section 7(o)(2) could lapse.

California Least Tern

We anticipate that some California least terns could be taken as a result of the proposed action. We expect the incidental take to be in the form of harm and/or harass if brooding birds flush and leave eggs or chicks unattended; and harm, harass, wound, and/or kill if unattended eggs and chicks become vulnerable to effects of exposure or predation. However, based on location of nesting California least terns on VAFB in relation to the range of predicted exposures to sonic boom noise and overpressure, the likelihood of injury or mortality is low.

We cannot quantify the precise number of California least terns that may be taken as a result of the actions that the Air Force has proposed because only up to 10 percent of active nests would be monitored using cameras. In addition, biological monitoring of California least terns using daily counts from 3 days before through 3 days after landings at SLC-4W will only be conducted at the Santa Ynez River estuary (not at the Purisima Point colony), and biological monitors may not observe all affected birds.

Consequently, we are unable to reasonably anticipate the actual number of California least terns that would be taken by the proposed project. The Environmental Baseline and Effects Analysis sections of this biological opinion indicate that adverse effects to California least terns would be likely given the nature of the proposed activities. We also recognize that for every California least tern found dead or injured, other individuals may be killed or injured that are not detected; so, when we determine an appropriate take level we are anticipating that the actual take would be higher and we set the number below that level.

Therefore, if visual or camera monitoring of California least terns indicates more than 1 nest or 1 chick is abandoned, injured or killed as a result of launch and landing events, the Air Force must contact our office immediately to reinitiate formal consultation. Project activities during the California least tern breeding season should cease during this review period because the exemption provided under section 7(o)(2) could lapse.

Western Snowy Plover

We anticipate that some western snowy plovers could be taken as a result of the proposed action. We expect the incidental take to be in the form of harm and/or harass if brooding birds flush and leave eggs or chicks unattended; and harm, harass, wound, and/or kill if unattended eggs and chicks become vulnerable to effects of exposure or predation, or if overpressures cause physical damage or death to eggs, chicks, or adults.

We cannot quantify the precise number of western snowy plovers that may be taken as a result of the actions that the Air Force has proposed because the severity of effects of the predicted magnitude of overpressure on nesting western snowy plovers is uncertain. In addition, only a small portion of the breeding population (i.e., up to 10 percent of active nests at South Surf Beach) would be monitored using cameras, and biological monitoring of breeding western snowy plovers using daily counts from 3 days before through 3 days after landings at SLC-4W will only be conducted at South Surf Beach; therefore, biological monitors may not observe all affected birds.

Consequently, we are unable to reasonably anticipate the actual number of western snowy plovers that would be taken by the proposed project. The Environmental Baseline and Effects Analysis sections of this biological opinion indicate that adverse effects to western snowy plovers would be likely given the nature of the proposed activities. We also recognize that for every western snowy plover found dead or injured, other individuals may be killed or injured that are not detected; so, when we determine an appropriate take level we are anticipating that the actual take would be higher and we set the number below that level.

Therefore, if more than 5 western snowy plovers of any life stage (egg, chick or adult) are injured or killed as a result of launch or landing events, or if greater than 10 percent of the total number of camera-monitored nests on South Surf Beach indicate nest abandonment or injury or mortality to eggs or chicks attributable to launch and landing events, the Air Force must contact our office immediately to reinitiate formal consultation. Project activities during the western snowy plover breeding season should cease during this review period because the exemption provided under section 7(o)(2) could lapse.

REASONABLE AND PRUDENT MEASURES

The measures described below are non-discretionary, and must be undertaken by the Air Force or made binding conditions of any grant or permit issued to SpaceX, as appropriate, for the exemption in section 7(o)(2) to apply. The Air Force has a continuing duty to regulate the activity covered by this incidental take statement. If the Air Force (1) fails to assume and implement the terms and conditions or (2) fails to require SpaceX to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, the Air Force must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR 402.14(i)(3)].

The Service's evaluation of the effects of the proposed action includes consideration of the measures developed by the Air Force, and repeated in the Description of the Proposed Action portion of this biological opinion, to minimize the adverse effects of the proposed action on the El Segundo blue butterfly, California red-legged frog, California least tern, and western snowy plover. Any subsequent changes in the minimization measures proposed by the Air Force may constitute a modification of the proposed action and may warrant reinitiation of formal consultation, as specified at 50 CFR 402.16.

For the El Segundo blue butterfly and California red-legged frog, the minimization measures listed in the Project Description will effectively minimize the impacts of any potential take of these species. Consequently, we are not including additional reasonable and prudent measures or implementing terms and conditions for the El Segundo blue butterfly or California red-legged frog in this incidental take statement.

For the California least tern and western snowy plover, we believe the following reasonable and prudent measures are necessary and appropriate to minimize the impacts of the incidental take of these species:

1. The Air Force must monitor breeding California least terns and western snowy plovers to determine the effects of the proposed activities and ensure that the level of incidental take that occurs during project implementation is commensurate with the analysis contained herein.

2. The Air Force must implement adaptive monitoring and management to minimize the impacts of potential take of California least terns and western snowy plovers.

TERMS AND CONDITIONS

To be exempt from the prohibitions of section 9 of the Act, the Air Force must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline reporting and monitoring requirements. These terms and conditions are nondiscretionary.

1. The following terms and conditions implement reasonable and prudent measure 1:

   a. For the first three landing events at SLC-4W during the breeding season, monitoring of California least terns must be conducted at both the Purisima Point colony and the Santa Ynez River estuary to determine potential effects from the proposed activities. The monitoring should occur three days before and three days after SLC-4W landings to measure changes in nest attendance at Purisima Point colony (during and after launch/landing operations in relation to "baseline" conditions); changes in breeding effort, distribution, or success (including decreases in nesting effort, nest success, and fledgling success); changes in habitat use; declines in population size within the action area; and injury or mortality.

   b. If after any landing event at SLC-4W, monitoring in South Surf Beach reveals any injury or mortality to any life stage of western snowy plovers from the proposed action, the Air Force will expand monitoring for the next three SLC-4W landings during the breeding season. The expanded monitoring will be conducted across each range of predicted sonic boom overpressures (i.e., 1-2, 2-3, 3-4, 4-5, 5-6, 6-7 and 7-8 psf) in which plovers are breeding to determine at what level plovers are adversely affected versus injured or killed from the proposed activities. The monitoring must be consistent with that proposed for

South Surf Beach (with the exception of the number of cameras). Use of and number of cameras for areas outside South Surf Beach will be agreed upon by the Air Force and Service based on information learned from the first launch.

2. The following term and condition implements reasonable and prudent measure 2:

   a. The Air Force must use information collected from monitoring to adapt species management actions and monitoring efforts accordingly for future launches or related consultations. Adapted species management actions and monitoring efforts may include restoring and expanding habitat for western snowy plovers away from areas exposed to higher overpressure levels if injury or mortality are directly attributed to boostback events. Monitoring adaptively for western snowy plovers on the NCI if monitoring on VAFB indicate adverse effects for western snowy plovers within the 3 psf range. Increasing or revising the overall monitoring efforts for the California least tern and/or western snowy plover if data collected from the current monitoring plan exceed anticipated adverse effects and appear not to be sufficiently assessing effects to them due to project activities; and increasing monitoring efforts for California red-legged frogs if initial bio-acoustic monitoring suggests effects of project activities greater than expected.

REPORTING REQUIREMENTS

Pursuant to 50 CFR 402. 14(i)(3), the Air Force must report the progress of Falcon 9 launch and landing operations at SLC-4 and their impact on the species to the Service as specified in this incidental take statement. This reporting will assist the Service and the Air Force in evaluating current and future measures for the conservation of the El Segundo blue butterfly, California red-legged frog, California least tern, and western snowy plover at VAFB. The Air Force must provide the following information to the Service:

1. A written report to the Service within 60 days following the launch/landing event during which bioacoustic monitoring of California red-legged frogs is conducted. The report must include: documentation of actual noise levels and overpressures at the monitoring sites in Cañada Honda Creek and upper Shuman Creek, associated with launch and landing; documentation of the results of bioacoustic monitoring, biological surveys and observations, and any other pertinent information records; documentation of potential impacts of the proposed activities on California red-legged frog or suitable breeding habitat, and the number of California red-legged frogs killed or injured, describing the circumstances of the mortalities or injuries if known. If documentation in the report suggests that amount of incidental take of California red-legged frogs we anticipate in the Incidental Take Statement may have been exceeded, or that effects to California red-legged frogs are potentially exceeding those analyzed in our effects analysis, the Air Force will work with the Service to better understand the amount of incidental take and severity of effects of the action.

2. For the first three landings of the Falcon 9 first stage at SLC-4W that occur while California least terns are nesting on VAFB, a written report to the a minimum of seven working days before the next launch/landing operation. The report must include: documentation of actual noise levels and overpressures associated with launch and landing; documentation of results of biological surveys and observation records; documentation of potential impacts of the proposed activities on California least terns at Purisima Point and the Santa Ynez River estuary; documentation of the number of individuals of California least tern harassed (e.g., flushed or relocated from an area), injured or killed; the date, time, and location of any form of take; approximate size and age of those individuals taken; and documentation of the location where individuals relocated after flushing and the amount of time before returning to the original location, including the amount of time away from a nest or chick after flushing/relocating compared with pre-launch nest attendance If documentation in the report suggests that amount of incidental take of California least terns we anticipate in the Incidental Take Statement may have been exceeded, or that effects to California least terns are potentially exceeding those analyzed in our effects analysis, the Air Force will work with the Service to better understand the amount of incidental take and severity of effects of the action.

3. For the first three landings of the Falcon 9 first stage at SLC-4W that occur while western snowy plovers are nesting on VAFB, a written report to the Service a minimum of seven working days before the next launch/landing operation launch/landing operation. The report must include: documentation of actual noise levels and overpressures associated with launch and landing; documentation of results of biological surveys and observation records; documentation of potential impacts of the proposed activities on western snowy plovers in each sonic boom psf range; documentation of the number of individuals of western snowy plovers harassed (e.g., flushed or relocated from an area), injured or killed; the date, time, and location of any form of take; approximate size and age of those individuals taken; and documentation of the location where individuals relocated after flushing and the amount of time before returning to the original location, including the amount of time away from a nest or chick after flushing/relocating compared with pre-launch nest attendance. If documentation in the report suggests that amount of incidental take of western snowy plovers we anticipate in the Incidental Take Statement may have been exceeded, or that effects to western snowy plovers are potentially exceeding those analyzed in our effects analysis, the Air Force will work with the Service to better understand the amount of incidental take and severity of effects of the action.

4. A written report due by January 1 for each fiscal year (October – September) that activities are conducted pursuant to this biological opinion. The annual report must include: documentation of the impacts of the proposed activities on the federally listed species covered within this biological opinion; results of biological surveys and observation records; documentation of the number of individuals of federally listed species harassed (e.g., flushed or relocated from an area), captured, or injured or killed; the date, time, and location of any form of take; approximate size and age of those individuals taken; a description of relocation sites for captured individuals; and the acreages of habitat for the federally listed species that

were restored/enhanced, temporarily disturbed and permanently lost. The report should also include a discussion of those problems encountered implementing the terms and conditions and other protective measures, recommendations for modifying the terms and conditions to enhance the conservation of federally listed species, and any other pertinent information. These reports will assist us in evaluating future measures for the protection of federally listed species at VAFB. As part of the annual report, the Air Force must continue to implement the monitoring programs to identify population trends and possible causes for any trends indicating declines that may result from cumulative effects of multiple launches and landings from SLC-4.

DISPOSITION OF DEAD OR INJURED SPECIMENS

Within 1 working day of locating a dead or injured El Segundo blue butterfly, California red-legged frog, California least tern, or western snowy plover, the Air Force must make initial notification by telephone and writing to the Ventura Fish and Wildlife Office in Ventura, California, (2493 Portola Road, Suite B, Ventura, California 93003, (805) 644-1766). The notification must include the time and date, location of the carcass, a photograph, cause of death if known, and any other pertinent information.

Care must be taken in handling injured animals to ensure effective treatment and care and in handling dead specimens to preserve biological material in the best possible state for later analysis. Injured animals must be transported to a qualified veterinarian. If any injured El Segundo blue butterflies, California red-legged frogs, California least terns, or western snowy plovers survive, the Air Force should contact us regarding their final disposition.

The remains of El Segundo blue butterflies, California red-legged frogs, California least terns, or western snowy plovers must be placed with educational or research institutions holding the appropriate State and Federal permits, such as the Santa Barbara Natural History Museum (Contact: Paul Collins, Santa Barbara Natural History Museum, Vertebrate Zoology Department, 2559 Puesta Del Sol, Santa Barbara, California 93460, (805) 682-4711, extension 321).

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to use their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to avoid or minimize adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service requests notification of the implementation of any conservation recommendations so we may be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats.

1. We recommend that the Air Force require SpaceX to conduct habitat restoration along South Surf Beach, immediately south of the Torch restoration area (as shown in the Air Force's email dated September 15, 2017) to compensate for impacts to the subspecies commensurate with the effects of the activities. This restoration effort would expand suitable habitat in the 3-4 psf range, allowing plovers that currently next closer to SLC-4 (e.g., up to 8 psf) to find additional nesting opportunities in less-impacted areas.

2. We recommend that Air Force require Space X to conduct habitat enhancement, including eucalyptus removal, in the middle/upper Cañada Honda Creek to compensate for impacts to the California red-legged frog commensurate with effects of the activities.

3. We recommend that the Air Force conduct more frequent surveys for California red-legged frogs in major drainages on VAFB, and that future surveys incorporate mark-recapture methodology to estimate detection probability. Such surveys would better identify long-term status and trends in California red-legged populations on VAFB. If the bioacoustics monitoring proves effective, this should be explored as a possible method of monitoring California red-legged populations that would be less invasive and more feasible.

4. We recommend the Air Force investigate the efficacy of capture and relocation of California red-legged frogs to determine if use of this minimization measure reduces adverse effects of project actions on the species. As part of this, information on repeat capture and behavior of individuals post-movement should be noted.

5. Relocation of California red-legged frogs has the potential to cause the transfer of chytrid fungus between drainages. Therefore, to avoid transferring disease or pathogens between aquatic habitats during the course of surveys and handling of California red-legged frogs, biologists should follow the Declining Amphibian Population Task Force's Code of Practice.

6. We recommend that the Air Force advise qualified biologists to relocate other native reptiles or amphibians found within work areas to suitable habitat outside of project areas if such actions are in compliance with State laws.

7. We recommend that the Air Force advise qualified biologists to remove non-native aquatic animals such as bullfrogs, crayfish, and brown bullhead which may prey on California red-legged frogs, unarmored threespine stickleback, and tidewater goby whenever these are detected during project monitoring activities, in compliance with State laws.

8. Spring Canyon is an important overwintering site for the monarch butterfly (*Danaus plexippus plexippus*). We recommend that invasive plant treatments conducted as part of the proposed Spring Canyon riparian mitigation avoid spraying nectar plants and follow the recommendations included in the VAFB Monarch Butterfly Report (Center for Environmental Management of Military Lands (CEMML) 2017). If there is interest in creating a long-term site-specific monarch overwintering site management plan to supplement the CEMML general recommendations, please contact the Service to assist you in assessing Spring Canyon and developing a plan.

REINITIATION NOTICE

This concludes formal consultation on the actions outlined in the request for formal consultation dated August 8, 2017 and subsequent revisions to the project description on November 20, 2017. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, the exemption issued pursuant to section 7(o)(2) may have lapsed and any further take could be a violation of section 4(d) or 9. Consequently, we recommend that any operations causing such take cease pending reinitiation.

If you have any questions regarding this consultation, please contact Heather Tipton of our staff at (805) 677-3326, or by electronic mail at heather_tipton@fws.gov.

Sincerely,

Stephen P. Henry
Field Supervisor

cc:
Darryl York, VAFB
Rhys Evans, VAFB

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APPENDIX C: National Oceanic & Atmospheric Administration, National Marine Fisheries Service Consultation

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

August 29, 2016

In response, refer to:
2016/5369:DDL

Ms. Beatrice L. Kephart
30 CES/CEI
1028 Iceland Ave
Vandenberg Air Force Base, California 93437-6010

Re: Endangered Species Act Section 7(a) (2) Concurrence Letter, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response, and Marine Mammal Protection Act for the SpaceX Boost-Back and Landing of the Falcon 9 First Stage

Dear Ms. Kephart:

On August 2, 2016, NOAA's National Marine Fisheries Service (NMFS) received your request for a written concurrence that the Vandenberg Air Force Base (VAFB) SpaceX Boost-Back and landing of the Falcon 9 First Stage (project) is not likely to adversely affect (NLAA) species listed as threated or endangered or critical habitats designated under the Endangered Species Act (ESA). On August 5, 2015, and January 26, 2016, NMFS provided Letters of Concurrence for this same proposed action with some adjustments to specific project details and consideration of potential impacts to ESA-listed species. This Letter of Concurrence replaces all previous letters that have been issued for this project and any previous letters that have been issued are no longer in effect. This response to your request was prepared by NMFS pursuant to section 7(a)(2) of the ESA, implementing regulations at 50 CFR 402, and agency guidance for preparation of letters of concurrence.

NMFS also provides preliminary comments concerning potential effects on whales, dolphins, porpoises, seals, and sea lions which are protected under the Marine Mammal Protection Act (MMPA). *See* 16 U.S.C. § 1361 *et seq.* Under the MMPA, it is generally illegal to "take" a marine mammal without prior authorization from NMFS. "Take" is defined as harassing, hunting, capturing, or killing, or attempting to harass, hunt, capture, or kill any marine mammal. Except with respect to military readiness activities and certain scientific research conducted by, or on behalf of, the Federal Government, "harassment" is defined as any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal in the wild, or has the potential to disturb a marine mammal in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.

This letter underwent pre-dissemination review using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The concurrence letter will be available through NMFS' Public Consultation Tracking System [https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts]. A complete record of this consultation is on file at the NMFS West Coast Regional Office.

Proposed Action and Action Area

SpaceX proposes up to six launches per year of the Falcon 9 rocket. The Falcon 9 is a two-stage rocket designed and manufactured by SpaceX which delivers payloads to space aboard the Dragon spacecraft or inside a composite fairing. Falcon 9 First Stage incorporates 9 Merlin engines and aluminum-lithium alloy tanks containing liquid oxygen and rocket-grade kerosene (RP-1) propellant. The rocket carries landing legs which will land the rocket back on Earth after take-off. Under the proposed action for the Falcon 9 First Stage Boost-back and landing, SpaceX proposes to return the Falcon 9 First Stage to a landing pad at SLC-4 West (W) on VAFB in California for potential reuse. Although, the SLC-4W is the preferred landing location, SpaceX identified the need for contingency landing locations. During previous consultations on this project, SpaceX has identified contingency landing locations on land and offshore VAFB. The August 2, 2016 letter indicates that Space X is proposing to modify the potential options for contingency landing locations again, and has now identified a location approximately 120 nautical miles (225 km) southwest of San Nicolas Island to serve as a contingency landing location, hereafter referred to as the Iridium Landing Location, in addition to the contingency landing location 31 miles (50 kilometers) offshore of VAFB that was previously proposed and analyzed in the January 26, 2016 Letter of Concurrence (see Figure 1 and 2). Consistent with previous consultations, the proposed project considers the possibility of a maximum of six contingency landings annually, including potential impacts resulting from unsuccessful barge landings, with contingency landings occurring at either offshore site on a case-by-case basis. No other changes to the proposed action as described and analyzed during previous consultations have been identified or proposed.

After launch of the Falcon 9, the boost-back and landing sequence begins when the First Stage separates from the Falcon 9 and the Merlin engines of the First Stage cut off. After First Stage engine cutoff, rather than dropping the First Stage in the Pacific Ocean, exoatmospheric cold gas thrusters would be triggered to flip the First Stage into position for retrograde burn. Three of the nine First Stage Merlin engines would be restarted to conduct the retrograde burn in order to reduce the velocity of the First Stage in the correct angle to land. Once the First Stage is in position and approaching its landing target, the three engines would be cut off to end the boost-back burn. The First Stage would then perform a controlled descent using atmospheric resistance to slow the stage down and guide it to the landing site.

Figure 1. Contingency landing location for the First Stage at Vandenberg Air Force Base (SLC-4W) and on a barge on the Pacific Ocean located 31 miles (50 kilometers) off of Vandenberg Air Force Base, California.

Barge Landing

Three vessels would be required to support a contingency barge landing, if such a landing is required: a barge/landing platform (300 ft long and 150 ft wide); a support vessel (165 ft long research vessel); and an ocean tug (120 ft long open water commercial tug). The barge was modified to accommodate the First Stage landing by increasing the width of the vessel and installing a dynamic positioning system and a redundant communications and command and control system. The support vessel is capable of housing the crew, instrumentation and communication equipment, and supporting debris recovery efforts. The tug will tow the barge into position at the landing site, after the First Stage lands, it will be secured onto the barge and the tug will tow the barge and the rocket back to Long Beach, California where it will be transported for off-load and transport back to the SLC-4W pad. The three vessels would be at sea for approximately 72 hours, including the 24 hours to transit to either contingency landing site, 12 hours for pre-launch activation, 12 hours to secure the First Stage and equipment for return trip, and 24 hours to transit back to Long Beach Harbor. The majority of the transit time would occur in Federal waters as it is expected that less than one hour of transit time would be within 3 nm miles from shore in California state waters.

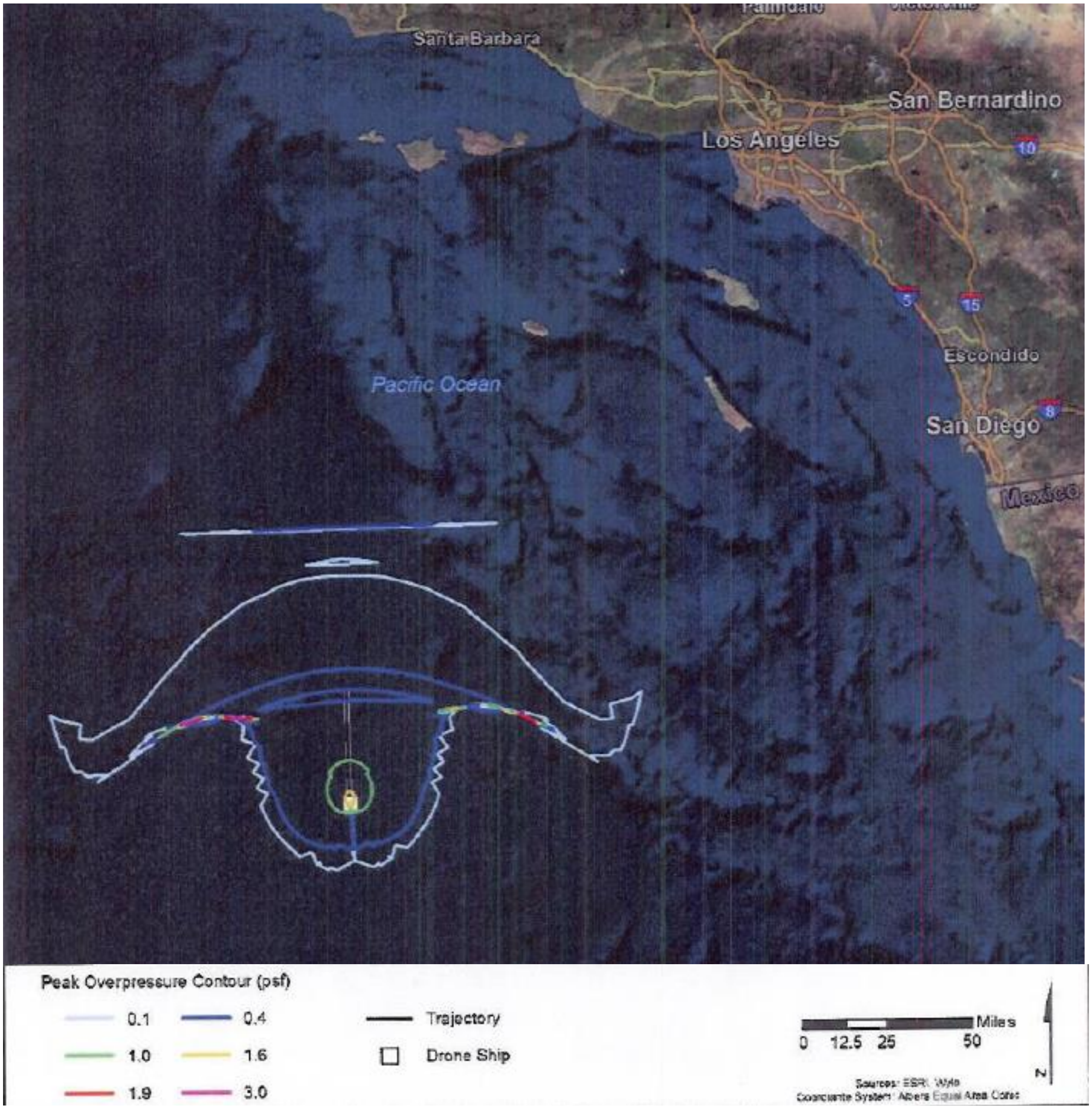

Figure 2. Contingency landing location for the First Stage on the Pacific Ocean located 120 miles (225 kilometers) southwest of San Nicholas Island, California. Figure also describes area expected to be impacted by the sonic boom associated with a contingency landing at this location.

In the event of an unsuccessful barge landing, the First Stage would explode upon impact with the barge. The explosive equivalence with maximum fuel and oxidizer is 503 pounds of trinitrotoluene (TNT) which is capable of a maximum projectile range of 384 m (1,250 ft) from the point of impact. Approximately 25 pieces of debris are expected to remain floating in the water and expected to impact less than 0.46 km2 (114 acres), and the majority of debris would be recovered. All other debris is expected to sink. These 25 pieces of debris are primarily made of Carbon Over Pressure Vessels (COPVs), the LOX fill line, and carbon fiber constructed legs. During previous landing attempts in other locations, SpaceX has performed successful debris recovery. All of the recovered debris would be transported back to Long Beach Harbor for proper disposal. Most of the fuel (estimated 50-150 gallons) is expected to be released onto the barge deck at the location of impact. In cases where the First Stage booster misses the barge entirely, it would be assumed that the 50-150 gallons of fuel would be released into the ocean.

Agency's Effects Determination

VAFB has determined that the proposed project is not likely to adversely affect threatened: Guadalupe fur seals (*Arctocephalus townsendi*), green sea turtles (*Chelonia mydas*), olive ridley sea turtles (*Lepidochelys olivacea*)*;* and endangered: blue whales (*Balaenoptera musculus*), fin whales (*B. physalus*), gray whales (*Eschrichtius robustus*; Western North Pacific stock), humpback whales (*Megaptera novaeangliae*), sei whales (*B. borealis*), sperm whales (*Physeter macrocephalus*), hawksbill sea turtles (*Eretmochelys imbricata*), loggerhead sea turtles (*Caretta caretta*), leatherback sea turtles (*Dermochelys coriacea*), steelhead (*Oncorhynchus mykiss*), green sturgeon *(Acipenser medirostris),* and scalloped hammerhead sharks (*Sphyrna lewini*).

Their reasoning for the above determinations include the low density of animals potentially present in the proposed project area, the low likelihood that the proposed project's impacts at the water's surface would reach a submerged animal, and the short duration of the proposed activity. In addition, VAFB determined that the addition of the Iridium Landing Location as a contingency site did not substantially alter previous assessments of risk for ESA-listed species.

Consultation History

Previously, NMFS and VAFB have been engaged in extensive communication and discussion about the project, as detailed in previous Letters of Concurrence (most recent dated January 26, 2016). For the purposes of this consultation request, VAFB sent a letter describing the proposed addition of the Iridium Landing Location as a contingency site, along with an assessment of the potential impacts this change would have on ESA-listed species in context with what had previously been analyzed. The determination made by VAFB and the analysis contained in this Letter of Concurrence are built upon the analyses contained in previous Letters of Concurrence for this project and the information provided by VAFB in the August 2, 2016, consultation request.

ENDANGERED SPECIES ACT

Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (50 CFR 402.02). The applicable standard to find that a proposed action is not likely to adversely affect listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur.

The proposed contingency actions associated with the proposed project include three potential impacts that may cause adverse effects on ESA-listed marine mammals, sea turtles, and fish species that occur in the vicinity of the contingency landing site. These include potential debris strike, acoustic impacts, and interactions with expended materials. In general, the potential exposure and likely response and overall risk associated with the proposed project for ESA-listed species are similar at both offshore contingency landing locations that have been proposed. Where applicable, we distinguish and consider where differences in exposure for ESA-listed species may be expected.

Debris Strike

Although the resulting explosion could reach a maximum impact area of 0.46 km^2 (114 acres), based on engineering analysis from SpaceX's Texas Rocket Development Facility, the debris would likely only impact 0.000706 km^2 of the 0.46 km^2 impact area. Using the United States Navy's analytical approach to estimate the probability of impact (U.S. Department of the Navy 2014), and assuming a dynamic scenario in which the width of the footprint is enhanced by a factor of 5 to reflect momentum created by the explosion, the probability of impact with a single marine mammal was calculated. SpaceX proposes to conduct six contingency offshore landings per year, which could result in 0-6 First Stage explosions and we therefore conservatively use the maximum number of six for our calculations. Based on the estimated marine mammal density per km^2 and assuming that animals are at the surface at all times, the estimated number of impacts per year for any ESA-listed marine mammal is <0.001 (VAFB 2015 and 2016). The density estimates used for this analysis represent coastwide estimates that are considered representative of expected densities that may occur in the vicinity of either offshore contingency landing location. As a result of this analysis, we have determined that it would be extremely unlikely that any of the seven ESA-listed marine mammals would be struck by debris as a result of the proposed Falcon 9 First Stage landings. As a result, we conclude the risk of potential debris strike from the First Stage explosion for ESA-listed marine mammals is discountable.

The probability of impact with an ESA-listed sea turtle can be estimated using the same approach presented above for marine mammals, but the calculations are limited by the lack of similar density data for most ESA-listed sea turtles in the action area. However, there is density information for leatherback sea turtles in Central California that can be used to analyze potential impacts for the contingency landing location 31 miles offshore VAFB (0.0036 animals per km^2; U.S. Department of the Navy 2014). In this location, we expect that leatherback sea turtles are the most common or likely sea turtle to be present based on the known distribution of the other 4 sea turtle species in the area, and thus we can use the we use the leatherback sea turtle density information as a conservative surrogate for the density of other sea turtles in this area. Based on the expected density of leatherback sea turtles, the estimated probability of debris impact with a leatherback sea turtle 31 miles offshore VAFB is 0.0003 leatherbacks per km^2 (VAFB 2015). This is then used to calculate an estimated annual number of takes of 0.0019 leatherback sea turtles at this location. We know that the density of the other 4 ESA-listed sea turtles likely to be in this impact area is less than what is expected for a leatherback sea turtle as calculated above, therefore, the estimated annual number of takes for the green sea turtle, loggerhead sea turtle, olive ridley sea turtle, and hawksbill sea turtle at this location is <0.0019 for each species (VAFB 2015).

However, at the Iridium Landing Location offshore San Nicholas in the Southern California Bight, other species of sea turtles are expected to be more common than they are in areas further north toward Central California; and likely more common in the proposed action area than leatherback sea turtles. Further away from Central California in the Southern California Bight where expected leatherback densities are less, we can expect that the likelihood of a debris strike for leatherback sea turtles at the Iridium Landing Location is also less than what was estimated for the area offshore VAFB. However, it is not appropriate to use estimated leatherback densities from Central California as a conservative surrogate for potential impacts to other sea turtle species in the Southern California

Bight. Based on historical fisheries bycatch data (NMFS 2013) and recent aerial surveys of the Southern California Bight, including the area offshore San Nicholas Island (SWFSC unpublished data), juvenile loggerhead sea turtles are likely the most common sea turtles that may be found in offshore areas of the Southern California Bight, at least seasonally during periods of warmer waters, including El Niño years. Unfortunately, no density data exist for loggerheads in this area at this time.

Recently, Seminoff *et al*. (2014) estimated loggerhead densities of 0.65 individuals per km^2 in coastal areas of Baja California Sur where juvenile loggerheads are known to congregate and forage in large numbers for extended periods of time. Compared to density values of leatherback turtles used in previous analyses, this value represents essentially 2 orders of magnitude higher density than the estimated leatherback density value off of Central California. However, the density of loggerhead turtles in the offshore environment in the Southern California Bight is not expected to be nearly as high as the coastal area in Baja. In 2013, NMFS concluded that loggerheads presence and abundance in U.S. waters off the coast of Southern California was significantly less compared those coastal foraging areas in Baja, and this area did not warrant designation of critical habitat (NMFS 2013). As a result, loggerhead density at the Iridium Landing Location is expected to be significantly less than what may be expected in Baja. Without any ability to quantitatively estimate the probability of debris striking a loggerhead sea turtle in this area similar to marine mammal species, we qualitatively have determined that the probability is likely very small given the relatively small size of the anticipated debris field in concert with the relative presence and abundance of loggerheads that can generally be expected in this area. From there we can also assume therefore, the estimated probability of debris strike for green sea turtles, olive ridley sea turtles, and hawksbill sea turtles at the Iridium Landing Location is even less than for loggerheads as these species are less likely than loggerheads to be present in abundance in this area.

Considering the relative probabilities of sea turtle presence within the debris field at both offshore contingency landing locations as described above, we have determined that it would be extremely unlikely that any of the ESA-listed sea turtles would be struck by debris as a result of the proposed Falcon 9 First Stage landings. As a result, we conclude the risk of potential debris strike from the First Stage explosion for ESA-listed sea turtles is discountable.

Sufficient density data are not available to conduct a debris strike analysis for ESA-listed fish species at either offshore contingency landing location in the manner conducted above for marine mammals and sea turtles. However, it is assumed that ESA-listed fish species likely to be in the area would be rare because of their known distribution in the area and likely swimming below the surface at all times. Should debris hit the water, it is expected that the initial impact at the water's surface or even slightly below the surface, would absorb much of the energy from that impact. If they were present at either location, ESA-listed fish would be expected to be below this initial area of impact, and therefore unaffected by the debris. Although previous consultations only analyzed the potential impact to steelhead and scalloped hammerhead shark because of the higher likelihood that they may inhabit the impact area, NMFS and VAFB assumed that a similar evaluation and analysis would pertain to the green sturgeon, although the potential contingency landing locations are south of its primary range. As a result, we conclude the risk of potential debris strike from the First Stage explosion for ESA-listed fish is discountable.

Acoustic Impacts

Impulse sounds may include a sonic boom from the First Stage boost-back or an explosion of the First Stage landing from an unsuccessful barge landing. Non-impulse noise would include engine noise from the First Stage landing and vessel noise from the barge, tug, and support vessel. Acoustic exposure to loud sounds may result in a temporary or permanent loss of hearing (termed a temporary (TTS) or permanent (PTS) threshold shift) depending upon the location of the marine mammal in relation to the source of the sound. Some marine mammal behavioral responses vary by individual, species, and circumstances. Some sounds may not cause any response, while others may result in minor to significant changes in a variety of behaviors, such as diving, surfacing, vocalizing, feeding, and/or mating, and flushing into the water from land. However, not all changes in behavior are cause for concern. Some marine animal responses are momentary inconsequential reactions, such as the turn of a head while other responses are within natural variation, such as a change in dive time. NOAA has developed new comprehensive guidance on sound characteristics likely to cause injury and behavioral disruption in the context of the MMPA, ESA, and other statutes.[1] However, until this formal guidance becomes widely accessible and used by the public, NMFS will continue to use conservative thresholds of received sound pressure levels from broad band sounds that may cause behavioral disturbance and injury referenced herein as current. These conservative thresholds are applied in both MMPA permits and ESA Section 7 consultations for marine mammals to evaluate the potential for sound effects. The criterion levels specified here are specific to the levels of harassment as defined under the MMPA. Level A criterion for in-water PTS (injury), excluding tactical sonar and explosives, is 190 $dB_{\text{Root Mean Square (rms)}}$ re 1 µPa for pinnipeds and 180 dB_{rms} re 1 µPa. Level B criterion for in-water for behavioral disruption for impulsive noise, is 160 dB_{rms} re 1 µPa; Level B criterion for in-water for behavioral disruption for non-pulse noise is 120 dB_{rms} re 1 µPa. There is no threshold established for Level A criterion for in-air PTS (injury), but for the Level B criterion in-air for harbor seals it is 90 dB_{rms} and for all other pinniped species, it is 100 dB_{rms}. We evaluated the proposed project activities using the above acoustic thresholds. In the ESA context, these thresholds are informative as the thresholds at which we might expect either behavioral changes or physical injury to an animal to occur, but the actual anticipated effects would be the result of the specific circumstances of the action (as further explained below).

Sonic Boom

A separate analysis is provided for the effects of a sonic boom on ESA listed species that are in the air above the water and for those underwater.

In-air

Guadalupe fur seals are the only ESA-listed marine mammal expected to haul out of the ocean onto the rocks within the proposed project area. They are found along the west coast of the United States, but are considered uncommon in Southern California. On San Miguel Island, California, one to several male Guadalupe fur seals had been observed annually between 1969 and 2000 (DeLong and Melin 2000) and juvenile animals of both sexes have been seen occasionally over the years (Stewart *et al.* 1987). Guadalupe fur seals display a high site fidelity to Point Bennett, on San Miguel Island, but SpaceX Boost-Back sonic boom impacts associated with activity offshore VAFB are expected to occur on the opposite side of San Miguel Island, away from Point Bennett. Guadalupe fur seals haul out in rocky habitat which provides them with protection and creates an environment that would deflect any potential loud noise stimuli (*e.g.*, the wave action would dampen noise and the rocks would deflect any sound waves away from the animals and back towards the sound source). Therefore, should a Guadalupe fur seal react to any stimulus, it is expected that they would not flush

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[1] On August 4, 2016, NMFS published NOAA Technical Memorandum NMFS-OPR-55 Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing - Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts (81 FR 51693). The process for how to implement this guidance into MMPA and ESA regulatory processes is under development.

into the water (*i.e.*, leave the haul out and move to or into the water) because of their typical rocky habitat. Thus, there is little to no threat of trampling of any age class, especially pups.

Sonic booms may potentially result in a short-duration startle response, which would not rise to the level of hearing damage to Guadalupe fur seals. NOAA Fisheries current in-air acoustic threshold for pinnipeds (except for harbor seals) is 100RMS dBA and all of the boom pressure signals measured in Sohn *et al.* (2000) experiment decayed to ambient levels in all frequency bands by 40-50 m (131-164 ft). Therefore, the amount of pressure that would damage hearing will decay to non-harmful levels prior to reaching Guadalupe fur seals hauled out on San Miguel Island. Results of monitoring during prior VAFB rocket launch operations have shown that reactions to sonic booms are correlated to the level of the sonic boom. Low energy sonic booms (<1.0 pounds psf) have resulted in little to no behavioral responses from harbor seals (*Phoca vitulina*) and California sea lions (*Zalophus californianus*). Any observed behavioral response has included a raise of the head or brief alert response, but animals returned to normal behavior shortly after the stimulus. VAFB monitoring reports from prior rocket launch operations indicate that more powerful sonic booms (>1.0 psf) have flushed harbor seals from their haul out sites, but have not resulted in any mortality or any sustained decrease in the total number of individuals following a stimulus and within 24 hours of a launch event (but more often it was within minutes), individuals returned to their pre-launch status. Guadalupe fur seals are considered to be less likely to be disturbed by sonic booms because when compared to harbor seals or California sea lions they are rarely observed showing any kind of behavioral reaction even when harbor seals or California sea lions have reacted (Jeff Harris, NMFS, pers. comm. 2015). Based on previous monitoring of rocket launches, harbor seals and California sea lions have resulted in little to no response. Also, VAFB's previous monitoring showed that only a portion of the pinnipeds present reacted (most often the most extreme reaction was for harbor seals to flush into the water, although sometimes an individual California sea lion or elephant seal would flush, but the majority would react with a head alert) to the sonic boom and that after all launches, all pinnipeds returned to their normal behavior. The same number of pinnipeds returned to their respective haul out sites within 24 hours of a launch event, but more often they returned to their haul out site within minutes.

During previous consultations on this proposed project, modeling was conducted for sonic boom impacts greater than 2 pounds per square foot (psf), in order to cover sonic booms that could occur at or slightly above 3.0 pounds psf, as the SpaceX data analysis concluded at the time was possible from the Boost-Back and landing of rockets. Actual data measured during the recent Jason-3 barge landing in January 2016, measured at 2.3 pounds psf. Based on this information, Bradley (2016) estimated the sonic boom at a contingency landing location could be up to 3.85 psf, slightly increasing the amount of energy transmitted into the water than what was predicted during previous consultations on this project. Based on the modeling, sonic boom impacts greater than 2 pounds psf are still expected to impact a very small area similar to what has been considered previously

Based on the modeling, sonic boom impacts greater than 2 pounds psf are expected to impact a very small area, which is likely to be offshore (See Figure 3) but does includes San Miguel Island. If such a sonic boom were to occur and reach San Miguel Island near the Point Bennet area, it is unlikely that a hauled out Guadalupe fur seal would detect it, based on the protection afforded by their rocky habitat as described above. In addition, based upon prior behavioral observations by Guadalupe fur seal experts, if the sonic boom was detected, the likelihood that a Guadalupe fur seal would be disturbed in excess of a startle or head response is minimal. Due to the low number of Guadalupe fur seals on San Miguel Island and their anticipated behavior during and following other types of human disturbance (including noise), in-air impacts from sonic booms are extremely unlikely and therefore discountable.

At the Iridium Landing Location, potential impacts from the sonic boom are likely to be completely offshore and away from any of the Channel Islands and potential haul out sites for Guadalupe fur seals (see Figure 2 above). Given the location of the Iridium Landing Location, there is no expectation of any ESA-listed species being hauled out of the water during any contingency landings there, and no risk of in-air impacts associated with the sonic boom.

Air to Underwater

It is likely that any noise associated with the sonic boom would transmit from the air to water and propagate some distance in the water column. A sonic boom at the surface of 2 pounds psf decayed to approximately 152 dB re 1µPa at a depth of 7 m (23 ft). By 22 m (72 ft), the received levels were approximately 140 dB re 1 µPa and at 37 m (121 ft), it was equal to ambient noise levels. All of these sound pressure levels are below the current NMFS threshold for potential permanent injury (190 dB_{rms} re 1 µPa sound pressure level for pinnipeds and 180 dB_{rms} re 1 µPa sound pressure level for cetaceans) and potential behavioral change or temporary injury (160 dB_{rms} re 1 µPa sound pressure level). The information provided to NMFS did not indicate the point at which underwater sound pressure levels would equal or exceed 160dB_{rms} re 1 µPa, but we estimate this would likely occur at less than 7 m which could be at or near the surface level of the water based on the decay rate provided above at a depth of 7m. An ESA-listed marine mammal or sea turtle would only be within the <7 m range for an extremely short time to either breathe or break the surface of the water at the conclusion a feeding event (*i.e.,* humpback whales breaking through the surface of the water after they congregate and feed on their prey). The onset of physical injury to fish would be expected if the peak levels exceed 206 dB re 1 µPa (Stadler and Woodbury 2009). As a result, the sonic boom associated with the contingency landing would be less than an explosion on the barge (blast injury and barotrauma is measured following exposure to an explosion) and would be less than what is estimated above at the water's surface generated by the Falcon 9 First Stage during the contingency barge landing.

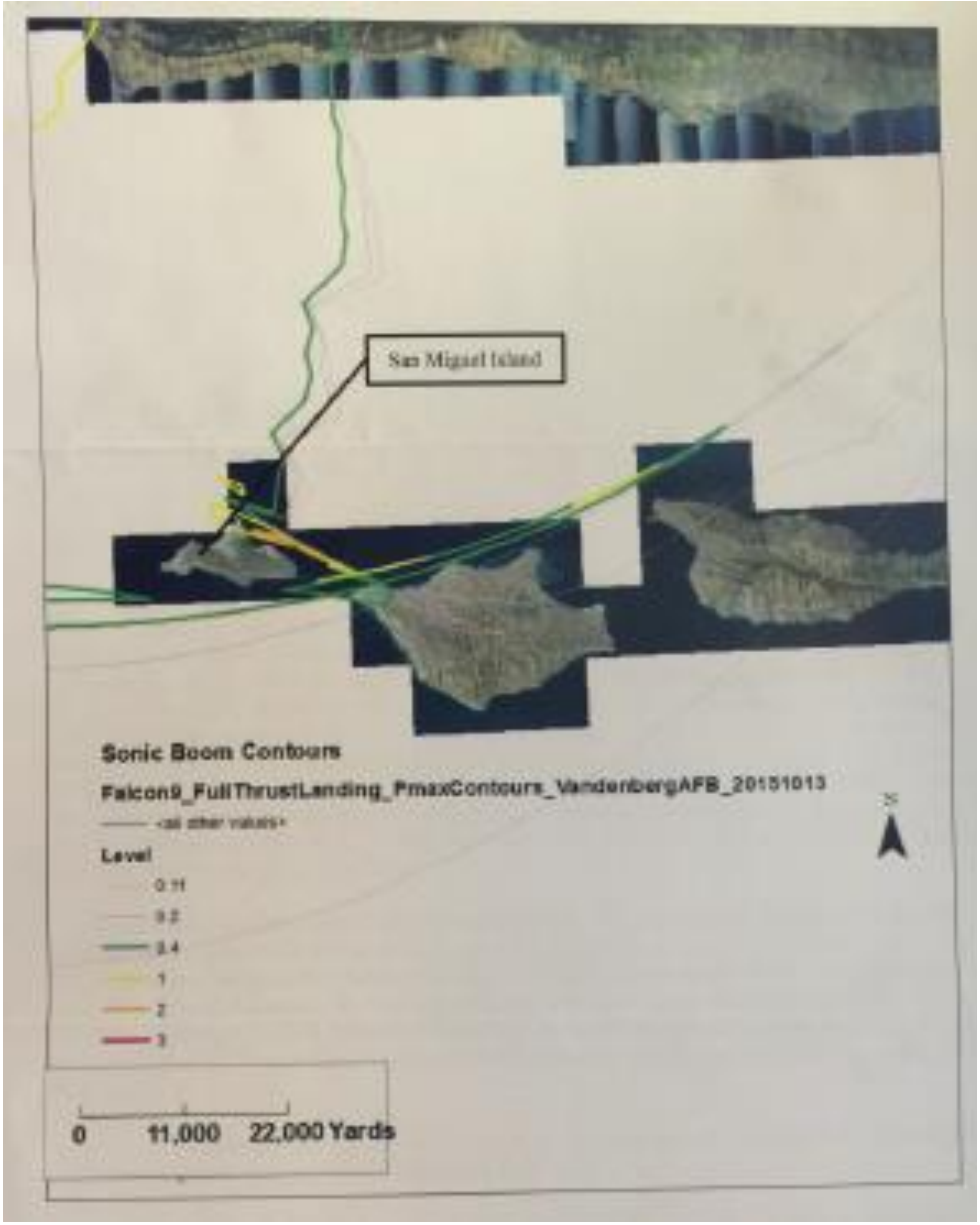

Figure 3: Example of a sonic boom impact area if a sonic boom reaches San Miguel Island, CA. In the model, all impacts greater than 2 pounds psf occur offshore (red dot and orange contour), and most impacts greater than 1.

Based on the estimated sound levels, the frequency with which the sonic booms may occur over the course of a year and the relative infrequency with which ESA-listed species may be in the immediate vicinity during those times at either contingency landing location, we conclude that the risk of sonic booms associated with contingency landing actions for ESA-listed species is discountable..

Explosion

Noise resulting from an unsuccessful barge landing could introduce impulse sound into the ocean or near the water's surface. The direct sound from the explosion would last less than a second. These sounds would be in the audible range of most marine mammals, even if the duration is expected to be very short. The six landing attempts would occur each year and likely dispersed over the course of that year. The spacing of the landing attempts would likely reduce the potential for long-term auditory masking. However, because of its intensity, the direct sound from an explosion could cause behavioral or physiological effects. Depending on the amount of fuel left, the intensity of the explosion will likely vary, but we considered the worst-case scenario, the largest possible amount of fuel left that could create the largest explosion. If an estimated 8% loss of energy is included as a result of the explosion occurring on the surface of the water, at a depth of 10 m (33 ft), the estimated received level is 249 dB re 1 µPa and at a depth of 100 m (328 ft), the estimated received level is 230 dB re 1 µPa which is the sound pressure level identified in Southall *et al.* (2007) for the onset of PTS in cetaceans to "discrete" noise events (either single or multiple exposures within a 24-h period). The onset of a temporary threshold shift (TTS) has been defined as being a temporary elevation of a hearing threshold by 6 dB (*e.g.,* Schlundt *et al.* 2000), although smaller threshold shifts have been demonstrated to be statistically significant with a sufficient number of samples (*e.g.,* Kastak *et al.* 1999; Finneran *et al.* 2005). If we use the TTS threshold for the most sensitive ESA-listed marine mammal species that could be in the proposed project area (Guadalupe fur seal), the µPa and at a depth of 100 m (328 ft), the estimated received level is 230 dB re 1 µPa which is the sound pressure level identified in Southall *et al.* (2007) for the onset of PTS in cetaceans to "discrete" noise events (either single or multiple exposures within a 24-h period). The onset of a temporary threshold shift (TTS) has been defined as being a temporary elevation of a hearing threshold by 6 dB (*e.g.,* Schlundt *et al.* 2000), although smaller threshold shifts have been demonstrated to be statistically significant with a sufficient number of samples (*e.g.,* Kastak *et al.* 1999; Finneran *et al.* 2005). If we use the TTS threshold for the most sensitive ESA-listed marine mammal species that could be in the proposed project area (Guadalupe fur seal), the threshold for onset of TTS is 212 dB re 1 µPa (Southall *et al.* 2007), which would occur within a 2,000 m (6,562 ft) radius, if an unsuccessful barge landing occurred in the water, which is extremely unlikely to occur (see below). When working with explosive sound impulses it is more appropriate to use the peak sound pressure level and the 180 dB and 160 dB thresholds are root mean^2 values that are not typically applied to explosions.[2]

However, if an explosion occurs as a result of an unsuccessful barge landing, SpaceX expects it would be on the barge and not directly in the water. VAFB provided a response from SpaceX who indicated[3] that they were 100% successful at hitting the barge in two previous attempts when the barge was in place for the landing attempt. Therefore, we will use the analysis provided above as a starting point, because we expect that significantly less energy from the explosion would transmit into the water if an explosion occurs on the barge and the zone of influence (ZOI) would be much less than what was calculated above. An explosion on the barge would cause an in-air blast that would propagate in all directions, including the surface of the water, but the barge itself would act as a barrier and would be expected to minimize the amount of energy directed into the ocean. It is expected that the in-water sound levels would be below the onset of PTS for any marine mammal species or the current NMFS threshold for Level A (in-water of 190 dB_{rms} re 1 µPa sound pressure

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[2] http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html
[3] Email from Darryl York (VAFB) on behalf of SpaceX to Monica DeAngelis (NMFS) dated July 20, 2015

level for pinnipeds and 180 dB_{rms} re 1 µPa sound pressure level for cetaceans), even though these thresholds are not typically applied to explosive activities. Based on the information provided for the ESA consultation, it seems unlikely that any explosion, should it occur, would have a ZOI surrounding the barge area that would extend much farther beyond that area in the vicinity of the barge's footprint that would correspond to the current NMFS threshold for potential behavioral change or temporary injury (in-water160 dB_{rms} re 1 µPa sound pressure level; or in-air for harbor seals it is 90 dB_{rms} and for all other pinniped species, it is 80 dB_{rms}) based on the source level of the explosion, the distance the sound would travel, and considering that the barge would act as a barrier to any sound produced. Disruption and disturbance of any marine mammal may occur, if they can detect the explosive event, but any disruption or disturbance caused by an explosion would be temporary (*e.g.*, an explosion is expected to last less than a second). Using the same analytical approach for the probability of debris strike above, analysis indicates that the probability of each ESA-listed marine mammal species occurring within the ZOI of an explosion at the water's surface in excess of NMFS thresholds for potential behavioral change is <0.002 for cetaceans and 0.1 for Guadalupe fur seals (VAFB 2015). The expected behavioral response by an animal exposed to the sound produced by an explosion could be relocation to an area away from the barge, disruption in feeding, or a change in dive pattern or respiration rate. Although there is a small chance that a marine mammal could be present in the acoustic ZOI in excess of NMFS thresholds for potential behavioral change, any behavioral response is not expected to reduce the fitness of that individual animal because the duration of the disturbance or avoidance response is expected to be very short, and will occur at most only a few times over the course of a year. Any marine mammal that may occur in this ZOI is expected to resume any behaviors that may be disrupted shortly after the exposure. As described above, the barge is expected to reduce the one second, one time acoustic impact of an explosion during unsuccessful barge landing; the resultant acoustic impact is not expected to disrupt the behavior pattern in ways that reduce the fitness of ESA-listed marine mammal individuals. As a result, we conclude any exposure to the explosion ZOI will be insignificant for ESA-listed marine mammals.

Since the onset for injury from sound pressure levels are evaluated in the same way for sea turtles as they are for marine mammals, a sea turtle would be expected to experience physiological impacts if it is within the 2000 m (6,562 ft) of an explosion that occurs at the water's surface. Beyond 2000 m (6,562 ft), it is unlikely that physiological impacts would occur, but possible behavioral responses could include relocation to an area away from the barge, disruption in feeding, or a change in dive pattern or respiration rate. Although there is a very small chance that a sea turtle could be present in this ZOI, any behavioral response is not expected to reduce the fitness of that individual animal because the duration of the disturbance or avoidance response is expected to be very short, and will occur at most only a few times over the course of a year. Any sea turtle that may occur in this ZOI is expected to resume any behaviors that may be disrupted shortly after the exposure. Similar to marine mammals, an explosion on the barge resulting from an unsuccessful landing would result in significantly less acoustic energy transmitting into the water than has been assumed. Using the Central California leatherback density as a surrogate for the contingency landing locations 31 miles offshore VAFB and same methodology applied to marine mammals, the estimated number of sea turtle occurring within the ZOI would be less than 0.0044 (VAFB 2015). For the Iridium Landing Location, there is no quantified estimate for the probability or number of sea turtles expected to occur in the ZOI in excess of NMFS thresholds for potential behavioral change at that location. Based on the analysis for the debris strike above, we have determined it is unlikely that any sea turtles will be within this ZOI at this location. Although there is a small chance that a marine mammal could be present in this acoustic ZOI at either contingency landing location proposed, any behavioral response is not expected to reduce the fitness of that individual animal because the duration of the disturbance or avoidance response is expected to be very short, and will occur at most only a few times over the course of a year. Any sea turtle that may occur in this ZOI is expected to resume any behaviors that may be disrupted shortly after the exposure. Ultimately, as described above, the barge is expected to reduce the one second, one time acoustic impact of an explosion during unsuccessful barge landing; the resultant acoustic impact is not expected to disrupt the behavior patterns in ways that reduce the fitness of ESA-listed sea turtles. As a result, we conclude any exposure to the explosion ZOI will be insignificant for ESA-listed sea turtles.

A conservative estimate of 10% mortality was estimated for fish with swim bladders potentially occurring in the contingency landing location would be 214 m (702 ft) (for a 1 pound fish). The estimated range in which injury could occur to fish with swim bladders (> 2 grams) would be 815 m (2,674 ft). Therefore, the area of potential impact to fish species with swim bladders is an approximately 815 m (2,674 ft) radial area around the surface of the water. The density of the fish killed by a surface water explosion would be density dependent and highly variable. As indicated above, NMFS does not expect that the ESA-listed fish species commonly occur in either contingency landing location proposed. In addition, an explosion on the barge resulting from an unsuccessful landing would result in significantly less acoustic energy transmitting into the water and the ZOI would be less, as discussed above. Behavioral disturbance thresholds for fish are lower than for mammals (150db), and similar to our assessment for mammals and turtles we do not expect behavioral disruption, to affect fitness of the exposed fish, in the unlikely event it occurs. As a result, we conclude any exposure to the explosion ZOI will be insignificant for ESA-listed fish.

Landing Noise

The Falcon 9 First Stage will generate landing noise up to 110 dB (well below the ESA and MMPA thresholds) for a short duration (minutes). Should a marine mammal be at the water’s surface at the time of the landing, the sound could elicit a response such as an alert, avoidance, or other behavioral reactions such as diving and moving away from the source, but any response is expected to be temporary, if it occurs at all. The landing noise is not expected to have an effect on submerged animals or those that spend a considerable amount of time submerged, such as large whales or sea turtles. Disturbance to landing noise would be unlikely to cause long-term impacts to marine mammals. As a result, we conclude that any exposure to the landing noise generated by the Falcon 9 First Stage during contingency landings will be insignificant for ESA-listed marine mammals or sea turtles.

Fish at or near the surface of the water would potentially experience behavioral disturbance, but in the unlikely event that a fish is near enough to the water’s surface at the time of the landing to detect the noise, any response is expected to be temporary due to the short duration of the landing noise and the sound levels transmitted into the water would be far below injury or disturbance levels. As a result, we conclude that any exposure to the landing noise generated by the Falcon 9 First Stage during contingency landings will be insignificant for ESA-listed fish.

Vessel Noise

Vessel noise does have the potential to disturb marine mammals by eliciting an alert, avoidance, or other behavioral reactions such as diving and moving away from the source. Marine mammals and sea turtles in the proposed zone of influence at either contingency landing location may be exposed to project-related vessels and vessel noise. However, it may be difficult for the animals to discern vessel noise associated with the proposed activities as additional to that which is already present due to research, ecotourism, commercial or private vessels, or government activities. As a result, we conclude that any exposure to vessel noise generated by the support vessels required to support the contingency landing actions will be insignificant for ESA-listed marine mammals and sea turtles.

Vessel noise has the potential to create in-water sound that could disturb ESA-listed fish species, which could result in behavioral (*e.g.,* avoidance) or physiological responses (*e.g.,* stress, increased heart rate). While vessel movements have the potential to expose ESA-listed fish species occupying the water column to noise and general disturbance, potentially resulting in short-term behavioral or physiological responses, such responses would not be expected to compromise the health, condition, or fitness of individual fish because the impacts from vessel noise would be temporary, infrequent, and localized. As a result, we conclude that any exposure to vessel noise generated by the support vessels required to support the contingency landing actions will be insignificant for ESA-listed fish.

Expended Materials and Fluids

Debris

Approximately 25 pieces of debris remain floating after a water landing or an unsuccessful barge landing with a potentially impacted surface area of less than 0.46 km^2 (114 acres), and the vast majority of debris would be recovered. All other debris is expected to sink to the bottom of the ocean. Depending on the type of materials involved, amount of debris, density, and other factors, the potential risks posed by the debris that was not collected are: degradation of water quality, substrate or habitat, which in turn would affect the listed species which use them. Since the area that would be impacted by falling debris is very small, the likelihood of adverse effects to ESA-listed marine mammals, fish, or sea turtles is very low. Furthermore, denser debris that would not float on the surface is anticipated to sink relatively quickly and is composed of inert materials which, by nature of their composition, would not affect water quality or bottom substrate or benthic habitat potentially used by ESA-listed marine mammals and sea turtles. The rate of deposition would vary with the type of debris; however, none of the debris is so dense or large that benthic habitat would be degraded. As a result, we conclude the risk associated with debris from an unsuccessful barge landing or water landing that enters the ocean environment at either contingency landing location for ESA-listed species is discountable.

Rocket Propellant

In the event of an unsuccessful landing attempt, the First Stage would explode upon impact with the barge or water. At most, the First Stage would contain 400 gallons of rocket propellant (RP-1 or "fuel") on board. In the event of an unsuccessful barge landing, most of this fuel would be consumed during the subsequent explosion. Residual fuel (estimated to be between 50 and 150 gallons) would be released into the ocean. The fuel used by the First Stage, RP-1, is a Type 1 "Very Light Oil", which is characterized as having low viscosity, low specific gravity, and are highly volatile (U.S. Fish and Wildlife Service 1998). Due to its high volatility, RP-1 evaporates quickly when exposed to the air, and would completely dissipate within one to two days after a spill in the water. Clean-up 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 a water landing (U.S. Fish and Wildlife Service 1998). Therefore, no attempt would be made to boom or recover RP-1 fuel from the ocean. RP-1 on the water's surface would move with the water flow, being transported due to the velocities in the surface layer. Given the offshore location of the contingency landing locations RP-1 is unlikely to reach any shoreline or any nearshore habitats (*e.g.,* kelp beds). The ESA-listed fish species, steelhead, green sturgeon, and scalloped hammerhead shark, are typically below the surface and would not be expected to interact with surface of the water frequently, making them unlikely to be exposed to RP-1 on the ocean surface during the one to two day period during which it would dissipate. “Very light oil” is not known to cause injury or harm to animals that are directly exposed to it and the spilled fuel from an unsuccessful barge landing or a water landing that enters the ocean environment at either contingency landing location is expected to evaporate quickly when exposed to the air, and would completely dissipate within one to two days after a spill in the water. As a result, we conclude the risk associated with exposure to rocket propellant for ESA-listed species is discountable.

Conclusion

Based on this analysis, NMFS concurs with VAFB and SpaceX that the proposed action is not likely to adversely affect the subject listed species. Critical habitat has not been designated or proposed for ESA-listed marine mammals, ESA-listed fish, green sea turtles, loggerhead sea turtles, olive ridley sea turtles, and hawksbill sea turtles in the action area; therefore, none was analyzed. Critical habitat for leatherback sea turtles is designated in the action area where the contingency landing location 31 miles offshore VAFB is located. Prey is an essential feature of leatherback critical habitat and the preferred prey of leatherbacks off the California coast is jellyfish, with other gelatinous prey, such as salps (a pelagic tunicate), considered of lesser importance (77 FR 4170). Based on the information provided and analyses of the proposed action conducted above, there is no indication that the proposed project activities could impact prey or the critical habitat of leatherback sea turtles offshore VAFB. The proposed addition of the Iridium Landing Location is outside of leatherback critical habitat. As a result, NMFS concludes that the proposed action is not likely to adversely affect critical habitat for leatherback sea turtles. Critical habitat for steelhead does exist on the mainland within the VAFB, but the proposed project’s action area will not overlap with the designated critical habitat.

Reinitiation of Consultation

Reinitiation of consultation is required and shall be requested by VAFB or by NMFS, where discretionary Federal involvement or control over the action has been retained or is authorized by law and (1) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (2) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this concurrence letter; or if (3) a new species is listed or critical habitat designated that may be affected by the identified action (50 CFR 402.16). This concludes the ESA portion of this consultation.

MARINE MAMMAL PROTECTION ACT

Although several marine mammal species are listed as federally endangered or threatened under the ESA, the Marine Mammal Protection Act of 1972 (MMPA) is the principal Federal legislation that guides marine mammal species protection and conservation. Under the MMPA, "take" of a marine mammal is permitted by NMFS under an Incidental Harassment Authorization (IHA) when the specified activity is incidental, but not intentional, of a small number of marine mammals.

As discussed in detail under the ESA section of this letter, sounds introduced into the sea by man-made devices could have a deleterious effect on marine mammals by causing stress or injury, interfering with communication and predator/prey detection, and changing behavior. Acoustic exposure to loud sounds may result in a temporary or permanent loss of hearing (termed a temporary (TTS) or permanent (PTS) threshold shift) depending upon the location of the marine mammal in relation to the source of the sound. As mentioned above, NMFS has recent published new guidance for determining safety criteria for marine species exposed to underwater sound. However, pending regular implementation and adoption of these guidelines for use in MMPA processes that is still under development, we have preliminarily determined, based on past projects, consultations with experts, and published studies, that 180 dB_{rms} re 1 μPa (190 dB_{rms} re 1 μPa for pinnipeds) is the impulse sound pressure level that can be received by marine mammals without injury. Marine mammals have shown behavioral changes when exposed to impulse sound pressure levels of 160 dB_{rms} re 1 μPa and when exposed to non-impulse sound pressure levels of 120 dB_{rms} re 1 μPa. Based on the estimated noise levels expected to be produced by the proposed project, Space X applied for authorization from NMFS under the MMPA for Level B harassment, specifically for the potential for behavioral harassment as a result of the proposed project activities. On May 19, 2016, NMFS issued Space X an IHA for the incidental harassment of marine mammals (81 FR 34984). Due to the proposed modification of the contingency landing locations, SpaceX has requested an amendment of the IHA for this action, which is currently under review by NMFS' Office of Protected Resources. At this time, we have no further guidance to provide other than compliance with the conditions of the IHA as issued by NMFS.

Thank you for coordinating with NMFS regarding this project. We appreciate your efforts to comply with Federal regulations and to conserve and protect marine mammals, sea turtles, and fish. Please direct questions regarding ESA and MMPA to Dan Lawson, 562-980-3209, Dan.Lawson@noaa.gov.

Sincerely,

William W. Stelle, Jr.
Regional Administrator

cc: Darryl York, Chief, Conservation 30 CES/CEIE Vandenberg AFB
Administrative File: 151422WCR2015PR00190

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July 10, 2017

Jolie Harrison, Division Chief
Permits and Conservation Division, Office of Protected Resources
1315 East-West Highway, F/PR1 Room 13805
Silver Spring, MD 20910
Jolie.Harrison@noaa.gov

SUBJECT: Request Incidental Take Authorization for Space Exploration Corporation Falcon 9 First Stage Boost-Back and Landing

Dear Ms. Harrison:

The purpose of this letter is to request that an Incidental Harassment Authorization (IHA) be issued under the authority of Section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1316 *et. seq.*) to Space Exploration Technologies Corporation's (SpaceX) for the taking, by level B harassment, of small numbers of six species of marine mammals incidental to Falcon 9 First Stage recovery activities. This request is based on the enclosed *Incidental Harassment Authorization Application Boost-Back and Landing of the Falcon 9 First Stage at SLC-4 West Vandenberg Air Force Base, California, and Contingency Landing Options Offshore* (June 2017).

SpaceX is currently operating the Falcon 9 Launch Vehicle Program at Space Launch Complex-4 (SLC-4) on Vandenberg Air Force Base (VAFB). NOAA Fisheries issued an IHA to SpaceX for the taking of six species of marine mammals incidental to Falcon 9 First Stage recovery activities on March 10, 2016. This IHA was valid from June 30, 2016, to June 29, 2017. SpaceX has yet to perform a Falcon 9 boost-back and landing at SLC-4 West (W). In addition, none of the Falcon 9 First Stage recovery activities that occurred during this reporting period impacted marine mammal haulouts. Therefore, SpaceX did not conduct any marine mammal monitoring during this reporting period and will not be submitting an annual monitoring report for this reporting period.

As described in the enclosed IHA application, SpaceX proposes to perform boost-backs and landings of the Falcon 9 First Stage at SLC-4W or at one of two offshore contingency landing locations. SpaceX proposes to increase the number of Falcon 9 First Stage boost-backs and landings to 12 events per year, using a three-engine burn. SpaceX would continue performing the conditions specified in the enclosed application, which includes preparing and submitting an annual monitoring report on all marine mammal monitoring conducted under the IHA.

Over the past year SpaceX has had success performing successful barge and land landings of the Falcon 9 First Stage within the Pacific and Atlantic Oceans offshore of California and Florida coastlines. Over this time period SpaceX has successfully landed

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9 first stages. Therefore, the enclosed application does not analyze the potential impacts to marine mammals from an explosion of the Falcon 9 First Stage during a landing in the Pacific Ocean, which is now considered an anomaly.

We look forward to working with you and your staff to answer any questions you may have about this application. Please feel free to contact John Hauenstein at John.Hauenstein@spacex.com or (310) 363-6345 with additional questions.

Sincerely,

Eric Krystkowiak
Director, Launch Operations, Vandenberg Air Force Base
Space Exploration Technologies

Enc.:
- SpaceX. 2016. Incidental Harassment Authorization Application Boost-Back and Landing of the Falcon 9 First Stage at SLC-4 West Vandenberg Air Force Base, California, and Contingency Landing Options Offshore.

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Incidental Harassment Authorization Application Boost-Back and Landing of the Falcon 9 First Stage at SLC-4 West

Vandenberg Air Force Base, California, and Contingency Landing Options Offshore

13 October 2017

Prepared for:

SPACEX

Space Explorations Technologies Corporation
1 Rocket Road
Hawthorne, CA 920250

Prepared by:

ManTech SRS Technologies, Inc.

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ACRONYMS AND ABBREVIATIONS

BIA	Biologically Important Areas
˚C	degrees Celsius
˚F	degrees Fahrenheit
dB	decibel
dBA	A-weighted decibe
dB_{RMS}	root mean square value of decibel
dB re uPa	decibels referenced to micropascals
ESA	Endangered Species Act
ft.	foot or feet
FTS	Flight System Termination
IHA	Incidental Harassment Authorization
km	kilometer
km^2	square kilometer(s)
lb.	pound(s)
LOA	Letter of Authorization
LOX	liquid oxygen
m	meter
MECO	Main Engine Cut Off
mi.	mile(s)
MMPA	Marine Mammal Protection Act
nm	nautical miles
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
psf	pounds per square foot
PTS	permanent threshold shift
rms	root mean squared
SLC	Space Launch Complex
SLC-4W	Space Launch Complex 4 West
SLC-4E	Space Launch Complex 4 East
SpaceX	Space Exploration Technologies Corporation
TTS	temporary threshold shift
U.S.	United States
U.S.C.	United States Code
USAF	United States Air Force
VAFB	Vandenberg Air Force Base

1 Description of Activity

1.1 Introduction

Space Exploration Technologies Corporation's (SpaceX) has prepared this application for an Incidental Harassment Authorization (IHA) for the taking, by Level B harassment, of small numbers of six species of marine mammals incidental to Falcon 9 First Stage recovery activities and the Pacific Ocean offshore of California. Under the Marine Mammal Protection Act (MMPA), 16 United States (U.S.) Code (U.S.C.) Section 1361 *et seq.*, the Secretary of Commerce shall allow, upon request, the incidental, but not intentional, taking of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographic region. The term “take" means “to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal” (16 U.S.C. § 1362[13]). IHAs are for actions that result in harassment (i.e., injury or disturbance) only and are effective for one year.

Vandenberg Air Force Base (VAFB) occupies approximately 99,100 acres (400 square kilometers [km^2]) of central Santa Barbara County, California, approximately halfway between San Diego and San Francisco (Figure 1-1). The Santa Ynez River and State Highway 246 divide VAFB into two distinct parts: North Base and South Base. Space Launch Complex (SLC) 4 West (SLC-4W), which is located on South Base, approximately 0.5 miles (mi.) (0.8 kilometer [km]) inland from the Pacific Ocean, is the primary landing facility for the Falcon 9 First Stage on VAFB (Figure 1-2). SLC-4 East (SLC-4E), which is located approximately 715 feet (ft.) (218 meters [m]) east of SLC-4W, is the launch facility for the Falcon 9 Program (Figure 1-2). Although SLC-4W is the preferred landing location for the Falcon 9 First Stage, SpaceX has identified two contingency landing locations in the Pacific Ocean that would be exercised if there were critical assets on south VAFB that would not permit an overflight of the First Stage or other reasons that would not permit landing at SLC-4W (e.g., heavy payload). These contingency landing locations are depicted in Figure 1-3 and are referred to as the Contingency Landing Location and Iridium Landing Area.

SpaceX is currently operating the Falcon 9 Launch Vehicle Program at SLC-4 on VAFB. National Oceanic and Atmospheric Administration (NOAA) Fisheries Office of Protected Resources previously issued regulations and Letters of Authorization (LOA) that authorize the take of marine mammals, by Level B harassment, incidental to launches of up to 50 rockets per year from VAFB (79 Federal Register 10016). This LOA is effective from March 2014 to March 2019 and includes Falcon 9 launches at VAFB.

SpaceX received an IHA from NOAA Fisheries, dated May 19, 2016, for Falcon 9 First Stage recovery activities. This IHA was valid from June 30, 2016, to June 29, 2017. On August 2, 2016, SpaceX notified NOAA Fisheries that it was proposing to perform barge landings southwest of San Nicolas Island (“Iridium Landing Area”) because of mission restrictions. NOAA Fisheries concurred that a take of marine mammals would not likely occur from this change and a revision to the IHA was not warranted (Jordan Carduner, NOAA Fisheries, pers. comm. August 3, 2016). Only one landing occurred during the IHA period, which was in the Iridium Landing Area. Therefore, the Falcon 9 boost-back and landing did not result in any takes of marine mammals during this period.

SpaceX proposes to perform Falcon 9 First Stage boost-back and landings, up to 12 events per year, at either SLC-4W or the contingency landing locations, which is an increase from the prior year.

Figure 1-1. Regional Location of VAFB

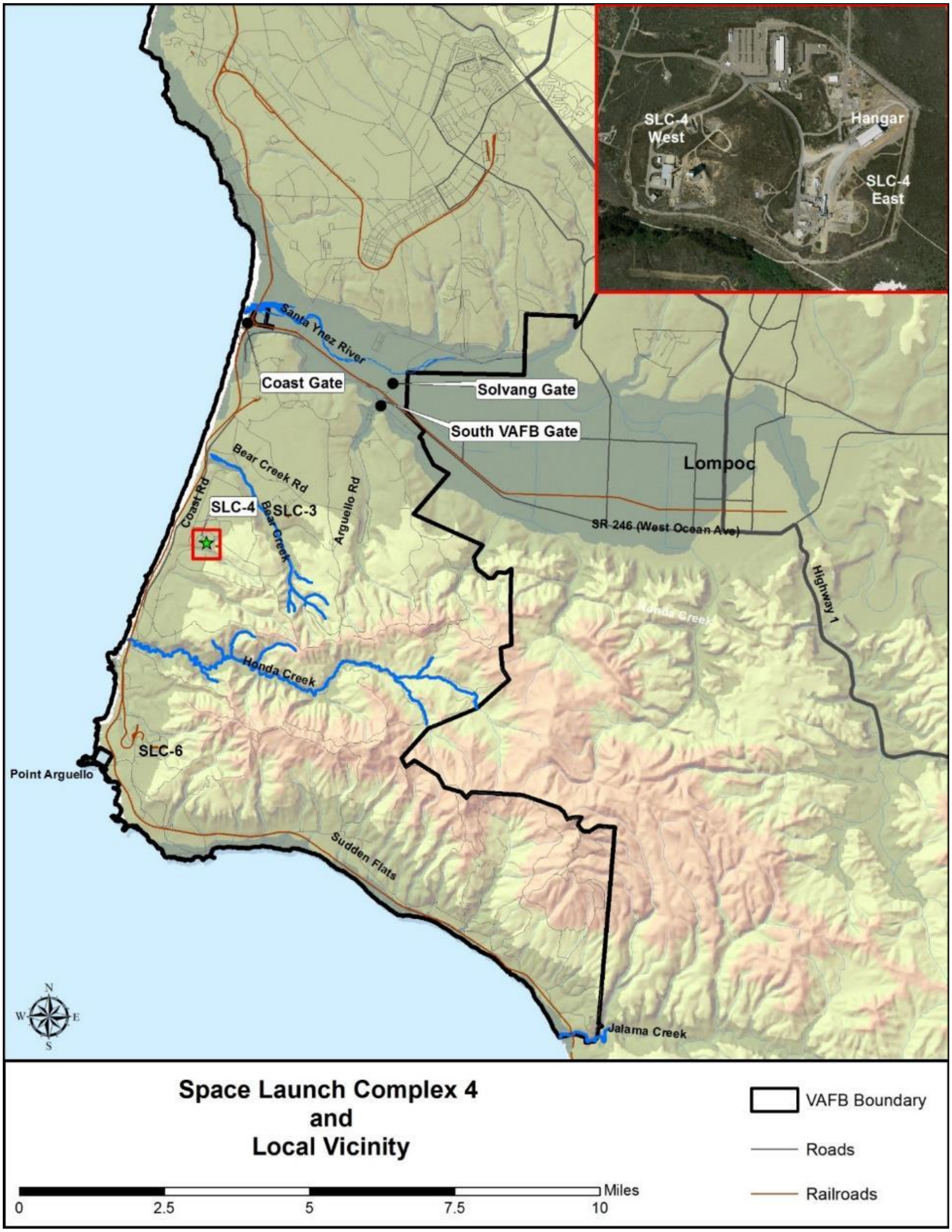

Figure 1-2. Location of SLC-4 and Vicinity

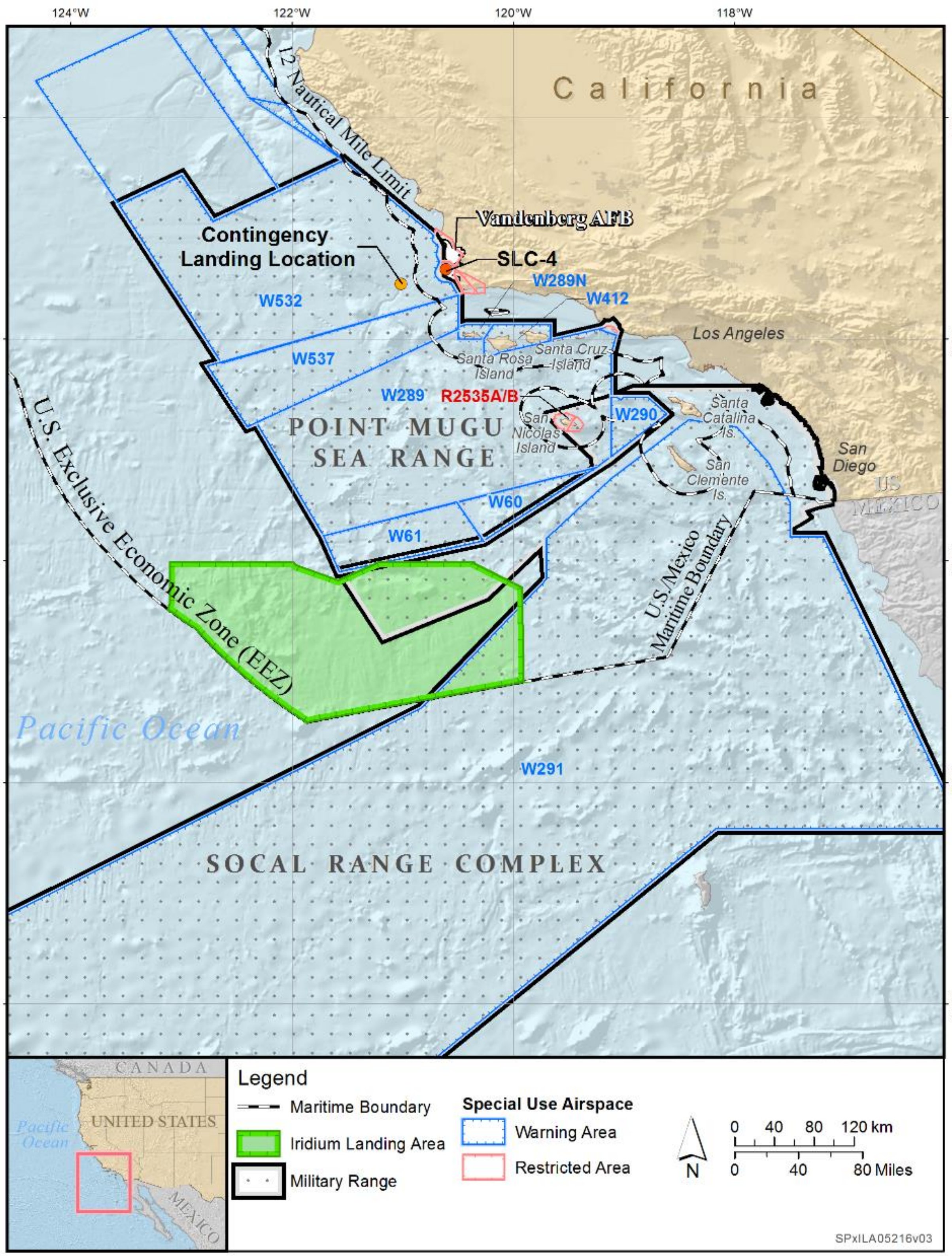

Figure 1-3. Proposed Contingency Landing Areas and Vicinity

1.2 Proposed Action

SpaceX proposes to return the Falcon 9 First Stage booster to SLC-4 for potential reuse up to 12 times per year. This includes performing boost-back maneuvers (in-air) and landings of the Falcon 9 First Stage on the pad at SLC-4W or at two contingency landing options should it not be feasible to land the First Stage at SLC-4W. The first contingency landing option is on a barge located at least 27 nautical miles (nm) (50 km) offshore of VAFB. The second contingency landing option is on a barge within the Iridium Landing Area. The Iridium Landing Area is an approximately 33,153 square kilometers (km^2) area that is located approximately 122 nm (225 km) southwest of San Nicolas Island's coastal waters and 133 nm (245 km) southwest of San Clemente Island's coastal waters. It extends as far north as 32nd parallel north (32°N), as far east as the Patton Escarpment, and as far south and west as the U.S. Pacific Coast Region Exclusive Economic Zone (Figure 1-3). Table 1-1 depicts the current SpaceX launch schedule from SLC-4 and the anticipated landing areas (Note that this schedule is subject to unanticipated changes).

Table 1-1. Notional Falcon 9 Launch Schedule from SLC-4

Date	Booster	Payload	Customer	Landing Location
November 2017	Falcon 9	Iridium NEXT	Iridium Communications	Iridium Landing Area
December 2017	Falcon 9	Paz	Hisdesat	SLC-4W
December 2017	Falcon 9	Iridium NEXT	Iridium Communications	Iridium Landing Area
Early 2018	Falcon 9	SSO-A with SHERPA	Spaceflight Industries	SLC-4W
January 2018	Falcon 9	Iridium NEXT	Iridium Communications	Iridium Landing Area
March 2018	Falcon 9	Iridium NEXT	Iridium Communications	Iridium Landing Area
May 2018	Falcon 9	Iridium NEXT	Iridium Communications	Iridium Landing Area
2018	Falcon 9	SAOCOM	CONAE	SLC-4W
2018	Falcon 9	SARah 1	Bundeswehr	SLC-4W
2018	Falon 9	SARah 2/3	Bundeswehr	SLC-4W
2018	Falcon 9	RADARSAT Constellation	Canadian Space Agency	SLC-4W

1.2.1 Falcon 9 Boost-back and Landing at SLC-4W

SpaceX proposes to return the Falcon 9 First Stage booster to SLC-4W at VAFB for potential reuse up to 12 times per year. The Falcon 9 First Stage is 12 ft. in diameter and 160 ft. in height, including the interstage that would remain attached during landing.

Figure 1-4 provides a graphical depiction of the boost-back and landing sequence. Figure 1-5 shows an example of the boost-back trajectory of the First Stage (depicted by the green path) and the second stage trajectory (depicted by the yellow path). After the First Stage engine cutoff, concurrent to the second stage ignition and delivery of the payload to orbit, exoatmospheric cold gas thrusters would be initiated to flip the First Stage into position for a "retrograde burn." Three of the nine First Stage Merlin engines would be restarted to conduct the retrograde burn in order to reduce the velocity of the First Stage and to place the First Stage in the correct angle to land. Once the First Stage is in position and approaching its landing target, the three engines would cut off to end the boost-back burn. The First Stage would then perform a controlled descent using atmospheric resistance to slow the stage down and guide it to the landing pad target. The First Stage is outfitted with grid fins that allow cross range corrections as needed. The landing legs on the First Stage would then deploy in preparation for a final single engine burn that would slow the First Stage to a velocity of zero before landing on the landing pad at SLC-4W.

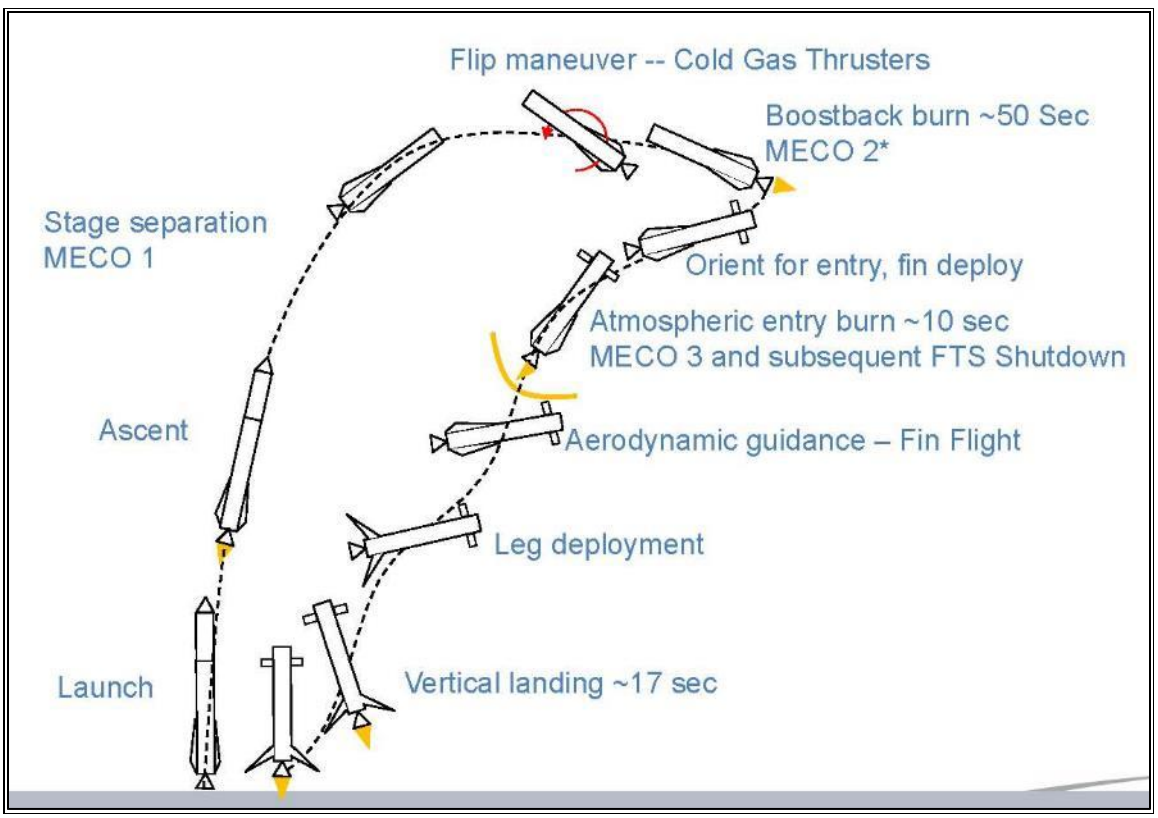

Figure 1-4. Stages of Boost-Back and Propulsive Landing
(Notes: MECO = Main Engine Cut Off; FTS = Flight Termination System)

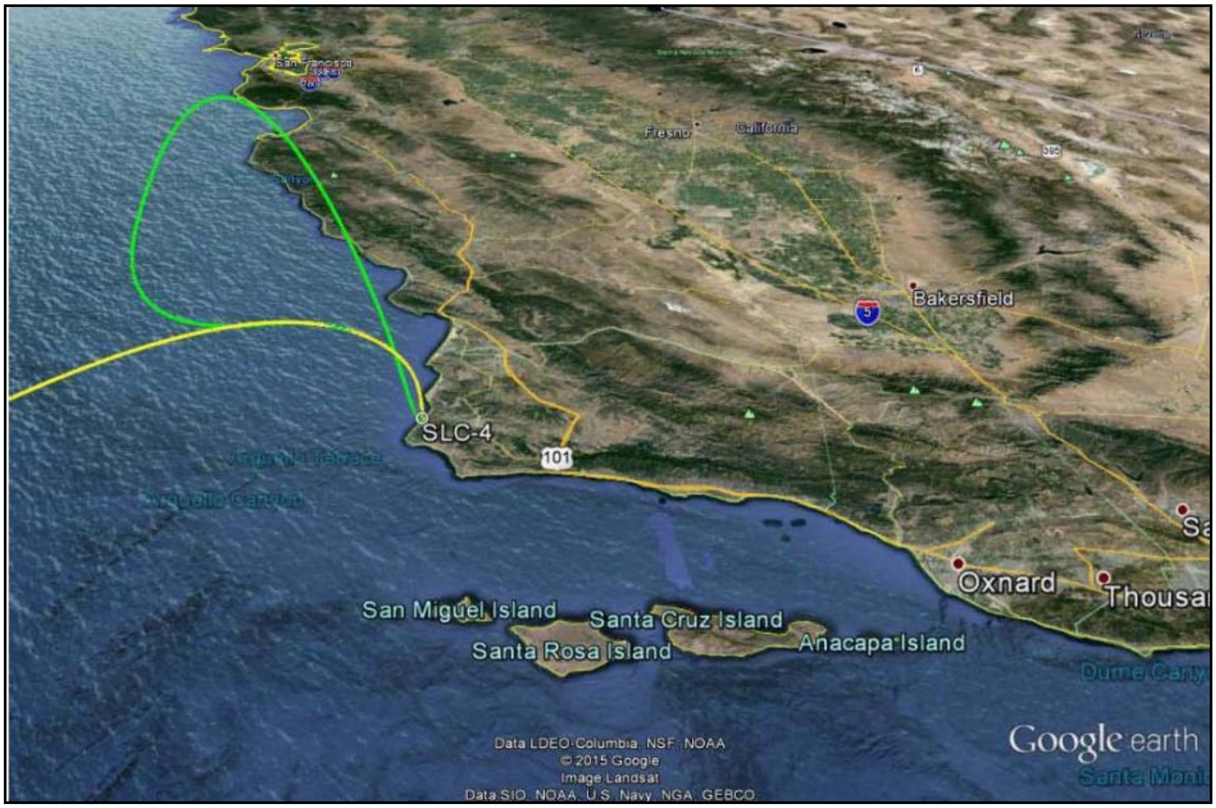

Figure 1-5. Example Trajectories for the Falcon 9's First Stage Return Path (green line) and Second Stage Path (yellow line) for a landing at SLC-4W on VAFB

1.2.2 Contingency Barge Landing

As a contingency action to landing the Falcon 9 First Stage on the SLC-4W pad at VAFB, SpaceX proposes to return the Falcon 9 First Stage booster to a barge in the Pacific Ocean (Figure 1-6). The barge is specifically designed to be used as a First Stage landing platform and would be located at least 27 nm (50 km) offshore of VAFB (Figure 1-7) or within the Iridium Landing Area (Figure 1-8). These contingency landing locations would be used when landing at SLC-4W would not be feasible. The maneuvering and landing process described above for a pad landing would be the same for a barge landing. Three vessels would be required for a barge landing:

1. Barge/Landing Platform – approximately 300 ft. long and 150 ft. wide;
2. Support Vessel – approximately 165 ft. long research vessel; and
3. Ocean Tug – 120 ft. long open water commercial tug.

The support vessels would originate from Long Beach Harbor and be positioned to support contingency landings. The tug and support vessel would be staged 5 to 7 mi. away from the landing location. The barge to be used as the landing platform was originally a McDonough Marine Deck Barge with dimensions of 300 ft. by 100 ft. The barge has an operational displacement of 24,000,000 pounds (lb.) and is classified as an American Bureau of Shipping Class-A1 Ocean barge. The Barge was modified to accommodate the First Stage landing by increasing its width to 150 ft. and installing a dynamic positioning system and a redundant communications and command and control system. The barge has been inspected by the U.S. Coast Guard, and SpaceX has obtained a Certificate of Inspection for its operation under the service of Research Vessel.

Figure 1-6. Barge Landing Platform

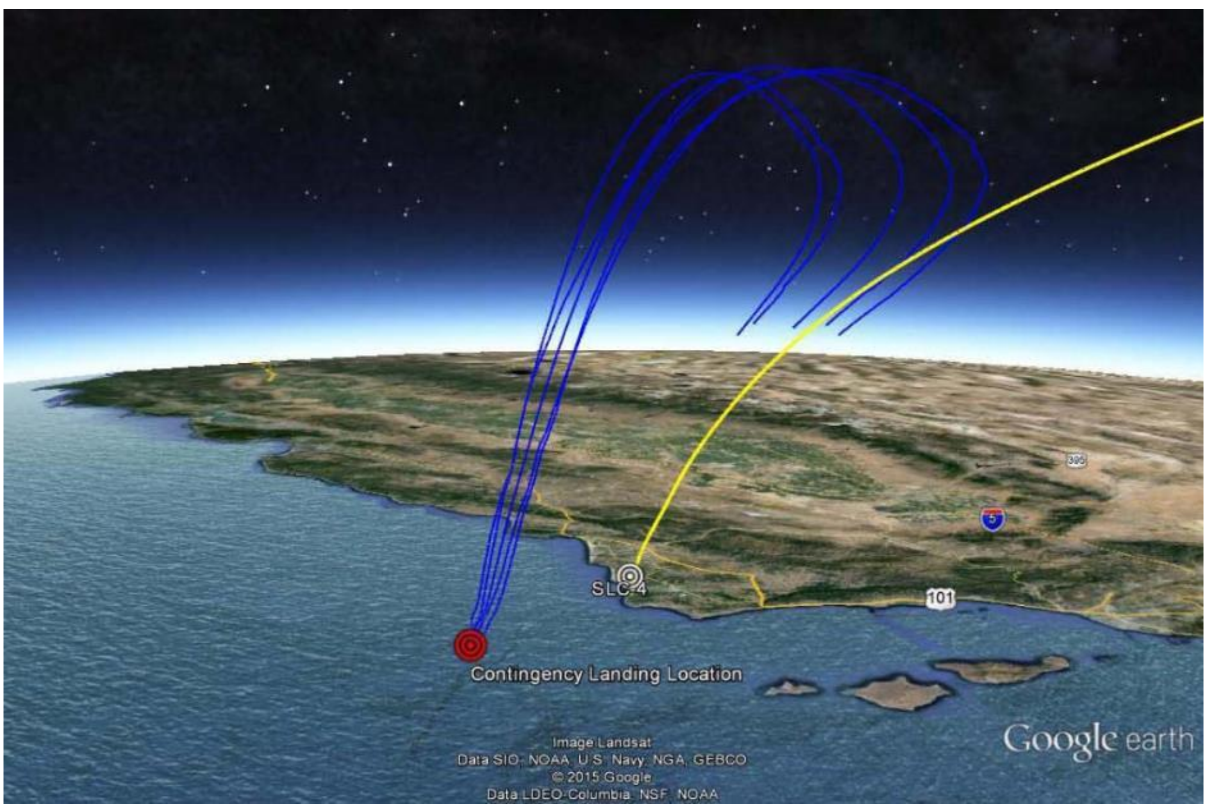

Figure 1-7. Trajectories for Variations of the Contingency First Stage Return Path to a Barge Landing at the Contingency Landing Location (blue lines) and Second Stage Path (yellow line)

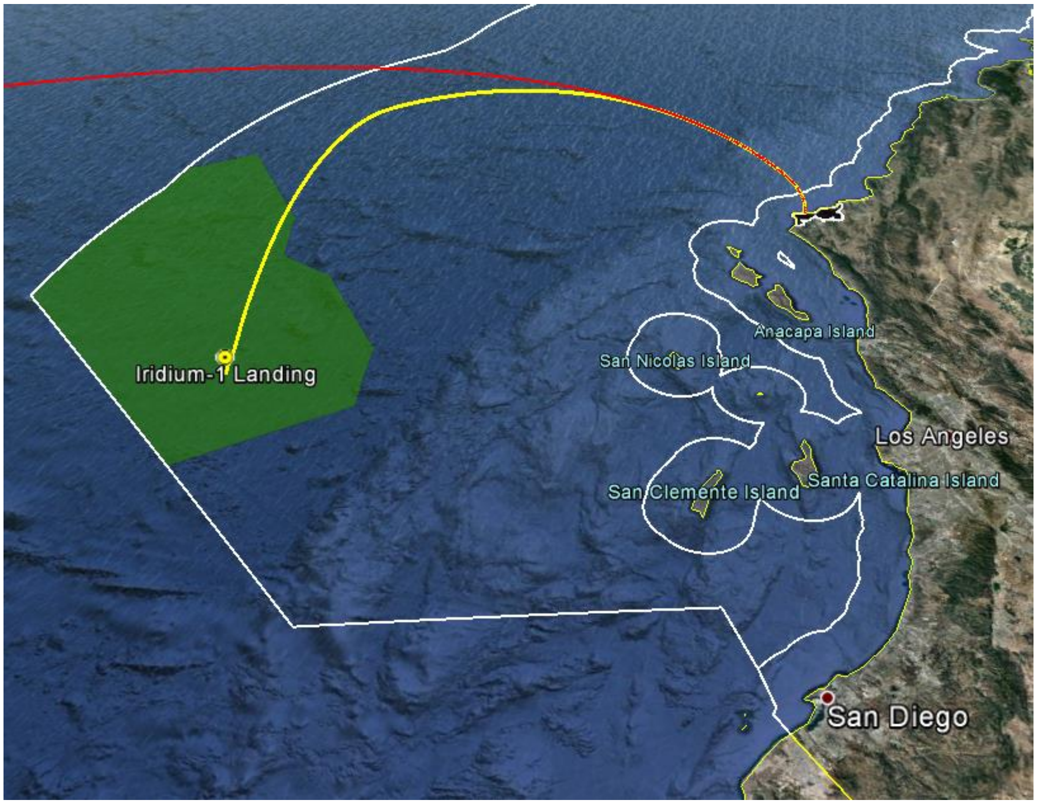

Figure 1-8. Trajectories for Variations of the Contingency First Stage Return Path to a Barge Landing within the Iridium Landing Area (yellow line)

The Support Vessel is a 165 ft. long research vessel that is capable of housing the crew, instrumentation and communication equipment, and supporting debris recovery efforts, if necessary. The U.S. Coast Guard would have the opportunity to have a representative on this vessel during the operation and a representative in the Launch and Landing Control on VAFB to coordinate required clearances and approve access back to the barge after the landing after the landing as they deem required.

The Tug is a 120 ft. open-water commercial ocean vessel. The primary operation of the tug is to tow the barge into position at the landing site and tow the barge and rocket back to Long Beach Harbor. After landing, the First Stage would be secured onto the barge and transported to the Long Beach Harbor for off-loading hazardous materials and transport to a SpaceX testing facility in McGregor, Texas, to complete acceptance testing again before re-flight. Once testing is completed, the First Stage would be transported back to the SLC-4W pad or another SpaceX launch facility for reuse.

1.2.2.1 Concept of Operation for Barge Landing

The following outlines the concept of operation for a barge landing. All times are correlated to a launch time of T-0:

T-12 Hours	Barge/landing platform on-station and crew begins system activations
T-6 Hours	Tow line is released and the barge is holding position via the dynamic positioning system
T-4 Hours	The crew transfers from the barge to the support vessel
T-2 Hours	The support vessel departs the area to a pre-determined staging area, and VAFB Range Safety is notified
T-1 Hour	The support vessel is at the staging area and Range Safety has been notified
T+8 minutes	Landing occurs
T+10 minutes	Range Safety confirms it is safe for the support vessel and tug to return to the landing site and conveys permission to reenter area
T+60 minutes	The support vessel and tug are back at the landing site
T+2 hours	The barge/landing platform is secured to the towline for towing to Long Beach Harbor.

T- = time to scheduled launch, T+ = time after launch

2 Duration and Location of Activities

SpaceX would perform up to twelve boost-back and landing events per year during all times of the year. A sonic boom (overpressure of high-energy impulsive sound) and landing noise would be generated during each boost-back event and are therefore expected parts of the Proposed Action that helps define the geographic area of impact. During an unsuccessful barge landing, the Falcon 9 First Stage would likely explode, creating an impulsive in-air noise. These acoustic stressors, as well as other potential stressors, would have different geographic regions of influence and are described below.

2.1 Launches

SpaceX launches the Falcon 9 at SLC-4E. During launch events, the Falcon 9 would emit a combustible light source (flame) as engines ignite. These light emissions would be more visible during nighttime operations. The launch noise is estimate to be up to approximately 110 A-weighted decibels (dBA) at the landing pad (Figure 2-1). This noise would attenuate below 70 dBA approximately 11 mi. from SLC-4E. From the launch pad, the trajectory of the Falcon 9 First Stage would be either westward or southward from SLC-4E depending on the payload's orbital mission.

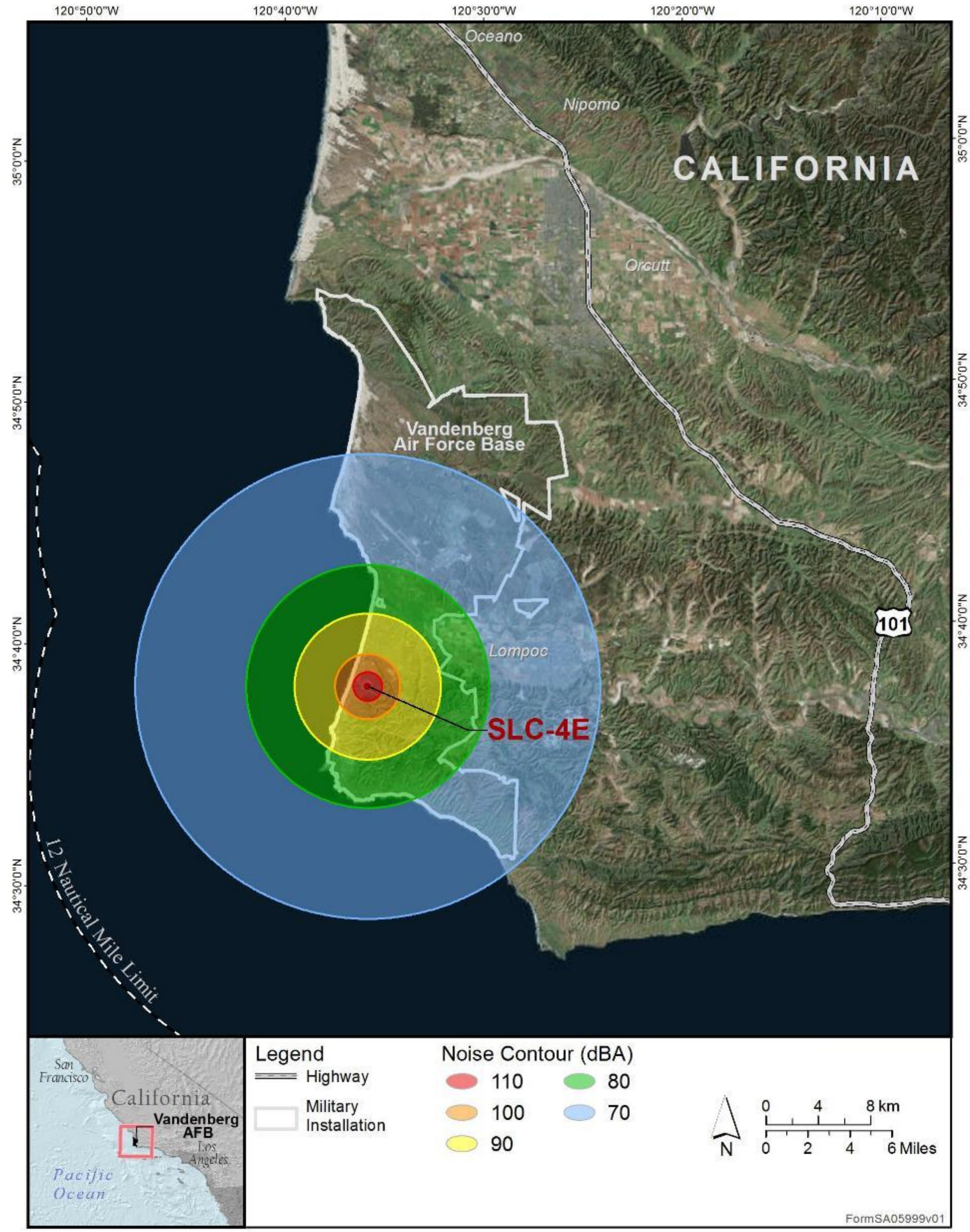

Figure 2-1. Estimated Launch Noise of Falcon 9 First Stage at SLC-4E

2.2 Sonic Boom

During descent, when the First Stage is supersonic, a sonic boom (overpressure of high-energy impulsive sound) would be generated. Sonic booms would occur in proximity to the landing areas and may be heard during or briefly after the boost-back and landing, depending on the location of the observer. Previous acoustic modeling determined these overpressures would reach as high as 2.0 pounds per square feet (psf) at the landing area and up to 3.1 psf south of the landing areas. Recent observations show that these early models underestimated the near-field overpressures. Therefore, SpaceX and the U.S. Air Force (USAF) have developed new estimates for near-field overpressures based on actual observations from past Falcon 9 First Stage boost-back and landing events.

The USAF predicts that a boost-back and landing of the Falcon 9 First Stage at SLC-4W would produce a sonic boom with overpressures as high as 8.5 psf at SLC-4W, which would attenuate to levels below 1.0 psf at approximately 15.90 mi. (25.59 km) from the landing area (Figure 2-2). This estimate is based, in part, on actual observations from Falcon 9 boost-backs and landings at Cape Canaveral. Wyle predicted that a boost-back and landing of the Falcon 9 First Stage at SLC-4W would produce a sonic boom with overpressures up to 3.1 psf in the North Channel Islands (San Miguel Island, Santa Rosa Island, and Santa Cruz Island) (Figure 2-5 and Figure 2-5). In addition, Blue Ridge Research Consultation predicts that a boost-back and landing of the Falcon 9 First Stage at SLC-4W would produce sonic boom with overpressures between 0.5 and 2 psf near the Northern Channel Islands (James, et al., 2017) (Figure 2-3). The Wyle and Blue Ridge Research Corporation models provide a more accurate representation of likely far-field effects from a sonic boom (i.e., overpressures at the North Channel Islands) than Figure 2-2.

During a contingency barge-landing event, sonic boom overpressure would be directed at the ocean surface while the first-stage booster is supersonic. The Wyle model is used to show potential far-field effects from First Stage landings offshore of VAFB or within the Iridium Landing Area. It is anticipated that the Northern Channel Islands would experience overpressures of less than 1 psf from a First Stage barge landing off the coast of VAFB (Figure 2-6 and Figure 2-7). First Stage boost-backs and landings within the Iridium Landing Area would not likely produce measurable overpressures at any land surface (Figure 2-8 and Figure 2-9).

2.3 Landing Noise

Previously, SpaceX proposed to use a single engine burn during landing. SpaceX now proposes to use a three-engine burn during landing. This engine burn, lasting approximately 17 seconds, would generate between 70 and 110 decibels (dB) of noise centered on SLC-4W, but affecting an area up to 15 nm (27.8 km) offshore of VAFB (Figure 2-10). Engine noise would also be produced during the barge landing of the Falcon 9 First Stage, which was estimated by extrapolating the landing noise profile from a SLC-4W landing. Engine noise during the barge landing is expected to be between 70 and 110 dB non-pulse, in-air noise affecting a radial area up to 15 nm (27.8 km) around the contingency landing location (Figure 2-11) and the Iridium Landing Area (Figure 2-12).

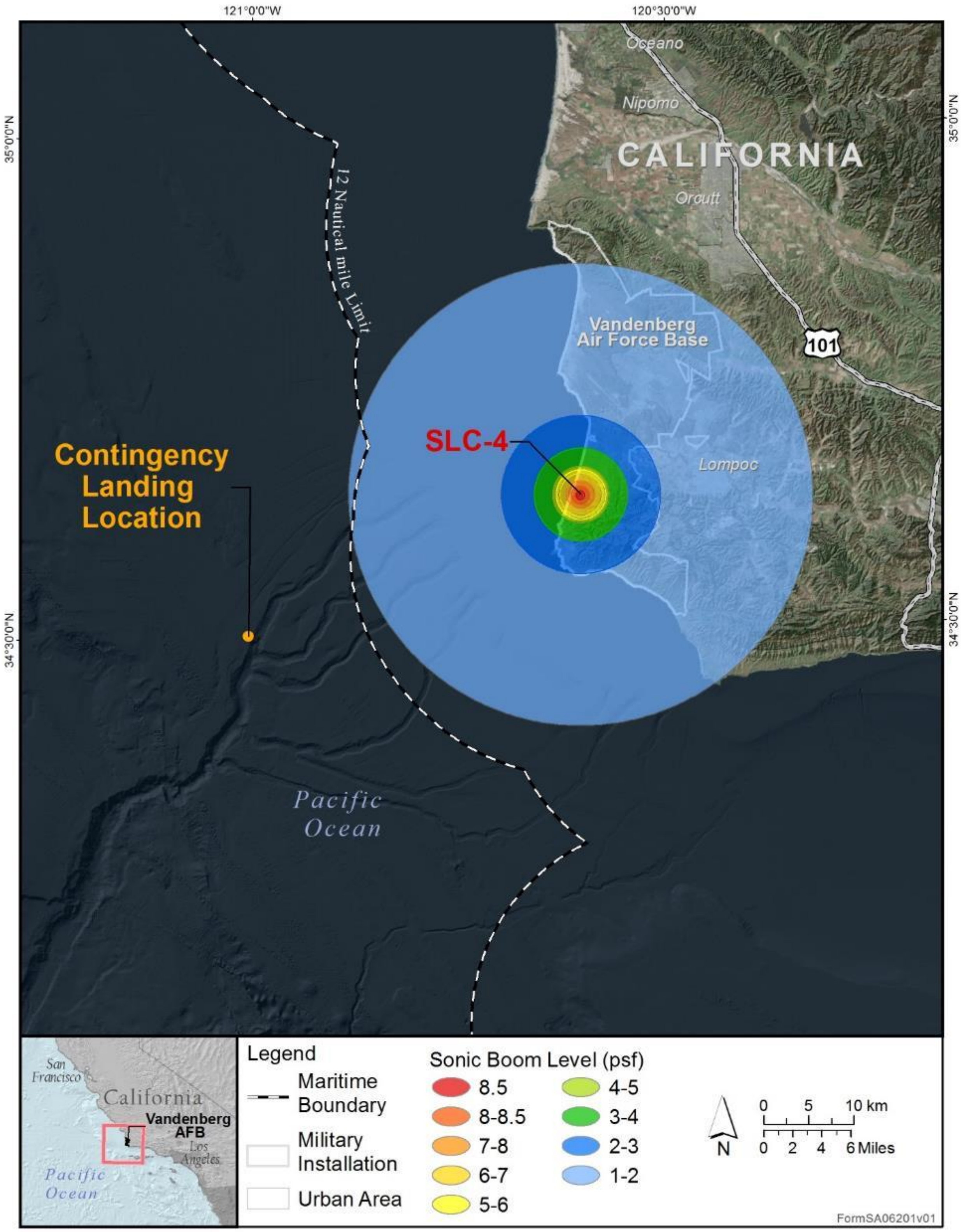

Figure 2-2. Estimated Near-Field Sonic Boom Contours for Falcon 9 First Stage Landing at SLC-4W (USAF Model)

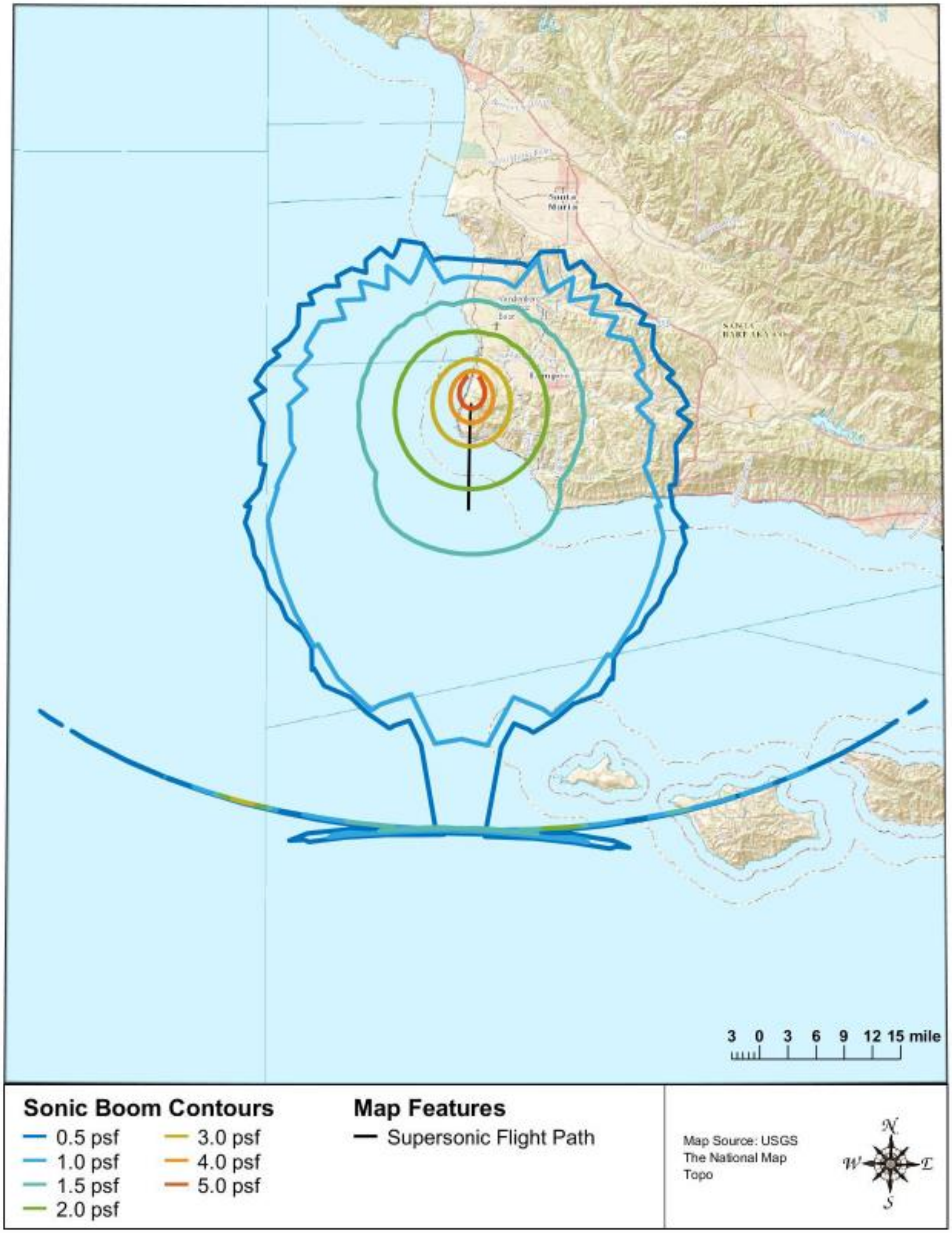

Figure 2-3. Estimated Far-Field Sonic Boom Contours for Falcon 9 First Stage Landing at SLC-4W (Blue Ridge Research Corporation Model)

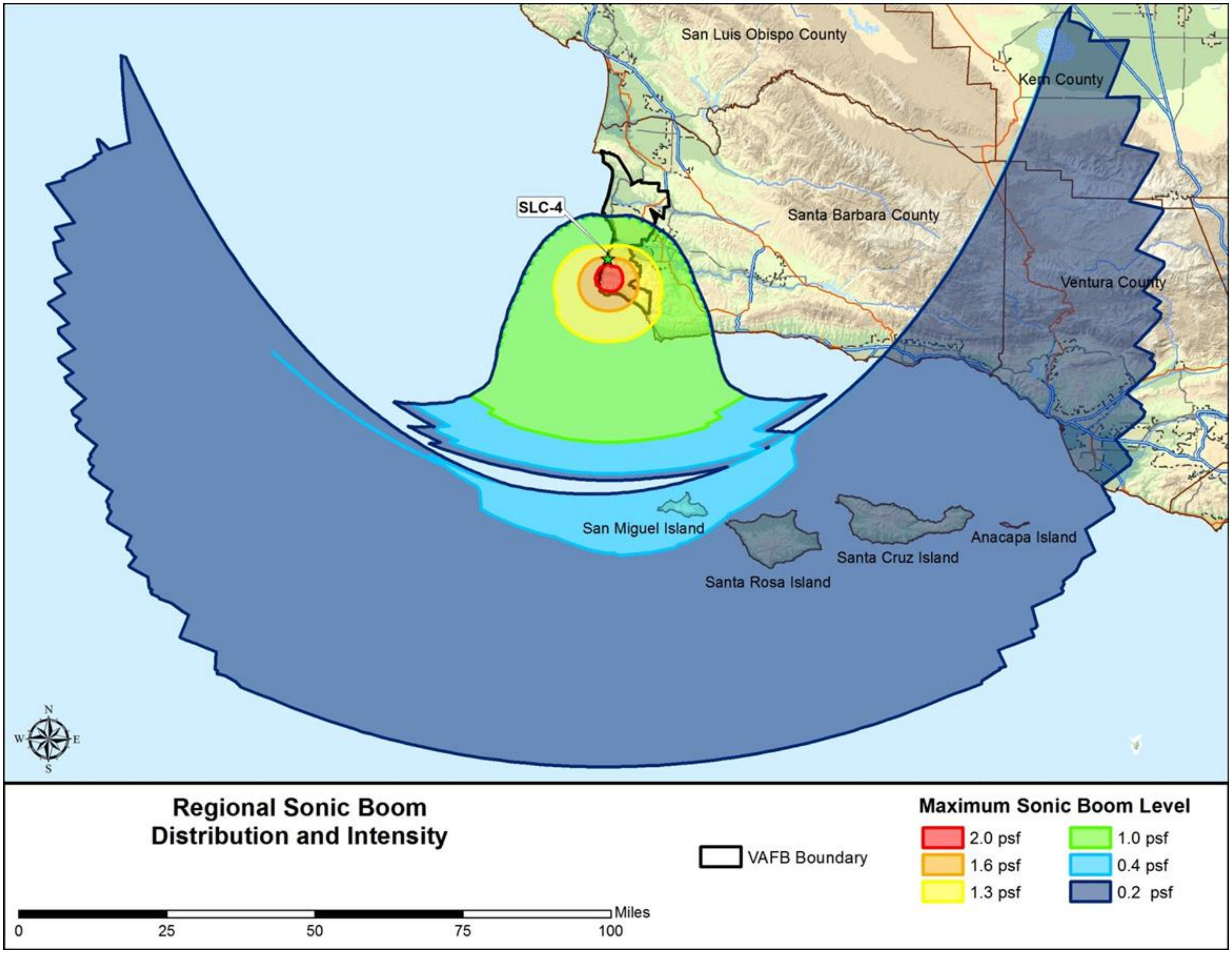

Figure 2-4. Estimated Far-Field Sonic Boom Contours for Falcon 9 First Stage Landing at SLC-4W with an Incoming Trajectory for a Light Payload (Wyle Model)

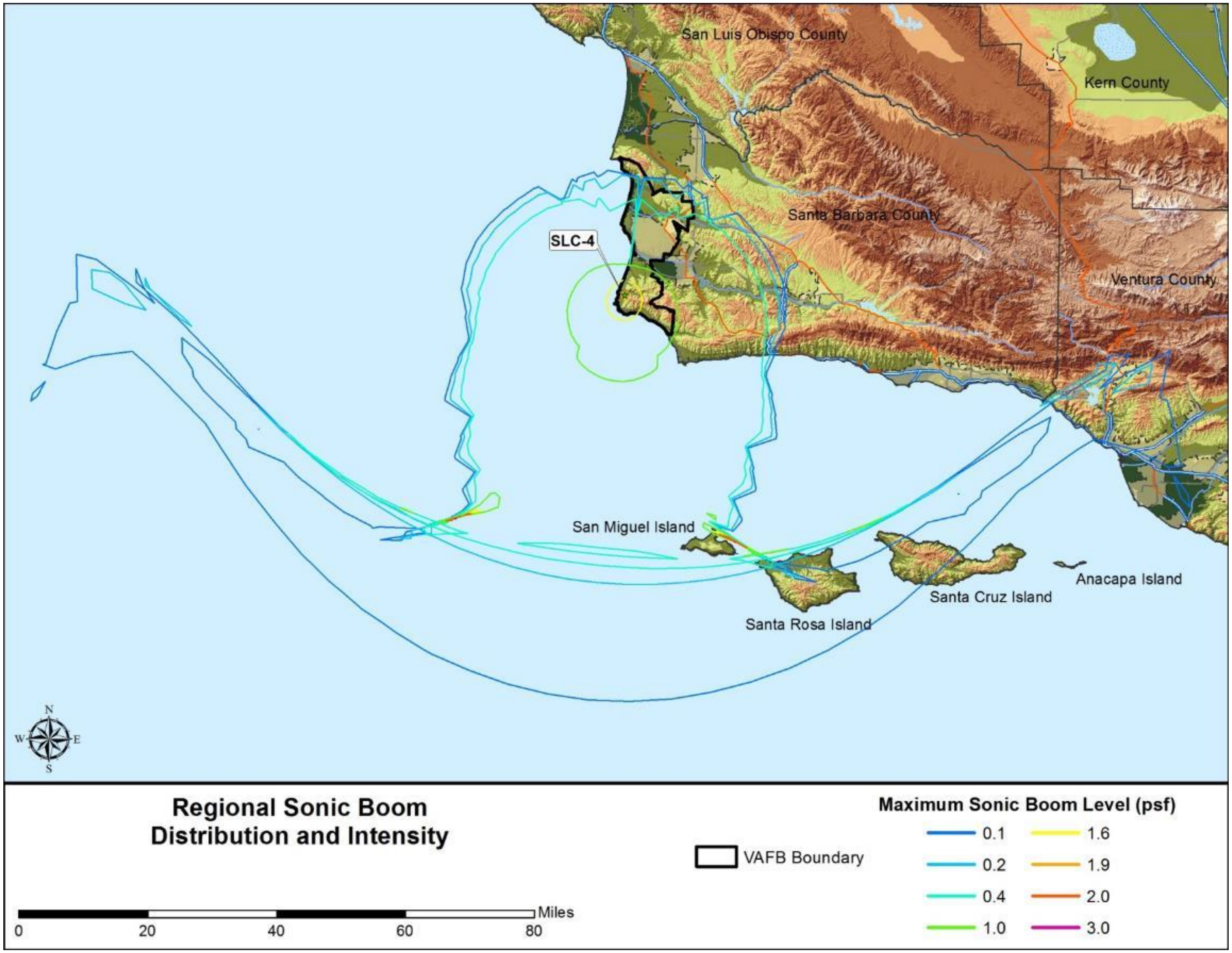

Figure 2-5. Estimated Far-Field Sonic Boom Contours for Falcon 9 First Stage Landing at SLC-4W with an Incoming Trajectory for a Heavy Payload (Wyle Model)

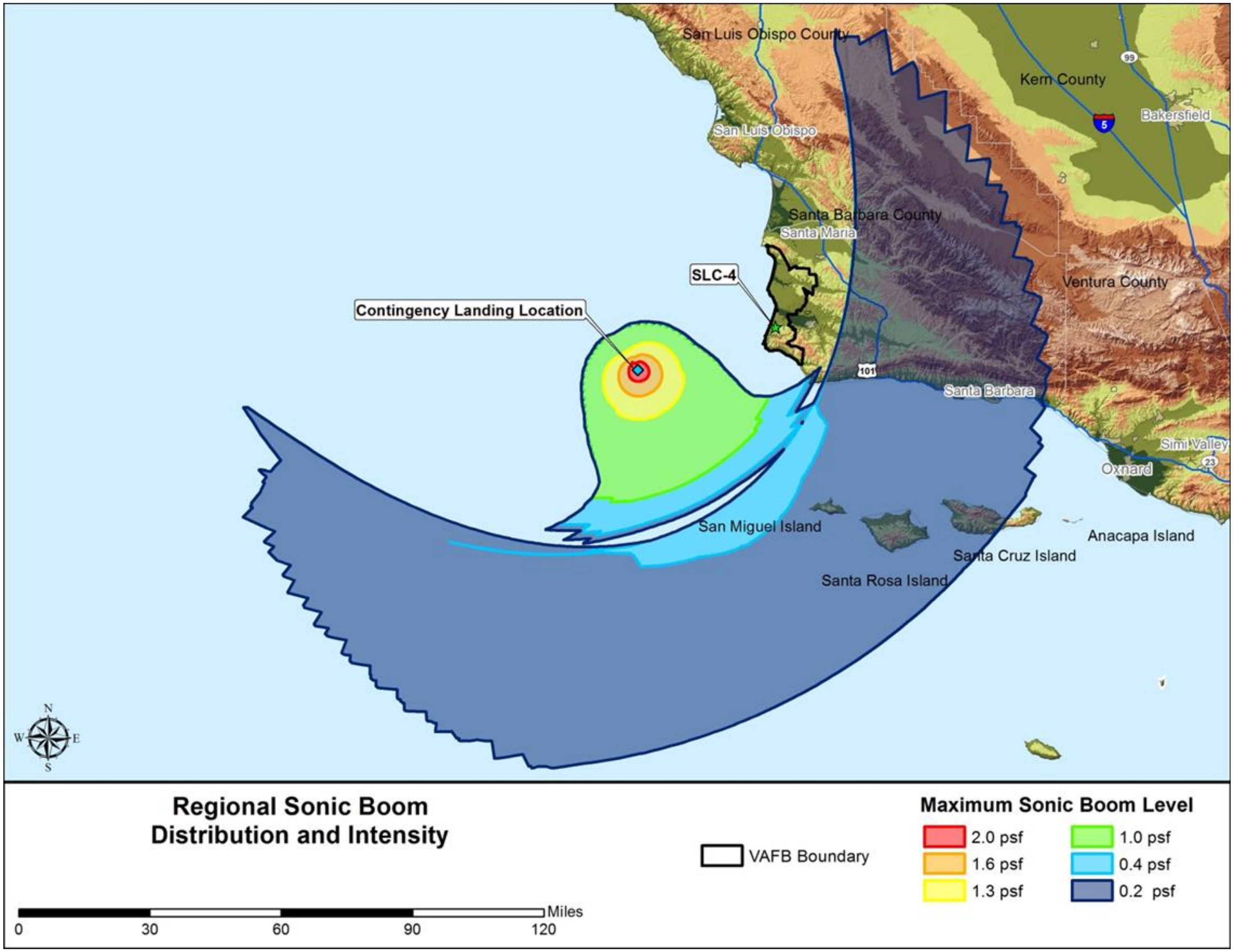

Figure 2-6. Hypothetical Far-field Sonic Boom Overpressure for Contingency Action of Drone Ship Landing Offshore of VAFB with an Incoming Trajectory for a Light Payload (Wyle Model)

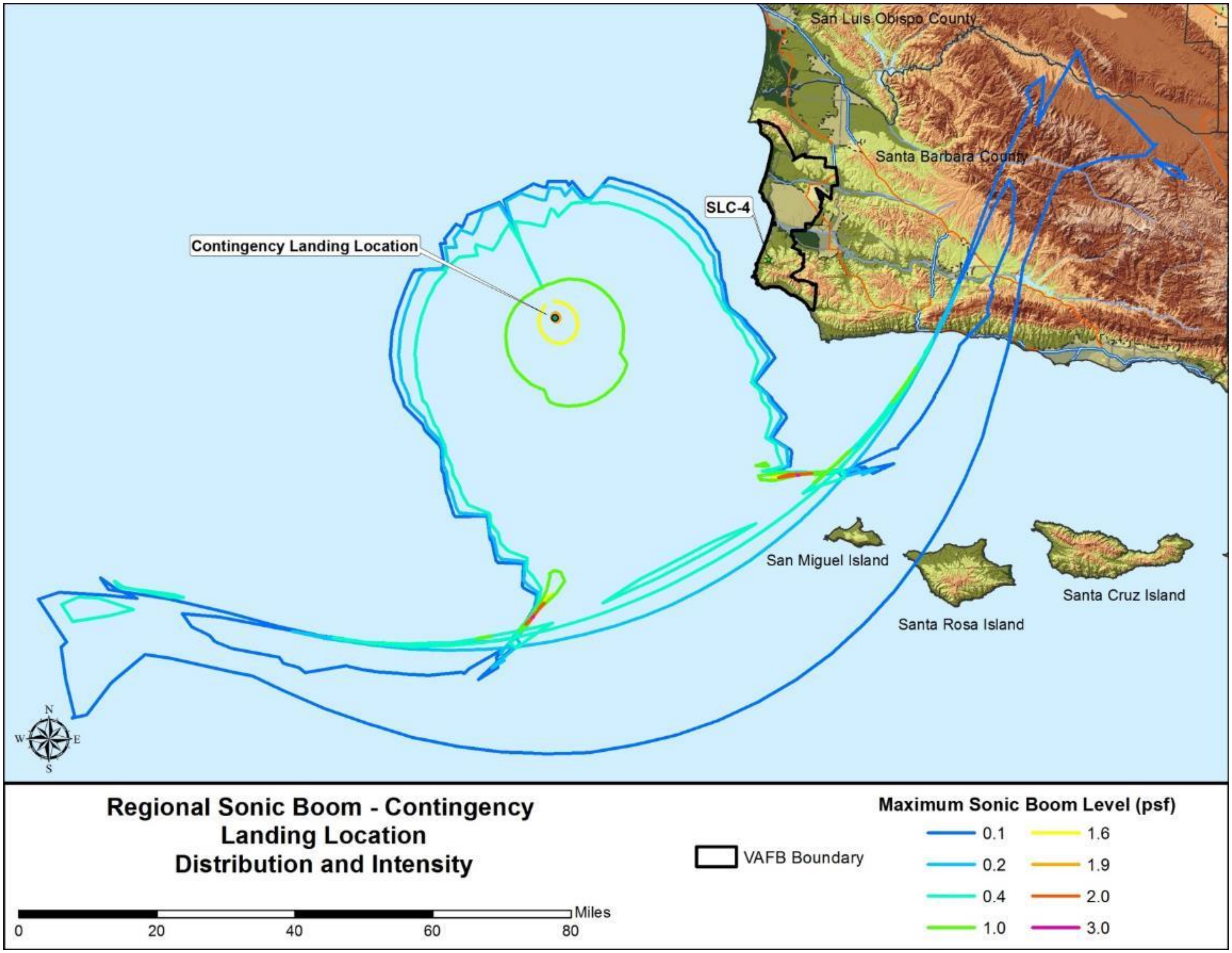

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Figure 2-7. Hypothetical Far-field Sonic Boom Overpressure for Contingency Action of Drone Ship Landing Offshore of VAFB with an Incoming Trajectory for a Heavy Payload (Wyle Model)

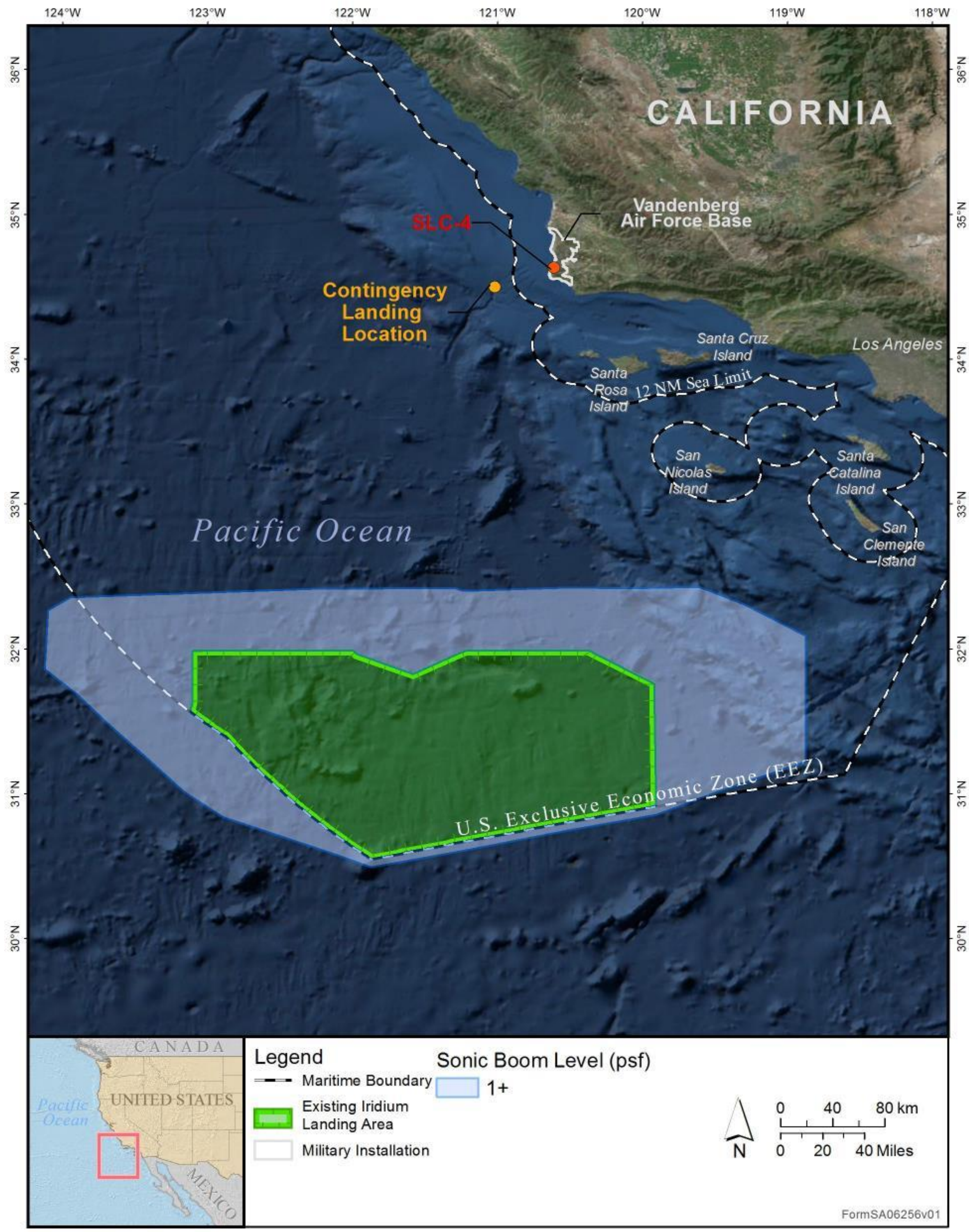
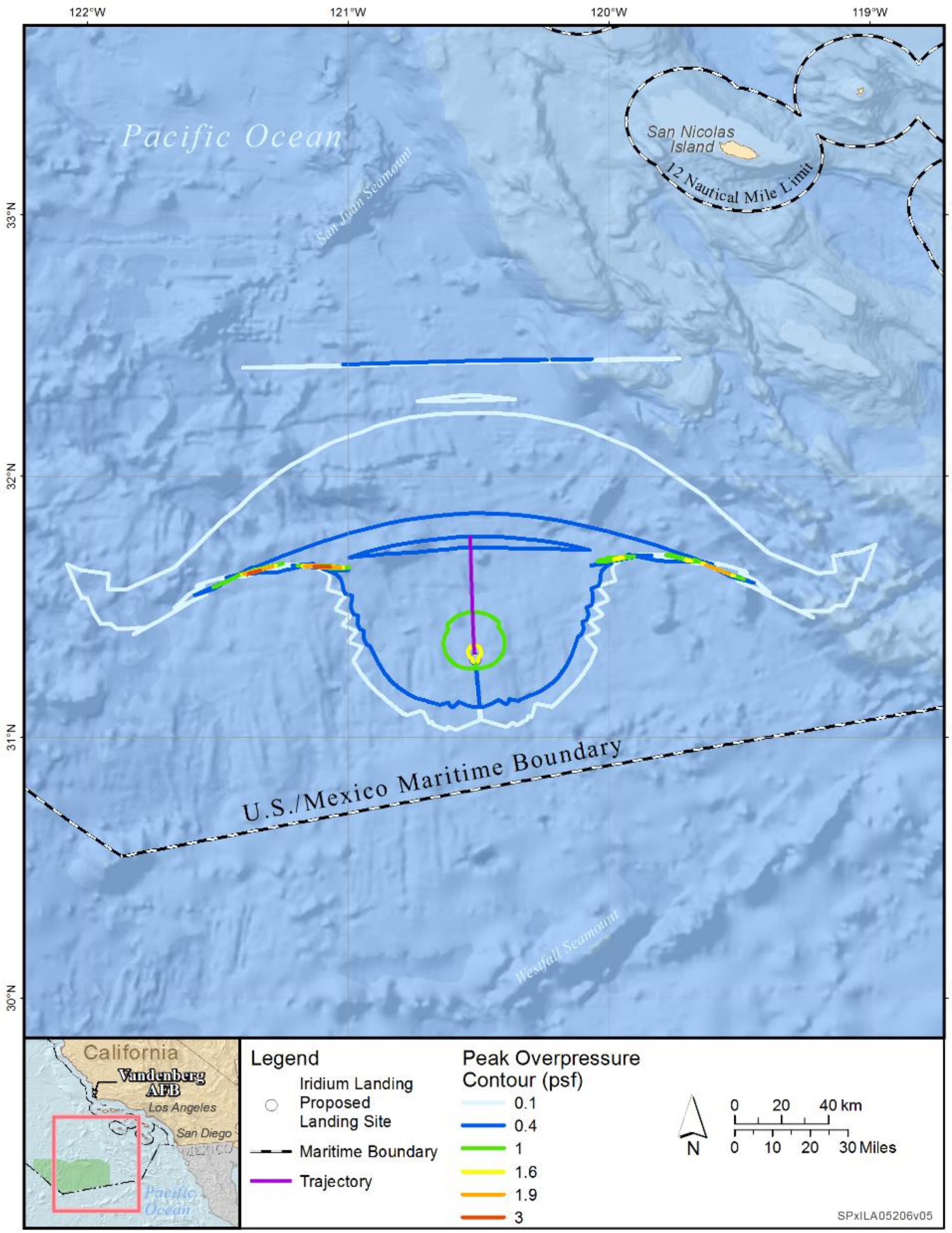
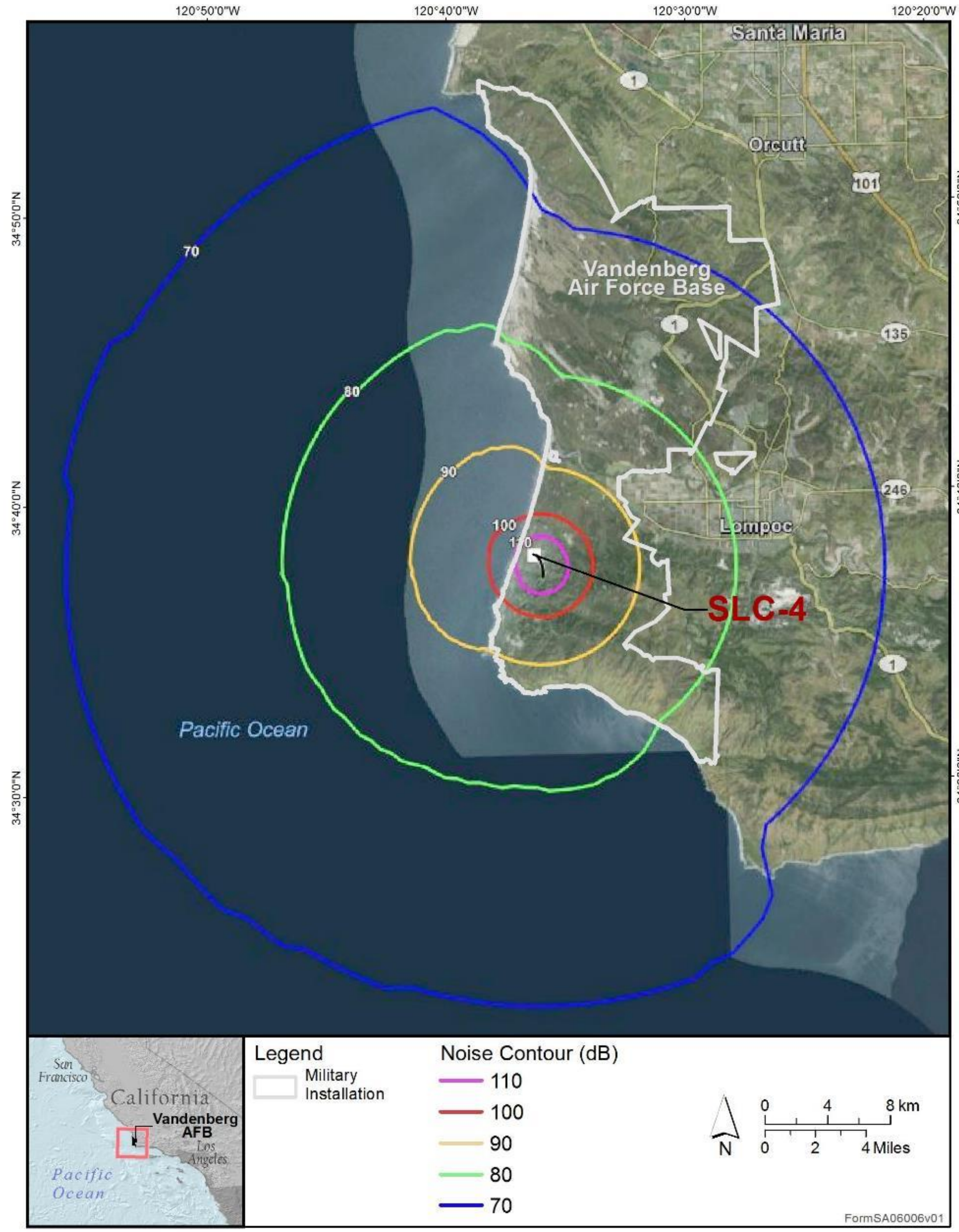


Figure 2-8. Estimated Far-Field Sonic Boom Contours for Falcon 9 First Stage Landing within the Iridium Landing Area



Source: (Bradley, 2016b)

Figure 2-9. Example Sonic Boom within the Iridium Landing Area (Wyle Model)



Source: (Bradley, 2016a)

Figure 2-10. Estimated Landing Noise of Falcon 9 First Stage at SLC-4

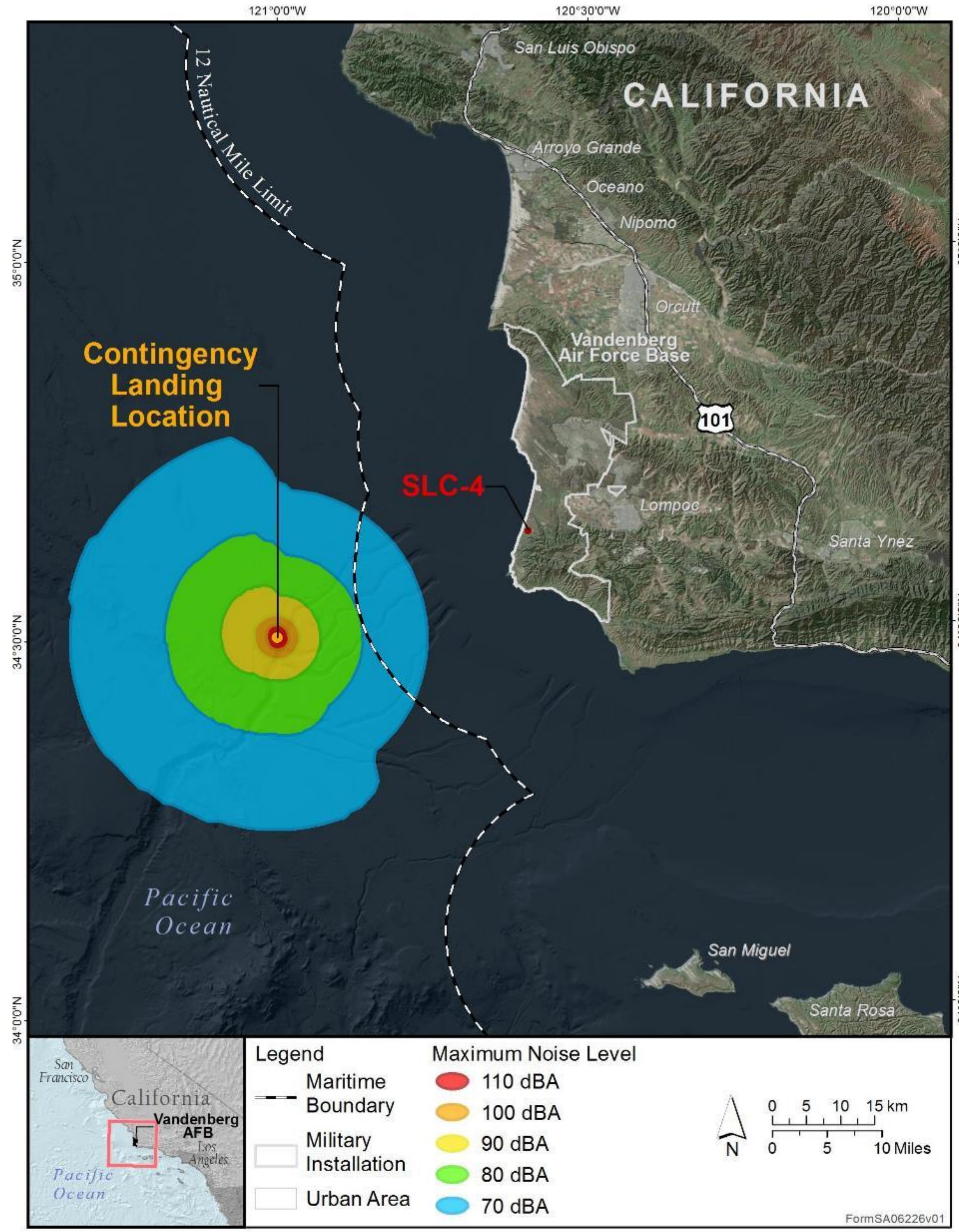


Figure 2-11. Estimated Landing Noise of Falcon 9 First Stage at the Contingency Landing Location

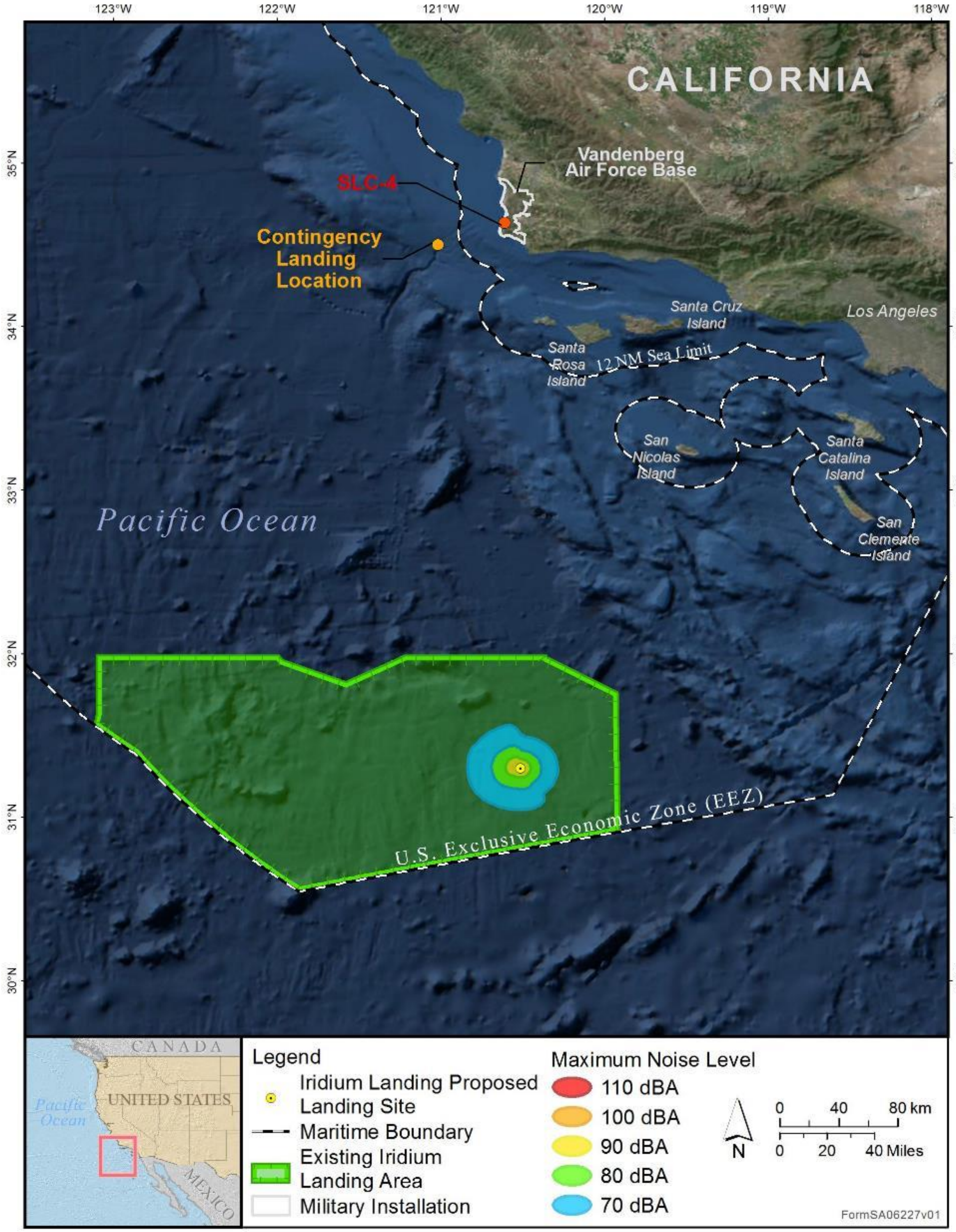


Figure 2-12. Example Landing Noise of Falcon 9 First Stage within the Iridium Landing Area

3 Species and Numbers of Marine Mammals

Six pinnipeds (seals and sea lions) and 29 cetaceans (whales and dolphins) may be present in the areas potentially impacted by boost-back and landing at either SLC-4W or the contingency landing locations. Table 3-1 summarizes the population status and abundance of each of these species, while Section 4 contains detailed life history information.

The estimated at-sea density for the following species is assumed to be zero in the affected area: Hawaiian monk seal (*Monachus schauinslandi*), pygmy killer whale (*Feresa attenuata*), false killer whale (*Pseudorca crassidens*), Longman's beaked whale (*Indopacetus pacificus*), Fraser's dolphin (*Lagenodelphis hosei*), spinner dolphin (*Stenella longirostris*), pantropical spotted dolphin (*Stenella attenuata*), rough-toothed dolphin (*Steno bredanensis*), and melon-headed whale (*Peponocephala electra*). Because these species are very unlikely to occur or are not known to occur in the region (U.S. Department of the Navy, 2016), these species are not considered further in this Application.

In 2015, the National Marine Fisheries Service (NMFS) identified areas where select cetaceans are known to concentrate at certain times of the year to engage in activities considered biologically important (e.g., feeding and migrating) (Calambokidis, et al., 2015). These areas, which are referred to as biologically important areas (BIAs), do not receive any additional regulatory protection, nor do they represent the totality of important habitat throughout a marine mammal's full range, which for many species extends well beyond the BIAs. The goal of identifying these BIAs was to synthesize existing biological information for use during the planning and design of anthropogenic activities. Figure 3-1 depicts the location of BIAs in relation to the project area. These BIAs were considered in the preparation of this application.

Table 3-1. Marine Mammal Species Status, Habitat Use, Stock Abundance, and Seasonality

Species	ESA Listing Status	MMPA Depletion Status	Occurrence within Project Area	Habitat Use in Project Area	Stock Abundance[1]	Seasonality
California Sea Lion *Zalophus californianus*	NL	N	Common	Rocks and beach haul-outs, nearshore, open ocean	296,750 (U.S.)	Year round
Pacific Harbor Seal *Phoca vitulina richardsi*	NL	N	Common	Rocks and beach haul-outs, nearshore, open ocean	30,968 (California)	Year round
Northern Elephant Seal *Mirounga angustirostris*	NL	N	Common	Beach haul-outs, nearshore, open ocean	179,000 (California breeding)	Year round, peak occurrence during winter breeding (Dec-Mar)
Steller Sea Lion *Eumetopias jubatus*	DL	D	Rare, but increasing	Rocks and beach haul-outs, nearshore, open ocean	2,781[2] (California)	Year round, rare
Northern Fur Seal *Callorhinus ursinus*	NL	N	Common	Rocks and beach haul-outs, nearshore, open ocean	14,050 (California)	Year round
Guadalupe Fur Seal *Arctocephalus townsendi*	T	D/S	Rare	Open ocean	7,408 (Mexico to California)	Slightly more common in summer and fall
Humpback whale *Megaptera novaeangliae*	E	D/S	Common Seasonal	Open ocean and coastal waters	1,918 (California, Oregon, Washington)	Summer feeding ground, peak occurrence is Dec – Jun[3]
Blue whale *Balaenoptera musculus*	E	D/S	Common Seasonal	Open ocean and coastal waters	1,647 (Eastern North Pacific)	Most common in summer and fall months
Fin whale *Balaenoptera physalus*	E	D/S	Common year-round	Offshore waters, open ocean	3,051 (California, Oregon, Washington)	Most common in summer and fall months
Sei whale *Balaenoptera borealis*	E	D/S	Rare	Offshore waters, open ocean	126 (Eastern North Pacific)	Primarily are encountered there during July to September and leave California waters by mid-October
Bryde's whale *Balaenoptera brydei/edeni*	NL	N	Rare	Open ocean	798 (Hawaii)	Year round, rare
Minke whale *Balaenoptera acutorostrata*	NL	N	Common	Nearshore and offshore	478 (California, Oregon, Washington)	Less common in summer; small numbers around northern Channel Islands
Gray whale *Eschrichtius robustus*	E	N	Seasonal	Nearshore and offshore	20,990 (Eastern North Pacific)	Most abundant Jan through Apr
Sperm whale *Physeter microcephalus*	E	D/S	Common year-round	Nearshore and offshore	2,106 (California, Oregon, Washington)	Widely distributed year-round; More likely in waters > 1,000 m depth, most often > 2,000 m
Pygmy sperm whale *Kogia breviceps*	NL	N	Potential	Nearshore and open ocean	579 (California, Oregon, Washington)	Year round, rare
Dwarf sperm whale *Kogia sima*	NL	N	Potential	Open ocean	Unknown	Year round, rare

Species	ESA Listing Status	MMPA Depletion Status	Occurrence within Project Area	Habitat Use in Project Area	Stock Abundance[1]	Seasonality
Killer whale *Orcinus orca*	NL	N	Uncommon	Nearshore and open ocean	240 (Eastern North Pacific) 82 (Eastern North Pacific Southern Resident)	Most common in summer and fall months
Short-finned pilot whale *Globicephala macrorhynchus*	NL	S	Uncommon	Offshore, open ocean	760 (California, Oregon, Washington)	Year round, rare
Long-beaked common dolphin *Delphinus capensis*	NL	N	Common	Nearshore (within 57.5 miles [92.5 km])	107,016 (California)	Most abundant during May to Oct
Short-beaked common dolphin *Delphinus delphis*	NL	N	Common	Nearshore and open ocean	411,211 (California, Oregon, Washington	One of the most abundant CA dolphins; higher summer densities
Common bottlenose dolphin *Tursiops truncates*	NL	N	Common	Coastal and offshore	1,006 (California offshore) 323 (California Coastal)	Year round
Striped dolphin *Stenella coeruleoalba*	NL	N	Uncommon	Offshore	10,908 (California, Oregon, Washington)	More abundant in summer/fall
Pacific white-sided dolphin *Lagenorhynchus obliquidens*	NL	N	Common	Open ocean and offshore	26,930 (California, Oregon, Washington)	More abundant Nov-Apr
Northern right whale dolphin *Lissodelphis borealis*	NL	N	Common	Open ocean	8,334 (California, Oregon, Washington)	Higher densities Nov-Apr
Risso's dolphin *Grampus griseus*	NL	N	Common	Nearshore and offshore	6,272 (California, Oregon, Washington)	Higher densities Nov-Apr
Dall's Porpoise *Phocoenoides dalli*	NL	N	Common	Inshore/offshore	42,000 (California, Oregon, Washington)	Higher densities Nov-Apr
Harbor Porpoise *Phocoena phocoena*	NL	N	Common	Nearshore and offshore	2,917 (Morro Bay Stock)	Year round
Cuvier's beaked whale *Ziphius cavirostris*	NL	S	Potential	Open ocean	6,590 (California, Oregon, Washington)	Possible year-round occurrence but difficult to detect due to diving behavior
Baird's beaked whale *Berardius bairdii*	NL	N	Potential	Open ocean	847 (California, Oregon, Washington)	Primarily along continental slope from late spring to early fall

Species	ESA Listing Status	MMPA Depletion Status	Occurrence within Project Area	Habitat Use in Project Area	Stock Abundance[1]	Seasonality
Mesoplodont Beaked Whales (Blainville's beaked whale *Mesoplodon densirostris*; Ginkgo-toothed beaked whale *Mesoplodon ginkgodens*; Perrin's beaked whale *Mesoplodon perrini*; Stejneger's beaked whale; *Mesoplodon stejnegeri*; Hubbs' beaked whale *Mesoplodon carlhubbsi*; Pygmy beaked whale *Mesoplodon peruvianus)*	NL	S	Rare/Potential	Open ocean	694	Year round, rare

[1] Carretta, et al., 2016
[2] Allen and Angliss, 2014
[3] Calambokidis et al., 2001
Notes: ESA = Endangered Species Act, E = Federal Endangered Species, T = Federal Threatened Species, C = Federal Candidate Species, DL = Federally De-listed Species, NL = Not Federally listed under the ESA, D = MMPA Depleted Stock, S= MMPA Strategic Stock

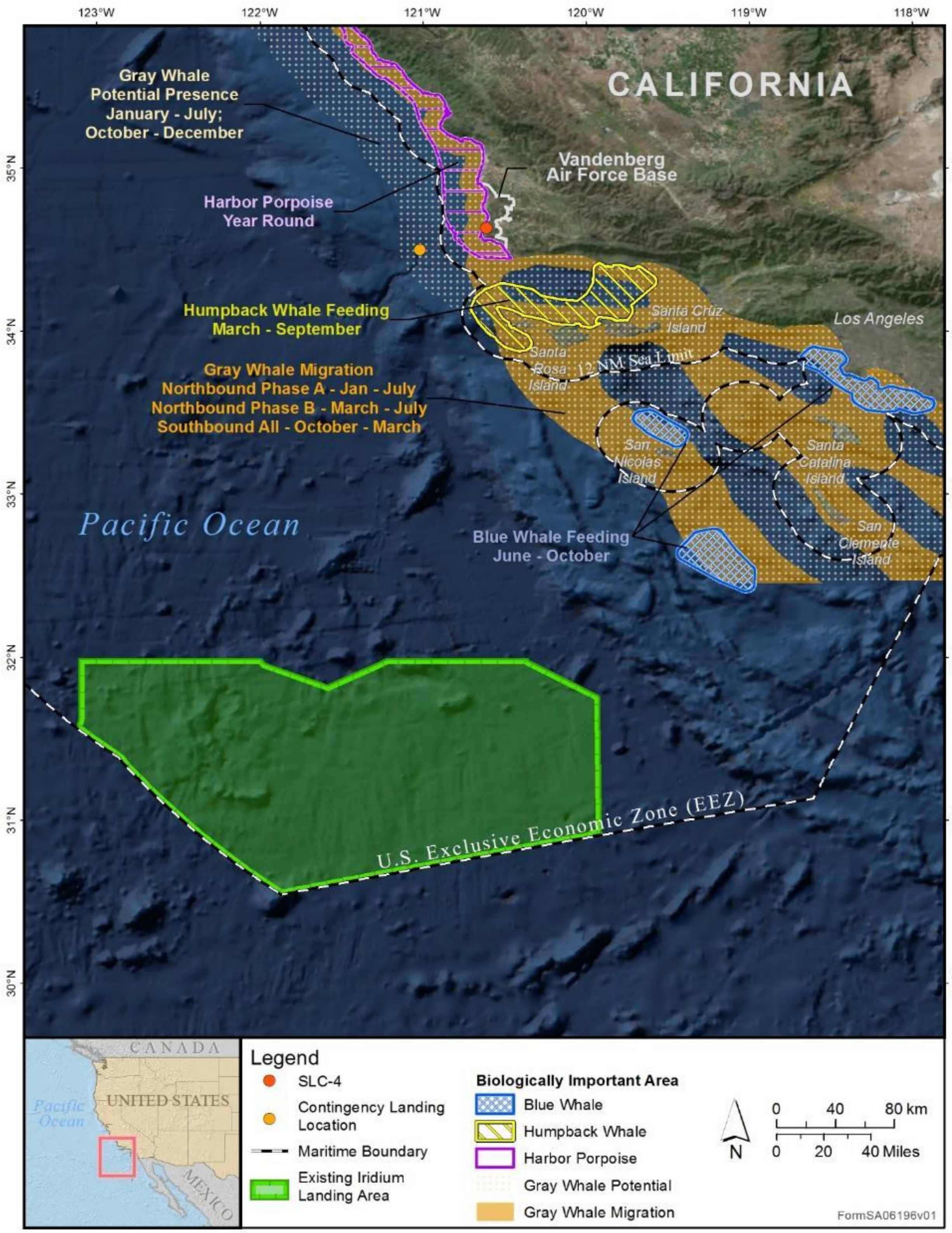


Figure 3-1. Biologically Important Areas in Relation to VAFB and the Landing Areas

4 Affected Species Status and Distribution

The following 6 pinnipeds and 29 cetaceans may be present in the affected area during boost-back and landing events. With the exception of the pacific harbor porpoise, density estimates reported below were extrapolated from raw data from the U.S. Department of the Navy (2016). These estimates are estimated as the highest at-sea seasonal and geographic densities reported within approximately 15 mi. of each landing area (i.e., “affected area,” those areas that are conservatively estimated to receive greater than a 1 psf sonic boom).

4.1 California Sea Lion (*Zalophus californianus*)

California sea lions are common offshore of VAFB and haul out sporadically on rocks and beaches along the coastline of VAFB. In 2014, counts of California sea lions at haulouts on VAFB increased substantially, ranging from 47 to 416 during monthly counts (ManTech SRS Technologies, Inc., 2015). However, California sea lions rarely pup on the VAFB coastline: no pups were observed in 2013 or 2014 (ManTech SRS Technologies, Inc., 2014, 2015) and one pup was observed in 2015 (VAFB, unpubl. data). California sea lions are the most abundant pinniped species in the Channel Islands (Lowry et al., 2017b). San Miguel Island is the northern extent of the species breeding range; and, along with San Nicolas Island, it contains one of the largest breeding colonies of the species in the Channel Islands (Melin et al., 2010; Lowry et al., 2017a). Pupping occurs in large numbers on San Miguel Island at the rookeries found at Point Bennett on the west end of the island and at Cardwell Point on the east end of the island. During aerial surveys of the Northern Channel Islands conducted by NOAA Fisheries in February 2010, 21,192 total California sea lions (14,802 pups) were observed at haulouts on San Miguel Island and 8,237 total (5,712 pups) at Santa Rosa Island (M. Lowry, NOAA Fisheries, unpubl. data). During aerial surveys in July 2012, 65,660 total California sea lions (28,289 pups) were recorded at haulouts on San Miguel Island, 1,584 total (3 pups) at Santa Rosa Island, and 1,571 total (zero pups) at Santa Cruz Island (M. Lowry, NOAA Fisheries, unpubl. data). The at-sea estimated density for California sea lions is assumed to be 0.0596 individuals per km^2 in the affected areas (U.S. Department of the Navy, 2016).

4.2 Pacific Harbor Seal (*Phoca vitulina richardsi*)

Pacific harbor seals congregate on multiple rocky haul-out sites along the VAFB coastline. Most haul-out sites are located between the Boat House and South Rocky Point, where most of the pupping on VAFB occurs. Pups are generally present in the region from March through July. Within the affected area on VAFB, up to 332 adults and 34 pups have been recorded in monthly counts from 2013 to 2015 (ManTech SRS Technologies, Inc., 2014, 2015; VAFB, unpublished data). During aerial pinniped surveys of haulouts located in the Point Conception area by NOAA Fisheries in May 2002 and May and June of 2004, between 488 to 516 harbor seals were recorded (M. Lowry, NOAA Fisheries, unpubl. data). Data on pup numbers were not provided. Harbor seals also haul out, breed, and pup in isolated beaches and coves throughout the coast of San Miguel Island. During aerial surveys conducted by NOAA Fisheries in May 2002 and May and June of 2004, between 521 and 1,004 harbors seals were recorded at San Miguel Island, between 605 and 972 at Santa Rosa Island, and between 599 and 1,102 Santa Cruz Island (M. Lowry, NOAA Fisheries, unpubl. data). Again, data on pup numbers were not provided. Lowry et al. (2017b) counted 1,367 Pacific harbor seals at the Channel Islands in July 2015. The at-sea estimated density for harbor seals is assumed to be 0.0183 individuals per km^2 in the affected areas (U.S. Department of the Navy, 2016).

4.3 Northern Elephant Seal (*Mirounga angustirostris*)

Northern elephant seals haul-out sporadically on rocks and beaches along the coastline of VAFB and observations of young of the year seals from May through November have represented individuals dispersing later in the year from other parts of the California coastline where breeding and birthing occur. Eleven northern elephant seals were observed during aerial surveys of the Point Conception area by NOAA Fisheries in February of 2010 (M. Lowry, NOAA Fisheries, unpubl. data). Northern elephant seals breed and pup at the rookeries found at Point Bennett on the west end of San Miguel Island and at Cardwell Point on the east end of the island (Lowry, 2002). Northern elephant seals are abundant in the Channel Islands from December to March (Lowry et al., 2017b). During aerial surveys of the Northern Channel Islands conducted by NOAA Fisheries in February 2010, 21,192 total northern elephant seals (14,802 pups) were recorded at haulouts on San Miguel Island and 8,237 total (5,712 pups) were observed at Santa Rosa Island (M. Lowry, NOAA Fisheries, unpubl. data). None were observed at Santa Cruz Island (M. Lowry, NOAA Fisheries, unpubl. data). Lowry (2017b) stated that aerial surveys found 16,208 pups in San Miguel Island, 10,882 pups at San Nicolas Island, and 5,946 pups at Santa Rosa Island. The at-sea estimated density for northern elephant seals is assumed to be 0.076 individuals per km^2 in the affected areas (U.S. Department of the Navy, 2016).

4.4 Steller Sea Lion (*Eumetopias jubatus*)

North Rocky Point was used in April and May 2012 by Steller sea lions (Marine Mammal Consulting Group and Science Applications International Corporation [MMCG and SAIC], 2012). This observation was the first time this species had been reported at VAFB during launch monitoring and monthly surveys conducted over the past two decades. Since 2012, Steller sea lions have been observed frequently in routine monthly surveys, with as many as 16 individuals recorded. In 2014, up to five Steller sea lions were observed in the affected area during monthly marine mammal counts (ManTech SRS Technologies, Inc., 2015) and a maximum of 12 individuals were observed during monthly counts in 2015 (VAFB, unpublished data). However, up to 16 individuals were observed in 2012 (MMCG and SAIC, 2012). Steller sea lions once had two small rookeries on San Miguel Island, but these were abandoned after the 1982-1983 El Niño event (DeLong and Melin, 2000; Lowry, 2002); however occasional juvenile and adult males have been detected since then. These rookeries were once the southernmost colonies of the eastern stock of this species. The Eastern Distinct Population Segment of this species, which includes the California coastline as part of its range, was de-listed from the federal Endangered Species Act in November 2013. The at-sea estimate density for Steller sea lion is assumed to be 0.0001 individuals per km^2 in the affected areas; however the species is not expected to occur in the Iridium Landing Area (U.S. Department of the Navy, 2015; U.S. Department of the Navy, 2016).

4.5 Northern Fur Seal (*Callorhinus ursinus*)

Northern fur seal occur from Southern California to Japan. Within California approximately 1 percent of the population occurs on San Miguel Island off southern California and 0.3 percent occurs on the Farallon Islands off the coast of central California. Males tend to be ashore for three months during the breeding season, whereas females may occur ashore for as long as six months (June to November) (Carretta, et al., 2016). Peak pupping is in early July. The pups are weaned at three to four months. Some juveniles are present year-round, but most juveniles and adults head for the open ocean and a pelagic existence until the next year. Animals found offshore of VAFB are most likely from the San Miguel Island stock, which remain in the area around San Miguel Island throughout the year (Koski et al., 1998).

Comprehensive count data for northern fur seals on San Miguel Island were not available during preparation of this application. However, based on prior harassment authorizations, it is estimated that approximately 5,000 norther fur seals may be hauled out on San Miguel Island. Northern fur seals have not been observed to haul out along the mainland coast of Santa Barbara County; however, one fur seal stranding has been reported at VAFB which involved a seal that came ashore at Surf Beach in 2012. The at-sea estimated density for northern fur seals is assumed to be is assumed to be 0.021 individuals per km^2 in the affected areas (U.S. Department of the Navy, 2016).

4.6 Guadalupe Fur Seal (*Arctocephalus townsendi*)

The Guadalupe fur seal is typically found on shores with abundant large rocks, often at the base of large cliffs. They are also known to inhabit caves, which provide protection and cooler temperatures, especially during the warm breeding season (Belcher and Lee, 2002). They are rare in southern California, only found occasionally visiting the northern Channel Islands, as they mainly breed on Guadalupe Islands, Mexico, in the months of May-July. On San Miguel Island, one to several Guadalupe fur seals were observed annually between 1969 and 2000 (DeLong and Melin, 2000) and an adult female with a pup was observed in 1997 (Melin and Delong, 1999). Over the past five years, two to three pups have been observed annually on San Miguel Island and 13 individuals and two pups were observed in 2015 (J. Harris, NOAA Fisheries, pers. comm.). Guadalupe fur seals can be found in deeper waters of the California Current Large Marine Ecosystem (Hanni et al., 1997; Jefferson et al., 2008). Guadalupe fur seals have not been observed hauling out on the mainland coast of Santa Barbara County. Adult males, juveniles, and nonbreeding females may live at sea during some seasons or for part of a season (Reeves et al., 1992). The movements of Guadalupe fur seals at sea are generally unknown, but strandings have been reported in northern California and as far north as Washington (Etnier, 2002). A 1993 population estimate of all age classes in Mexico was 7,408 (Carretta et al., 2016). The at-sea estimated density for northern Guadalupe fur seals is assumed to be 0.0278 individuals per km^2 in the affected areas (U.S. Department of the Navy, 2016).

4.7 Humpback Whale (*Megaptera novaeangliae*)

Humpback whales are listed as depleted under the MMPA. The California, Oregon, and Washington stock of humpback whales use the waters offshore of Southern California as a summer feeding ground. Peak occurrence occurs in Southern California waters from December through June (Calambokidis et al., 2001). During late summer, more humpback whales are sighted north of the Channel Islands, and limited occurrence is expected south of the northern Channel Islands (San Miguel, Santa Rosa, Santa Cruz) (Carretta et al., 2010). The at-sea estimated density for humpback whales is assumed to be 0.017539 individuals per km^2 in the affected areas for SLC-4, 0.016099 individuals per km^2 in the affected area for the Conditional Landing Location, and 0.000276 individuals per km^2 in the affected area for the Iridium Landing Area (U.S. Department of the Navy, 2016).

4.8 Blue Whale (*Balaenoptera musculus*)

The blue whale is listed as depleted under the MMPA. The blue whale inhabits all oceans and typically occurs near the coast, over the continental shelf, though it is also found in oceanic waters.

Their range includes the California Current system (Ferguson, 2005; Stafford et al., 2004). The U.S. Pacific coast is known to be a feeding area for this species during summer and fall (barlow et al., 2009; Carretta et al., 2010). This species has frequently been observed in Southern California waters (Carretta et al., 2000; U.S. Department of the Navy, 2011), and in the Southern California Bight, the highest densities of blue whales occurred along the 200 m. isobath in waters with high surface chlorophyll concentrations (Redfern et al., in review). The at-sea estimated density for blue whales is assumed to be 0.10006 individuals per km^2 in the affected area for SLC-4W, 0.007651 individuals per km^2 in the affected area for the Contingency Landing Location, and 0.002476 individuals per km^2 in the affected area the Iridium Landing Area (U.S. Department of the Navy, 2016).

4.9 Fin Whale (*Balaenoptera physalus*)

The fin whale is listed as depleted under the MMPA. This species has been documented from 60° N to 23° N, and they have frequently been recorded in offshore waters within the Southern California current system (Carretta et al., 2010, Mizroch et al., 2009). Aerial surveys conducted in October and November 2008 within Southern California offshore waters resulted in the sighting of 22 fin whales (Oleson and Hill, 2009, Acevedo-Gutiérrez et al., 2002). Navy-sponsored monitoring in the Southern California Range Complex for the 2009–2010 period also recorded the presence of fin whales (U.S. Department of the Navy, 2010). Moore and Barlow (2011) indicate that, since 1991, there is strong evidence of increasing fin whale abundance in the California Current area; they predict continued increases in fin whale numbers over the next decade. The at-sea estimated density for fin whales is assumed to be 0.017677 individuals per km^2 in the affected area for SLC-4W, and 0.02548 individuals per km^2 for the Conditional Landing Location, and 0.1752 individuals per km^2 in the affected areas for the Iridium Landing Area (U.S. Department of the Navy, 2016).

4.10 Sei Whale (*Balaenoptera borealis*)

The sei whale is listed as depleted under the MMPA. Sei whales are rare in offshore waters of Southern California (Carretta et al., 2010). They are generally found feeding along the California Current (Perry et al., 1999). There are records of sightings in California waters as early as May and June, but primarily are encountered there during July to September and leave California waters by mid-October. The at-sea estimated density for sei whales assumed to be 0.000050 individuals per km^2 in the affected areas (U.S. Department of the Navy, 2016).

4.11 Bryde’s Whale (*Balaenoptera brydei/edeni*)

Bryde’s whales are only occasionally sighted in the California Current Large Marine Ecosystems (Carretta et al., 2010, Jefferson et al., 2008). Aerial surveys conducted in October and November 2008 off the Southern California coast resulted in the sighting of one Bryde’s whale (Smultea et al., 2012). This was the first sighting in this area since 1991 when a Bryde’s whale was sighted within 345 mi. (555 km) of the California coast (Barlow, 1995). The at-sea estimated density for bryde's whales is assumed to be 0.000020 individuals per km^2 in the affected areas (U.S. Department of the Navy, 2016).

4.12 Minke Whale (*Balaenoptera acutorostrata*)

Minke whales are present in summer and fall in Southern California waters (Carretta et al., 2009). They often use both nearshore and offshore waters as habitats for feeding and migration to wintering areas. The at-sea estimated density for minke whales is assumed to be 0.00068 individuals per km^2 in the affected areas (U.S. Department of the Navy, 2016).

4.13 Gray Whale (*Eschrichtius robustus*)

There are two North Pacific populations of gray whales: the Western subpopulation and the Eastern subpopulation. Both populations (stocks) could be present in Southern California waters during their northward and southward migration (Sumich and Show, 2011). The Western North Pacific stock is listed as depleted under the MMPA. Eastern gray whales are frequently observed in Southern California waters (Carretta et al., 2000; Forney et al., 1995, Henkel and Harvey 2008, Hobbs et al., 2004). During aerial surveys off San Clemente Island, California, eastern gray whales were the most abundant cetacean from January through April, a period that covers both the northward and southward migrations (Carretta et al., 2000; Forney et al., 1995). The at-sea estimated density for gray whales is assumed to be 0.17910 individuals per km^2 in the affected area for SLC-4W, and 0.01066 individuals per km^2 in the affected area for the Contingency Landing Location. This species is not known to occur in the Iridium Landing Area (U.S. Department of the Navy, 2016).

4.14 Sperm Whale (*Physeter microcephalus*)

The sperm whale is listed as depleted under the MMPA. Sperm whales are found year round in California waters (Barlow 1995; Forney and Barlow 1993). Sperm whales are known to reach peak abundance from April through mid-June and from the end of August through mid-November (Carretta et al., 2010). The at-sea estimated density for sperm whales is assumed to be 0.003380 individuals per km^2 in the affected areas for SLC-4 and the Conditional Landing Location, and 0.008503 individuals per km^2 in the affected areas for the Iridium Landing Area (U.S. Department of the Navy, 2016).

4.15 Pygmy Sperm Whale (*Kogia breviceps*)

Pygmy sperm whales apparently occur close to shore, sometimes over the outer continental shelf. However, several studies have suggested that this species generally occurs beyond the continental shelf edge (Bloodworth and Odell, 2008; MacLeod et al., 2004). A total of two sightings of this species have been made in offshore waters along the California coast during previous surveys (Carretta et al., 2010). The at-sea estimated density for *Kogia spp.* is assumed to be 0.00159 individuals per km^2 in the affected area for SLC-4W and the Contingency Landing Location, and 0.003660 individuals per km^2 in the Iridium Landing Area (U.S. Department of the Navy, 2016).

4.16 Dwarf Sperm Whale (*Kogia sima*)

Along the U.S. Pacific coast, no reported sightings of this species have been confirmed as dwarf sperm whales. This may be somewhat due to their pelagic distribution, cryptic behavior (i.e., “hidden” because they are not very active at the surface and do not have a conspicuous blow), and physical similarity to the pygmy sperm whale (Jefferson et al., 2008; McAlpine, 2009). However, the presence of dwarf sperm whales off the coast of California has been demonstrated by at least five dwarf sperm whale strandings in California between 1967 and 2000 (Carretta et al., 2010). The at-sea estimated density for *Kogia spp.* is assumed to be 0.00159 individuals per km^2 in the affected area for SLC-4W and the Contingency Landing Location and 0.003660 individuals per km^2 in the Iridium Landing Area (U.S. Department of the Navy, 2016).

4.17 Killer Whale (*Orcinus orca*)

Along the Pacific coast of North America, killer whales are known to occur (from stranding records and acoustic detection) along the outer coasts of Washington, Oregon, and California (Calambokidis and Barlow, 2004, Dahlheim et al., 2008, Ford and Ellis, 1999, Forney et al., 1995). Although they are not commonly observed in Southern California coastal areas, killer whales are found year round off the coast of Baja California (Carretta et al., 2010; Forney et al., 1995). The at-sea estimated density for killer whales is assumed to be 0.000250 individuals per km^2 in the affected areas (U.S. Department of the Navy, 2016).

4.18 Short-finned Pilot Whale (*Globicephala macrorhynchus*)

Along the U.S. Pacific coast, short-finned pilot whales are most abundant south of Point Conception (Carretta et al., 2010; Reilly and Shane, 1986) in deep offshore waters over the continental shelf break, in slope waters, and in areas of high topographic relief (Olson, 2009). A few hundred pilot whales are believed to group each winter at Santa Catalina Island (Carretta et al., 2010; Reilly and Shane, 1986), although these animals are not seen as regularly as in previous years. The at-sea estimated density for short-finned pilot whales is assumed to be 0.001260 individuals per km^2 in the affected areas (U.S. Department of the Navy, 2016).

4.19 Long-beaked Common Dolphin (*Delphinus capensis*)

The long-beaked common dolphin's range within California Current waters is considered to be within about 57.5 mi. (92.5 km) of the coast, from Baja California north through central California. Stranding data and sighting records suggest that the abundance of this species fluctuates seasonally and from year to year off California (Carretta et al., 2010; Zagzebski et al., 2006). It is found off Southern California year round, but it may be more abundant there during the warm-water months (May to October) (Bearzi, 2005; Carretta et al., 2010). The long-beaked common dolphin is not a migratory species, but seasonal shifts in abundance (mainly inshore/offshore) are known for some regions of its range. The at-sea estimated density for long-beaked common dolphins is assumed to be 2.507585 individuals per km^2 in the affected area for SLC-4, 1.713031 individuals per km^2 in the affected area for the Conditional Landing, and 0.000337 individuals per km^2 in the affected area for the Iridium Landing Area (U.S. Department of the Navy, 2016).

4.20 Short-beaked Common Dolphin (*Delphinus delphis*)

Along the U.S. Pacific coast, short-beaked common dolphin distribution overlaps with that of the long-beaked common dolphin. Short-beaked common dolphins are found in California Current waters throughout the year, distributed between the coast and at least 345 mi. (555 km) from shore (Carretta et al., 2010; Forney and Barlow, 1998). Although they are not truly migratory, the abundance of the short-beaked common dolphin off California varies, with seasonal and year-to-year changes in oceanographic conditions; movements may be north-south or inshore-offshore (Barlow, 1995; Carretta et al., 2010; Forney and Barlow, 1998). The at-sea estimated density for short-beaked common dolphins is assumed to be 0.947400 individuals per km^2 in the affected areas for SLC-4W and the Contingency Landing Location, and 1.079803 individuals per km^2 in the affected area for the Iridium Landing Area (U.S. Department of the Navy, 2016).

4.21 Common Bottlenose Dolphin (*Tursiops truncates*)

During surveys off California, offshore bottlenose dolphins were generally found at distances greater than 1.9 mi. (3.06 km) from the coast and throughout the southern portion of California Current waters (Bearzi et al., 2009; Carretta et al., 2010). Sighting records off California and Baja

California suggest continuous distribution of offshore bottlenose dolphins in these regions. Aerial surveys during winter/spring 1991–1992 and shipboard surveys in summer/fall 1991 indicated no seasonality in distribution (Barlow, 1995; Carretta et al., 2010; Forney et al., 1995). In the North Pacific, common bottlenose dolphins have been documented in offshore waters as far north as about 41° N (Carretta et al., 2010). The at-sea estimated density for common bottlenose dolphins is assumed to be 0.06386 individuals per km^2 in the affected areas. The California coastal stock is assumed to have an estimated density of 0.535291 individuals per km^2 in the affected areas for SLC-4 but would not occur at the Contingency Landing Location or the Iridium Landing Area (U.S. Department of the Navy, 2016).

4.22 Striped Dolphin (*Stenella coeruleoalba*)

In and near California waters, striped dolphins are found mostly offshore and are much more common during the warm-water period (summer/fall), although they are found there throughout the year. During summer/fall surveys, striped dolphins were sighted primarily from 115 to 345 mi. (185 to 555 km) offshore of the California coast. Based on sighting records, striped dolphins appear to have a continuous distribution in offshore waters from California to Mexico (Carretta et al., 2010). The at-sea estimated density for striped dolphins is assumed to be .000063 individuals per km^2 in the affected area for SLC-4W, 0.000551 individuals per km^2 in the affected area for the Contingency Landing Location, and 0.138230 individuals per km^2 in the affected area for the Iridium Landing Area (U.S. Department of the Navy, 2016).

4.23 Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*)

Primary habitat includes the cold temperate waters of the North Pacific Ocean and deep ocean regions. They range as far south as the mouth of the Gulf of California, northward to the southern Bering Sea and coastal areas of southern Alaska (Leatherwood et al., 1984; Jefferson et al., 2008). Off California, Forney and Barlow (1998) found significant north/south shifts in the seasonal distribution of Pacific white-sided dolphin, with the animals moving north into Oregon and Washington waters during the summer, and showing increased abundance in the Southern California Bight in the winter. Off California, the species is found mostly at the outer edge of the continental shelf and slope and does not frequently move into shallow coastal waters. Although Pacific white-sided dolphins do not migrate, seasonal shifts have been documented as noted above. From November to April, Pacific white-sided dolphins can be found in shelf waters off the coast of Southern California. The at-sea estimated density for Pacific white-sided is assumed to be 1.70129 individuals per km^2 in the affected area for SLC-4W, 0.220652 individuals per km^2 in the affected area for the Contingency Landing Location, and 0.010258 individuals per km^2 in the affected area for the Iridium Landing Area (U.S. Department of the Navy, 2016).

4.24 Northern Right Whale Dolphin (*Lissodelphis borealis*)

This species is known to occur year round off California, but abundance and distribution vary seasonally. This species is most abundant off central and northern California in relatively nearshore waters in winter (Dohl et al., 1983). In the cool water period, the peak abundance of northern right whale dolphins in Southern California waters corresponds closely with the peak abundance of squid (Forney and Barlow, 1998). In the warm water period, the northern right whale dolphin is not as abundant in Southern California waters due to shifting distributions north into Oregon and Washington, as water temperatures increase (Barlow, 1995; Carretta et al., 2015; Forney and Barlow, 1998; Leatherwood and Walker, 1979).The at-sea estimated density for northern right whale dolphins is assumed to be 0.137820 individuals per km^2 in the affected area for SLC-4W and the Contingency Landing Location, and 0.139480 individuals per km^2 in the affected area for the Iridium Landing Area (U.S. Department of the Navy, 2016).

4.25 Risso's Dolphin (*Grampus griseus*)

Off California, they are commonly seen over the slope and in offshore waters (Carretta et al., 2010; Forney et al., 1995; Jefferson et al., 2008). This species is frequently observed in the waters surrounding San Clemente Island, California. They are generally present year round in Southern California, but are more abundant in the cold-water months, suggesting a possible seasonal shift in distribution (Carretta et al., 2000; Soldevilla, 2008). Several stranding records have been documented for this species in central and Southern California between 1977 and 2002 (Zagzebski et al., 2006). The at-sea estimated density for Risso's dolphins is assumed to be 0.202440 individuals per km^2 in the affected area for SLC-4W and the Contingency Landing Location, and 0.025717 individuals per km^2 in the affected area for the Iridium Landing Area (U.S. Department of the Navy, 2016).

4.26 Dall's Porpoise (*Phocoenoides dalli*)

In Southern California waters, Dall's porpoises are sighted seasonally, mostly during the winter (Carretta et al., 2010). Inshore/offshore movements off Southern California have been reported, with individuals remaining inshore in fall and moving offshore in the late spring (Houck and Jefferson, 1999). The at-sea estimated density for Dall's porpoises is assumed to be 0.069206 individuals per km^2 in the affected area for SLC-4W and the Contingency Landing Location, and 0.055840 individuals per km^2 in the affected area for the Iridium Landing Area (U.S. Department of the Navy, 2016).

4.27 Harbor Porpoise (*Phocoena phocoena*)

In the Pacific Ocean, the Harbor Porpoise can be found from Point Conception, California, to Alaska and as far west as Kamchatka and Japan. Individuals found between Point Conception and the Russian River are treated as a separate stock, which is referred to as the Morro Bay Stock. Unlike its Atlantic counterpart, harbor porpoises in the Pacific are not panmictic or migratory (Carretta, et al., 2016). The maximum at-sea estimated density for harbor porpoises is assumed to be 0.9591 individuals per km^2 in the affected areas for SLC-4W and the Contingency Landing Location. The Iridium Landing Area is outside the species' known range (U.S. Department of the Navy, 2015).

4.28 Cuvier's Beaked Whale (*Ziphius cavirostris*)

Cuvier's beaked whale is the most commonly encountered beaked whale off the eastern North Pacific Coast. There are no apparent seasonal changes in distribution, and this species is found from Alaska to Baja California, Mexico (Carretta et al., 2010; Mead 1989; Pitman et al., 1988). However, Mitchell (1968) reported strandings from Alaska to Baja California to be most abundant between February and September. Repeated sightings of the same individuals have been reported off San Clemente Island in Southern California, which indicates some level of site fidelity (Falcone et al., 2009). The at-sea estimated density for Cuvier's beaked whales is assumed to be 0.001538 individuals per km^2 in the affected area for SLC-4W, 0.004687 individuals per km^2 in the affected areas for the Contingency Landing Location, and 0.019156 individuals per km^2 in the affected areas for the Iridium Landing Area (U.S. Department of the Navy, 2016).

4.29 Baird's Beaked Whale (*Berardius bairdii*)

The continental shelf margins from the California coast to 125° West (W) longitude were recently identified as key areas for beaked whales (MacLeod and D'Amico, 2006). Baird's beaked whale is found mainly north of 28° N in the eastern Pacific (Kasuya and Miyashita, 1997; Reeves et al., 2003). Along the West Coast, Baird's beaked whales are seen primarily along the continental slope, from late spring to early fall (Carretta et al., 2010; Green et al., 1992). Baird's beaked whales are sighted less frequently and are presumed to be farther offshore during the colder water months of November through April (Carretta et al., 2010). The at-sea estimated density for Baird's beaked whales is assumed to be 0.000381 individuals per km^2 in the affected area for SLC-4W, and 0.001825 individuals per km^2 in the affected area for the Contingency Landing Location, and 0.012094 individuals per km^2 in the affected area for the Iridium Landing Area (U.S. Department of the Navy, 2016).

4.30 Mesoplodont Beaked Whales (*Mesoplodon spp.*)

The following six Mesoplodont species are known to occur in the region: Blainville's beaked whale (*M. densirostris*), Perrin's beaked whale (*M. perrini*), Lesser beaked whale (*M. peruvianus*), Stejneger's beaked whale (*M. stejnegeri*), Gingko-toothed beaked whale (*M. gingkodens*), and Hubbs' beaked whale (*M. carlhubbsi*). These species are distributed throughout deep waters and along the continental slope in the region. The at-sea estimated density for Cuvier's beaked whales is assumed to be 0.001538 individuals per km^2 in the affected area for SLC-4W, 0.004687 individuals per km^2 in the affected areas for the Contingency Landing Location, and 0.019156 individuals per km^2 in the affected areas for the Iridium Landing Area (U.S. Department of the Navy, 2016).

5 Type of Incidental Taking Authorization Requested

In this Application, SpaceX requests an IHA for the take of marine mammals incidental to the boost-back and landing of the Falcon 9 First Stage at SLC-4W and within the contingency landing locations described in Sections 1 and 2 for one year following the date of issuance. The term "take," as defined in Section 3 of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal" (16 U.S.C. § 1362[13]). "Harassment" was further defined in the 1994 amendments to the MMPA, which provided two levels of "harassment," Level A (potential injury) and Level B (potential disturbance).

Under the MMPA, the 30th Space Wing at VAFB was issued a 5-year LOA to take, by Level B harassment only, Pacific harbor seals, California sea lions, northern elephant seals, Steller sea lions, and northern fur seals incidental to launches, aircraft and helicopter operations, and harbor activities related to vehicles from VAFB from 26 March 2014 to 26 March 2019 (NOAA Fisheries, 2014). This LOA authorizes Level B harassment to these species resulting from sonic boom and engine noise generated during the launch of the Falcon 9 First Stage at SLC-4E (M. DeAngelis, NOAA Fisheries, pers. comm.).

SpaceX received an IHA for the take, Level B harassment only, of a small number of marine mammals incidental to the Falcon 9 First Stage recovery activities in California and the Pacific Ocean. This IHA is valid from June 30, 2016 through June 29, 2017. SpaceX notified NOAA Fisheries of the propose use of the Iridium Landing Area for recovery activities in August 2016, who concurred that a take of marine mammals would not likely occur from this change and a revision to the IHA was not warranted at that time.

The Incidental Take Authorization requested herein is for the authorization of Level B harassment to marine mammals protected under the MMPA that are identified in Chapter 6 as a result of boost-back and landing at SLC-4W on VAFB and boost-back and contingency landing on a barge 27 nm (50 km) offshore of VAFB. A boost-back and landing on a barge within the Iridium Landing Area would not result in an incidental take of a marine mammal.

The specific activities outlined in Section 1 that are analyzed in Section 6 for potential impacts to marine mammals are listed below with associated stressors that were considered.

1) Boost-back and landing of the Falcon 9 First Stage at SLC-4W.
    a. Sonic boom (in-air impulsive noise).
    b. Landing noise (in-air non-pulse noise) and visual stimuli.

2) Boost-back and landing of the Falcon 9 First Stage on a barge at the contingency landing location 27 nm (50 km) offshore
    a. Sonic boom (in-air impulsive noise).
    b. Landing noise (in-air non-pulse noise) and visual stimuli.

Of these, the following stressors were determined to have discountable or no effect on one or both marine mammal groups (see Section 6):

1) Boost-back and landing of the Falcon 9 First Stage at SLC-4W
    a. Sonic boom (in-air impulsive noise) – no effect on cetaceans
    b. Landing noise (in-air non-pulse noise) and visual stimuli – no effect on cetaceans or pinnipeds

2) Boost-back and landing of the Falcon 9 First Stage on a barge at the contingency landing location 27 nm (50 km) offshore.
    a. Sonic boom (in-air impulsive noise) – no effect on cetaceans or pinnipeds
    b. Landing noise (in-air non-pulse noise) and visual stimuli – no effect on cetaceans or pinnipeds.
    c. Vessel noise (in-water non-pulse noise) – no effect on pinnipeds or cetaceans

Therefore, SpaceX requests the issuance of an IHA pursuant to Section 101(a)(5) of the MMPA for incidental take of six pinniped species listed in Section 4 by Level B harassment during the boost-back and landing of the Falcon 9 First Stage during a one-year period from date of issuance for the following. Note that all potential stressors are determined to have no effect or a discountable effect on cetaceans):

1) Boost-back and landing of the Falcon 9 First Stage at SLC-4W
    a. Sonic boom (in-air impulsive noise) – may cause behavioral disturbance (Level B harassment) to six pinniped species listed in Section 4.

Note that all potential stressors are determined to have no effect or a discountable effect on cetaceans. In addition, the boost-back and landing of the Falcon 9 at any of the identified contingency landing locations would have no effect or a discountable effect on pinnipeds.

6 Take Estimates for Marine Mammals

There are 35 marine mammal species known to exist in the study area, as presented in Table 3-1. The methods for estimating the number of takes for each activity and associated stressors are described in the sections below.

6.1 Acoustic Impact Thresholds

NOAA Fisheries developed interim sound threshold guidance for received sound pressure levels from broadband sound that may cause behavioral disturbance and injury in the context of the MMPA (NOAA Fisheries, 2015). Table 6-1 provides thresholds for temporary threshold shifts (TTS; Level B Harassment) for pinnipeds based on this interim guidance. These thresholds were used to determine the potential geographic area where in-air acoustic impacts to pinnipeds from the boost-back and landing actions would be possible. Currently, there is no guidance for a permanent threshold shift (PTS; Level A Harassment) from in-air sound for marine mammals.

Table 6-1. NOAA Fisheries Interim Sound Threshold Guidance

Criterion	Criterion Definition	Threshold
In-Air Acoustic Thresholds		
Level A	PTS (injury) conservatively based on TTS	None established
Level B	Behavioral disruption for harbor seals	90 dB_{rms}
Level B	Behavioral disruption for non-harbor seal pinnipeds	100 dB_{rms}

Source: NOAA Fisheries, 2015

Notes: PTS = permanent threshold shift in hearing sensitivity (i.e., loss of hearing); TTS = temporary threshold shift in hearing sensitivity (behavioral disruption); dB_{rms} = root mean square value of decibels, obtained by squaring the amplitude at each instant, obtaining the average of the squared values over the interval of interest, and then taking the square root of this average

NOAA Fisheries (2016) provided final guidance for underwater thresholds in July 2016. This guidance groups cetaceans into low-frequency cetaceans, mid-frequency cetaceans, and high frequency cetaceans and pinnipeds into phocid and otariid (Table 6-2). These thresholds are provided in

Table 6-3.

Table 6-2. Marine Mammal Hearing Groups

Hearing Group	**Generalized Hearing Range**
Low-frequency (LF) cetaceans (baleen whales)	7 Hz to 35 kHz
Mid-frequency (MF) cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	150 Hz to 160 kHz
High-frequency (HF) cetaceans (true porpoises, Kogia, river dolphins, *cephalorhynchid, Lagenorhynchus cruciger and L. australis*)	275 Hz to 160 kHz
Phocid pinnipeds (PW) (underwater) (true seals)	50 Hz to 86 kHz
Otariid pinnipeds (OW) (underwater) (sea lions and fur seals)	60 Hz to 39 kHz

Source: NOAA Fisheries, 2016

Table 6-3. Disturbance Thresholds for Underwater Impulsive and Non-Impulsive Noise

Group	Hearing Threshold	Non-impulsive		Impulse			
		TTS (threshold)	PTS (threshold)	TTS (threshold)		PTS (threshold)	
	SPL	SEL (weighted)	SEL (weighted)	SEL (weighted)	Peak SPL (unweighted)	SEL (weighted)	Peak SPL (unweighted)
LF	54 dB	179 dB	199 dB	168 dB	213 dB	183 dB	219 dB
MF	54 dB	178 dB	198 dB	170 dB	224 dB	185 dB	230 dB
HF	48 dB	153 dB	173 dB	140 dB	196 dB	155 dB	202 dB
OW	67 dB	199 dB	219 dB	188 dB	226 dB	203 dB	232 dB
PW	53 dB	181 dB	201 dB	170 dB	212 dB	185 dB	218 dB

Sources: NOAA Fisheries (2016); Finneran (2016)
Notes: SEL = sound exposure level, SPL = sound pressure level, TTS = temporary threshold shift, PTS = permanent threshold shift, dB = decibel(s), LF = low frequency, MF = mid-frequency, HF = high frequency, OW = Otariid pinnipeds, PW = phocid pinnipeds

After estimating the geographic areas of potential impact for each acoustic stressor, marine mammal density data (U.S. Department of the Navy, 2016), haulout data (ManTech SRS Technologies, Inc., 2014, 2015; VAFB, unpubl. data; M. Lowry, NOAA Fisheries, unpubl. data), and stock assessments (Carretta et al., 2015) were used to estimate the potential number of exposures for each species. In a conservative manner, the highest values were used for each marine species (see species descriptions in Section 4) when estimating potential impacts. Below, each potential acoustic stressor is analyzed for potential impacts to marine mammals and, where take is predicted, take estimates are presented for each species under the associated acoustic stressor.

6.2 In-Air Acoustic Impacts

Cetaceans spend their entire lives in the water and spend most of their time (>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. As a result, in-air noise caused by sonic boom and landing engine noise during landing would not have an effect on cetacean species.

Pinnipeds spend significant amounts of time out of the water during breeding, molting, and hauling out periods. In the water, pinnipeds spend varying amounts of time underwater. NOAA Fisheries does not currently believe that in-air noise is likely to result in behavioral harassment of animals at sea (J. Carduner, NOAA Fisheries, pers. comm.). 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. NOAA Fisheries believes the potential for such disruption, from in-air noise, is extremely unlikely for animals that are at sea. As such, it is not necessary for SpaceX to seek MMPA authorization for the incidental take of marine mammals at sea as a result of in-air noise. The proposed action, however, would create in-air noise that may impact marine mammals that are hauled out and these potential impacts are analyzed below.

6.2.1 Sonic Boom

Sonic booms would disturb pinnipeds that may be at the surface in the area of exposure, depending on the strength of the overpressure. This impulsive in-air noise is expected to cause variable levels of disturbance to pinnipeds that may be hauled out within the area of exposure depending on the species exposed and the level of the sonic boom. The USAF has monitored pinnipeds during launch-related sonic booms on the Northern Channel Islands during numerous launches over the past two decades and determined that there are generally no significant behavioral disruptions caused to pinnipeds by sonic booms less than 1.0 psf (see Chapter 7 for further discussion). Furthermore, past pinniped monitoring of sonic booms on San Miguel Island by the USAF has shown that certain species, including northern elephant seal and northern fur seal tend not to respond or respond only mildly (e.g., head raise alert) to any sonic booms, whereas harbor seal, California sea lion, and Steller sea lion tend to be more reactive. Guadalupe fur seal also tends to be non-responsive to auditory stimuli (J. Harris, NOAA Fisheries, pers. comm.).

For a SLC-4W landing, haulouts are included from the areas of Point Arguello and Point Conception (Figure 2-2 and Figure 6-1). Only haulouts along northeastern San Miguel Island, northern and northwestern Santa Rosa Island, and northwestern Santa Cruz Island would experience overpressures greater than 1 psf during a boost-back and landing at SLC-4W (Figure 2-3, Figure 2-4, Figure 2-5, and Figure 6-2). For a contingency landing event, sonic booms are sufficiently offshore so that no haulouts would be exposed to a 1.0 psf or greater sonic boom (Figure 2-6 and Figure 2-7). In addition, a boost-back and landing event in the Iridium Landing Area would not overlap any marine mammal haulout areas (Figure 2-8). Therefore, landing at these areas would not result in any annual takes.

The annual take estimate assumes 12 landing events per year at either SLC-4W (

Table 6-4, page 45). Where sufficient data exists, SpaceX used the average number of individuals of each species from multiple count data for haulouts within the geographic area of potential impact to calculate take estimates. For California sea lion and northern elephant seal, the number of individuals hauled out at different times of the year can vary exponentially within the project area, depending on breeding behaviors and dispersal activity. Lowry (2017) was used to identify the maximum number of California sea lion, northern elephant seals, and Pacific harbor seals at haulouts that could be affected by a 1+ psf sonic boom in the North Channel Islands and Point Conception. These estimates are also consistent with VAFB's take estimates for sonic booms on the Northern Channel Islands that are caused by similar VAFB launch activities (VAFB, 2013).

SpaceX conservatively estimates that the entire population of California sea lions, harbor seals, northern elephant seals, steller sea lions, northern fur seals, and Guadalupe fur seals at or near VAFB and Point Conception would experience a behavioral disruption from a sonic boom of between 1 and 8.5 psf at SLC-4W. This estimate conservatively overestimates that all individual marine mammals are hauled out at the time of the sonic boom. Haulout areas within the North Channel Island would receive a sonic boom between 1 and 3.1 psf. SpaceX conservatively estimates that 5 percent of northern elephant seals, northern fur seals, and Guadalupe fur seals and 100 percent of California sea lions, harbor seals, and steller sea lions would have a behavioral reaction to a sonic boom of this magnitude on the North Channel Islands.

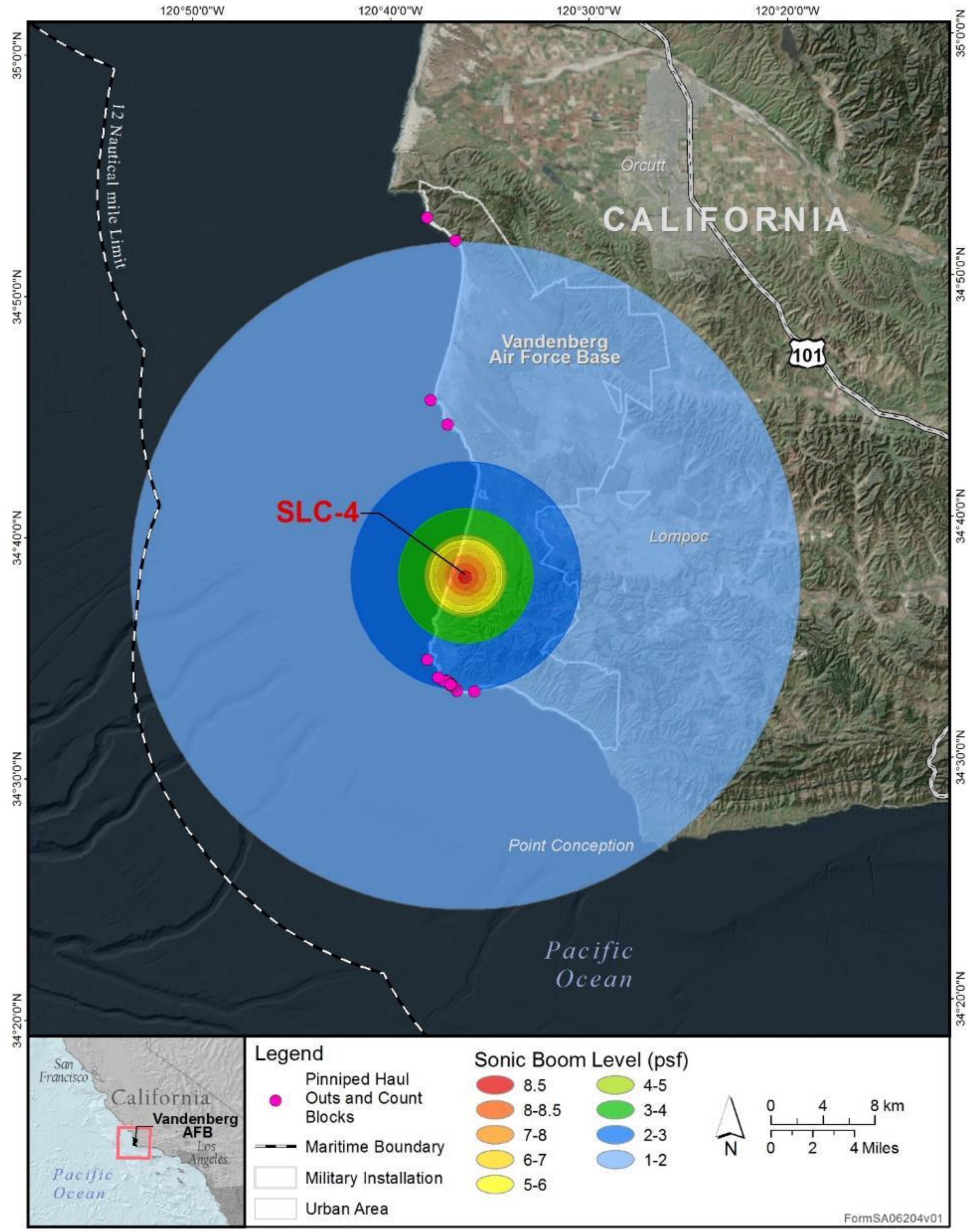


Figure 6-1. Marine Mammal Haulouts at VAFB

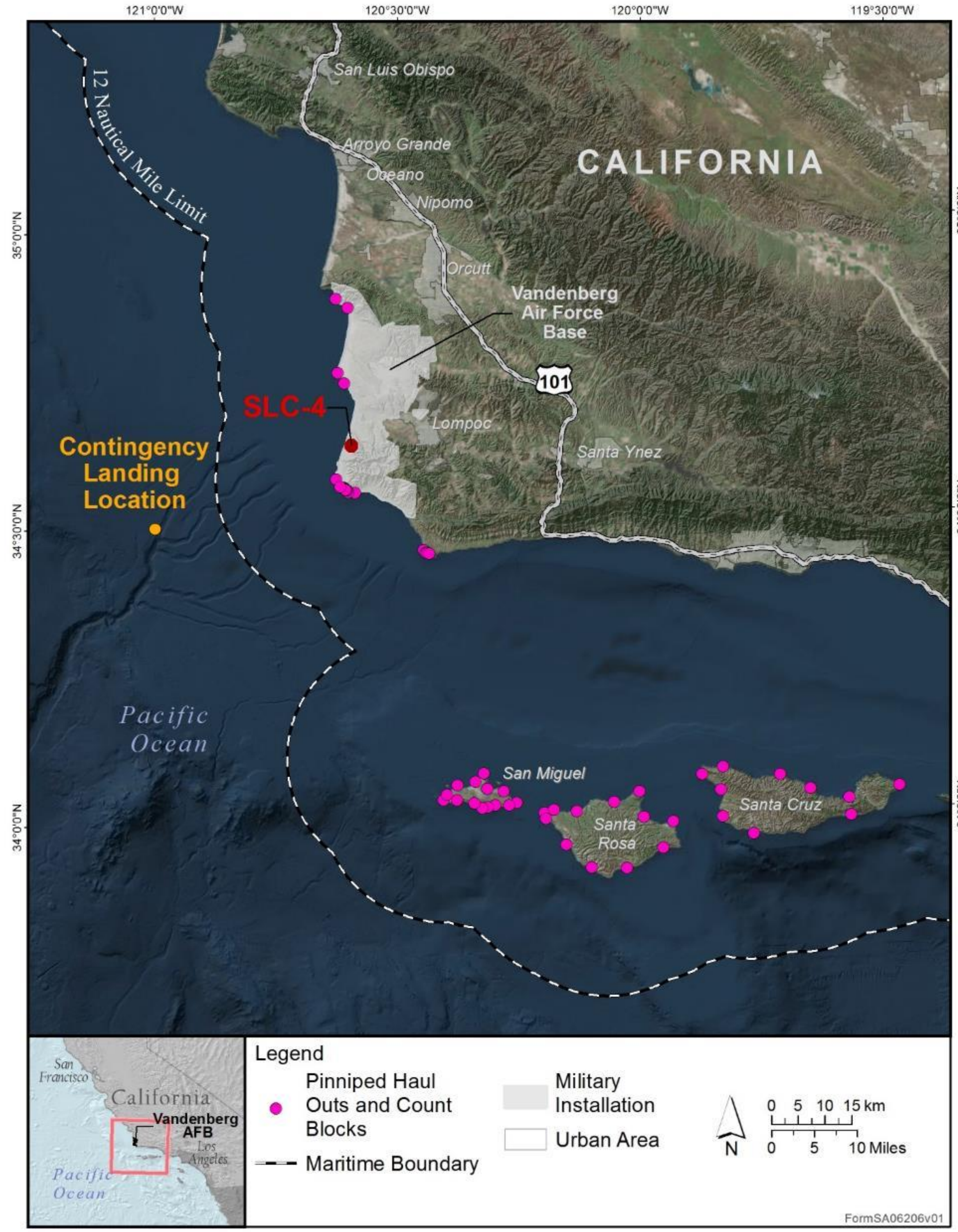


Figure 6-2. Marine Mammal Haulouts at North Channel Islands

Table 6-4. SLC-4W landing – Level B harassment take estimates per year (twelve events)

Species	**Geographic Location**	**Estimated # of Marine Mammals at Haulouts in 1.0+ psf Area**	**Estimated # Individuals in 1.0+ psf Exposure Area per Event**	**Level B Harassment: Estimated # Individuals in 1.0+ psf Exposure Area per Year ^**
Pacific Harbor Seal	VAFB[a]	366	1,384	16,608
	Pt. Conception[b]	516		
	San Miguel Island[b]	310		
	Santa Rosa Island[b]	192		
	Santa Cruz Island[b]	0		
California Sea Lion	VAFB[a]	416	4,561	54,732
	Pt. Conception	N/A		
	San Miguel Island[b]	2,134		
	Santa Rosa Island[b]	1,200		
	Santa Cruz Island[b]	811		
Northern Elephant Seal	VAFB[a]	190	227	2,724
	Pt. Conception[b]	11		
	San Miguel Island[b]	18*		
	Santa Rosa Island[b]	8*		
	Santa Cruz Island[b]	0		
Steller Sea Lion	VAFB[a]	16	20	240
	Pt. Conception	N/A		
	San Miguel Island	4		
	Santa Rosa Island	N/A		
	Santa Cruz Island	N/A		
Northern Fur Seal	VAFB	N/A	250	3,000
	Pt. Conception	N/A		
	San Miguel Island[c]	250*		
	Santa Rosa Island	N/A		
	Santa Cruz Island	N/A		
Guadalupe Fur Seal	VAFB	N/A	1	12
	Pt. Conception	N/A		
	San Miguel Island[e]	13*		
	Santa Rosa Island	N/A		
	Santa Cruz Island	N/A		

[a] VAFB monthly marine mammal survey data 2013-2015 (ManTech SRS Technologies, Inc., 2014, 2015; USAF, 2017).
[b] Lowry (2017b).
[c] Testa (2013); USAF (2013); pers. comm., T. Orr, NMFS NMML, to J. Carduner, NMFS, Feb 27, 2016.
[d] NOAA Fisheries aerial survey data February 2010 (M. Lowry, NOAA Fisheries, unpubl. data).
[e] DeLong and Melin (2000); J. Harris, NOAA Fisheries, pers. comm.
^ Based on twelve SLC-4W landing events per year.
*5 percent of animals exposed to sonic booms above 1.0 psf are assumed to experience Level B exposure.

6.2.2 Landing Noise

The Falcon 9 First Stage would generate non-pulse engine noise up to 110 dB re 20 uPa while landing on the landing pad or barge. This landing noise event would be of short duration (approximately 17 seconds). Although, during a landing event at SLC-4W, landing noises between 70 and 90 dB would overlap pinniped haulout areas at and near Point Arguello and Purisima Point, no pinniped haulouts would experience landing noises of 90 dB or greater (Figure 2-10, Figure

2-11, and

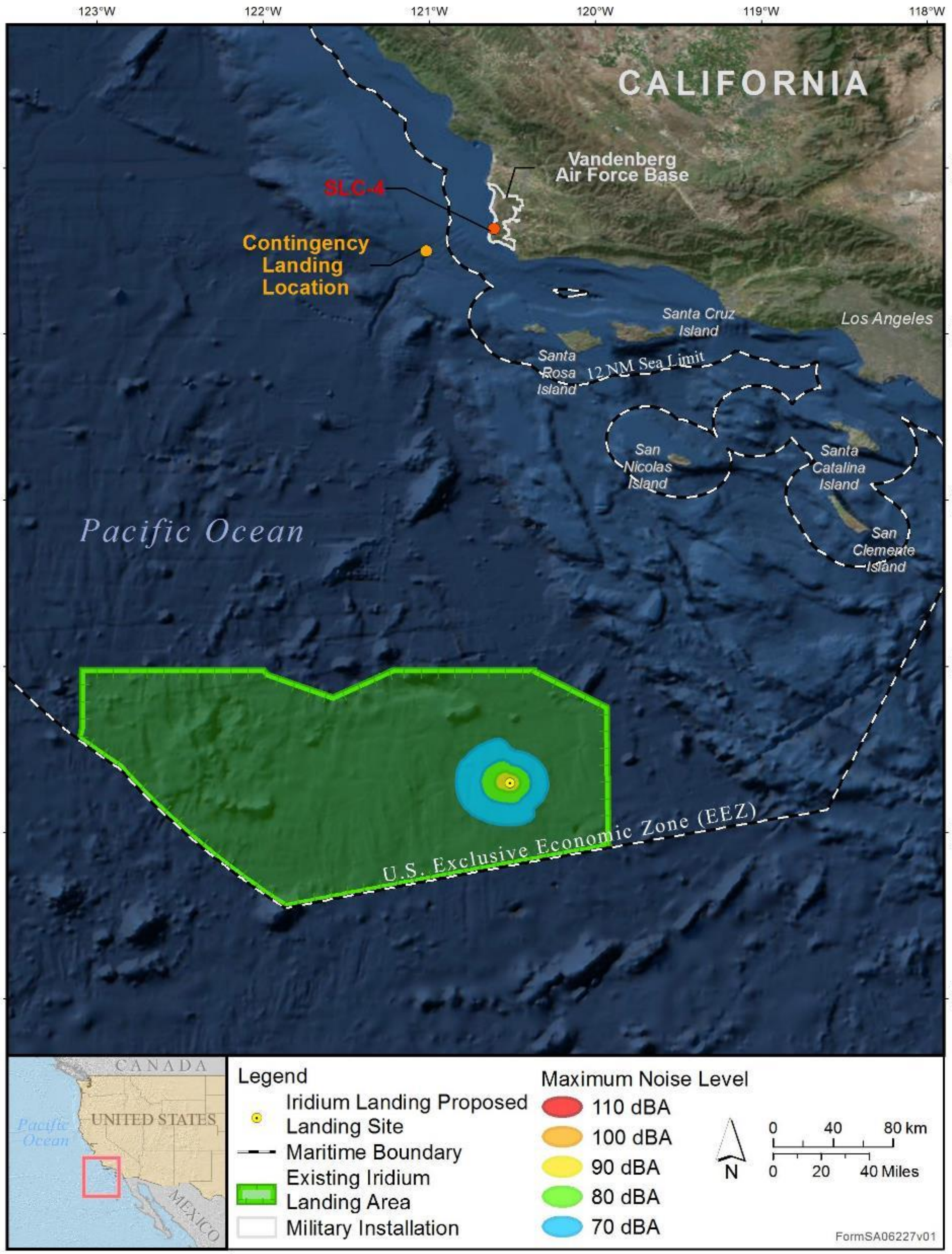


Figure 2-12).

In addition, the trajectory of the return flight includes a nearly vertical descent (Figure 1-7 and Figure 1-8), as such, there would be no significant visual disturbance to marine mammals. The First Stage would either be shielded by coastal bluffs or too far away to cause significant stimuli to marine mammals. Therefore, landing noise and visual disturbance associated with the Falcon 9 First Stage boost-back would not result in Level B harassment of marine mammals.

7 Anticipated Impact of the Activity

The activities and associated stressors analyzed in Section 6 that were determined to have no effect or a discountable effect on marine mammals are not carried forward. Below is a discussion of the biological context and consequences of the in-air sonic boom on hauled out pinnipeds, identified in Section 6 as the only stressor that may result in Level B harassment to pinnipeds.

7.1 Sonic Boom

Pinnipeds would be taken only by incidental Level B harassment from noise or visual disturbances associated with the boost-back and landing of the Falcon 9 First Stage. Reactions of pinnipeds to sonic booms range from no response to heads-up alerts, from startle responses to some movements on land, and from some movements into the water to occasional stampedes, especially involving California sea lions at the Northern Channel Islands. Sonic booms generated during the return flight of the Falcon 9 First Stage may elicit an alerting, avoidance, or other short-term behavioral reaction, including diving or fleeing to the water if hauled out. The number of individuals impacted are based on conservative estimates of the size of the exposure areas and the numbers of individuals that would be exposed and react to a sonic boom over 1.0 psf. In reality, the density for each pinniped species would fluctuate throughout the year and not be uniform throughout the exposure area. As a result, a realistic number of individuals exposed to sonic boom is likely to be less than the densities assumed herein for some or all of the events.

In addition, behavioral reactions to noise can depend on relevance and association to other stimuli. A behavioral decision is made when an animal detects increased background noise, 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; they can be visual, olfactory, or tactile stimuli; the stimuli can be conspecifics or predators in the area; or the stimuli can be 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 illicit a stronger reaction than the acoustic stimuli itself otherwise would have. The visual stimulus of the Falcon 9 First Stage would not be coupled with the sonic boom, since the First Stage will be at significant altitude when the overpressure is produced. This would decrease the likelihood and severity of a behavioral response. It is difficult to separate the stimulus of the sound from the stimulus of source creating the sound. The sound may act as a cue, or as one stimulus of many that the animal is considering when deciding how to react.

In addition, data from launch monitoring by the USAF on the Northern Channel Islands has shown that pinniped's reaction to sonic booms is correlated to the level of the sonic boom. Low energy sonic booms (< 1.0 psf) have resulted in little to no behavioral responses, including head raising and briefly alerting but returning to normal behavior shortly after the stimulus. Sonic booms that are more powerful have flushed animals from haulouts but not resulted in any mortality or sustained decreased in numbers after the stimulus.

Table 7-1 presents a summary of monitoring efforts on from 1999 to 2011. The associated reports have been previously submitted to NOAA Fisheries but are available upon request. These data show that reactions to sonic booms tend to be insignificant below 1.0 psf, and that even above 1.0 psf, only a portion of the animals present react to a sonic boom. Reactions between species are also different, as harbor seals and California sea lions tend to be more sensitive to disturbance than northern elephant seals.

Table 7-1. Summary of Responses of Pinnipeds on San Miguel Island to Sonic Booms Resulting from VAFB Launches

Launch Event	Sonic Boom Level (psf)	Species and Associated Reaction
Athena II (27 April 1999)	1.0	*Z. californianus* – 866 alerted; 232 flushed into water *M. angustirostris* and *C. ursinus* – alerted but did not flush
Athena II (24 September 1999)	0.95	*Z. californianus* – 600 alerted; 12 flushed into water *M. angustirostris* and *C. ursinus* – alerted but did not flush
Delta II 20 (November 2000)	0.4	*Z. californianus* – 60 flushed into water; no reaction from rest *M. angustirostris* – no reaction
Atlas II (8 September 2001)	0.75	*Z. californianus* and *M. angustirostris* – no reaction *P. vitulina* – 2 of 4 flushed into water
Delta II (11 February 2002)	0.64	*Z. californianus, C. ursinus*, and M. *angustirostris* – no reaction
Atlas II (2 December 2003)	0.88	*Z. californianus* – 40 percent alerted; several flushed to water *M. angustirostris* – no reaction
Delta II (15 July 2004)	1.34	*Z. californianus* – 10 percent alerted
Atlas V (13 March 2008)	1.24	*M. angustirostris* – no reaction
Delta II (5 May 2009)	0.76	*Z. californianus* – no reaction
Atlas V (14 April 2011)	1.01	*M. angustirostris* – no reaction
Atlas V (3 April 2014)	0.74	*P. vitulina* – 1 of ~25 flushed into water; no reaction from rest
Atlas V (12 December 2014)	1.16	*Z. californianus* – 5 of ~225 alerted; none flushed

With the conservative estimates for density and the assumption that all animals present would be exposed to and react to the sonic boom, the number of individuals estimated to experience behavioral disruption resulting from sonic boom would likely be even lower than the estimated values shown in

Table 6-4. Additionally, the sonic boom events would be infrequent (up to twelve times annually) and therefore unlikely to result in any permanent avoidance of the area. Finally, since the sonic boom is decoupled from biologically relevant stimuli there would likely be less reaction, or no reaction, to the sonic boom, depending on intensity.

8 Impacts on Subsistence Use

Potential impacts resulting from the Proposed Action would be limited to individuals of marine mammal species located in areas that have no subsistence requirements. Therefore, no impacts on the availability of species or stocks for subsistence use are considered.

9 Anticipated Impacts on Habitat

The Proposed Action would not result in in-water acoustic sound that would cause significant injury or mortality to prey species and would not create barriers to movement of marine mammals or prey. Behavioral disturbance caused by in-air acoustic impacts may result in marine mammals temporarily moving away from or avoiding the exposure area but are not expected to have long term impacts, as supported by over two decades of launch monitoring studies on the Northern Channel Islands by the U.S. Air Force (MMCG and SAIC, 2012).

10 Anticipated Effect of Habitat Impacts on Marine Mammals

Since the acoustic impacts associated with the boost-back and landing of the Falcon 9 First Stage are of short duration and infrequent (up to twelve events annually), the associated behavioral responses in marine mammals are expected to be temporary. Therefore, the Proposed Action is unlikely to result in long term or permanent avoidance of the exposure areas or loss of habitat, as supported by over two decades of launch monitoring studies on the Northern Channel Islands by the USAF (MMCG and SAIC, 2012).

11 Mitigation Measures

It would not be feasible to stop or divert an inbound First Stage booster if a marine mammal was identified within the exposure area of one of the activities, and thereby attempt to avoid impact. Once the boost-back and landing sequence is underway, there would be no way to change the trajectory to avoid impacts to marine mammals. Thus, SpaceX does not propose any mitigation measures associated with the boost-back and landing of the Falcon 9 First Stage. However, SpaceX would continue to implement the following mitigation measure:

(a) Unless constrained by other factors including human safety or national security concerns, launches would be scheduled to avoid, whenever possible, boost-backs and landings during the harbor seal pupping season of March through June.

12 Arctic Subsistence Plan of Cooperation

Potential impacts resulting from the Proposed Action would be limited to individuals of marine mammal species located in areas that have no subsistence requirements. Therefore, an arctic subsistence plan of cooperation is not applicable.

13 Monitoring and Reporting

Implementation of the monitoring measures outlined below would allow SpaceX to better quantify the characteristics of the various stressors analyzed here and document impacts to marine mammals as a result of the Proposed Action. Implementation of all measures would be overseen by qualified SpaceX personnel or contractor staff. The following measures would be implemented to monitor potential impacts to offshore marine mammals and the offshore marine environment:

13.1 Sonic Boom Modeling

Sonic boom modeling would be performed prior to all boost-back events. PCBoom, a commercially available modeling program, or an acceptable substitute, would be used to model sonic booms. Launch parameters specific to each launch would be incorporated into each model. These include direction and trajectory, weight, length, engine thrust, engine plume drag, position versus time from initiating boost-back to additional engine burns, among other aspects. Various weather scenarios would be analyzed from NOAA weather records for the region, then run through the model. Among other factors, these would include the presence or absence of the jet stream, and if present, its direction, altitude and velocity. The type, altitude, and density of clouds would also be considered. From these data, the models would predict peak amplitudes and impact locations.

13.2 Pinniped Monitoring

(a) SpaceX would notify the Administrator, West Coast Region, NMFS, by letter or telephone, at least 2 weeks prior to activities possibly involving the taking of marine mammals;

(b) To conduct monitoring of Falcon 9 First Stage recovery activities, SpaceX would designate qualified, on-site individuals approved in advance by NMFS;

(c) Should model results indicate that a peak overpressure of 1 psf or greater is likely to impact VAFB, then acoustic and biological monitoring at VAFB would be implemented;

(d) If sonic boom model results indicate that a peak overpressure of 1.0 psf or greater is predicted to impact the Channel Islands between March 1 and June 30, greater than 1.5 psf between July 1 and September 30, and greater than 2.0 psf between October 1 and February 28, monitoring of haulout sites on the Channel Islands would be implemented. Monitoring would be conducted at the haulout site closest to the predicted sonic boom impact area;

(e) Monitoring would be conducted at the haulout site closest to the predicted sonic boom impact area. Monitoring locations would be selected based on what species have pups at the haul outs and which of those would be the most reactive. Predictions of the areas likely to receive the greatest sonic boom and the current haulout locations and distribution of pinniped species as well as the geography, wind exposure, and accessibility of a location would be considered when selecting monitoring locations. Rookeries are highly preferred if accessible;

(f) Monitoring would be conducted for at least 72 hours prior to any planned Falcon 9 First Stage recovery and continue until at least 48 hours after the event;

(g) Monitors would conduct hourly counts for 6 hours per day centered around the scheduled launch time to the extent possible. The monitors would be at the monitoring location continuously for 6 hours per day and would take a count every hour during this period;

(h) For daytime events, counts would be centered around the launch time so there are observations for 2-3 hours before and after the event. For nighttime events, counts would be conducted from daybreak to 6 hours after daybreak and observers would go to the monitoring location approximately one hour before launch to set up recording equipment and record the boom. The monitors would observe pinniped reactions with night vision binoculars to the best extent possible. Monitors would remain at the location until pinniped behavior is observed to return to normal.

(i) New northern elephant seal pupping location(s) at VAFB would be prioritized for monitoring when landings occur at SLC-4W during northern elephant seal pupping season (January through February) when practicable;

(j) For launches during the harbor seal pupping season (March through June), follow-up surveys would be conducted within 2 weeks of the Falcon 9 First Stage recovery to monitor for any long-term adverse effects on marine mammals;

(k) If Falcon 9 First Stage recovery is scheduled during daylight, time-lapse photography or video recording would be used to document the behavior of marine mammals during Falcon 9 First Stage recovery activities;

(l) Monitoring would include multiple surveys each day that record the species, number of animals, general behavior, presence of pups, age class, gender and reaction to noise associated with Falcon 9 First Stage recovery, sonic booms or other natural or human caused disturbances, in addition to recording environmental conditions such as tide, wind speed, air temperature, and swell; and

(m) Acoustic measurements of the sonic boom created during boost-back at the monitoring location would be recorded to determine the overpressure level.

(n) Monitors would use the "3-Point Scale" depicted in Figure 13-1 to assess whether harassment has occurred. Level 1 is not considered harassment, while Level 2 and 3 would be considered harassment.

Figure 13-1. National Marine Fisheries Service "3-Point Scale" for Harassment

Level	Type of Response	Definition
1	Alert	Seal head orientation or brief movement in response to disturbance, which may include turning head towards the disturbance, craning head and neck while holding the body rigid in a u-shaped position, changing from a lying to a sitting position, or brief movement of less than twice the animal's body length.
2	Movement	Movements away from the source of disturbance, ranging from short withdrawals at least twice the animal's body length to longer retreats over the beach, or if already moving a change of direction of greater than 90 degrees.
3	Flush	All retreats (flushes) to the water.

13.3 Reporting

(a) Submit a report to the Office of Protected Resources, NMFS, and the West Coast Regional Administrator, NMFS, within 60 days after each Falcon 9 First Stage recovery action. This report would contain the following information:

1. Date(s) and time(s) of the Falcon 9 First Stage recovery action;
2. Design of the monitoring program; and
3. Results of the monitoring program, including, but not necessarily limited to the following:
    a. Numbers of pinnipeds present on the haulout prior to the Falcon 9 First Stage recovery;
    b. Numbers of pinnipeds that may have been harassed as noted by the number of pinnipeds estimated to have moved more than one meter or entered the water as a result of Falcon 9 First Stage recovery activities;
    c. For pinnipeds estimated to have entered the water as a result of Falcon 9 First Stage recovery noise, the length of time pinnipeds remained off the haulout or rookery;
    d. Any other observed behavioral modifications by pinnipeds that were likely the result of Falcon 9 First Stage recovery activities, including sonic boom; and
    e. Results of acoustic monitoring including comparisons of modeled sonic booms with actual acoustic recordings of sonic booms.

(b) Submit an annual report on all monitoring conducted under the IHA. A draft of the annual report would be submitted within 90 calendar days of the expiration of the IHA, or, within 45 calendar days of the renewal of the IHA (if applicable). A final annual report would be prepared and submitted within 30 days following resolution of comments on the draft report from NMFS. The annual report would summarize the information from the 60-day post-activity reports, including but not necessarily limited to the following:

1. Date(s) and time(s) of the Falcon 9 First Stage recovery action;
2. Design of the monitoring program; and
3. Results of the monitoring program, including, but not necessarily limited to the requirements in section 13.3(a) of this application as well as
    a. Any cumulative impacts on marine mammals as a result of the activities, such as long term reductions in the number of pinnipeds at haulouts as a result of the activities.

(c) Reporting injured or dead marine mammals:

1. In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by this IHA (as determined by the lead marine mammal observer), such as an injury (Level A harassment), serious injury, or mortality, SpaceX would immediately cease the specified activities and report the incident to the Office of Protected Resources, NMFS, and the West Coast Regional Stranding Coordinator, NMFS. The report must include the following information:
    a. Time and date of the incident;
    b. Description of the incident;
    c. Status of all Falcon 9 First Stage recovery activities in the 48 hours preceding the incident;
    d. Description of all marine mammal observations in the 48 hours preceding the incident;

e. Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility);
f. Species identification or description of the animal(s) involved;
g. Fate of the animal(s); and
h. Photographs or video footage of the animal(s).

Activities would not resume until NMFS is able to review the circumstances of the prohibited take. NMFS would work with SpaceX to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. SpaceX may not resume their activities until notified by NMFS via letter, email, or telephone.

2. In the event that SpaceX discovers an injured or dead marine mammal, and the lead observer determines that the cause of the injury or death is unknown and the death is relatively recent (e.g., in less than a moderate state of decomposition), SpaceX would immediately report the incident to the Office of Protected Resources, NMFS, and the West Coast Regional Stranding Coordinator, NMFS. The report would include the same information identified in section 13.3(a) of this application. Activities may continue while NMFS reviews the circumstances of the incident and makes a final determination on the cause of the reported injury or death. NMFS would work with SpaceX to determine whether additional mitigation measures or modifications to the activities are appropriate.
3. In the event that SpaceX discovers an injured or dead marine mammal, and the lead observer determines that the injury or death is not associated with or related to the activities authorized in the IHA (e.g., previously wounded animal, carcass with moderate to advanced decomposition, scavenger damage), SpaceX would report the incident to the Office of Protected Resources, NMFS, and the West Coast Regional Stranding Coordinator, NMFS, within 24 hours of the discovery. SpaceX would provide photographs or video footage or other documentation of the stranded animal sighting to NMFS. The cause of injury or death may be subject to review and a final determination by NMFS.

14 Suggested Means of Coordination

SpaceX would share biologically relevant data related to the potential stressors identified herein, including data collected on their acoustic characteristics in the field and observed impacts to marine mammal species as described in section 13 of this application.

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

INCIDENTAL HARASSMENT AUTHORIZATION

Space Exploration Technology Corporation (SpaceX) is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA; 16 U.S.C. 1371(a)(5)(D)) to harass marine mammals incidental to recovery of Falcon 9 rockets at Vandenberg Air Force Base in California, and at contingency landing locations in the Pacific Ocean, when adhering to the following terms and conditions.

1. This Incidental Harassment Authorization (IHA) is valid from December 1, 2017 through November 30, 2018.

2. This IHA is valid only for Falcon 9 First Stage recovery activities at Vandenberg Air Force Base (VAFB), California, and at auxiliary landing sites offshore.

3. General Conditions

   (a) A copy of this IHA must be in the possession of SpaceX, its designees, and work crew personnel operating under the authority of this IHA.

   (b) The species authorized for taking are listed in Table 1. The taking, by Level B harassment only, is limited to the species and numbers listed in Table 1. Any taking exceeding the authorized amounts listed in Table 1 is prohibited and may result in the modification, suspension, or revocation of this IHA.

   (c) The taking by injury (Level A harassment), serious injury, or death of any of the species listed in Table 1, or any taking of any species of marine mammal other than those listed in Table 1, is prohibited and may result in the modification, suspension, or revocation of this IHA.

4. Mitigation Requirements

   The holder of this Authorization must implement the following mitigation measures:

   (a) Unless constrained by other factors including human safety or national security concerns, launches must be scheduled to avoid boost-backs and landings during the harbor seal pupping season of March through June when practicable.

5. Monitoring

   The holder of this Authorization must conduct marine mammal and acoustic monitoring as described below.

   (a) To conduct monitoring of Falcon 9 First Stage recovery activities, SpaceX must designate qualified, on-site individuals approved in advance by NMFS;

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(b) If sonic boom model results indicate that a peak overpressure of 1.0 pounds per square foot (psf) or greater is likely to impact VAFB, then acoustic and biological monitoring at VAFB must be implemented;

(c) If sonic boom model results indicate that a peak overpressure of 1.0 psf or greater is predicted to impact the Channel Islands between March 1 and June 30, greater than 1.5 psf between July 1 and September 30, and greater than 2.0 psf between October 1 and February 28, monitoring of pinniped haulout sites on the Channel Islands must be implemented;

(d) Monitoring must be conducted at the haulout site closest to the area predicted to experience the greatest sonic boom intensity, when practicable;

(e) If Falcon 9 First Stage recovery activities are scheduled during daylight, time-lapse photography or video recording must be used to document the behavior of marine mammals during Falcon 9 First Stage recovery activities;

(f) If Falcon 9 First Stage recovery activities are scheduled during nighttime, night vision devices must be used by monitors to observe pinniped behavior;

(g) Monitors must conduct hourly pinniped counts for 6 hours per day on the day of the Falcon 9 launch. Hourly pinniped counts shall be centered around the launch time when events occur during daylight hours. For nighttime events, hourly pinniped counts shall be conducted from daybreak to 6 hours after daybreak;

(h) Monitors must remain at the monitoring location until pinniped behavior is observed to return to normal, when practicable;

(i) Monitoring must be conducted for at least 72 hours prior to any planned Falcon 9 First Stage recovery and continue until at least 48 hours after the event;

(j) Monitoring must include multiple surveys each day that record the species, number of animals, general behavior, presence of pups, age class, gender and reaction to noise associated with Falcon 9 First Stage recovery, sonic booms or other natural or human caused disturbances, in addition to recording environmental conditions such as tide, wind speed, air temperature, and swell;

(k) Monitors must document marine mammal responses to noise associated with Falcon 9 First Stage recovery activities using the categories shown in Table 2.

(l) For Falcon 9 First Stage recovery activities that occur from March through June, follow-up surveys of harbor seal haulouts on VAFB will be conducted within two weeks of the Falcon 9 First Stage recovery;

(m) If sonic boom model results indicate a peak overpressure of 1.0 psf or greater is likely to impact VAFB during January or February, then acoustic and biological monitoring must be implemented at northern elephant seal rookeries at VAFB, when practicable;

(n) Acoustic measurements of the sonic boom created during boost-back at the monitoring location must be recorded to determine the overpressure level.

6. Reporting

The holder of this Authorization is required to:

(a) Submit a report to the Office of Protected Resources, NMFS, and the West Coast Regional Administrator, NMFS, within 60 days after each Falcon 9 First Stage recovery action. This report must contain the following information:

(1) Date(s) and time(s) of the Falcon 9 First Stage recovery action;

(2) Design of the monitoring program; and

(3) Results of the monitoring program, including, but not necessarily limited to:

(i) Numbers of pinnipeds present on the haulout prior to the Falcon 9 First Stage recovery;

(ii) Numbers of pinnipeds that may have been harassed as a result of Falcon 9 First Stage recovery activities;

(iii) For pinnipeds estimated to have been harassed as a result of Falcon 9 First Stage recovery noise, the length of time pinnipeds remained off the haulout or rookery;

(iv) Any other observed behavioral modifications by pinnipeds that were likely the result of Falcon 9 First Stage recovery activities, including sonic boom; and

(v) Results of acoustic monitoring including comparisons of modeled sonic booms with actual acoustic recordings of sonic booms.

(b) Submit an annual report on all monitoring conducted under the IHA. A draft of the annual report must be submitted within 90 calendar days of the expiration of this IHA, or, within 45 calendar days of the requested renewal of the IHA (if applicable). A final annual report must be prepared and submitted within 30 days following resolution of comments on the draft report from NMFS. The annual report will summarize the information from the 60-day post-activity reports, including but not necessarily limited to:

(1) Date(s) and time(s) of the Falcon 9 First Stage recovery action;

(2) Design of the monitoring program; and

(3) Results of the monitoring program, including, but not necessarily limited to:

(i) Numbers of pinnipeds present on the haulout prior to the Falcon 9 First Stage recovery;

(ii) Numbers of pinnipeds estimated to have been harassed as a result of Falcon 9 First Stage recovery activities at the monitoring location;

(iii) For pinnipeds estimated to have been harassed as a result of Falcon 9 First Stage recovery noise, the length of time pinnipeds remained off the haulout or rookery;

(iv) Any other observed behavioral modifications by pinnipeds that were likely the result of Falcon 9 First Stage recovery activities, including sonic boom;

(v) Any cumulative impacts on marine mammals as a result of the activities, such as long term reductions in the number of pinnipeds at haulouts as a result of the activities; and

(vi) Results of acoustic monitoring including comparisons of modeled sonic booms with actual acoustic recordings of sonic booms.

(c) Reporting injured or dead marine mammals:

(1) In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by this IHA (as determined by the lead marine mammal observer), such as an injury (Level A harassment), serious injury, or mortality, SpaceX will immediately cease the specified activities and report the incident to the NMFS Office of Protected Resources ((301) 427-8401) and the NMFS West Coast Region Stranding Coordinator ((562) 980-3230). The report must include the following information:

(i) Time and date of the incident;

(ii) Description of the incident;

(iii) Status of all Falcon 9 First Stage recovery activities in the 48 hours preceding the incident;

(iv) Description of all marine mammal observations in the 48 hours preceding the incident;

(v) Environmental conditions (*e.g.*, wind speed and direction, Beaufort sea state, cloud cover, and visibility);

(vi) Species identification or description of the animal(s) involved;

(vii) Fate of the animal(s); and

(viii) Photographs or video footage of the animal(s).

Activities will not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with SpaceX to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. SpaceX may not resume their activities until notified by NMFS via letter, email, or telephone.

(2) In the event that SpaceX discovers an injured or dead marine mammal, and the lead observer determines that the cause of the injury or death is unknown and the death is relatively recent (*e.g.*, in less than a moderate state of decomposition), SpaceX will immediately report the incident to the NMFS Office of Protected Resources ((301) 427-8401) and the NMFS West Coast Region Stranding Coordinator ((562) 980-3230). The report must include the same information identified in 6(c)(1) of this IHA. Activities may continue while NMFS reviews the circumstances of the incident and makes a final determination on the cause of the reported injury or death. NMFS will work with SpaceX to determine whether additional mitigation measures or modifications to the activities are appropriate.

(3) In the event that SpaceX discovers an injured or dead marine mammal, and the lead observer determines that the injury or death is not associated with or related to the activities authorized in the IHA (*e.g.*, previously wounded animal, carcass with moderate to advanced decomposition, scavenger damage), SpaceX will report the incident to the NMFS Office of Protected Resources ((301) 427-8401) and the NMFS West Coast Region Stranding Coordinator ((562) 980-3230), within 24 hours of the discovery. SpaceX will provide photographs or video

footage or other documentation of the stranded animal sighting to NMFS. The cause of injury or death may be subject to review and a final determination by NMFS.

7. Modification and suspension

(a) This IHA may be modified, suspended or withdrawn if the holder fails to abide by the conditions prescribed herein, or if NMFS determines that the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals.

Donna S. Wieting,
Director,
Office of Protected Resources,
National Marine Fisheries Service.

NOV 30 2017

Date

Table 1. Numbers of Incidental Take of Marine Mammals Authorized

Species	Number of Takes by Level B Harassment Authorized
Pacific Harbor Seal	16,608
California Sea Lion	45,000
Northern Elephant Seal	2,724
Steller Sea Lion	240
Northern Fur Seal	3,000
Guadalupe Fur Seal	12

Table 2. Classifications of Levels of Pinniped Behavioral Disturbance on Land

Level	Type of response	Definition	Classified as behavioral harassment by NMFS
1	Alert	Head orientation or brief movement in response to disturbance, which may include turning head towards the disturbance, craning head and neck while holding the body rigid in a u-shaped position, changing from a lying to a sitting position, or brief movement of less than twice the animal's body length.	No
2	Movement	Movements in response to the source of disturbance, ranging from short withdrawals at least twice the animal's body length to longer retreats over the beach, or if already moving a change of direction of greater than 90 degrees.	Yes
3	Flush	All retreats (flushes) to the water.	Yes

APPENDIX D: Native American Tribal Consultation

From:	RYAN, CHRISTOPHER D GS-12 USAF AFSPC 30 CES/CEANC
To:	Freddie Romero; Marti, Duane@Parks
Cc:	Carroll, Ed@Parks; YORK, DARRYL L GS-13 USAF AFSPC 30 CES/CEIEA; KAISERSATT, SAMANTHA O CIV USAF AFSPC 30 CES/CEIEA
Subject:	RE: Question about flame trench catchment area at SLC-4 East
Date:	Wednesday, November 01, 2017 4:29:33 PM

Hi Freddie:

No apology necessary. Thank you for your reply.

Best, Chris

From: Freddie Romero [mailto:FRomero@santaynezchumash.org]
Sent: Wednesday, November 01, 2017 4:20 PM
To: RYAN, CHRISTOPHER D GS-12 USAF AFSPC 30 CES/CEANC <christopher.ryan.7@us.af.mil>; Marti, Duane@Parks <Duane.Marti@parks.ca.gov>
Cc: Carroll, Ed@Parks <Ed.Carroll@parks.ca.gov>; YORK, DARRYL L GS-13 USAF AFSPC 30 CES/CEIEA <darryl.york@us.af.mil>; KAISERSATT, SAMANTHA O CIV USAF AFSPC 30 CES/CEIEA <samantha.kaisersatt@us.af.mil>
Subject: [Non-DoD Source] Re: Question about flame trench catchment area at SLC-4 East

Chris,

I apologize, I thought that I responded to this already. I am ok with this project moving forward. Should any cultural material be discovered during the life of this project, the Elders Council would like to be notified.

Freddie Romero
Cultural Resources Coordinator
SYBCI Elders Council
805-688-7997
805-403-2873

**Notice of Privacy: This information is private & confidential. It is intended solely for the person or persons addressed herein. If you have received this communication in error, immediately notify the sender & destroy/delete any copies of this transmission. Thank you for your compliance. **

From: RYAN, CHRISTOPHER D GS-12 USAF AFSPC 30 CES/CEANC
Sent: Wednesday, November 01, 2017 3:49:57 PM
To: Marti, Duane@Parks; Freddie Romero
Cc: Carroll, Ed@Parks; YORK, DARRYL L GS-13 USAF AFSPC 30 CES/CEIEA; KAISERSATT, SAMANTHA O CIV USAF AFSPC 30 CES/CEIEA
Subject: RE: Question about flame trench catchment area at SLC-4 East

Hello Duane:

Thank you for checking in on this. Yes, we consulted with the Santa Ynez Band of Chumash Indians for this. Tribal member Charles Centeno monitored the fieldwork, and I sent Tribal

member Freddie Romero the same report I sent to you. I have not received comments back from the Mr. Romero yet. When I do, I will certainly forward them to you. But as you say, yes, consultation will be ongoing for the life of this project.
Respectfully, Chris

Hello Freddie:
If you have any questions regarding the SpaceX project to construct the water-deflection wall to the south of the SLC-4 East flame duct, please do not hesitate to contact me. May I request your comments via e-mail at your earliest possible convenience with a "cc:" that includes Mr. Duane Marti at the Office of Historic Preservation? Thank you in advance.
Respectfully, Chris

Christopher Ryan
Cultural Resources Mgmt
1028 Iceland Ave, Bldg 11146
VAFB, CA 93437-6010
805.605.0748

From: Marti, Duane@Parks [mailto:Duane.Marti@parks.ca.gov]
Sent: Wednesday, November 01, 2017 2:26 PM
To: RYAN, CHRISTOPHER D GS-12 USAF AFSPC 30 CES/CEANC <christopher.ryan.7@us.af.mil>
Cc: Carroll, Ed@Parks <Ed.Carroll@parks.ca.gov>
Subject: [Non-DoD Source] Question about flame trench catchment area at SLC-4 East

I did not see any mention of USAF consulting with the tribe on this project. Did I overlook that section or it tribal consultation an on-going process?

Duane Marti
Archaeologist
Office of Historic Preservation
1725 23rd Street, Suite 100
Sacramento, California 95816
Telephone: 916-445-7030

APPENDIX E: Air Quality & Climate Analysis

	Equipment	Number of Days	Number of Equipment	Hours per Day	Horse-power	Load Factor	TOG	ROG	CO	NOX	SO2	PM10	PM2.5	CO2	CH4
							Emissions per Year (Tons)								
Grading	Dozer	2	1	1	255	0.4	0.0001671	0.00014	0.001189	0.001573	1E-06	7.32E-05	6.73E-05	0.104715	3.2E-05
	Concrete/Industrial Saw	2	1	8	81	0.73	0.0059007	0.000587	0.003425	0.004193	5.68E-06	0.000315	0.000315	0.537657	5.2E-05
	Tractors/Loaders/Backhoes	2	2	6	98	0.37	0.0005572	0.000468	0.003317	0.004475	4.26E-06	0.000345	0.000317	0.444993	0.00013
	Graders	2	1	8	175	0.41	0.0011062	0.00093	0.004496	0.009471	5.74E-06	0.000532	0.00049	0.592518	0.00018
	Cement and Mortor Mixer	1	1	8	9	0.56	4.338E-05	2.67E-05	0.00014	0.000167	3.23E-07	6.73E-06	6.73E-06	0.022914	2.4E-06
	Compressor	1	1	8	78	0.48	0.0037793	0.000223	0.001139	0.001435	1.8E-06	0.000119	0.000119	0.170217	2E-05
Wall Construc-tion	Mortor Mixer	28	4	6	9	0.56	0.0036443	0.002242	0.011749	0.014066	2.71E-05	0.000566	0.000566	1.924764	0.0002
	Pumps	28	4	6	84	0.74	0.5832975	0.025481	0.147161	0.187053	0.000251	0.013576	0.013576	23.73871	0.0023
	Concrete/Industrial Saw	28	1	8	81	0.73	0.0826098	0.008212	0.047947	0.058702	7.95E-05	0.004411	0.004411	7.527202	0.00073
	Generator Set	28	1	8	84	0.74	0.1648583	0.008118	0.048302	0.061404	8.35E-05	0.004302	0.004302	7.912904	0.00072
	Tractors/Loaders/Backhoes	28	2	8	98	0.37	0.0104016	0.00874	0.061915	0.083535	7.96E-05	0.006431	0.005918	8.306543	0.0025
Retention Basin	rs/Backhoes	14	2	8	98	0.37	0.0052008	0.00437	0.030958	0.041767	3.98E-05	0.003216	0.002959	4.153272	0.00125
	Excavator	14	1	8	163	0.38	0.0029518	0.00248	0.021906	0.028311	3.4E-05	0.001393	0.001281	3.513698	0.00106

	Vehicle	Number of Days	Number of Vehicles	Number of	Miles per		rs (	TOG	ROG	CO	NOX	SO2	PM10	PM2.5	CO2	CH4
								Emissions per Year (Tons)								
Construction Worker Trans-portation	LDA	60	3	2	14.7			7.541E-05	5.42E-05	0.002363	0.000201	1.58E-05	1.35E-05	1.24E-05	1.575057	
	LDT1	60	2	2	14.7			5.158E-05	3.71E-05	0.001612	0.000138	1.14E-05	9.02E-06	8.3E-06	1.142081	
	LDT2	60	1	2	14.7			3.159E-05	2.28E-05	0.000905	8.19E-05	6.67E-06	4.51E-06	4.15E-06	0.666909	
								0.00016	0.00011	0.00488	0.00042	0.00003	0.00003	0.00002	3.38405	

Total Construction Emissions

TOG	ROG	CO	NOX	SO2	PM10	PM2.5	CO2	CH4
0.8646765	0.06213	0.388524	0.496572	0.000647	0.035312	0.034352	62.33416	0.00919

Fugitive Dust Analysis	Grading Equipment Passes	Acreage	Blade Width (ft)					Number of Passes	VMT per Pass	Number of Grading Vehicles	PM10 Emissions (tons)	PM2.5 Emissions (tons)
		0.25	12					2	0.172	4	0.00106	6.3E-05
	Bulldozing	Hours of Bulldozing									PM10 Emissions (tons)	PM2.5 Emissions (tons)
		2									0.000475	0.000656
								Total Fugitive Dust Generation			0.001535	0.000719

Assume 15 construction workers carpooling in vehicles with 2-3 workers per vehicle to give 6 vehicles
Assume all vehicles and equipment are from 2016
Assume all construction takes place within two months in 2018
Assume less than 1 acre of impact
Assume Shotcrete application is performed during grading and site preparation
Assume shotcrete uses an air compressor and a cement and mortor mixer
Assume Grading Acreage of 0.25 acres
Assume 14 days for digging retention pond and 14 days for laying concrete in retention pond
Assume all default numbers provided in CalEEMod Appendices

VAFB 2011 EA

Operations	ROG	NO_x	CO	SO_x	PM_{10}	$PM_{2.5}$
Employee Vehicles	0.79	1.47	13.99	0.01	0.08	0.08
Operations Deliveries	0.03	0.48	0.14	0	0.02	0.02
Emergency Genera	0.18	2.23	0.48	0.15	0.16	0.16

VAFB 2017 - 12 launches per year

Operations	ROG	NO_x	CO	SO_x	PM_{10}	$PM_{2.5}$
Employee Vehicles	0.948	1.764	16.788	0.012	0.096	0.096
Operations Deliveries	0.036	0.576	0.168	0	0.024	0.024
Emergency Genera	0.216	2.676	0.576	0.18	0.192	0.192

VAFB 2011 EA

Scenario/Activity	Total Metric Tons			
	CO_2	CH_4	N_2O	CO2e
Operations				
Transit Employee vehicles	790	0.1	0.13	830
Emergency Generators	75	0	0	75
Operations Deliveries	55	0	0.04	67

Scenario/Activity	Total Metric Tons			
	CO_2	CH_4	N_2O	CO2e
Operations				
Transit Employee vehicles	948	0.12	0.156	997
Emergency Generators	90	0	0	75
Operations Deliveries	66	0	0.048	67

APPENDIX F: Monitoring and Minimization Plan for the Boost-Back and Landing for the Falcon 9 Full Thrust First Stage at SLC-4 West

Monitoring and Minimization Plan for the Boost-Back and Landing of the Falcon 9 Full Thrust First Stage at SLC-4 West at Vandenberg Air Force Base, California

20 November 2017

Prepared for:

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and

30th Space Wing, Installation Management Flight
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1 Project Description

1.1 Introduction and Project Overview

Vandenberg Air Force Base (VAFB or Base) submitted a biological assessment (BA) on behalf of Space Exploration Technologies Corporation (SpaceX) to the United States Fish and Wildlife Service (USFWS) on 13 June 2017, requesting Section 7 consultation for potential effects of a proposed Falcon 9 project on the federally endangered California condor (*Gymnogyps californianus*) and California least tern (*Sterna antillarum browni*), the federally threatened California red-legged frog (*Rana draytonii*), marbled murrelet (*Brachyramphus marmoratus*), western snowy plover (*Charadrius alexandrinus nivosus*), and southern sea otter (*Enhydra lutris nereis*), and critical habitat for these species, if designated. An overview of the proposed project is presented below. A full description can be referenced in the biological assessment (ManTech SRS Technologies, Inc. 2017).

1.1.1 Project Overview

The proposed project consists of the launch, boost-back, and landing of the Falcon 9 first stage at Space Launch Complex 4 West (SLC-4W) on VAFB in Santa Barbara County. SpaceX proposes to return the first stage of the Falcon 9 rocket to SLC-4W for potential reuse up to 12 times per year (maximum of once per month). Engine noise would be produced during Falcon 9 launch and landings (Figures 1-1 and 1-2). SpaceX proposes to use a three-engine thrust landing for some boost-back events. A three-engine thrust landing would generate engine noises of up to 110 A-weighted decibels (dBA). The engine noise would be primarily within the vicinity of SLC 4 and would attenuate below 80 dBA at approximately 8 mi. (12.9 km) from SLC-4 (Bradley, 2016; Figure 1-2).

The trajectory of the Falcon 9 first stage would be either westward or southward from SLC-4 depending on the payload's orbital mission. During ascent, a sonic boom (overpressure of high-energy impulsive sound) up to 3.0 pounds per square foot (psf) may be generated at the Northern Channel Islands (NCI). After the first stage engine cutoff, exoatmospheric cold gas thrusters would be triggered to flip the first stage into position for retrograde burn. Three of the nine first stage Merlin engines would be restarted to conduct the retrograde burn to reduce the velocity of the first stage and to place the first stage in the correct angle to land. Once the first stage is in position and approaching its landing target, the three engines would be cut off to end the boost-back burn. The first stage would then perform a controlled descent using atmospheric resistance to slow the stage down and guide it to the landing pad target.

During the descent, a sonic boom would be generated while the first-stage booster is supersonic. The USAF predicts overpressures as high as 8.5 psf at SLC-4W, which would attenuate to levels below 2.0 psf at approximately 5.5 miles (mi.) (8.9 kilometers [km]) and below 1.0 psf at approximately 15.97 mi. (25.7 km) from the landing area (Figure 1-3). In addition, the USAF is estimating that the NCI may be impacted by a sonic boom of up to 3.1 psf during the return flight based on the higher of the two predictions between the model run by Wyle and Blue Ridge Research Consultation (James et al., 2017).

In addition to acoustic impacts, SpaceX has determined that up to 200,000 gallons of water would be required in the flame duct to reduce vibration impacts on payloads for certain missions. This would result in a release of water and vapor into Spring Canyon. A majority of this water would flow overland into Spring Canyon. A much lesser quantity of water would be ejected through the air directly into Spring Canyon. In order to reduce impacts to Spring Canyon, SpaceX would install a civil structure to help capture and divert any water that would flow overland and potentially enter Spring Canyon. This water would be contained in a newly constructed 60,000-gallon capacity retention basin and subsequently pumped to the existing spray field for discharge of similar waters. After launch operations, the water in the retention basin would be removed to below 4 inches in depth within 48 hours to reduce chances of attracting frogs and other animals.

Even despite the civil structure, some water is expected to be discharged to Spring Canyon. To consider the worst-case scenario it is assumed that up to 25,000 gallons of liquid water could reach Spring Canyon. The maximum temperature of the water and water vapor is expected to be up to 130 degrees Fahrenheit (ºF) by the point at which it would reach Spring Canyon. SpaceX plans to remove all vegetation to just above ground level within a 3.327-acres (ac.) (1.346-hectares [ha]) impact area of Spring Canyon (Figure 1-4) to avoid and minimize impacts to nesting migratory birds. Removal of the vegetation would be performed by mowers and hand equipment prior to nesting bird season and attempts would be made to reduce impacts to the drainage as much as possible. Additional vegetation removal (e.g., mowing) of the impact area would be performed outside of nesting bird season annually as needed to maintain low stature vegetation.

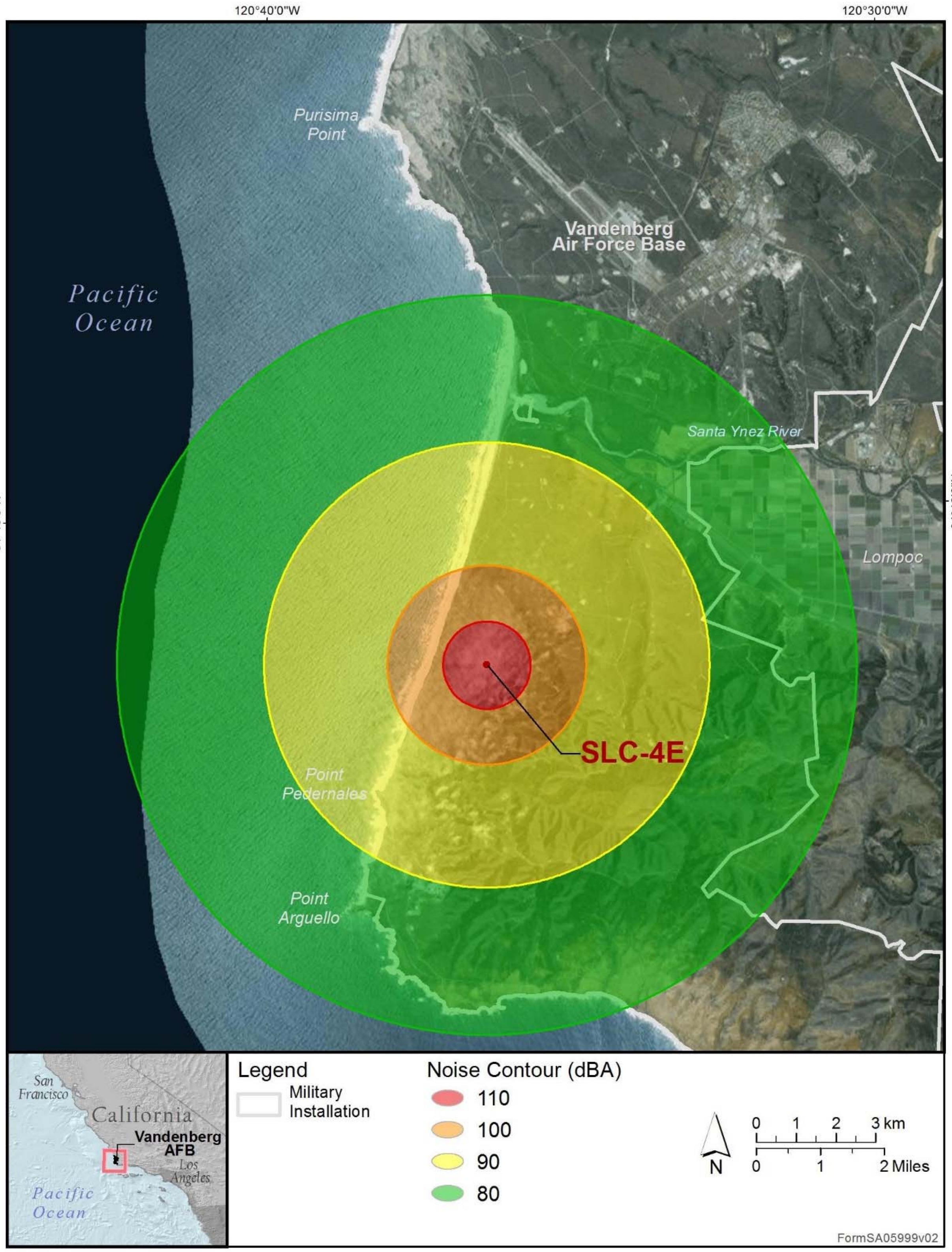

Figure 1-1. Estimated launch noise of Falcon 9 First Stage at SLC-4.

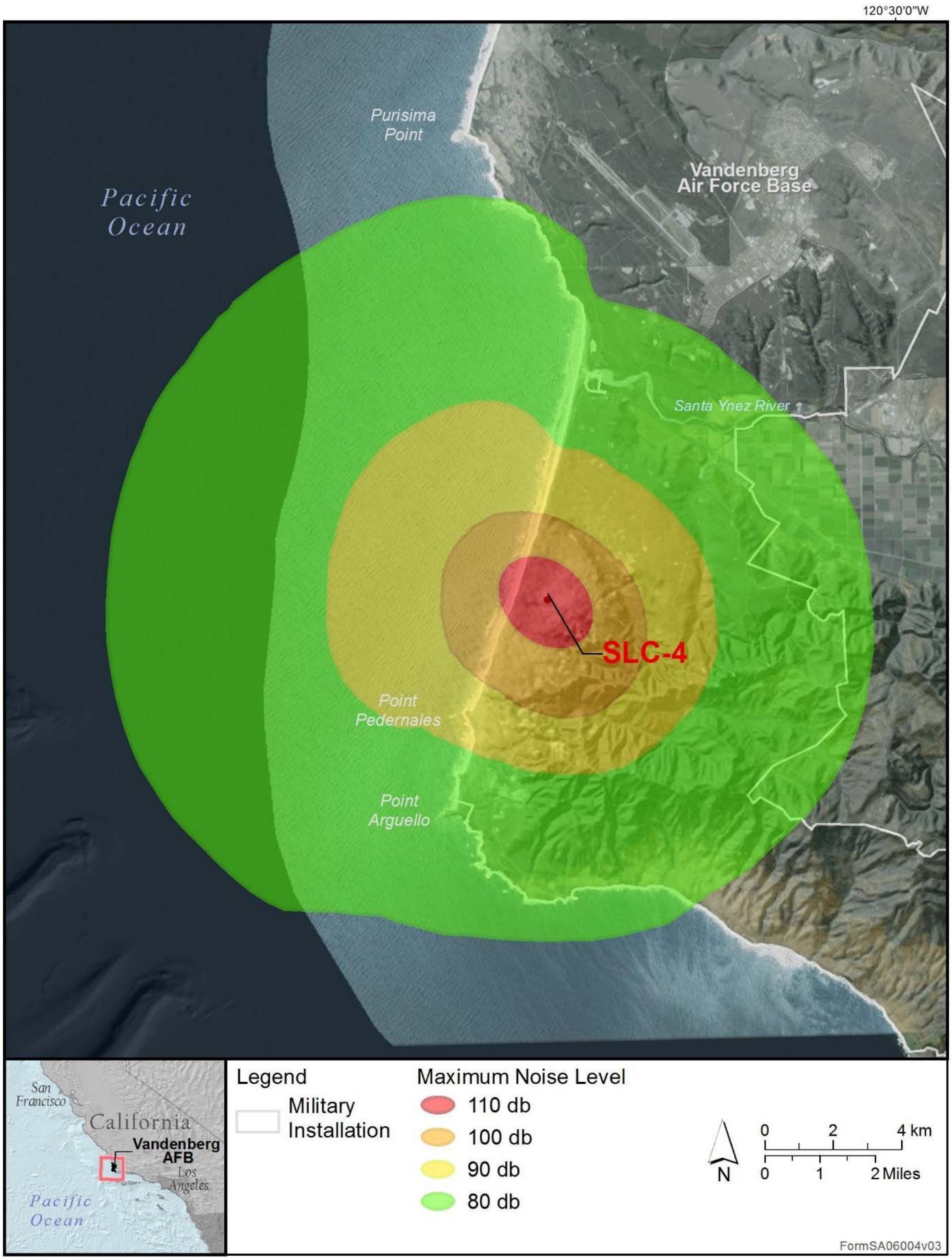

Figure 1-2. Estimated landing noise of Falcon 9 First Stage at SLC-4.

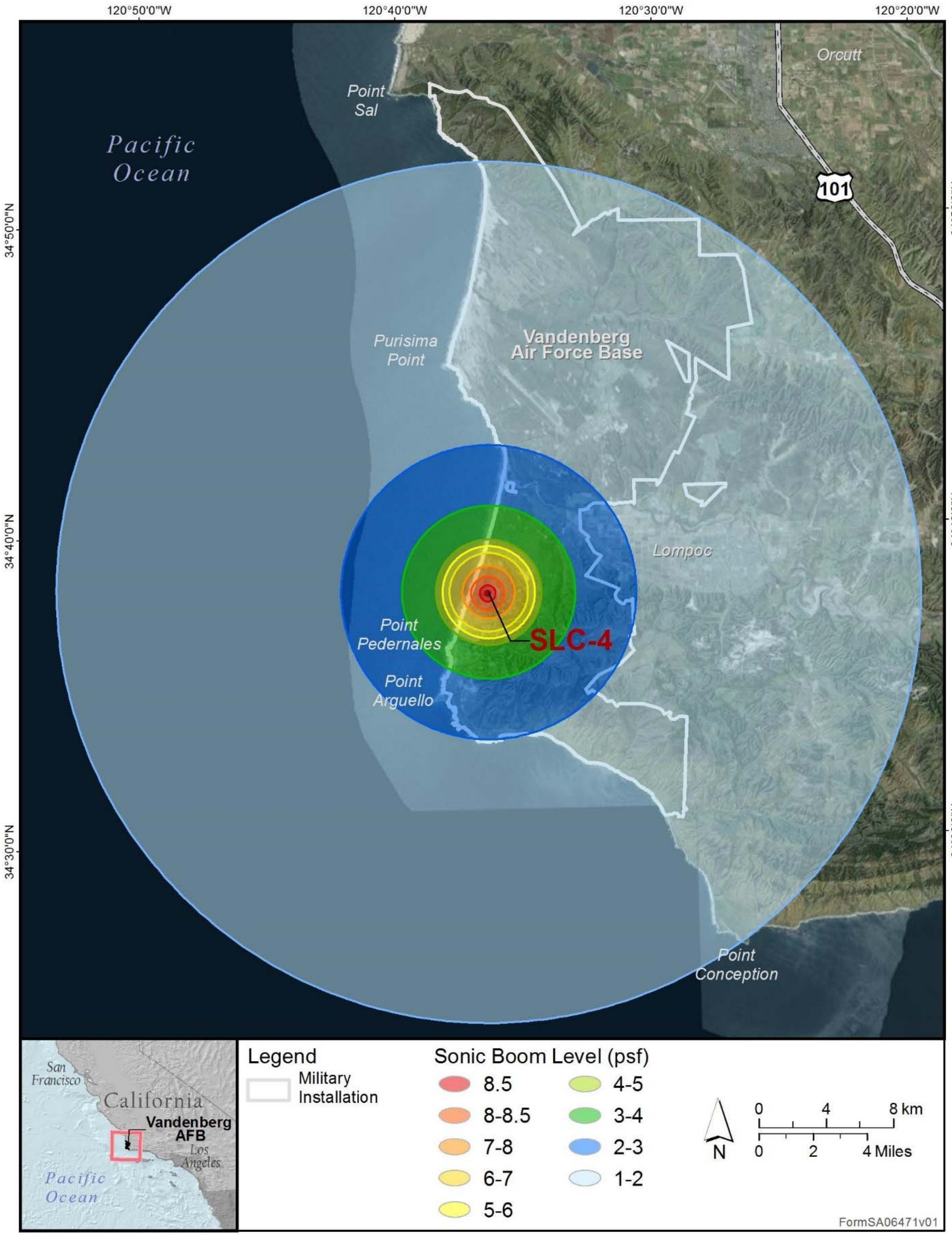

Figure 1-3. Estimated sonic boom of Falcon 9 Landing First Stage at SLC-4.

Figure 1-4. Spring Canyon civil structure and vegetation removal area.

2 Monitoring and Minimization Plan

2.1 El Segundo Blue Butterfly

2.1.1 Flight Season Surveys

On an annual basis, the condition of stands of seacliff buckwheat in the areas surrounding SLC-4 would be evaluated for likelihood to support ESBB, based largely on plant maturity, density, and flowering conditions. Sites consistently supporting high numbers of mature seacliff buckwheat plants would be prioritized for ESBB flight season surveys. Four surveys would be conducted each season, timed to coincide with the beginning, middle, and end of flight season as observed at nearby known occupied localities on south VAFB. Three of the surveys would target adult ESBB. These surveys would be spaced at least one week apart and take place when seacliff buckwheat are in the late bud to early senescent stages. These surveys would be conducted between 9 am and 6 pm local time, at temperatures of at least 60 degrees, average windspeeds of under 10 miles per hour, and no rain or wet fog conditions. The fourth survey would focus on larval detection. It would be timed such that seacliff buckwheat is in the late peak to early senescent stage or when larvae have been detected in adjoining occupied habitat. This survey would be timed to occur when average wind speeds do not exceed 15 mpg and no rain or wet fog is present.

Larval detections would be reliant of using tending ants to locate ESBB larvae within flowerheads. At sustained high wind speeds, ant activity on flowerheads is reduced. The surveyor's ability to detect smaller ant species is also hampered by plant movement in high winds. Ants will, however, remain active at temperatures below 60 degrees and though the night.

In addition, historically occupied habitat on Avery Road, Bear Creek, and Coast Roads would be surveyed at least once annually during the ESBB flight season when seacliff buckwheat is in early to late peak bloom or ESBB are determined to be active in adjoining areas. These surveys will act as a comparative indicator of ESBB emergence timing and density in the general area and would also be conducted between 9 am and 6 pm local time, at temperatures of at least 60 degrees, average windspeeds of under 10 mph, and no rain or wet fog conditions.

Monitoring would be conducted for at least three years. If ESBB are found in the area experiencing, sonic booms in excess of 5 psf, or if ESBB occupancy is re-established and potential launch or landing related impacts are detected in the Avery Road and Bear Creek and Coast Road sites, additional monitoring may be conducted.

2.1.2 Habitat Enhancement

ESBB habitat enhancement would be conducted within suitable ESBB habitat on Tranquillon Ridge along Honda Ridge Road adjacent to two existing ESBB restoration efforts (Figure 2-1). Habitat enhancement would occur through a combination of invasive plant removal and planting seacliff buckwheat. Habitat would be enhanced and seacliff buckwheat planted at a 2:1 ration: area of habitat enhanced through invasive plant removal to area of potential ESBB habitat impacted, and number of seacliff buckwheat propagated and planted to number of seacliff buckwheat impacted.

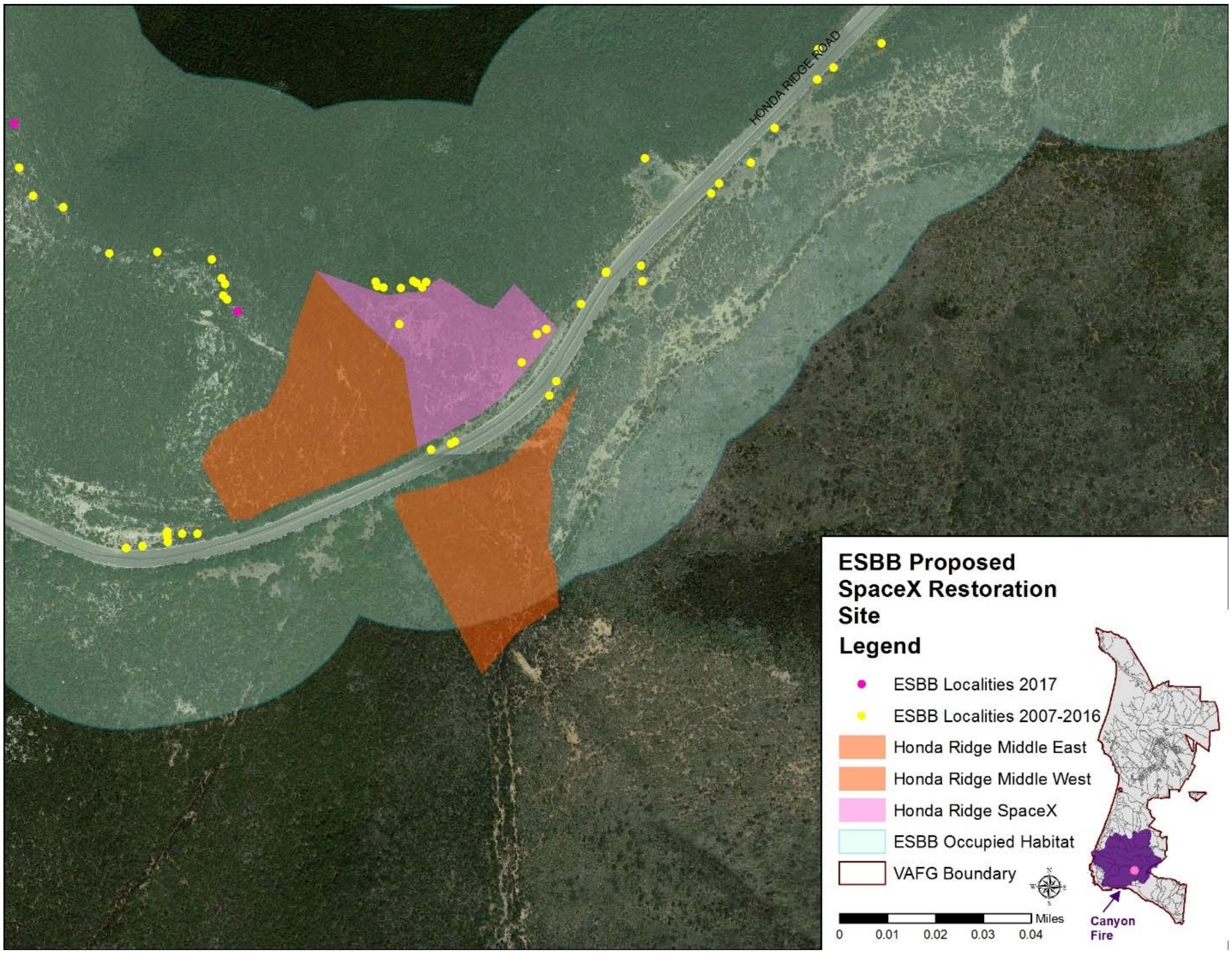

Figure 2-1. ESBB restoration site, designated as "Honda Ridge SpaceX"

To calculate area to be restored, the number of seacliff buckwheat plants destroyed, damaged, or disturbed due to the proposed action would be recorded. Site surveys in 2017 estimated that a total of 258 buckwheat would be removed during vegetation clearing. The Spring Canyon Fire occurred on 19 August 2017 and 29 of these plants were destroyed (Figure 2-2). Therefore, it is currently estimated that 229 remaining buckwheat would be impacted. Any activity leading to soil disturbance or compaction within 1 m of a seacliff buckwheat plant would be considered a disturbance due to its potential to impact pupae within the root or debris zone of the plant. For every seacliff buckwheat plant impacted, a value of 3.14 m^2 would be assessed (calculated by applying a 1-m buffer centered on the seacliff buckwheat). This would determine the area to be restored.

Within the restoration area, invasive weeds would be treated using the most appropriate herbicide for the task:

- Milestone VM – 6-8 ounces per acre with 0.5 percent Dyne-Amic surfactant and 0.5 percent blue dye;
- Glyphosate-based herbicide – 2 percent solution with non-ionic surfactant and 0.5 percent blue indicator dye;

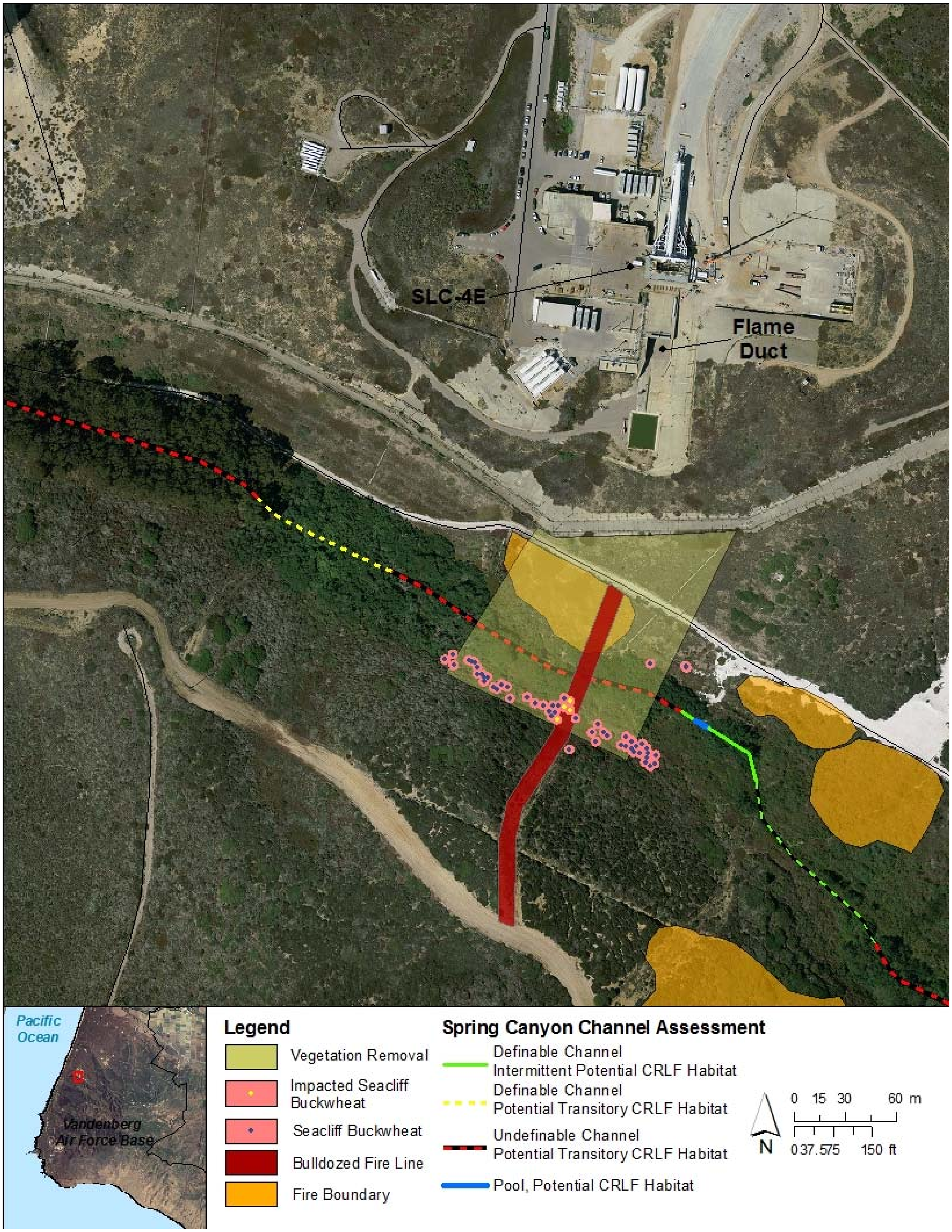

Figure 2-2. Seacliff buckwheat in vegetation clearing area and Spring Canyon Fire impacts.

- Clethodim – 0.25 to 0.5 percent solution with non-ionic surfactant at 0.25 percent and 0.5 percent blue indicator dye.

The following measures will be implemented to reduce the risk of impacts to seacliff buckwheat and ESBB:

- Individuals trained and proficient in seacliff buckwheat identification would conduct all herbicide applications.
- Seacliff buckwheat would be avoided during herbicide application with plants covered to prevent drift if broad spectrum herbicide application is necessary adjacent to plants.
- Herbicide treatments would occur under low wind conditions.
- Herbicide application would take place outside of the ESBB flight season (1 June – 15 September) when adults or larvae may be present.

Seacliff buckwheat would be propagated from seed sourced on south VAFB in long containers, suchs as “cone-tainers” which are at least 7 inches deep, to promote good root development. Seacliff buckwheat would be grown organically (no insecticides would be applied to plants or soil) and be free of invasive invertebrates (i.e. argentine ants).

Seacliff buckwheat plantings would be installed during the wet season (1 December – 15 March) with an estimated completion date of 31 March 2017 and will be funded and implemented by SpaceX. During this period naturally moist soil conditions and precipitation will aid in establishment. If rain is not forecast with more than 60 percent certainty within three days of planting, plants should be watered at the time of installation. This supplemental watering will create good contact between the roots and native soil increasing the likelihood of successful establishment.

2.2 California Red-legged Frog

In addition to the minimization and monitoring measures described in the BA, the effect of sonic boom on breeding behavior will be studies by using bioacoustics data loggers to study calling behavior during breeding season.

2.2.1 Study Area

Spring Canyon, immediately south of SLC-4 contains suitable upland habitat for CRLF, but lacks areas of sufficient surface water to support breeding or perennial CRLF occupancy. Due to the lack of perennial water and consistent occupancy and the unlikelihood of breeding, or even observing CRLF in Spring Canyon, the study will instead be focused on Canada Honda. Canada Honda is the closest drainage to SLC-4 that consistently supports CRLF, has documented breeding, and is readily accessible to surveyors without significant habitat modification. In addition, prior studies of CRLF in Canada Honda provide some baseline information about potential breeding locations. Although there is no directly comparable site to Canada Honda, upper Shuman Creek will be studied as the most appropriate comparable site to be used a control population and account for potential confounding factors that may influence breeding behavior.

2.2.2 Methods

Increased disturbance in Canada Honda as a result of sonic boom may result in a reduction in non-essential behaviors, such as male calling to attract mates during breeding season (potentially November to March). To determine whether this is impact occurs, bioacoustic monitoring would be conducted during the breeding season in Canada Honda and Shuman Creek. Similar bioacoustic monitoring of anuran populations is currently being conducted by Dr. Aaron Rice and associated researchers at Cornell University. Dr. Rice was consulted for the development of this monitoring protocol, will construct the monitoring devices, provide training on proper deployment and maintenance, and train local biologists on analyzing these data.

Acoustic data would be collected by deploying recording devices at CRLF breeding pools within the respective drainages. These devices would record the frequency, number, and volume of calls. Pre-surveys would be conducted to identify locations of calling males in these drainages and determine where bioacoustic monitoring units should be deployed. Shuman Creek would serve as a control site. CRLF in Shuman Creek would be subjected to the same monitoring related disturbance as CRLF in Canada Honda, but would not be subjected to intense launch noise and sonic booms.

To conduct monitoring, up to a total of 4 bioacoustic recording units would be deployed in Canada Honda and Shuman Creek. Units would be deployed and operated during the first wet season launch, between 30 November to 1 April. Units may be temporarily removed if it is predicted that high rainfall, likely to cause high flow events, may impact these watersheds. During periods of high flow, CRLF temporarily escape creeks and move into upland habitats therefore it is unlikely that temporarily removing these units will result in a loss of breeding data.

2.2.3 Spring Canyon Monitoring

A qualified biologist would conduct pre-activity surveys for CRLF in Spring Canyon adjacent to SLC-4 and would conduct post-activity surveys to document any injured or killed individuals. If present within the area to be impacted by water and water vapor, adult CRLF would be captured when possible and released at the nearest suitable habitat within Spring Canyon, outside of the impact zone.

One day prior to vegetation removal in Spring Canyon, a qualified biologist would conduct surveys for CRLF within the area to be affected. Any CRLF present would be captured if possible and released at the nearest suitable habitat within Spring Canyon outside of the area to be affected by vegetation removal, as determined by the biologist. Because ground conditions change depending on rainfall and season, this location cannot be identified in advance. The monitor would also be present during vegetation removal to capture and relocate CRLF that are encountered during the mowing activities to the extent that safety precautions allow. This monitor would also search for injured or dead CRLF after vegetation removal to document take.

During construction of the civil water diversion structure, the following measures will be implemented:

- All work would occur during daylight hours during periods when there is no rainfall.
- A qualified biologist would monitor grading of the gunite application site.
- Any open holes or trenches would be covered with plywood or metal sheets if left over night to minimize the risk of entrapment of CRLF.
- A qualified biologist would survey the site, including any open holes or trenches, each day prior to initiation of work.
- Any CRLF encountered during construction of the civil water diversion structure would be captured, if possible, and relocated out of harm’s way to the nearest suitable habitat.

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2.3 California Least Tern

2.3.1 Direct Monitoring

Monitoring of breeding California least terns (LETE) at the Santa Ynez River estuary would be conducted by qualified individuals for boost-back and landings at SLC-4W that occur when California least terns are present (typically 15 April to 15 August). These data would be used to determine if the proposed action had an effect on habitat use patterns within the impact area or results in any mortality, injury, or abnormal behavior. If terns are present at the Santa Ynez River estuary, a USFWS approved biologist would:

- Conduct daily counts of LETE beginning three days before the boost-back and landing event through three days after.
- If practicable and not resulting in safety concerns to the monitor, visual and/or video monitoring terns during boost-back landing would be conducted for daytime launches.
- Acoustic recording equipment would be deployed at or near the monitoring location to document and quantify the level of the sonic boom.

If active tern nests are present at the Purisima Point nesting colony:

- Motion triggered video cameras would be placed at up to 10 percent of active nests to monitor potential impacts to the nest as a result of the launch and landing.
- Acoustic recording equipment would be deployed at or near the monitoring location to document and quantify the level of the sonic boom.

2.3.2 Tern Rehabilitation

If LETE eggs or chicks are abandoned or directly impacted and injured by launch activities, these animals would be transferred to the Monterey Bay Aquarium for rehabilitation to the extent possible by USFWS qualified individuals. During the nesting season, an incubator will be on standby operated by qualified individuals at Point Blue to receive abandoned eggs or chicks and safely transport them to the Monterey Bay Aquarium for rehabilitation. This requirement would be reviewed and adapted or eliminated if necessary depending on reviewing the number of eggs/chicks/adults requiring rehabilitation after the first year of activity.

2.4 Western Snowy Plover

2.4.1 Direct Monitoring

Monitoring of western snowy plovers (SNPL) would be conducted for Falcon 9 boost-back and landing at SLC-4 between 1 March and 30 September. Monitoring of nesting SNPL would be conducted three days before and three days after the boost-back and landing event on South Surf Beach to characterize potential impacts on SNPL reproductive success.

Up to 10 percent of active SNPL nests would be monitored with motion triggered video cameras for potential impacts to the nest as a result of the launch and landing. Acoustic recording equipment would be deployed at or near the monitoring location to document and quantify sonic boom levels. In addition, VAFB will continue to perform proactive annual management and monitoring of SNPL on Base, including habitat enhancement to expand potential breeding habitat, population monitoring, nest monitoring, and predator management.

2.4.2 Plover Rehabilitation

If SNPL eggs or chicks are abandoned or directly impacted and injured by launch activities, these animals would be transferred to the Santa Barbara Zoo for rehabilitation to the extent possible by USFWS qualified individuals. During the nesting season, an incubator will be on standby operated by qualified individuals at Point Blue to receive abandoned eggs or chicks and safely transport them to the Santa Barbara Zoo for rehabilitation. This requirement would be reviewed and adapted or eliminated if necessary depending on reviewing the number of eggs/chicks/adults requiring rehabilitation after the first year of activity.

2.5 California Condor

Movements of California condor would be monitored in the vicinity of VAFB, if present, via satellite telemetry during launch and landing events to determine whether launch and boost-back had an effect on movement patterns within the Action Area. Determination of presence will be coordinated with Ventana Wildlife Society, USFWS Condor Recovery Coordinator beginning two weeks in advance of each launch event at SLC-4W. If condor(s) are determined to be present and more than infrequent or determined to have an impact from the Proposed Action reinitiation with the USFWS may be necessary.

2.6 Marbled Murrelet

Population surveys would continue to be conducted at the current levels performed by VAFB. If the results of these annual seabird surveys show that marbled murrelet are more frequently observed on Base or within the Action Area, reinitiation may be required.

2.7 Southern Sea Otter

A USFWS-approved biologist would monitor southern sea otters for boost back and landing events at SLC-4W whenever a sonic boom of 2 psf or greater is predicted to be generated by the boost-back that would impact southern sea otter habitat. The monitoring location would be selected based on where pressure waves greater than 2 psf are predicted to impact and the relation of these locations to occupied sea otter habitat, which is commonly Sudden Flats on South VAFB. The biologist would conduct daily counts of sea otters at the selected monitoring location beginning three days before and continuing three days after the boost-back and landing. The monitor would note any mortality, injury, or abnormal behavior observed during these counts. Weather permitting, the counts would be conducted between 09:00 AM and 12:00 PM local time when otters are most likely to be rafting. This would maintain daily consistency in detectability between counts. Monitors would use both binoculars (10X) and a high-resolution 50–80X telescope to conduct counts. Acoustic recording equipment would be deployed at or near the monitoring location to document and quantify sonic boom levels.

Regular otter counts are currently conducted by the United States Geological Survey (USGS). If USGS surveys or other non-related survey efforts, show the establishment of new populations within the Action Area, new survey locations would be considered for boost-back and landing events.

3 References

Bradley, K.A. 2016. Noise Assessment of Falcon 9 (3 Engine Thrust) Landing at Vandenberg AFB. Wyle Technical Note TN 16-15. May 2016. 13 pp.

James, M., Salton, A., and M. Downing. 2017. *Technical Memo Sonic Boom Study for SpaceX Falcon 9 Flybacks to CCAFS and VAFB.* Asheville, North Carolina: Blue Ridge Research and Consulting. Prepared for Space Exploration Technologies.

APPENDIX G: Spring Canyon Restoration Plan

Spring Canyon Riparian Mitigation and Monitoring Plan for the Falcon 9 Launch and Landing Program at SLC-4 at Vandenberg Air Force Base, California

27 November 2017

Prepared For:

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Table of Contents

1 Project Description

1.1 Responsible Parties

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1.2 Project Location and Introduction

This Mitigation and Monitoring Plan (MMP) provides the concepts and direction for implementation and maintenance of mitigation required to compensate for impacts to California State Waters in Spring Canyon associated with Space Exploration Technologies Corporation's (SpaceX) Falcon 9 launch and landing program at Space Launch Complex 4 (SLC-4) on Vandenberg Air Force Base (VAFB).

Spring Canyon is located on VAFB in Santa Barbara County, California (Figure 1-1), and is found within the United States Geological Survey Surf and Tranquillon Mountain, California 7.5-minute topographic maps. Spring Canyon has a poorly defined channel through most of the drainage due to little or no surface flow within channel in most years. The site is dominated by a combination of non-native tree stands, willow riparian vegetation, and upland vegetation communities.

As a necessary component of the Falcon 9 program, riparian vegetation will be removed from a small portion of Spring Canyon and water will be released into the drainage (Figure 1-2). As a result, the Air Force developed and will implement this MMP. To mitigate impacts to California State Waters, riparian restoration will take place within the drainage. Invasive species control will occur within the bed and bank of Spring Canyon and native riparian plantings will occur at the base of Spring Canyon (Figure 1-3). Details are described below.

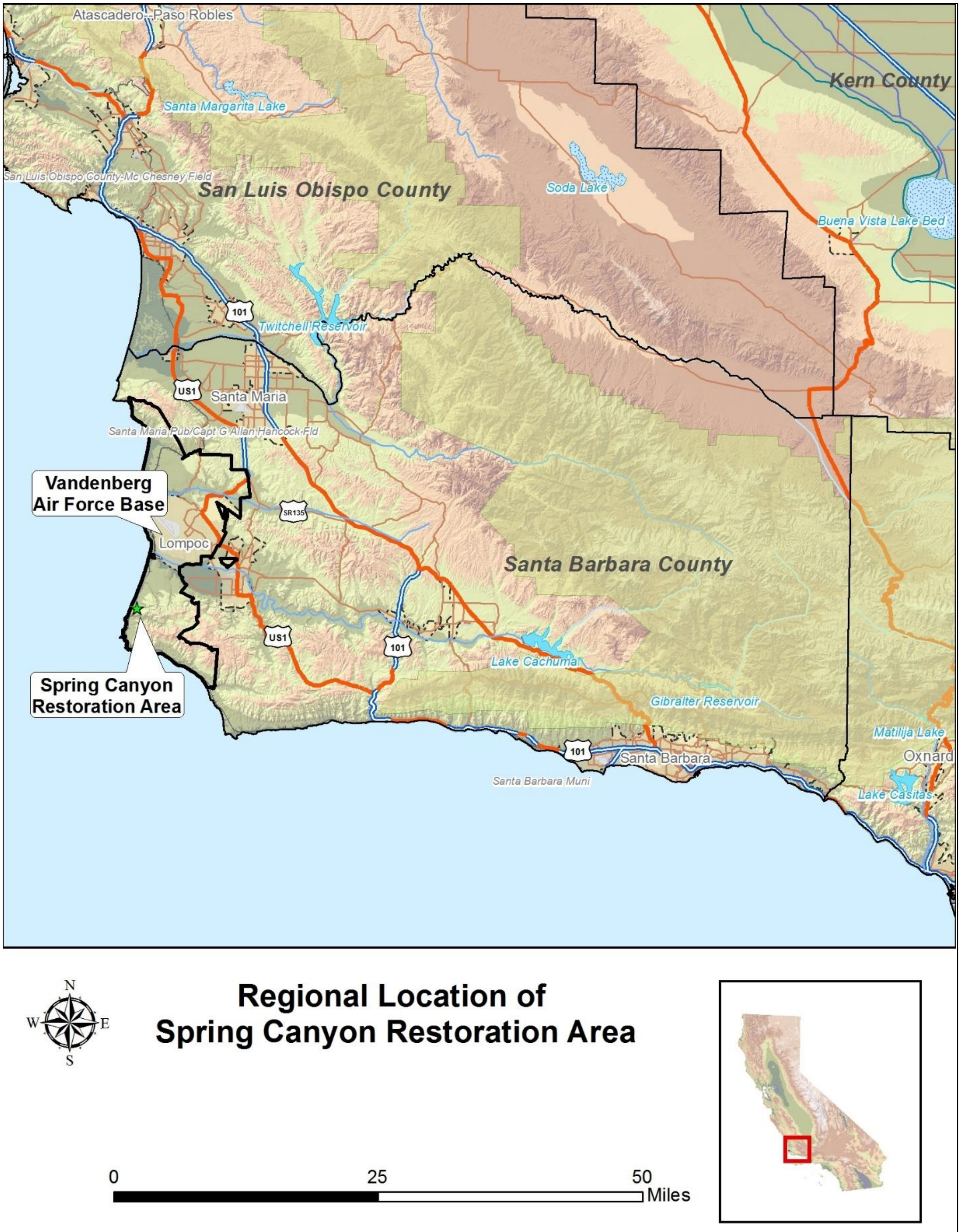

Figure 1-1. Regional Overview.

1.3 Project Summary

As part of the proposed changes to the Falcon 9 program at SCL-4 at VAFB, a maximum of 200,000 gallons of water would be required in the flame duct at SLC-4E to achieve vibration requirements for certain missions. During the Cassiope Mission in September 2014, when a similar amount of water was present in the flame duct, there was an unanticipated release of water into Spring Canyon. Upon evaluation of the flow path of the water, it was determined that a majority of this water flowed overland on its path to Spring Canyon. It was also determined that a much lesser quantity of water was ejected through the air directly into Spring Canyon.

In order to reduce impacts to Spring Canyon, SpaceX would install a civil water diversion structure to help capture and divert any water that would flow overland and potentially enter Spring Canyon. This water would be contained in a newly constructed 60,000-gallon capacity retention basin and subsequently pumped to an existing spray field for discharge with similar waters. Water containing prohibited chemical levels would be removed and hauled to an approved industrial wastewater treatment facility outside of VAFB. The ground cloud formed by the steam during a launch would not contain any hazardous materials.

Even despite the civil structure, some liquid water may reach Spring Canyon. It is difficult to evaluate exactly how much water would be discharged to Spring Canyon during launches. Based on the Cassiope Mission, it is estimated that of the 200,000 gallons of water placed in the flame duct, half of this volume would remain in the flame duct and half would be expelled as water and water vapor. Approximately 25,000 gallons of water would be expelled as steam, with the remaining 75,000 gallons expelled as liquid water. The civil structure would be designed to capture the majority of the water to the extent possible, but some water would be discharged to Spring Canyon. To consider the worst-case scenario, it is assumed that up to 25,000 gallons of liquid water could reach Spring Canyon during each launch event. Water discharged as part of this action would meet the thresholds identified by the California State Water Resources Control Board (SWRCB) in the statewide low threat discharge to surface waters permit.

SpaceX would remove all vegetation to just above ground level within a 3.327-acres (ac.) impact area of Spring Canyon (Figure 1-2) to avoid and minimize impacts to nesting migratory birds. Removal of the vegetation would be performed by mowers and hand equipment prior to nesting bird season and attempts would be made to reduce impacts to the drainage as much as possible. Additional vegetation removal (e.g., mowing) of the impact area would be performed outside of nesting bird season (15 February to 15 August) annually as needed to maintain low stature vegetation

Vegetation removal will result in an estimated 1.121 acres of permanent impacts to willow riparian habitat. To offset these impacts, the SWRCB requires mitigation at a 2:1 ratio: area of habitat enhanced through restoration and invasive species control to area of riparian woodland impacted. This mitigation would be accomplished by treating at least 2.5 acres of the riparian restoration at the base of Spring Canyon drainage near Coast Road beyond SLC-4 (Figure 1-3). This area is herein referred to as the Spring Canyon Restoration Area.

1.4 Jurisdictional Areas within the Project Area

A delineation of jurisdictional areas within Spring Canyon has not been conducted. The National Wetlands Inventory has designated this creek as a freshwater forested/shrub or freshwater emergent wetland, which is a biological delineation, not a jurisdictional delineation. The VAFB 2016 geodatabase “wetland_area_cal” feature class identifies two palustrine wetlands within the project area (Figure 1-3).

1.5 Spring Canyon Hydrology, Soils, Vegetation, and Biological Resources

1.5.1 Hydrology

Spring Canyon Creek originates approximately 1.4 miles inland and flows toward the Pacific Ocean. Lower Spring Canyon is an ephemeral creek that occasionally has intermittent standing water upstream from Surf Road. Surface flow percolates into the groundwater to pass beneath road embankments and eventually enters the Pacific Ocean (USAF, 1987). Scientific evidence demonstrates that stream channels and open waters that form river networks are connected to downstream waters and influence the integrity of downstream water. Although the evidence is less abundant than that of perennial and intermittent streams, there is compelling scientific evidence that ephemeral washes are connected and influence downstream water as well, particularly when there is physical connectivity and channelized flow that form and maintain a network of streams (USEPA, 2015). However, the physical connectivitiy in Spring Cnayon is blocked at Coast Road.

Spring Canyon Creek is not listed as an impaired water body, nor would it qualify as a water of the United States under the current definition. Lower Spring Canyon was sampled during the VAFB Ambient Monitoring Program from December 2005 to December 2006. Low flow and highly saturated soil conditions were causing anaerobic decomposition, suppressing the dissolved oxygen and pH levels, increasing metals concentration. The results for metals exceeded the criteria in 13 of 20 metals analyzed at that time (VAFB, 2006). There was also a large amount of leaf litter that appeared to be decomposing.

The SWRCB has not designated a beneficial use for Spring Canyon Creek (SWRCB, 2016). The Basin Plan provides the following designations for surface water bodies that do not have designated beneficial uses, which would apply to Spring Canyon Creek:

- Municipal and domestic water supply; and
- Protection of both recreation and aquatic life

1.5.2 Soils

The Project Area is comprised of the following soil types: marina sand, Santa Lucia shaly clay loam, and elder sandy loam eroded. The soils in the Project Area have the following characteristics:

Marina Sand

Marina sand is a well-drained soil formed from eolian (wind-blown) deposits and typically occurs near the coast at low elevations. Marina sand typically has sand textures from the surface to at least 88 inches depth. Areas mapped as marina sand in the Project Area are vegetated with central coast scrub and non-native grassland with open sand areas.

Santa Lucia Shaly Clay Loam

The Santa Lucia series consists of moderately deep, well drained soils that formed in material weathered from white shale containing some ash and some siliceous and diatomaceous material. The depth to a lithic contact is 20 to 40 inches. These soils occur generally on uplands at elevations are 100 to 3,000 feet and are well-drained, very low to high runoff, moderate permeability.

Elder Sandy Loam, Eroded

Elder sandy loam, eroded, is a well-drained soil that occurs on alluvial fans and footslopes. It formed in alluvium derived from acid sandstone and shale. The typical profile has sandy loam textures to at least 35 inches, with fine sandy loam texture below to at least 72 inches.

1.5.3 Vegetation Types

Vegetation types were classified across VAFB in 2009 using a modified Holland system (VAFB 2009). Types are based on Holland vegetation types, as described in Preliminary Descriptions of the Terrestrial Natural Communities of California, published by Robert F. Holland in 1986, and Documented Flora of Vandenberg Air Force Base, Santa Barbara County, California, published by David J. Keil and V.L. Holland in 1998. Based on the 2009 vegetation classification, the Project Area consists of the following vegetation types: central coast arroyo willow riparian forest and scrub, maritime chaparral, central coastal scrub, and iceplant – herb. These vegetation types were confirmed during site visits in 2017. Dominant vegetation types and species are discussed below.

Central Coast Arroyo Willow Riparian Forest and Scrub

The main canopy consists of arroyo willow (*Salix lasiolepis*). Within the willow riparian understory, ephemeral flow occurs supporting sporadic hydrophytic vegetation growing where intermittent standing water is found. The majority of the drainage consist of drier soils that are shaded by a canopy of arroyo willow. Species typical of the understory in this region include mugwort (*Artemisia douglasiana*), mulefat (*Baccharis salicifolia*), California blackberry (*Rubus ursinus*), western poison oak (*Toxicodendron diversilobum*), and stinging nettle (*Urtica dioca*).

Non-Native Tree

Much of the lower portion of Spring Canyon is dominated by a large stand of non-native trees, primarily Tasmanian bluegum (*Eucalyptus globulus*), with a sparse understory of remnant willow riparian forest and central coast scrub (Figure 1-3). The Tasmanian bluegum stand is a documented Monarch butterfly (*Danaus plexippus*) roost and therefore cannot be removed. Several Monterey cypress (*Cupressus macrocarpa*) trees are found in the lower section of Spring Canyon as well.

Maritime Chaparral

Maritime chaparral encompasses areas dominated by chamise (*Adenostoma fasciculatum*), La Purisima manzanita (*Arctostaphylos purissima*), and Santa Barbara mountain lilac (*Ceanothus impressus*). This vegetation type tends to be relatively short in stature; in some cases, plants are less than 1 foot in height, especially in windblown areas. This type includes stands where black sage is present in significant quantities but not a dominant, because black sage is associated with both chaparral and coastal scrub vegetation types.

Central Coastal Scrub

The species composition of this type varies. California sagebrush (*Artemisia californica*) occurs throughout; however, California goldenbush (*Ericameria ericoides*) occurs primarily near the coast. In relatively xeric areas, and coyote brush (*Baccharis pilularis*) occurs most frequently in mesic, disturbed areas. Seacliff buckwheat (*Eriogonum parvifolium*), deer weed (*Lotus scoparius*), and black sage (*Salvia mellifera*) are also common components.

Iceplant - Herb

Iceplant - Herb encompasses areas where iceplant occurs in scattered patches in herb dominated areas. The majority of the herbs in this vegetation type are non-native grasses and forbs, including veldt grass (*Ehrharta calycina*), Brome (*Bromus* sp.), iceplant (*Carpobrotus edulis*), black mustard (*Brassica nigra*), summer mustard (*Hirschfeldia incana*), Jubata grass (*Cortaderia jubata*), and poison hemlock (*Conium maculatum*) are the dominant plants.

1.5.4 Wildlife and Special Status Species

Common birds likely to be found within and around the project area include house finch (*Carpodacus mexicanus*), Brewer's blackbird (*Euphagus cyanocephalus*), cliff swallow (*Hirundo pyrrhonota*), barn swallow (*Hirundo rustica*), red-tailed hawk (*Buteo jamaicensis*), white-throated swift (*Aeronautes saxatalis*), California quail (*Callipepla californica*), black phoebe (*Sayornis nigrican*s), and California thrasher (*Toxostoma redivivum*).

The project site may contain upland habitat for amphibians that inhabit Spring Canyon. California chorus frogs (*Pseudacris hypochondriaca*) are likely to be the most common amphibian species within the project area. Other wetland amphibian species, western toad (*Bufo boreas*), Monterey ensatina (*Ensatina eschscholtzii*) and arboreal salamander (*Aneides lugubris*) would also be expected to occur within the project area. Due to the ephemeral nature of the drainage, Spring Canyon is marginal habitat for the California red-legged frog (*Rana draytonii*) since it has very little to no standing water during most years (ManTech SRS Technologies, Inc. 2013). The CRLF is a federally threatened species as well as a California species of concern.

Reptile species expected to occur within the project area include Western fence lizard (*Sceloporus occidentalis*), southern alligator lizard (*Elgaria multicarinata*), side-blotched lizard (*Uta stansburiana*), western skink (*Eumeces skiltonianus*), gopher snake (*Pituophis catenifer*), and Pacific rattlesnake (*Crotalus helleri*). A variety of large and medium-sized mammal species are also expected to occur within the project area including coyote (*Canis latrans*), mule deer (*Odocoileus hemionus*), raccoon (*Procyon lotor*), bobcat (*Felis rufus*), brush rabbit (*Sylvilagus bachmani*), and long-tailed weasel (*Mustela frenata*). Small mammals, including various species of mice (*Peromyscus* ssp.), and Botta's pocket gopher (*Thomomys bottae*) are also expected to occur

Figure 1-2. Civil Water Diversion Structure and Vegetation Removal Area south of SLC-4 in Spring Canyon.

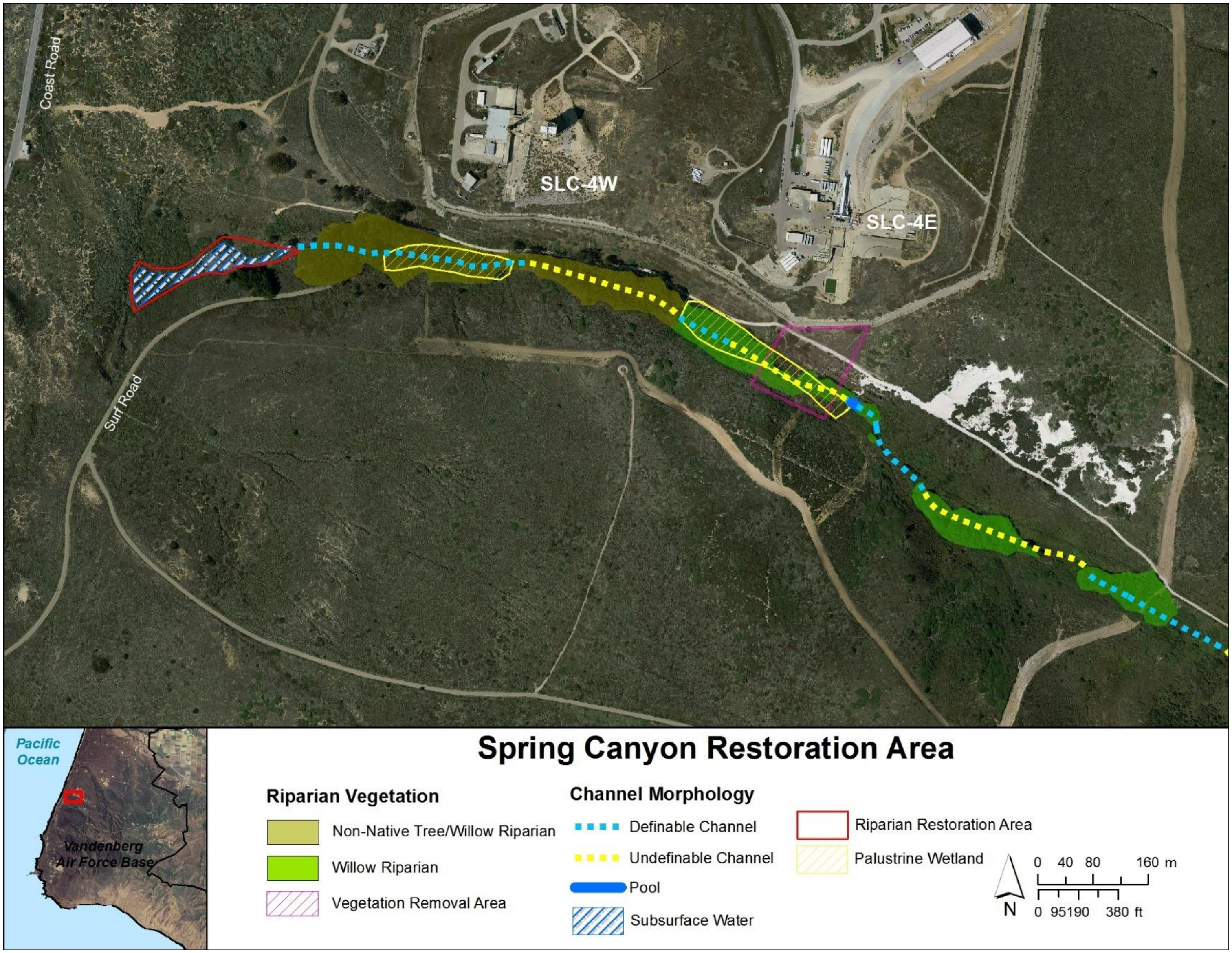

Figure 1-3. Spring Canyon Restoration Area. Note: "Definable" versus "Undefinable" channel were primarily estimated during an assessment performed in 2013 (ManTech SRS Technologies, Inc. 2013).

1.6 Types, Functions, and Values of Habitats to Be Impacted within the Project Area

Considering the hydrology, soils, and biological resources present, Spring Canyon provides the following functions and values that may be impacted by the proposed action:

- Erosion Reduction: vegetation helps moderate erosion by reducing water velocities, binding soil and contributing to the vertical and lateral stability of stream channels.
- Carbon Storage: vegetation and soils in Spring Canyon sequester carbon and reduce climate change. Many wetlands and floodplains store carbon in carbon-rich wetland soils, trees and vegetation, reducing carbon output.
- Wildlife Habitat: amphibians, reptiles, migratory birds, mammals, and insect species reside in Spring Canyon which provides, shelter, foraging and breeding habitat, and a corridor for migration or movement.
- Threatened and Endangered Species Habitat: although marginal, Spring Canyon may provide transitory and upland habitat for California red-legged frog.
- Short-Term Storage of Surface Water: short term storage of surface water helps replenish soil moisture, reduce downstream peak discharge, discharge volume, and helps maintain and improve water quality.
- Storage of Subsurface Water: the storage of subsurface water helps maintain biogeochemical processes, recharge groundwater, and maintains baseflow flow in streams.
- Dissipation of Energy and Retention of Particulates: the reduction of energy in moving water contributes to nutrient cycling in an ecosystem, helps reduce downstream sedimentation, and contributes to maintenance or improvement of surface water quality.

Impacts to these functions and values by the proposed action would be mitigated by replacing them through habitat enhancement and restoration, described in the following section.

1.7 Mitigation Design

1.7.1 Project Summary

The mitigation would be performed in Spring Canyon within the bed and bank in two phases: invasive species control followed by habitat restoration through re-establishing native vegetation, which are explained in detail below.

Invasive Species Control

Within the 2.5-acre Spring Canyon Restoration Area the following invasive plant species will be treated and/or removed within the Spring Canyon Restoration Area:

- Jubata grass (*Cortaderia jubata*)
- Iceplant (*Carpobrotus edulis*)
- Fennel (*Foeniculum vulgare*)
- Poison hemlock (*Conium maculatum*)

- Black mustard (*Brassica nigra*)
- Summer mustard (*Hirschfeldia incana*)

Prior surveys of the area in 2017 showed these species to be prevalent in this area and interspersed into riparian woodland habitat to varying degrees. These target species would be treated using the following herbicide solution:

- Glyphosate-based herbicide (Rodeo or RoundupCustom) – 2 percent (%) solution with 1% Agridex and 0.5 % blue indicator dye.

This formulation is approved for aquatic use and would be applied to invasive plants up to the edge of surface water; however, would not be applied directly to any surface water. Manual control will be performed as necessary to remove flower stalks and seed heads. Treatments would be timed to kill invasives prior to flowering and seed set to the extent possible and documented by mapping the extent of each stand of target species treated to record the location and extent using a GPS device, as well as the amount of chemical applied and date of application. GPS mapping in the field would ensure a record of the amount of area treated and enable follow up maintenance and verification of treatment success.

The control of these invasives would enhance habitat for native vegetation communities and wildlife by reducing pressure on native vegetation communities that provide shelter, forage, nesting, and support for prey species for nesting birds, amphibians, reptiles, and mammals.

Habitat Restoration

Riparian restoration will be conducted in an approximately 2.5-acre Spring Canyon Restoration Area (Figure 1-3). This area has a slightly elevated water table due to subsurface hydrology in sandy soils and could support a suite of native riparian plant species. After treatment of invasive plant species in the spring and summer of 2018, native outplantings and willow pole plantings will be installed in this area. Depending on ground conditions at the time of implementation, plantings may occur in suitable locations upstream of this location. Outplanting species will be chosen from a palette of riparian natives occurring in Spring Canyon from the following:

- Arroyo willow (*Salix lasiolepis*)
- Mule fat (*Baccharis salicifolia*)
- California mugwort (*Artemisia douglasiana*)
- California blackberry (*Rubus ursinus*)
- Creeping wild rye (*Leymus triticoides*)

Mule fat, mugwort, blackberry, and wild rye would be propagated in 4-inch pots or “supertubes” from seed collected in Spring Canyon and planted by hand with the aid of hand tools. Other riparian associated species may be substituted depending on seed availability and ground conditions at the time of implementation. During container plant installation, plants will be inspected for proper root development and condition before planting. Planting holes will be equal in size to the container size. Holes will be dug manually with a hand trowel. Holes will be approximately 6-12 inches in depth and backfilled with native soil.

Willows will be installed by one or more of the following methods:

- Water jet installation: If site conditions are dry and allow for equipment, a truck and trailer or water pump hose will be used to liquefy the soil to create a hole that is one inch in diameter, or approximately the diameter of the willow pole. Willow cuttings will be installed to a depth of the soil's capillary fringe. Using this method, willow cuttings will be installed at a depth of 3-4 feet.
- Hand-held power auger: Can be used if water truck and or trailer cannot access site. Auger will be used to drill a hole that is 4-6 inches in diameter and 2.5-4.5 feet deep. One to three willow cuttings will be set in each hole. The exposed hole will then be filled with a slurry of muddy soil to ensure good soil contact with the planting.
- A hole can be manually driven with a 5-foot steel rod (0.75 inches diameter) to approximately 3-4 feet in depth, depending on soil conditions. The willow cuttings will then be installed in the hole, and the soil will be compacted around the willow stem.

Outplantings would be monitored throughout the first five years after planting to determine if artificial irrigation is needed to help improve establishment. Irrigation may be required depending on the amount of rainfall received at the site, since water may be too deep subsurface in the drainage for the root systems of the plants to reach. If required, irrigation would be achieved by providing water to plants on an as-needed basis through drip irrigation, hose, or other means such that supplemental water is provided to the native plant installations but not to the extent that invasive weed species are encouraged to grow in the irrigated spaces. Once established any irrigation would be discontinued. A gradual decrease and eventual elimination of irrigation is the end-goal; however, prolonged drought conditions may necessitate a longer irrigation period.

Riparian habitat restoration would replace functionality and value lost at the site of vegetation removal. Once established, this habitat will provide a variety of habitat functions for native plants and wildlife, including nesting, shelter, and foraging habitat. In addition, the restoration area will help reduce surface flow and groundwater velocities thereby retaining particulates, reducing erosion, increasing storage of surface and subsurface water, and sequester carbon. These functions and values will help maintain and improve water quality in Spring Canyon.

Follow-up Herbicide Treatments

To ensure that invasives do not re-infest the site before native plantings can establish, the restoration area VAFB will perform monitoring and spot treatment of the target invasive species, as needed. These treatments will generally occur between April and October of each year.

2 Goals of Mitigation

The goal of this mitigation is to enhance 2.5 acres of riparian habitat through invasive species control and native habitat restoration within Spring Canyon that will act as a replacement for permanent impacts to 1.121 acres of willow riparian habitat. The Riparian Restoration Area (Figure 1-3), when revegetated with native riparian species, will provide refuge for native wildlife species to potentially include the federally threatened California red legged frog (*Rana draytonii*). In the long term, the mitigation area must be healthy, self-sustaining, regenerating, and result in improvements to the Spring Canyon riparian corridor, thus providing expanded habitat for wildlife.

3 Minimization and Avoidance Measures

The following minimization and avoidance measures will be implemented to reduce the risk of impacts to California red-legged frog (*Rana draytonii*, CRLF), El Segundo blue butterfly (*Euphilotes battoides allyni*, ESBB), and seacliff buckwheat (*Eriogonum parvifolium*), the host plant of the ESBB:

- All individuals conducting herbicide application would be trained and demonstrate proficiency in the identification and avoidance of special status species.
- Established roads, both paved and unpaved, would be used for vehicle access.
- Herbicide would be applied in accordance with the pesticide label and Department of Defense (DoD) recommendations. The proposed herbicide formulation is currently DoD approved.
- Herbicide mixing would occur in non-sensitive areas in accordance with the VAFB Integrated Pest Management Plan.
- Herbicide treatments would only occur under low wind conditions to avoid drift to non-target species.
- Herbicide application would take place outside of the rainy season (15 October to 15 March).
- Seacliff buckwheat, although unlikely to occur in the riparian zone, would be avoided during all application of herbicides if encountered.
- No broad scale herbicide application would take place in areas supporting seacliff buckwheat from 1 May through 30 September.
- No vehicle traffic would occur through surface water if present unless the route is pre-cleared by a qualified biologist.
- All access for treatments would be restricted to daylight hours.
- No glyphosate would be used in ephemeral aquatic habitats during the rainy season (15 October – 15 March).
- No glyphosate would be used in aquatic habitats 24 hours before or after a significant precipitation event (0.1 inches or more).

4 Monitoring Plan

4.1 Final Success Criteria

Successful mitigation will rely on meeting criteria for invasive control success and habitat restoration goals. The following success criteria must be met for the mitigation to be considered successful.

Invasive species control must achieve 90 percent or greater success. Control will be determined during follow up treatments of the target species. Maintenance treatments will continue until 90 percent control has been achieved.

The restoration will be considered successful when 2.5 acres of riparian habitat have been established, determined when all of the following criteria are achieved:

- Evidence that the site is sustainable by showing signs of regeneration (progeny and new growth) of healthy plants, a low mortality rate, and resistance to weeds.
- The level of ecological services provided within the mitigation area following restoration is commensurate with services provided at within the rest of Spring Canyon. Any acceptable loss in services must be the result of natural processes and not the proposed action.
- Native cover and non-native cover achieve a level equivalent or better than similar to at least two native dominated reference sites that will be selected within Spring Canyon or the unnamed drainage immediately south of Spring Canyon. Both the restoration site and reference sites will be assessed following methods described in Section 4.2.
    - Pre-action conditions will be determined by a site survey prior to restoration activities to determine percent native cover and percent non-native cover.
    - Native cover in the restoration area must reach or exceed that found in the reference site determined during the site survey.
    - Non-native cover in the restoration area must be equal to or less than that found in the reference site determined during the site survey.
    - Both native and non-native cover in the restoration area will be estimated during annual assessments of the restoration area and reference sites, as described in Section 4.2, Monitoring Methods.
- It is the goal of the project to meet all of the above success criteria within five years following the completion of mitigation activities.

4.2 Monitoring Methods

The mitigation area will be assessed annually for five years. Assessments will be conducted within the fall of each year using the “Rapid Vegetation Assessment” sampling method, developed by the California Native Plant Society (http://www.cnps.org/cnps/vegetation/protocol.php). Fall assessments will be used to guide the upcoming planting and weed control strategies for the following year. Assessments will measure native and non-native cover, as well as health, growth, and reproduction of plantings, species composition, and how these affect the ecological functions and values of the Spring Canyon watershed.

In addition, at least three photo points will be established in the restoration area and at least one in each reference site. Photos will be taken prior to restoration activities and annually thereafter. The photo point locations will be recorded with a handheld GPS device and marked in the field with a stake. At least four photos will be taken in general north-south-east-west directions. The azimuth of each photo will be recorded to enable recreation annually.

5 Timeline

The initial goal of this restoration effort will be to control the target invasive species through herbicide treatments within the bed and bank of the Spring Canyon Restoration Area (Figure 1-1). These would occur throughout the first spring and summer of 2018, with follow-on maintenance treatments through the following four years as necessary. Native outplantings would be installed in the Riparian Restoration Area (Figure 1-3) during the late fall 2018 through winter 2019. Follow-on maintenance treatments throughout the Spring Canyon Restoration Area will occur for four additional years through 2022. Irrigation would occur as necessary from 2018 through 2022 or until native plantings have been able to establish. Table 5-1 shows a timeline of anticipated restoration activities.

6 Reporting

Annual reports will be submitted to the SWRCB documenting all restoration activities by 31 December of each calendar year. The annual reports will document invasive species control efforts, including target species, acreage and area treated, and control success; and restoration activities, including areas planted with native riparian outplantings, number and species of plantings, and survival success. Annual reports will also report the results of assessments and determine progress towards the success criteria and provide recommendations, if necessary, to improve ecological functionality and restoration success.

Table 5-1. Spring Canyon Restoration Area – Five Year Restoration Timeline.

Year 1 (2018)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Invasive Species Treatments				■	■	■	■	■	■	■		
Irrigation (as necessary)						■	■	■	■	■	■	
Native Outplantings												■
Success Criteria Assessments & Photo Monitoring										■	■	■
Annual Report												■
Year 2 (2019)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Native Outplantings	■	■	■									
Irrigation (as necessary)						■	■	■	■	■	■	
Maintenance Treatments				■	■	■	■	■	■	■		
Success Criteria Assessments & Photo Monitoring										■	■	■
Annual Report												■
Year 3 (2020)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Irrigation (as necessary)						■	■	■	■	■	■	
Maintenance Treatments				■	■	■	■	■	■	■		
Success Criteria Assessments & Photo Monitoring										■	■	■
Annual Report												■
Year 4 (2021)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Irrigation (as necessary)						■	■	■	■	■	■	
Maintenance Treatments				■	■	■	■	■	■	■		
Success Criteria Assessments & Photo Monitoring										■	■	■
Annual Report												■
Year 5 (2022)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Irrigation (as necessary)						■	■	■	■	■	■	
Maintenance Treatments				■	■	■	■	■	■	■		
Success Criteria Assessments & Photo Monitoring										■	■	■
Annual Report												■

7 References

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APPENDIX H: Notice of Availability for Public Review, Proof of Delivery/Publication, Comments Received on Final Draft and Responses

DEPARTMENT OF THE AIR FORCE
30TH SPACE WING (AFSPC)

20 December 2017

MEMORANDUM FOR ALL INTERESTED GOVERNMENT AGENCIES, PUBLIC OFFICIALS, ORGANIZATIONS, AND INDIVIDUAL PARTIES

FROM: 30 CES/CEI
1028 Iceland Avenue
Vandenberg AFB CA 93437-6010

SUBJECT: Final Draft Supplemental Environmental Assessment (SEA) and Finding of No Significant Impact (FONSI) for the Launch, Boost-Back, and Landing of the Falcon 9 at Vandenberg Air Force Base (VAFB), California, and Offshore Landing Contingency Options

1. Attached as public and agency notification, to comply with the National Environmental Policy Act of 1969, and the President's Council on Environmental Quality's implementing regulations, is the Final Draft SEA and FONSI for the Launch, Boost-Back, and Landing of the Falcon 9 at VAFB, California, and Offshore Landing Contingency Options.

2. This Final Draft SEA supplements the *Falcon 9 and Falcon 9 Heavy Launch Vehicle Programs Environmental Assessment (EA) from Space Launch Complex 4 East, VAFB, California* (2011); *Final EA Boost-Back and Landing of the Falcon 9 Full Thrust First Stage at SLC-4 West VAFB, California and Offshore Landing Contingency Option* (2016); and *SEA Boost-Back and Landing of the Falcon 9 First Stage at the Iridium Landing Area* (2016). These documents are available at:

http://www.vandenberg.af.mil/

and at the Lompoc, Santa Maria, and Santa Barbara Public Libraries, and the VAFB Library. The Proposed Action (Alternative 1) is Space Exploration Technologies Corporation's proposal to launch the Falcon 9 from VAFB and perform a boost-back maneuver (in-air) and landing of the Falcon 9 First Stage at either VAFB or one of two offshore contingency landing areas up to twelve times per year. The Proposed Action also includes the construction of a civil water diversion structure at Space Launch Complex-4 East. Resources analyzed in the attached Final Draft SEA include air quality, climate, noise, biological resources, water resources, cultural resources, geology and earth resources, coastal zone management, and Department of Transportation Section 4(f) properties. This Final Draft SEA concludes that there will be no significant environmental impacts resulting from the Proposed Action.

3. The public comment period for this Final Draft SEA/FONSI will be from 22 Dec 17 through 21 Jan 18. Comments may be sent to the above address attention of Ms. Samantha Kaisersatt, emailed to samantha.kaisersatt@us.af.mil, or faxed to (805) 606-6137. If you have any questions, please contact Ms. Samantha Kaisersatt at (805) 605-0392.

BEATRICE L. KEPHART
Chief, Installation Management Flight

Attachment:
Final Draft SEA and FONSI for the Launch, Boost-Back, and Landing of the Falcon 9 at VAFB, California, and Offshore Landing Contingency Options.

*** Proof of Publication ***

PROOF OF PUBLICATION
(2015.5 C.C.P.)

STATE OF CALIFORNIA.

LOMPOC RECORD

ManTech
102 E. Ocean Ave
Lompoc, CA 93436

ORDER NUMBER 117139

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FINAL DRAFT SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT AND FINDING OF NO SIGNIFICANT IMPACT

LAUNCH, BOOST-BACK, AND LANDING OF THE FALCON 9 FIRST STAGE AT VANDENBERG AIR FORCE BASE, CALIFORNIA, AND OFFSHORE LANDING CONTINGENCY OPTIONS

The U.S. Air Force and Space Exploration Technologies Corporation (SpaceX) has prepared a Final Draft Supplement Environmental Assessment (SEA) and Finding of No Significant Impact (FONSI) that evaluates the potential environmental impacts of SpaceX's proposal to launch the Falcon 9 from Vandenberg Air Force Base (VAFB) and perform a boost-back maneuver (in-air) and landing of the Falcon 9 First Stage at either VAFB or one of two offshore contingency landing areas up to twelve times per year. The Proposed Action also includes the construction of a civil water diversion structure at Space Launch Complex-4 East. This Final Draft SEA supplements the Falcon 9 and Falcon 9 Heavy Launch Vehicle Programs Environmental Assessment (EA) from Space Launch Complex 4 East, VAFB, California (2011); Final EA Boost-Back and Landing of the Falcon 9 Full Thrust First Stage at SLC-4 West at VAFB, California and Offshore Landing Contingency Option (2016); and SEA Boost-Back and Landing of the Falcon 9 First Stage at the Iridium Landing Area (2016). Resources analyzed in the Final Draft SEA include air quality, climate, noise, biological resources, water resources, cultural resources, geology and earth resources, coastal zone management, and Department of Transportation Section 4(f) properties. This Final Draft SEA concludes that there will be no significant environmental impacts resulting from the Proposed Action.

The Final Draft SEA/FONSI is available for review at the Lompoc, Santa Maria, and Santa Barbara Public Libraries, and the VAFB Library. The public comment period for this Final Draft SEA/FONSI is 22 December 2017 through 21 January 2018. Comments may be sent to the 30 CES/CEIEA, 1028 Iceland Avenue, Vandenberg AFB, CA 93437, to the attention of Samantha Kaisersatt, e-mailed to samantha.kaisersatt@us.af.mil, or faxed to (805) 606-6137. If you have any questions, please contact Ms. Samantha Kaisersatt at (805) 605-0392.

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COMMENTOR: Federal Aviation Administration

ITEM NO.	PAGE NO	PARA/SEC/ LINE NO	COMMENT	RESPONSE
1	3-8	Section 3.3.1	Is there a map identifying the "areas" at issue? Alternatively, explain where these areas are. We need to define the Study Area for noise analysis. If this is covered in an earlier EA, we need to provide a cross-reference.	The Region of Influence is defined for each resource analyzed in the SEA. For example, the region of influence for noise is included in Section 3.3.1 as "the ROI includes the SLC 4 complex and areas potentially overflown by the First Stage, areas that may be impacted by landing noise, and areas that may be impacted by sonic booms from the Falcon 9". Added reference to figures within Section 3.3.1 (Figure 2-2 and Figure 2-3 Estimated Launch Noise, Figure 2-4 and Figure 2-5 Landing Noise).
2	3-53	Section 3.5.4	Provide a conclusion whether there are any state or federal jurisdictional wetlands. It doesn't sound like there are, but it is worth stating clearly.	Added "Due to the absence of a continuous surface connection from the stream/riparian zone adjacent to SLC-4 and the Pacific Ocean, Spring Canyon Creek is not considered federal jurisdictional waters, however it is considered state waters".
3	3-54	Section 3.6	Define the Area of Potential Effect	The Region of Influence for Cultural Resources is defined in Section 3.6.1 as "the vicinity of SLC-4 where ground-disturbing activities would take place".
4	3-55	Section 3.6.2	As described in Falcon 9 EA, an archaeological site record and literature search were completed for all sites within 0.25 miles of SLC-4E. This effort identified seven archaeological sites and one artifact within a 0.25 mile radius of SLC-4E. These include CA-SBA-537, -1127,-1815, -1816, 1940, -2305, -2427, and VAFB-ISO-300." (emphasis added) Are these identification numbers depicted on a map or somewhere else? Where can someone reference these numbers?	We do not disclose where the location of archaeological sites are, especially for public documents.

ITEM NO.	PAGE NO	PARA/SEC/ LINE NO	COMMENT	RESPONSE
5	4-1 and 4-2	Section 4.1.1.1	As described in the Falcon 9 EA (USAF, 2011), each Falcon 9 launch is anticipated to produce up to 95.22 tons of CO and trace amounts of other pollutants. The maximum amount of Falcon 9 launches under Alternative 1 would be 12 per year, resulting in up to 1,142.64 tons per year of CO emissions." If the de minimis threshold for CO is 100 (see Table 4-1), doesn't 1,142 tons per year of CO emission this indicate an exceedance for CO? Or are these 1,142 tons of emissions above 3,000 feet? Table 4-1 says that CO has 0 emissions below 3000 feet but the language in the sentence seems contradictory. If there are truly 0 emissions below 3000 feet, the language should be clarified.	Added "The 1,142 tons of CO emissions include emissions above 3,000 feet. These emissions are above the mixing level and are therefore not included in the conformity analysis."
6	4-3	Section 4.1.1.1	Table 4-4 estimates the total ambient air quality emissions per year for SpaceX's operations of the Falcon 9 at VAFB. Although the SCAB is in extreme non-attainment for O3, which would mean that the de minimis threshold for O3 is 10, the majority of the emissions being produced by the Proposed Action would be released within the SCCAB." Are the referenced emissions "operational emissions?" Please confirm.	Both operational and construction emissions are being referenced in this statement.
7	4-3	Section 4.1.1.1	Explain why the majority of emissions would be released in the SCCAB and not the SCAB. It is not obvious here or in the Air Quality discussion in Chapter 3. Note: I think the Summary on p. 4-4 and 4-5 may respond to some of my comments. Please verify and if so, incorporate it into the discussion on p. 4-3 so it is clear. "The only emissions being released in the SCAB would come from contingency vessels, which produce relatively small amounts of emissions. Therefore, the de minimis threshold for a moderate non-attainment area was used below." Explain why the only emissions released in SCAB are from contingency vessels.	Added "Emissions that would take place below 3,000 feet would be released in the SCCAB since the rocket would be above the 3,000-foot threshold before leaving the SCCAB." Added "A small number of support vehicles would be used within Long Beach Harbor during loading and unloading operations".
8	4-3	Section 4.1.1.1	What is considered "small amounts?" Provide a number based on the analysis.	Changed "which produce relatively small amounts of emissions" to "Less than one ton of pollutants would be released annually by contingency vessels. These are small in comparison to both other aspects of the operation as well as the de minimis thresholds for the SCAB".
9	4-3	Section 4.1.1.1	"Therefore, the de minimis threshold for a moderate non-attainment area was used below." Why is a moderate non-attainment area used?	Changed "Therefore, the de minimis threshold for a moderate non-attainment area was used below" to "Since the SCCAB is where almost all of the emissions will be released, it is best to use the de minimis thresholds for that basin, which for the referenced pollutant is the moderate non-attainment threshold."

ITEM NO.	PAGE NO	PARA/SEC/ LINE NO	COMMENT	RESPONSE
10	4-5	Section 4.1.2	As presented in the Falcon 9 Boost-Back EA (USAF, 2016a) and Iridium SEA (USAF, 2016b), emissions from the operation of the three vessels cause pollutant concentrations to exceed one or more of the NAAQS, for any of the time periods analyzed, or if it were to increase the frequency or severity of any such existing violations (Table 4-6). Therefore, the No Action Alternative would result in less than significant impacts to air quality." The first sentence is unclear. Is it supposed to say that operational emissions do not "cause pollutant concentrations to exceed" NAAQS?	Changed to "would not cause pollutant concentrations to exceed one or more of the NAAQS".
11	4-3 Noise		It is unclear whether the SEA relies entirely on the prior EA's for noise analysis data or on its own noise modelling. If the EA was used, this section and its subsections should state that it is relying on that data and provide cross-references to that report. Otherwise, the noise analysis conducted for this SEA should be included as an Appendix or an addendum.	Section 2.2.1 discuss the launch and landing modeling that was completed for this SEA. Figures showing the results are provided within the document. Section 2.2-1 discusses how the USAF arrived at the nearfield sonic boom levels for boost-back and landing.
12	4.3.1.1. Sonic Boom		Was a noise analysis done for sonic boom impacts? Noise analysis data should be included as an appendix or provided in the body of the report. The USAF predicts nearfield overpressures as high as 8.5 psf at the landing location, which would attenuate to levels below 2.0 psf at approximately 6.2 miles (10.0 km) from the location (Figure 2 6)." (emphasis added). What does USAF use to "predict"? Is this based on its noise analysis? USAF needs to clarify how it comes up with 8.5 psf at the landing site and 2.0 psf at ~6 miles out.	See response to comment 11
13		Section 4.3.1.1.	The report concludes: "Therefore, effects from the boost-back and landing at SLC-4 would be less than significant." Identify what threshold is being used to determine significance for sonic booms.	Changed "Additionally, these overpressures do not cause adverse effects such as structure damage. Therefore, effects from the boost-back and landing at SLC-4 would be less than significant" to "The general threshold for significance is whether a sonic boom could cause damage to structures. While received overpressures (at nearby city and counties) are loud enough to be heard, they are not anticipated to cause damage, and are thus not significant".
14			Please include a list of existing or required air quality permits. (1050.1F Desk Reference, Section 1.1.1 and Section 1.2).	Added "SBCAPCD Permit to Operate 13711-R1 is inclusive of all SpaceX operations".