Draft Final

Environmental Assessment

Boost-Back and Landing of the Falcon 9 First Stage at SLC-4 West

Vandenberg Air Force Base, California and Offshore Landing Contingency Option

31 March 2016

30th Space Wing, Installation Management Flight
1028 Iceland Avenue, Building 11146
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ACRONYMS AND ABBREVIATIONS

˚C	Degree(s) Centigrade
˚F	Degree(s) Fahrenheit
30 CES/CEI	30th Space Wing, Installation Management Flight
30 CES/CEIEA	30th Space Wing, Installation Management Flight, Environmental Conservation
30 CES/CEIEC	30th Space Wing, Installation Management Flight, Environmental Quality
30 CES/CEIOP	30th Space Wing, Installation Management Flight, Comprehensive Planning
30 SW	30th Space Wing
30 SW/SEW	30th Space Wing, Weapons Safety Office
30 SWI	30th Space Wing Instruction
30 SWP	30th Space Wing Plan
AB	Assembly Bill
ac.	acre or acres
ADT	Average Daily Traffic
AFCEC/CZO	Air Force Civil Engineering Center, Environmental Center for Excellence Operations
AFI	Air Force Instruction
AFOSH	Air Force Occupational Safety and Health
AFSPC	Air Force Space Command
AFSS	Autonomous Flight Safety System
AICUZ	Air Installation Compatible Use Zone
AGL	above ground level
APE	Area of Potential Effect
APZ	Accident Potential Zone
Base	Vandenberg Air Force Base
BCC	USFWS Bird Species of Conservation Concern
BGEPA	Bald and Golden Eagle Protection Act
bhp	brake horse power
BIA	Biologically Important Area
BMP	Best Management Practice
BO	Biological Opinion
BP	Before Present
C&D	construction and demolition
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAAQS	California Ambient Air Quality Standards
Cal/OSHA	California Division of Occupational Safety and Health
CARB	California Air Resources Board
CASQA	California Stormwater Quality Association
CCA	California Coastal Act
CCC	California Coastal Commission
CCS	central coast scrub
CD	Consistency Determination
CDFW	California Department of Fish and Wildlife
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CetMap	Cetacean Density and Distribution Mapping Working Group
C.F.R	Code of Federal Regulations
CH_4	methane
CINMS	Channel Islands National Marine Sanctuary
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CO	carbon monoxide
CO_2	carbon dioxide
CO_{2e}	carbon dioxide equivalent
COC	contaminants of concern
COI	Certificate of Inspection
COPV	Carbon Over Pressure Vessel
CSC	California Species of Special Concern
CRLF	California red-legged frog
CSE	Comprehensive Site Evaluation
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
dB	decibel
dBA	A-weighted decibel
dBP	unweighted decibel
dB re µPa	decibel(s) referenced to micropascal(s)
DMM	Discarded Military Munitions
DNL	Day-Night Average Sound Level
DoD	Department of Defense
DOT	Department of Transportation
DPE	dual phase extraction
DPS	Distinct Population Segment
E	East
EA	Environmental Assessment

EELV	Evolved Expendable Launch Vehicle
EFH	Essential Fish Habitat
EIAP	Environmental Impact Analysis Process
EIS	Environmental Impact Statement
EMS	Environmental Management System
ENVIRON	ENVIRON International Corporation
EO	Executive Order
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
EPM	Environmental Protection Measure
ERP	Environmental Restoration Program
ESA	Endangered Species Act
ESBB	El Segundo blue butterfly
FAA	Federal Aviation Administration
FE	federally endangered
FFDP	Final Flight Data Package
FONPA	Finding of No Practicable Alternative
FONSI	Finding of No Significant Impact
FP	California Fully Protected Species
FR	Federal Register
FSDP	Flight Safety Data Plan
ft.	foot or feet
$ft.^2$	square feet
FT	federally threatened
FTS	Flight Termination System
GHG	greenhouse gas
GPS	Global Positioning System
GSE	ground support equipment
GVWR	gross vehicle weight rating
GWP	global warming potential
HFC	hydroflourocarbon
HS	hydrogen sulfide
Hwy	Highway
Hz	Hertz
IICEP	Interagency and Intergovernmental Coordination for Environmental Planning
IFAT	In Flight Abort Test
IHA	Incidental Harassment Authorization
INRMP	Integrated Natural Resources Management Plan
IRP	Installation Restoration Program
ITLO	Installation Tribal Liaison Officer
kHz	kilohertz
km	kilometer(s)
km^2	square kilometer(s)
lb.	pound(s)
LCZ	Lateral Clear Zone
L_{eq}	single equivalent sound level
L_{eq1H}	the continuous sound level that would contain the same acoustical energy for 1 hour as the fluctuating sound levels during the same period
lbs.	pounds
LETE	California least tern
LLC	Launch and Landing Control
LOS	Level of Service
LOX	liquid oxygen
m	meter
MBTA	Migratory Bird Treaty Act
MC	munitions constituents
MD	munitions debris
MEC	munitions and explosives of concern
mi	miles
MMPA	Marine Mammal Protection Act
MMRP	Military Munitions Response Program
mph	miles per hour
MSRS	ManTech SRS Technologies, Inc.
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
ND	Negative Determination
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
nm	nautical mile(s)
NNG	non-native grassland
NOAA Fisheries	National Oceanic and Atmospheric Administration, National Marine Fisheries Service
NOI	Notice of Intent
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
NSR	New Source Review
O_3	ozone
OSHA	Occupational Safety and Health Administration
P2	pollution prevention
PAH	polycyclic aromatic hydrocarbon
Pb	lead
PCB	polychlorinated biphenyl

PERP	Portable Equipment Registration Program
PFC	perfluorocarbon
PL	Public Law
$PM_{2.5}$	particulate matter less than 2.5 microns
PM_{10}	particulate matter less than 10 microns
PPA	Pollution Prevention Act
ppmv	parts per million
psf	pounds per square foot
RMS	Root Mean Squared
ROG	reactive organic gases
ROI	region of influence
RP-1	rocket propellant
RWQCB	Regional Water Quality Control Board
SAA	Space Act Agreement
SBCAPCD	Santa Barbara County Air Pollution Control District
SC	State Candidate Species
SE	California State Endangered
SEL	Sound Exposure Level
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SF_6	sulfur hexafluoride
SLC	Space Launch Complex
SNPL	western snowy plover
SO_2	sulfur dioxide
SpaceX	Space Exploration Technologies Corporation
SR	State Route
SCCAB	South Central Coast Air Basin
SSLV	Standard Small Launch Vehicle
SSPP	Strategic Sustainability and Performance Plan
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
SYBCI	Santa Ynez Band of Chumash Indians
TCE	trichloroethylene
TNT	trinitrotoluene
UPRR	Union Pacific Railroad
U.S.	United States
U.S.C.	United States Code
USGS	U.S. Geological Survey
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UXO	unexploded ordnance
VAFB	Vandenberg Air Force Base
V/C	volume-to-capacity
VOC	volatile organic compounds
VSMR	Vandenberg State Marine Reserve
W	west

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1 Purpose of and Need for the Proposed Action

This Environmental Assessment (EA) evaluates the potential environmental impacts associated with the boost-back and vertical landing of the Falcon 9 First Stage booster at Space Launch Complex 4 West (SLC-4W) on Vandenberg Air Force Base (VAFB or Base), California or on a special purpose barge no less than 50 kilometers (km) off VAFB's shore. This EA also addressed related infrastructure improvements at SLC-4W and implementation of the Autonomous Flight Safety System (AFSS). Space Exploration Technologies Corporation (SpaceX) is currently operating the Falcon Launch Vehicle Program at SLC-4E on VAFB. SpaceX proposes regular employment of stage recovery (boost-back and landing) by returning the Falcon 9 First Stage to SLC-4W or another SpaceX launch facility for potential reuse approximately six times per year. Per agreements between the United States (U.S.) Air Force (USAF) and the Federal Aviation Administration (FAA), the USAF will act as the lead agency for the preparation and coordination of the National Environmental Policy Act (NEPA) documentation for the Proposed Action, and the FAA will act as a cooperating agency.

To ensure that launch services provided by private enterprises are consistent with national security and foreign policy interests of the United States and do not jeopardize public safety and the safety of property, the Commercial Space Launch Act of 2011 (51 United States Code [U.S.C.] Subtitle V, Chapter 509, Sections 50901-50923) authorizes the Department of Transportation (DOT) to license and regulate U.S. commercial launch activities. Within the DOT, the Secretary of Transportation's authority under the Commercial Space Launch Act has been delegated to the FAA Office of Commercial Space Transportation. Therefore, the FAA is a cooperating agency in reviewing the preparation of this EA.

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

This EA has been prepared per the NEPA of 1969 (42 U.S.C. §4321 et seq.), the Council on Environmental Quality's (CEQ's) Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations [C.F.R.] 1500-1508), the USAF's Environmental Impact Analysis Process (EIAP) (32 C.F.R. 989), and FAA Order 1050.1E, Change 1, *Environmental Impacts: Policies and Procedures*.

1.1 Background

The Commercial Space Launch Act of 2011 (Public Law 98-575), declares that the development of commercial launch vehicles and associated services is in the national economic interest of the United States. The Commercial Space Launch Act also allows government infrastructure and resources currently underutilized to be used as excess capacity to promote commercial investment and use of space. The USAF provides support to the U.S. Government and commercial entities for low-cost and reliable access to space.

The United States has recognized that space transportation costs must be significantly reduced to make continued exploration, development, and use of space more affordable. The National Space Policy of 28 June 2010 (U.S. Government 2010) includes as one of its principles a commitment to "encouraging and facilitating the growth of a U.S. commercial space sector that supports U.S. needs, is globally competitive, and advances U.S. leadership in the generation of new markets and innovation-driven entrepreneurship." The National Space Policy provides its following guidelines (in part):

- Encourage an innovative and entrepreneurial commercial space sector.
- Enhance operational efficiency, increase capacity, and reduce launch costs by investing in the modernization for space launch infrastructure.
- Develop launch systems and technologies necessary to assure and sustain future reliable and efficient access to space, in cooperation with U.S. industry, when sufficient U.S. commercial capabilities and services do not exist.
- Purchase and use commercial space capabilities and services to the maximum practical extent when such capabilities and services are available in the marketplace and meet U.S. Government requirements.

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 through the reuse of the Falcon 9 First Stage booster and implementation of the AFSS, 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*, and the Commercial Space Launch Act for oversight of commercial space launch activities. The FAA expects to receive a license application from SpaceX that could include Falcon 9 First Stage boost-back and landing at VAFB. The FAA would be required to review the application and determine whether to issue a license. The action continues to fulfill the U.S. expectation that space transportation costs are reduced to make continued exploration, development, and the use of space more affordable.

The reuse of the Falcon 9 First Stage would enable SpaceX to efficiently conduct lower cost launch missions from VAFB in support of commercial and government clients. 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 U.S. 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.

Implementation of the AFSS would reduce overall costs as well by reducing the number of engineering and support hours through automation. It also reduces infrastructure and the associated costs of operating and maintaining it.

The Proposed Action is needed so that SpaceX can implement missions for the USAF and NASA (under the Space Act Agreement [SAA]). In addition, the Proposed Action supports VAFB's vision of becoming the "world's most innovative space launch and landing team" (USAF 2014a). 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 do not permit for a successful landing attempt. In this case, the First Stage would be landed on a barge no less than 31 mi. (50 km) offshore of VAFB. The contingency landing location is the furthest location from the coastline that SpaceX is able to place the landed first stage. A contingency landing location further from the coastline would increase forces on the rocket due to an increased angle of return trajectory, causing the rocket to explode. A contingency barge landing is possible several hundred miles offshore downrange, however landing offshore of VAFB requires the least amount of distance from the launch location to avoid diverting from the primary mission trajectory. Since Range conditions could change up until the day of launch it is important to maintain a seamless alternative to landing at SLC-4W that does not drastically change the primary mission trajectory.

1.3 Project Location

VAFB occupies approximately 99,100 acres (ac.) (400 square kilometers [km^2]) of central Santa Barbara County, California (Figure 1-1), approximately halfway between San Diego and San Francisco. The Base 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-4W is located on South Base, approximately 0.5 mi. (0.8 km) inland from the Pacific Ocean (Figure 1-2). SLC-4E is the launch facility for the Falcon 9 program, which is located approximately 715 feet (ft.) (218 meters [m]) to the east of SLC-4W, the proposed landing site for the Falcon 9 First Stage (Figure 1-2, inset). The contingency landing location is located 31 mi. (50 km) offshore of VAFB (Figure 2-9).

The 30th Space Wing (30 SW) at VAFB is the USAF Space Command organization responsible for Department of Defense (DoD) space and missile launch activities on the west coast of the United States. Satellites destined for polar or near-polar orbit are launched from VAFB, and ballistic missiles are tested. The wing supports West Coast launch activities for the USAF, DoD, Missile Defense Agency, NASA, foreign nations, and various private industry contractors, including SpaceX.

Figure 1-1. Regional Location of VAFB.

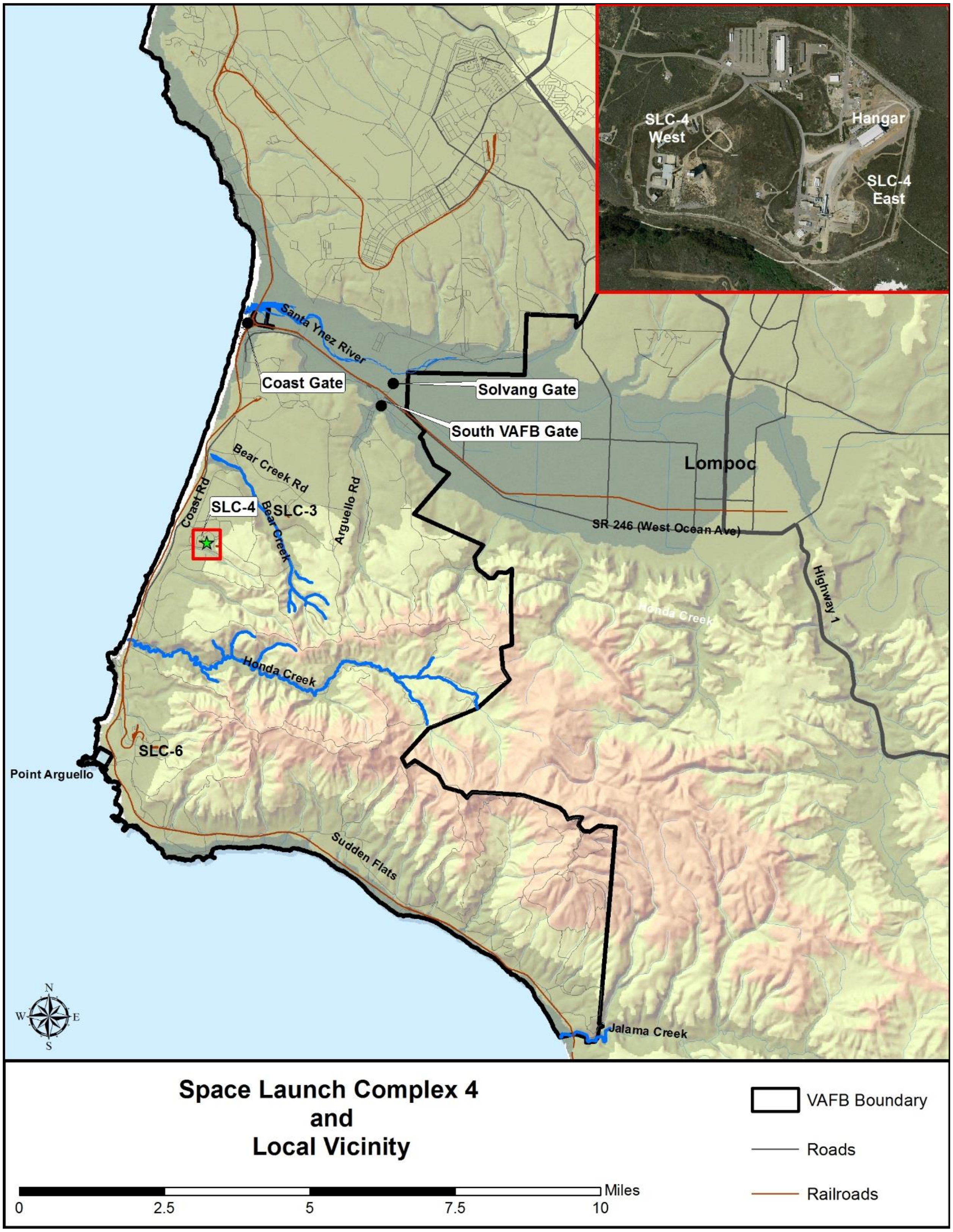


Figure 1-2. Proposed Project Area and Vicinity.

1.4 Scope of the Environmental Assessment

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

The scope of this EA is limited to the boost-back and landing of the first stage of a Falcon 9 Full Thrust vehicle at SLC-4W and the contingency offshore location, and the alternative described in Chapter 2 (Description of the Proposed Action and Alternatives). Launch activities and potential environmental impacts were previously analyzed in the 2011 EA for Falcon 9 and Falcon 9 Heavy Launch Vehicle Programs from SLC-4E on VAFB (USAF 2011a). This EA does not include a multiple booster landing scenario or boost-back and landing of a Falcon Heavy single first stage, as it was included in the Falcon 9 launch program.

1.5 Interagency Coordination and Consultation

The USAF implements a process known as Interagency and Intergovernmental Coordination for Environmental Planning (IICEP), which is used for the purpose of agency coordination and implements scoping requirements. Through the IICEP process, VAFB notified relevant federal, state, and local agencies, and the surrounding communities of the Proposed Action, and provided them sufficient time to make known their environmental concerns specific to the action (Appendix A).

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. VAFB determined that the Proposed Action would not adversely affect coastal zone resources, and the California Coastal Commission (CCC) concurred with a Negative Determination (ND) on 13 October 2014 for modifications to SLC-4W and a one-time Falcon 9 first stage boost-back and landing at SLC-4W, and a ND on 31 August 2015 for recurring boost-back and landing of the Falcon 9 First Stage at SLC-4W and on a barge at least 31 miles (50km) offshore of VAFB, pursuant to 15 C.F.R. 930.35 of the National Oceanic and Atmospheric Administration (NOAA) implementing regulations (Appendix B).

If, after reviewing the EA, 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 reentry license to SpaceX. The FAA will draw its own conclusions from the analysis presented in this EA and assume responsibility for its environmental decisions and any related mitigation measures. For the FAA to use this analysis to support its determination, the EA must meet the requirements of FAA Order 1050.1E, Change 1, *Environmental Impacts: Policies and Procedures*, which contains the FAA's policies and procedures for compliance with NEPA.

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 initiated consultation with the State Historic Preservation Officer (SHPO) 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 C). Native American traditional cultural properties are also protected by the NHPA of 1966, as amended (16 U.S.C. 470). 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. Consultation with the Santa Ynez Band of the Chumash Indians is discussed below in Section 1.6 (Intergovernmental Coordination and Consultation).

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 NOAA National Marine Fisheries Service (NOAA Fisheries) 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. VAFB initiated formal Section 7 consultations with the USFWS to address potential adverse impacts to federally protected species, associated with the construction of the landing pad at SLC-4W. The completed consultation was in the form of a Biological Opinion ([BO] 8-8-14-F-41 [Appendix D]) issued by the USFWS. VAFB also completed informal consultation with the USFWS (2015-I-0208; Appendix D) and informal consultations with NOAA Fisheries (Appendix E) for non-adverse impacts to federally protected wildlife species associated with the boost-back and landing of the Falcon 9 First Stage.

1.6 Intergovernmental Coordination and Consultation

Native American traditional cultural properties are protected by the NHPA of 1966, as amended (16 U.S.C. 470). Traditional cultural properties are eligible for listing in the National Register of Historic Places because of their association with cultural practices or beliefs of a living community that (1) are rooted in that community's history, and (2) are important in maintaining and continuing cultural identity of the community. Traditional cultural properties may be identified by Native Americans or other living communities. Even if resources that are significant to Native American Tribes may not be considered traditional cultural properties, these resources may be afforded protection by other laws, regulations, or EOs.

Section 106 of the NHPA requires federal agencies to consider the effects of their actions on cultural resources listed in or eligible for inclusion in the National Register. The regulations implementing Section 106 (36 C.F.R. §800) specify a consultation process to assist in satisfying this requirement. The 30 SW Commander appointed Christopher Ryan (30 CES/CEIEA) as the Installation Tribal Liaison Officer (ITLO). Mr. Ryan carried out American Indian consultation with Sam Cohen of the Santa Ynez Band of the Chumash Indians (SYBCI), who is the tribal chairman's appointee to VAFB for Section 106 consultations, and Mr. Freddie Romero, who is the elder's council appointee for Section 106 consultations. As the SYBCI is a federally recognized tribe, this also constitutes government-to-government consultation. The SYBCI was notified of the Proposed Action in an e-mail dated 14 October 2014 requesting tribal comments on the Proposed Action and initiating government-to-government consultation (Appendix F). The SYBCI responded on 28 July 2015, indicating that there were no concerns with the Proposed Action (Appendix F).

2 Description of the Proposed Action and Alternatives

This chapter provides detailed descriptions of the Proposed Action (Alternative 1), Alternative 2 for landing the First Stage on a barge in the Pacific Ocean, and the No Action Alternative. Chapter 2 also describes selection criteria used to identify and select alternatives and summarizes alternatives that were considered but eliminated.

2.1 Introduction

SpaceX is currently operating the Falcon Launch Vehicle Program at Space Launch Complex 4 East (SLC-4E). The 2011 EA included First Stage recovery by parachute into the Pacific Ocean between 300 and 500 miles (mi.) west of the California coast (in all launch azimuth directions from VAFB). Modifications to SLC-4W to support landing was not included as part of the analyzed action. SLC-4W was previously used for Titan II launches until this site was officially decommissioned in 2006 after the last Titan IV rocket along with the Titan IV program on SLC 4E. This EA covers the Falcon 9 boost-back and landing and contingency action, not previously analyzed in past EAs.

The Falcon 9 Full Thrust First Stage is 12 ft. (3.7 m) in diameter and 160 ft. (49 m) in height, including the interstage that would be attached during landing. The First Stage includes nine Merlin 1D engines with a total lift off thrust of approximately 1.53 million pounds (lbs.) and consists of aluminum liquid oxygen (LOX) and rocket propellant (RP-1) tanks that hold approximately 662,250 lbs. of LOX and 260,760 lbs. of RP-1. The First Stage currently drops into the Pacific Ocean approximately 300–500 mi. (480–800 km) west of the Baja California coast and is non recoverable.

2.2 Selection Criteria

The range of reasonable alternatives in this EA was identified at VAFB by evaluating their ability to meet the purpose and need of the Proposed Action and their ability to meet the following selection criteria:

- Criterion 1: Landing location within fence line and with controlled access or at contingency landing location in Pacific Ocean if necessary;
- Criterion 2: Contingency landing locations as far from the coastline as possible while maintaining the same boost-back trajectory as for a land landing at SLC-4W.
- Criterion 3: No conflicting or current or future land use has been declared for the VAFB landing site;
- Criterion 4: Recovery and processing of the Falcon 9 First Stage after landing would occur with minimum disturbance to VAFB operations;
- Criterion 5: VAFB landing location with existing water, electrical, and communication infrastructure required for a landing site to minimize the need for new construction and meet timeline goals for implementation;

- Criterion 6: Ability to utilize an existing commercial fiber connection to run video feeds and post-landing communication of the First Stage to mission control, which avoids constructing a new fiber connection to another location on VAFB;
- Criterion 7: VAFB landing location that can accommodate the required 200 x 200 ft. diameter landing pad area;
- Criterion 8: VAFB landing location close enough to the launch site to support a timely processing of the recovered First Stage for subsequent launches; and
- Criterion 9: Minimization of potential negative effects to the environment, including a VAFB landing location that would require minimal impacts to previously undisturbed land and activities that would minimize potential effects to sensitive resources.

In addition, *CEQ Regulations for Implementing the Procedural Provisions of NEPA* 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. A number of alternatives were originally considered but dismissed from detailed analysis in this EA as they were not considered reasonable. The Proposed Action and one action alternative, landing the First Stage on a barge, were the only alternatives that were carried forward for further evaluation because these alternatives best met the purpose and need while meeting the screening criteria. One feasible alternative was identified for consideration but eliminated (see Section 2.5, Other Alternatives Considered and Eliminated from Further Analysis).

2.3 Alternative 1 (Proposed Action)

Alternative 1 includes: infrastructure improvements at SLC-4W; the boost-back maneuver (in-air) and landing of the Falcon 9 First Stage on the new pad at SLC-4W; the boost-back and landing of the Falcon 9 First Stage on a barge specifically designed for the landing and located at least 31 mi. (50 km) offshore of VAFB; and implementation of an autonomous flight termination system for Falcon 9 launch and boost-back.

Alternative 1 meets all of the selection criteria and has been selected as the Proposed Action for the following reasons:

- SLC-4W was previously used as a launch complex facility; the area is fenced with controlled access (Criterion 1).
- The contingency landing location is the furthest from the coastline that SpaceX is able to place the landed stage and maintain the same boost-back trajectory as for a land landing at SLC-4W (Criterion 2).
- Use of SLC-4W is compatible with current and future land use plans (Criterion 3).
- SLC-4W offers an area removed from most current VAFB operations; recovery and processing of the First Stage after landing would occur with minimum disturbance to VAFB operations (Criterion 4).
- SLC-4W contains existing water, electrical, communication infrastructure (Criterion 5)
- SLC-4W has a commercial fiber connection (Criterion 6).

- SLC-4W can accommodate the required 200 x 200 ft. diameter landing pad area (Criterion 7).
- SLC-4W is adjacent to the launch pad at SLC-4E (Criterion 8), which will support a timely processing of the First Stage for subsequent launches. SLC-4W is a previously disturbed site (Criterion 9).

2.3.1 SLC-4W Infrastructure Improvements

SpaceX would construct a 200 ft. (61 m) diameter concrete landing pad at SLC-4W (Figure 2-1). There is currently no flat area within SLC-4W that can support this configuration without site grading activities. Construction activities would require approximately 30 personnel onsite, originating from the local area. Construction of the pad is anticipated to occur in April 2016; however, it may occur any time of year. Construction would require up to 45 days. Site grading is required to provide a flat compacted area to construct the concrete pad. Approximately 25,000 cubic yards (19,114 cubic meters [m^3]) of soil would be excavated. Any soil excavated at the project site would be redistributed on-site and not transported elsewhere.

The concrete for the new landing pad would be sourced from a combination of two contractors located in Lompoc and Nipomo, California. Approximately 153 truckloads of concrete would be delivered from Lompoc, California, and approximately 77 loads would be delivered from Nipomo, California. Each load would carry approximately 8 cubic yards (6.1 m^3) of concrete. Aggregate base would be applied under the concrete landing pad, requiring approximately 215 truckloads of P209 base delivered from Santa Ynez, California. Recycled ¾-inch aggregate base would be applied under the perimeter and approach roads, which require approximately 350 truckloads delivered from Buellton, California.

The pad would be constructed to control all runoff from the landing pad. A v-ditch surrounding the pad would convey storm water to the appropriate location as well as provide containment for potential spill or firefighting measures, including any water applied by the FireX system. In addition, all stormwater coming off the landing pad would be directed to an infiltration basin designed and sized according to the SWRCB Construction General Permit (WDID Number: 3 42W000312).

A FireX system would be constructed to control any fires that could be ignited during the Falcon 9 First Stage landing. The system would have 3 to 4 remote controlled water cannons (similar to SLC-4 East [E]) mounted on posts above ground to allow for remote firefighting capabilities. The existing underground water lines at SLC-4 are sufficient in size to support the FireX system. Trenching for new water lines to connect the FireX system to the existing water distribution system would be required.

The existing access road would be realigned, widened to approximately 40 ft. (12 m) and paved with asphalt, to support First Stage removal from the landing pad and ground support equipment access to process the First Stage. Ground support equipment includes a 16 ft. flatbed trailer and a fuel truck to offload any remaining RP-1 from the First Stage.

Figure 2-1. Proposed Concrete Landing Pad and New Road.

Construction of the pad and roadway improvements would result in approximately 56,000 square feet ($ft.^2$) (5,203 square meters [m^2]) of new impervious surface. Ground based communication, tracking, and video equipment is required and existing infrastructure at SLC-4W (existing conduits, camera stands, junction boxes) would be used to the greatest extent possible to reduce requirements for trenching. Further site design is required to determine exact locations of this infrastructure.

Project Equipment Needs and Site Access

The Proposed Action includes construction of the concrete landing pad at SLC-4W and improvements to existing access roads. Construction is anticipated to take 45 days. During an additional 45 to 75 days, concrete would be curing and minimal construction activities and noise would occur. Table 2-1 lists the equipment that would be used for construction of the project. Generators would be registered under California's PERP. In areas where sensitive resources are noted by the 30th Space Wing, Installation Management Flight, Environmental Quality (30 CES/CEIEC), or Environmental Conservation (30 CES/CEIEA) personnel, access would be either straight from a paved area or circuitously in a route that would avoid impacts.

Table 2-1. Estimated Equipment Usage under the Proposed Action.

Equipment Description	Quantity	Make/Model or horsepower	Estimated Usage (days)*
Bulldozer	1	Caterpillar D-6	14
Excavator	1	Caterpillar 450	30
Vibratory drum compactor	1	6-foot sheepsfoot	30
Loader (2 cubic yards)	1	Caterpillar 950	30
Water truck	1	2,000 gal	30
Dump truck	1	12 yard	30
Pickup trucks (crew transportation)	2	Ford F250	30
Concrete pumping truck	1	300 hp diesel	7
Concrete hauling truck (8 cubic yards)	5	300 hp diesel	7

* Estimated usage is based on 5 working days per week, at 8 hours per day.

It is likely that any construction or oversize trucks would access SR 246 from Hwy 101 (Figures 1-1 and 1-2). From the north, SR 246 would be accessed through the city of Lompoc, at Hwy 1 (H Street) and Ocean Avenue (Figure 1-2). This route is not likely to be used as it entails traversing the entire length of Lompoc. It is more likely that any large construction trucks or oversize trucks would travel south on Hwy 101 to SR 246 in Buellton, CA, and take SR 246 west to either the South Gate or the Coast Gate (depending on the truck's size).

Workers and construction equipment for this project would likely access the Base through the South VAFB Gate, and proceed south on Arguello Road, then west on Bear Creek Road to access Coast Road. They would proceed south on Coast Road until reaching Kelp Road, and then proceed east on Kelp Road to SLC-4W. Oversized trucks bringing construction materials would likely take SR 246 to its terminus and enter VAFB through the Coast Gate. They would then proceed south on Coast Road until reaching Kelp Road and then proceed west to SLC-4W.

2.3.2 Falcon 9 Boost-Back and Landing

SpaceX proposes to return the Falcon 9 Full Thrust First Stage to SLC-4W at VAFB for potential reuse. 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 triggered to flip the First Stage into position for retrograde burn. Three of the nine First Stage Merlin 1D engines would restart 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 should 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 should slow the First Stage to a velocity of zero before landing on the landing pad at SLC-4W. Figure 2-2 provides a graphical depiction of the boost-back and landing sequence.

The frequency of boost-back and landings at SLC-4W of the Falcon 9 First Stage would be up to six per year. Operation of the facility would be completed by existing onsite personnel.

Boost-back trajectories would be specific to each particular mission, but would fall within lower and upper limit azimuths (153 degrees to 301 degrees), as defined for the Western Range in Volume 1 (1 July 2004) of the AFSPCMAN 91-710, *Range Safety Requirements*. Figure 2-3 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). The detailed sequence of events for First Stage landing along with trajectory data would be provided in the Flight Safety Data Plan (FSDP) once it is finalized.

SpaceX would submit a Final Flight Data Package (FFDP) to 30 SW/SE specific to each particular mission to assess the acceptance of flight and determination of the hazards to the general public. The FFDP would include information on the boost-back and landing at an offshore location 31 mi. (50 km) offshore from VAFB. This data would be used to perform launch vehicle risk assessments, develop in-flight abort criteria and identify risk mitigation measures (evacuation of launch area, define hazardous airspace/seascape, etc.) to ensure safety of flight. Each stage of the Falcon 9 vehicle would have an USAF approved Flight Termination System that would be used to terminate flight if any of the predetermined flight criteria are violated during flight. The landing trajectory would take into account all valuable assets to minimize risk of impact from potential debris corridors if the flight must be terminated. Over-flights of manned assets may not be feasibly avoided during all boost-back events. In these cases, all manned facilities are already evacuated during the launch and would remain evacuated during the boost-back, since the boost-back occurs immediately after the launch.

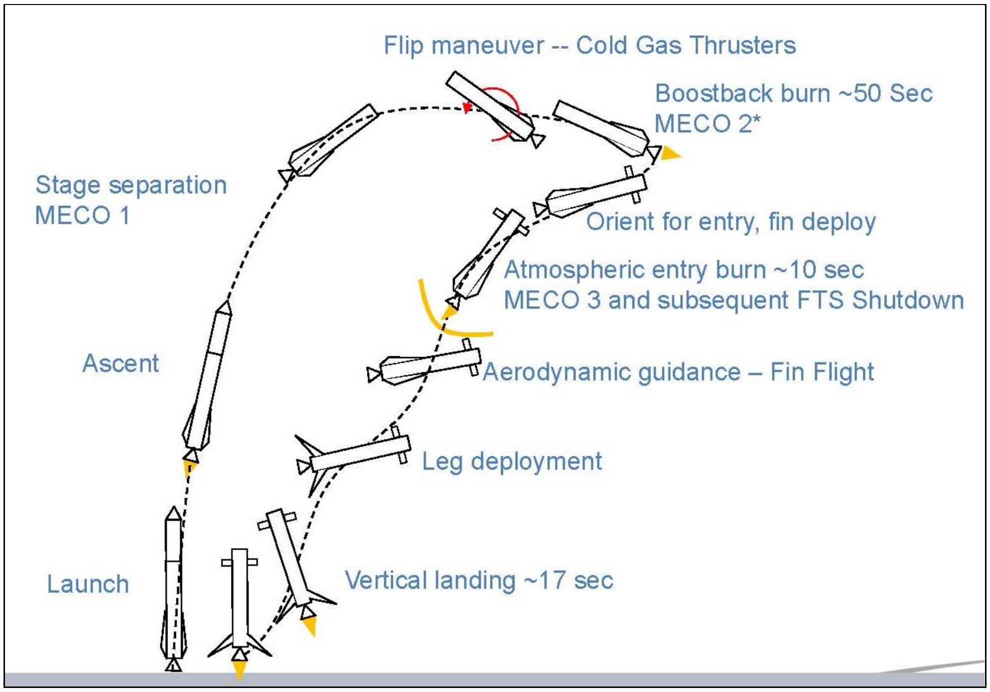


Figure 2-2. Stages of Boost-Back and Propulsive Landing.

During descent, a sonic boom (overpressure of high energy impulsive sound) would be generated while the first-stage booster is supersonic. The overpressure would be directed at the coastal area south of SLC-4 and would reach as high as 2.0 pounds per square foot (psf) on VAFB. The Northern Channel Islands may experience a sonic boom of 3.1 psf. Figures 2-4 and 2-5 show the modeled sonic boom of a landing event with an incoming trajectory for a light payload and heavy payload. Engine noise would also be produced during the landing of the Falcon 9 First Stage (**Error! Reference source not found.**6), but it would be less than the noise enerated during the launch. The sonic boom and landing noise are an expected part of the Proposed Action and help define the region of influence for the affected environment. As such, they are described here and the effects of the expected sonic boom and landing noise are described in Chapter 4 (Environmental Consequences).

Although propellants would be burned to depletion during flight, there is a potential for approximately 7,000 lbs. of densified LOX and a maximum of 2,750 lbs. of RP-1 to remain in the Falcon 9 First Stage upon landing. Final volumes of fuel remaining in the First Stage upon landing may vary and would be included in the FSDP.

Safing activities would begin upon completion of all landing activities and engine shutdown. The LOX oxidizer system would be purged, and any excess fuel would be drained into a suitable truck mounted container or tanker for disposal or re-use. Any remaining pressurants (i.e., helium or nitrogen) would be vented, and any flight termination system (FTS) explosives would also be rendered "inert" prior to declaring the vehicle safe. The vehicle would then be lifted and placed on to the stand; the landing legs would then be removed or folded back into place. The vehicle would then be lowered into a horizontal position, placed on a transport vehicle and taken to a post-processing

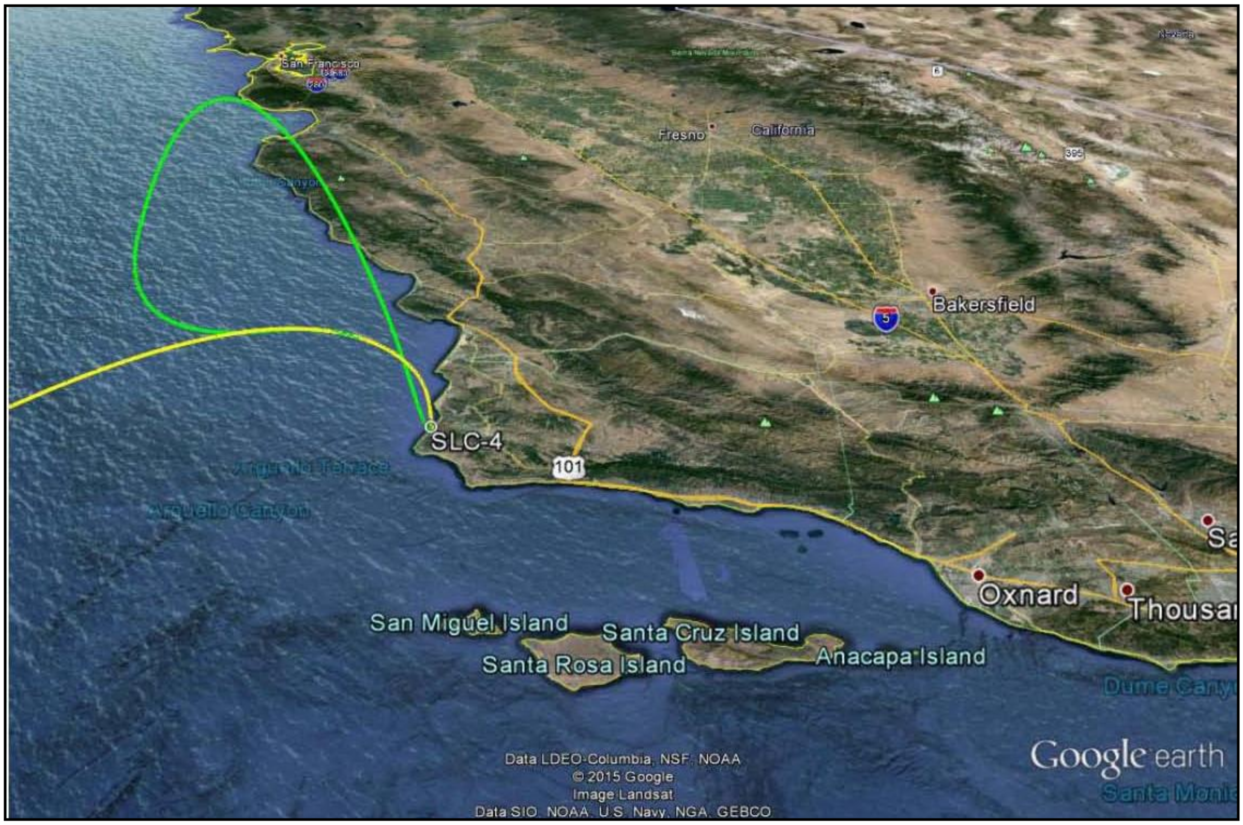


Figure 2-3. Trajectories for the First Stage Return Path (green line) and Second Stage Path (yellow line) of the Falcon 9 for a landing at SLC-4W on VAFB.

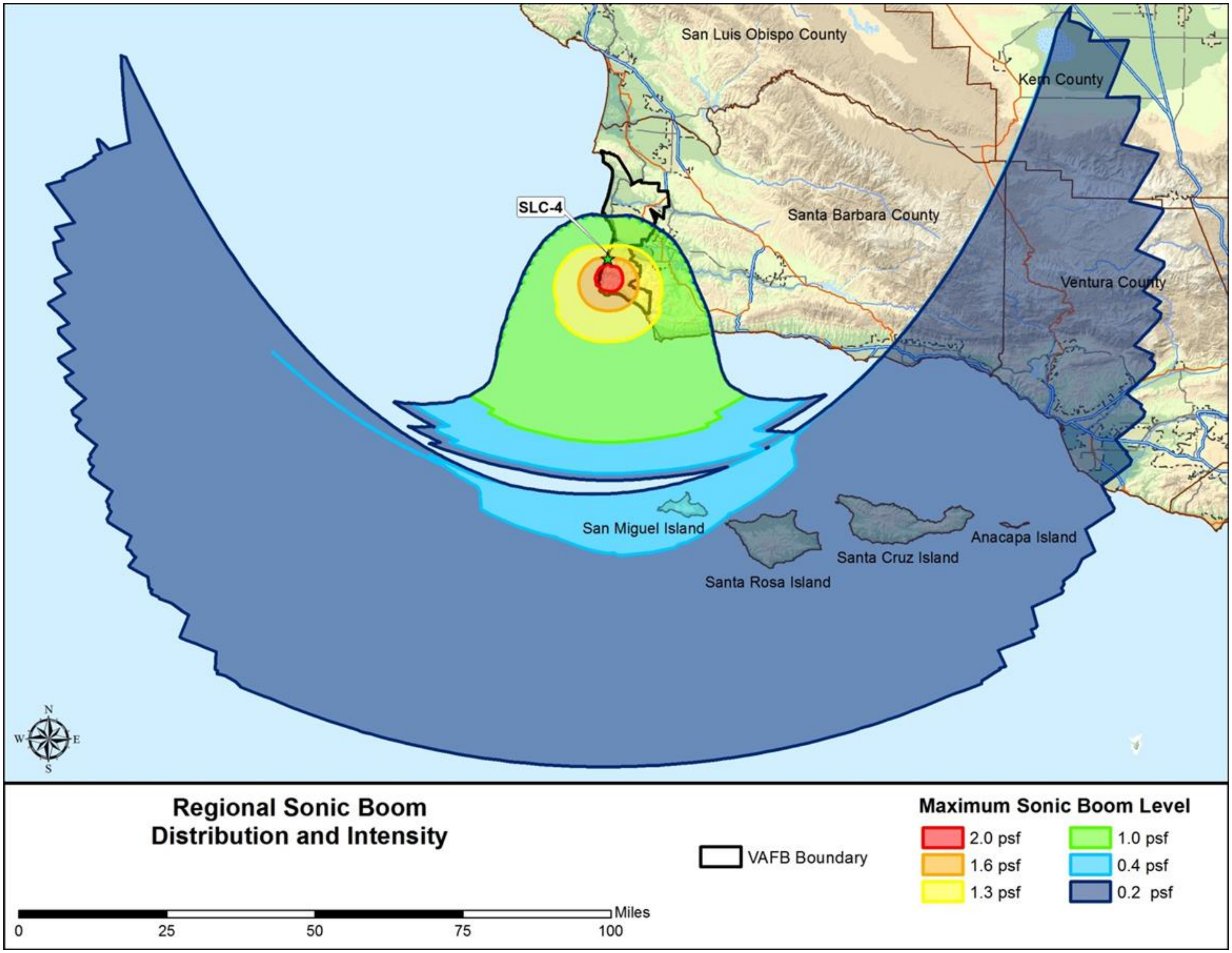


Figure 2-4. Regional Sonic Boom Distribution and Intensity for Pad Landing at SLC-4W with an Incoming Trajectory for a Light Payload on VAFB.

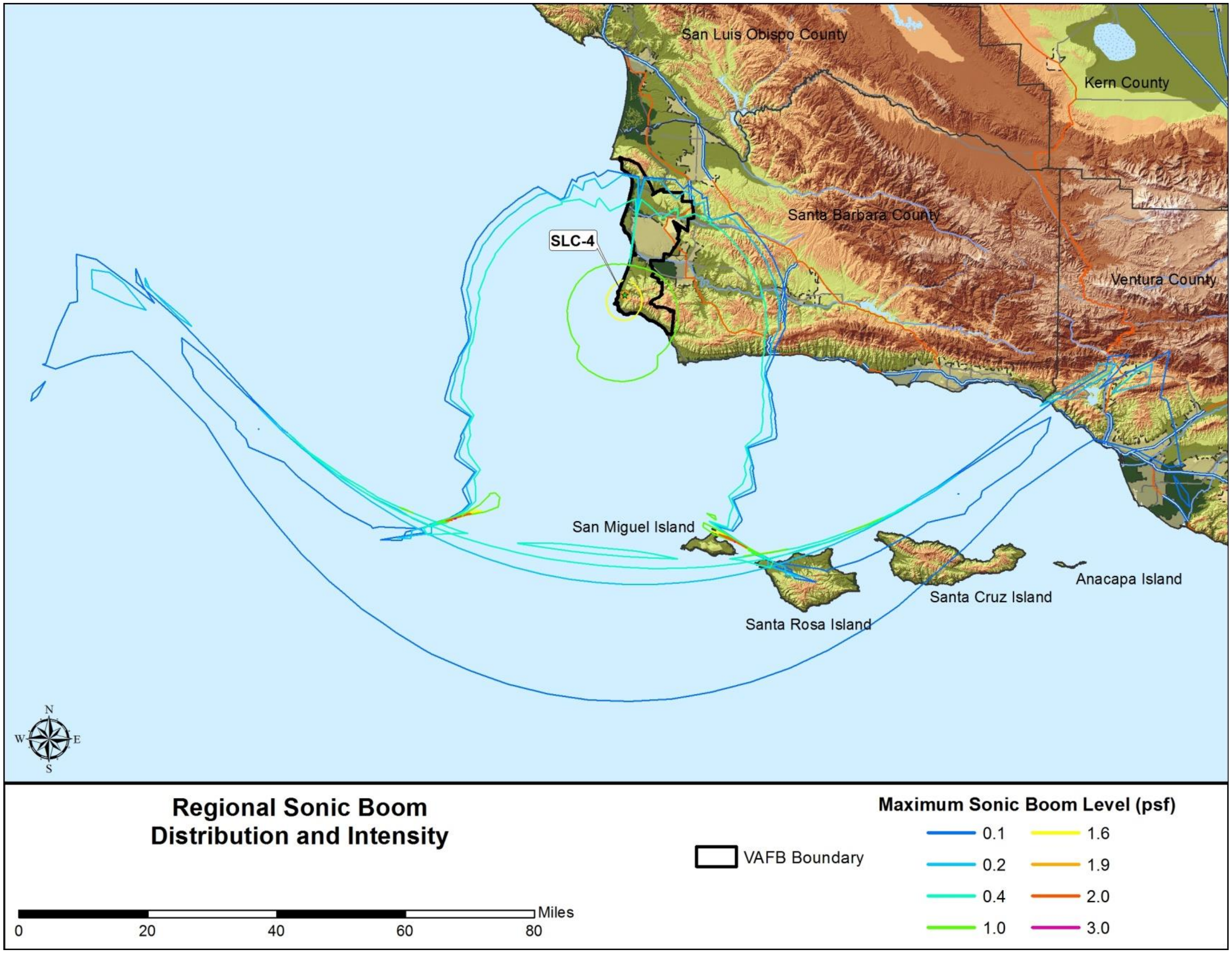


Figure 2-5. Regional Sonic Boom Distribution and Intensity for Pad Landing at SLC-4W with an Incoming Trajectory for a Heavy Payload on VAFB.

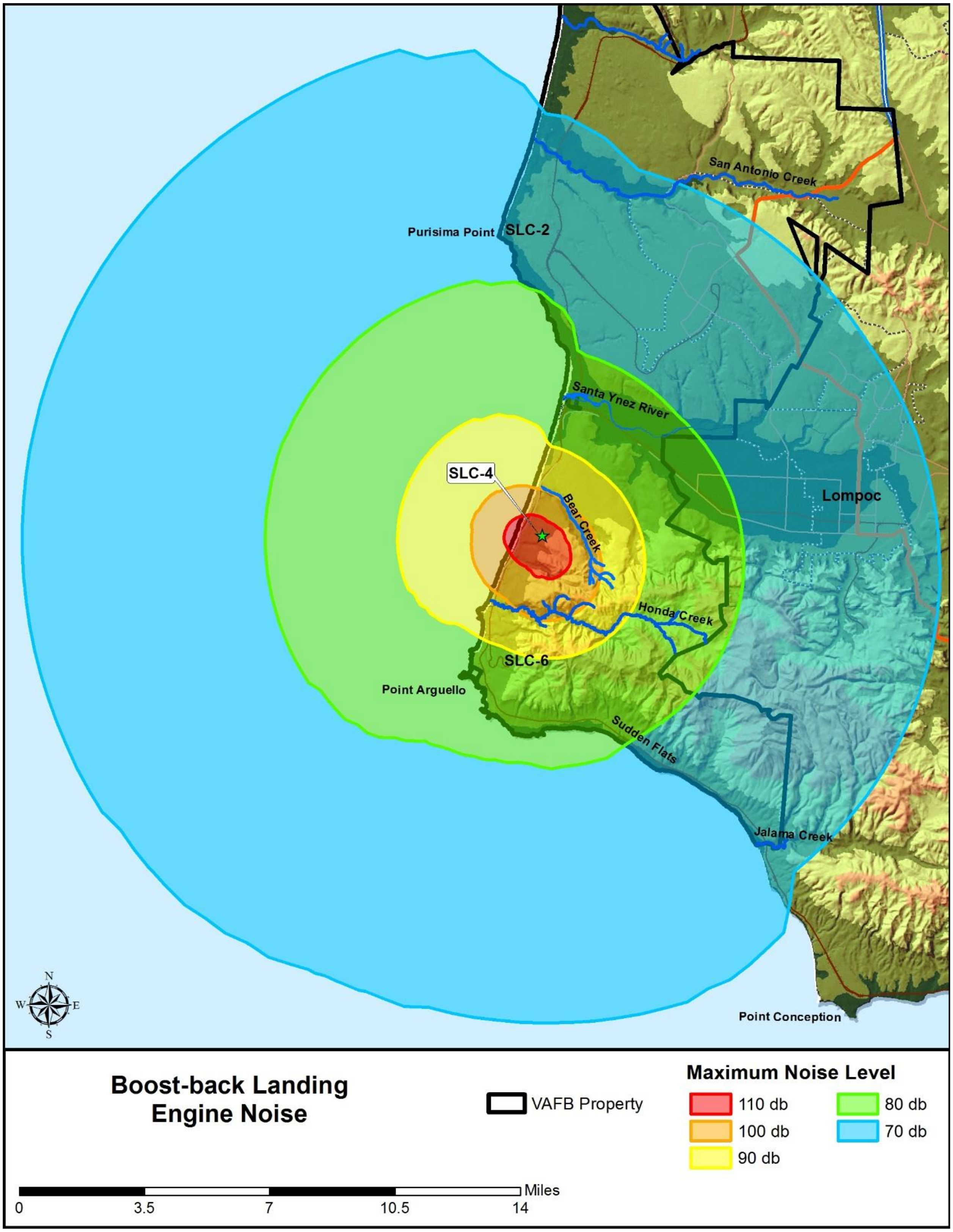


Figure 2-6. Regional Landing Noise Intensity Map for Pad Landing at SLC-4 on VAFB.

facility. A ground crew would perform and supervise all landing operations and would be familiar with the operating protocol including all potential "off nominal" events.

2.3.2.1 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 to a barge, specifically designed to be used as a landing platform for the First Stage, and located no less than 31 mi. (50 km) offshore of VAFB (Figure 2-7). 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 do not permit for a successful landing attempt. The contingency landing location is the furthest from the coastline that SpaceX is able to place the landed stage and maintain the same boost-back trajectory as for a land landing at SLC-4W. It is important for Range Safety analysis that the trajectory for a barge landing is the same as land landing to verify stage-landing performance.

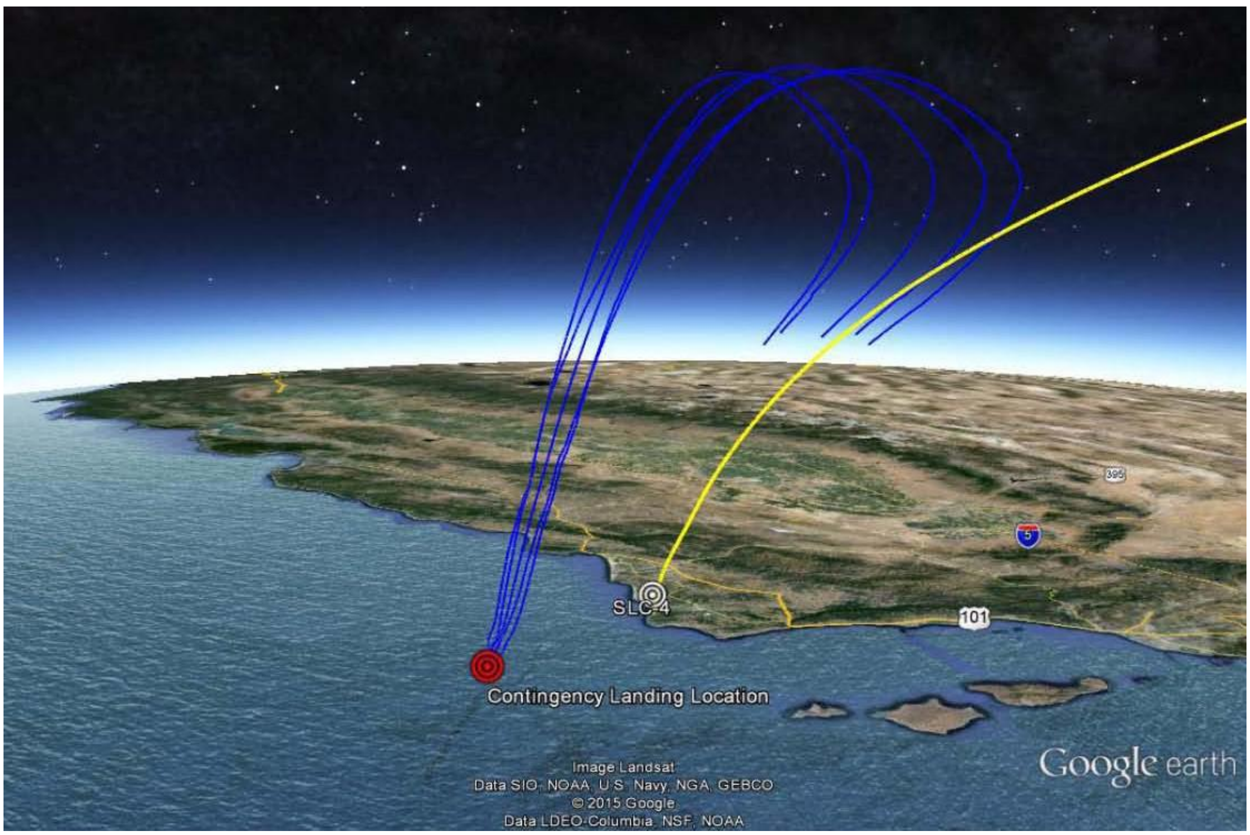


Figure 2-7. Trajectories for Variations of the Contingency First Stage Return Path to a Barge Landing Location 31 mi. (50 km) off of VAFB (blue lines) and Second Stage Path (yellow line).

The maneuvering and landing process described above for a pad landing would be the same for a barge landing. Prior to a barge landing a notice to mariners and a notice to air man for all pilots would be issued via the Range.

Three vessels would be required for a barge landing:

1. Barge/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 barge to be used as the landing platform was originally a McDonough Marine Deck Barge with dimensions of 300 ft. (91.4 m) by 100 ft. (30.5 m) (**Error! Reference source not ound.**8). 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. (45.7 m) 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 (COI) for its operation under the service of Research Vessel.

Figure 2-8. Barge Landing Platform.

The Support Vessel is a 165 ft. (50.3 m) 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 a representative on this vessel during the operation and a representative in the Launch and Landing Control (LLC) on VAFB to coordinate required clears and approve access back to the barge after the landing.

The Tug is a 120 ft. (36.6 m) 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 and transport to a SpaceX testing facility in McGregor, Texas to complete acceptance testing again before re-flight. Once testing is completed, it would be transported back to the SLC-4W pad or another SpaceX launch facility for reuse. Hazardous materials would be off-loaded from the First Stage after the barge is docked in Long Beach Harbor (see Section 2.2.3, Falcon 9 Boost-Back and Landing, for discussion of fuels).

During descent, a sonic boom (overpressure of high energy impulsive sound) would be generated while the first-stage booster is supersonic. The overpressure would be directed at the ocean surface no less than 31 mi. (50 km) off the coast of VAFB. SpaceX contracted Wyle to perform a noise analysis for a boost-back landing on the pad at VAFB, and Wyle determined sonic overpressures would reach as high as 2.0 psf approximately 6 mi. (3.7 km) south of SLC-4 and 3.1 on the Northern Channel Islands (Figure 2-4 and 2-5; Wyle 2015). The SLC-4W pad-based landing overpressure modeling was roughly extrapolated to show potential noise impacts for landing 31 mi. (50 km) to the west of VAFB. This extrapolation suggests that the maximum overpressure that would impact land during a barge landing would be 0.4 psf (Figure2-9 and 2-10).

Engine noise would also be produced during the barge landing of the Falcon 9 First Stage; similar to the sonic boom intensity estimation, data extrapolation from the pad landing suggests that engine noise would not be heard on land from this action (Figure 2-11).

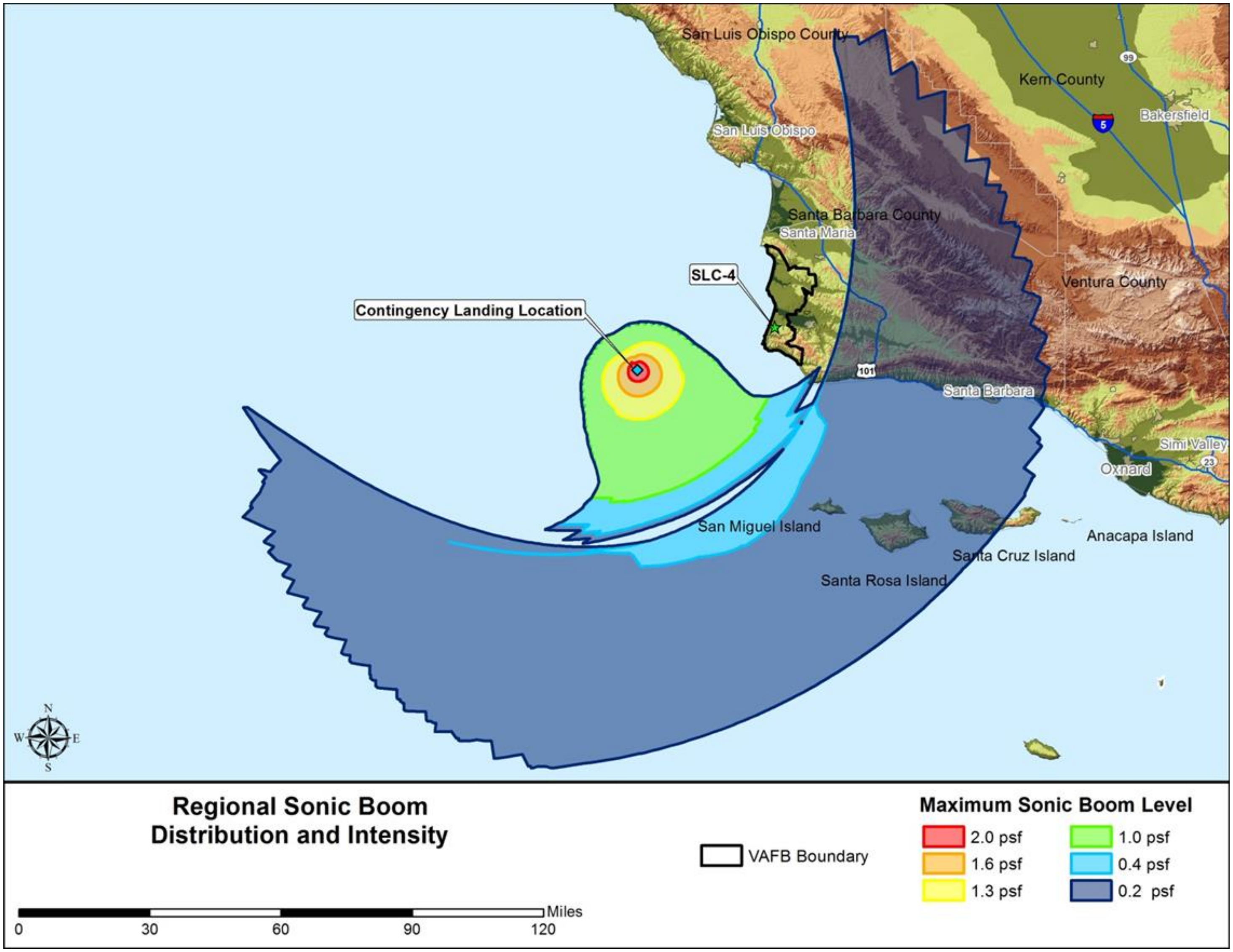


Figure 2-9. Hypothetical Sonic Boom Overpressure for Contingency Action of Barge Landing 31 mi. (50 km) Offshore of VAFB with an Incoming Trajectory for a Light Payload.

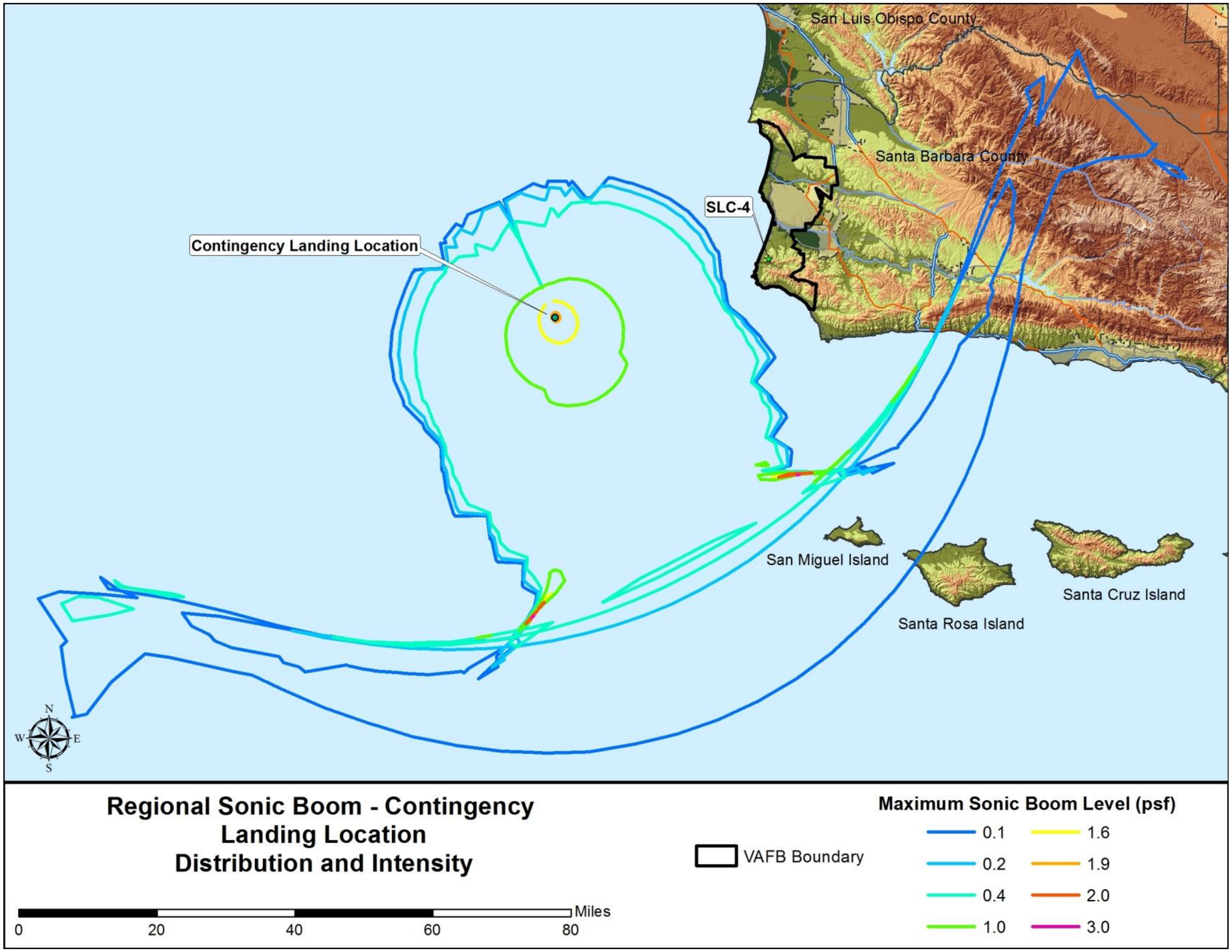


Figure 2-10. Hypothetical Sonic Boom Overpressure for Contingency Action of Barge Landing 31 mi. (50 km) Offshore of VAFB with an Incoming Trajectory for a Heavy Payload.

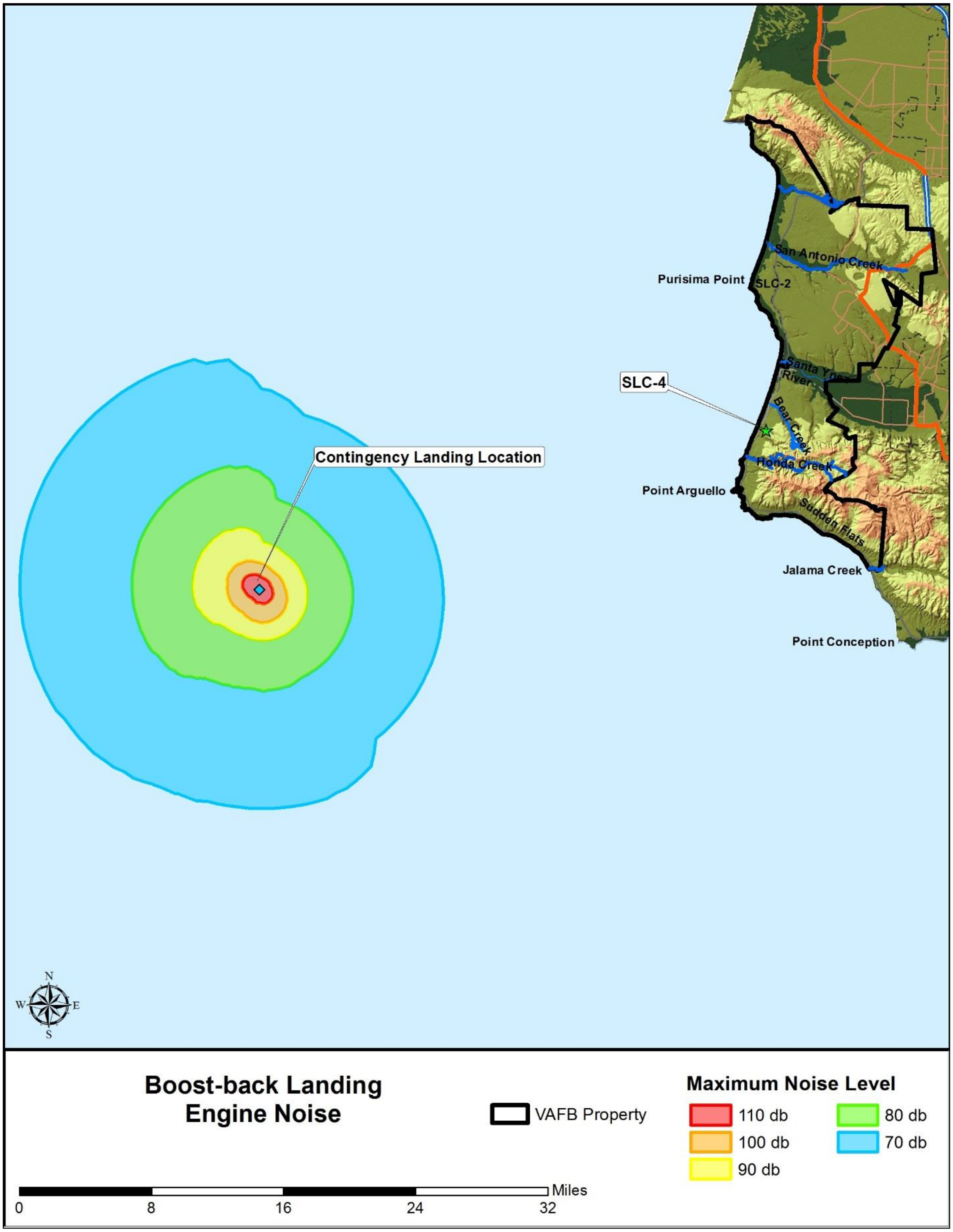


Figure 2-11. Approximate Regional Landing Noise Intensity Map for Contingency Action Barge Landing 31 mi. (50 km) off of VAFB.

2.3.2.1.1 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 tow line for towing to Long Beach Harbor.

T- = time to scheduled launch; T+ = time after launch

2.3.2.1.2 For an Unsuccessful Barge Landing Attempt

SpaceX has attempted barge landings on three separate occasions, two off the coast of Florida and one off the coast of California (Figure 2-12). All of these attempts were not successful and resulted in the First Stage impacting the barge and exploding. A photograph of the barge after one of the unsuccessful landing attempts is shown in Figure 2-13. In the event of an unsuccessful landing attempt, the First Stage would explode upon impact with the barge. A system safety analysis was performed by Bastion Services related to First Stage recovery operations. This analysis concentrated on safety hazards related to an unsuccessful First Stage landing attempt. The explosive equivalence of the First Stage with maximum fuel and oxidizer is 503 lb. of trinitrotoluene (TNT). This amount of TNT would be capable of generating a maximum projectile range of 1,250 ft. (381 m) from the point of impact.

SpaceX has experience performing recovery operations after unsuccessful barge landings for previous Falcon 9 First Stage landing attempts. This experience, in addition to the debris catalog that identifies all floating debris, has revealed that approximately 25 pieces of debris remain floating after an unsuccessful barge landing. The surface area potentially impacted with debris

Figure 2-12. Barge Landing Attempt

Figure 2-13. Barge Landing Platform after an Unsuccessful Landing Attempt.

would be less than 114 ac. (0.46 km^2), and the vast majority of debris would be recovered. All other debris sinks to the bottom of the ocean.

These 25 pieces of floating debris are primarily made up of Carbon Over Pressure Vessels (COPVs), the LOX fill line, and carbon fiber constructed landing legs. SpaceX has performed successful recovery of all of these floating items during previous landing attempts. An unsuccessful barge landing would result in a very small debris field, making recovery of debris relatively straightforward and efficient. All debris recovered offshore would be transported back to Long Beach Harbor.

Upon impact with the landing barge, the First Stage should contain at most 2,750 lbs. of RP-1 on board. If the landing is unsuccessful, most of this fuel would be consumed during the subsequent explosion; residual fuel would be released onto the barge deck at the location of impact. In cases where the First Stage booster misses the barge entirely, SpaceX's scientists assume that 2,750 lbs. of RP-1 would be released into the ocean. Final volumes of fuel remaining in the First Stage upon landing may vary and would be included in the FSDP, but SpaceX's scientists anticipate it to be below the high range estimations.

Very light oils, including RP-1, are highly volatile, which means they evaporate quickly when exposed to the air, and are usually completely dissipated within 1–2 days after a spill. Clean-up following a spill is usually not necessary, or possible, with spills of very light oil, particularly with such a small quantity of oil (USFWS 1998). Therefore, no attempt would be made to boom or recover RP-1, if any of the fuel is released directly into the ocean. Any RP-1 remaining on the barge deck from an unsuccessful landing attempt would be recovered, contained, and handled per federal, state, and local agency requirements.

The trajectory path of the First Stage for a barge landing is shown in Figure 2-7. The explosion of the First Stage would generate an in-air impulsive noise that would propagate in a radial fashion away from the barge. Based on the size of the anticipated explosion, Sadovsky equations were used to calculate peak received levels (received levels are a function of charge weight and distance from source) at sound pressure contour lines. Since the sound pressure levels were peak levels, the approximate root mean squared (RMS) values were estimated by converting peak to RMS (peak pressure value * 0.707). These values were then converted into dB re 20 μPa to determine distances to defined contour levels and in-air threshold levels. To generate realistic sound pressure contour lines, atmospheric attenuation was included in the model. Calculations for atmospheric attenuation included the following assumptions: the explosion was assumed to be 250 hertz (Hz) or less, relative humidity was assumed to be 30 percent, and air temperature was assumed to be 50 degrees Fahrenheit (°F).

Figure 2-14 depicts dB contours from the source level (150–180 dB) to 16.5 mi. (26.5 km), at which point the blast wave would deteriorate to 90 dB. This model does not take into account additional factors that would attenuate the blast wave further, including sea surface roughness, changes in atmospheric pressure, frontal systems, precipitation, clouds, and degradation when encountering other sound pressure waves. Thus, the estimated area of exposure is conservatively overestimated.

2.3.3 Autonomous Flight Safety System

The launch vehicle would be equipped with both a thrust termination and a destructive flight termination system in the event it varied from the planned trajectory. The thrust termination system is activated by a command from the appointed officer from the 30 SW Safety (30

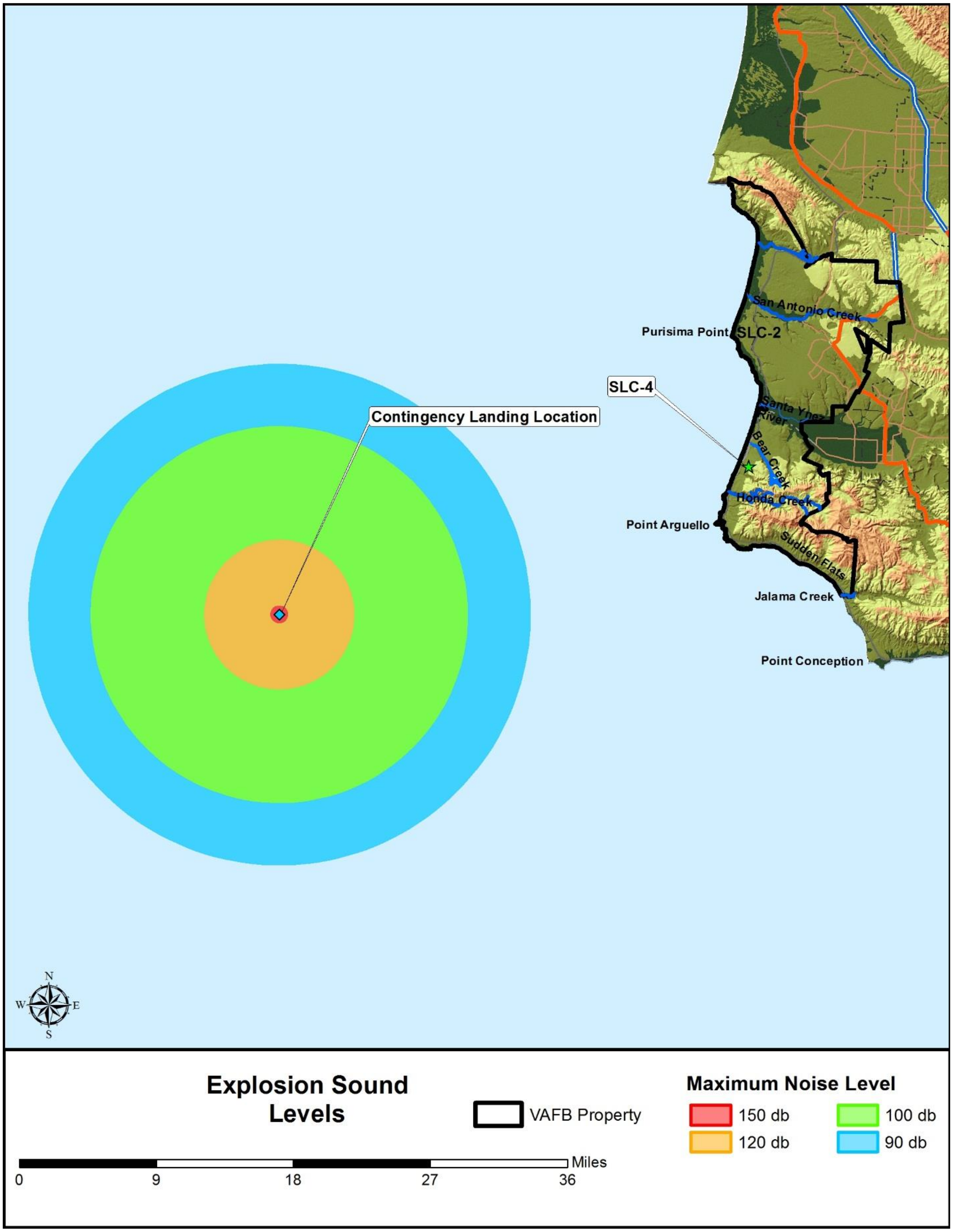


Figure 2-14. Estimated Explosion Blast Noise Intensity Map for an Unsuccessful Barge Landing 31 mi. (50 km) off VAFB.

SW/SE) and disables power to the vehicle engines. Once power is removed, there are up to six different valves that close and immediately shut off the first stage engines. Four valves close on the second stage, again shutting down the stage's engines. Thus, upon activation of the thrust termination system, the Falcon 9 launch vehicle would fall intact and may explode upon impact, depending on the circumstances and time in the flight when the termination is activated. The flight termination system also includes linear shaped charges intended to rupture the vehicle tanks when commanded to destruct, thus dispersing propellants. In this event, the debris would impact a wider area but in smaller pieces. The termination method selected by 30 SW/SE officer would be based on the vehicle's trajectory and its payload.

In addition, the AFSS would be used as the primary FTS after three certification flights and completion of qualification testing by 30 SW/SE. The AFSS uses a Global Positioning System (GPS) aided, onboard computing system to process flight performance data and compare against precompiled mission rules determined by the 30 SW/SE. The use of existing 30 SW "mission rules" provides the criteria used to determine if a flight should be terminated in exactly the same way the Mission Flight Control Officer would do in the existing concept of operations. If, and when, a violation is detected the system activates explosive shape charges on both stages of the vehicle, in the same way as the current systems. These charges are designed to rupture the vehicle propellant tanks and primary structure, thereby ensuring that the vehicle is cleanly destroyed and the flight effectively terminated. The AFSS would the same ordnance as the manned FTS in the event of an erratic or out of control flight.

2.3.4 Environmental Protection Measures

Implementation of the environmental protection measures (EPMs) outlined below would avoid or minimize potential adverse effects to various environmental resources during implementation of the Preferred Alternative. Mandatory EPMs (denoted by "shall" or "would") are part of the project design and would be implemented as part of the Proposed Action so as 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. Implementation of all measures would be overseen by qualified SpaceX personnel or contractor staff.

2.3.4.1 Air Quality – 1 (Air-1)

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

- 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 mi. 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.
- The amount of disturbed area at any given time would be minimized by limiting disturbance to the smallest area practicable.

- On-site vehicle speeds would be reduced to a maximum of 15 mph.
- Gravel pads or rumble plates would be installed at all access points to prevent tracking mud onto public roads.
- 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.
- Designate a person or persons to monitor the dust control program and to order increased watering, as necessary, to prevent transporting dust off-site.

2.3.4.2 Air Quality – 2 (Air-2)

The following measures would be implemented to reduce nitrogen oxides (NO_x) and fine particulate matter ($PM_{2.5}$) emissions from construction equipment:

- Before construction begins, portable equipment meeting the criteria defined in the Emergency Regulation Order, effective 27 April 2007 for the California PERP 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 or unloading would be limited to 5 minutes.
- Worker trips would be minimized through carpooling.
- All 1995 and older engine model vehicles with a gross vehicle weight rating (GVWR) of 26,000 lb. or less (e.g., trucks delivering materials, water trucks and cement mixers) must meet 2010 manufacturing year engine emission standards. Additionally, all 1996 models must meet 2010 manufacturing year engine emission standards if the project construction extends into 2016.
- All vehicles with a GVWR greater than 26,000 lb. (e.g., semi-trucks) must meet particulate matter best available control technology. Additionally, all 1993 and older engine model vehicles must meet 2010 manufacturing year engine emission standards. If the project construction extends into 2016, all 1994 through 1995 engine model vehicles must meet 2010 manufacturing year engine emission standards.

2.3.4.3 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, the USAF would stage and operate vehicles and equipment 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.
- 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.

2.3.4.4 Biological Resources – 2 (Bio-2)

The following measures would be implemented to minimize potential impacts on federally listed species protected under the jurisdiction of the USFWS, in addition to the following EPMs:

- Prior to conducting any project activities, a qualified biologist would clearly mark sensitive species and habitats within the project site and the immediate area to prevent workers or equipment from adversely affecting species or habitats that are not expected to be damaged during the project.
- SpaceX would cover trenches, holes, and pipeline routes at the conclusion of project activities to avoid the entrapment of animals. If a project lasts for more than 1 day, the SpaceX would cover these areas or provide an escape route.
- All applicable minimization, monitoring, and avoidance measures in VAFB's Biological Opinions pertaining to the project (8-8-14-F-41 [USFWS 2014a] and the USFWS concurrence letter (2015-I-0208) would be implemented during construction and operation and maintenance of the project.

El Segundo Blue Butterfly

- Areas with seacliff buckwheat would be flagged and a 2-ft. buffer maintained where avoidance does not jeopardize fire suppression, security requirements, or program operation needs. If seacliff buckwheat is removed, El Segundo blue butterfly (*Euphilotes battoides allyni* [ESBB]) habitat would be enhanced following the ratio described below.

- If removal of or damage to seacliff buckwheat is necessary to meet fire suppression, security requirements, or program operation needs, a qualified biological monitor would be present to ensure impacts are minimized and quantified.
- To avoid potential impacts to adult ESBB, vegetation clearance and access road construction would occur outside of the ESBB flight season, 1 June through 15 September, if feasible.
- ESBB habitat would be enhanced at a 2:1 ratio (habitat enhanced: habitat affected). Enhancement activities would include herbicide treatment and hand removal of invasive plants, planting native seedlings, and sowing native seed. Herbicides would not be applied during the flight season (1 June through 15 September). USFWS-approved biologists would collect native seed for sowing and propagating buckwheat seedlings.
- An appropriate area for ESBB habitat enhancement activities would be selected by CEIEA that would not have impacts to sensitive species (i.e., an area currently occupied by invasive species, with no federally listed species present, and that is not anticipated for future development).
- Only buckwheat species that are native to VAFB would be planted. Habitat enhancement activities would be conducted after construction of the landing pad is complete and the area of affected habitat can be assessed. Planting would occur during the following late fall or early winter to coincide with the onset of the rainfall season.
- If more than 118 seacliff buckwheat plants are removed during SLC-4W site improvements, the USAF would reinitiate formal Section 7 consultation with the USFWS.

California Red-legged Frog

- If construction activities are conducted during the wet season and water is present in Spring Canyon, daily pre-construction surveys would be conducted to ensure that dispersing frogs have not entered the project site.
- If trenching activities occur during the wet season, open trenches would be inspected at the end of the day for the presence of California red-legged frog (*Rana draytonii* [CRLF]), covered at night, and inspected in the morning to determine whether CRLF have inadvertently become trapped in the trenches.
- A USFWS-approved biologist would relocate all life stages of CRLF found within the project site to the nearest suitable habitat outside of the project site but within the same watershed.
- If two adult, subadult, or juvenile CRLF are found dead or injured or if five are captured and relocated, the USAF would contact the USFWS Ventura office immediately to reinitiate formal Section 7 consultation. Project activities that are likely to cause additional take would cease during this review period.
- Silt fence would be installed in between the project site and Spring Creek to ensure no siltation occurs and to minimize dispersing frogs from entering the project site.

Southern Sea Otter

- Sonic boom modeling would be conducted prior to boost-back and landing events to determine the intensity and most likely impact locations.

- A USFWS-approved biologist would monitor southern sea otters (*Enhydras lutris nereis*) whenever a sonic boom of 1 psf or greater is predicted to be generated by the boost-back that would impact southern sea otter habitat. At a minimum, monitoring would be conducted during the initial three boost-back and landing events when a sonic boom of 1 psf or greater is predicted to impact sea otter habitat. If adverse effects are documented or the results of monitoring are inconclusive, monitoring would continue for subsequent boost-back and landing events until the nature of effects can be accurately determined.
- The monitoring locations would be selected based on where pressure waves greater than 1 psf are predicted to impact and the relation of these locations to sea otter habitat. The monitoring locations are generally expected to be on Sudden Flats on South VAFB.
- A USFWS-approved biologist would conduct daily counts of sea otters at each of the selected monitoring locations beginning 3 days before, and continuing 3 days after the boost-back and landing events. The monitor would note any mortality, injury, or abnormal behavior observed during these counts. Weather permitting, the counts would be conducted between 09:00 and 12:00, when otters are most likely to be rafting (Estes et al. 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 locations to document and quantify noise impacts.

California Least Tern

- Monitoring of foraging California least terns [*Sternula antillarum browni* (LETE)] at the Santa Ynez River estuary would be conducted, at a minimum, during the initial three boost-back and landing events that occur when LETE are present, when a sonic boom of 1 psf or greater is predicted to impact LETE foraging habitat to characterize any potential impacts from the Proposed Action. If adverse effects are documented or the results of monitoring are inconclusive, monitoring would continue for subsequent boost-back and landing events until the nature of effects can be accurately determined.
- A USFWS-approved biologist would conduct daily counts of LETE at the Santa Ynez River estuary beginning 3 days before boost-back and landing events through 3 days after. These data would be used to determine whether the Proposed Action had an effect on habitat use patterns within the impact area or caused any mortality, injury, or abnormal behavior.
- If there are no safety zone closures, foraging LETE at the Santa Ynez River estuary would be visually monitored during boost-back and landing events 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 impacts.

Western Snowy Plover

- Between 1 March and 30 September, monitoring of nesting western snowy plover (*Charadrius nivosus nivosus* [SNPL]) would be conducted during boost-back and landing events to characterize potential impacts on SNPL reproductive success. At a minimum, monitoring would be conducted during the initial three boost-back and landing events during SNPL nesting season when a sonic boom of 1 psf or greater is predicted to impact SNPL breeding habitat. If adverse effects are documented or the results of monitoring are inconclusive, monitoring would continue for subsequent boost-back and landing events until the nature of effects can be accurately determined.
- Sonic boom modeling would be conducted prior to boost-back and landing events to determine the intensity, most likely impact locations, and whether SNPL breeding habitat would potentially be impacted by a sonic boom greater than 1 psf.
- If a sonic boom of 1 psf or greater is expected to impact SNPL breeding habitat during SNPL nesting season, a USFWS-approved biologist would monitor SNPL populations within the predicted impact area. Daily counts and nest monitoring would begin 3 days prior to boost-back and landing events and continue through 3 days after. These data would be used to determine whether the Proposed Action had an effect on habitat use patterns, population size within the impact area, nesting success, or caused any mortality, injury, or abnormal behavior.
- If there are no safety zone closures, active SNPL nests nearest to the peak sonic boom impact area would be monitored during boost-back and landing events during daytime launches. Monitoring would be conducted by a USFWS-approved biologist or via video depending feasibility and access constraints.
- Acoustic recording equipment would be deployed at or near the monitoring location to document and quantify noise impacts.

2.3.4.5 Biological Resources – 3 (Bio-3)

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.

2.3.4.6 Biological Resources – 4 (Bio-4)

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

- Sonic boom modeling will be performed prior to each boost-back event. Launch parameters specific to each launch will be incorporated into each model to predict peak amplitudes and impact locations.

  - Should model results indicate that a peak overpressure of 1 psf or greater is likely to impact VAFB, then acoustic and biological monitoring will be implemented on VAFB.
  - If it is determined that a sonic boom of 1 psf or greater is likely to impact one of the Northern Channel Islands between 1 March and 30 June, greater than 1.5 psf between 1 July and 30 September, and greater than 2 psf between 1 October and 28 February, monitoring will be conducted at the haul out site closest to the predicted sonic boom impact area.
- Monitoring would commence at least 72 hours prior to the boost-back and continue until at least 48 hours after the event. Monitoring data collected would include multiple surveys each day that record the species; number of animals; general behavior; presence of pups; age class; gender; and reaction to booms or other natural or human-caused disturbances. Environmental conditions such as tide, wind speed, air temperature, and swell would also be recorded. If the boost-back is scheduled for daylight; video recording of pinnipeds on NCI would be conducted during the boost-back to collect required data on reaction to launch noise
- Acoustic measurements of the sonic boom created during boost-back at the monitoring location would be recorded to determine the overpressure level.
- An appropriate compensatory mitigation plan will be implemented to offset adverse effects to EFH resulting from the discharge of unrecoverable marine debris.

2.3.4.7 Cultural Resources

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

- Vehicular access would be prohibited within National Register of Historic Places (NRHP)-eligible sites. Temporary exclusionary fencing would be installed between NRHP-eligible sites and construction areas to prohibit vehicular access.
- 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. 30 CES/CEIEA would be contacted so that the significance of the find can be assessed.

2.3.4.8 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.

2.3.4.9 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 Occupational Safety and Health Administration (OSHA), Air Force Occupational Safety and Health (AFOSH), and California's Division of Occupational Safety and Health (Cal/OSHA) requirements over the entire project.
- 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 (UXO) 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 (AFCEC/CZO) Military Munitions Response Program (MMRP) manager and contact with the weapons safety specialist for 30 SW/SEW.

2.3.4.10 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.

2.3.4.11 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/CEA Solid Waste Manager at least quarterly, with copies of weight tickets and receipts provided.

2.3.4.12 Water Resources

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

- A site-specific SWPPP would be prepared for the project. Stormwater Best Management Practices (BMPs) would be selected and implemented following the latest California Stormwater Quality Association's (CASQA) Stormwater BMP 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.
- If present within the construction area, storm drain inlets would be protected from sediment-ladened waters by the use of inlet protection devices, such as gravel bag barriers, filter fabric fences, block and gravel filters, and excavated inlet sediment traps.
- Erosion and sediment control measures would be in place throughout grading and development of the site until all disturbed areas are permanently stabilized.
- Non-domestic wastewater would be handled, stored, and disposed of per the Construction General Permit and VAFB policy.
- Construction materials and waste, such as fuels, would be stored, handled, and disposed of in a manner that minimizes the potential for stormwater contamination. Bulk storage locations for construction materials and any measures proposed to contain the materials would be shown on final project plans.
- All disturbed soil areas shall be restored to have 70 percent density vegetation coverage or equivalent soil stabilization to meet the Notice of Termination requirements under Order No 2009-0009-DWQ (NPDES Construction General Permit).
- Vegetation removal would be minimized.
- Permanent roads shall be designed and constructed to prevent erosion and would require a gravel overlay or equivalent surface erosion control.

2.4 Alternative 2 - First Stage Landing Site on Barge in Pacific Ocean

Under this alternative, the construction of a landing pad at SLC-4W would not occur. The boost-back and landing of the First Stage would occur as described in Section 2.2.3.1 (Contingency Barge Landing), except that it would land 320 mi. (321.6 km) offshore (Figure 2-15). All applicable EPMs described above would be implemented under Alternative 2. These would include EPMs under Section 2.2.4.4 (Biological Resources – 2 [Bio-2]) for southern sea otter, LETE, and SNPL, Section 2.2.4.6 (Biological Resources – 4 [Bio-4]), and under Section 2.2.4.9 (Human Health and Safety).

2.5 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, the current launch processes would continue without using the boost-back capabilities of the Falcon 9 First Stage or autonomous flight termination system. Depending on the trajectory of the launch vehicle, the First Stage would drop into the Pacific Ocean approximately 300–500 mi. (480–800 km; Figure 2-15) west of the Baja California coast (in all launch azimuth directions). The First Stage is not recoverable due to previous attempts at recovering First Stages during boost-back attempts at sea. The First Stage would subsequently sink and therefore, would not be recovered. The potential impacts of the No Action Alternative have been previously analyzed in the *Final Environmental Assessment Falcon 9 and Falcon 9 Heavy Launch Vehicle Programs from Space Launch Complex 4 East Vandenberg Air Force Base, California* (USAF 2011a).

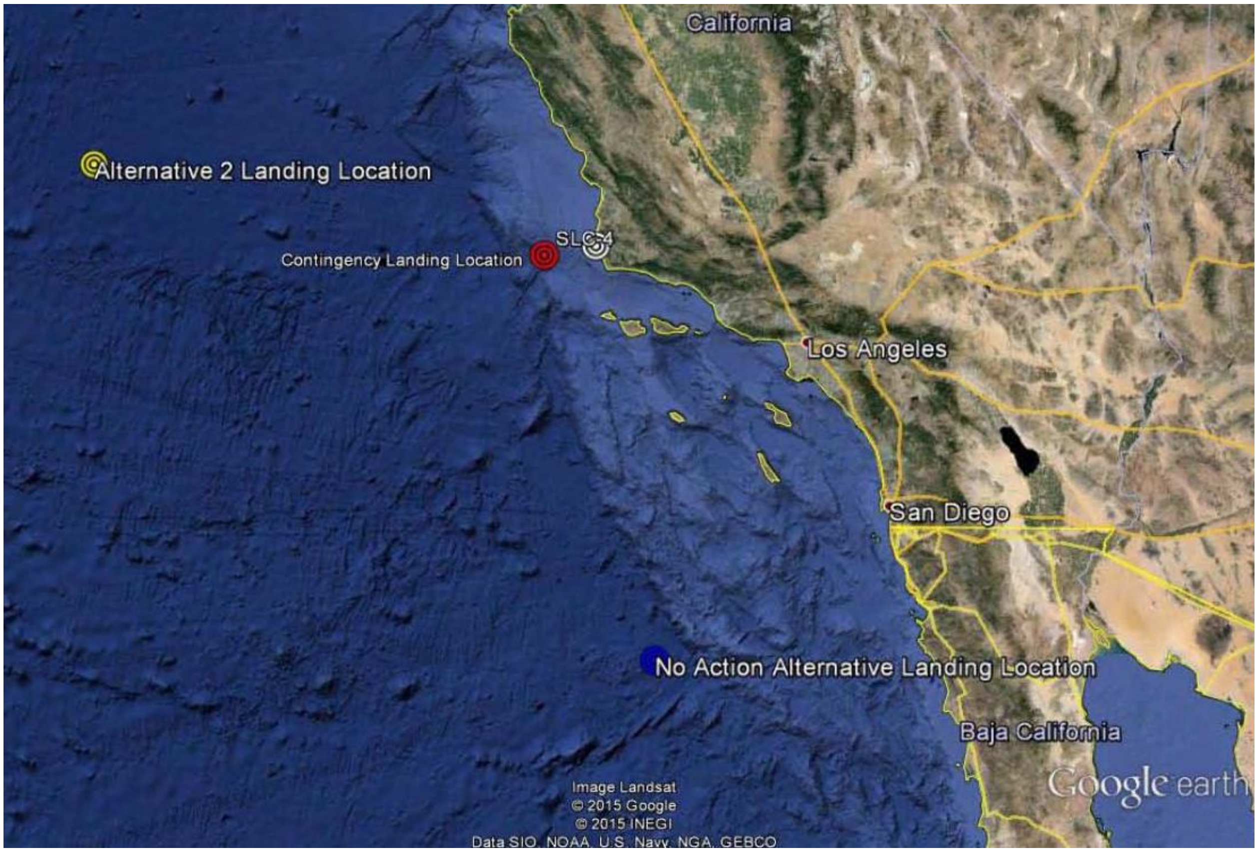


Figure 2-15. Alternative 2 and No Action Alternative Landing Locations.

Although propellants would be burned to depletion during flight, there is a potential for a minimum amount of LOX and RP-1 to remain in the expended Falcon 9 First Stage. The tanks would explode upon impact; thus, remaining LOX and RP-1 would be burned.

The No Action alternative would negatively affect SpaceX's ability to satisfy the USAF and NASA requirements under the SAA to continue to support the U.S. goal of encouraging activities by enhancing operational efficiency and reduce launch costs by investing in the modernization of space launch infrastructure.

2.6 Other Alternatives Considered and Eliminated from Further Analysis

Other alternatives were considered for this action but were determined to be impracticable to meet the underlying purpose and need of the Proposed Action, as described below.

One alternative that was considered was the utilization of the undeveloped SLC-7 site. The location would have resulted in potentially extensive disturbance to a previously undisturbed area, thereby potentially resulting in a greater environmental impact to various resources. This would have included the improvement and surfacing of a dirt road, construction of a new access road, and installation of utilities including fiber optic pathways for internet over long distances to meet up with existing utility tie-ins. In addition, post-landing processing of the Falcon 9 rocket would require transportation back to SLC-4E. This alternative would not allow SpaceX to meet its launch schedule, as development of this site would be several years away due to more extensive regulatory requirements. Therefore, this alternative was eliminated for not meeting Criteria 5, 6, 8, and 9.

A contingency landing action on the water (rather than on a barge) 31 mi. (50 km) offshore at the contingency landing location was also considered but not carried forward due to significant environmental impacts. USFWS concurrence that a water landing may affect but was not likely to adversely affect ESA-listed species under the jurisdiction of the USFWS was received (2015-I-0208; Appendix D); however, the contingency water landing was subsequently removed from the project due to potentially significant effects on species protected under the jurisdiction of NOAA Fisheries. If a water landing is proposed in the future, it would require further environmental analysis under NEPA.

The use of the VAFB Harbor for offloading the First Stage after a contingency landing was considered; however, vessel traffic in this location would have potential impacts to the federally listed southern sea otter. As a result, SpaceX did not pursue this alternative to avoid these potential impacts. Utilization of the VAFB Harbor was eliminated from further analysis since it did not meet Criterion 9.

No other reasonable alternatives were identified and carried forward.

3 Affected Environment

This chapter describes the existing environment near and within the project area for Alternative 1 (Proposed Action), Alternative 2, and the No-Action Alternative. The area considered for most resources was the immediate area of the proposed construction (SLC-4W) and the areas potentially impacted by overpressure, landing noise, and the overflight path. For some environmental resources, a wider regional area was used.

The resources identified for analysis in this EA include air quality, noise (airborne), biological resources, water resources, cultural resources, geology and earth resources, human health and safety, hazardous materials and waste management, solid waste management, land use and aesthetics, coastal zone management, transportation, Section 4(f) properties, and utilities. The resources identified for analysis for implementation of the AFSS only include human health and safety. The following resources were considered but not analyzed in this EA:

- ***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. The project would neither affect nor disproportionately affect low-income or minority populations within the region of influence (Lompoc and Santa Maria Valleys). 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. With regard to potential impacts from noise, given the short duration (typically 60 seconds) of the landing noise and the relatively low received noise levels at sensitive receptors, the contribution of launch noise would be minimal, and it is unlikely that DNL levels would be elevated as a result of a single landing event. Additionally, 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) and, thus, less than significant impacts to minority communities and low-income communities.
- ***Socioeconomics.*** Implementing the Proposed Action could result in the creation of some temporary new jobs. Temporary jobs may be created from new construction for the SLC-4W landing pad. Once construction is complete, operation of the facility would be conducted by existing SpaceX staff and its subcontractors. However, any potential new jobs would not have a significant effect on the socioeconomic environment of the region (Lompoc Valley and Santa Maria Valley) and no substantial change to economic factors from the Proposed Action is expected.
- ***Recreation.*** Access to VAFB is controlled by the USAF. Military personnel can utilize portions of South VAFB for general outdoor recreation; however, public access to the South VAFB and the vicinity of SLC-4W is not allowed for general outdoor recreation. Surf Beach, Wall Beach, County of Santa Barbara Ocean Beach Park, Jalama Beach County Park, and Miguelito Park, however, are open to the public. During launches from SLC-4E, access to these parks is restricted. The boost-back and landing of the First Stage

would happen immediately after a launch from SLC-4E, if the First Stage is returned to SLC-4W. Therefore, restrictions are already in place as a result of the launch, and the Proposed Action would not require any additional restrictions on access to these parks and beaches for recreation.

Recreational boating and fishing occurs offshore of VAFB, however the contingency landing location is sufficiently far from shore (31 mi. [50 km]) to make impacts to recreational boating unlikely. The U.S. Coast Guard would issue a Local Notice to Mariners that defines a Public Ship Avoidance Area for contingency landing events. The avoidance area would be temporary and lifted as soon as the U.S. Coast Guard determines it is safe to do so. Since potential impacts to recreational boating are unlikely (due to the distance from shore) and temporary (no permanent closures) and there are no new impacts to recreation on land, recreational resources are not assessed further in this EA.

- ***Floodplains.*** SLC-4W is outside of floodplains, and floodplains would not be affected by the Proposed Action; therefore, floodplains are not assessed in this EA.

3.1 Air Quality

3.1.1 Definition of Resource

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 $PM_{2.5}$, 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.

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

Pollutant emissions typically refer to the amount of pollutants or pollutant precursors introduced into the atmosphere by a source or group of sources. Pollutant emissions contribute to the ambient air concentrations of criteria pollutants, either by directly affecting the pollutant concentrations measured in the ambient air or by interacting in the atmosphere to form criteria pollutants. Primary pollutants, such as CO, SO_2, lead, 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 (for example, 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 state or federal standard are considered to be non-attainment for that pollutant. Table 3-1 shows both the federal and state ambient air quality standards.

Toxic air pollutants, also called hazardous air pollutants, are a class of pollutants that do not have ambient air quality standards but are examined on an individual basis when there is a source of these pollutants. The State of California has identified particulate emissions from diesel engines as a toxic air pollutant.

Global temperatures are moderated by naturally occurring atmospheric gases, including water vapor, carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), which are known as greenhouse gases (GHGs). These gases allow solar radiation (sunlight) into the Earth's atmosphere, but prevent radiative heat from escaping, thus warming the Earth's atmosphere. Gases that trap heat in the atmosphere are often called GHGs, analogous to a greenhouse. GHGs are emitted by both natural processes and human activities. State law defines GHGS as any of the following compounds: CO_2, CH_4, N_2O, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6) (California Health and Safety Code Section 38505(g)). 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" (U.S. Environmental Protection Agency 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 CH_4, 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.

Table 3-1. Ambient Air Quality Standards.

Pollutant	Averaging Time	NAAQS[1]		CAAQS[2]
		Primary[3]	**Secondary[4]**	**Concentration[5]**
Ozone (O_3)	1-Hour	-	Same as Primary Standard	0.09 ppm (180 µg/m^3)
	8-Hour	0.08 ppm		0.070 ppm (137 µg/m^3)[7]
Respirable Particulate Matter (PM_{10})	24-Hour	150 µg/m^3	Same as Primary Standard	50 µg/m^3
	Annual Arithmetic Mean	-		20 µg/m^3
Fine Particulate Matter ($PM_{2.5}$)	24-Hour	35 µg/m^3	Same as Primary Standard	-
	Annual Arithmetic Mean	12.0 µg/m^3	15 µg/m^3	12 µg/m^3
Carbon Monoxide (CO)	8-Hour	9 ppm (10 µg/m^3)	None	9.0 ppm (10 µg/m^3)
	1-Hour	35 ppm (40 µg/m^3)		20 ppm (23 µg/m^3)
Nitrogen Dioxide (NO_2)	Annual Average	0.053 ppm (100 µg/m^3)	Same as Primary Standard	0.030 ppm (56 µg/m^3)
	1-Hour	0.100 ppm (188 µg/m^3)		0.18 ppm (338 µg/m^3)
Sulfur Dioxide (SO_2)	Annual Arithmetic Mean	0.030 ppm	-	-
	24-Hour	0.14 ppm	-	0.04 ppm (105 µg/m^3)
	3-Hour	-	1300 µg/m^3 (0.5 ppm)	-
	1-Hour	75 ppb (196 µg/m^3)	-	0.25 ppm (655 µg/m^3)
Lead (Pb)[6]	30-Day Average	-	-	1.5 µg/m^3
	Calendar Quarter	1.5 µg/m^3	Same as Primary Standard	-
	3-Month Rolling Average	0.15 µg/m^3	Same as Primary Standard	-
Hydrogen Sulfide (HS)	1-Hour	No Federal Standards		0.03 ppm (42 µg/m^3)
Sulfates (SO_4)	24-Hour			25 µg/m^3
Visibility Reducing Particles	8-Hour (10 am to 6 pm, Pacific Standard Time)			In sufficient amount to produce an extinction coefficient of 0.23 per km due to particles when the relative humidity is less than 70 percent.
Vinyl chloride[6]	24 Hour			0.01 ppm (26 µg/m^3)

[1] NAAQS (other than O_3, particulate matter, and those based on annual averages or annual arithmetic mean) are not to be exceeded more than once a year. The O_3 standard is attained when the fourth highest 8-hour concentration in a year, averaged over 3 years, is equal to or less than the standard. For PM_{10}, the 24-hour standard is attained when 99 percent of the daily concentrations, averaged over 3 years, are equal to or less than the standard. For $PM_{2.5}$, the 24-hour standard is attained when 98 percent of the daily concentrations, averaged over 3 years, are equal to or less than the standard. Contact the USEPA for further clarification and current federal policies.

[2] California Ambient Air Quality Standards for O_3, CO (except Lake Tahoe), SO_2 (1- and 24-hour), NO_2, PM_{10}, and visibility reducing particles, are values that are not to be exceeded. All others are not to be equaled or exceeded.

[3] National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health.

[4] National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

µg/m^3 = milligrams per cubic meter

Source: California Air Resources Board 2015

[5] Concentration expressed first in units in which it was promulgated. Ppm in this table refers to ppm by volume or micromoles of pollutant per mole of gas.

[6] The CARB has identified lead and vinyl chloride as “toxic air contaminants” with no threshold level of exposure for adverse health effects determined. These actions allow for the implementation of control measures at levels below the ambient concentrations specified for these pollutants.

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 South Central Coast Air Basin (SCCAB). The SCCAB includes San Luis Obispo, Santa Barbara, and Ventura Counties.

The SCCAB, and all of Southern California, lies in a semi-permanent high-pressure zone of Eastern Pacific Region. The coastal island 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 annually. The mean temperature in the VAFB area, as reported by monitors in Lompoc, is 58.3°F and the mean maximum and mean minimum temperatures are 69.6°F and 47.0°F, respectively (Western Regional Climatic Center 2015).

Santa Barbara County is classified as an attainment/unclassified area for the NAAQS for all criteria pollutants. Santa Barbara County is considered a nonattainment area for the CAAQS for ozone and PM_{10}. 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 3-2 presents a summary of ambient air quality measurements for the period from 2011 to 2013. The 1-hour CAAQS for ozone was not exceeded at the VAFB monitoring station during the period from 2011 through 2013. The federal 8-hour ozone standard was not exceeded at the VAFB monitoring station during the period from 2011 through 2013. The 8-hour CAAQS for ozone was exceeded once in 2013. The Vandenberg station measured one exceedance of the 1-hour NO_2 standard in 2013; however, the standard is not based on a single exceedance and the region remains unclassified/attainment. The 24-hour CAAQS for PM_{10} was exceeded at the Vandenberg station in 2011 and again in 2013. The data from the monitoring stations indicate that air quality is in attainment of all other state and federal standards. Exceeding CAAQS standards may result in additional mitigation requirements, as described in Section 4.1 (Air Quality). If emissions were to exceed a significance threshold, further analysis of the emissions and their potential consequences may be performed to assess the likelihood of a significant impact to air quality. The nature and extent of such analysis would depend on the specific circumstances. The analysis could range from a more detailed and precise examination of the activities and equipment resulting in the greatest contribution to emissions, to air dispersion modeling analyses.

Table 3-2. Background Ambient Air Quality at VAFB (concentrations in ppm unless otherwise indicated).

Pollutant	Averaging Time	2011	2012	2013	CAAQS (ppm)	NAAQS (ppm)	Monitoring Station
Ozone	8 hour	0.067	0.062	0.071	0.070	0.075	Vandenberg
	1 hour	0.079	0.069	0.074	0.09	-	Vandenberg
PM_{10}	Annual Arithmetic Mean	17.9 $\mu g/m^3$	15.9 $\mu g/m^3$	19.9 $\mu g/m^3$	20 $\mu g/m^3$	-	Vandenberg
	24 hour	54.0 $\mu g/m^3$	47.0 $\mu g/m^3$	57.6 $\mu g/m^3$	50 $\mu g/m^3$	150 $\mu g/m^3$	Vandenberg
$PM_{2.5}$	Annual Arithmetic Mean	7.5 $\mu g/m^3$	N/A	N/A	12 $\mu g/m^3$	12.0 $\mu g/m^3$	Lompoc
	24 hour	18.8 $\mu g/m^3$	18.1 $\mu g/m^3$	15.9 $\mu g/m^3$	-	35 $\mu g/m^3$	Lompoc
NO_2	Annual	0.001	0.000	0.000	0.030	0.053	Vandenberg
	1 hour	0.012	0.013	0.130	0.18	0.100	Vandenberg
CO	8 hour	0.30	0.41	N/A	9.0	9	Vandenberg
SO_2	Annual	0.000	0.000	0.000	-	0.030	Vandenberg
	24 hour	0.002	0.003	0.001	0.04	0.14	Vandenberg

California averages reported for PM_{10}
N/A = not available from current website data
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 = parts per millions, $\mu g/m^3$ = micrograms per cubic meter

3.1.3 Region of Influence

Specifically identifying the region of influence (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 ozone and its precursors), the ROI is generally limited to a few miles downwind from the source. However, for photochemical pollutant such as ozone, the ROI may extend much farther downwind. Ozone is a secondary pollutant that is formed in the atmosphere by photochemical reactions of previously emitted pollutants, or precursors (ROG, NO_x, and PM_{10}). The maximum effect of precursors on ozone levels tends to occur several hours after the time of emission during periods of high solar load and may occur many miles from the source. Ozone and ozone precursors transported from other regions can also combine with local emissions to produce high local ozone concentrations. The ROI for the Proposed Action includes the SCCAB.

3.1.4 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, to classify areas as to their attainment status relative to the NAAQS, to develop schedules and strategies to meet the NAAQS, and to regulate emissions of criteria pollutants and air 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 (CAAA) (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 CAAA 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 Clean Air Act 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.

Executive Order 13693: This EO, *Planning for Federal Sustainability in the Next Decade*, was signed by President Obama on March 19, 2015. The EO sets a goal of reducing Federal agency GHG emissions by 40 percent over the next decade. The EO sets agency GHG reduction targets and sustainability goals, and requires the head of each Federal agency to propose to the Chair of the CEQ and the Director of the Office of Management and Budget percentage reduction targets for agency-wide reductions of scope 1 and 2 and scope 3 GHG emissions in absolute terms by the end of fiscal year 2025 relative to a fiscal year 2008 baseline. The EO sets sustainability goals for Federal agencies.

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. Because Santa Barbara County is an unclassified/attainment area for all NAAQS, the General Conformity Rule does not apply to the Proposed Action at VAFB.

3.1.5 Local Requirements

As indicated previously, in Santa Barbara County, the SBCAPCD is the agency responsible for the administration of federal and state air quality laws, regulations, and policies. Included in the local air districts' tasks are monitoring of air pollution, maintenance of air quality standards through programs to control air pollutant emissions, and the promulgation of Rules and Regulations.

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. SpaceX anticipates that the Proposed Action would not require any stationary sources. 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.

On 30 April 2015, the SBCAPCD adopted revisions to their Environmental Review Guidelines to the California Environmental Quality Act (CEQA) by adding significance thresholds for GHG cumulative impacts. The District has adopted a screening threshold of 10,000 metric tons of carbon dioxide equivalents (CO_{2e}) per year consistent with Assembly Bill (AB) 32. As a lead agency, the SBCAPCD is required to address the cumulative impacts of GHG emissions from the project as part of their CEQA review during the permitting process, should permits be mandated. Should emissions exceed the screening threshold, mitigation measures could be required to reduce emissions of GHGs.

3.2 Sound (Airborne)

3.2.1 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 EA, the ROI for Alternative 1 (Proposed Action) includes the SLC-4 complex and areas potentially overflown by the First Stage vehicle landing at SLC-4W, the contingency landing area 31 mi. (50 km) offshore, areas that may be impacted by landing noise, and areas that may be impacted by a sonic boom as illustrated in Figures 2-4, 2-5, 2-6, 2-9, 2-10, and 2-11.

3.2.2 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 (dBP; defined in Section 3.2.3, 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).

3.2.3 Sound Spectrum

Sound oscillates in waves, and the rates of oscillation (frequencies) are measured in cycles per second, or 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).

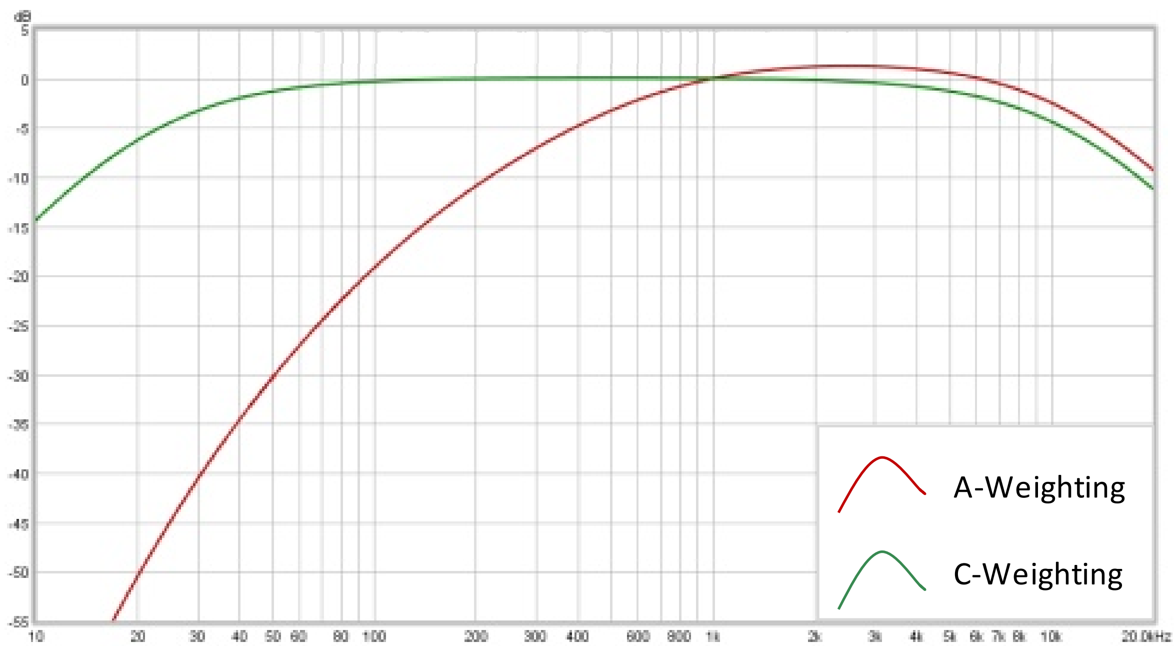


Figure 3-1. A and C Weighting Scales.

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.

3.2.4 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. 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 10 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).

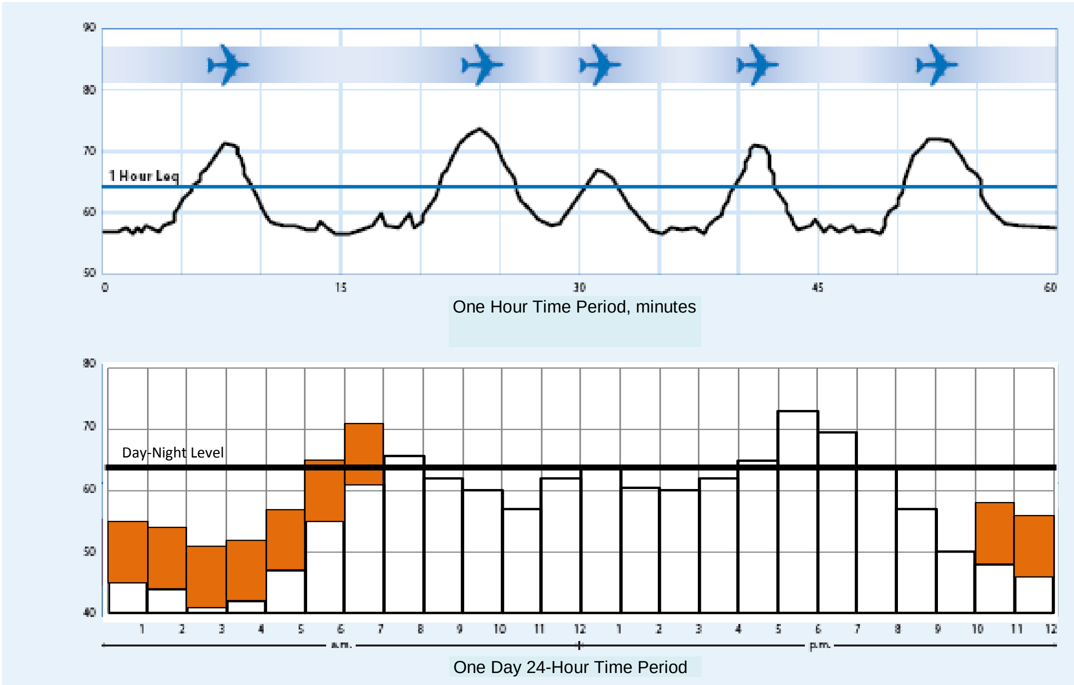


Figure 3-2. Relationship of Sound Level, L_{eq}, and Day-Night Average Sound Level.

3.2.5 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 (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 mi. (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 = decibels, A-weighted; ft. = feet; m = meter(s); mph = miles per hour; mi. = miles
Sources: Federal Interagency Committee on Noise 1992, U.S. Army 2005, USAF 2013b

3.2.6 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.

3.2.7 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.

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 (L_{eq1H}) 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 2013).

3.2.8 Ambient Sound Guidance Documents

- 49 U.S.C. 40101 et seq., as amended by Public Law (PL) 103–305 (23 August 1994) (The Federal Aviation Act of 1958). This act is the basic aviation policy and has been amended often since 1958. In its original provisions the Act gave the FAA responsibility for all aspects of aviation but did not specifically authorize the FAA to establish noise abatement rules.
- 49 U.S.C. 44715 (Controlling Aircraft Noise and Sonic Boom, 1968). Authorized the FAA to prescribe standards for the measurement of aircraft noise and to establish regulations to abate noise.
- 42 U.S.C. 4901 (The Noise Control Act of 1972, as amended). This act amended the Federal Aviation Act and the Aircraft Noise Abatement Act to involve the U.S. Environmental Protection Agency in the regulation of airport noise.
- FAA Order 1050.1 "Environmental Impacts: Policies and Procedures" Appendix A, Section 14 Noise.

3.2.9 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. Individuals and 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.E [paragraph 11(b)(8)]. 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 5 mi. (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.

3.3 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 NOAA Fisheries 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 (CESA), as a goal of its Integrated Natural Resource Management Plan (INRMP), VAFB also protects and conserves species considered sensitive by the state not in direct conflict with the military mission.

The Marine Mammal Protection Act (MMPA) of 1972 (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 NOAA Fisheries and USFWS. NOAA Fisheries 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 NOAA Fisheries 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.

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

3.3.1 Region of Influence

The existing biological setting includes the regional setting of VAFB, the SLC-4W landing pad construction area, the contingency landing area 31 mi. (50 km) offshore, past and present disturbances in and near SLC-4W, and areas potentially impacted by sonic boom, landing noise, and noise of potential explosion (Figures 2-4, 2-5, 2-6, 2-9, 2-10, 2-11 and 2-14). 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 (BIA) 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.

3.3.2 Methodology

Impacts to biological resources were considered for all areas potentially impacted by construction, visual disturbance, direct impact, landing noise, and sonic boom. Prior special status species monitoring data, surveys, the California Natural Diversity Database (CNDDB), 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 CRLF habitat assessments were conducted at SLC-4W on 11 March and 9 April 2014. The survey area included the SLC-4W complex and a 30 ft. buffer from the outer perimeter fence. To conduct surveys, two biologists walked meandering transects throughout the survey area and visually scanned for CRLF habitat and 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.

3.3.3 Vegetation Resources

The ROI for vegetation resources is the SLC-4W construction area where ground-disturbing activities would take place. Only non-native grassland (NNG), mixed central coast scrub (CCS), 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 Holland (1986).

3.3.3.1 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.

3.3.3.2 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-4W 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.

3.3.3.3 Anthropogenic

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

3.3.3.4 Special Status Plant Species and Sensitive Plant Communities

There were no special-status plant species documented during surveys. However, one hundred and eighteen (118) seacliff buckwheat plants were documented during surveys conducted in March 2014 within SLC-4W in non-native grassland habitat (Table 3-4; Figure 3-3; Tetra Tech, Inc. 2014). 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. On VAFB, seacliff buckwheat is considered potential ESBB habitat and receives degrees of protection, depending on proximity to ESBB localities. The SLC-4W project site is approximately 1.5 mi. (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,

Table 3-4. 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	El Segundo blue butterfly habitat	June–September

Note: NL = Not listed

Inc. 2010, 2014). The closest ESBB population to the proposed construction area is on Honda Ridge approximately 3.3 mi. south-southeast of the project site (ManTech SRS Technologies, Inc. 2014a).

3.3.4 Wildlife Resources

The ROI for wildlife resources includes the SLC-4W construction area where ground-disturbing activities would take place and terrestrial areas that would potentially be affected by acoustic impacts (Figures 2-4, 2-5, 2-6, 2-9 and 2-10). 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. Appendix G lists wildlife species documented within the project area during a biological survey conducted in March 2010 (ManTech SRS Technologies, Inc. 2010). This Appendix also includes wildlife species not encountered during surveys but potentially present based on prior records in the vicinity.

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, an ephemeral drainage located immediately south of SLC-4. Due to prolonged drought conditions and low rainfall, Spring Canyon is currently dry; however, if water were present, California chorus frogs (*Pseudacris hypochondriaca*) would likely be the most common amphibian species within the project area. Other wetland amphibian species, such as CRLF, western toad (*Bufo boreas*), Monterey ensatina (*Ensatina eschscholtzii*) and arboreal salamander (*Aneides lugubris*) would also be expected to occur due to the proximity to Spring Canyon. The CRLF is a federally threatened species as well as a California species of concern (see Section 3.3.5, Special Status Wildlife Species in the Terrestrial Portion of the Project Area).

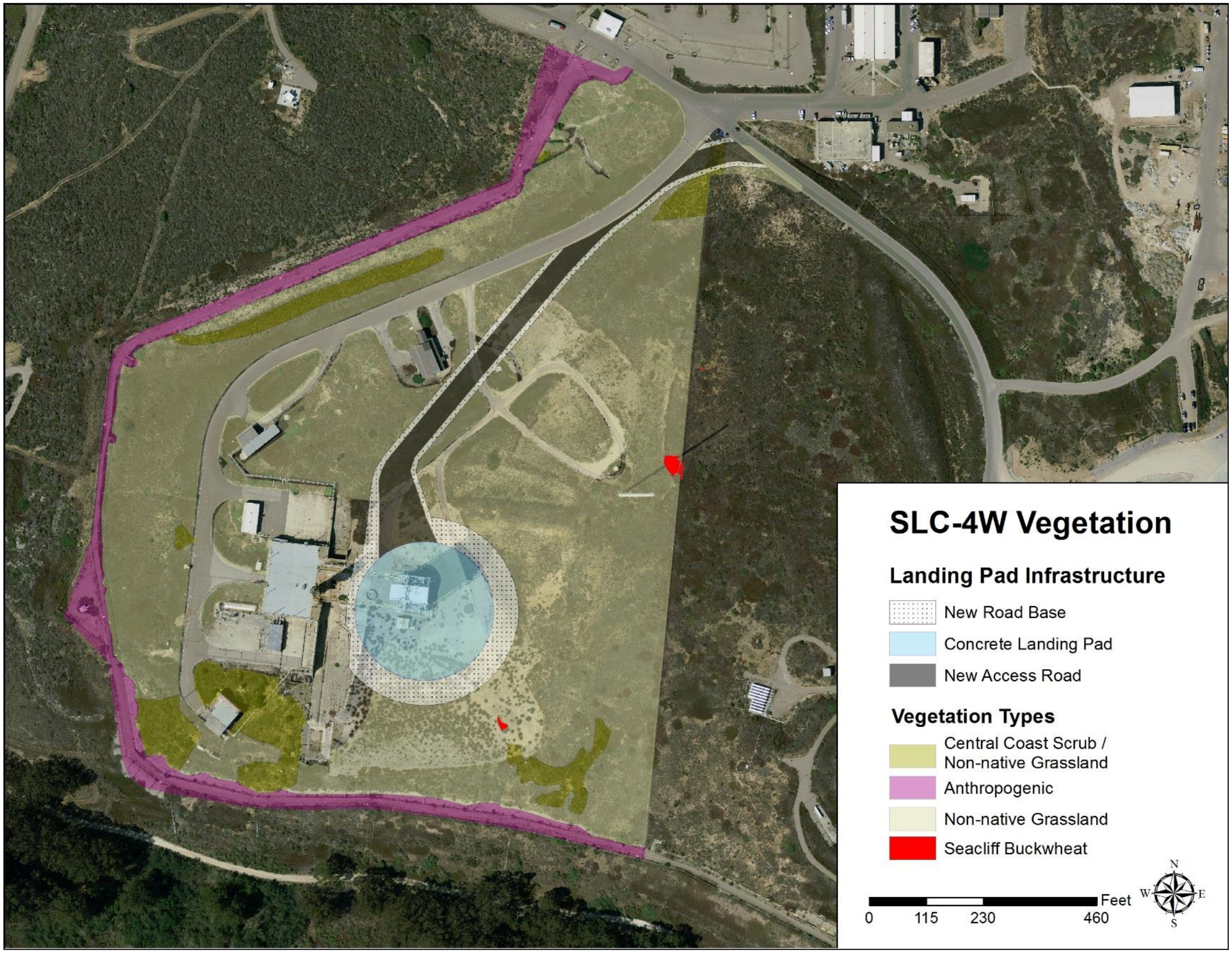


Figure 3-3. Habitat Types and Special Status Species within the Project Area.

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. The project area and surrounding habitat support foraging opportunities for several bat species, but do not provide suitable roosting areas.

3.3.5 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 SLC-4W construction area where ground-disturbing activities would take place and terrestrial areas that would potentially be affected by acoustic impacts (Figures 2-4, 2-5, 2-6, 2-9 and 2-10) and visual disturbance. Table 3-5 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.

Several species were excluded from potential occurrence because they either do not occur at the site during the time construction activities would occur, they do not breed within the project area and their special status affords them protection during their breeding period, or they do not occur in a manner that affords them special status protection (i.e., rookeries or nesting colonies). This EA considers species that may be affected by activities under the Proposed Action and Alternatives. Species unlikely to be affected by SLC-4W modifications, landscape maintenance, launch noise, and not present within the overpressure or overflight zones, were not given further consideration. This includes federally listed plant species such as the federally endangered Lompoc yerba santa (*Eriodictyon capitatum*), Gaviota tarplant (*Deinandra increscens* ssp*. villosa*) and Gambel's watercress (*Nasturtium gambellii*).

Special status fish species such as the federally endangered tidewater goby (*Eucyclogobius newberryi*) and federal endangered unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*), were also not considered due to their absence from the overflight zone, distance from SLC-4W, and the ability of water to attenuate sound. An introduced population of unarmored threespine stickleback occurred at one time within Honda Creek; however, surveys conducted by ManTech SRS Technologies Inc. in 2008 indicated that this population is no longer extant (ManTech SRS Technologies, Inc. 2009a). The nearest tidewater goby potential habitat is in Cañada Honda Creek, approximately 2.6 mi. (4.2 km) southwest of the project site (ManTech SRS Technologies, Inc. 2009a).

Potential habitat for least Bell's vireo (*Vireo bellii pusillus*, federal endangered species/state endangered species) and southwestern willow flycatcher (*Empidonax traillii extimus*, federal endangered species/state endangered species) exists on VAFB and adjacent areas. However, these species have not been documented within the area potentially impacted by a significant sonic boom and landing noise generated by the First Stage boost-back and landing at SLC-4W in the last 10 years (Seavy et al. 2012). As shown in Figure 2-9, under the contingency landing action, a low-pressure sonic boom (0.2 psf) would extend up to 60 mi. (97 km) onto the mainland, which includes areas where these species may be found. However, at these large distances from the source of the sonic boom, the received frequencies would be low (less than 200 Hz) and therefore outside of the hearing sensitivity of these species (200 Hz to 8 kHz; Okanoya and Dooling 1987), and thus would not be perceived. Therefore, these species were not carried forward to analyses of impacts.

Golden eagles (*Aquila chrysaetos*, Federal Bird Species of Conservation Concern, California Fully Protected Species) and bald eagles (*Haliaeetus leucocephalus* [Federal Bird Species of Conservation Concern, California Endangered Species, California Fully Protected Species]) are occasionally seen throughout VAFB and may forage in open scrub, grassland, and estuarine habitats. However, these are rarely sighted and are not anticipated to be affected by project activities.

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 (CNPS)
- 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

Federally listed, proposed listed, or candidate plant and wildlife species that are known to occur in the project area are described below. In addition, species covered under the MMPA that occur in the project area are listed below.

Table 3-5. Special Status Species Occurring or Potentially Occurring within the Terrestrial Portion of the Project Area

Species	Conservation Status		Occurrence within Proposed Action Area		Habitat	Notes
	Federal	CDFW	SLC-4	Overpressure		
Invertebrates						
El Segundo Blue Butterfly *Euphilotes battoides allyni*	FE	-	Potential	Documented	Occurrence is tied to host plant; seacliff buckwheat	Adult flight period June - September
Amphibians						
California Red-legged Frog *Rana draytonii*	FT	CSC	-	Documented	Chiefly associated with perennial ponds, streams	Common, but localized resident in wetlands
Reptiles						
Western Pond Turtle (*Antinemys pallida*)		CSC		Documented	Chiefly associated with perennial ponds, streams	Documented in Honda Creek
Blainville's Horned Lizard *Phrynosoma blainvillii*	-	CSC	Potential	Documented	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	Documented	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	Documented	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	-	Potential	Coastal marine, estuaries	
Ferruginous Hawk *Buteo regalis*	BCC	-	-	Rare	Open grassland, prairie	Wintering birds hunt in fallow fields within the Proposed Action Area
Northern harrier *Circus cyaneus*	-	CSC	Potential	Common	Prairie grasslands, marshes, wetlands	Nesting records near the Proposed Action Area
White-tailed Kite *Elanus leucurus*	-	CSC	Potential	Rare - Common	Open grassland, prairie	Nesting records near SLC-4; numbers vary annually
Golden Eagle *Aquila chrysaetos*	BGEPA, BCC	FP	-	Potential	Grasslands, open woodland	
Bald Eagle *Haliaeetus leucocephalus*	BGEPA, FD	SE	-	Potential	Large lakes, wetlands	Rare winter migrant
American Peregrine Falcon *Falco peregrinus anatum*	FD, BCC	SD, FP	-	Potential	Open with proximity to water	
Western Snowy Plover *Charadrius nivosus nivosus*	FT, BCC	CSC	-	Common	Beaches, barren ground	
Black Oystercatcher *Haematopus bachmani*	BCC	-	-	Common	Intertidal	
Long-billed Curlew *Numenius americanus*	BCC	-	-	Common	Intertidal	
California Least Tern	FE	SE	-	Potential	Coastal marine, estuaries	

Sternula antillarum browni						
Burrowing Owl *Athene cunicularia hypugea*	BCC	CSC	-	Common	Grasslands	
Allen's Hummingbird *Selasphorus sasin*	BCC	-	Common	Common	Coastal sage scrub, riparian shrubs	Resident riparian breeder Santa Ynez River
Nuttall's Woodpecker *Picoides nuttallii*	BCC	-	-	Common	Deciduous riparian and adjacent oak woodland	Resident riparian breeder Santa Ynez River
Olive-sided Flycatcher *Contopus cooperi*	-	CSC	-	Rare	Coniferous woods	Summer resident, potential breeder in non-native woodland near Proposed Action Area
Loggerhead Shrike *Lanius ludovicianus*	BCC	-	-	Common	Open grasslands	Resident central coast scrub breeder near the Proposed Action Area
Purple Martin *Progne subis*	-	CSC	-	Very Rare	Open areas, riparian	Fall/Spring transient at the Santa Ynez River mouth
Oak Titmouse *Baeolophus inornatus*	BCC	-	Potential	Common	Dry oak, oak-pine woodlands	Resident riparian breeder Santa Ynez River
Yellow Warbler *Dendroica petechia brewsteri*	BCC	CSC	-	Common	Riparian	Summer resident riparian breeder Santa Ynez River
Yellow-breasted Chat *Icteria virens*	-	CSC	-	Common	Riparian	Summer resident riparian breeder Santa Ynez River
Black-Chinned Sparrow *Spizella atrogularis*	BCC	-	-	Potential	Chaparral, sage, scrub	
Belding's Savannah Sparrow *Posserculucs sandwhichensis beldingi*	-	SE	-	Common	Coastal salt marsh	Localized resident breeder within wetlands on VAFB
Tricolored Blackbird *Agelaius tricolor*	BCC	CSC	-	Rare	Marsh, riparian, agricultural fields	Resident with historic breeding records on VAFB
Lawrence's Goldfinch *Spinus lawrencei*	BCC	-	-	Common	Dry, open woodlands	Summer resident riparian breeder Santa Ynez River
Mammals						
Pallid Bat *Antrozous pallidus*	-	CSC	Potential	Common	Rocky outcroppings, sparsely vegetated grasslands	Resident forager on VAFB
Townsend's Big-eared Bat *Corynorhinus townsendii*	-	SC	Potential	Potential	Pine forests, scrub	
Western Red Bat *Lasiurus blossevillii*	-	CSC	Potential	Common	Forages in forests, woodlands from sea-level up	Resident breeder on VAFB at 13th Street Bridge
Southern Sea Otter *Enhydras lutris nereis*	FE	-		Common	Common in coastal waters with numbers concentrated around kelp beds	May be hauled out within the Project Area
American Badger *Taxidea taxus*	-	CSC	Potential	Potential	Open plains, prairies, dry grasslands	
Pacific Harbor Seal[1] (*Phoca vitulina*)	-	-		Common	Common in coastal waters	Rookery use of VAFB and may be hauled out within the Project Area
California Sea Lion[1] (*Zalophus californianus*)	-	-		Common	Common in coastal waters	Sporadically hauled out within the Project Area
Northern Elephant Seal[1]	-	-		Common	Common in coastal waters	Sporadically hauled out within the Project

(*Mirounga angustirostris*)					Area
Stellar Sea Lion[1] (*Eumetopias jubatus*)	-	-	Uncommon	Present in small numbers	Sporadically hauled out within the Project Area

[1] These species are discussed further under Section 3.3.6.4 (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

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

ESBB were listed as federally endangered on 1 June 1976 (40 Federal Register [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. and Pratt 2008). 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 3.3.3.4 (Special Status Plant Species and Sensitive Plant Communities), 118 seacliff buckwheat plants were documented during surveys conducted in March 2014 within SLC-4W (Figure 3-3; Tetra Tech, Inc. 2014). 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 mi. (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. 2010, 2014). The closest ESBB population to the proposed construction area is on Honda Ridge approximately 3.3 mi. (5.3 km) south-southeast of the project site (ManTech SRS Technologies, Inc. 2014a).

3.3.5.2 California Red-legged Frog (*Rana draytonii* [Federal Threatened Species/California Species of Special Concern])

CRLF 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 CRLF 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. Critical habitat does not occur within the ROI. As a result, the Proposed Action would not affect critical habitat for this species.

The CRLF is a member of the family Ranidae and is California's largest native frog. To breed, CRLF 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 CRLF 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 CRLF surveys have occurred across VAFB since the early 1990s (Christopher 1996, 2004; ManTech SRS Technologies, Inc. 2009b) and have shown that CRLF can potentially occur in virtually all known wetlands and bodies of water on VAFB. The Santa Ynez River and Bear Creek, to the north of SLC-4, have CRLF populations and suitable breeding habitat (Christopher 1996, 2004; ManTech SRS Technologies 2009b). Spring Canyon is an ephemeral drainage located approximately 200 ft. south of SLC-4 that has potentially suitable habitat for CRLF in high rain years (ManTech SRS Technologies, Inc. 2013). South of SLC-4, suitable CRLF populations and breeding habitat are found in Cañada Honda Creek and Jalama Creek, along with scattered CRLF localities in minor wetlands and drainages across south VAFB (Christopher 1996, 2004; ManTech SRS Technologies, Inc. 2009a). CRLF populations at Cañada Honda Creek and potentially at Spring Canyon would be within the overflight zone.

During the boost-back and landing of the Falcon 9 First Stage, a sonic boom of 1–2 psf is expected to impact CRLF populations from Purisima Point south to Jalama Creek, including the Santa Ynez River and all of south VAFB (Figure 3-4). During landing, engine noise of approximately 70 dB is expected to impact CRLF populations from San Antonio Creek to Jalama Creek (Figure 3-5). However, only CRLF in Bear Creek, Cañada Honda Creek, the vicinity of SLC-6, and, potentially, Spring Canyon, would be expected to experience landing noise over 100 dB (Figure 3-5).

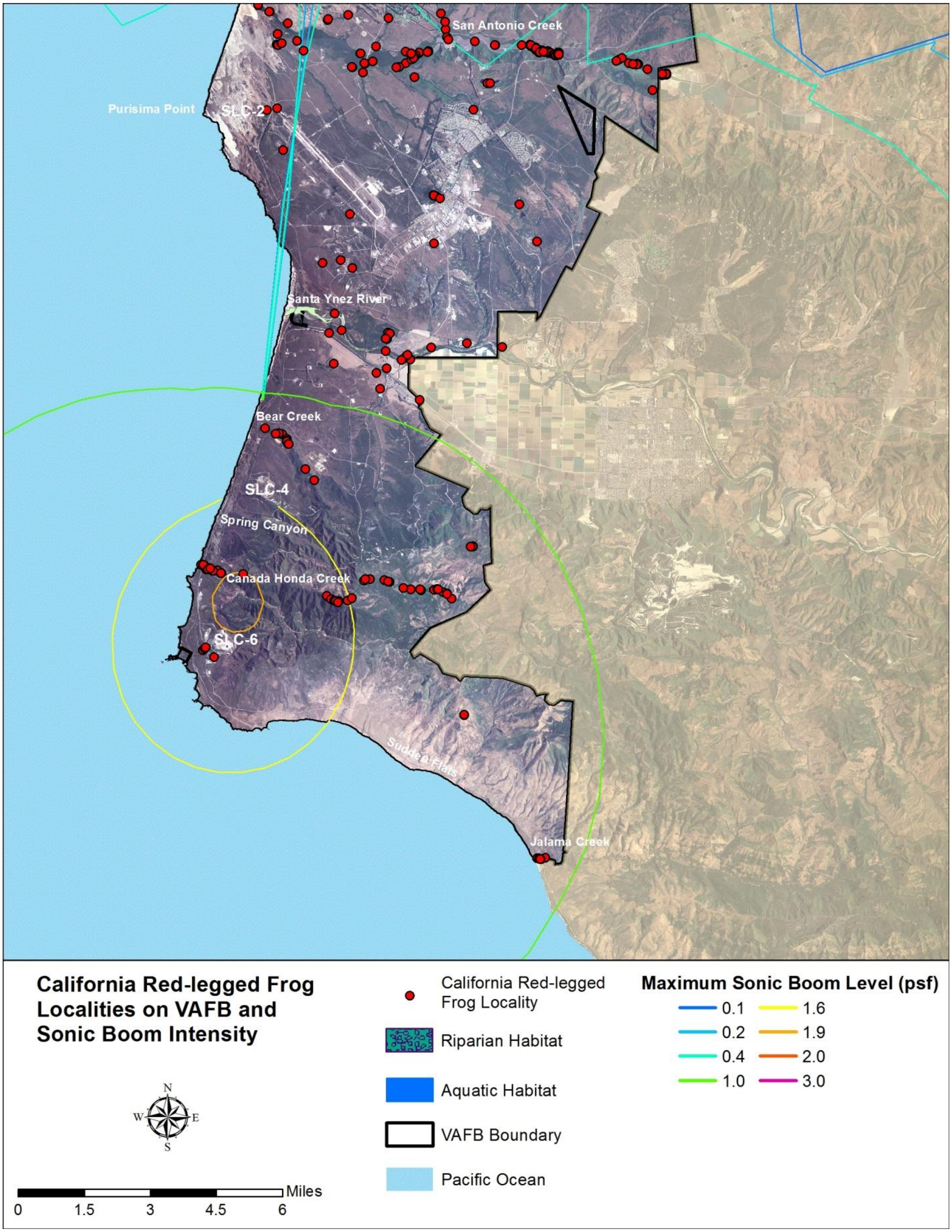


Figure 3-4. CRLF Localities on VAFB and Sonic Boom Intensity.

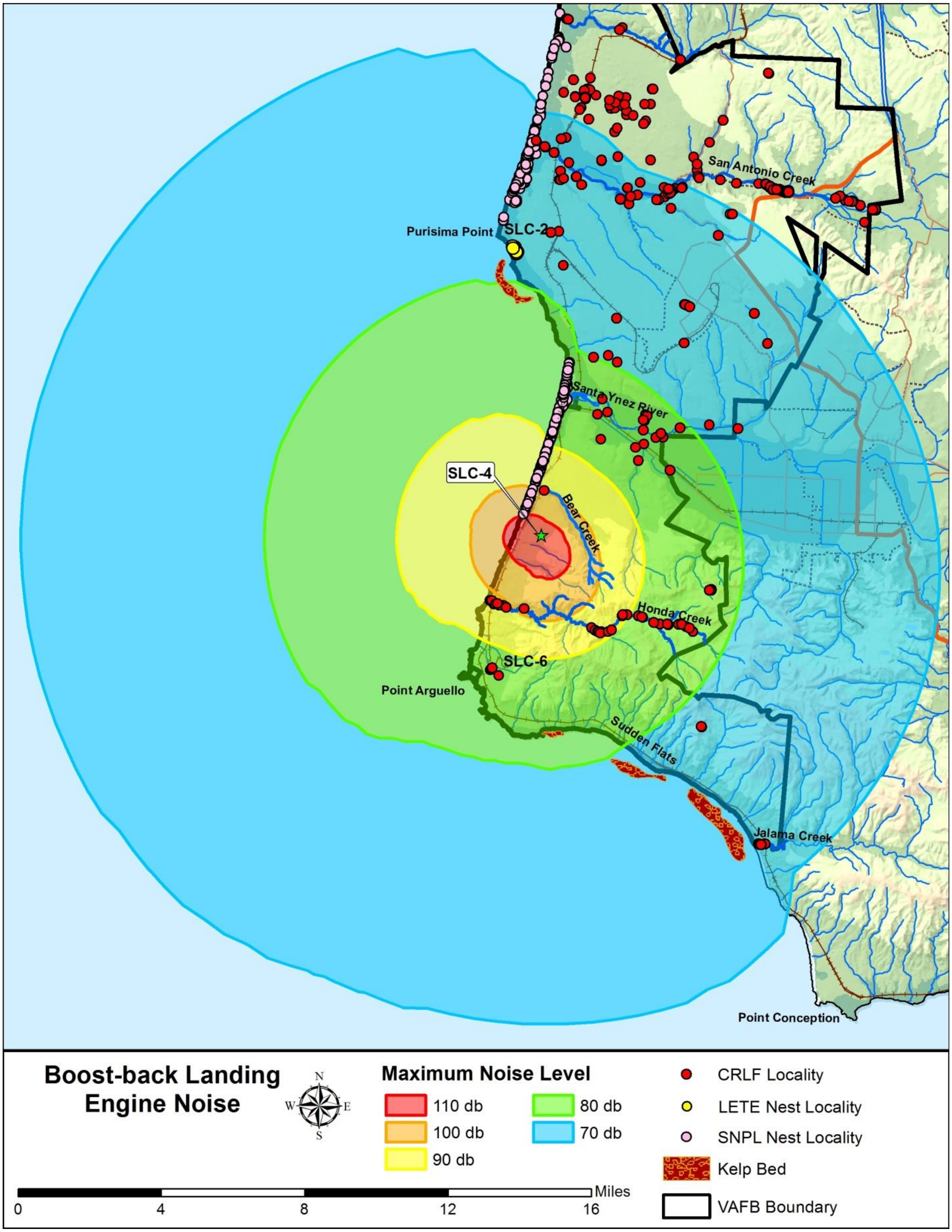


Figure 3-5. Boost-Back Engine Landing Noise Contours Generated by a Sample Trajectory.

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

The USFWS listed the LETE 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 LETE 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. LETE 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, LETE 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, LETE have nested only at the primary colony site, in relatively undisturbed bluff top open dune habitat at Purisima Point. On VAFB, a LETE breeding colony is found at Purisima Point and LETE forage in the lagoons formed at the mouths of the Santa Ynez River and San Antonio Creek (Figure 3-5), and at other near-shore locations at VAFB. VAFB supports a very small percentage of California's breeding population of LETE. However, as one of only three known breeding colonies between Monterey and Point Conception, the population on VAFB remains significant.

LETE foraging and breeding areas are not within the overflight zone of the Proposed Action. The nearest LETE nesting colony at Purisima Point is located approximately 8 mi. (12.9 km) north (Figure 3-5). The breeding colony is within an area expected to receive landing engine noise within 70–80 dB (Figure 3-5), and a sonic boom up to 0.2 psf (Figure 3-6). Adult LETE forage in the Santa Ynez River lagoon and estuary. After young have fledged in late summer, LETE will 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 Santa Ynez River lagoon is approximately 3.7 mi. (6 km) north of SLC-4W, expected to receive landing engine noise within 80–90 dB (Figure 3-5), and within the area expected to receive a sonic boom up to 1 psf (Figure 3-6).

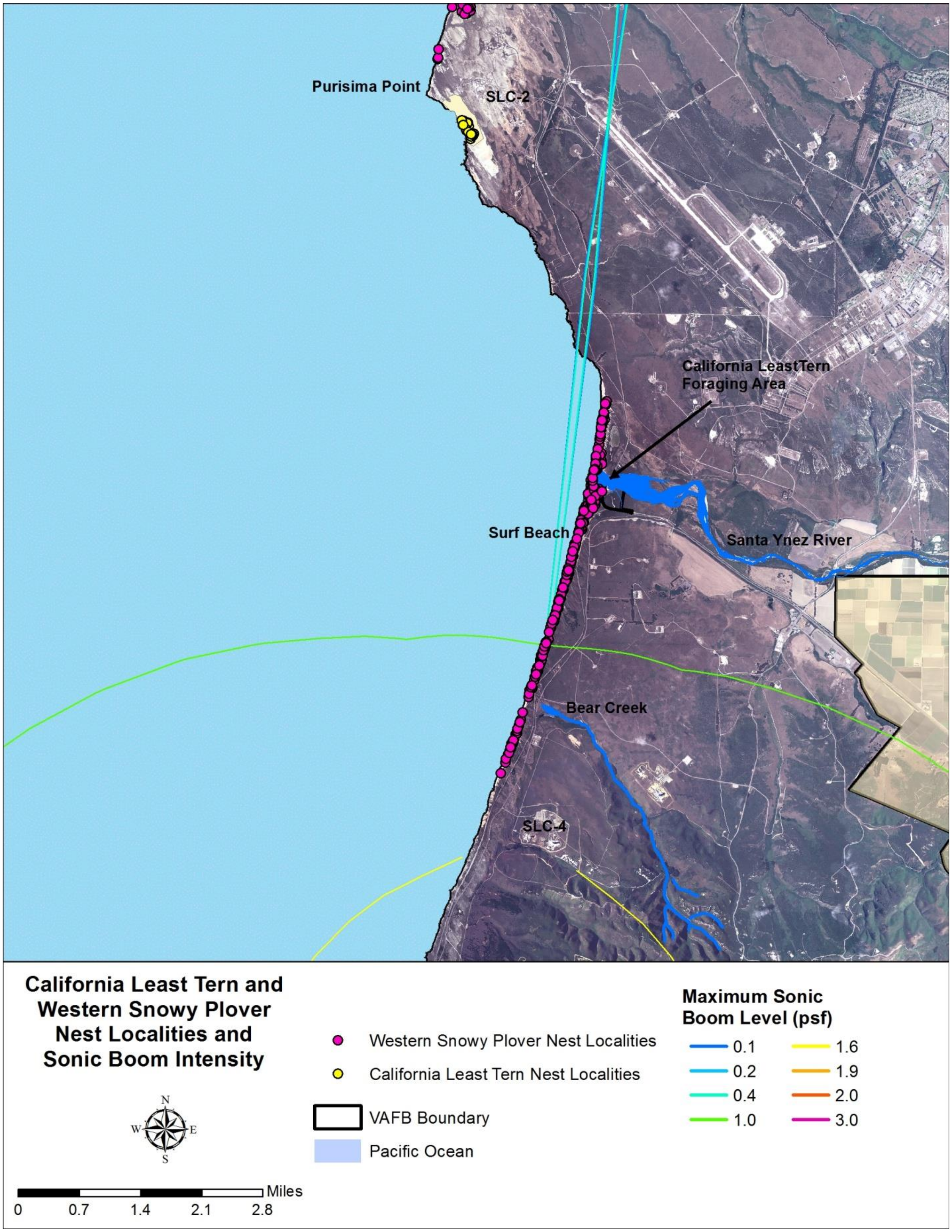


Figure 3-6. Current LETE and SNPL Nesting Localities and Sonic Boom Intensity.

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

The USFWS listed the Pacific coast population of the SNPL 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 SNPL 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 SNPL. SNPL 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 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 SNPL along the west coast of the United States (Page and Persons 1995). In 2014, VAFB supported an estimated 11 percent of California's breeding population (USFWS 2014b).

SNPL nest and overwinter along the coast of VAFB. The nearest observation of a SNPL nest was approximately 0.9 mile northwest of SLC-4. Almost all SNPL nesting habitat on VAFB south of Purisima Point is expected to be impacted by a sonic boom of approximately of 1.0–1.6 psf (Figure 3-6) and would experience landing engine noise between 70 and 100 dB (Figure 3-4).

3.3.6 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 (Figures 2-4, 2-5, 2-6, 2-9, 2-10, 2-11, and 2-14), but also by expended materials in the vicinity of the contingency landing location. Fish, sea turtle, seabird species, and marine mammal species protected under the ESA or MMPA, and managed by NOAA Fisheries have the potential to occur in the vicinity of the contingency landing location. Brief descriptions of the species and their potential for occurring in the project area are provided below. Table 3-6 lists non-mammal species potentially occurring within the marine portion of the project area. Table 3-7 lists protected marine mammal species potentially occurring with the marine portion of the project area. One species, the LETE, 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.

Table 3-6. Special-Status Non-Mammal Species within the ROI for the Proposed Action.

Species	Conservation Status	Occurrence within Proposed Action Area	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 (NOAA Fisheries and USFWS 1998a).

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

3.3.6.1 Fish

3.3.6.1.1 Steelhead Trout (Oncorhynchus mykiss [Federally Endangered DPS])

Steelhead trout are federally protected by the designation of distinct population segments (DPS), which is defined as a population or group of populations that is discrete or separate from other populations of the same species and are equivalent to evolutionarily significant units. Distinct population segments are also the smallest division of a taxonomic species permitted to be protected under the ESA (West Coast Salmon Biological Review Team et al. 2003).

Critical habitat for 10 west coast steelhead DPSs has been designated. Critical habitat in southern California includes the estuarine and freshwater habitat of San Juan Creek, Trabuco Creek, and San Mateo Creek, which is approximately 250 mi. (402 km) south of VAFB, and about 71 mi. (114 km) south of Long Beach, CA.

The Pacific Ocean distribution of steelhead extends from the Kamchatka Peninsula in Asia, east to Alaska and south to southern California, although the species' historical range extended at least to Mexico (Good et al. 2005). North American steelhead often migrate to distant ocean areas. The known ocean range of North American steelhead utilizing tagging information extends in a broad swath across almost the entire North Pacific, south to 40^{o} 58' N and west to 163^{o} 32' E (Quinn and Myers 2004). Spawning occurs exclusively in freshwater habitat, including inshore rivers and streams. After moving downstream and into marine waters, steelhead tend to migrate immediately offshore. Although, in general, steelhead tend to remain closer to shore than other Pacific salmon species, and are expected to occur mainly within the coastal waters of the California Current (Beamish et al. 2005; Quinn and Myers 2004).

3.3.6.1.2 Scalloped Hammerhead Shark (Sphyrna lewini [Federally Endangered DPS])

In 2013, based on the best scientific and commercial information available, including the status review report (Miller et al. 2013), and other information available since completion of the status review report, NOAA Fisheries determined that the species is comprised of six DPSs that qualify as species under the ESA. After reviewing the best available scientific and commercial information on the DPSs, they determined that two DPSs warranted listing as endangered, the Eastern Atlantic and Eastern Pacific DPSs. The Eastern Pacific DPS occurs within Action Area. Critical habitat for this species has not been designated for this species. As a result, the Proposed Action would not affect critical habitat for this species. The scalloped hammerhead shark is circumglobal, occurring in all temperate to tropical waters (Duncan and Holland 2006) from the surface to depths of 275 m (902 ft.). It typically inhabits nearshore waters of bays and estuaries where water temperatures are at least 22 degrees Centigrade (°C) (72°F) (Castro 1983; Compagno 1984). The scalloped hammerhead shark remains close to shore during the day and moves to deeper waters at night to feed (Bester 1999). In the eastern Pacific, the scalloped hammerhead ranges from southern California (including the Gulf of California) to Panama, Ecuador, and northern Peru, and includes waters in the project area.

3.3.6.1.3 North American Green Sturgeon (Acipenser medirostris [Federally Threatened DPS])

Upon completion of a status review, NOAA Fisheries determined that green sturgeon comprise two DPSs that qualify as species: a northern DPS, consisting of populations in coastal systems from the Eel River, California northward, that was determined to not warrant listing; and a southern DPS consisting of coastal and Central Valley populations south of the Eel River, with the only known spawning population in the Sacramento River. In 2006, NOAA Fisheries listed the southern DPS of North American green sturgeon (hereafter referred to as "green sturgeon") as a threatened species under the ESA. Critical habitat for this species has not been designated for this species. As a result, the Proposed Action would not affect critical habitat for this species. Green sturgeon are a long-lived, slow-growing species like all sturgeon. Adult green sturgeon typically migrate into freshwater beginning in late February and spawn from March to July. The principal factor in the decline of the green sturgeon is the reduction of the spawning habitat to a limited section of the Sacramento River

3.3.6.2 Sea Turtles

3.3.6.2.1 Green Sea Turtle (Chelonia mydas [Federally Threatened])

The green sea turtle was listed under the ESA in July 1978 because of excessive commercial harvest, a lack of effective protection, evidence of declining numbers, and habitat degradation and loss (NOAA Fisheries and USFWS 2007a). The green sea turtle breeding populations off Florida and the Pacific coast of Mexico are listed as endangered, and all other populations are listed as threatened. The green sea turtle is found in tropical and subtropical coastal and open ocean waters, between 30° N and 30° S. Critical habitat has not been designated in the Pacific Ocean. As a result, the Proposed Action would not affect critical habitat for this species. There are very few reports of turtles from southern Pacific Ocean populations occurring in the northern Pacific Ocean (Limpus et al. 2009). Green sea turtles are widely distributed in the subtropical coastal waters of southern Baja California, Mexico, and Central America, several hundred km south of the Action Area (Cliffton et al. 1995; NOAA Fisheries Service and USFWS 1998b). Another green sea turtle population resides in Long Beach, California, although less is known about this population (Eguchi et al. 2010). Ocean waters off Southern California and northern Baja California are designated as areas of occurrence because of the presence of rocky ridges and channels and floating kelp habitats suitable for green sea turtle foraging and resting (Stinson 1984); however, these waters are often at temperatures below the thermal preferences of this primarily tropical species. Sufficient data is not currently available to estimate densities of this species off the coast of VAFB (U.S. Department of the Navy 2014a).

3.3.6.2.2 Hawksbill Sea Turtle (Eretmochelys imbricata [Federally Endangered])

The hawksbill turtle is listed as endangered under the ESA (NOAA Fisheries and USFWS 1998c). Critical habitat has not been designated for the hawksbill in the Pacific Ocean. As a result, the Proposed Action would not affect critical habitat for this species. Water temperature in the Southern California region of the Study Area is generally too low for hawksbills, and they are rare. Nesting is rare in the eastern Pacific Ocean region, and does not occur along the U.S. west coast (NOAA Fisheries and USFWS 1998c; Witzell 1983). Stinson (1984) did not mention the hawksbill turtle in her summary of sea turtle occurrences in eastern north Pacific waters from Baja California to the Gulf of Alaska, and no hawksbill sightings have been confirmed along the U.S. west coast in recent history (Eckert 1993; NOAA Fisheries and USFWS 2007b). If hawksbills were to occur in the Southern California region of the Study Area, it would most likely be during an El Niño event, when waters along the California current are unusually warm (NOAA Fisheries 2008). The U.S. Navy has assumed that this species does not occur in the Eastern Pacific off the coast of Southern California (U.S. Department of the Navy 2014a). As a result, we assume this species is very unlikely to occur within the region of the contingency landing area.

3.3.6.2.3 Loggerhead Sea Turtle (Caretta [Federally Endangered])

In September 2011, NOAA Fisheries listed all three Pacific Ocean distinct population segments of loggerhead sea turtles as endangered (76 FR 588868). There is no critical habitat designated for the North Pacific Ocean DPS. As a result, the Proposed Action would not affect critical habitat for this species. Loggerhead sea turtles are one of the larger species of turtle, named for their large blocky heads that support powerful jaws used to feed on hard-shelled prey. The loggerhead is found in temperate to tropical regions of the Atlantic, Pacific, and Indian Oceans and in the Mediterranean Sea (Conant et al. 2009). The highest densities of loggerheads can be found just north of Hawaii in the North Pacific Transition Zone (Polovina et al. 2000). The North Pacific Transition Zone is defined by convergence zones of high productivity that stretch across the entire northern Pacific Ocean from Japan to California (Polovina et al. 2001). The loggerhead turtle is known to occur at sea in Southern California, but does not nest on Southern California beaches. Loggerhead turtles primarily occupy areas where the sea surface temperature is between 59°F and 77°F (15°C and 25°C). Sufficient data is not currently available to estimate densities of this species off the coast of VAFB (U.S. Department of the Navy 2014a).

3.3.6.2.4 Olive Ridley Sea Turtle (Lepidochelys olivacea [Federally Endangered])

The Mexican Pacific Ocean coast nesting population has been classified as endangered because of extensive overharvesting of olive ridley turtles in Mexico, which caused a severe population decline (NOAA Fisheries and USFWS 1998d). Olive ridleys in the Action Area would likely belong to this population. All other populations are listed under the ESA as threatened (NOAA Fisheries and USFWS 1998d). Critical habitat has not been designated for the olive ridley. As a result, the Proposed Action would not affect critical habitat for this species. Most olive ridley turtles lead a primarily open ocean existence (NOAA Fisheries and USFWS 1998d). Individuals occasionally occur in waters as far north as California and as far south as Peru, spending most of their life in the oceanic zone (NOAA Fisheries and USFWS 2007c). The olive ridley has a large range in tropical and subtropical regions in the Pacific Ocean, and is generally found between 40° N and 40° S. Sufficient data is not currently available to estimate densities of this species off the coast of VAFB (U.S. Department of the Navy 2014a).

3.3.6.2.5 Leatherback Sea Turtle (Dermochelys coriacea [Federally Endangered])

The leatherback turtle is listed as a single population, and is classified as endangered under the ESA. Leatherbacks are known as an open ocean species, but can also be found in coastal waters within the Action Area. In 2012, NOAA Fisheries designated critical habitat for the leatherback sea turtle in California (from Point Arena to Point Arguello) and from Cape Flattery, Washington, to Winchester Bay, Oregon, out to the 2,000 mi. (3,219 km) depth contour (NOAA Fisheries 2012). This critical habitat designation is within the area of the contingency plan for the Proposed Action and is discussed in Section 3.3.7 (Sensitive Marine Habitats), below. There is one primary constituent element that is essential to the conservation of leatherback sea turtles in marine waters on the U.S. West Coast. It is the occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (*Chrysaora, Aurelia, Phacellophora* and *Cyanea*), of sufficient condition, distribution, diversity, abundance, and density necessary for growth and success of leatherback sea turtles (NOAA Fisheries 2012).

The leatherback turtle is the most widely distributed of all sea turtles, found from tropical to subpolar oceans, and nests on tropical and occasionally subtropical beaches (Gilman 2008; Myers and Hays 2006; NOAA Fisheries and USFWS 1992). Found from 71° N to 47° S, it has the most extensive range of any adult turtle (Eckert 1995). Leatherback sea turtles typically are found to forage in the area around the Proposed Action during the spring and early summer when waters are cool, they move further east and north during the late summer (NOAA Fisheries 2012). Leatherback turtles are regularly seen off the western coast of the United States, with the greatest densities found off central California. Off central California, sea surface temperatures are highest during the summer and fall, and oceanographic conditions create favorable habitat for leatherback turtle prey jellyfish (NOAA Fisheries 2012). Numerous NOAA Fisheries survey sightings of leatherbacks have been recorded in the waters of Southern California, with nearly all of those sightings occurring in deeper waters seaward of the Channel Islands. We assumed a conservative estimate for density of 0.036 individuals per km^2, based on densities off shore of San Francisco (U.S. Department of the Navy 2014a).

3.3.6.3 Marine Mammals

In additional to the six pinniped species described in the sections below, 28 cetaceans (whales and dolphins) may be present in the area identified for a contingency barge landing, as described in Section 2.2.3 (Falcon 9 Boost-Back and Landing) (Table 3-8). Information on the likelihood of cetaceans occurring in the vicinity of the contingency landing location is provided following the pinniped sections. The estimated at-sea density for the following species is assumed to be zero in the project area, because these species are very unlikely to occur or are not known to occur in the region: pygmy killer whale (*Feresa attenuata*), false killer whale (*Pseudorca crassidens*), Hawaiian monk seal (*Monachus schauinslandi*), Longman's beaked whale (*Indopacetus pacificus*), Fraser's dolphin (*Lagenodelphis hosei*), spinner dolphin (*Stenella longirostris*), pantropical spotted dolphin (*Stenella attenuata*), and melon-headed whale (*Peponocephala electra*).

3.3.6.3.1 Southern Sea Otter (Enhydra lutris nereis [Federal Threatened Species])

The USFWS listed the southern sea otter as federally threatened on 14 January 1977 (42 FR 2965). Critical habitat for this species has not been designated. As a result, the Proposed Action would not affect critical habitat for the sea otter.

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. 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 eating sea urchins that eat and destroy kelp beds.

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

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 3-7). VAFB sea otters inhabiting the coast between Purisima Point and Sudden Flats could be impacted by a sonic boom of 1.0–1.6 psf (Figure 3.7). Sea otters inhabiting the kelp beds at Purisima Point and the kelp beds between Point Arguello and Jalama Creek would be expected to experience landing engine noise between 70 and 80 dB (Figure 3-5). Transitory otters traversing the coast between SLC-4 and Point Arguello may be impacted by a sonic boom as high as 2 psf (Figure 3-7) and landing engine noise as great as 110 dB. (Figure 3-5); 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 2014 (U.S. Geological Survey Western Ecological Resource Center 2014). Sea otters would not be present at the contingency landing area described under Alternative 1 or offshore landing areas under Alternative 2 and the No Action Alternative.

Table 3-7. 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 Barge/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]
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*	NL	-	Rare	Open ocean	

Species	Conservation Status		Occurrence within Proposed Project Area	Habitat	Notes
	ESA	MMPA	Offshore Barge/landing site		
brydei/edeni					
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	
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

Species	Conservation Status		Occurrence within Proposed Project Area	Habitat	Notes
	ESA	MMPA	Offshore Barge/landing site		
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
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).

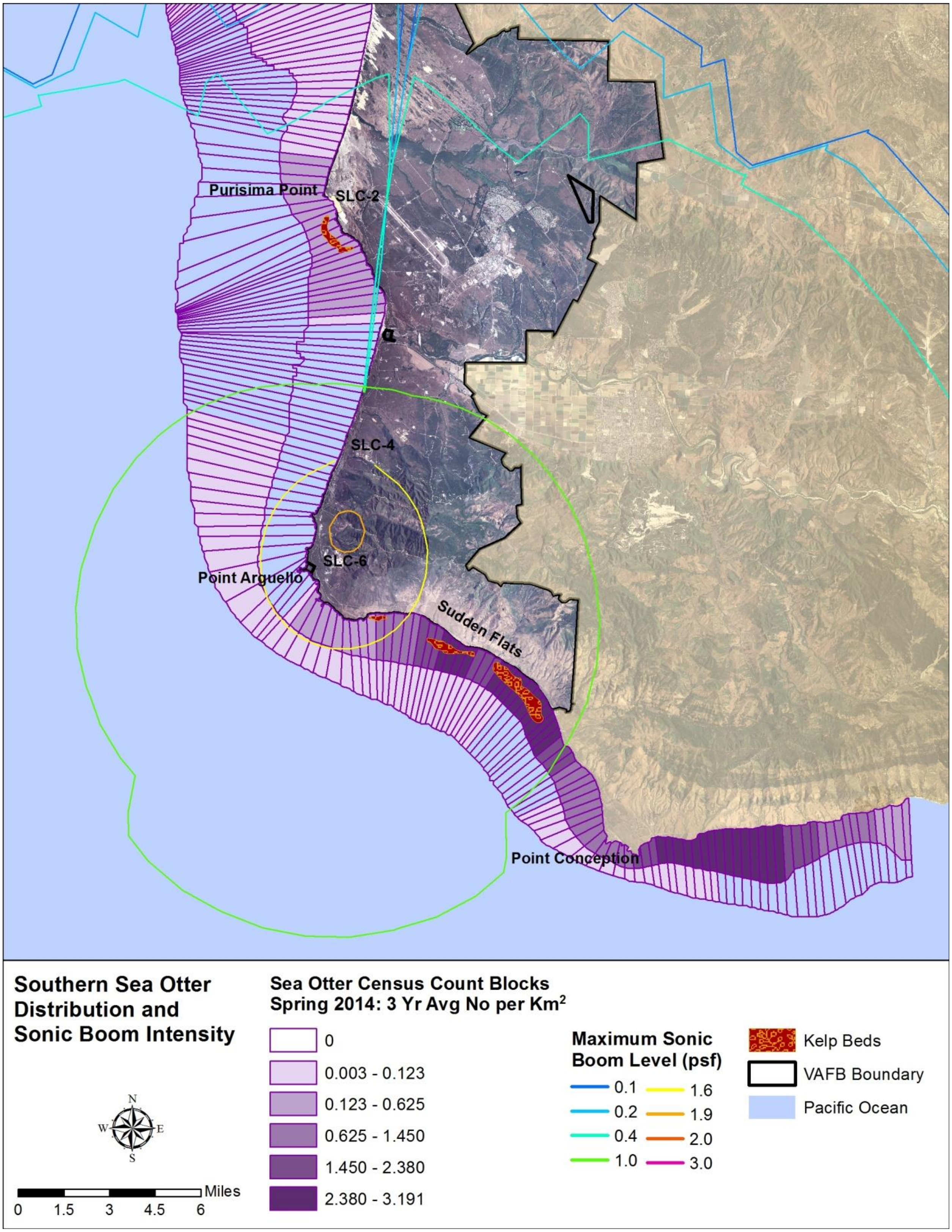
[3] Calambokidis et al. 2001

[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: 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



Source: U.S. Geological Survey 2014

Figure 3-7. Southern Sea Otter Distribution and Sonic Boom Intensity.

3.3.6.3.2 Pacific Harbor Seal (Phoca vitulina richardsi [Not Listed])

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, as shown in Figure 3-8, where most of the pupping on VAFB occurs. These haul-out sites are more than 5 mi. (8.1 km) from SLC-4W and are not within the overflight zone of Alternative 1 or Alternative 2. However, noise levels from the First Stage landing may reach 80 dB at the haul-out sites (Figure 3-8), and sonic boom pressure levels could reach 2.0 psf (Figure 3-9). 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. 2014b, 2015b; VAFB, unpublished data). During aerial pinniped surveys of haul outs 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). Harbor seals also haul out, breed, and pup in isolated beaches and coves throughout the coasts of San Miguel, Santa Rosa, and Santa Cruz Islands (Lowry 2002). 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). The at-sea estimated density for harbor seals is 0.02 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.3 California Sea Lion (Zalophus californianus [Not Listed])

California sea lions haul out sporadically on rocks and beaches along the coastline of VAFB. Therefore, there is the potential that California sea lions could haul-out within the overflight zone of the Alternative 1 or Alternative 2. Noise levels from the First Stage landing may reach 80 dB at the haul-out sites (Figure 3-8), and sonic boom pressure levels could reach 2.0 psf (Figure 3-9). In 2014, counts of California sea lions at haul outs on VAFB increased substantially, ranging from 47 to 416 during monthly counts (ManTech SRS Technologies, Inc. 2015b). However, California sea lions rarely pup on the VAFB coastline: no pups were observed in 2013 or 2014 (ManTech SRS Technologies, Inc. 2014b, 2015b) and 1 pup was observed in 2015 (VAFB, unpubl. data). 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 (Lowry 2002). 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 haul outs 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 haul outs 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 estimate density for California sea lions is 2.5 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.4 Northern Elephant Seal (Mirounga angustirostris [Not Listed])

Northern elephant seals also haul-out sporadically on rocks and beaches along the coastline of VAFB. Therefore, there is the potential that northern elephant seals could haul out within the overflight zone of the Alternative 1 or Alternative 2. Noise levels from the First Stage landing may reach 80 dB at the haul-out sites (Figure 3-8), and sonic boom pressure levels could reach 2.0 psf (Figure 3-9). However, northern elephant seals do not pup on the VAFB coastline 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. 11 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). 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 haul outs 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). The at-sea estimate density for northern elephant seals is 0.05 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.5 Steller Sea Lion (Eumetopias jubatus [Federal De-Listed Species])

North Rocky Point was used in April and May 2012 by Steller sea lions (Marine Mammal Consulting Group and Science Applications International Corporation 2013). 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). Noise levels from the First Stage landing may reach 80 dB at the haul-out sites (Figure 3-8), and sonic boom pressure levels could reach 2.0 psf (Figure 3-9). 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 ESA in November 2013. The at-sea estimate density for Steller sea lion is assumed to be 0.0001 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.6 Northern Fur Seal (Callorhinus ursinus [Not Listed])

Two stocks of northern fur seals are recognized in United States waters: an eastern Pacific stock and a San Miguel Island stock (Carretta et al. 2015). 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). Adult males stay on San Miguel Island from May through August, with some non-breeding individuals remaining until November. Adult females generally stay from June to as late as November. 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). 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 seal is 0.005 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.7 Guadalupe Fur Seal (Arctocephalus townsendi [Federally Threatened Species])

The Guadalupe fur seal is listed as threatened under the ESA and depleted under the MMPA. Critical Habitat for the Guadalupe fur seal has not been designated for this species. As a result, the Proposed Action would not affect Critical Habitat for this species.

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.). Observations of adult males are rare on San Miguel Island and there have not been any breeding territories established (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. 2015). The estimated at-sea density of this species is assumed to be 0.007 individuals per km^2 in the affected area (U.S. Department of the Navy 2014a).

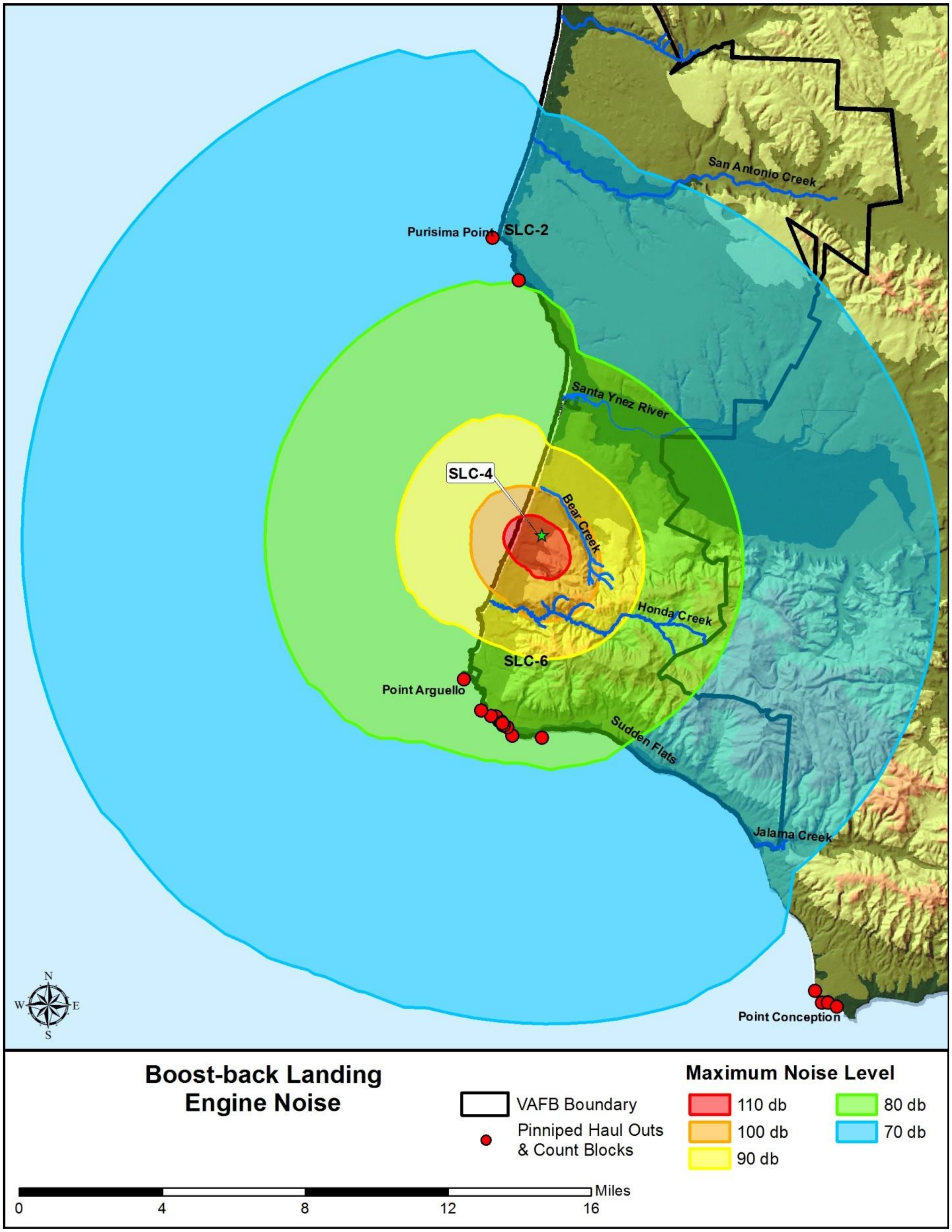


Figure 3-8. Marine Mammal Haul-out sites on Within the Region of Expected Landing Noise for SLC-4W Landing.

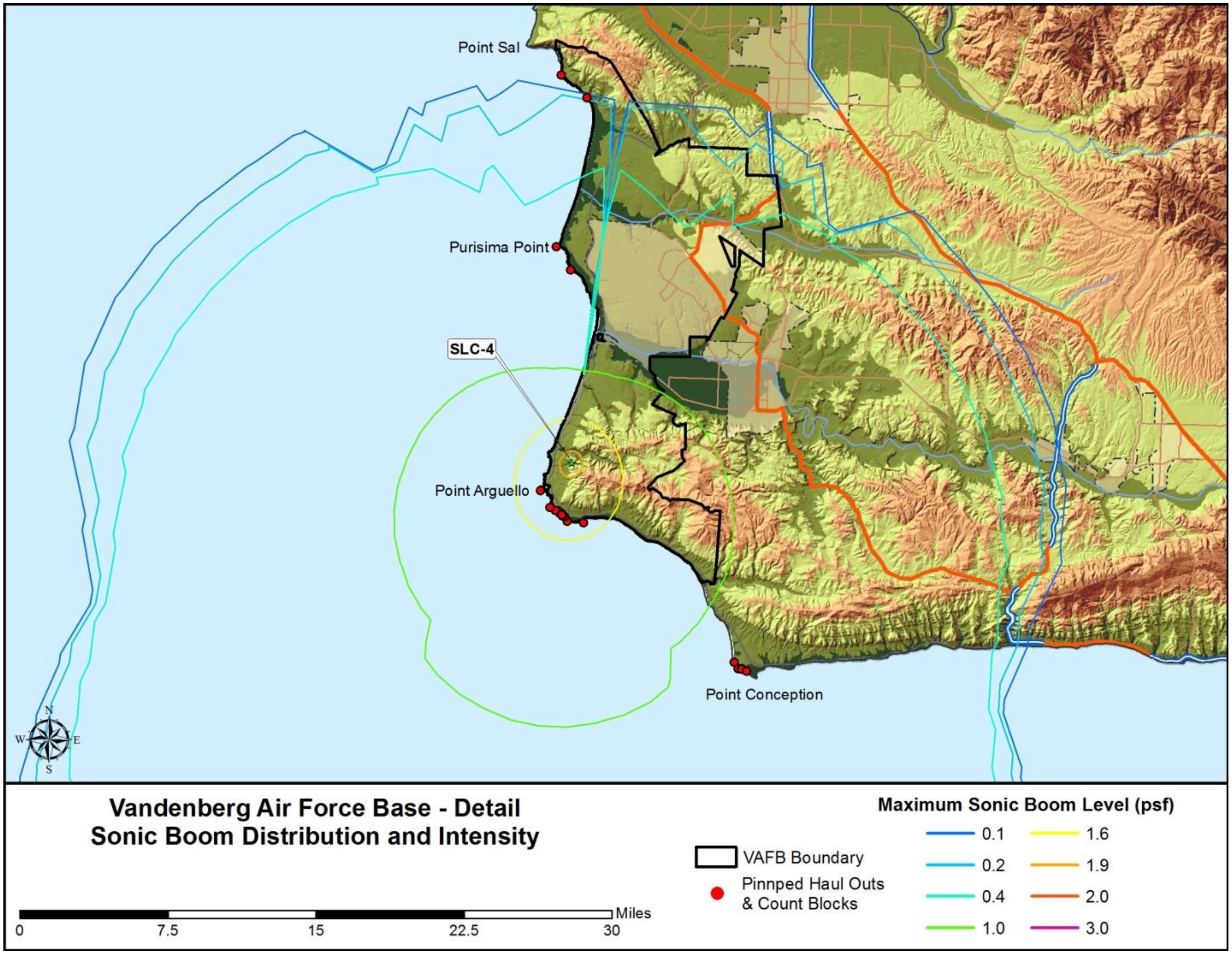


Figure 3-9. Marine Mammal Haulouts on VAFB and Expected Sonic Boom Levels for SLC-4W Landing

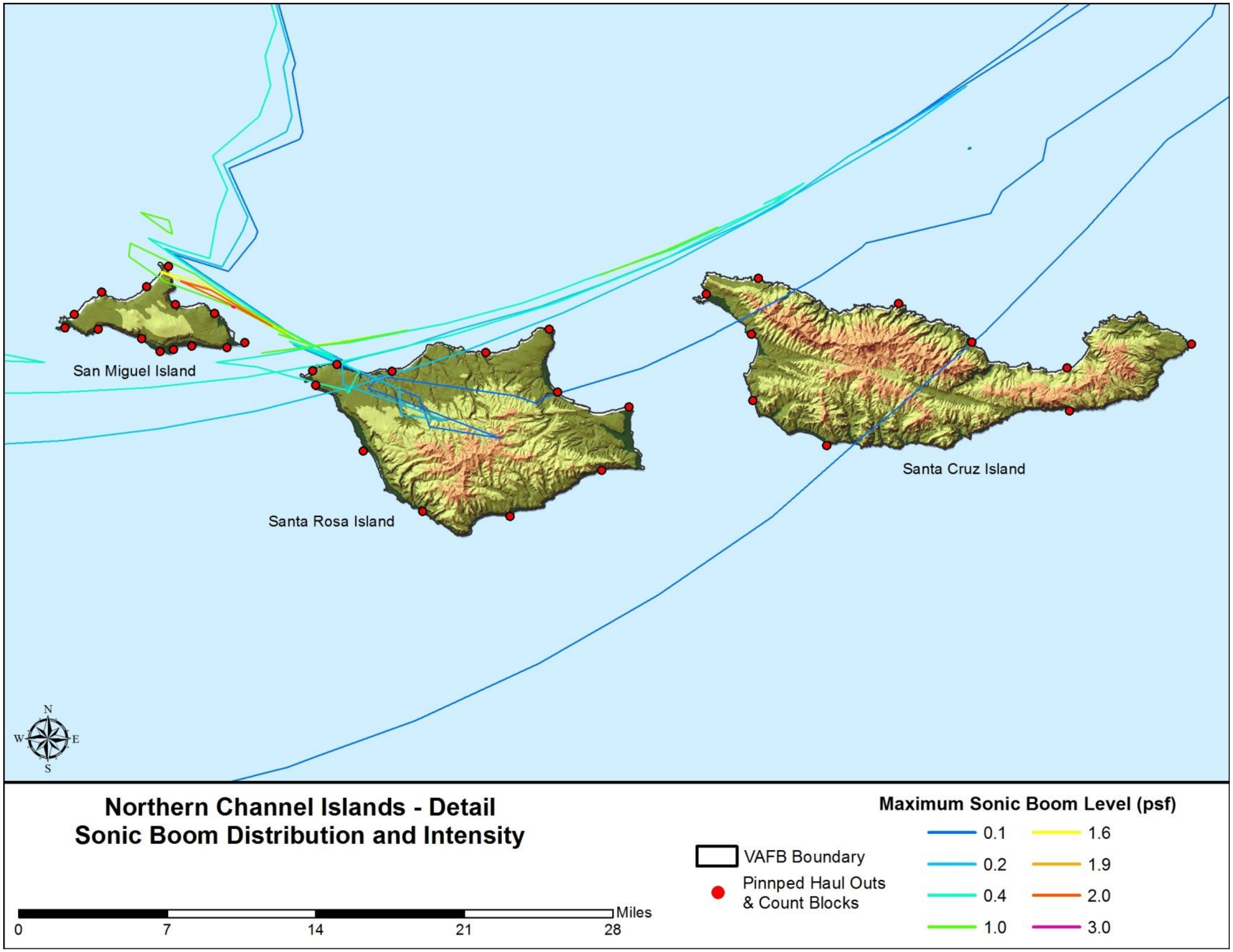


Figure 3-10. Marine Mammal Haulouts on VAFB and Expected Sonic Boom Levels for SLC-4W Landing.

3.3.6.3.8 Humpback Whale (Megaptera novaeangliae [Federally Endangered Species])

Humpback whales are listed as depleted under the MMPA and endangered under the ESA. Based on evidence of population recovery in many areas, the species is being considered by NOAA Fisheries for removal or down-listing from the ESA (NOAA Fisheries 2009a). 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. 2015). The at-sea estimated density for humpback whales is 0.02 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.9 Blue Whale (Balaenoptera musculus [Federally Endangered Species])

The blue whale is listed as endangered under the ESA and 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 (Bailey et al. 2009; Carretta et al. 2015). 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 0.01 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.10 Fin Whale (Balaenoptera physalus [Federally Endangered Species])

The fin whale is listed as endangered under the ESA and 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. 2015; 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 0.01 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.11 Sei Whale (Balaenoptera borealis [Federally Endangered Species])

The sei whale is listed as endangered under the ESA and as depleted under the MMPA. Sei whales are distributed in offshore waters in the Southern California portion of the Study Area (Carretta et al. 2015). 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 is 0.00009 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.12 Bryde's Whale (Balaenoptera brydei/edeni [Not Listed])

Bryde's whales are protected under the MMPA and are not listed under the ESA. Bryde's whales are only occasionally sighted in the California Current Large Marine Ecosystems (Carretta et al. 2015; Jefferson et al. 2008; Smultea 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 0.00001 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.13 Minke Whale (Balaenoptera acutorostrata [Not Listed])

The minke whale is protected under the MMPA and is not listed under the ESA. 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 0.0007 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.14 Gray Whale (Eschrichtius robustus [Federally Endangered Species])

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). 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). During aerial surveys off San Clemente Island, California, eastern gray whales were the most abundant marine mammal 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 0.002 per km2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.15 Sperm Whale (Physeter microcephalus [Federally Endangered Species])

The sperm whale has been listed as endangered since 1970 under the precursor to the ESA (NOAA Fisheries 2009b), and is 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. 2015). The at-sea estimated density for sperm whales is 0.009 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.16 Pygmy Sperm Whale (Kogia breviceps [Not Listed])

The pygmy sperm whale is protected under the MMPA but is not listed under the ESA. 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. 2015). The at-sea estimated density for pygmy sperm whales is 0.001 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.17 Dwarf Sperm Whale (Kogia sima [Not Listed])

The dwarf sperm whale is protected under the MMPA and is not listed under the ESA. 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. 2015). The at-sea estimated density for dwarf sperm whales is 0.001 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.18 Killer Whale (Orcinus orca [Not Listed])

The killer whale is protected under the MMPA, and the overall species is not listed on the ESA. The southern resident population in Puget Sound (not found in the landing area) is listed as endangered under the ESA and is depleted under the MMPA. 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. 2015; Forney et al. 1995). The at-sea estimated density for killer whales is 0.0007 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.19 Short-finned Pilot Whale (Globicephala macrorhynchus [Not Listed])

Short-finned pilot whales are protected under the MMPA and are not listed under the ESA. Along the U.S. Pacific coast, short-finned pilot whales are most abundant south of Point Conception (Carretta et al. 2015; 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. 2015; 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 0.0003 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.20 *Long-beaked Common Dolphin (Delphinus capensis [Not Listed])*

Long-beaked common dolphins are protected under the MMPA and are not listed under the ESA. 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 this species' abundance fluctuates seasonally and from year to year off California (Carretta et al. 2015; 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 2005a, 2005b; Carretta et al. 2015). 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 0.69 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.21 *Short-beaked Common Dolphin (Delphinus delphis [Not Listed])*

Short-beaked common dolphins are protected under the MMPA and are not listed under the ESA. 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. 2015; 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. 2015; Forney and Barlow 1998). The at-sea estimated density for short-beaked common dolphins is 1.3 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.22 *Common Bottlenose Dolphin (Tursiops truncates [Not Listed])*

The common bottlenose dolphin is protected under the MMPA and is not listed under the ESA. 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. 2015). 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. 2015; 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. 2015). The at-sea estimated density for common bottlenose dolphins is 0.71 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.23 *Striped Dolphin (Stenella coeruleoalba [Not Listed])*

The striped dolphin is protected under the MMPA and is not listed under the ESA. 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. 2015). The at-sea estimated density for striped dolphins is 0.03 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.24 Pacific White-sided Dolphin (Lagenorhynchus obliquidens [Not Listed])

The Pacific white-sided dolphin is not listed under the ESA but is protected under the MMPA. 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 dolphins is 0.75 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.25 Northern Right Whale (Lissodelphis borealis [Not Listed])

The northern right whale dolphin is not listed under the ESA but is protected by the MMPA. This species is known to occur year round off of 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. 1995; Forney and Barlow 1998; Leatherwood and Walker 1979).The at-sea estimated density for northern right whale dolphins is 0.107 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.26 Risso's Dolphin (Grampus griseus [Not Listed])

Risso's dolphin is protected under the MMPA and is not listed under the ESA. Off California, they are commonly seen over the slope and in offshore waters (Caretta et al. 2015; 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 0.20 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.27 Dall's Porpoise (Phocoenoides dalli [Not Listed])

The Dall's Porpoise is protected under the MMPA and is not listed under the ESA. In Southern California waters, Dall's porpoises are sighted seasonally, mostly during the winter (Carretta et al. 2015). 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 dolphins is 0.06 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.28 Cuvier's Beaked Whale (Ziphius cavirostris [Not Listed])

Cuvier's beaked whale is protected under the MMPA and is not listed under the ESA. 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. 2015; 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 0.005 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.29 Baird's Beaked Whale (Berardius bairdii [Not Listed])

Baird's beaked whale is protected under the MMPA and is not listed under the ESA. 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. 2015; 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. 2015). The at-sea estimated density for Baird's beaked whales is 0.0015 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.30 Blainville's Beaked Whale (Mesoplodon densirostris [Not Listed])

Blainville's beaked whale is protected under the MMPA and is not listed under the ESA. There are a handful of known records of the Blainville's beaked whale from the coast of California and Baja California, Mexico, but the species does not appear to be common in California waters (Carretta et al. 2015; Mead 1989; Pitman et al. 1988). The at-sea estimated density for Blainville's beaked whales is 0.0001 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.31 Ginko-toothed Beaked Whale (Mesoplodon ginkgodens [Not Listed])

The ginkgo-toothed beaked whale is protected under the MMPA and is not listed under the ESA. The distribution of the ginkgo-toothed beaked whale likely includes the California Current system North Pacific Gyre. The handful of known records of the ginkgo-toothed beaked whale are from strandings, one of which occurred in California (Jefferson et al. 2008; MacLeod and D'Amico 2006). The at-sea estimated density for Ginko-toothed beaked whales is 0.0003 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.32 Perrin's Beaked Whale (Mesoplodon perrini [Not Listed])

Perrin's beaked whale is protected under the MMPA and is not listed under the ESA. Perrin's beaked whale range generally includes the California Current system and North Pacific Gyre (MacLeod et al. 2006). Perrin's beaked whale is known only from five stranded specimens along the California coastline (Dalebout et al. 2002; MacLeod et al. 2006). Regional distribution and abundance within the California Current system have not been estimated to date, due to scarcity of data. Known records of this species come from five strandings from 1975 to 1997. These strandings include two at U.S. Marine Corps Base Camp Pendleton, and one each at Carlsbad, Torrey Pines State Reserve, and Monterey (Dalebout et al. 2002; Mead 1981), all of which are in California. The at-sea estimated density for Perrin's beaked whales is 0.001 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.33 Stejneger's Beaked Whale (Mesoplodon stejnegeri [Not Listed])

Stejneger's beaked whale is protected under the MMPA and is not listed under the ESA. This species may be found in the California Current system and has an assumed preference for colder water (Jefferson et al. 2008; MacLeod et al. 2006). The southern limit in the central Pacific is unknown but is likely to range between 50° N and 60° N, and 30° N (Loughlin and Perez 1985; MacLeod et al. 2006). The at-sea estimated density for Stejneger's beaked whales is 0.001 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.34 Hubb's Beaked Whale (Mesoplodon carlhubbsi [Not Listed])

Hubbs' beaked whale is protected under the MMPA and is not listed under the ESA. MacLeod et al. (2006) speculated that the distribution might be continuous across the north Pacific between about 30° N and 45° N, but this remains to be confirmed. Mead (1989) speculated that the Hubbs' beaked whales' range includes the northernmost central California coastline. The at-sea estimated density for Hubb's beaked whales is 0.001 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.6.3.35 Pygmy Beaked Whale (Mesoplodon peruvianus [Not Listed])

The pygmy beaked whale is protected under the MMPA and is not listed under the ESA. beaked whales normally inhabit continental slope and deep oceanic waters (greater than 656 ft. [200 m]) and are only occasionally reported in waters over the continental shelf (Canadas et al. 2002;

Ferguson et al. 2006; MacLeod et al. 2006; Pitman 2008; Waring et al. 2001). Based on stranding data from the Pacific coast of Mexico, the range of the pygmy beaked whale generally includes the California Current system and North Pacific Gyre (Aurioles and Urban-Ramirez 1993; Jefferson et al. 2008; Urban-Ramirez and Aurioles-Gamboa 1992). The at-sea estimated density for Pygmy beaked whales is 0.0003 individuals per km^2 in the contingency landing area of effect (U.S. Department of the Navy 2014a).

3.3.7 Sensitive Marine Habitats

3.3.7.1 Region of Influence

The ROI for sensitive marine habitats includes marine areas that would potentially be affected by potential impacts of the Proposed Action, primarily acoustic impacts (Figures 2-4, 2-5, 2-9, 2-10, and 2-12), but also by expended materials in the vicinity of the contingency landing location.

3.3.7.2 Essential Fish Habitat

In 1996, the Magnuson-Stevens Fishery Conservation and Management Act (MSA) was reauthorized and amended by the Sustainable Fisheries Act (Public Law 104-267). The reauthorized MSA mandated numerous changes to the existing legislation designed to prevent overfishing, rebuild depleted fish stocks, minimize bycatch, enhance research, improve monitoring, and protect fish habitat. One of the most significant mandates in the MSA that came out of the reauthorization was the EFH provision, which provides the means to conserve fish habitat.

The EFH mandate requires that the regional Fishery Management Councils, through federal fishery management plans, describe and identify EFH for each federally managed species; minimize, to the extent practicable, adverse effects on such habitat caused by fishing; and identify other actions to encourage the conservation and enhancement of such habitats. Congress defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (16 United States Code (U.S.C.) §1802(10). The term “fish” is defined in the MSA as “finfish, mollusks, crustaceans, and all other forms of marine animals and plant life other than marine mammals and birds.” The regulations for implementing EFH clarify that “waters” include all aquatic areas and their biological, chemical, and physical properties, while “substrate” includes the associated biological communities that make these areas suitable fish habitats (50 C.F.R. §600.10). Habitats used at any time during a species’ life cycle (i.e., during at least one of its lifestages) must be accounted for when describing and identifying EFH.

Authority to implement the MSA is given to the Secretary of Commerce through NOAA Fisheries. The MSA requires that EFH be identified and described for each federally managed species. The MSA also requires federal agencies to consult with NOAA Fisheries on activities that may adversely affect EFH or when the NOAA Fisheries independently learns of a federal activity that may adversely affect EFH. The MSA defines an adverse effect as “any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions" (50 C.F.R. §600.810).

The contingency landing area under Alternative 1 is located within EFH for federally managed fish species within the Pacific Coast Groundfish, Coastal Pelagic Species, and Highly Migratory Species Management Plans, as shown in Figure 3-11. The Proposed Action is also located approximately 2.5 miles and 12.6 miles from the Point Conception and East San Lucia Bank EFH Conservation Areas, respectively (Figure 3-11).

In addition to EFH designations, areas called Habitat Areas of Particular Concern (HAPC) are also designated by the Regional Fishery Management Councils. Designated HAPCs are discrete subsets of EFH which are rare, particularly vulnerable to human-induced degradation, provide extremely important ecological functions, or located in an environmentally stressed area (50 C.F.R. §600.805–600.815). Categorization of an area as a HAPC does not confer additional protection or restriction to the designated area.

Kelp, rocky reef, and seagrass habitats are designated as HAPC for various federally managed fish species within the Pacific Coast Groundfish Fishery Management Plans. The nearest kelp habitat is located offshore of SLC-4W, while the nearest rocky reef habitat is located approximately 10 miles north-northeast of the contingency barge landing site. Seagrass beds are located along the coastline of VAFB or within coastal estuaries.

3.3.7.3 Critical Habitat – Leatherback Sea Turtle

Critical Habitat for the leatherback sea turtle was designated in California waters from Point Arena south to Point Arguello in 2012 (77 FR 4170). The contingency landing location of Alternative 1 is approximately 6.2 mi. (10 km) south of this Critical Habitat (Figure 3-12). The only primary constituent element for leatherback sea turtles in this Critical Habitat is the occurrence of prey species of sufficient condition, distribution, diversity, abundance, and density necessary for growth and success of leatherback sea turtles (NOAA Fisheries 2012). The Proposed Action would not affect the leatherback sea turtle's prey, and therefore would not affect its Critical Habitat.

3.3.7.4 Marine Reserves

Under the National Marine Sanctuaries Act, NOAA established national marine sanctuaries for marine areas with special conservation, recreational, ecological, historical, cultural, archaeological, scientific, educational, or aesthetic qualities. The Channel Islands National Marine Sanctuary (CINMS) is a collection of marine reserves and marine sanctuaries located at the Channel Islands approximately 40 mi. (65 km) south of SLC-4W (Figures 3-13 and 3-14). CINMS regulations listed in 15 C.F.R. 922.71 - 922.74. Section 922.72(a)(1) prohibits taking any marine mammal, sea turtle, or seabird within or above the CINMS, except as authorized by the MMPA, ESA, MBTA, or any regulation promulgated under the MMPA, ESA, or MBTA. Both the boost-back and landing of the Falcon 9 First Stage at SLC-4W and the contingency landing location 31 mi. (50 km) offshore would produce a sonic boom at or slightly above 3.0 psf within the CINMS.

In addition, the coastline from Purisima Point to just north of Point Arguello (Figures 3-13 and 3-14) has been designated as the Vandenberg State Marine Reserve (VSMR) pursuant to the Marine Managed Areas Improvement Act. The VSMR management objectives include providing for complete protection of a diverse area containing shallow hard and soft habitats, kelp beds, and associated marine life. The project area overlaps the VSMR and a sonic boom up to 2 psf is expected within this reserve.

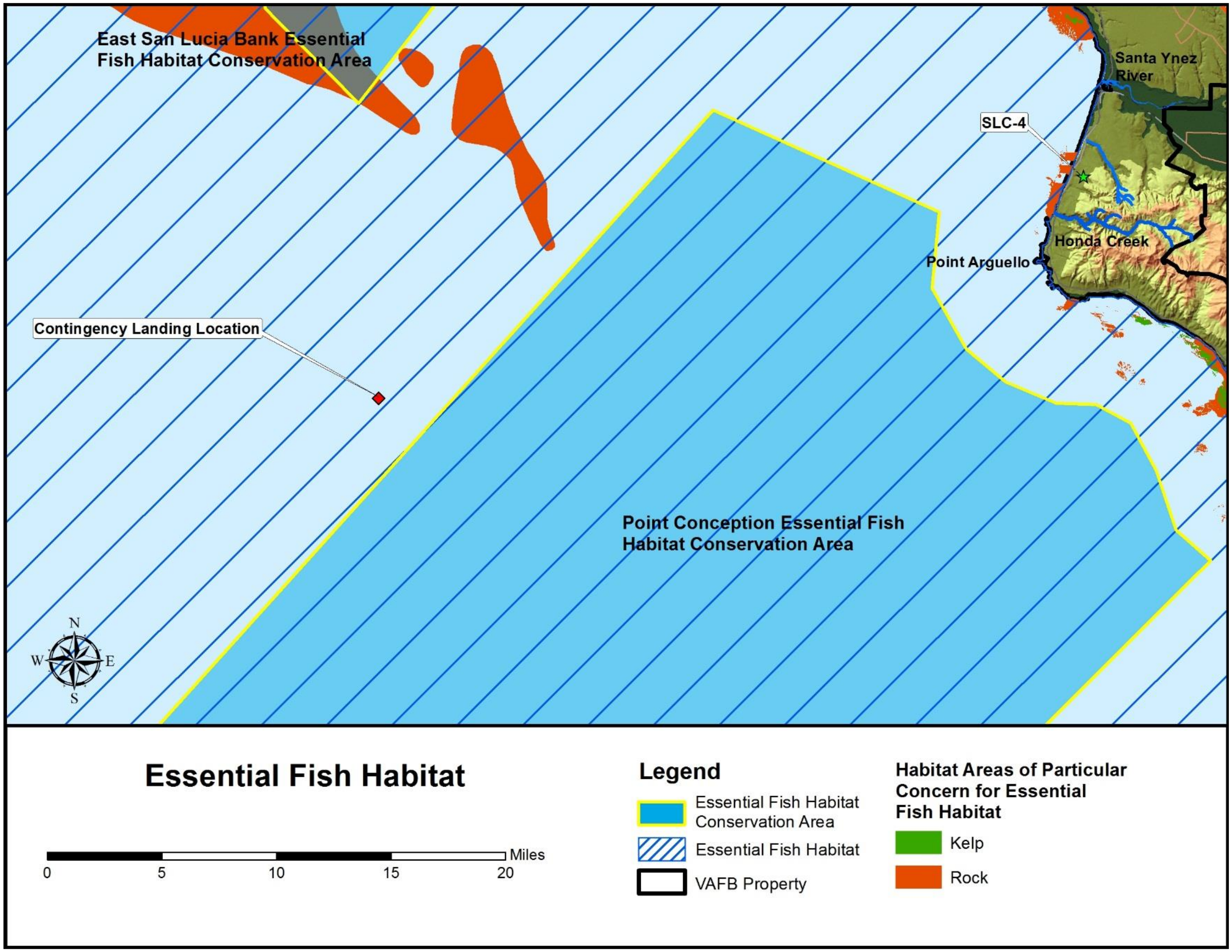


Figure 3-11. Essential Fish Habitat Within the Project Area.

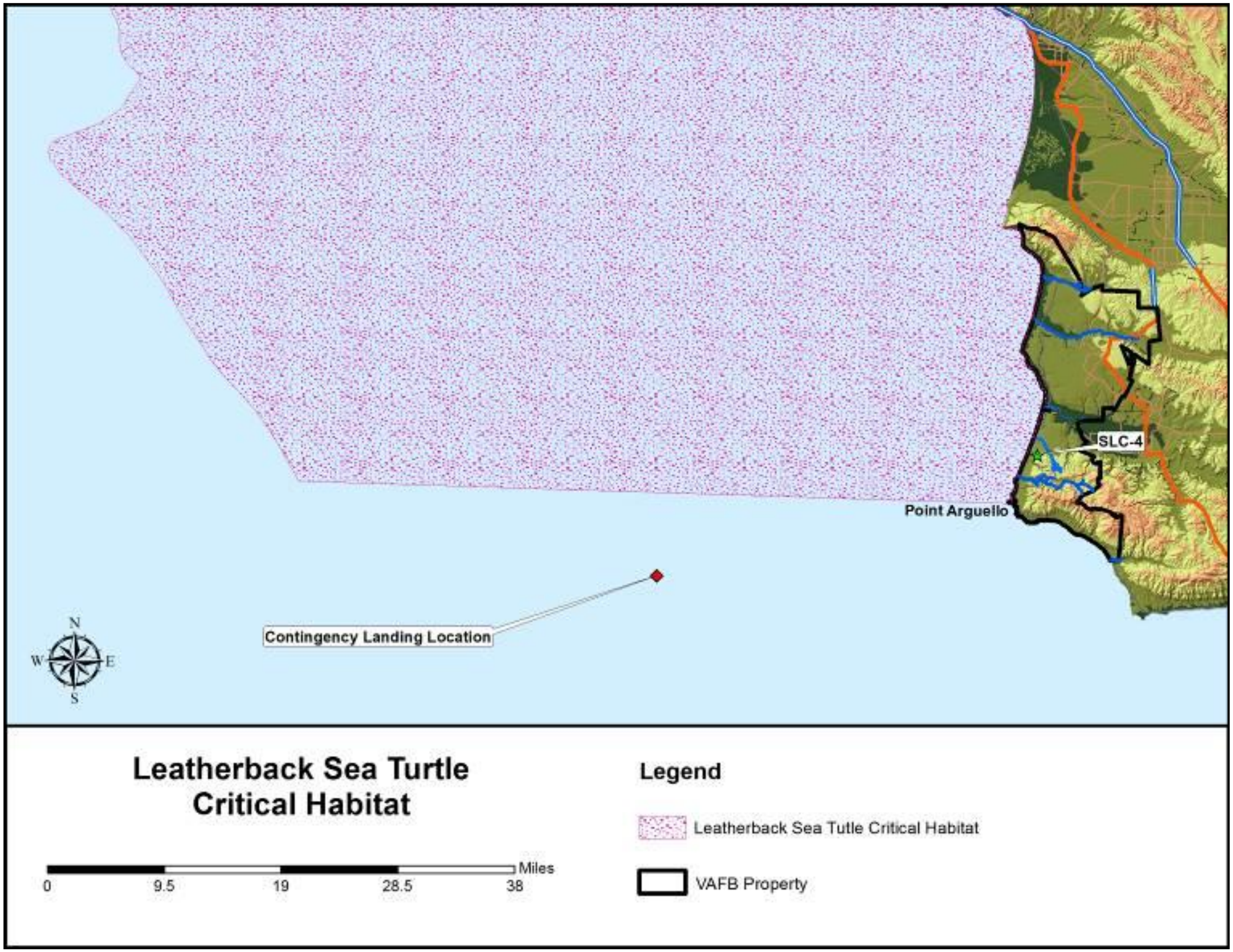


Figure 3-12. Leatherback Sea Turtle Critical Habitat.

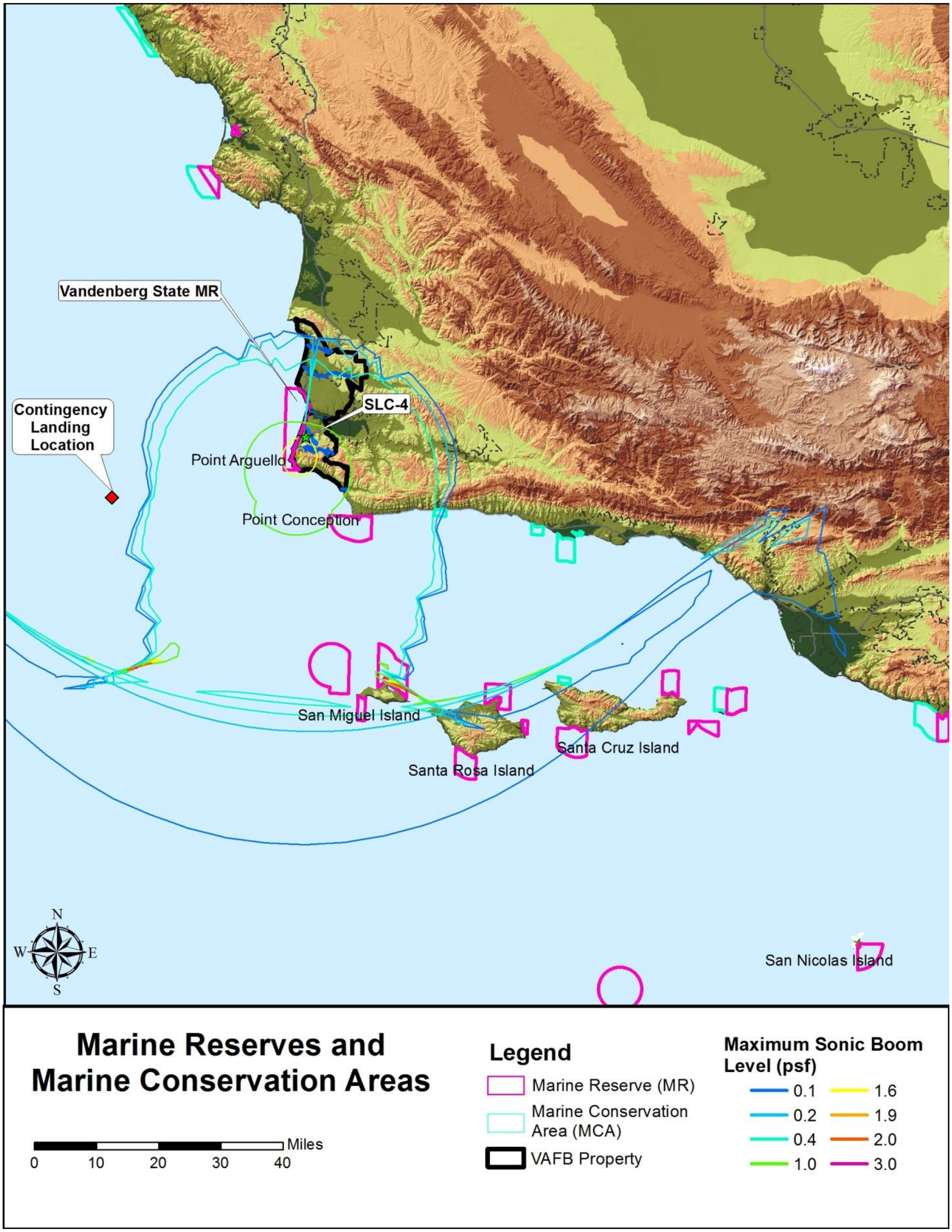


Figure 3-13. Marine Reserves and Marine Conservation Areas Impacted by Sonic Boom as a Result of Falcon 9 Boost-Back and Landing at SLC-4W.

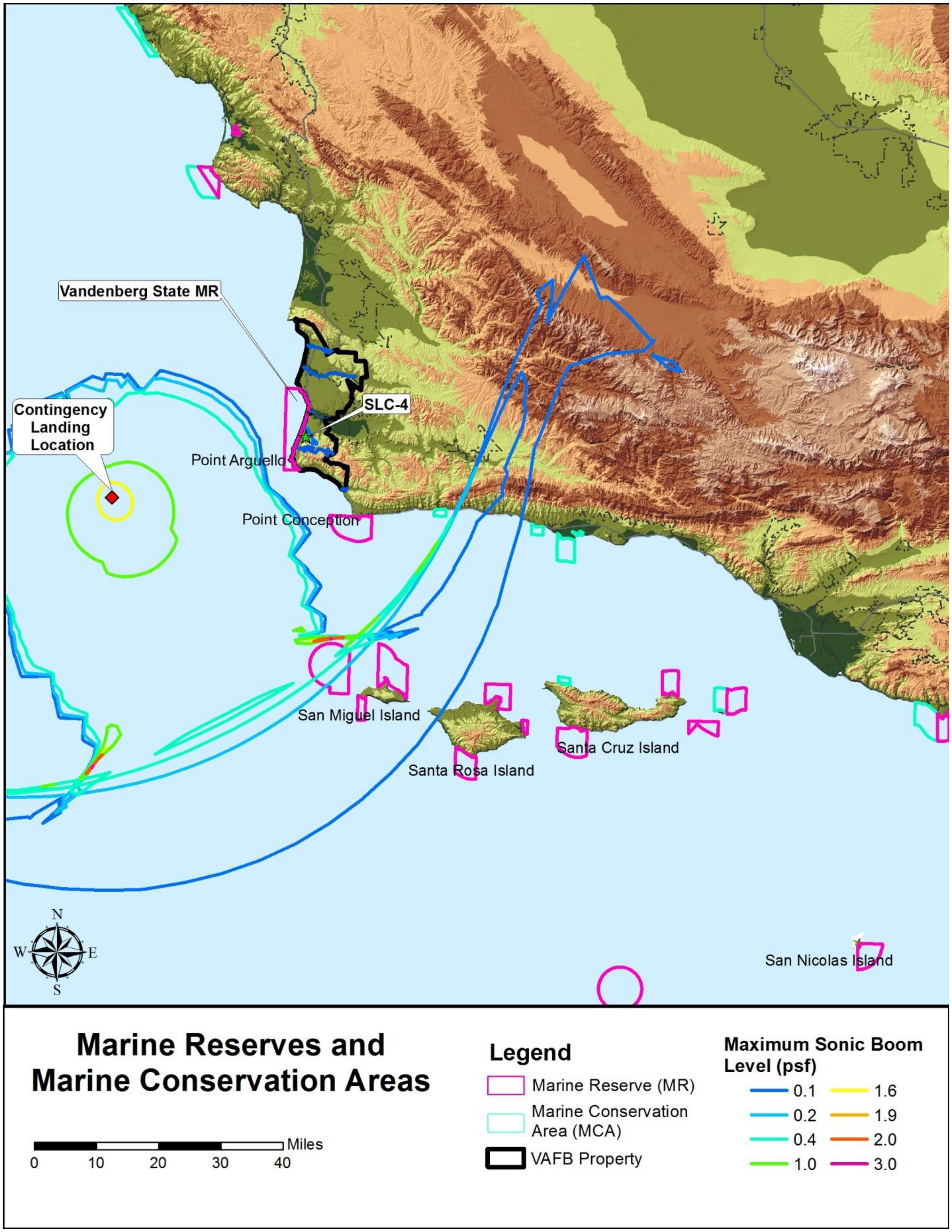


Figure 3-14. Marine Reserves and Marine Conservation Areas Impacted by Sonic Boom as a Result of Falcon 9 Boost-Back and Landing at the Contingency Landing Location.

3.4 Water Resources

Water resources and wetlands of the U.S. include surface water and groundwater and their physical, chemical, and biological characteristics. Under Section 404 of the CWA, wetlands are defined as areas that are "inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." Surface water includes lakes, rivers, streams, and wetlands, while groundwater refers to water below the surface. Industrial or hazardous waste management, as it applies to water resources, is also discussed in this section. The Clean Water Act (CWA) establishes the structure for regulating discharges of pollutants in Waters of the United States (Waters of the U.S.) The CWA mandates 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. The CWA and implementing USEPA regulations provide the authority and framework for state regulations. In California, the SWRCB administers the NPDES program through the Porter Cologne Water Quality Act/California Water Code. The SWRCB and the Regional Water Quality Control Board (RWQCB) administers 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.

3.4.1 Region of Influence

The ROI for Water Resources include those areas where surface water, groundwater, wetlands and Waters of the U.S. may be potentially affected by the Proposed Action. This includes the construction area at SLC-4W where ground-disturbing activities would take place (Figure 2-1), 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. There are no jurisdictional Waters of the U.S. or wetlands within the construction area or area affected by the boost-back operations of the Falcon 9 First Stage.

3.4.2 Surface Water

The California Porter-Cologne Water Quality Act 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. The California Ocean Plan provides water quality objectives to protect ocean water quality. The Santa Ynez River is considered the dividing line between North and South VAFB. 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 and ephemeral streams. Drainage from these basins is predominantly to the west, toward the

Pacific Ocean. Surface water resources in the vicinity of SLC-4W include Spring Canyon Creek and the Pacific Ocean. Spring Canyon Creek, approximately 0.1 mile (0.2 km) south of SLC-4W, originates approximately 1.4 mi. (2.3 km) inland and flows toward the ocean. Lower Spring Canyon is an ephemeral creek that often has standing water upstream of Surf Road. Surface flow percolates into the groundwater to pass beneath road embankments and eventually enters the Pacific Ocean. 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. The results for metals exceeded the criteria in 13 of 20 metals analyzed (VAFB 2006). There was also a large amount of leaf litter that appeared to be decomposing into a thick, orange substance.

3.4.3 Groundwater

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-4W is located on the southern margin of the Santa Ynez River groundwater basin/Lompoc Terrace sub-basin. Groundwater at the site 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 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).

Previous launch operations at SLC-4W resulted in the release of hazardous materials to the environment, which has resulted in volatile organic compounds (VOCs) and perchlorate contaminating groundwater at the site (see Section 3.8.5, Environmental Restoration Program at VAFB).

3.4.4 Wetlands and Waters of the United States

Waters of the U.S. most commonly encompass navigable waters bound by the ordinary high water line, adjacent wetlands, relatively permanent tributaries and territorial seas. Wetlands generally include swamps, marshes, bogs, and similar areas (U.S. Environmental Protection Agency, 40 C.F.R. 230.3 and U.S. Army Corps of Engineers, 33 C.F.R. 328.3). EO 11990, dated 24 May 1977 and amended by EO 12608 on 9 September 1987, requires federal agencies to minimize the destruction, loss, or degradation of wetlands and to enhance their natural and beneficial values. Territorial waters, defined by the 1982 United Nations Convention on the Law of the Sea, extend 12 nautical mi. (13.8 mi.; 22.2 km) from the mean low-water mark of a coastal state.

There are no jurisdictional wetlands within the construction area or area affected by the boost-back operations of the Falcon 9 First Stage as described in the Proposed Action and identified alternatives. Under Alternative 1, the First Stage would fly over jurisdictional wetlands on South VAFB, but not have any ground-disturbing effects. Under the Alternative 1 contingency action, Alternative 2, and the No Action Alternative, the First Stage would land in the Pacific Ocean further than 13.8 mi. (22.2 km), thus outside of territorial waters. Therefore, Alternative 1, Alternative 2, and the No Action Alternative would not have any effect on jurisdictional wetlands or Waters of the U.S.

3.5 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).

3.5.1 Region of Influence

The ROI for Cultural Resources is the SLC-4W construction area 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 years 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 hunter-gatherer 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 and 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 flight-tested 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).

3.5.2 Cultural Resources within the Project Area

Most of the cultural resources studies in the general vicinity of SLC-4 have been outside of the complex boundary; only a small part of the launch complex itself has been surveyed for archaeological resources. Most previous surveys within SLC-4 have been linear and include one for a security clear zone (Stone and Haley 1981); one for a fiber-optic cable project (Environmental Solutions et al. 1988); another for a fiberoptic cable project (Bergin 1989); and one for a power line (Berry 1989). Undisturbed portions of SLC-4E were surveyed in conjunction with SpaceX's Falcon 9 Program (Lebow 2010).

Within SLC-4W, a survey was completed in 2010 prior to an investigation of hazardous soil contaminants resulting from past launch activities. The survey encompassed an area of about 1 ac. (0.004 km^2) immediately around and extending south (downslope) from the former launch pad at SLC-4W (Cote 2010). In addition to archaeological surveys, detailed archaeological excavations have been completed at site CA-SBA-537/1816. The site is partially within SLC-4W, described as follows.

On 15 May 2014, all previously unsurveyed areas were examined within the launch complex (Lebow 2014). That effort included a systematic walk-over by a team of two archaeologists spaced 15 m apart. One isolated artifact (designated VAFBISO-962) was identified in an area that had previously been disturbed and thus the artifact is considered to be out of context and was probably transferred there from another location. No previously unknown archaeological sites were identified during the survey.

Five archaeological sites and two isolated artifacts are recorded within 0.25 mile (0.4 km) of SLC-4W. These include CA-SBA-537, -1127, -1815, -1816, -2427, VAFB-ISO-300, and VAFB-ISO-962. The latter was recorded within SLC-4W during the survey noted above. Of those, only CA-SBA-537 and VAFB-ISO-962 are within or partially within SLC-4W. CA-SBA-1816, while recorded as a separate site, is within CASBA-537 and forms a complex designated as CA-SBA-537/1816. Less than half of the site complex is within SLC-4W.

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 12 July 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). Due to their 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). However, VAFB, in consultation with the SHPO, subsequently determined that SLC-4 was not eligible for the NRHP.

3.6 Geology and Earth Resources

The ROI for Geology and Earth Resources is the SLC-4W construction area where ground-disturbing activities would take place. 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). The dominant soil types on VAFB are (Shipman 1981)

- The Tangair-Narlon association, characterized by sands and loamy sands;
- The Marina-Oceano association, made up of sands;
- The Chamise-Arnold-Crow Hill association, characterized by sand to clay loams;
- The Concepcion-Botella association, characterized by loamy sands, fine sandy loams, and silty clay loams;
- The Sorrento-Mocho Camarillo association, characterized by sandy loams to silty clay loams;
- The Shedd-Santa Lucia-Diablo association, characterized by shaley clay loams accompanied by silty clays; and
- The Los Osos-San Andreas-Tierra association, which ranges from fine sandy loams to sandy loams with clay loams.

The predominant soil type (approximately 70 percent of SLC-4W) found at the proposed project site is the Oceano Sand, with 2 to 15 percent slopes. Oceano Sand is characterized by excessive drainage and a slight to moderate erosion hazard under normal climatic conditions. This soil type has a high infiltration rate with a low runoff potential. The Marina Sand soil type is found on the southern part of SLC-4W and is not in the direct area of the proposed landing pad.

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.

3.7 Human Health and Safety

3.7.1 Region of Influence

The ROI for Human Health and Safety resources includes all areas where activities associated with the Proposed Action may impact human health and safety. This includes the construction area at SLC-4W and all areas potentially impacted during boost-back and landing operations. All activities on VAFB are subject to the requirements of the federal OSHA, AFOSH and Cal/OSHA regulations and procedures.

The affected environment for Human Health and Safety includes all established regulations to minimize or eliminate potential risk to the general public and personnel involved in the proposed project. The Proposed Action would involve construction activities where workers would potentially be exposed to conditions that could adversely impact their health and safety. The ROI of these potential impacts is the Proposed Action area and surrounding vicinity.

Hazards associated with some past and present mission activities and operations on VAFB can constrain locations where projects can be sited to ensure the health and safety of workers. The following hazard zones have been established on VAFB to protect workers from various hazards:

- **Toxic hazard zones** are areas established downwind of launch site operations to protect workers from exposure to toxic vapors emitted during the transfer or loading of liquid propellants or maintenance of launch systems. These zones can extend 20,000 ft. (6,096 m) or more from a launch site.
- **Missile/Space Launch Vehicle Flight Hazard Zones and Explosive Safety Zones** are established under the flight path of missile or space launch vehicle launches to protect personnel from debris fall-out under the launch trajectory. Explosive safety zones are established from 75 to 5,000 ft. (22.9 to 1,524 m) around launch sites and buildings where rocket propellants are stored to protect personnel from potential explosive hazards. Both of these hazard zones must be evacuated before any launch.

- **Radiofrequency Radiation Hazard Areas** are established around transmitters on VAFB that can present radiation hazards to people and potentially detonate electroexplosive devices. The size of the hazard areas vary, depending on the transmitter power and antenna reception.
- **Airfield Clear Zones, Lateral Clear Zones (LCZs), and Accident Potential Zones (APZs)** are established around the VAFB airfield runway and contain restrictions on certain land uses. Clear zones and LCZs are areas where the accident potential is so high that land use restrictions prohibit reasonable use of the land. Clear zones occur at both ends of the runway, and LCZs extend 1,000 ft. (304.8 m) from both sides of the centerline along the length of the runway. The ground surface within the LCZ must be graded to certain requirements and kept clear of fixed or mobile objects, except for necessary navigational aids and meteorological equipment. There are two APZs, APZs I and II, which are less critical than clear zones but still possess significant potential for accidents. Acceptable uses within APZ I areas include industrial or manufacturing, communication and utilities transportation, wholesale trade, open space, recreation, and agriculture, but not uses that concentrate people in small areas. Acceptable uses within APZ II areas include low business services and commercial retail trade uses of low intensity or scale of operation, but not high density operations.
- **Air Installation Compatible Use Zones (AICUZs)** are areas where certain land uses are restricted due to the combination of the potential for accidents and noise and the need for clearance of obstacles.
- **Unexploded Ordnance Closure Areas** are areas on VAFB that were used as ordnance training ranges and have the potential to contain UXO. On 27 September 2010, all areas known or suspected to contain UXO on VAFB were closed to non-mission/recreational activities. Any proposed work in these areas must be coordinated with the Weapons Safety and Explosive Ordnance Disposal (EOD) offices. Depending on the area, escorts may or may not be required.

3.7.2 Construction Activities

Industrial hygiene and ground safety during SLC-4W modifications and boost-back landing operations would be the responsibility of SpaceX and/or its contractor(s) safety department. Industrial hygiene responsibilities include monitoring and exposure to workplace chemicals, radiation, physical hazards, hearing and respiratory protection, medical monitoring of workers subject to chemical exposures, and oversight of all hazardous or potentially hazardous operations. Ground safety responsibilities include protection from hazardous situations and hazardous materials.

Because of conditions described in detail in Section 3.8 (Hazardous Materials and Waste Management), the potential exists for persons participating in the construction and grading activities to become exposed to hazardous materials and hazardous waste. In addition to those hazards, other physical hazards (e.g., confined spaces, uneven terrain, holes, and ditches) and biological hazards (e.g., rattlesnakes, ticks, black widow spiders, and poison oak) occur at the project site.

3.7.3 General Public and On-Base Personnel Safety

The 30 SW Safety Office has the responsibility to ensure the safety of launch support personnel and the general public from all launch and landing operations as defined in AFSPCI 91-217 (Space Safety and Mishap Prevention Program). Safety would assess proposed mission profiles (landing at SLC 4W and off-shore contingency) to ensure public safety criteria are met. The evaluation would assess hazards associated with debris, toxics, and blast distant focusing overpressure for a normal launch and landing failure. All launch area, high-risk offshore, and airspace would be controlled and monitored to ensure public safety during launch and landing operations. In addition, launch day meteorological conditions would be accounted for in day of launch and landing risk analysis to ensure compliance with acceptable risk criteria.

3.7.3.1 Debris Impact Corridors

All launch and landing programs at VAFB are required to establish debris impact corridors as a part of their program's safety review, in case of a launch or landing anomaly that requires flight termination. When any launch and landing, including a commercial launch, is scheduled to take place from VAFB, the 30 SW/SEL notifies the 2nd Range Operations Squadron (2 ROPS) of the associated hazard areas. SpaceX would accomplish a debris analysis, for the boost-back and landing program and would accomplish an analysis prior to its first landing. 30 SW/SEL would review and approve these analyses prior to authorizing any activities. Impact debris corridors would be established off the Santa Barbara County coast between Point Sal and Point Conception to meet security requirements and reduce hazards to persons and property during landing related activities. Specific debris impact areas would be determined for each landing, based on its specific trajectory. Once notified of hazard areas by the 30 SW/SEL, the 2 ROPS notifies the FAA so that appropriate airspace restrictions are in place during launches and landings. The U.S. Coast Guard issues a Local Notice to Mariners prior to launches from VAFB that defines the times and locations of Public Ship Avoidance Areas related to launch activities. Local Notice to Mariners are broadcast via radio and posted in harbors along the coast, as well as being published in the weekly U.S. Coast Guard Long Beach Broadcast to Mariners.

Offshore oil rigs located west of 120 degrees 15 minutes longitude also have evacuation or shelter-in-place procedures in place for use during launch and landing operations. The 2 ROPS notifies the Minerals Management Service to notify oil rig personnel of launch and landing operations.

Some local beaches, including Ocean Beach and Jalama Beach county parks, also fall within some debris impact corridors necessitating their closures during launch and landing operations. Although the beaches are not directly over flown by the First Stage during boost-back, an anomaly could impact them. Therefore, for the safety of park visitors, the County Parks Department and the County Sheriff close the parks upon request from VAFB.

A Union Pacific railroad line runs through VAFB. On south VAFB, the track passes between the Pacific Ocean and the launch facilities, and are over flown during launches and landings. Railroad schedules and close coordination between train engineers and VAFB personnel, ensure that trains are never over flown, to reduce potential risk to people and property. To that end, 30 SW/SEL defines appropriate railroad mile markers to 2 ROPS, who coordinates with the Manager Road Operations to ensure trains are kept clear of the landing area.

The FireX system would be installed to control any fires ignited during landing. Flame detectors on the landing pad would activate the system and alarms to the 30th Civil Engineer Squadron, Fire Department (30 CES/CEF).

3.7.4 Security and Anti-Terrorism

Site security requirements, including those for security lighting and intrusion detection, are part of the requirements integral to launch program safety. 30th Space Wing Instruction (SWI) 31-101, Air Force Instruction (AFI) 31-101, and DoD Manual 5220.22-M detail these security requirements. Unified Facilities Criteria 4-010-01 was issued in January 2007 under the authority of DoD Instruction 2000.16, Antiterrorism Standards. This guidance requires DoD components to adopt and adhere to common definitions, criteria, and minimum construction standards for building to mitigate vulnerabilities and terrorist threats. Modifications to SLC-4W made by SpaceX would be required to meet these construction standards.

3.7.5 Existing Noise Environment

For a detailed description of Noise see Section 3.2 (Sound [Airborne]). The Noise Control Act (NCA; 42 U.S.C. 4901 et seq.) sought to limit the exposure and disturbance that individuals and communities experience from noise. It focuses on surface transportation and construction sources, particularly near airport environments. The NCA also specifies that performance standards for transportation equipment be established with the assistance of the DOT. Section 7 of the NCA regulates sonic booms and gave the FAA regulatory authority after consultation with the U.S. Environmental Protection Agency. In 1987, the Quiet Community amendment gave state and local authorities greater involvement in controlling noise.

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. Rocket launches and aircraft overflights create louder intermittent noise levels. On VAFB, general ambient L_{eq1H} (the continuous sound level that would contain the same acoustical energy for 1 hour as the fluctuating sound levels during the same period) measurements have been found to range from around 35 to 57 dB (Berg et al. 2002). Most activities associated with the Proposed Action would generate relatively continuous noise throughout the implementation period.

3.8 Hazardous Materials and Waste Management

3.8.1 Region of Influence

The ROI for Hazardous Materials and Waste Management resources includes all areas where activities associated with the Proposed Action may be impacted by the use of hazardous materials and the generation of hazardous waste. This includes the construction area at

SLC-4W, all areas potentially impacted during boost-back and landing operations, and operations and activities associated with the recovery of the First Stage for reuse.

Hazardous materials and wastes are those substances defined as hazardous by the Comprehensive Environmental Response, Compensation, and Liability Act, as amended by the Superfund Amendments and Reauthorization Act (42 U.S.C. 9601-9675); the Toxic Substances Control Act (15 U.S.C. 2601-2671); the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (Resource Conservation and Recovery Act; 42 U.S.C. 6901-6992); and as defined in the State of California corresponding laws and regulations. SpaceX would use an existing 90-day hazardous waste accumulation point located at SLC-4W for hazardous materials and waste management. In addition, federal and state OSHA regulations govern protection of personnel in the workplace. In general, the definitions within the citations include substances that, because of their quantity, concentration, or physical, chemical, or infectious characteristics, may present substantial danger to public health and welfare, to workers, or to the environment.

3.8.2 Hazardous Materials at VAFB

Operations at VAFB and associated properties require the use of hazardous materials by military personnel and on-base contractors in varying quantities throughout the base.

Hazardous material use on VAFB is regulated by AFI 32-7086, Hazardous Materials Management Plan, and emergency response procedures for hazardous materials spills are established in VAFB's Hazardous Materials Emergency Response Plan (USAF 2010a). SpaceX would be responsible for preparing its own Emergency Response Plan for boost-back program per the VAFB Hazardous Materials Emergency Response Plan. This Plan would ensure that adequate and appropriate guidance, policies, and protocols regarding hazardous material incidents and associated emergency response are available to and followed by all installation personnel and commercial entities. In the event of a spill, SpaceX would also be responsible for completing a Community Awareness and Emergency Response reporting form per local Santa Barbara County hazardous material and hazardous waste spill reporting requirements.

3.8.3 Hazardous Waste at VAFB

Hazardous waste regulations are implemented at VAFB through hazardous waste handling procedures outlined in AFI 32-7042, Waste Management, and the VAFB Hazardous Waste Management Plan (USAF 2011b). The plan details hazardous waste packaging, turn-in, transportation, storage, recordkeeping, and emergency procedures. SpaceX would be required to follow all federal, state, and local laws and regulations regulating the generation, storage, transportation, and disposal of hazardous waste.

3.8.3.1 Hazardous Materials Transportation Safety

Hazardous materials such as propellants, ordnance, chemicals, and other hazardous material payload components must be transported to VAFB per DOT regulations for interstate and intrastate shipment of hazardous materials (Title 49 C.F.R. 100–199).

3.8.4 Toxic Release Contingency Plans and Toxic Hazard Corridors

Toxic hazard assessments would be required for the Falcon 9 and Falcon 9 Heavy programs to determine program-specific toxic material used for launches, payloads, ground support equipment, and at facilities. 30 SW has detailed procedures in place to control use of toxic gases. VAFB maintains 30 SWI 91-106, Toxic Hazard Assessments, which defines control measures and procedures for conducting operations involving toxic fuels. Atmospheric and dispersion computer models are run by 30 SW/SE to predict toxic hazard corridors (THCs) for nominal and aborted launches, as well as for spills or releases of toxic materials from storage tanks or that occur during loading or unloading of propellants. 2 ROPS uses THCs to reduce the risk of exposure of launch personnel and the general public from toxic materials, including toxic gases. Dispersion modeling for the Falcon 9 and Falcon 9 Heavy programs would be run for nominal and abort scenarios prior to each launch. If the model predicts THCs over populated areas, the launch would be delayed until meteorological conditions allowed for launch to occur without this risk.

3.8.4.1 Exposure Criteria

The USAF Surgeon General (HQ AF/SG) has, through AFMAN 48-155, Occupational and Environmental Health Exposure Controls, granted local authority to determine the Occupational and Environmental Exposure Limit (OEEL). The OEEL is defined as, "…the most appropriate limit adopted from established recognized standards including, but not limited to, those in AFIs and AFOSH Standards, the latest edition of the TLV® Booklet published annually by the American Conference of Government Industrial Hygienists; 29 C.F.R. 1910.1000 Tables Z-1, Z-2, and Z-3; and 40 C.F.R. 141…" Bioenvironmental Engineering at the 30th Medical Group (30 MDG) would determine the OEEL for chemicals estimated to pose the most significant health concerns to the public and launch facility workers. The exposure criteria are factored into the exposure prediction and risk management models, and the launch commit decisions used by 30 SW/SE at VAFB.

3.8.5 Environmental Restoration Program at VAFB

The Environmental Restoration Program (ERP), formerly known as the Installation Restoration Program (IRP), was developed by the DoD in 1984 to identify, investigate, and remediate potentially hazardous material disposal sites on DoD property. Once the areas and constituents had been identified, the ERP was tasked to remove or monitor the hazards in an environmentally responsible manner. The only IRP requirement within the Project Area is to protect all Monitoring Wells within the area.

The installation also manages MMRP sites. The MMRP was established to address UXO, discarded military munitions (DMM), and munitions constituents (MC) located on current and former defense sites (U.S. Army Environmental Center 2009). These sites are separate from operational ranges or munitions storage facilities.

In addition to ERP and MMRP sites, the installation also identifies those areas that have had known or suspected contamination from Underground Storage Tanks.

Previous launch operations at SLC-4W resulted in the release of hazardous materials to the environment during maintenance and operations. SLC-4W is located within ERP Site 9, which is part of a larger ERP Site 8 cluster (Figure 3-15). The ERP Site 8 cluster consists of Sites 8 (SLC-4E), 9 (SLC-4W), and 10 (Spring Canyon). These sites have been grouped together due to their similar operational and contaminant release history. The contaminants of concern (COCs) include VOCs and perchlorate in groundwater, and metals, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs) in subsurface soil.

Trichloroethylene (TCE) and perchlorate released at the site during launch motor flushing and from solid fuel rocket booster motors have been identified as the source of groundwater contamination. Sandblast grit blown by wind or spread for disposal during operations in areas located west, and southeast of the launch pad are the source of metals, PAHs and PCBs in soils.

Remedial actions for groundwater contamination has included source reduction using a dual-phase extraction (DPE) system that was comprised of twenty-three vertical extraction wells. In 2009, additional treatment wells were installed within the deluge channel. The deluge channel is the flame duct that runs directly south from the old Titan II launch mount and would be adjacent to the landing pad.

Previous remedial actions for soil at SLC-4W have removed PCBs, PAHs, and metals from soils to levels below clean-up goals for the site. Actions included removing sandblast grit from three areas at the Site to remediate metals, PAHs and PCBs in surface soil (USAF 2010b). The primary objective of the excavation activities at ERP Site 9 was to remove soil impacted with PCBs, PAHs, lead, and zinc that exceeded the cleanup goals established for the site. However, the areas beneath the concrete foundations of the launch pad and flame duct were not remediated at that time. Remedial activities at Site 8 cluster are ongoing and are specified in the Final Record of Decision/Remedial Action Plan, Installation Restoration Program Site 8 Cluster (USAF 2013a).

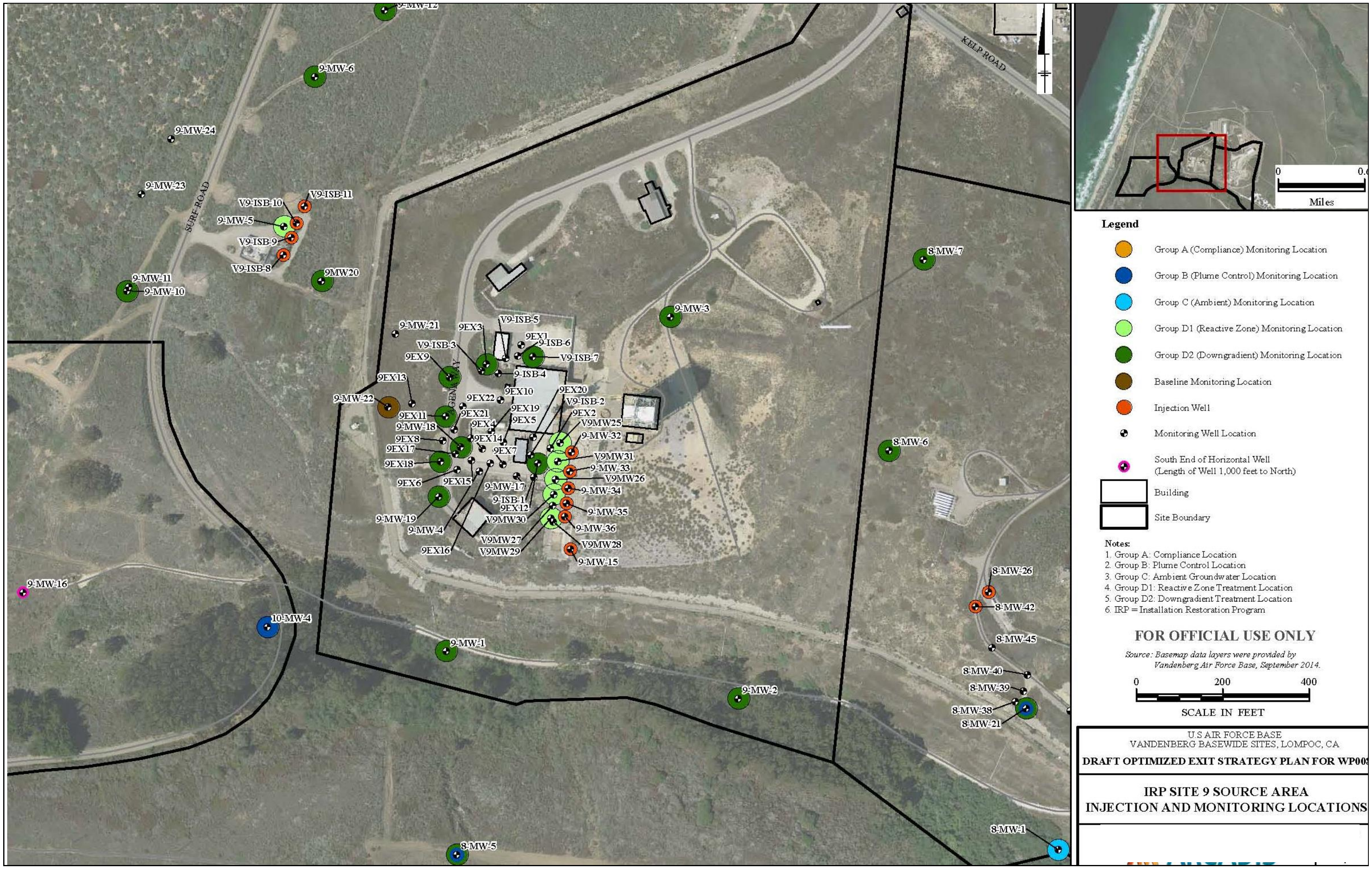


Figure 3-15. ERP Sites at SLC-4W.

3.8.6 Military Munitions Response Program

The project site straddles the boundary of former artillery impact area MU816 and Training and Maneuver Area TM817B; each formerly used by the U.S. Army before USAF acquisition of the site (Shaw 2006). According to data provided in the CSE Final Phase II Report (Shaw 2010) and After Action Report (U.S. Army Corps of Engineers 2013), the surrounding areas of the project site were searched for munitions and explosives of concern (MEC) and munitions debris (MD) associated with historic range use. MEC and MD were found on the south portion of VAFB near the project site (Shaw 2010; U.S. Army Corps of Engineers 2013).

3.9 Solid Waste Management

The affected environment for Solid Waste Management is the regulatory environment for solid waste management issues established to control construction debris and promote pollution prevention involved with the Proposed Action. The ROI of potential impacts to Solid Waste Management as a result of the Proposed Action encompasses VAFB, which may be impacted by increased solid waste generation during construction of the landing pad at SLC-4W. In addition, waste generated by the recovery of the Falcon 9 First Stage would impact VAFB diversion and solid waste metrics. In 1989, the California Integrated Waste Management Act (AB 939) mandated a 50 percent reduction of the quantity of solid waste disposed of in California landfills from a 1990 baseline. The 50 percent reduction was to be accomplished by 1 January 2000. The most recent USAF mandate regarding solid waste diversion came from Headquarters Air Force Space Command (AFSPC) in 2008, requiring a 50 percent diversion rate goal for all solid waste generated at AFSPC installations (AFI 32-7042).

The State of California passed Senate Bill 1374, amending the Public Resources Code, Section 42912, which addresses the issue of construction and demolition (C&D) debris, diversion requirements, and the development of a model ordinance to be implemented by local jurisdictions (e.g., Santa Barbara County). EO 13514, "Federal Leadership in Environmental, Energy, and Economic Performance," was signed on 5 October 2009. With respect to solid waste diversion, EO 13514 requires federal agencies to have as a goal to achieve 50 percent or higher diversion rate for Non-hazardous solid waste and construction and demolition materials and debris by fiscal year 2015. In August 2010, the DoD issued its updated Strategic Sustainability and Performance Plan (SSPP), which was followed up by Headquarters Air Force releasing its SSPP Implementation Plan in October 2011. The established diversion goals of the SSPP are 60 percent diversion, by weight, for C&D debris by 2015. AFI 32-7042 requires installations to strive to divert as much solid waste as economically feasible and the VAFB Integrated Solid Waste Management Guide (USAF 2012a) requires source segregation of recyclable materials to the greatest extent possible.

In addition, on 1 March 2004, the California Integrated Waste Management Board promulgated a model ordinance for local agencies to follow for implementing a 50 to 75 percent diversion of C&D waste from landfills, per California Senate Bill 1374. Currently, the local enforcement agency, the Santa Barbara County Environmental Health Services Division, has not promulgated its final model ordinance.

However, a locally adopted diversion ordinance would affect requirements because the Federal Facilities Compliance Act waived sovereign immunity with respect to California solid waste programs. Since 1998, waste diversion at VAFB has been greater than 70 percent (USAF 2012a). Due to the detailed tracking requirements for waste disposal and diversion levied by the State of California, VAFB is required to track all materials going off-base for diversion, recycling, or disposal. VAFB must report the weight (in tons), the type of material, and the destination. Additionally, any materials recycled on-base by processes other than the base landfill must be reported to the 30 CES/CEI Solid Waste Manager at least quarterly, with copies of weight tickets and receipts provided. SpaceX would transport solid waste to the Santa Maria Landfill for disposal. The party/unit responsible for the diversion, disposal, or recycling reports the information to the Solid Waste Manager.

3.9.1 Construction Debris

There are different processes established for handling and disposing of construction debris. Debris from new construction is typically uncontaminated and is reused or recycled whenever feasible. Material segregation and storage are also less of a problem with new construction than with demolition. Cost differentials between tipping fees and costs associated with reuse and recycling also influence disposal decisions.

3.9.2 Pollution Prevention

The Pollution Prevention Act (PPA) of 1990 focused the national approach to environmental protection toward pollution prevention (P2). Implementation of the USAF Environmental Management System (EMS) carries P2 a step further toward mission sustainability principles. The P2 program is defined in detail in the VAFB Pollution Prevention Management Plan, 30 SW Plan 32-7001 and is aimed at achieving 30 SW EMS objectives and targets, through documented practices, procedures, and operational requirements. VAFB implements EMS and its associated P2 program elements by following the P2 hierarchy:

- Reduce (source reduction to prevent the creation of wastes);
- Reuse (keep item or material for its intended purpose);
- Recycle (use item or material for some other beneficial purpose);
- Disposal (in an environmentally compliant manner, only as a last resort).

3.10 Land Use and Aesthetics

The affected environment for Land Use and Aesthetics is the regulatory environment for land use planning and aesthetics on VAFB. The ROI for land use purposes in this EA encompasses the landing pad construction area at SLC-4W (Figures 2-1 and 3-16) and south VAFB. The construction area is located on South Base, approximately 0.5 mile (0.8 km) inland from the Pacific Ocean (Figures 1-1 and 1-2).

VAFB covers approximately 99,099 ac. (0.40 km^2) in western Santa Barbara County and is divided into North VAFB and South VAFB by the Santa Ynez River and Highway 246, a public thoroughfare. Much of VAFB is open space set aside for security and safety buffer zones. VAFB accommodates agricultural outleasing as a major land use on base. At present, 23,500 ac.

(0.09 km^2) of rangeland are permitted for grazing activities, supporting a maximum of 800 head of cattle, and 1,104 ac. (0.004 km^2) are dryland farmed. All grazing land and farmland at VAFB is used by the U.S. Department of Justice, Bureau of Prisons, and U.S. Penitentiary in Lompoc for livestock grazing and 1,104 ac. (0.004 km^2) for dryland farming.

Facilities used for space launches, missile tests, and telemetry and tracking are scattered throughout the base. The urbanized cantonment area is on North VAFB, which includes various administrative, training, industrial, commercial, and residential land uses. North VAFB also has missile test launch sites, space launch sites, and tracking facilities. South VAFB supports space launch sites, telemetry, and tracking facilities. All of these facilities support the primary mission of VAFB. The 30th Civil Engineering Squadron, Comprehensive Planning (30 CES/CEIOP) manage development and land use at VAFB. The primary document that outlines development goals and constraints is the VAFB General Plan (USAF 2014a). Land use areas on both North and South VAFB include recreational use of beaches by the military. In addition, there is public access to Surf Beach. Immediately east of these recreational beach areas is open land set aside for security and safety buffer zones.

A Union Pacific railroad line passes through VAFB near the coast. It serves as the main line for Los Angeles to San Francisco coastal rail transportation, providing freight service to most cities along the coast. A number of spur lines operate off the main line in the VAFB area to provide local freight delivery. Amtrak passenger service from Seattle to San Diego, share these Union Pacific Railroad lines (USAF 1988). The Surf Amtrak Station is located adjacent to Surf Beach, at the west end of State Route 246.

The existing site is surrounded by open space with Industrial land use designated approximately 2 mi. (3.2 km) south, and 1 mile (1.6 km) north of SLC-4W. Dryland farming and cattle grazing occurs to the north, east and west of 13th Street and south of Terra Road, which are approximately 1.5 mile (2.4 km) northeast of SLC-4W. Dryland farming continues to the south of the 13th Street Bridge, east and west of 13th Street and north of West Ocean Avenue (State Route 246). Wildlife viewing areas are located at the Waterfowl Natural Resources Area south of Terra Road and west of 13th Street, approximately 5 mi. (8.1 km) northeast of SLC-4W. The County of Santa Barbara Ocean Beach Park is located immediately west of the Wetland Mitigation Area, approximately 4 mi. (6.4 km) north of SLC-4W, where there is wildlife viewing, beach access, and a picnic area (Figure 3-16).

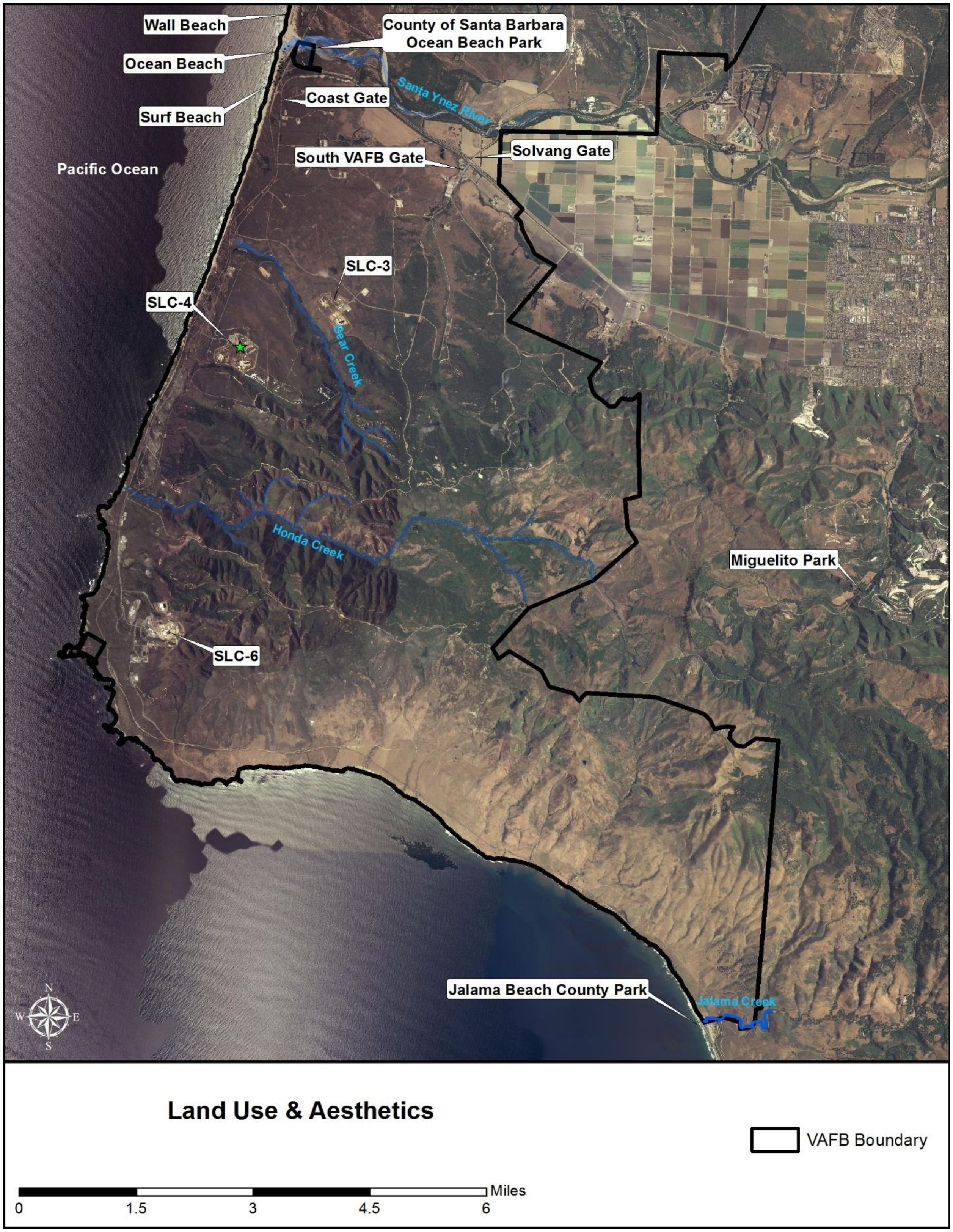


Figure 3-16. Land Use and Aesthetics around SLC-4W on VAFB.

3.10.1 Land Use

Under the 2014 General Plan for VAFB, which is the primary comprehensive planning document for the installation, there are 12 land use designations on Base. They are Administrative, Air Education and Training Command, Agriculture/Grazing, Airfield, Community (Commercial and Service), Housing, Industrial, Launch Operations, Medical, Open Space, Outdoor Recreation, and Water/Coastal (USAF 2014a). SLC-4W is in an area designated for Launch Operations.

3.10.2 Aesthetics

NEPA Section 101 states that, "the Nation may assure for all Americans, safe, healthful, productive, and aesthetically and culturally pleasing surroundings," (42 U.S.C. §§4321-4370h). As such, aesthetics of the Proposed Action must be taken into consideration. CZMA also has a policy that protects the scenic beauty of the coastal landscape. Although VAFB is excluded from the coastal zone as it is land wholly owned and operated by the Department of Defense, the USAF is required to maintain consistency with CZMA. The site of the Proposed Action, SLC-4W, is located within the California Coastal Zone. The SLC-4W launch complex is visible from Coast road because of its Mobile Service Tower. SLC-4W is not visible however, from any public beach, and is only momentarily visible from a passing train (USAF 1991). See Section 3.11 (Coastal Zone Management), for additional discussion.

3.11 Coastal Zone Management

Federal activity in, or affecting, a coastal zone requires preparation of a Coastal Zone Consistency Determination (CD) or an ND, per the CZMA. The ROI for Coastal Zone Management includes the landing pad construction area at SLC-4W (Figure 2-1) and Coastal Zone resources in the Pacific Ocean, including marine mammals and marine mammal habitats, that may be affected by the Proposed Action.

The California Coastal Zone Management Program was formed through the California Coastal Act (CCA) of 1972, the federal law that protects the nation's coastlines. "Coastal zone" is defined in Section 304 of the CZMA and does not include "lands the use of which is by law subject solely to the discretion of or which is held in trust by the Federal government." The Proposed Action occurring at VAFB is wholly owned and operated by the Department of Defense and is therefore excluded from the coastal zone. However, the USAF is required to maintain consistency with the CZMA and is responsible for making final coastal zone determinations for its activities occurring within the state coastal zone or having effects on it. Although the Proposed Action does not occur within the Coastal Zone, it may potentially affect resources within the Coastal Zone, therefore a CD or ND is required for the Proposed Action. The CCC reviews federally authorized projects for consistency with the California Coastal Zone Management Program, and either concurs with a ND finding or does not.

Applicable California Coastal Act policies include:

- 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.

3.12 Transportation

The ROI for Transportation resources are the existing access roadways to SLC-4W, including Coast Road, Highway (Hwy) 101, Hwy 1, State Route (SR) 1, SR 135, and SR 246 (Figures 1-1, 1-2, and 3-17). Existing roadway conditions are evaluated based on roadway capacity and traffic volume. The capacity, which reflects the ability of the network to serve the traffic demand of a roadway, depends on the roadway width, number of lanes, intersection control, and other physical factors. Traffic volumes can be reported as the number of vehicles averaged over a daily period (average daily traffic or ADT).

A road's ability to accommodate different volumes of traffic is generally expressed in terms of Level of Service (LOS). The Institute of Transportation Engineers (1982) defines LOS as "a qualitative measure that incorporates the collective factors of speed, travel time, traffic interruptions, freedom to maneuver, safety, driving comfort, and convenience, and operating costs provided by a highway facility under a particular condition." The LOS scale ranges from A to F, with each level defined by a range of traffic volume to roadway capacity (V/C). LOS A represents the best operating conditions, while a LOS F represents the worst (Table 3-8).

Table 3-8. Level of Service (LOS) Scale.

LOS Level	Condition
A	Traffic flows at or above the posted speed limit and all motorists have complete mobility between lanes.
B	Traffic slightly more congested than LOS A, but speed remains the same. Some restrictions to maneuverability; motorists may drive side by side limiting lane changes.
C	More congestion than LOS B. Ability to pass or change lanes not always assured. Target for most urban highways and most rural highways. Roads are efficiently close to capacity, and posted speed is maintained.
D	Speeds are somewhat reduced, motorists are restricted by other cars and trucks. Equivalent to a functional urban highway during commuting hours. Common goal for urban streets during peak hours.
E	Flow becomes irregular and speed varies rapidly without reaching posted limits. Consistent with a road at or approaching its designated capacity.
F	Lowest measure of efficiency. Flow is forced, with all vehicles restricted by those in front; frequent slowing required. This is a road in constant traffic jam.

3.12.1 Regional Access

VAFB is located approximately 5 mi. (8.1 km) west of the City of Lompoc. The main access route to VAFB is Hwy 101 (Figure 1-1). Highway 101 is a coastal four-lane divided freeway connecting northern California to southern California.

The VAFB connections to Hwy 101 are Hwy 1, SR 135, and SR 246. Highway 1, a north-south highway, traverses VAFB and provides access to Santa Maria to the northeast, and Santa Barbara to the southeast (Figure 1-2). When used in conjunction with Hwy 101, SR 246, an east-west highway, provides access to Lompoc to the east, and Santa Barbara to the southeast. SR 135 and SR 246 are mostly two-lane undivided highways with four-lane rural expressway portions. SR 246 is accessible from the south through Hwy 1 and Hwy 101.

SR 246 services the South Base Gate, the primary access for south VAFB. Further west, at the terminus of SR 246, is the Coast Gate, which is normally closed, but is occasionally opened for oversized shipments to south VAFB. SLC-4W lies within the entry-controlled area of south VAFB. Only authorized military personnel and their families, civilian employees of Base with approved identification, and visitors with pre-approved authorization, can enter the entry- controlled area.

On VAFB, roads are categorized as highways, primary, local (secondary roads), and patrol (USAF 2014b). Primary roads serve large volumes of traffic, are divided, and provide limited access to adjacent land uses. They act as the main circulation routes into and through the cantonment areas and connect to local streets (USAF 2014a). Local streets provide for traffic movement between primary roads and access roads and provide access to community facilities, parking lots, and housing and service areas. They make up the majority of the road network in the cantonment area and have frequent traffic stops and low speeds (USAF 2014a). Patrol roads are remote roads that are paved or unpaved and are used for security patrol and monitoring of infrastructure (USAF 2014a). On South Base the primary roads include Arguello Road, Bear Creek Road and Coast Road (USAF 1994a), all of which could be used to access SLC-4W (Figure 3-17). All primary roads on VAFB operate at a LOS between A and C (USAF 1994b). Local (secondary) roads operate at a LOS between A and B (USAF 1994b). Informal traffic studies indicate gates operate at LOS A to C range (USAF 2005a).

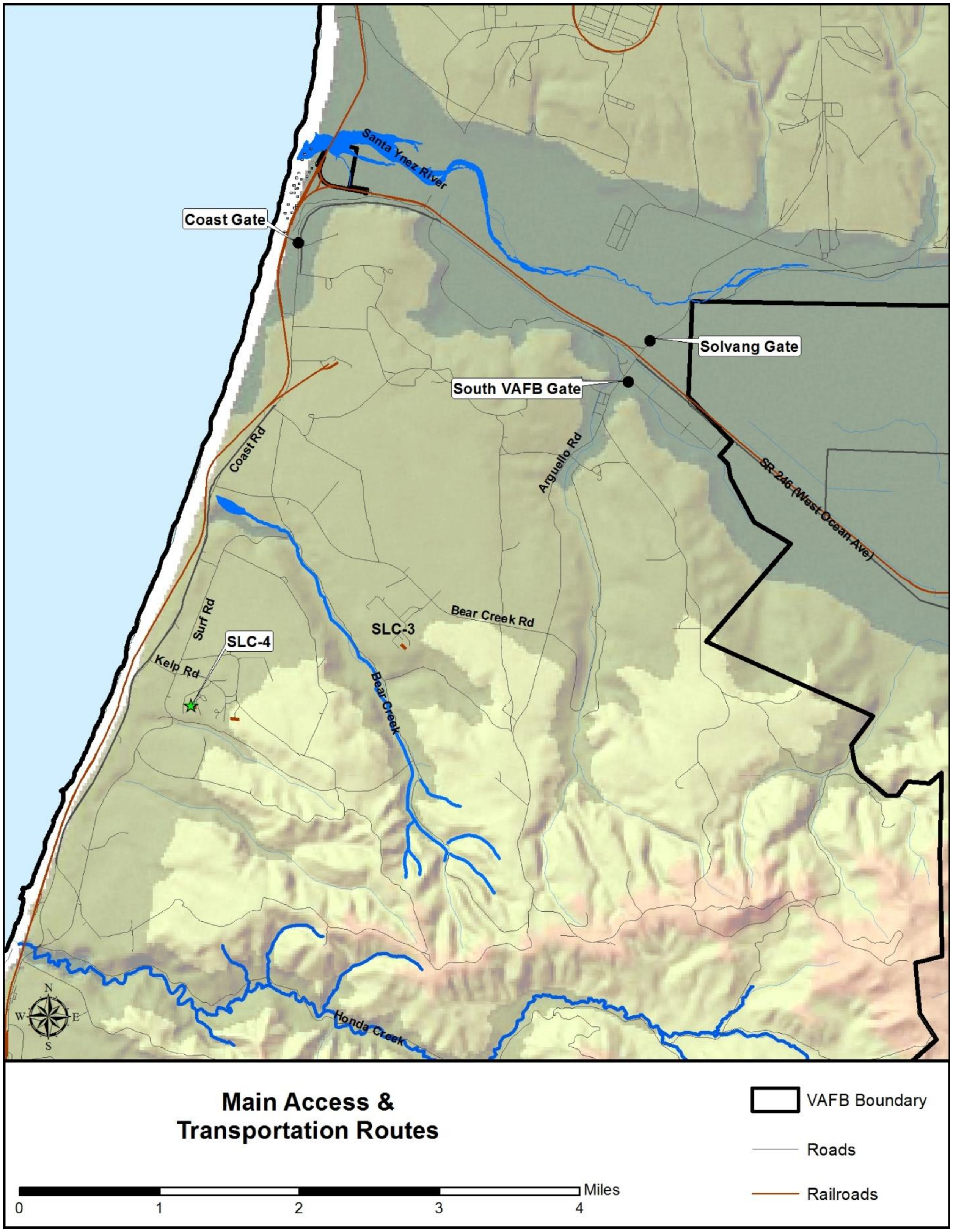


Figure 3-17. Main Access and Transportation Routes Associated with the Proposed Action.

3.13 Department of Transportation Act Section 4(f) Properties

The ROI for Department of Transportation Act Section 4(f) Properties includes public parks and recreation areas are located near SLC-4W (Figures 1-1 and 3-16), described below. The FAA is subject to Section 4(f) of the Department of Transportation Act (49 U.S.C. Section 303(c)) as a non-exempt Department of Transportation agency. Section 4(f) properties include publicly owned parks, recreation areas, and wildlife or waterfowl refuges, or any publicly or privately owned historic site listed or eligible for listing in the NRHP. Per FAA Order 1050.1E, Change 1, 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 resulting from the use.

The term use—as it relates to Section 4(f)—denotes an adverse impact to, or occupancy of, a Section 4(f) property. There are three conditions under which use occurs:

- Permanent Incorporation – when a Section 4(f) property is acquired outright for a transportation project.
- Temporary Occupancy – when there is temporary use of property that is adverse in terms of Section 4(f)'s preservationist purpose.
- Constructive Use – when the proximity impacts of a transportation project on a Section 4(f) property, even without acquisition of the property, are so great that the activities, features, and attributes of the property are substantially impaired. Substantial impairment would occur when impacts to Section 4(f) lands are sufficiently serious that the value of the site in terms of its prior significance and enjoyment are substantially reduced or lost.

Public parks and recreation areas are located near SLC-4W and could be considered properties subject to Section 4(f). These include 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 (Figures 1-1 and 3-16).

Jalama Beach, Surf Beach, and Ocean Beach County Parks are closest to SLC-4W. Jalama Beach County Park is a 23.5 ac. (0.1 km^2) park located south of SLC-4W. A popular camping spot, Jalama Beach maintains 98 campsites overlooking the ocean or beachfront with peak attendance over the summer and holiday weekends. In addition to camping facilities, Jalama Beach offers picnicking, surfing, whale watching, bird watching, nature photography, and fishing. Ocean Beach County Park is a 36 ac. (0.15 km^2) park located north of SLC-4W. It is a day-use only park, providing recreational opportunities such as bird watching, nature photography, and picnic facilities, from 8:00 a.m. to sunset.

3.14 Utilities

The ROI for Utilities includes the SLC-4 complex and south VAFB utilities (i.e., communications, electricity, domestic water supply, and domestic wastewater). The affected environment for Utilities summarizes the utility systems available in the project area and its vicinity. SLC-4W is an above-ground launch pad with full utilities available. Existing utilities at the project site include electrical, communications, domestic water supply, and domestic wastewater. Due to SLC-4W being an active launch site as of 1999, it currently has all utilities required for the Proposed Action already installed to the site, including sewer, water, communication, electrical, and nitrogen. For most of these utilities, simple above-ground modifications are required to provide final routing of these utilities to their final destinations. These utilities at the project site would be extended from their current location to provide services (including a FireX system) to the proposed concrete landing pad at SLC-4W. SLC-4W has a packaged septic tank-leach system with a maximum design capacity of 15,000 gallons per day (USAF 1991). New utility usage above what has previously been experienced at the project site or nearby would not occur under the Proposed Action.

3.14.1 Electrical

Existing electrical infrastructure around the SLC-4W area (existing conduits, camera stands, junction boxes) would be used to the greatest extent possible to reduce requirements for trenching.

3.14.2 Communications

There is an existing commercial fiber connection at SLC-4W. This existing commercial fiber connection would allow the USAF to avoid making a fiber connection at another location on VAFB to execute the Proposed Action.

3.14.3 Water

Existing underground water lines are sufficient in size to support the proposed FireX system at SLC-4W. A tie into the water system would be required and trenching for new water lines to connect to the FireX system is required.

3.14.4 Wastewater Treatment

The existing facilities at the pad building at SLC-4W, including a restroom and septic system, would be used for any additional wastewater inputs. The site would not be manned permanently and these facilities would be used when personnel are on site. Since the existing system has sufficient capacity to support the Proposed Action no additional wastewater inputs from the development and use of the landing pad at SLC-4W would be required. The site is not manned permanently, the existing facilities at the pad building (get number) would be used to support personnel present on site.

4 Environmental Consequences

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

4.1 Air Quality

Potential impacts to air quality from the Proposed Action would be associated with construction of the landing pad at SLC-4W, and with the boost-back and landing operations. The analysis involves estimating emissions generated from the proposed construction activities and assessing potential impacts on air quality, and estimating emissions associated with the boost-back and landing operations.

Significant air quality impacts would occur if implementation of any of the alternatives would directly or indirectly:

- Expose people to localized (as opposed to regional) air pollutant concentrations that potentially violate federal or state ambient air quality standards; and/or
- Exceed caps (limits) as imposed by federal and state GHG regulations. These regulations are in the draft stage, but would likely be in place during project construction.

On 18 February 2010, the CEQ released draft guidance on addressing climate change in NEPA documents. This draft document was revised on 18 December 2014, and CEQ solicited public comments until 23 Feb 2015. The 2010 draft guidance, which has been issued for public review and comment, recommends quantification of GHG emissions, and proposes a threshold of 25,000 metric tons of CO_{2e} emissions. The 2010 guidance indicates that use of 25,000 metric tons of CO_{2e} emissions as a reference point would provide federal agencies with a useful indicator, rather than an absolute standard of significance, to provide action-specific evaluation of GHG emissions and disclosure of potential impacts. This analysis complies with the recommendations of both the 2010 and 2014 versions of the draft guidance.

Standard dust control measures (see Section 2.2.4.1, Air Quality – 1 [Air-1]) must be implemented for any discretionary project involving earth-moving activities. Some projects have the potential for construction-related dust to cause a nuisance. Since Santa Barbara County violates the state standard 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.

To determine the significance of operational impacts, emissions from the project were compared with the federal major source thresholds. The federal major source threshold for criteria pollutants is 100 tons per year, which is the major source threshold under 40 C.F.R. 70, the Federal Operating Permit Program, for all pollutants.

For purposes of this air quality analysis, project emissions within the VAFB region would be potentially significant if they exceed these thresholds. This is a conservative approach, as the analysis compares emissions from both project-related stationary and mobile sources to these thresholds.

If Proposed Action emissions were determined to increase ambient pollutant levels from below to above a national or state ambient air quality standard, these emissions would be significant.

4.1.1 Alternative 1 (Proposed Action)

4.1.1.1 SLC-4W Infrastructure Improvements

As discussed in Chapter 2 (Description of the Proposed Action and Alternatives), the Proposed Action includes construction of the concrete landing pad at SLC-4W. Construction is anticipated to require 90 to 120 days. During 30 days of this construction, concrete would be curing and minimal construction activities would occur. Construction emissions that would be associated with the Proposed Action include fugitive dust emissions from grading, exhaust emissions from heavy construction equipment, and emissions from worker vehicles and trucks. Table 4-1 lists the equipment that would be used for construction of the project.

To calculate emissions associated with construction, the CalEEMod Model, Version 2013.2.2 (ENVIRON 2013) was used. The CalEEMod Model is the latest version of the land use model in California, and takes into account emission factors for construction equipment from the CARB's OFFROAD model and emission factors for on-road vehicles from the CARB's EMFAC2011 model. As shown in Table 4-2, construction emissions would not exceed the significance thresholds for any criteria pollutant. The 24-hour CAAQS standard for PM_{10} has been recently exceeded at the Vandenberg station (Table 3-2); however, an increase of 0.05 tons per year in emissions would not have a substantial effect on the 24-hour standard or the annual standard and would not contribute significantly to any future exceedance. Nevertheless, dust mitigation measures would be implemented as required by the 1979 Air Quality Attainment Plan.

Furthermore, as discussed in Section 2.2.4 (Environmental Protection Measures), the Proposed Action would include EPMs to reduce impacts to the environment, including air quality.

All 1995 and older engine model vehicles with a GVWR of 26,000 lb. or less (e.g., trucks delivering materials, water trucks and cement mixers) must meet 2010 manufacturing year engine emission standards. Additionally, all 1996 models must meet 2010 manufacturing year engine emission standards if the project construction extends into 2016.

All vehicles with a GVWR greater than 26,000 lb. (e.g., semi-trucks) must meet particulate matter best available control technology. Additionally, all 1993 and older engine model vehicles must meet 2010 manufacturing year engine emission standards. If the project construction extends into 2016, all 1994 through 1995 engine model vehicles must meet 2010 manufacturing year engine emission standards.

Table 4-1. Estimated Equipment Usage Under the Proposed Action.

Equipment Description	Quantity	Make/Model or horsepower	Estimated Usage (days)*
Bulldozer	1	Caterpillar D-6	14
Excavator	1	Caterpillar 450	30
Vibratory drum compactor	1	6-foot sheepsfoot	30
Loader (2 cubic yards)	1	Caterpillar 950	30
Water truck	1	2,000 gal	30
Dump truck	1	12 yard	30
Pickup trucks (crew transportation)	2	Ford F250	30
Concrete pumping truck	1	300 hp diesel	7
Concrete hauling truck	5	300 hp diesel	7

* Estimated usage is based on 5 working days per week at 8 hours per day.

Table 4-2. Proposed Action Construction Emissions (tons/year).

	Emissions, tons/year					
Construction Phase	**ROG**	**NO_x**	**CO**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**
Site Preparation						
Fugitive Dust	-	-	-	-	0.0167	0.0091
Heavy Construction Equipment	0.0089	0.1007	0.0768	0.00006	0.0047	0.0043
Construction Worker Travel	0.0003	0.0005	0.0040	0.00001	0.0005	0.0001
Subtotal	**0.0092**	**0.1012**	**0.0808**	**0.0001**	**0.0219**	**0.0135**
Grading						
Fugitive Dust	-	-	-	-	0.0003	0.00003
Heavy Construction Equipment	0.0398	0.4440	0.2217	0.0005	0.0205	0.0189
On-road Diesel	0.00001	0.0002	0.0002	0.0000	0.00001	0.0000
Construction Worker Travel	0.0013	0.0022	0.0193	0.00003	0.0025	0.0007
Subtotal	**0.0411**	**0.4464**	**0.2412**	**0.0005**	**0.0233**	**0.0196**
Paving – Pad Construction						
Heavy Construction Equipment	0.0055	0.0483	0.0309	0.00005	0.0032	0.0030
On-road Diesel	0.0001	0.0009	0.0009	0.0000	0.0001	0.0000
Construction Worker Travel	0.0003	0.0004	0.0038	0.00001	0.0005	0.0001
Subtotal	**0.0059**	**0.0496**	**0.0356**	**0.0001**	**0.0038**	**0.0031**
Total Annual Emissions						
Total Annual Emissions	**0.0561**	**0.5972**	**0.3575**	**0.0006**	**0.0489**	**0.0363**
Significance threshold	100	100	100	100	100	100
Exceeds threshold?	No	No	No	No	No	No

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

4.1.1.2 Boost-Back and Landing at SLC-4W

As discussed in Chapter 2 (Description of the Proposed Action and Alternatives), SpaceX proposes to return the Falcon 9 First Stage to SLC-4W at VAFB for potential reuse. 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. This part of the operation would occur above 3,000 ft. above ground level (AGL), and would not result in emissions within the mixing layer. Therefore, emissions associated with the retrograde burn are not quantified in this analysis.

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. Although propellants are expected to be burned to depletion during flight, there is a potential for a maximum approximately 7,000 lbs. of LOX and a maximum of 2,750 lbs. of RP-1 to remain in the Falcon 9 First Stage upon landing, based on prior landing events. Final volumes of fuel remaining in the First Stage upon landing may vary and would be included in the FSDP. 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.

Emissions associated with the launch of the Falcon 9 have been evaluated in the *Final Environmental Assessment Falcon 9 and Falcon 9 Heavy Launch Vehicle Programs from Space Launch Complex 4 East Vandenberg Air Force Base, California* (USAF 2011a). 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.

Seventy-seven percent of emissions from the Falcon rocket consist of nitrogen (N_2) and 20 percent consist of oxygen (O_2) with the remaining three percent comprised of CO_2, CO, argon (Ar), and water vapor (USAF 2007 and 2011a). Trace amounts of other pollutants could be emitted during launch operations; however, these amounts would be anticipated to be minor and would disperse after launch. It is estimated that approximately 4,000 lbs. (1,810 kg) of RP-1 fuel would be consumed below 3,000 ft. AGL.

Measurements of criteria pollutant emissions presented in SpaceX (2007) estimate that a single launch of the Atlas V Heavy rocket would produce 1.2 tons of NO_x below 3,000 ft. (914.4 m) AGL. Only insignificant amounts of other criteria pollutants would be produced, and totals for those pollutants are reported as zero. Like the Falcon 9, the Atlas V Heavy rocket uses a mixture of RP-1 and LOX as fuel and is used here as a surrogate for estimating emissions from the boost-back landing of the Falcon 9 First Stage. As discussed in Chapter 2 (Description of Proposed Action and Alternatives), it is anticipated that up to six landings per year would occur at SLC-4W. Estimated emissions per landing are presented in Table 4-3.

Table 4-3. Proposed Action Operational Emissions (tons/year).

Emissions, tons/year						
Operations	**ROG**	**NO_x**	**CO**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**
Emissions per Landing	0	1.2	0	0	0	-
Total Emissions for 6 Landings/year	0	7.2	0	0	0	-

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

Operational emissions for all pollutants are below the major source threshold of 100 tons per year for all criteria pollutants; therefore, the Proposed Action would result in less than significant impacts to air quality.

4.1.1.3 Contingency Barge Landing

The process of landing the First Stage on a barge is the same as the process for landing on the SLC-4W pad at VAFB, and the emissions described associated with the landing would be the same as those described in Section 4.1.1.2 (Boost-Back and Landing at SLC-4W). The only difference is that gas emission would occur at least 31 mi. (50 km) offshore.

The three Merlin rocket engines used to position the First Stage for landing would be cutoff above 3,000 ft. AGL and would not result in emissions within the mixing layer. A final single engine burn would be used to slow the First Stage to a velocity of zero before landing on the landing barge. Although propellants would be burned to near depletion during flight, there is a potential for approximately 7,000 lbs. of LOX and a maximum of 2,750 lbs. of RP-1 to remain in the Falcon 9 First Stage upon landing. Final volumes of fuel remaining in the First Stage upon landing may vary and would be included in the FSDP. Once the First Stage has landed and been secured, any remaining LOX and RP-1 would be properly off loaded and transported to Long Beach Harbor for offloading and transport back to SLC-4W. Hazardous materials and ordnance would be offloaded from the First Stage after the barge is docked in Long Beach Harbor.

Emissions associated with the landing would result from combustion of RP-1 during the final single engine burn. Minor emissions of ROG would be associated with off-loading of the remaining RP-1 fuel from the Falcon 9 fuel tank (USAF 2011a). As described in Section 4.1.1.2 (Boost-Back and Landing at SLC-4W), exhaust from the Merlin engines consists mainly of CO_2, CO, hydrogen, and water vapor. Trace amounts of other pollutants could be emitted during launch operations; however, we anticipate these amounts to be minor and would disperse after launch (USAF 2007). Emissions associated with a barge landing would occur no less than 31 mi. (50 km) offshore of VAFB, but are otherwise the same as those for a landing on the SLC-4W pad (Table 4-3). Air emissions beyond the three nautical mile (nm) limit of California waters would take place outside the boundaries of any air district.

In additional to emissions from the First Stage rocket engine, the barge landing would result in air emission from the three vessels (barge, tug, and support vessel) as they transit between Long Beach Harbor and the landing site. The three vessels would be at-sea for approximately 72 hours, including 24 hours to transit to the landing site, 12 hours for pre-launch activation, 12 hours to secure the First Stage and equipment for the return trip, and 24 hours to transit back to Long Beach Harbor. The tug uses a 5,000 horsepower Tier 2 diesel engine, the support vessel has a 1,500 horsepower diesel engine, and the barge uses a 2,600 horsepower diesel engine. The barge engine would only be used for approximately 12 hours and would not be used when the barge is being towed or maneuvered by the tug. A 200 kW Tier 3 generator with a 9L engine located on the barge would be operating for the entire 72 hours. All three vessels and the generator run on diesel fuel. The average transit speed would be six knots.

The barge landing site would be located no closer than 31 mi. (50 km) from shore, and the vessels would be within the 3 nm limit of California state waters for approximately 1 hour of the total transit time (30 minutes outbound and 30 minutes inbound). Emissions from the operation of the three vessels would be below the major source threshold of 100 tons per year for all criteria pollutants (Table 4-4) and would result in less than significant impacts to air quality.

Table 4-4. Proposed Action Vessel Emissions for the Contingency Barge Landing Within and Beyond California State Waters (tons/year).

Emissions, tons/year					
Operations	**ROG**	**NO_x**	**CO**	**SO_x**	**PM_{10}**
Combined emissions for all three vessels per roundtrip transit (entire transit)	0.0005	0.0113	0.0042	0.0014	0.0006
Combined emissions for all three vessels per roundtrip transit (CA state waters only)	-	0.0002	0.0001	-	-
Total emissions for 6 roundtrip transits/year (entire transit)	0.0028	0.0678	0.0252	0.0085	0.0037
Total emissions for 6 roundtrip transits/year (CA state waters only)	-	0.009	0.003	0.001	0.001

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

4.1.2 Alternative 2

Under Alternative 2, the landing pad at SLC-4W would not be constructed, and the boost-back and landing of the Falcon 9 First Stage would occur on a barge located approximately 320 mi. (515 km) west of VAFB. Air emissions associated with the rocket would be the same as those described in Section 4.1.1.3 (Contingency Barge Landing). The only difference would be that emissions would occur 189 mi. (465 km) farther offshore. Air emissions from the barge, tug, and support vessel from the consumption of fuel would be approximately 10 times greater than emissions described for a barge landing, because the Proposed Action under Alternative 2 would take place approximately 10 times farther from shore than under Alternative 1. However, emissions within CA state waters and the SBCAPCD would be the same as described in Section 4.1.1.3 (Contingency Barge Landing), and air emissions would not exceed the significance threshold of 100 tons per year. Therefore, we anticipate no significant impact to air quality from the Proposed Action as implemented under Alternative 2.

4.1.3 No Action Alternative

Under the No Action Alternative, the landing pad at SLC-4W would not be constructed, and the boost-back and landing of the Falcon 9 First Stage would not occur. No additional impacts would be associated with the No Action Alternative; therefore, we anticipate no impact to air quality from the Proposed Action as implemented under the No Action Alternative.

4.1.4 Greenhouse Gas Emissions

4.1.4.1 Alternative 1 (Proposed Action)

Emissions of GHGs are considered to have a potential incremental impact on global climate. The emissions associated with construction of the landing pad at SLC-4W would incrementally increase regional emissions of CO_2 and other GHGs. Scientists are in general agreement that the

Earth's climate is gradually changing, and that change is due, at least in part, to emissions of CO_2 and other GHG from anthropogenic sources.

On the issue of global climate change, however, there are no adopted federal plans, policies, regulations, or laws mandating reductions in the GHG emissions that cause global climate change. The climate change research community has not yet developed tools specifically intended to evaluate or quantify end-point impacts attributable to the emissions of GHGs from a single source. In particular, because of the uncertainties involving the assessment of such emissions regionally and locally, the incremental contribution of the Proposed Action to climate change cannot be determined given the current state of the science and assessment methodology.

On 18 February 2010, the CEQ released draft guidance on addressing climate change in NEPA documents. The draft guidance, which has been issued for public review and comment, recommends quantification of GHG emissions and proposes a threshold of 25,000 metric tons of CO_{2e} emissions. The CEQ indicates that use of 25,000 metric tons of CO_{2e} emissions as a reference point would provide federal agencies with a useful indicator, rather than an absolute standard of significance, for agencies to provide action-specific evaluation of GHG emissions and disclosure of potential impacts.

Under CEQA, the California Natural Resources Agency recently adopted amendments to the CEQA guidelines to address global climate change impacts. According to Appendix G of the CEQA Guidelines, the following criteria are considered to establish a significance threshold for GHG impacts:

Would the project:

- Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment?
- Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of GHG?

As discussed in Section 15064.4 of the CEQA Regulations, the determination of the significance of GHG emissions calls for a careful judgment by the lead agency consistent with the provisions included therein. A lead agency should make a good-faith effort, based to the extent possible on scientific and factual data, to describe, calculate, or estimate the amount of GHG emissions resulting from a project. A lead agency shall have discretion to determine, in the context of a particular project, whether to:

> (1) Use a model or methodology to quantify GHG emissions resulting from a project, and which model or methodology to use. The lead agency has discretion to select the model or methodology it considers most appropriate provided it supports its decision with substantial evidence. The lead agency should explain the limitations of the particular model or methodology selected for use; or
>
> (2) Rely on a qualitative analysis or performance-based standards.

A lead agency should consider the following factors, among others, when assessing the significance of impacts from GHG emissions on the environment:

(1) The extent to which the project may increase or reduce GHG emissions as compared to the existing environmental setting;

(2) Whether the project emissions exceed a threshold of significance that the lead agency determines applies to the project;

(3) The extent to which the project complies with regulations or requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of GHG emissions. Such requirements must be adopted by the relevant public agency through a public review process and must reduce or mitigate the project's incremental contribution of GHG emissions. If there is substantial evidence that the possible effects of a particular project are still cumulatively considerable notwithstanding compliance with the adopted regulations or requirements, an EIR must be prepared for the project.

On 30 April 2015, the SBCAPCD adopted revisions to its Environmental Review Guidelines to the CEQA by adding significance thresholds for GHG impacts. The SBCAPCD has adopted a screening threshold of 10,000 metric tons of CO_{2e} per project per year consistent with AB 32. As a lead agency, the SBCAPCD is required to address the impacts of GHG emissions from the project as part of its CEQA review during the permitting process, should permits be mandated. Should emissions exceed the screening threshold, mitigation measures could be required to reduce emissions of GHGs.

For the Proposed Action, GHG emissions include emissions associated with construction of the landing pad at SLC-4W and the boost-back and landing of the Falcon 9 First Stage. Table 4-6 summarizes the annual GHG emissions associated with the Proposed Action. GHG emissions associated in construction of the landing pad at SLC-4W would produce 62.66 tons (56.84 metric tons) of CO_{2e}. These emissions would only occur during construction and would not contribute to annual GHG emissions beyond the first year. Only a small proportion of the emissions associated with the boost-back and landing event would have the potential to affect ambient air quality, which is defined as the area below the mixing height, typically defined as 3,000 ft. (914.4 m) AGL. The amount of CO_{2e} released by the re-landing would be between 60 and 88 percent less than a Falcon 9 launch, since only three engines would be re-lit, and only one would operate during landing (USAF 2014b). For six boost-back First Stage landings per year, the amount of CO_{2e} produced would be 281.98 tons (255.81 metric tons) per year (Table 4-6). GHG emissions for the landing of the Falcon 9 First Stage on a barge located 31 mi. (50 km) from VAFB would be the same for boost-back and landing at SLC-4W, but with the additional emissions from the barge, tug, and support vessel. The maximum total GHG emissions for operation of these vessels, assuming six contingency landing events per year, would be 1,009.56 tons (915.86 metric tons) of CO_{2e} (Table 4-5).

Overall, the Proposed Action would produce a maximum of 1,354.20 tons (1,228.51 metric tons) of CO_{2e} during the first year (when construction is conducted) and a maximum of 1,291.55 tons (1,171.67 metric tons) annually thereafter, both of which are less than the SBCAPCD's significance threshold of 10,000 metric tons of CO_{2e} per year. Furthermore, only 1 of the 72 hours of vessels emissions would occur within 3 nm of shore, and the vast majority of emissions would occur approximately 31 mi. (50 km) from shore. Finally, there would likely be less than six contingency landing events per year since the preferred option would be to land at SLC-4W.

Therefore, emissions from the Falcon 9 First Stage landing would not have a significant adverse environmental impact on GHG emissions or climate change.

Table 4-5. Proposed Action GHG Emissions.

Scenario/Activity	Total Metric Tons			
	CO_2	CH_4	N_2O	CO_{2e}
Total Construction GHG Emissions	56.51	0.0157	0	56.84
GHG Emissions Boost-Back and Landing per Event	42.58	0	0.0002	42.64
Total Annual GHG Emissions for 6 Landings/year	255.48	0	0.0011	255.81
GHG Emission for Barge, Tug, and Support Vessel (per Contingency Landing event)	150.25	0.0015	0.008	152.64
Maximum Total Annual GHG Emissions for Barge, Tug and Support Vessel (Assumes 6 Contingency Landings/year)	901.52	0.009	0.047	915.86
Maximum Total Annual GHG Emissions for the Proposed Action (Assumes 6 Contingency Landings/year)	**1,213.51**	**0.247**	**0.048**	**1,228.51**

Note: CO_{2e} = (CO_2 * 1) + (CH4* 21) + (N2O * 298)

4.1.4.2 Alternative 2

Under Alternative 2, the landing pad at SLC-4W would not be constructed, and the boost-back and landing of the Falcon 9 First Stage would occur on a barge located approximately 320 mi. (515 km) west of VAFB. Emissions of GHGs associated with the boost-back and landing of the Falcon 9 First Stage would be the same as those described in Section 4.1.4.1 (Alternative 1 [Proposed Action]). The only difference would be that emissions would occur 189 mi. (465 km) farther offshore. GHG emissions from the barge, tug, and support vessel from the consumption of fuel would be approximately 10 times greater than emissions described for a barge landing, because the Proposed Action under Alternative 2 would take place approximately 10 times farther from shore than under Alternative 1. However, GHG emissions within CA state waters and the SBCAPCD would be the same as described in Section 4.1.4.1 (Alternative 1 [Proposed Action]), and would not exceed the significance threshold of 10,000 metric tons per year. Therefore, no significant impact on GHG emissions or climate change would be anticipated from the Proposed Action as implemented under Alternative 2.

4.1.4.3 No Action Alternative

Under the No Action Alternative, the landing pad at SLC-4W would not be constructed, and the boost-back and landing of the Falcon 9 First Stage would not occur. No additional impacts would be associated with the No Action Alternative; therefore, no significant impact to GHG emissions or climate change would be anticipated under the No Action Alternative.

4.2 Sound (Airborne)

The primary factor considered in determining potential noise impacts includes the extent or degree to which implementation of the Proposed Action would affect the baseline sound environment. Concerns over noise include hearing loss, non-auditory health effects, annoyance, speech interference, and sleep interference. At elevated noise levels, people living in high noise environments for an extended period of time (40 years) can be at risk for hearing loss called Noise Induced Permanent Threshold Shift. DoD policy (Methodology for Assessing Hearing Loss Risk and Impacts in DoD Environmental Impact Analysis) requires that hearing loss risk be estimated for the at-risk population, defined as the population exposed to 80 DNL or greater. Specifically, DoD components are directed to use the 80 DNL noise contour to identify populations at the most risk of potential hearing loss. Boost-back and construction activities at VAFB do not generate noise at intensities that could contribute to hearing loss in people living near VAFB, so this issue is not further addressed. However, the potential effects would be conversation interruption, sleep interference, distraction, and annoyance. Based on numerous sociological surveys, and recommendations of federal interagency councils, the most common benchmark for assessing environmental noise impacts is a DNL of 65 dBA (Schomer 2005; Federal Interagency Committee on Noise 1992). When subjected to sound levels of 65 dBA DNL, approximately 12 percent of exposed individuals would be "highly annoyed." A sound level of 75 dBA DNL is a threshold above which effects other than annoyance can occur.

4.2.1 Approach to Analysis

Contours for boost-back noise were generated for activities performed under the Proposed Action. Additionally, construction noise propagation was evaluated for peak and hourly equivalent sound levels and compared against expected ambient noise levels.

Noise impacts from a project would be considered significant if a project were to generate noise levels in excess of 65 dBA DNL that could affect sensitive receptors, such as schools, residences, commercial lodging facilities, hospitals, or care facilities. Additionally, a significant noise impact would occur if the Proposed Action would cause noise sensitive areas to experience an increase in noise of annual DNL 1.5 dBA or more at or above DNL 65 dBA noise exposure when compared to the No- Action Alternative during the same time frame (FAA Order 1050.1).

Additionally, noise levels generated by sonic booms have the potential to break glass or damage structures. A significant impact from sonic booms would occur if there was a high risk or potential for glass to break or damage to structures due to the sonic boom. Sonic booms that generate an overpressure greater than 6 psf have the potential to cause this type of impact (Haber and Nakaki 1989; Plotkin et al. 2012). Sonic boom noise impacts are oriented along the path of a vehicle's trajectory.

4.2.2 Alternative 1 (Proposed Action)

4.2.2.1 SLC-4W Infrastructure Improvements

SpaceX's model for reusability requires that the landing pad be close enough to the launch site to support a timely processing of the recovered First Stage for subsequent launches. As part of this Proposed Action, SpaceX would construct a 300-ft. diameter concrete pad at the SLC-4W site (Figure 2-1). There is currently no flat area within SLC-4W that can support this configuration without site grading activities. Site grading is anticipated to be required to provide a flat compacted area to construct the concrete pad. Construction is anticipated to take 90–120 days. During 30 days of this construction, concrete would be curing and minimal construction activities and noise would occur. Table 2-1 lists the equipment that would be used for construction of the project and Table 4-6 presents typical construction noise at various distances from the source.

The construction equipment would be used to create a concrete landing pad at SLC-4W, which is approximately 500 ft. (152.4 m) north of Spring Canyon. The construction site is well away from any sensitive receptors, with the main entry gate at Arguello Boulevard and West Ocean Avenue is which is approximately 4 mi. (6.4 km) to the northeast.

Table 4-6. 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
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 = decibels, A-weighted; ft. = feet; m = meter
Source: U.S. Department of Transportation 2006

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.

4.2.2.2 Boost-Back and Landing at SLC-4W

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. Noise levels at the landing site are expected to be between 110 and 120 dBA. Received noise levels above 90 dBA would occur on VAFB, but the contours would not extend beyond the base boundary. The western portion of Lompoc would be exposed to 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 launch 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).

During descent of the First Stage, a sonic boom would be generated while the booster is supersonic. The overpressure would reach as high as 2.0 psf on VAFB and 3.1 psf on the Northern Channel Islands. The boom contours are generally broad forward-facing crescents. The majority of the boom occurs over the ocean. 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.

At VAFB, sonic boom overpressures would be between 1.0 and 2.0 psf, and would not extend beyond the VAFB boundaries. Overpressures between 1.6 and 1.0 psf would extend off-base approximately 5 mi. (8.1 km) to the east, impacting the western portion of Lompoc. The 1.0 psf footprint extends approximately 12 mi. (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 significant 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. Additionally, these overpressures do not cause adverse effects such as structure damage. Therefore, effects from the Boost-back and landing at SLC-4W would be less than significant.

4.2.2.3 Contingency Barge Landing

Engine noise would be produced during the barge landing, but would be focused on an area well offshore of California. The sonic boom overpressure would be directed at the ocean and would reach as high as 2.0 psf. Portions of Santa Barbara County would experience sonic boom overpressures between 0.2 and 0.4 psf. Engine noise would also be produced during the landing of the Falcon 9 First Stage, but it would be less than the noise generated during a launch, and would occur over a shorter time period. The landing noise would fall below 70 dB at 10 mi. (6.1 km) from the landing site (Figure 2-11). Since the barge would be located 31 mi. (50 km) west of VAFB, there would be no impacts on shore and sensitive receptors located there.

Given that there are no changes to the launch processes at VAFB and noise from boost-back activities would occur well offshore of sensitive receptors, there would be no significant impacts associated with implementation of the contingency barge landing.

4.2.3 Alternative 2

Under this alternative, the construction of a landing pad at SLC-4W would not occur. Boost-back landing noise would occur from boost-back activities, but would be focused on an area well offshore of California. The sonic boom overpressure would be directed at the ocean and would reach as high as 2.0 psf. Engine noise would also be produced during the landing of the Falcon 9 First Stage, but it would be less than the noise generated during a launch, and would occur over a shorter time period. The landing noise would fall below 70 dB at 10 mi. (6.1 km) from the landing pad. Since the barge would be located 320 mi. (515 km) of site, there would be no noise impacts on shore.

Given that there are no changes to the launch processes at VAFB and noise from boost-back activities would occur well offshore of sensitive receptors, there would be no significant impacts associated with the implementation of Alternative 2.

4.2.4 No Action Alternative

Under the No-Action Alternative, the current launch processes at VAFB would continue without using the boost-back capabilities of the Falcon 9 First Stage, and without construction of the landing pad.

Launch noise under the No Action Alternative is intermittent and was previously analyzed (USAF 2011a) but is presented here to facilitate comparison with boost-back activities. Four types of noise generally occur during a launch: (1) combustion noise from the launch vehicle chambers, (2) jet noise generated by the interaction of the exhaust jet and the atmosphere, (3) combustion noise from postburning of combustion products, and (4) sonic booms. The first three of these types of noise are often collectively referred to as “launch noise” and occur in the vicinity of the launch pad.

Acoustic levels versus distance from plume were modeled for the Falcon 9 and Falcon 9 Heavy launch vehicles (USAF 2011a). Ground acoustic levels modeling completed for the Falcon 9 and Falcon 9 Heavy indicate that sound pressure levels fall below 100 dBA at 5.3 mi. (8.5 km) from the launch site for the Falcon 9, and 7.4 mi. (12 km) for the Falcon 9 Heavy (USAF 2011a). Noise levels reaching Lompoc during a Titan IV launch were estimated to be between 100 and 104 dBA, and those reaching Santa Maria were estimated to be between 91 to 94 dBA. Noise from a Falcon 9 or Falcon 9 Heavy launch would be less than that from a Titan IV launch based on the noise modeling and thrust factors.

Sonic boom noise impacts typically occur downrange from the rocket launch pad and are orientated along the path of the vehicle's trajectory, which for launches from VAFB are directed over the Pacific Ocean. Sonic booms produced by launches from VAFB would impact the ocean and have the potential to impact the main northern Channel Islands, located approximately 40 to 75 mi. (120.7 km) southeast of SLC-4E. The three main islands comprising the northern Channel Islands include San Miguel Island, Santa Rosa Island, and Santa Cruz Island.

Sonic boom modeling was also performed for the Falcon 9 vehicle (USAF 2011a). The Falcon 9 modeling falls within the range seen from previous and current launch programs at VAFB and is well below the 8.97 psf level that occurred under the Titan IV program.

Based on noise modeling and sonic boom modeling for the Falcon 9 vehicle, impacts from the Falcon 9 program were concluded to be less than those from the Titan IV program and are anticipated to be less than significant (USAF 2011a). Given that there are no changes to the current launch processes at VAFB, there would be no additional impacts associated with the implementation of the No Action Alternative.

4.3 Biological Resources

Factors considered in determining whether implementing an alternative may result in significant impacts on biological resources include the extent or degree to which implementation of an alternative would result in:

- Unmitigable loss of important quantities of declining vegetation communities (including wetlands) that are considered rare;
- Impacts to endangered, threatened, or protected species; or
- Alteration of regionally- and locally important wildlife corridors that would severely and permanently limit their use.

Impacts to biological resources would occur if species (endangered, threatened, rare, candidate, or species of concern) or their habitats, as designated by federal and state agencies, would be affected directly or indirectly by project-related activities. These impacts can be short- or long-term impacts, for example, short-term or temporary impacts from noise and dust during construction and demolition, and long-term impacts from the loss of habitat to support wildlife populations.

The USAF initiated formal Section 7 consultation with the USFWS to address potential adverse impacts to federally protected species, associated with the construction of the landing pad at SLC-4W. The completed consultation was in the form of a BO (BO 8-8-14-F-41) issued by USFWS (Appendix D) and the requirements would be fully implemented. Additionally, the USAF requested concurrence with a Not Likely to Adversely Affect determination associated with potential impacts to federally protected species associated with the boost-back and landing of the Falcon 9 First Stage at SLC-4W and a contingency landing action. The USFWS completed informal consultation and issued concurrence with the USAF determination (2015-I-0208; Appendix D).

VAFB initiated consultation for potential impacts to federally protected species under the jurisdiction of NOAA Fisheries for boost-back and landing of the Falcon 9 First Stage at the contingency landing action 31 mi. (50 km) offshore of VAFB in the Pacific Ocean. NOAA Fisheries concurred that the contingency landing action may affect, but is not likely to adversely affect federally protected species (2015/3042; Appendix E). The USAF also initiated informal consultation for potential impacts to Guadalupe fur seal under NOAA Fisheries jurisdiction as a result of the Proposed Action and NOAA Fisheries concurred that the action may affect, but is not likely to adversely affect the Guadalupe fur seal (Appendix E).

VAFB requested concurrence from NOAA Fisheries that the Proposed Action was likely to adversely affect EFH. NOAA Fisheries determined that the proposed action would adversely affect EFH. Therefore, NOAA Fisheries offered recommendations to avoid, minimize, mitigate, or otherwise offset the adverse effects to EFH (2015/3042; Appendix E). Per these recommendations, SpaceX will contribute to a NOAA Fisheries approved marine debris removal program to offset impacts to EFH as a result of the Proposed Action.

SpaceX submitted an application to NOAA Fisheries for an Incidental Harassment Authorization (IHA) for Level B harassment to marine mammals protected under the MMPA on 29 January 2016. SpaceX is pursuing this IHA as a private entity. NOAA Fisheries is currently reviewing this application.

4.3.1 Alternative 1 (Proposed Action)

4.3.1.1 Botanical Resources

4.3.1.1.1 SLC-4W Infrastructure Improvements

Two habitat types were identified within the area to be impacted by landing pad construction activities: non-native grassland and mixed central coast scrub and non-native grassland. Both habitats are dominated by non-native plant species. Temporary and permanent disturbances to these habitat types would occur during construction. Permanent losses of 2.6 ac. (0.01 km^2) of non-native grassland and 0.4 ac. (0.002 km^2) of mixed central coast scrub and non-native grassland within the project area would occur as a result of construction of the landing pad.

No federal or state-listed plant species were documented within the footprint of the construction area during the botanical surveys. Seacliff buckwheat, the host plant of the federally endangered ESBB is, however, 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 may 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 (BO 8-8-14-F-41) and would implement all applicable minimization, monitoring, and avoidance measures in this Biological Opinion and the EPMs described in Section 2.2.4.4 (Biological Resources – 2 [Bio-2]). Potential effects to ESBB habitat would therefore be less than significant.

4.3.1.1.2 Boost-Back and Landing at SLC-4W

Potential impacts to terrestrial botanical resources as a result to the boost-back and landing of the Falcon 9 First Stage would be limited to the potential for fire. A FireX system would utilize remote water cannons to promptly distinguish a resultant fire during landing at SLC-4W. Ground firefighting crews would also be present to move onto the site and distinguish resultant fires as soon as the site is cleared for access. As a result, there are no anticipated impacts to botanical resources as a result of the boost-back and landing of the Falcon 9 First Stage at SLC-4W.

4.3.1.1.3 Contingency Barge Landing

Potential impacts as a result of the contingency action, boost-back and landing of the Falcon 9 First Stage 31 mi. (50 km) offshore would not include any terrestrial ground disturbance. Therefore, there are no anticipated impacts to botanical resources as a result of the contingency action.

4.3.1.2 Terrestrial Wildlife Resources

4.3.1.2.1 SLC-4W Infrastructure Improvements

Construction of the concrete pad at SLC-4W would result in the permanent loss of plant communities that provide habitat for common wildlife species. However, the small quantity of habitat (approximately 1.6 ac. [0.006 km^2]) that would be permanently lost would not measurably reduce regional populations of common wildlife species. No natural riparian or wetland habitat would be lost. Scattered shrubs within the site provide potential nesting bird habitat. Impacts to potential nesting bird habitat would be minimized with the EPMs outlined in Section 2.2.4.5 (Biological Resources 3 – [Bio-3]).

Temporary impacts to wildlife species may occur within adjacent wildlife habitat due to an increase in noise, dust, and other construction related disturbances. Temporary disturbances due to construction noise and human presence could disrupt foraging and roosting activities, or cause common bird and wildlife species to avoid the work area during construction periods. Temporary disturbances could also potentially result in the loss of wildlife species that are present during construction activities. Adult birds would likely move to adjacent suitable habitat due to project related disturbances and not be likely to experience direct physical effects. In addition, qualified biologists would be present during all construction and demolition activities and additional minimization measures designed to protect nesting birds and native wildlife would be implemented (Section 2.2.4.5, Biological Resources 3 – [Bio-3]).

Wildlife species present in the area could be affected by construction and demolition noise. For airborne sound, one of the most useful measurements to assess the effects of noise is the one-hour average sound level, abbreviated L_{eq1H}. The L_{eq1H} can be thought of in terms of equivalent sound. For example, a L_{eq1H} of 45.3 dB is what would be measured if a sound measurement device were placed in a sound field of 45.3 dB for one hour. However, this is not what happens during real sound measurements. When a L_{eq1H} level of 45.3 dB is measured, the sound level has fluctuated above and below 45.3 dB, but the average during that hour is 45.3 dB. The L_{eq1H} is usually A-weighted unless specified otherwise. A-weighting is a standard filter used in acoustics that approximates human hearing and in many cases is the most appropriate weighting filter when investigating sound effects on wildlife as well as humans. L_{eq} measurements can also be specified for other time periods such as eight or 24-hour periods.

Predictions of non-transient noise levels associated with activities such as those that would occur during the construction and demolition of a bridge for distances up to 0.5 mi. (0.8 km) are depicted in Table 4-8, with the assumption that equipment is located in one area and operating simultaneously.

The construction equipment used to create a concrete landing pad at SLC-4W would be a temporary source of disturbance to wildlife. Most wildlife species would avoid the construction area or have adapted to some level of ongoing human activity in the area. It is expected that most wildlife species would continue to use the adjacent areas in the intervals between disturbances. In addition, the EPMs described in Section 2.2.4.5 (Biological Resources 3 – [Bio-3]), would be implemented, therefore impacts to wildlife species would be less than significant.

4.3.1.2.2 Boost-Back and Landing at SLC-4W

Temporary disturbances to terrestrial wildlife species within the project area may occur during the Falcon 9 boost-back, landing and associated sonic boom. These disturbances would be short in duration and would vary by species. Amphibians may leave shelter sites increasing the potential for predation and desiccation. Wildlife responses to noise can be physiological or behavioral. Physiological responses can range from mild, such as an increase in heart rate, to more damaging effects on metabolism and hormone balance. Behavioral responses to man-made noise include attraction, tolerance, and aversion. Each has the potential for negative and positive effects, which vary among species and among individuals of a particular species due to temperament, sex, age, and prior experience with noise. Responses to noise are species-specific; therefore, it is not possible to make exact predictions about hearing thresholds of a particular species based on data from another species, even those with similar hearing patterns. 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).

The Proposed Action would create landing noise and up to a 3.1 psf sonic boom on the Northern Channel Islands and a 2 psf sonic boom on VAFB and visual disturbances, which could cause temporary behavioral disruption to common wildlife species. These events would be infrequent and of short duration. Therefore, no significant impacts to wildlife species are anticipated.

4.3.1.2.3 Contingency Barge Landing

Under the contingency action, landing noise would be sufficiently offshore so that it would not have any impact to terrestrial wildlife onshore. A sonic boom of up to 0.4 psf may impact land (Figure 2-10). As discussed above, a sonic boom may cause temporary physiological or behavioral disturbances to wildlife species. These disturbances would be short in duration and would vary by species and can range from mild, such as an increase in heart rate, to more damaging effects on metabolism and hormone balance. Each has the potential for negative and positive effects, which vary among species and among individuals of a particular species due to temperament, sex, age, and prior experience with noise. Responses to noise are species-specific; therefore, it is not possible to make exact predictions about hearing thresholds of a particular species based on data from another species, even those with similar hearing patterns. 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).

4.3.1.3 Special Status Terrestrial Wildlife Species

4.3.1.3.1 SLC-4W Infrastructure Improvements

Construction and demolition activities may directly or indirectly affect migratory birds and the federally listed ESBB and CRLF. The EPMs described in Section 2.2.4.4 (Biological Resources 2 – [Bio-2]) and Section 2.2.4.5 (Biological Resources 3 – [Bio-3]), would be implemented to minimize potential impacts. A list of special status wildlife species is provided in Table 4-7.

Migratory Birds

Temporary impacts to birds protected by the MBTA may occur within adjacent habitat due to an increase in noise, dust, and other construction related disturbances. Temporary disturbances due to construction noise and human presence could disrupt foraging and roosting activities, or cause bird species to avoid the work area during construction periods. As discussed above, predictions of non-transient noise levels associated with activities such as those that would occur during the construction and demolition of a bridge for distances up to 0.5 mi. (0.8 km). Temporary disturbances could also potentially result in the loss of bird species that are present during construction activities. Adult birds would likely move to adjacent suitable habitat due to project related disturbances and not be likely to experience direct physical effects. In addition, qualified biologists would be present during all construction and demolition activities and additional minimization measures designed to protect nesting birds and native wildlife would be implemented (Section 2.2.4.5, Biological Resources 3 – [Bio-3]).

Vegetation or structures that could support nesting native birds would be cleared or demolished outside of the bird nesting season or would be checked for active nests by a biological monitor prior to clearing. If eggs or chicks are found, construction would be delayed until after young had fledged. Adult birds are expected to move to adjacent suitable habitat due to construction related disturbances and are not likely to experience direct physical effects. As a result, potential effects to migratory birds from direct physical effects would be less than significant.

El Segundo Blue Butterfly

All life stages of the ESBB could be affected by the removal of their host plant, seacliff buckwheat during construction activities. When host plants are lost, individual ESBB larvae could be killed or injured as the plant is damaged or removed. Adult butterflies, if present, are expected to be able to move out of harm's way to suitable habitat available nearby. Although the seacliff buckwheat plants will be removed by mowing and the soil would not be disturbed beneath the plants, all ESBB pupae diapausing in the soil could be injured or killed through crushing by the mowing equipment. If ESBB 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. Once the 118 seacliff buckwheat plants located within SLC-4W are removed during site improvements, the site will be routinely mowed. Any

Table 4-7. Potential Impacts to Special Status Wildlife within the Terrestrial Portion of the Proposed Action Area.

Species		Status	Potential Impacts
Invertebrates			
El Segundo Blue Butterfly	(*Euphilotes battoides allyni*)	FE	Loss of potential habitat and mortality.
Amphibians			
California Red-legged Frog	(*Rana draytonii*)	FT, CSC	Disturbance from noise, vibration, & light.
Reptiles			
Western Pond Turtle	(*Antinemys pallida*)	CSC	Disturbance from noise, vibration, & light.
Blainville's Horned Lizard	(*Phrynosoma blainvillii*)	CSC	Loss of potential habitat; disturbance from noise, vibration, & light
Silvery Legless Lizard	(*Anniella pulchra pulchra*)	CSC	Loss of potential habitat; disturbance from vibration
Two-striped Garter Snake	(*Thamnophis hammondii*)	CSC	Disturbance from vibration, & light
Birds*			
California Brown Pelican	(*Pelecanus occidentalis californicus*)	FD, SD, FP	Disturbance from noise, vibration, & light.
Ferruginous Hawk	(*Buteo regalis*)	BCC	Disturbance from noise, vibration, & light.
Northern Harrier	(*Circus cyaneus*)	CSC	Loss of potential foraging habitat; disturbance from noise, vibration, & light.
White-tailed Kite	(*Elanus leucurus*)	CSC	Loss of potential foraging habitat; disturbance from noise, vibration, & light.
Golden Eagle	(*Aquila chrysaetos)*	BCC, FP	Disturbance from noise, vibration, & light.
Bald Eagle	(*Haliaeetus leucocephalus*)	BGEPA, FD, SE	Disturbance from noise, vibration, & light.
American Peregrine Falcon	(*Falco peregrinus anatum*)	FD, BCC, SD, FP	Disturbance from noise, vibration, & light.
Western Snowy Plover	(*Charadrius nivosus nivosus*)	FT, BCC, CSC	Disturbance from noise, vibration, & light.
Black Oystercatcher	(*Haematopus bachmani*)	BCC	Disturbance from noise, vibration, & light.
Long-billed Curlew	(*Numenius americanus*)	BCC	Disturbance from noise, vibration, & light.
California Least Tern	(*Sternula antillarum browni*)	FE, CSC	Disturbance from noise, vibration, & light.
Burrowing Owl	(*Athene cunicularia hypogea*)	BCC, CSC	Disturbance from noise, vibration, & light.
Allen's Hummingbird	(*Selasphorus sasin*)	BCC	Loss of potential foraging habitat; disturbance from noise, vibration, & light.
Nuttall's Woodpecker	(*Picoides nuttallii*)	BCC	Disturbance from noise, vibration, & light.
Olive-sided Flycatcher	(*Contopus cooperi*)	CSC	Disturbance from noise, vibration, & light.
Loggerhead Shrike	(*Lanius ludovicianus*)	BCC	Disturbance from noise, vibration, & light.
Purple Martin	(*Progne subis*)	CSC	Disturbance from noise, vibration, & light.
Oak Titmouse	(*Baeolophus inornatus*)	BCC	Loss of potential foraging habitat; disturbance from noise, vibration, & light.
Yellow Warbler	(*Dendroica petechia brewsteri*)	BCC, CSC	Disturbance from noise, vibration, & light.
Yellow-breasted Chat	(*Icteria virens*)	CSC	Disturbance from noise, vibration, & light.
Black-chinned Sparrow	(*Spizella atrogularis*)	BCC	Disturbance from noise, vibration, & light.
Savannah Sparrow	(*Passerculus sandwichensis* possible *beldingi*)	Possible SE	Disturbance from noise, vibration, & light.
Tricolored Blackbird	(*Agelaius tricolor*)	BCC, CSC	Disturbance from noise, vibration, & light.
Lawrence's Goldfinch	(*Spinus lawrencei*)	BCC	Disturbance from noise, vibration, & light.

Species		Status	Potential Impacts
Mammals			
Pallid Bat	(*Antrozous pallidus*)	CSC	Loss of potential foraging habitat; disturbance from noise, vibration, & light.
Townsend's Big-eared Bat	(Corynorhinus townsendii)	SC	Loss of potential foraging habitat; disturbance from noise, vibration, & light.
Western Red Bat	(*Lasiurus blossevillii*)	CSC	Loss of potential foraging habitat; disturbance from noise, vibration, & light.
Southern Sea Otter	(*Enhydras lutris nereis*)	FE	Disturbance from noise, vibration, & light.
American Badger	(*Taxidea taxus*)	CSC	Loss of potential habitat; disturbance from noise, vibration, & light.

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.
* All birds listed in the table are also protected under the MBTA.

seacliff buckwheat plants that may emerge between mowing events are not expected to grow large enough to provide habitat for ESBB.

Although the number of seacliff buckwheat plants occurring on VAFB has not been estimated, the 0.04 acre (0.016 hectare) area where the 118 individual plants would be removed represents less than one hundredth of a percent of the 1,090 acres (441 hectares) of known occupied ESBB habitat on base.

Seacliff buckwheat habitat would be enhanced at a 2:1 ratio (habitat enhanced: habitat affected) to replace the buckwheat plants removed. While the distribution of seacliff buckwheat, both regionally and on VAFB, is greater than the known distribution of ESBB, in general, the butterfly is negatively affected by its host plants' competition with non-native vegetation. Therefore, the enhancement of seacliff buckwheat plants in an area designated by a biologist familiar with the habitat requirements of the ESBB should improve and add to the available habitat on VAFB. Implementation of these measures would result in less than significant impacts to ESBB as a result of construction of the landing pad at SLC-4W.

California Red-Legged Frog

Although unlikely under typical conditions, CRLF may be present in Spring Canyon, immediately south of the project area, in high rainfall years (ManTech SRS Technologies, Inc. 2013). It is therefore possible that CRLF could disperse through the project area and be present during construction and demolition activities. As a result, CRLF may be inadvertently killed or injured during construction and demolition activities if present. A qualified biological monitor would be present to survey the project site before activities, monitor operations that could affect CLRF when they may be present, and relocate CRLF to the nearest suitable habitat outside of the project area prior to the onset of construction activities.

Relocating CRLF out of harm's way may reduce injury or mortality from equipment, foot traffic, or ground disturbing activities; however, injury or mortality of individuals may occur as a result of improper handling, containment, or transport of individuals or from releasing them into unsuitable habitat (e.g., where exotic predators are present). Observations of diseased and parasite-infected amphibians are frequently reported. This has given rise to concerns that releasing amphibians following a period of captivity, during which time they can pick up infections of disease agents, may cause an increased risk of mortality in wild populations. Amphibian pathogens and parasites can also be carried between habitats on the hands, footwear, or equipment of fieldworkers, which can spread them to localities containing species which have had little or no prior contact with such pathogens or parasites.

Construction noise is not likely to impact CRLFs because of the 1.53 mi (2.5 km) distance between SLC-4W and the nearest occupied CRLF habitat. Excavation and backfilling associated with the construction of the landing pad and access roads may increase erosion that can lead to sedimentation that could smother CRLF or reduce the availability of plants and insects that serve as their habitat and food sources. Silt fencing would be installed between SLC-4W and Spring Canyon and BMPs would be implemented during project activities to minimize the effects of sedimentation resulting from the proposed project. These measures will control and minimize erosion and sedimentation and their effects on CRLF and habitat.

The populations of CRLF on VAFB are considered plentiful and many of the habitats on base are of high quality. Overall, the effects to the species and its habitat would be relatively minor and temporary. Therefore, construction of the landing pad at SLC-4W would result in less than significant impacts to CRLF

4.3.1.3.2 Boost-Back and Landing at SLC-4W

The boost-back and landing of the Falcon 9 First Stage would produce a visual disturbance, landing engine noise, and a pressure wave (sonic boom) that may cause short-term disruption of behavior and may elicit a startle response, resulting in temporary disturbance to special status wildlife species, including migratory birds and federally listed CRLF, LETE, and SNPL. These disturbances would be short in duration and would vary by species and can range from mild, such as an increase in heart rate, to more damaging effects on metabolism and hormone balance. Each has the potential for negative and positive effects, which vary among species and among individuals of a particular species due to temperament, sex, age, and prior experience with noise. Responses to noise are species-specific; therefore, it is not possible to make exact predictions about hearing thresholds of a particular species based on data from another species, even those with similar hearing patterns.

California Red-Legged Frog

Exceptionally little sound is transmitted between the air-water interface (Godin 2008). Thus, in air sound, as a result of the sonic boom and landing noise, is not likely to have a significant effect on submerged terrestrial reptiles or amphibians. The combined effect of visual and noise related disturbance would be expected to trigger a startle response in CRLF, causing them to flee to water or attempt to hide in place. Any animals that dive underwater would be less susceptible to acoustic effects (Godin 2008; USFWS 2011b). Since the noise generated by landing the Falcon 9 First Stage would be of short duration (approximately 25-35 seconds), and water would significantly buffer sound for any submerged animals, injury to hearing is highly unlikely. Similarly, a sonic boom of 2 psf is unlikely to result in hearing damage. Therefore, the effects of these visual and auditory stimuli are expected to only cause temporary disruption of CRLF behaviors, including potential temporary cessation of foraging or basking. During the breeding season, CRLF may stop calling, but would be expected to resume normal activities quickly once the disturbance has ended. Additionally, water quality is not anticipated to be affected by project activities.

The USFWS concurred with the USAF determination that the Proposed Action may affect, but is not likely to affect the CRLF (2015-I-0208; Appendix D). Any potential adverse effects resulting from the Proposed Action would be insignificant (i.e., the size of the impact would be so small that a person would not be able to meaningfully measure, detect, or evaluate the effects) and discountable (i.e., the effects are extremely unlikely to occur).

California Least Tern

Engine landing noise at Purisima Point is expected to be approximately between 70 and 80 dBA and 80–90 dBA at the Santa Ynez River mouth (Figure 3-5). A sonic boom up to 0.2 psf is expected to impact Purisima Point (Figure 3-6). The Santa Ynez River mouth, as shown in Figure 3-6, may be impacted by a sonic boom of up to 1 psf (approximately 130 dB [unweighted]). LETE foraging and breeding areas are not within overflight zone of the boost-back. Visual disturbance is not anticipated as a result of the boost-back and landing due to the distance of the craft from Purisima Point and the Santa Ynez River mouth. In addition, the First Stage vehicle would remain above 1,000 ft. (305 m) for the majority of the landing. Flight below 1,000 ft. (305 km) would only occur for 5 seconds.

Monitoring of LETE has been conducted for five Delta II launches from SLC-2 on north VAFB. SLC-2 is 0.4 mi. (0.32 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 3-6). LETE response has been mixed. Pre- and post-launch monitoring of non-breeding LETE for the 7 June 2007 Delta II COSMO-1 launch, and monitoring of nesting LETE 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. 2007b, 2008a, 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 LETE by owls may have been responsible for some of the losses observed (BioResources 1997). Given the distance from SLC-4 and the overflight zone to Purisima Point, and the fact that landing-related noise would be less than that of launch noise, it is unlikely that landing related noise would cause LETE to alter their behavior at Purisima Point. The Santa Ynez River area (3.7 mi. [5.9 km] north of SLC-4), occasionally used for foraging, may receive a significant amount of noise, including the impact of 1 psf sonic boom, which could briefly affect foraging behavior. These effects would be short-term and temporary and have no adverse effects.

The USFWS concurred with the USAF determination that the Proposed Action may affect, but is not likely to affect the LETE (2015-I-0208; Appendix D). Any potential adverse effects resulting from the Proposed Action would be insignificant (i.e., the size of the impact would be so small that a person would not be able to meaningfully measure, detect, or evaluate the effects) and discountable (i.e., the effects are extremely unlikely to occur).

Western Snowy Plover

SNPL may experience boost-back related noise in excess of 100 dBA and a sonic boom of up to 1.6 psf (approximately 130 dB [unweighted]). SNPL monitoring for impacts related to boost-back related engine noise and visual disturbance has been conducted during numerous past launches. Direct observations of wintering birds were made during a Titan IV and Falcon 9 launch from SLC-4E (SRS Technologies, Inc. 2006d; Robinette and Ball 2013). Both the Titan IV and Falcon 9 are larger, louder (130 dBA and 100 dBA respectively) launch vehicles than the Falcon 9 First Stage boost-back. SNPL did not exhibit any adverse reactions to these launches (SRS Technologies, Inc. 2006d; Robinette and Ball 2013). Additionally, monitoring of SNPL during the breeding and non-breeding season for other launches has routinely demonstrated that SNPL behavior is not adversely affected by launch noise or vibrations, and no incidents of injury or mortality to adults, young, or eggs have been documented following any of the launches (SRS Technologies, Inc. 2006a, 2006b, 2006c, 2006f, 2006g, 2006h, 2006i; ManTech SRS Technologies, Inc. 2007a, 2008b, 2008c, 2009d).

Similar to LETE, due to the short-term, transient nature of anticipated boost-back and sonic boom noise and their lack of adverse responses to rocket launch noise, responses to boost-back noise are only anticipated to be behavioral. These behavioral reactions would be short term and temporary and adverse effects are not anticipated.

The USFWS concurred with the USAF determination that the Proposed Action may affect, but is not likely to affect the SNPL (2015-I-0208; Appendix D). Any potential adverse effects resulting from the Proposed Action would be insignificant (i.e., the size of the impact would be so small that a person would not be able to meaningfully measure, detect, or evaluate the effects) and discountable (i.e., the effects are extremely unlikely to occur).

4.3.1.3.3 Contingency Barge Landing

Under the contingency action, landing noise would be sufficiently offshore so that it would not have any impact to special status wildlife species (Figure 2-11), including the southern sea otter which tend to remain nearshore, between shore and the 65 ft. (20 m) depth contour (USFWS 2003).

A sonic boom of up to 0.4 psf may impact land (Figures 2-9 and 2-10). As discussed above, a sonic boom may cause temporary physiological or behavioral disturbances to special status wildlife species. These disturbances would be short in duration and would vary by species and can range from mild, such as an increase in heart rate, to more damaging effects on metabolism and hormone balance. Each has the potential for negative and positive effects, which vary among species and among individuals of a particular species due to temperament, sex, age, and prior experience with noise. Responses to noise are species-specific; therefore, it is not possible to make exact predictions about hearing thresholds of a particular species based on data from another species, even those with similar hearing patterns. The effect of the sonic boom generated during the contingency action nearshore and onshore would be expected to be less for the SLC-4W landing since the overpressure would be significantly less powerful (up to 0.4 psf versus 2.0 psf). 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). As a result, activities associated with the contingency action of Alternative 1 are not expected to have a significant effect on special status wildlife species.

4.3.1.4 Marine Mammals

The marine mammal species that may be found within areas potentially affected by the Proposed Action include up to 28 cetaceans and six pinnipeds, as well as the southern sea otter. The potential impacts to these species as a result of the Proposed Action are analyzed below.

NOAA Fisheries has 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 (Table 4-8; NOAA Fisheries 2015). In addition, NOAA Fisheries provided sound threshold guidance for in-water explosives (Table 4-9; J. Carduner, NOAA Fisheries, pers. comm.). These thresholds were used to determine the potential geographic area where acoustic impacts to marine mammals from the boost-back and landing actions would be possible.

4.3.1.4.1 SLC-4W Infrastructure Improvements

Construction of the concrete landing pad at SLC-4W is within terrestrial habitat and relatively far from the nearest haul out location (4.3 mi. [7.0 km]; Figure 3-8) and thus would have no potential impact on marine mammals, such as pinnipeds or sea otters.

4.3.1.4.2 Boost-Back and Landing at SLC-4W

The boost-back of the Falcon 9 First Stage at SLC-4W would generate landing noise, visual stimuli, and a sonic boom that could disturb marine mammals protected under the ESA and MMPA (southern sea otter, pinniped species, and cetacean species).. 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. Cetaceans spend their entire lives in the water and spend most of their time (>90% 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% 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 at SLC-4W would not have an effect on cetacean species. Pinnipeds, however, spend significant amounts of time out of the water during breeding, molting, and hauling out periods, therefore the potential effects of in-air noise generated during the boost-back and landing of the Falcon 9 First Stage at SLC-4W on pinniped species at haul outs are analyzed below. Southern sea otter locations along the coast of mainland California would also be impacted by the sonic boom generated during a SLC-4W landing and are discussed below.

Table 4-8. NOAA Fisheries Interim Sound Threshold Guidance[1]

Criterion	Criterion Definition	Threshold
In-Water Acoustic Thresholds		
Level A	PTS (injury) conservatively based on TTS	190 dB_{rms} for pinnipeds 180 dB_{rms} for cetaceans
Level B	Behavioral disruption for impulsive noise	160 dB_{rms}
Level B	Behavioral disruption for non-pulse noise	120 dB_{rms}
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}

[1] NOAA Fisheries 2015

Table 4-9. NOAA Fisheries sound threshold guidance for in-water explosives[1].

Group	Species	Behavior		Slight Injury			Mortality
		Behavioral (for ≥ 2 pulses per24 hrs)	TTS	PTS	Gastro-Intestinal Tract	Lung	
Low-Frequency Cetaceans	Mysticetes	167 dB SEL	172 dB SEL or 224 Db peak SPL	187 dB SEL or 230 dB peak SPL	237 dB SPL or 104 psi	39.1 $M^{1/3}$ $(1+[D_{Rm}/10.081]^{1/2}$ Pa-sec Where: M=mass of the animal in kg D_{Rm}=depth of the receiver in meters	91.4 $M^{1/3}$ $(1+[D_{Rm}/10.081]^{1/2}$ Pa-sec Where: M=mass of the animal in kg D_{Rm}=depth of the receiver in meters
Mid-Frequency Cetaceans	Most delphinids, medium & large toothed whales	167 dB SEL	172 dB SEL or 224 Db peak SPL	187 dB SEL or 230 dB peak SPL			
High-Frequency Cetaceans	Elephant & harbor seal	172 dB SEL	177 dB SEL or 212 Db peak SPL	192 dB SEL or 218 Db peak SPL			
Otariidae	Sea lions & fur seals	195 dB SEL	200 dB SEL or 212 Db peak SPL	215 dB SEL or 218 Db peak SPL			

[1] J. Carduner, NOAA Fisheries, pers. comm.

Pinniped Species

Sonic Boom

During the return flight of the Falcon 9 First Stage at SLC-4W, a sonic boom up to 2.0 psf would impact pinniped haul outs on VAFB (Figure 3-8) and a sonic boom up to 3.1 psf may impact haul outs on San Miguel, Santa Rosa, and Santa Cruz Islands (Figure 3-10). The sonic boom 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 (reviewed in MMCG and SAIC 2013). Even above 1.0 psf, only a portion of the animals present tend to react to sonic booms. Reactions between species are also different. For example, harbor seals and California sea lions tend to be more sensitive to disturbance than northern elephant seals. Guadalupe fur seals also tend to be less sensitive to disturbance than other pinniped species (J. Harris, NOAA Fisheries, pers. comm.). Monitoring of past sonic booms have shown that normal behavior and numbers of hauled out pinnipeds typically return to normal within 24 hours or less after a launch event. Any observations of injury or mortality of pinnipeds during monitoring have not been attributable to past launches.

Reactions of pinnipeds to sonic booms have ranged from no response to heads-up alerts, from startle responses to some movements on land, and from some movements into the water to, in rare cases, stampedes. Behavioral reactions to noise can be dependent 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 will not be coupled with the sonic boom, since the First Stage will be at significant altitude when the overpressure impacts land. This would decrease the likelihood and severity of a behavioral response.

Figures 3-9 and 3-10 show haul out sites on the mainland coast of central California and the Northern Channel Islands that would be affected by sonic booms during a SLC-4W landing. Pacific harbor seals, northern elephant seals, California sea lions, and Steller sea lions utilize the haul outs near Point Arguello and Point Conception. Within the affected area on the Northern Channel Islands (San Miguel, Santa Rosa, and Santa Cruz Islands), Pacific harbor seals, northern elephant seals, California sea lions, and northern fur seal use haul outs in relatively large numbers. Guadalupe fur seals are also observed in very low numbers at San Miguel Island.

SpaceX submitted an application for an IHA to NOAA Fisheries to incidentally take by Level B harassment Pacific harbor seals, northern elephant seals, California sea lion, Stellar sea lion, northern fur seal, and Guadalupe fur seal as a result of the boost-back and landing of the Falcon 9 First Stage at SLC-4W. NOAA Fisheries is currently reviewing the application.

Guadalupe fur seals are relatively insensitive to disturbance, occur in low numbers and isolated locations, and are adept at jumping into the water in the event that they do flee from a disturbance (J. Harris, NOAA Fisheries, pers. comm.). VAFB determined that the impacts from sonic boom as a result of boost-back and landing at SLC-4W were not likely to adversely affect the ESA-listed Guadalupe fur seal. NOAA Fisheries concurred that the action may affect, but is not likely to adversely affect the Guadalupe fur seal (2016/4011; Appendix E).

Mortality or injury to pinnipeds is not anticipated to occur. As a result, the sonic boom generated by the Falcon 9 First Stage during the boost-back and landing at SLC-4W would not have a significant effect on pinnipeds.

Landing Noise and Visual Disturbance

During landing at SLC-4W, the engines will generate pulse engine noise up to 110 dB re 20 μPa while landing on the pad at SLC-4W (Figure 3-8). This landing noise event would be of short duration (17 seconds). Landing noise between 70 and 90 dB would overlap pinniped haul outs at and near Point Arguello and haul outs at Purisima Point (Figure 3-8). NOAA Fisheries interim guidance thresholds for in-air acoustic impacts resulting in Level A harassment have not been established (Table 4-8; NOAA Fisheries 2015). However, NOAA Fisheries has established interim guidance for Level B harassment for harbor seals (90 dB; Table 4-8; NOAA Fisheries 2015) and for non-harbor seal pinnipeds (100 dB; Table 4-8; NOAA Fisheries 2015). There are no pinniped haul outs within the area impacted by landing noise at 90 dB or greater for a SLC-4W landing (Figure 3-8). In addition, the trajectory of the return flight includes a nearly vertical descent in both the SLC-4W and contingency barge landings (Figure 2-3). As a result, there would be no significant visual disturbance since it would either be shielded by coastal bluffs or too far away to cause significant stimuli. Therefore, landing noise and visual disturbance associated with the Falcon 9 First Stage boost-back will not result in Level B harassment or have significant effects on marine mammals.

Southern Sea Otter

Areas where sea otters may be present would be impacted by landing noise and sonic boom noise of up to 135 dB. Sea otter rafting areas off Purisima Point and Sudden Flats are projected to receive a sonic boom with pressure levels between 1 and 1.6 psf (Figure 3-7). Additionally, otters in transit along the coast southwest of SLC-4 may be impacted by a sonic boom as high as 2 psf (Figure 3-7). The response to sonic booms or other sudden disturbances is similar among many species (Moller 1978). Sudden and unfamiliar sounds usually act as an alarm and trigger a “fight or flight” startle reaction. However, sonic booms are not expected to cause more than a temporary startle-response because the “pursuit” would not be present, as monitoring sea otters during launch operations has indicated that launch noise is not a primary driver of sea otter behavior. Additionally, USFWS has stated that they had no evidence that defense-related activities have had any adverse effects on the well-monitored experimental population of southern sea otters at San Nicolas Island or in the Southern California Range Complex (USFWS 2011).

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 SLC-576 (Taurus launch site), 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, Inc. 2006a, 2006b, 2006c, 2006d, 2006e, 2006f, 2007; ManTech SRS Technologies, Inc. 2007a, 2007b, 2007c, 2008a, 2008b, 2008c, 2008d, 2008e, 2009c, 2009d, 2010). During the Delta IV launches, the number of sea otters observed after launch activities was similar to or greater than pre-launch counts. Given these observations, any launch-related effects on sea otter populations are likely negligible and temporary. In addition, the past launches during which monitoring of sea otters was conducted involved launch vehicles that produced louder noise than the boost-back is expected to produce.

Davis et al. (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 purposefully move sea otters 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 kilohertz [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 m) before resuming normal activity.

Sounds from rocket launches are typically at a maximum at initiation of the booster rockets. These sounds (including any sonic booms from supersonic flight) would be transient and of short duration, lasting no more than a few seconds at any given location. Launch and boost-back activities may expose sea otters to levels of sound that could produce brief startle reactions or diving. However, 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. Figure 4-1 illustrates the frequency spectrum of a 1.5 psf sonic boom (recorded at San Nicholas Island on 12 December 2014) as well as the hearing curve of a sea otter (Ghoul and 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 4-1). 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.

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 Proposed Action is not expected to cause more than a temporary startle-response, and adverse effects are not anticipated.

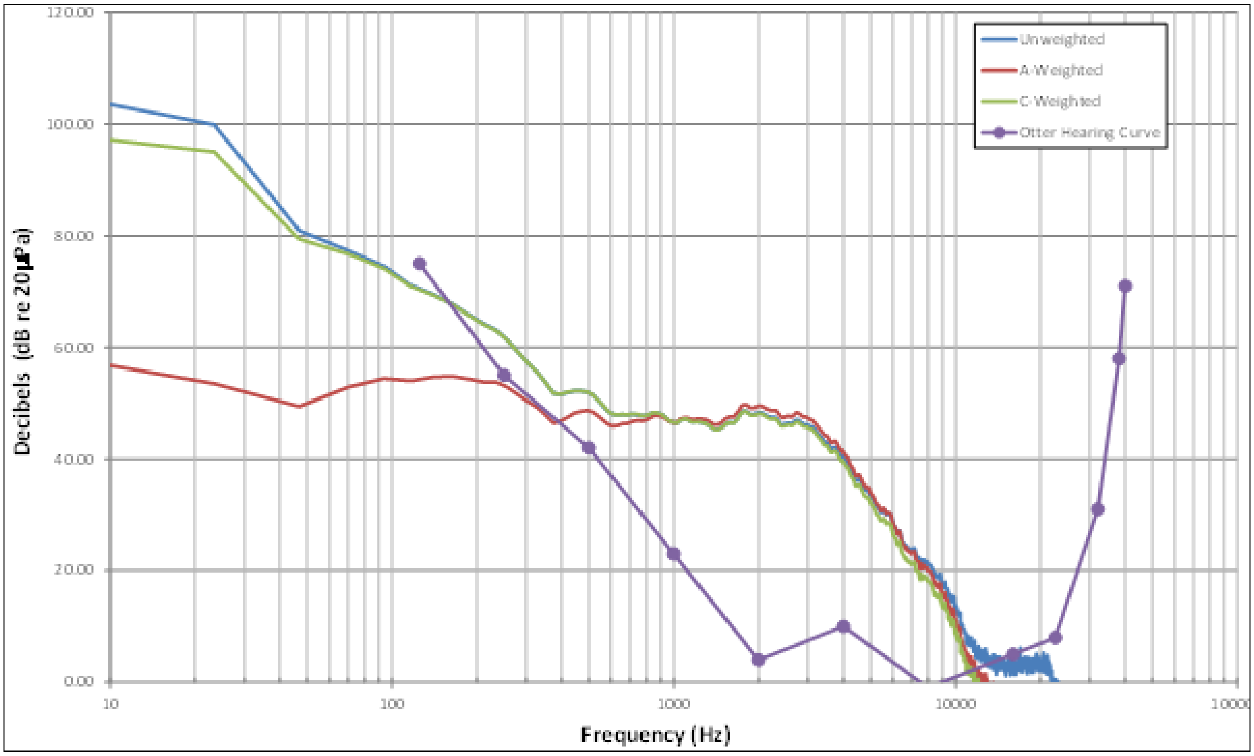


Figure 4-1. Sonic Boom Spectrum and Sea Otter Hearing Sensitivity Curve.

The USFWS concurred with the USAF determination that the Proposed Action may affect, but is not likely to affect the southern sea otter (2015-I-0208; Appendix D). Any potential adverse effects resulting from the Proposed Action would be insignificant (i.e., the size of the impact would be so small that a person would not be able to meaningfully measure, detect, or evaluate the effects) and discountable (i.e., the effects are extremely unlikely to occur).

4.3.1.4.3 Contingency Barge Landing

The return flight of the Falcon 9 First Stage during a contingency barge landing would not produce a significant sonic boom or engine noise that would impact any haul out locations (Figure 2-9 and Figure 2-10). Likewise, in-air noise that would be generated in the event of an explosion of the Falcon 9 First Stage would not reach haul out locations (Figure 2-11). The contingency action includes three potential impacts that may cause adverse effects to marine mammals occurring in the vicinity of the contingency landing site. These include potential debris strike, acoustic impacts, and interactions with expended materials, which are summarized in Table 4-11 at the end of this section. These impacts are analyzed below.

Debris Strike

Under the contingency action, in the event of an unsuccessful barge landing, the booster is expected to explode upon impact with the barge. The maximum estimated remaining fuel and oxidizer onboard the booster when it explodes would be the equivalent a net explosive weight of 503 lbs. of TNT, although differing from TNT in brisance (i.e., shattering capability of a high explosive). The resulting explosion of the estimated onboard remaining fuel would be capable of scattering debris a maximum estimated range of approximately 1,250 ft. (384 m) from the landing point and thus spread over a radial area of 114 ac. (0.46 km^2) as an impact area. Based on engineering analysis collected during a flight anomaly that occurred during a Falcon 9 test at SpaceX's Texas Rocket Development Facility, debris would impact 0.17 ac. (0.000706 km^2) of the total 114 ac. (0.46 km^2) impact area.

Using a statistical probability analysis for estimating direct air strike impact developed by the U.S. Navy (U.S. Department of the Navy 2014b) the probability of impact of debris with a marine mammal (*P*) can be estimated for individual marine mammals of each species that may occur in the impact footprint area (*I*) (0.000706 km^2). For this analysis we assumed a dynamic scenario with broadside collision, in which the width of the impact footprint is enhanced by a factor of five (5) to reflect forward momentum created by an explosion (U.S. Department of the Navy 2014b). Forward momentum typically accounts for five object lengths, thus the applied factor of five (5) area (U.S. Department of the Navy 2014b).

The probability of impact with a single animal (*P*) is calculated as the likelihood that an animal footprint area (*A*, defined as the adult length [L_a] and width [W_a] for each species) intersects the impact footprint area (*I*) within the overall "testing area" (*R*). Note that to calculate (*P*) it is assumed that the animal is in the testing area. For the purposes of this model, *R* was estimated as the maximum range of debris spread as a result of the First Stage explosion at the landing location (0.46 km^2). The probability impact with a single animal (*P*) depends on the degree of overlap of *A* and *I*. To calculate this area of overlap (A_{tot}), a buffer distance is added around *A* that is equal to one-half of the impact area (0.5**I*). This buffer accounts for an impact with the center of the object anywhere within the combined area of overlap (A_{tot}) would result in an impact with the animal. A_{tot} is then calculated as $(L_a + 2*W_i)*(W_a + (1 + 5)*L_i)$, where W_i and L_i are the length and width of the impact area (*I*). We assumed that $W_a = W_i$ = square root of *I*. The single animal impact probability (*P*) for each species is then calculated as the ratio of total area (A_{tot}) to testing area (*R*): $P = A_{tot}/R$. This single animal impact probability (*P*) is then multiplied by the number of animals expected in the testing area (*N* = density * *R*) to estimate the probability of impacting an individual for each species per event (*T*).

SpaceX proposes to conduct up to six contingency offshore landings per year, which may result in between zero and six explosions of the First Stage. In the model presented herein, we assume that the maximum of six events per year result in an explosion. This is a conservative estimate, since the actual number of contingency landing events resulting in the First Stage explosion is likely to be less than six.

The modeling results, as applied to the contingency landing actions, are presented below. Table 4-10 presents results based on estimated at-sea densities for each species (see Section 2, Description of the Proposed Action and Alternatives, above).

For ESA-listed marine mammals, modeling based on the estimated density of individuals for each species result in estimates of the probability of a direct strike of debris with an individual during each event of 0.0002 or less, (Table 4-10). The estimated number of takes for each species annually, assuming the maximum of six that result in explosion of the First Stage, was

Table 4-10. Estimated At-Sea Density of Individuals per km^2, Probability of Direct Impact of Rocket Debris per Event, and Estimated Number of Takes.

Species	Estimated At-Sea Density (km^2)*	Probability of Impact per Event (*T*)	Estimated Number of Impacts per year^
Harbor Seal	0.0200	0.0002	0.0010
California Sea Lion	2.5000	0.0222	0.1330
Northern Elephant Seal	0.0500	0.0005	0.0030
Steller Sea Lion	0.0001	0.0000008	0.000005
Northern Fur Seal	0.005	0.00004	0.003
Guadalupe Fur Seal#	0.0070	0.00006	0.0003
Humpback Whale#	0.0169	0.0002	0.001
Blue Whale#	0.0102	0.0001	0.0008
Fin Whale#	0.0132	0.0002	0.0010
Sei Whale#	0.00009	0.000001	0.000006
Bryde's Whale	0.00001	0.0000001	0.0000006
Minke Whale	0.0007	0.000007	0.00004
Gray Whale#	0.0024	0.00003	0.0002
Sperm Whale#	0.0085	0.0001	0.0006
Pygmy Sperm Whale	0.0010	0.000009	0.00005
Dwarf Sperm Whale	0.0010	0.000009	0.00005
Killer Whale	0.0007	0.000007	0.00004
Short-Finned Pilot Whale	0.0003	0.000003	0.00002
Long-Beaked Common Dolphin	0.6870	0.00612	0.0367
Short-Beaked Common Dolphin	1.3190	0.0117	0.0703
Common Bottlenose Dolphin	0.7140	0.0065	0.0392
Striped Dolphin	0.0300	0.0003	0.0016
Rough Toothed Dolphin	0.0010	0.000008	0.00005
Pacific White-Sided Dolphin	0.7500	0.0067	0.0400
Northern Right-Whale Dolphin	0.1070	0.0013	0.0075
Risso's Dolphin	0.2000	0.0018	0.0110
Dall's Porpoise	0.0550	0.0005	0.0029
Cuvier's Beaked Whale	0.0050	0.00005	0.0003
Baird's Beaked Whale	0.0015	0.00002	0.0001
Blainville's Beaked Whale	0.0001	0.000001	0.000006
Ginkgo-toothed Beaked Whale	0.0003	0.000003	0.00002
Perrin's Beaked Whale	0.0010	0.00001	0.00006
Stejneger's Beaked Whale	0.0010	0.000009	0.00006
Hubb's Beaked Whale	0.0010	0.000009	0.00006
Pygmy Beaked Whale	0.0003	0.000003	0.00002

* U.S. Department of the Navy 2014a.
^ Based on up to six events per year.
\# ESA-listed species.

approximately 0.001 or less (Table 4-10). With the intentionally conservative overestimation of parameters and assumptions in the model, the results indicate that it is extremely unlikely the explosion of the First Stage booster would result in debris impacting the ESA-listed species.

These probabilities are sufficiently low to reasonably conclude that it would be unlikely that any of the seven ESA-listed marine mammals would be struck by debris as a result of conducting up to six contingency landings per year that result in explosion of the Falcon 9 First Stage. As a result, the potential debris strike of First Stage explosion may affect, but is not likely to adversely affect the seven ESA-listed marine mammals: Guadalupe fur seal, blue whale, fin whale, gray whale, humpback whale, sei whale, and sperm whale. For marine mammals protected under the MMPA, the probability of debris strike for individuals of all species was also negligible (Tables 4-10) and therefore the potential debris strike as a result of Falcon 9 First Stage explosion would not have a significant effect on these species.

Underwater Acoustic Impacts

Underwater sounds can be organized into two types: impulse and non-impulse sounds. Impulse sounds may include sonic boom from First Stage boost-back and explosion of First Stage landing during an unsuccessful barge landing. Non-impulse noise would include engine noise from First Stage landing and vessel noise from the barge, tug, and support vessel. .

NOAA Fisheries has 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 (Tables 4-8 and 4-9). These interim thresholds were used to determine the potential geographic area where acoustic impacts to marine mammals from the boost-back and landing actions would be possible. The type, intensity, and frequency of the sound measured at the receiver (i.e., the animal) is compared to the acoustic criteria to determine what type of reaction the animal might have. Table 4-9 presents the criteria for physiological effects from explosives for marine mammals.

Sonic Boom

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 psf decayed to approximately 152 dB re 1 µPa 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 dBrms re 1 µPa sound pressure level for pinnipeds and 180 dBrms re 1 µPa sound pressure level for cetaceans) and potential behavioral change or temporary injury (160 dBrms re 1 µPa sound pressure level). The point at which underwater sound pressure levels would equal or exceed 160dBrms re 1 µPa 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 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). 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.

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 mammals may be in the immediate vicinity during those times, we conclude that sonic booms associated with contingency landing actions may affect, but are not likely to adversely affect the ESA-listed marine mammals and would not be significant.

First Stage Explosion

Noise resulting from an unsuccessful barge landing (explosion) can introduce loud, impulse, broadband sounds into the ocean or near the water's surface. These sounds can be within the audible range of most marine mammals, but the expected duration is very short. The direct sound from explosions would last less than a second, and most events involve only one explosion. Furthermore, events are dispersed in time, with maximum of six barge landing attempts occurring each 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 to marine mammals.

If an explosion occurs upon the barge, as in an unsuccessful barge landing, exceptionally little of the acoustic energy from the explosion would transmit into the water (Yagla and Stiegler 2003). An explosion on the barge would create a blast in air that propagates away in all directions, including toward the water surface, although the barge's deck would act as a barrier that would minimize the amount of energy directed directly downward towards the water (Yagla and Stiegler 2003). As described above, most sound enters the water in a narrow cone beneath the sound source (within 13 degrees [°] of vertical). Since the explosion would occur on the barge, most of this sound would be reflected by the barge's surface, and sound waves would approach the water's surface at angles higher than 13°, minimizing transmission into the ocean.

An explosion on the barge would also send energy through the ship structure, into the water, and away from the ship. This effect was investigated in conjunction with the measurements described in Yagla and Stiegler (2003). The energy transmitted through the ship to the water for the firing of a typical 5-inch round was about 6 percent of that from the air blast impinging on the water. Therefore, sound transmitted from the gun through the hull into the water is a minimal component of overall weapons firing noise, and would be expected to be a minimal component for an explosion occurring on the surface of the barge.

Depending on the amount of fuel remaining in the booster at the time of the explosion, the intensity of the explosion would likely vary. As indicated above, the explosive equivalence of the First Stage with maximum fuel and oxidizer is 503 lb. of TNT. Explosion shock theory has proposed specific relationships for the peak pressure and time constant in terms of the charge weight and range from the detonation position. Utilizing these equations, and modifying them for use in the far-field (Continental Shelf Associates, Inc. 2004), the received level at 32.8 ft. (10 m) during a surface water explosion would be approximately 268 dB re 1 μPa. If it is assumed that the barge absorbs approximately 94 percent of that energy (Yagla and Stiegler 2003), the received level at a 32.8 ft. (10 m) distance underwater from the barge would be 21 dB re 1 μPa. This is far below the threshold levels at which physiological impacts would occur for cetaceans and pinnipeds (Table 4-9).

As a result, an explosion on the barge during an unsuccessful barge landing attempt generated by the Falcon 9 First Stage during the contingency barge landing action may affect, but is not likely to adversely affect the seven ESA-listed marine mammals: Guadalupe fur seal, blue whale, fin whale, gray whale, humpback whale, sei whale, and sperm whale. Likewise, an explosion on the barge during an unsuccessful barge landing would not result in Level B harassment or have a significant effect on marine mammals protected under the MMPA.

Landing Noise

The Falcon 9 First Stage will generate landing noise up to 150 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. Disturbance to landing noise would be unlikely to cause long-term impacts to marine mammals. As a result, landing noise generated by the Falcon 9 First Stage during the contingency landings may affect, but is not likely to adversely marine mammals protected under the ESA and MMPA.

Vessel Noise

Vessel noise has 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 in the proposed zone of influence 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, vessel noise generated by the support vessels required to support the contingency landing actions may affect, but are not likely to adversely affect marine mammals.

Expended Materials and Fluids

Floating Debris

SpaceX has experience performing recovery operations after water and unsuccessful barge landings for previous Falcon 9 First Stage landing attempts. This experience, in addition to the debris catalog that identifies all floating debris, has revealed that approximately 25 pieces of debris remain floating after an unsuccessful barge landing. The surface area potentially impacted with debris would be less than 114 ac. (0.46 km^2), and the vast majority of debris would be recovered. All other debris sinks to the bottom of the ocean.

These 25 pieces of floating debris are primarily made up of Carbon Over Pressure Vessels (COPVs), the LOX fill line, and carbon fiber constructed landing legs. SpaceX has performed successful recovery of all of these floating items during previous landing attempts. An unsuccessful barge landing would result in a very small debris field, making recovery of debris relatively straightforward and efficient. All debris recovered offshore would be transported back to Long Beach Harbor.

Since the area that would be impacted by falling debris is very small, the likelihood of adverse effects to marine mammals is very low. Denser debris that would not float on the surface is anticipated to sink relatively quickly and is composed of inert materials that would not affect water quality or bottom substrate potentially used by marine mammals. 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. Also, the area that would be impacted by a piece or pieces of sinking debris is only 0.17 ac. (0.000706 km^2), a relatively small portion of the total 114 ac. (0.46 km^2) potential impact area, based on a maximum range of 1,250 ft. (384 m) that a piece of debris would travel following an explosion. As a result, debris from an unsuccessful barge landing that enters the ocean environment approximately 31 mi. (50 km) from shore may affect, but is not likely to adversely affect the seven ESA-listed marine mammals: Guadalupe fur seal, blue whale, fin whale, gray whale, humpback whale, sei whale, and sperm whale. Likewise, debris would not have a significant effect on marine mammals protected under the MMPA.

Rocket Propellant

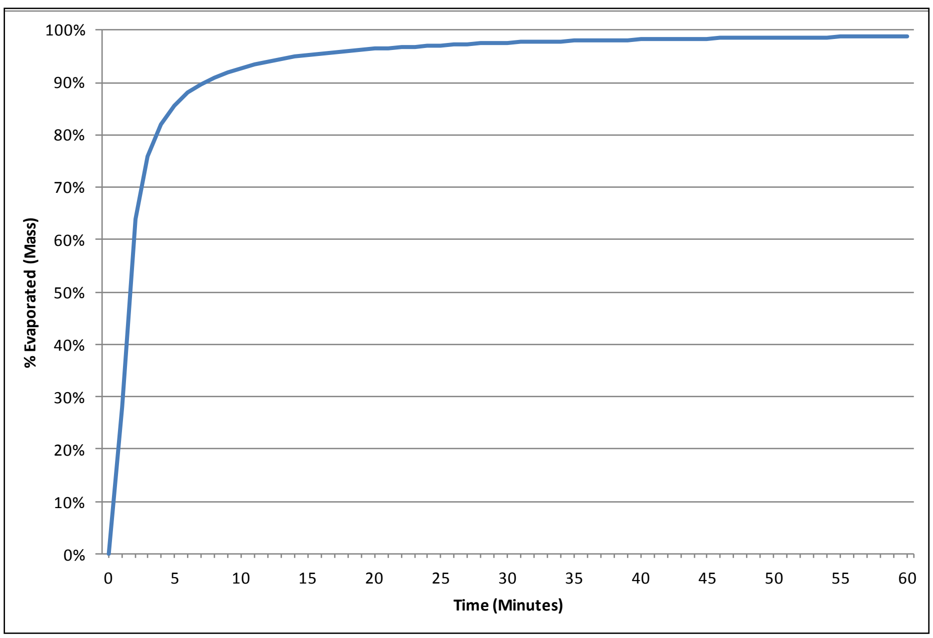
In the event of an unsuccessful landing attempt, the First Stage would explode upon impact with the barge. At most, the First Stage would contain 2,750 lbs. of rocket propellant (RP-1 or "fuel") on board. In the event of an unsuccessful barge landing, most of this fuel would be consumed during the subsequent explosion. Residual fuel would be released into the ocean. Final volumes of fuel remaining in the First Stage upon impact may vary, but are anticipated to be below the high range estimations.

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 (USFWS 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 an unsuccessful barge landing (USFWS 1998). Therefore, no attempt would be made to boom nor recover RP-1 fuel from the ocean.

In relatively high concentrations, exposure to very light oils can cause skin and eye irritation, increased susceptibility to infection, respiratory irritation, gastrointestinal inflammation, ulcers, bleeding, diarrhea, damage to organs, immune suppression, reproductive failure, and death. The effects of exposure primarily depend on the route (internal versus external) and amount (volume and time) of exposure. Although the U.S. Environmental Protection Agency (EPA) has established exposure levels for kerosene and jet fuel (RP-1 is a type of kerosene) for toxicity in mammals and the environment (U.S. Environmental Protection Agency 2011), in reality it is difficult to predict exposure levels, even with a known amount of fuel released. This is because exposure level is dependent not only on the amount of fuel in the spill area, but also on unpredictable factors, including the behavior of the animal and the amount of fuel it contacts, ingests, or inhales.

However, precluding these factors is the overall risk of a marine mammal being within the fuel spill area before the RP-1 dissipates. For the case of RP-1, a Very Light Oil, this risk depends primarily on how quickly RP-1 dissipates in the environment and the area affected by the spill. Since RP-1 is lighter than water and almost completely immiscible (i.e., very little will dissolve into the water column), RP-1 would stay on top of the water surface. Due to its low viscosity, it would rapidly spread into a very thin layer (several hundred nanometers) on the surface of the water and would continue to spread as a function of sea surface conditions, wind, current, and wave conditions. This spreading rapidly reduces the concentration of RP-1 on the water surface at any one location and exposes more surface area of the fuel to the atmosphere, thus increasing the amount of RP-1 that is able to evaporate.

RP-1 is highly volatile and evaporates rapidly when exposed to the air (USFWS 1998). The evaporation rate for jet fuel (a kerosene similar to RP-1) on water can be determined by the following equation from Fingas (2013): $\%EV = (0.59 + 0.13T)/t$, where $\%EV$ is the percent of mass evaporated within a given time in minutes (t) at a given temperature in ^{o}C (T). If we assume an air temperature of 50^{o} F (10^{o} C), the percent of mass evaporated versus time can be determined, as shown in Figure 4-2. Although 1–2 days would be required for the RP-1 to completely dissipate, over 90 percent of its mass would evaporate within the first 7 minutes and 99 percent of its mass would evaporate within the first hour (Figure 4-2). In the event of adverse ocean conditions (e.g., large swells, large waves) and weather conditions (e.g., fog, rain, high winds) RP-1 would be volatilized more rapidly due to increased agitation and thus dissipate even more quickly and further reduce the likelihood of exposure.



Fingas 2013

Figure 4-2. Evaporation Rate of Jet A1 fuel (similar to RP-1) as Function of Time (minutes).

Given the relatively small volume of RP-1 that would be spilled (2,750 lbs.), the potential exposure area would be small, and thus it is unlikely that a marine mammal would be within the exposure area. Based on the thinness of the layer of RP-1 on the water surface, spreading on the surface (thus rapidly reducing concentration), and rapid evaporation (further reducing concentration), an animal would need to be at the surface within the layer of RP-1 and be exposed to a toxic level within a very short period of time (minutes) after the spill to experience negative effects. Additionally, since the spill would occur concurrent to the explosion of the

First Stage, any animals that may have been in the immediate area of the barge would likely submerge and move away from the area due to the disturbance associated with the explosion. Similarly, since RP-1 would be a very thin, rapidly evaporating layer on the water surface, fish and other prey species would not be negatively impacted to any significant degree.

It is therefore highly unlikely that RP-1 spilled as a result of an unsuccessful barge landing that enters the ocean environment approximately 31 mi. (50 km) from shore would have an effect on marine mammal species. Therefore, spilled fuel from an unsuccessful barge landing that enters the ocean environment approximately 31 mi. (50 km) from shore may affect, but is not likely to adversely affect the seven ESA-listed marine mammals: Guadalupe fur seal, blue whale, fin whale, gray whale, humpback whale, sei whale, and sperm whale. Given the small estimated volume of RP-1 that may be spilled and that it would dissipate quickly, marine mammals protected under the MMPA are highly unlikely to be affected.

Table 4-11. Potential Impacts to Marine Mammal Species Potentially Occurring within the Contingency Area.

Species	Status	Potential Impacts
Pinnipeds		
Pacific Harbor Seal *Phoca vitulina richardsi*	MMPA	Nearshore - disturbance from in-air noise, vibration, & light, Offshore – Disturbance from debris, underwater noise, & expended materials.
California Sea Lion *Zalophus californianus*	MMPA	Nearshore - disturbance from in-air noise, & light, Offshore – Disturbance from debris, underwater noise, & expended materials.
Northern Elephant Seal *Mirounga angustirostris*	MMPA	Nearshore - disturbance from in-air noise, & light, Offshore – Disturbance from debris, underwater noise, & expended materials.
Steller Sea Lion *Eumetopias jubatus*	FD	Nearshore - disturbance from in-air noise, & light, Offshore – Disturbance from debris, underwater noise, & expended materials.
Northern Fur Seal *Callorhinus ursinus*	MMPA	Nearshore - disturbance from in-air noise, & light, Offshore – Disturbance from debris, underwater noise, & expended materials.
Guadalupe Fur Seal *Arctocephalus townsendi*	FT	Nearshore - disturbance from in-air noise, & light, Offshore – Disturbance from debris, underwater noise, & expended materials.
Cetaceans		
Humpback whale *Megaptera novaeangliae*	FE	Disturbance from debris, underwater noise, & expended materials.
Blue whale *Balaenoptera musculus*	FE	Disturbance from debris, underwater noise, & expended materials.
Fin whale *Balaenoptera physalus*	FE	Disturbance from debris, underwater noise, & expended materials.
Sei whale *Balaenoptera borealis*	FE	Disturbance from debris, underwater noise, & expended materials.
Bryde's whale *Balaenoptera brydei/edeni*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Minke whale *Balaenoptera acutorostrata*	NL	Disturbance from debris, underwater noise, & expended materials.
Gray whales *Eschrichtius robustus*	FE/NL[4]	Disturbance from debris, underwater noise, & expended materials.
Sperm whale *Physeter microcephalus*	FE	Disturbance from debris, underwater noise, & expended materials.
Pygmy sperm whale *Kogia breviceps*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Dwarf sperm whale *Kogia sima*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Killer whale *Orcinus orca*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Short-finned pilot whales *Globicephala macrorhynchus*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Long-beaked common dolphins *Delphinus capensis*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Short-beaked common dolphins *Delphinus delphis*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Common bottlenose dolphin *Tursiops truncates*	MMPA	Disturbance from debris, underwater noise, & expended materials.

Species	Status	Potential Impacts
Striped dolphin *Stenella coeruleoalba*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Rough-toothed dolphin *Steno bredanensis*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Pacific white-sided dolphin *Lagenorhynchus obliquidens*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Northern right whale dolphin *Lissodelphis borealis*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Risso's dolphin *Grampus griseus*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Dall's Porpoise *Phocoenoides dalli*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Cuvier's beaked whale *Ziphius cavirostris*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Baird's beaked whale *Berardius bairdii*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Blainville's beaked whale *Mesoplodon densirostris*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Ginkgo-toothed beaked whale *Mesoplodon ginkgodens*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Perrin's beaked whale *Mesoplodon perrini*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Stejneger's beaked whale *Mesoplodon stejnegeri*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Hubbs' beaked whale *Mesoplodon carlhubbsi*	MMPA	Disturbance from debris, underwater noise, & expended materials.
Pygmy beaked whale *Mesoplodon peruvianus*	MMPA	Disturbance from debris, underwater noise, & expended materials.

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; SOC = Species of Concern

4.3.1.5 Offshore Special Status Species (Non-Mammal)

Offshore protected species in addition to marine mammals considered under this EA include sea turtles, seabirds, and ESA-listed fish species. Analyses of impacts to these species are based on the Alternative 1 analysis of potential debris impacts to marine mammals presented above. The likelihood of special status seabirds occurring within the potential debris impact zone during an unsuccessful barge landing is very low (Table 4-5); thus, it is unlikely that any of individual sea birds would be adversely affected by the contingency action under Alternative 1.

4.3.1.5.1 Sea Turtles

Debris Strike

The probability of impact of debris with a sea turtle was estimated using the same approach as presented above for marine mammals; however, we were limited by the lack of density data for green sea turtle, loggerhead sea turtle, olive ridley sea turtle, and hawksbill sea turtle. These four species are considered rare in the Pacific Ocean offshore of Central California so the probability of impact would be less than the much more commonly observed leatherback sea turtle. Using the debris impact analysis presented above (U.S. Department of the Navy 2012b), the estimated probability of debris strike as a result of explosion of the First Stage with an individual leatherback sea turtle is 0.0003 and the annual estimated number of takes would be 0.0019 (Table 4-17). A conservative probability of debris strike with individual green sea turtle, loggerhead sea turtle, olive ridley sea turtle, or hawksbill turtle would be less than 0.0003, and annual estimated takes for these two species less than 0.0019 (Table 4-17). In addition, sea turtles spend a significant amount of time at depth while off shore; thus, these estimates are conservative since they assume the animals are at the surface at all times.

Table 4-12. Estimated At-Sea Density of Individuals per km^2, Probability of Direct Impact of Rocket Debris per Event, and Estimated Number of Takes.

Species	Estimated At-Sea Density (km^2)	Probability of Impact per Event (*T*)	Estimated Number of Impacts per year^
Green Sea Turtle	< 0.035	< 0.0003	< 0.0019
Loggerhead Sea Turtle	< 0.035	< 0.0003	< 0.0019
Olive Ridley Sea Turtle	< 0.035	< 0.0003	< 0.0019
Hawksbill Sea Turtle	< 0.035	< 0.0003	< 0.0019
Leatherback Sea Turtle	0.035*	0.0003	0.0019

* U.S. Department of the Navy 2014a.

^ Based on up to six events per year.

These probabilities are sufficiently low to reasonably conclude that it would be unlikely the any of the three ESA-listed sea turtles would be struck by debris as a result of conducting up to six contingency landings per year that result in explosion of the Falcon 9 First Stage. As a result, the potential debris strike as a result of First Stage explosion may affect, but is not likely to adversely affect the five ESA-listed sea turtles: green sea turtle, loggerhead sea turtle, olive Ridley sea turtle, hawksbill sea turtle, and leatherback sea turtle.

Underwater Acoustic Impacts

Acoustic impacts criteria and thresholds have been developed for sea turtle exposures to various sound sources (U.S. Department of the Navy 2013). These acoustic impacts criteria for impulsive sources are summarized in Table 4-17.

Table 4-13. Sea Turtle Impact Threshold Criteria for Impulsive Sources.

Impulsive Sound Exposure Impact	Threshold Value
Onset Mortality[1] (1% Mortality Based on Extensive Lung Injury)	$= 91.4M^{1/3}\left(1+\frac{D_{Rm}}{10.081}\right)^{1/2} Pa-s$
Onset Slight Lung Injury[1]	$= 39.1M^{1/3}\left(1+\frac{D_{Rm}}{10.081}\right)^{1/2} Pa-s$
Onset Slight Gastrointestinal Tract Injury	237 dB re 1 μPa SPL (104 psi)
Onset PTS	230 dB re 1 μPa Peak SPL
Onset TTS	224 dB re 1 μPa Peak SPL

[1] M = mass of animals (kg) as shown for each species, D_{Rm} = depth of animal (m). Impulse calculated over a delivery time that is the lesser of the initial positive pressure duration or 20 percent of the natural period of the assumed-spherical lung adjusted for animal size and depth.
[2] Turtle Weighting Function. When the cetacean criteria were weighted to correlate with Type II frequency weighting, the turtle threshold was inadvertently lowered by 17 dB, even though Type II weighting is not applied to sea turtle hearing. This resulted in an increased number of model-predicted turtle impacts, although the actual impacts are expected to be substantially lower.
[3] The interval for determining the root mean square is that which contains 90% of the total energy within the envelope of the pulse. This windowing procedure for impulse signals removes uncertainty about where to set the exact temporal beginning or end of the signal, which may be obscured by ambient noise.
Notes: kg = kilograms, m = meters, PTS = permanent threshold shift, TTS = temporary threshold shift, SEL = sound exposure level, SPL = sound pressure level

Sonic Boom

A sonic boom of 2 psf at the surface, as anticipated from Falcon 9 First Stage boost-back, is expected to decay to approximately 152 dB re 1 μPa at a depth of 23.0 ft. (7 m). By 72.2 ft. (22 m), the received level was approximately 140 dB re 1 μPa and by 121.4 ft. (37 m), the acoustic wave would be subsumed by ambient noise levels. All of these levels are below the peak SPL criteria for physiological effects from acoustics on sea turtles. As a result, the sonic boom generated by the Falcon 9 First Stage during the contingency landing actions may affect, but is not likely to adversely affect the five ESA-listed sea turtles: green sea turtle, loggerhead sea turtle, olive Ridley sea turtle, hawksbill sea turtle, and leatherback sea turtle.

First Stage Explosion

The approach to analyzing impacts from the explosion of the Falcon 9 First Stage near the water is the same as presented for marine mammals above. Onset TTS and PTS SPL values are the same for cetaceans and sea turtles. Therefore, a sea turtle would not experience physiological impacts as a result of the explosion of the First Stage during an unsuccessful barge landing, since the barge would reflect and absorb approximately 94 percent of the energy from the blast (Yagla and Steigler 2003).

As a result, explosion of the Falcon 9 First Stage on the barge the contingency landing action may affect, but is not likely to adversely affect the five ESA-listed sea turtles: green sea turtle, loggerhead sea turtle, olive Ridley sea turtle, hawksbill sea turtle, and leatherback sea turtle.

Landing Noise

The Falcon 9 First Stage would generate landing noise up to 110 dB. This landing noise event would be of short duration (minutes). Landing noise would likely disturb sea turtles at the water surface and elicit an alerting, avoidance, or other short term behavioral reactions, including diving and potentially moving away from the source of the noise. In addition, sea turtle species spend most of the time underwater and exceptionally little sound is transmitted between the air-water interface (Godin 2008); thus, in-air sound would not have a significant effect on submerged sea turtles. Disturbance due to landing noise would be unlikely to cause long-term consequences for individuals or populations of sea turtles. As a result, landing noise generated by the Falcon 9 First Stage during the contingency landing actions may affect, but is not likely to adversely affect the five ESA-listed sea turtles: green sea turtle, loggerhead sea turtle, olive Ridley sea turtle, hawksbill sea turtle, and leatherback sea turtle.

Vessel Noise

Vessel noise has the potential to disturb sea turtles and elicit an alerting, avoidance, or other behavioral reaction. As a result, vessel noise generated by the Falcon 9 First Stage during the contingency landing actions may affect, but is not likely to adversely affect the five ESA-listed sea turtles: green sea turtle, loggerhead sea turtle, olive Ridley sea turtle, hawksbill sea turtle, and leatherback sea turtle.

Expended Materials and Fluids

Debris

As described above, SpaceX would remove the approximately 25 pieces of debris that are expected to remain floating after an unsuccessful barge landing. Denser debris that would not float on the surface is anticipated to sink relatively quickly and is composed of inert materials, which would not affect water quality or bottom substrate. 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. Since the area that would be impacted by sinking debris is very small 0.17 ac. (0.000706 km^2) the likelihood of adverse effects to ESA-listed sea turtles is very low. As a result, debris from an unsuccessful barge landing that enters the ocean environment approximately 31 mi. (50 km) from shore may affect, but is not likely to adversely affect the five ESA-listed sea turtles: green sea turtle, loggerhead sea turtle, olive Ridley sea turtle, hawksbill sea turtle, and leatherback sea turtle.

Rocket Propellant

As described above, a maximum of 2,750 lbs. of RP-1 would be released into the ocean as a result of an unsuccessful barge landing. RP-1 is a very light oil, which is highly volatile and would evaporate quickly (90 percent within first 7 minutes; 99 percent within first hour; Figure 4-2) when exposed to the air and would completely dissipate within 1–2 days after a spill in the water. In the event of adverse ocean conditions (e.g., large swells, large waves) and weather conditions (e.g., fog, rain, high winds) RP-1 would be volatilized more rapidly due to increased agitation and thus dissipate even more quickly. Since the amount of spilled fuel would be small and would dissipate quickly, spilled fuel from an unsuccessful barge landing that enters the ocean environment approximately 31 mi. (50 km) from shore may affect, but is not likely to adversely affect the six ESA-listed sea turtles: green sea turtle, loggerhead sea turtle, olive Ridley sea turtle, hawksbill sea turtle, and leatherback sea turtle.

4.3.1.5.2 Special Status Fish Species

Debris Strike

Sufficient density data are not available to conduct a debris strike analysis in the manner conducted above. Steelhead, if present in the area of potential debris impacts, would be less likely to be at or near the water surface where debris could strike them than marine mammals or sea turtles. Scalloped hammerhead sharks, although occasionally at the water surface, tend to be found where water temperatures are at least 22°C (72°F) (Castro 1983; Compagno 1984). Water temperatures in the region of the contingency landing location are typically below 18°C (64°F); therefore, scalloped hammerhead sharks would be rare. Both species, therefore, would be expected to have lower effective densities than the marine mammals and sea turtles discussed above and the probability that an individual of either species would potentially be impacted by debris is discountable. As a result, potential debris strike as a result of First Stage explosion may affect, but is unlikely to adversely affect the ESA-listed fish species: steelhead trout and scalloped hammerhead shark. The basking shark is occasionally observed at the surface of the water, is expected to be in low densities and would be unlikely to be impacted. The cowcod is not observed at the surface and would not be affected by debris strike. Therefore, there would be no significant impacts to special status fish species as a result of debris strike during an unsuccessful barge landing.

Underwater Acoustic Impacts

For fish, the greatest potential for direct, non-auditory tissue effects is primary blast injury and barotrauma following exposure to explosions. Primary blast injury refers to those injuries that result from the initial compression of a body exposed to a blast wave. Primary blast injury is usually limited to gas-containing structures (e.g., swim bladder) and the auditory system, although, with increased proximity, even non-gas filled structures could be damaged. Barotrauma refers to injuries caused when the swim bladder or other gas-filled structures vibrate in response to the signal, particularly if there is a relatively sharp rise-time and the walls of the structure strike near-by tissues and damage them.

The potential fish mortality associated with the use of at-sea explosives led military researchers to develop mathematical and computer models that predict safe ranges for fish from explosions of various sizes. Young (1991) provides equations that allow estimation of the potential effect of underwater explosions on fish possessing swim bladders using a damage prediction method developed by Goertner (1982). Table 4-19 lists estimated explosive effects ranges using Young's (1991) method for fish possessing swim bladders exposed to explosions 3.3 ft. (1 m) below the water surface from a 503 lb. explosion.

Table 4-14. Estimated Explosive Effects Ranges for Fish with Swim Bladders.

Net Explosive Weight (lb.)	10% Mortality Range (m)		
	1 oz. Fish	1 lb. Fish	30 lb. Fish
503	308	215	138

Sonic Boom

A sonic boom of 2 psf at the surface, as anticipated from the Falcon 9 First Stage boost-back, is expected to decay to approximately 152 dB re 1 μPa at a depth of 23.0 ft. (7 m). By 72.2 ft. (22 m), the received level was approximately 140 dB re 1 μPa and by 121.4 ft. (37 m), the acoustic wave would be subsumed by ambient noise levels. Stadler and Woodbury (2009) established that the onset of physical injury to fish would be expected if the peak SPL exceeds 206 dB re 1 μPa. The anticipated received sound levels from a sonic boom are below these criteria for physiological effects to fish. As a result, the sonic boom generated by the Falcon 9 First Stage during the contingency landing action may affect, but is not likely to adversely affect ESA-listed fish species: steelhead and scalloped hammerhead shark. By the same reasoning, underwater noise generated by the sonic boom would not have a significant effect on special status fish species.

First Stage Explosion

As discussed above, the barge would absorb approximately 94 percent of the energy resulting from an explosion of the First Stage during an unsuccessful barge landing. The resulting pressure level that is transmitted through the barge would not be great enough to cause physiological impacts to fish. As a result, explosion at or near the water surface generated by the Falcon 9 First Stage during the contingency barge landing action may affect, but is not likely to adversely affect ESA-listed fish species: steelhead trout, green sturgeon and scalloped hammerhead shark and would not be significant.

Landing Noise

The Falcon 9 First Stage would generate landing noise up to 110 dB. This landing noise event would be of short duration (minutes) and exceptionally little sound is transmitted between the air-water interface (Godin 2008). Fish at or near the surface of the water would potentially experience behavioral disruption, but the sound levels transmitted into the water would be far below injury levels. Thus, in-air sound would not have a significant effect on ESA-listed fish species, which are submerged. As a result, landing noise generated by the Falcon 9 First Stage during the contingency landing action may affect, but is not likely to adversely affect ESA-listed fish species: steelhead trout, green sturgeon and scalloped hammerhead shark. Similarly, underwater noise generated by landing noise is not expected to have a significant impact on special status fish species.

Vessel Noise

Vessel noise has the potential to create in-water sound that could disturb ESA-listed fish species, which could result in short-term 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 general health or condition of individual fish, since fish can move away from the disturbance. Therefore, impacts from vessel noise would be temporary, infrequent, and localized and long-term consequences for individuals or the population are not expected. As a result, vessel noise in support of the Falcon 9 First Stage during the contingency landing action may affect, but is not likely to adversely affect ESA-listed fish species: steelhead trout, green sturgeon and scalloped hammerhead shark. Similarly, vessel noise is not expected to have a significant impact on special status fish species.

Expended Materials

Debris

As described above, SpaceX would remove the approximately 25 pieces of debris that are expected to remain floating after an unsuccessful barge landing. Denser debris that would not float on the surface is anticipated to sink relatively quickly and is composed of inert materials that would not affect water quality or bottom substrate. 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. Since the area that would be impacted by sinking debris is very small (0.17 ac. [0.000706 km^2]), the likelihood of adverse effects to special status fish species is very low. As a result, debris from an unsuccessful barge landing that enters the ocean environment approximately 31 mi. (50 km) from shore may affect, but is not likely to adversely affect ESA-listed fish species: steelhead trout, green sturgeon and scalloped hammerhead shark. Similarly, debris is not expected to have a significant impact on special status fish species.

Rocket Propellant

The maximum of 2,750 lbs. of RP-1 that would be released into the ocean as a result of an unsuccessful barge landing. RP-1 is a very light oil, which is highly volatile and would evaporate quickly (90 percent within first 7 minutes; 99 percent within first hour; Figure 4-2) when exposed to the air and would completely dissipate within 1–2 days after a spill in the water. In the event of adverse ocean conditions (e.g., large swells, large waves) and weather conditions (e.g., fog, rain, high winds) RP-1 would be volatilized more rapidly due to increased agitation and thus dissipate even more quickly. In addition, the ESA-listed fish species, steelhead 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. As discussed above, the probability of steelhead and scalloped hammerhead sharks being present at contingency landing location during a landing event would be very low, thus reducing likelihood of exposure even greater. As a result, spilled fuel from an unsuccessful barge landing that enters the ocean environment approximately 31 mi. (50 km) from shore may affect, but is not likely to adversely affect the ESA-listed fish species: steelhead trout, green sturgeon and scalloped hammerhead shark. Similarly, release of RP-1 is not expected to have a significant impact on other special status fish species.

Table 4-15. Potential Impacts to Special Status Non-Mammal Species Potentially Occurring within the Contingency Area.

Species	Status	Potential Impacts
Fish		
Steelhead trout *Oncorhynchus mykiss*	FE	Disturbance from debris, noise, vibration, & expended materials.
Green sturgeon Acipenser medirostris	FT	Disturbance from debris, noise, vibration, & expended materials.
Scalloped Hammerhead Shark *Sphyrna lewini*	FE	Disturbance from debris, noise, vibration, & expended materials.
Basking shark *Cetorhinus maximus*	SOC	Disturbance from debris, noise, vibration, & expended materials.
Bocaccio *Sebastes paucispinis*	SOC	Disturbance from debris, noise, vibration, & expended materials.
Cowcod *Sebastes levis*	SOC	Disturbance from debris, noise, vibration, & expended materials.
Reptiles		
Green sea turtle *Chelonia mydas*	FT/FE	Disturbance from debris, noise, vibration, & expended materials.
Hawksbill sea turtle *Eretmochelys imbricata*	FE	Disturbance from debris, noise, vibration, & expended materials.
Loggerhead sea turtle *Caretta caretta*	FE	Disturbance from debris, noise, vibration, & expended materials.
Olive ridley sea turtle *Lepidochelys olivacea*	FT/FE	Disturbance from debris, noise, vibration, & expended materials.
Leatherback sea turtle *Dermochelys coriacea*	FE	Disturbance from debris, noise, vibration, & expended materials.
Seabirds		
California Brown Pelican *Pelecanus occidentalis californicus*	FD	No Effect
Short Tailed Albatross *Phoebastria albatrus*	FE	No Effect
Marbled murrelet Brachyramphus marmoratus	FT	No Effect
Guadalupe Murrulet *Synthliboramphus hypoleucus*	FC	No Effect
Scripps's Murrelet *Synthliboramphus scrippsi*	FC	No Effect

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; SOC = Species of Concern.

4.3.1.6 Sensitive Marine Habitats

4.3.1.6.1 Essential Fish Habitat

An unsuccessful barge landing of the Falcon 9 First Stage may include the discharge of fuel. Adverse effects to EFH species and their prey associated with petroleum-based contaminants can range from acute toxicity at high levels of exposure to chronic sub-lethal toxicity. However, the first stage booster uses RP-1, characterized as a "Very Light Oil" that has a low viscosity, low specific gravity and is highly volatile. In addition, the anticipated amount of residual fuel during an unsuccessful landing attempt would be limited (i.e., 50-150 gallons) and would most likely be released onto the barge deck upon impact. In the event the first stage booster misses the barge entirely and the fuel is released into the ocean, the RP-1 would be expected to evaporate quickly and would completely dissipate within one to two days after a spill. Clean-up of very light oil spills are usually not possible, especially with such small quantities. Given the small quantity and composition of the fuel that may be released, any adverse impacts to EFH would be minimal.

An unsuccessful barge landing would result in a projectile range of up to 1,250 feet and the actual surface area potentially impacted with debris would be less than 114 ac. (0.46 km^2). Since the area that would be impacted by falling debris is relatively very small, the likelihood of large-scale impacts to the groundfish and pelagic species EFH is very low. A direct strike to a federally managed fish species from debris, though not impossible, is highly unlikely given the relatively small impact area and amount of debris.

The contingency landing area is approximately 31 mi. (50 km) offshore from the nearest kelp beds and estuary habitat (Figure 3-11) and any floating debris would be retrieved. As a result, there would be no impact to these HACPs. Debris that would sink is anticipated to sink relatively quickly and is composed of inert materials. The potential area of impact from sinking debris consists primarily of sandy substrate, which is not identified as a particularly sensitive habitat for federally managed fish species. However, there are a number of species managed under the Pacific Coast Groundfish Fishery Management Plan that utilize offshore unconsolidated benthic habitats for at least part of their life cycle (e.g., various rockfish, flatfish, and sharks/skates) for functions such as foraging or refuge. Introducing foreign material could reduce the functionality of those habitats. Marine debris, which can consist of a wide variety of manmade materials, is a growing concern due to the increasing number of species for which negative interactions with debris have been demonstrated (Smith and Edgar 2014). In addition, debris may settle in areas off the west coast that already have high concentrations, such as deep water habitat and waters south of 36°N (Keller et al. 2010). Although the debris associated with the Proposed Action is inert, it could still result in adverse impacts. For instance, marine debris could be ingested by or entangle marine organisms and alter the benthic invertebrate community (Katsanevakis et al. 2007). Marine debris can also become snagged on or damage sensitive habitats.

NOAA Fisheries concluded that, although one unsuccessful barge landing would not contribute substantially to marine debris, the contingency action could have an adverse effect on EFH for various federally managed fish species within the Pacific Coast Groundfish, Coastal Pelagic Species, and Highly Migratory Species Fisheries Management Plans as a result of the cumulative addition of marine debris to the seafloor after a number of unsuccessful landing attempts (Appendix E). Therefore, pursuant to section 305(b)(4)(A) of the Magnuson-Stevens Fishery Conservation and Management Act, NOAA Fisheries recommended VAFB develop an appropriate compensatory mitigation plan to avoid, minimize, mitigate, or otherwise offset the adverse effects to EFH. The USAF is developing an appropriate compensatory marine debris removal plan in coordination with NOAA Fisheries to offset these impacts. This plan involves the contribution to a marine debris removal program in the region.

4.3.1.6.2 Critical Habitat – Leatherback Sea Turtle

The contingency landing location of Alternative 1 is approximately 6.2 mi. (10 km) south of this Critical Habitat (Figure 3-12). The area of potential impact in the event of an explosion of the Falcon 9 First Stage is relatively small (114 ac. [0.46 km^2]) and would not reach into Critical Habitat. The contingency action is not anticipated to have any measurable impact on jellyfish, the primary food source for leatherback sea turtles. Since leatherback sea turtles do not breed or nest within the project area, Alternative 1 would have no impacts to breeding or nesting habitat for this species.

4.3.1.6.3 Marine Reserves

Channel Islands National Marine Sanctuary

The prohibitions of the CINMS do not apply to military activities carried out by the DoD, as of the effective date of the revised regulations and specifically identified in Section 3.5.9 of the CINMS FEIS, entitled “Department of Defense Activities” ("pre-existing activities") as indicated in Section 922.72(b)(1). Section 3.5.9.1 (VAFB) of the CINMS Final EIS describes spacelift operations originating from VAFB and potential sonic booms from these activities as “pre-existing activities” (NOAA Fisheries 2007). In addition, impacts to the CINMS would be temporary and we anticipate no significant impacts.

Vandenberg State Marine Reserve

A Memorandum of Understanding was established between the CDFW and VAFB. Within the VSMR, no take of living marine resources is permitted except take incidental to the mission critical activities of VAFB. Mission critical activities include, but are not limited to, all those activities that are important for the support and defense of U.S. launch, range, expeditionary, exercise, test, training and installation operations, including, but not limited to, space-launch vehicles. Impacts to marine resources within the VSMR would be limited to landing noise and sonic boom, which would be temporary. Therefore, we anticipate no significant impacts to the VSMR.

4.3.2 Alternative 2

Under Alternative 2, the landing pad at SLC-4W would not be constructed and landing would not occur at SLC-4W. Landing the Falcon 9 on a barge located approximately 320 mi. (515 km) offshore in the Pacific Ocean would have no impact to terrestrial biological resources since the boost-back trajectory, sonic boom, and landing noise would not impact land. In addition, since the landing location is 320 mi. (515 km) offshore, there would be no impact to EFH or Critical Habitat, since none exists in the area. The sonic boom and landing noise would also be sufficiently offshore so that there would be no impacts to marine reserves. As detailed in the Alternative 1 analysis for the offshore landing contingency options, there would not be significant impacts to marine mammals, sea turtles, sea birds, or ESA-listed fish species in the event of an unsuccessful barge landing attempt.

4.3.3 No Action Alternative

Under the No Action Alternative, no construction or alteration at SLC-4W would occur. Therefore, we expect no additional impacts to biological resources under the No Action Alternative.

4.4 Water Resources

Impacts to jurisdictional Waters of the U.S. and wetlands are considered significant if the project would result in a net loss of wetland area or habitat value, either through direct or indirect impacts to wetland vegetation, loss of habitat for wildlife, degradation of water quality, or alterations in hydrological function.

4.4.1 Alternative 1 (Proposed Action)

4.4.1.1 Surface Water

Surface water resources in the vicinity of SLC-4W include Spring Canyon Creek and the Pacific Ocean. Construction of the landing pad under the Proposed Action would remove vegetation, expose soils, and has the potential for releases of hazardous materials and wastes because work with heavy machinery is being conducted in the vicinity of Spring Canyon Creek and the Pacific Ocean; therefore, surface water may be potentially impacted without proper implementation of adequate EPMs. A v-ditch surrounding the pad would convey storm water to an existing infiltration basin designed to meet the NPDES Construction General Permit, Post Construction Storm Water Standards or Energy Independence and Security Act of 2007 Section 438. Wastewater from a potential spill or firefighting measures would be contained and disposed of per the NPDES Industrial General Permit and would not enter the infiltration basin. 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 this EA) would reduce or eliminate the potential for contaminated runoff. EPMs that would be implemented per the NPDES Construction General Permit are described in detail the Section 2.2.4.12 (Water Resources) and EPMs described under Section 2.2.4.8 (Geology and Earth Resources) would help protect surface water resources. These EPMs include BMPs designed to properly manage materials while on-site, especially during the rainy season, prevent and reduce the risk of spills, and minimize the potential for erosion.

In the event of an explosion of the Falcon 9 First Stage resulting from an unsuccessful barge landing surface water quality may be affected by expended materials. However, SpaceX would recover all floading pieces of debris. Denser debris that would not float on the surface is anticipated to sink relatively quickly and is composed of inert materials that would not affect water quality. In the event of an unsuccessful barge landing, between 50 and 150 gallons of residual RP-1 may be released into the ocean. RP-1, is a Type 1 “Very Light Oil”, which is characterized as having low viscosity, low specific gravity, and highly volatile (USFWS 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 an unsuccessful barge landing (USFWS 1998). Therefore, no attempt would be made to boom nor recover RP-1 fuel from the ocean. Since RP-1 is lighter than water and almost completely immiscible (i.e. very little will dissolve into the water column), RP-1 would stay on top of the water surface. Due to its low viscosity, it would rapidly spread into a very thin layer (several hundred nanometers) on the surface of water and would continue to spread as a function of sea surface, wind, current, and wave conditions. This spreading rapidly reduces the concentration of RP-1 on the water surface at any one location and exposes more surface area of the fuel to the atmosphere, thus increasing the amount of RP-1 that is able to evaporate. Although it would require one to two days for the RP-1 to completely dissipate, over 90% of its mass would evaporate within the first seven minutes and 99% of its mass would evaporate within the first hour (see Section 4.3.1.4.3, Contingency Barge Landing, Expended Materials and Fluids). In the event of adverse ocean conditions (e.g., large swells, large waves) and weather conditions (e.g., fog, rain, high winds) RP-1 would be volatilized more rapidly due to increased agitation and thus dissipate even more quickly and further reduce the likelihood of exposure.

Therefore, we anticipate no significant impacts to surface water resulting from the Proposed Action.

4.4.1.2 Groundwater

SLC-4W is located on the southern margin of the Santa Ynez River groundwater basin/Lompoc Terrace sub-basin. Groundwater at the site is unconfined and restricted to the unconsolidated material immediately above Sisquoc Formation bedrock. As noted in Section 3.4.3 (Groundwater), groundwater is typically found approximately 50–140 ft. below ground surface. Construction of the landing pad at SLC-4W would not require footings or foundations at this depth, therefore direct interaction with groundwater is unlikely. In addition, proper management of materials and wastes (as described in Sections 4.8, Hazardous Materials and Waste Management, and 4.9, Solid Waste Management, of this EA) would reduce or eliminate the potential for contaminated runoff that could infiltrate groundwater. EPMs that would be implemented per the NPDES Construction General Permit and those described under Section 2.2.4.8 (Geology and Earth Resources) would further help protect groundwater resources. Therefore, we anticipate no significant impacts to groundwater resulting from the Proposed Action.

4.4.1.3 Wetlands and Waters of the United States

There are no jurisdictional Waters of the U.S. or wetlands within the area subject to physical impacts under the Proposed Action. The nearest wetland habitat to SLC-4W is Spring Canyon Creek, approximately 0.08 mi. (0.13 km) to the south of SLC-4W. This habitat has not been delineated. 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 this EA) would reduce or eliminate the potential for contaminated runoff into nearby Waters of the U.S. and Wetlands. EPMs that would be implemented per the NPDES Construction General Permit and are described in detail the Section 2.2.4.12 (Water Resources) and EPMs described under Section 2.2.4.8 (Geology and Earth Resources) would help protect these resources. These EPMs include BMPs designed to properly manage materials while on-site, especially during the rainy season, prevent and reduce the risk of spills, and minimize the potential for erosion. The contingency landing location is 31 mi. (50 km) offshore of VAFB, outside of the boundary for territorial seas (Waters of the U.S.), which only extend 13.8 mi. (22.2 km) offshore. Therefore, the Proposed Action and contingency action would have no effect on Waters of the U.S or jurisdictional wetlands.

4.4.2 Alternative 2

Under the Alternative Action, the concrete landing pad at SLC-4W would not be constructed and the Falcon 9 First Stage would land on a barge situated approximately 320 mi. (515 km) offshore, outside of territorial seas (Waters of the U.S.), which only extend 13.8 mi. (22.2 km) from the coast. Therefore, Alternative 2 would have no effect on surface waters, groundwater, Waters of the U.S., or wetlands since the location would be over the ocean and beyond the jurisdictional boundary for Waters of the U.S. and wetlands considerations are not applicable at sea.

4.4.3 No Action Alternative

Under the No-Action Alternative, the concrete landing pad and SLC-4W would not be constructed and the boost-back and landing of the Falcon 9 First Stage would not occur. Therefore, the No Action Alternative would have no additional impacts on surface water, groundwater, Waters of the U.S., or wetlands.

4.5 Cultural Resources

Factors considered in determining whether implementing an alternative may result in significant adverse impacts on cultural resources include the extent or degree to which implementation of an alternative would result in:

- The permanent loss of a significant cultural resource or the loss of a value or characteristic that qualify a historic resource for listing on the NRHP; or
- Substantially alter the natural environment or access to it in such a way that traditional cultural or religious activities were restricted.

Effects to cultural resources would be considered adverse if they resulted in disturbance or loss of value or data that qualify a site for listing in the NRHP; if there is substantial disturbance or loss of data from newly discovered properties or features prior to their recordation, evaluation and possible treatment; or if the project substantially changes the natural environment or access to it such that the practice of traditional cultural or religious activities would be restricted. For known cultural resource sites, rerouting or redesigning to avoid impacts is typically the recommended option. If rerouting or redesigning is not possible, subsurface testing is usually recommended to determine a site's value or data potentials relative to the NRHP, to assess possible adverse project effects, and to establish the physical relationship of site boundaries with the Area of Potential Effects (APE). In addition, 30 CES/CEIEA requires archaeological monitoring during construction through or adjacent to any known site, regardless of a site's NRHP eligibility. Archaeological monitoring is also typically required in areas where buried sites are possible (USAF 2005b).

4.5.1 Alternative 1 (Proposed Action)

Archaeological site complex CA-SBA-537/1816 extends into SLC-4W and isolated artifact VAFB-ISO-962 is recorded within the launch complex. The isolated artifact was found in a disturbed context and represents a secondary deposit. Isolated artifacts have no regulatory status and management of VAFB-ISO-962 is not necessary.

Both CA-SBA-537 and -1816 were formally determined eligible for the NRHP by the USAF in the late 1980s, and the SHPO concurred with that determination. Extensive data recovery excavations were completed at the sites in conjunction with repairs and restoration of SLC-4. Subsurface testing at CA-SBA-537/1816 within the launch complex found it not only of poor integrity, but also the portion of the site within the launch complex was manifest as a low-density and low diversity deposit (Lebow et al. 2005).

Further study related to construction of the new landing pad that was performed and indicated that the portion of CA-SBA-537/1816 within SLC-4W lacks the qualities that make it eligible for the NRHP. Consequently, the site complex would not be adversely affected by the implementation of Alternative 1. VAFB has received concurrence from the California SHPO regarding a determination of no adverse effects. The Proposed Action would not have a significant impact on cultural resources (Appendix C).

Per 36 C.F.R. 800.3, VAFB carried out Section 106 consultation with Sam Cohen of the SYBCI, who is the tribal chairman's appointee to VAFB for Section 106 consultations, and Mr. Freddie Romero, who is the elder's council appointee for Section 106 consultations. As the SYBCI is a federally recognized tribe, this also constitutes government-to-government consultation. The 30 SW Commander appointed Christopher Ryan (30 CES/CEIEA) as the ITLO. The SYBCI was notified of the Proposed Action in an e-mail dated 14 October 2014 requesting tribal comments on the Proposed Action and initiating government-to-government consultation (Appendix F). SYBCI responded on 28 July 2015 indicating that there were no concerns with the Proposed Action (Appendix F).

The boost-back and landing of the Falcon 9 First Stage at SLC-4W, or on a barge under the contingency action, would not result in impacts to cultural resources at VAFB or elsewhere. Cultural resource sites would not be disturbed as a result of landing the First Stage at the landing pad at SLC-4W or 31 mi. (50 km) offshore under the contingency action.

4.5.2 Alternative 2

Under the Alternative Action, no construction or alteration at SLC-4W would occur. The First Stage would land on and be secured to the barge and transported to the Long Beach Harbor for offloading and transport back to SLC-4W. Therefore, no impacts to cultural resources would be expected under Alternative 2.

4.5.3 No Action Alternative

Under the No Action Alternative, no construction or alteration at SLC-4W would occur. Therefore, we expect no additional impacts to cultural resources under the No Action Alternative.

4.6 Geology and Earth Resources

Impacts would be considered potentially significant if the project were to result in substantially increased erosion, landslides, soil creep, mudslides, and unstable slopes. Impacts would also be considered significant if they were to increase the likelihood of or result in exposure to earthquake damage, slope failure, foundation instability, land subsidence, or other severe geologic hazards. Geologic impacts may also be considered significant if they were to result in the loss of the use of soil for agriculture or habitat, the loss of aesthetic value from a unique landform, or the loss of mineral resources.

4.6.1 Alternative 1 (Proposed Action)

4.6.1.1 Soil and Erosion

Activities with the potential to impact geology and soils would be associated with the construction of the landing pad and the realignment and widening of the existing roadways. Vegetation would be removed in areas to lay down concrete/asphalt and grade for stormwater control.

Project activities could disturb up to 3 ac. (0.01 km^2) of land. Due to the realignment and amount of disturbed land, coverage under the NPDES Construction General Permit is required. As a result, the USAF must prepare a SWPPP. The SWPPP would include erosion control measures. In addition, BMPs would be implemented during ground-disturbing activities and the EPMs detailed in Section 2.2.4.8 (Geology and Earth Resources) would be implemented. As a result, we expect no long-term or significant impacts from Alternative 1.

4.6.1.2 Seismicity

The project site is not underlain by any mapped active faults and the project does not include development of any new permanent structures beyond the concrete pad and road realignment. Although active faults located within the region could result in strong seismically induced ground shaking, the potential for surface fault rupture and liquefaction at the project site is low. Therefore, we expect adverse impacts associated with seismically-induced ground shaking would not occur and the boost-back and landing would not have any impacts on seismicity.

4.6.1.3 Contingency Barge Landing

Under the contingency action, no additional construction or alteration activities at SLC-4W would occur. The first contingency action involves the First Stage landing on a barge 31 mi. (50 km) west of VAFB and transported to the Long Beach Harbor for offloading and transport back to SLC-4W. For an unsuccessful barge landing, all recovered debris would be transported to the Long Beach Harbor for offloading. Therefore, we expect no impacts to soil and erosion or seismicity would occur under the contingency action.

4.6.2 Alternative 2

Under the Alternative Action, no construction or alteration at SLC-4W would occur. The First Stage would land on and be secured to the barge and transported to the Long Beach Harbor for offloading and transport back to SLC-4W. Therefore, we expect no impacts to soil and erosion or seismicity would occur under Alternative 2.

4.6.3 No Action Alternative

Under the No Action Alternative, no construction or alteration at SLC-4W would occur. Therefore, we expect no additional impacts to soil and erosion or seismicity would occur under the No Action Alternative.

4.7 Human Health and Safety

An impact to Human Health and Safety would be considered significant if it were to create a potential public health hazard or to involve the improper use, production, or disposal of materials that pose a hazard to people in the affected area. An impact would also be considered significant if project activities were to pose a serious risk of fire, especially wildland fires, or were to involve potential obstruction of emergency response or evacuation routes in and around the project area.

4.7.1 Alternative 1 (Proposed Action)

4.7.1.1 SLC-4W Infrastructure Improvements

Construction of the concrete landing pad could result in the exposure of construction workers to hazards associated with construction activities. These hazards include the potential for trips, slips, falls, and vehicular accidents. There is also potential for biological hazards such as spider and snake bites, disease vectors, and attack from wild animals. Because the above conditions, potential exists for persons participating in the construction and grading activities to become exposed to hazardous materials and hazardous waste. To minimize potential adverse impacts from biological hazards and physical hazards (such as from rocky and slippery surfaces), awareness training would be incorporated into the worker health and safety protocol. Contractors would be required to develop a site specific safety plan that would address these potential hazards. Daily safety briefings would be conducted and workers would be expected to comply with federal OSHA and Air Force Occupational and Environmental Safety regulations. While adhering to these procedures, no impacts to Safety and Occupational Health would be expected. As described in Section 4.2 (Sound [Airborne]), the Proposed Action would have no significant impacts to Human Health and Safety associated with noise.

SpaceX would coordinate with 30 SW/SEW to insure VAFB policies on UXO safety for construction work is incorporated into the site safety plan. The safety program would include coordination with the AFCEC/CZO MMRP manager and contact with the weapons safety specialist for 30 SW/SEW. SpaceX would continue to implement Land Use Control Procedures, as documented in the VAFB General Plan (USAF 2014a). Therefore, we expect no significant impacts to Human Health and Safety would occur.

4.7.1.2 Boost-Back and Landing at SLC-4W and Contingency Barge Landing

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. Existing procedures for offloading fuels exist and adherence would be expected of all applicable personnel. 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.

With adherence to existing procedures for offloading propellants and the restrictions already in place for launch operations, and with SpaceX and subcontractors compliance with current OSHA regulations, we expect no impacts to Human Health and Safety from implementation of Alternative 1.

To minimize potential adverse impacts to Human Health and Safety, all safety precautions for SLC-4W Operations and evacuation procedures for the project site would be followed per Space Launch Vehicle Flight Hazard Zone requirements. SpaceX and Subcontractors would comply with federal OSHA regulations, and a U.S. Coast Guard COI would be completed before the barge landing. The U.S. Coast Guard would also be coordinated to oversee the day of landing operations for the barge landing. With these safety precautions in place, we expect no impacts to Human Health and Safety from implementation of the Contingency Action under Alternative 1.

4.7.1.3 Autonomous Flight Safety System

The AFSS must meet the same stringent requirements of any human-based FTS currently used on VAFB. The requirements for AFSS are specified in the Range Commanders Council 319-07 Flight Termination Systems Commonality Standard. The AFSS criteria would be configured prior to launch per specific “mission rules” established by the 30 SW/SE to protect Human Health and Safety. With these safety precautions in place, we expect no impacts to Human Health and Safety from implementation of the AFSS for Falcon 9 launch or boost-back and landing. In addition, this GPS-based system would enable very accurate tracking information and decrease response time as compared to the current FTS.

4.7.2 Alternative 2

The impacts to Human Health and Safety from the boost-back and landing of the Falcon 9 First Stage on the barge and transporting it to the Long Beach Harbor for offloading and transport back to SLC-4W, are anticipated to be similar to impacts of landing the First Stage at SLC-4W. Personnel would be expected to maintain adherence to OSHA regulations and SpaceX’s Hazardous Materials Emergency Response Plan. However, there would be no new construction, and therefore none of the impacts to Human Health and Safety from construction activities would occur. With adherence to existing safety protocols for transport of hazardous materials, we expect no impacts to Human Health and Safety would occur from implementation of Alternative 2.

4.7.3 No Action Alternative

Under the No Action Alternative the landing pad construction at SLC-4W and the boost-back and landing of the Falcon 9 First Stage would not occur, and we expect no additional impacts to Human Health and Safety from implementation of the No Action Alternative.

4.8 Hazardous Materials and Waste Management

An impact involving hazardous materials and hazardous waste would be considered significant if their transport, use, or disposal were to pose a serious hazard to the public or the environment. Issues include the potential for accidents to release hazardous materials, emissions of hazardous materials especially within one-quarter mile of a school, and violation of any associated federal, California, or Santa Barbara County regulation or applicable permit condition.

4.8.1 Alternative 1 (Proposed Action)

4.8.1.1 Hazardous Materials

Compliance with all applicable federal, state, and local laws and regulations, and applicable VAFB plans, would govern all actions associated with implementing the Proposed Action, and should minimize the potential for significant impacts.

The use of hazardous materials during construction would be limited to vehicle maintenance (fuels, oils, and lubricants). Such materials would be required to be properly contained, manifested, and managed per all federal, state, and local regulations, AFIs, and DoD directives, and the site specific health and safety plan. Authorization from the VAFB Environmental Element would need to be acquired before use of hazardous materials. Impacts to hazardous materials for the boost-back and landing would include propellant, ordnance, and chemicals.

A site specific spill plan would be developed and spills would be quickly contained onsite consistent with existing procedures. At VAFB, hazardous materials are managed per federal and state regulations, contract specific requirements, and the VAFB Hazardous Materials Management Plan, 30 Space Wing Plan (30 SWP) 32-7086.

With adherence to existing policies and procedures as outlined in the applicable federal, state, and local regulations, as well as the EPMs described in Chapter 2 (Description of the Proposed Action and Alternatives), we expect no impacts to hazardous materials would occur.

4.8.1.2 Hazardous Waste

Hazardous waste generated from the Proposed Action would be handled and disposed of in strict adherence with the requirements of the procedures outlined in VAFB Hazardous Waste Management Plan, 30 SWP 32-7043, state, federal, DoD, and contract-specific requirements. Although propellants would be burned to depletion during flight, there is a potential for approximately 7,000 lbs. of LOX and a maximum of 2,750 lbs. of RP-1 to remain in the Falcon 9 First Stage upon landing. Final volumes of fuel remaining in the First Stage upon landing may vary. 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.

In the unlikely event that the FireX system is initiated, the water would be contained and tested to determine whether it is hazardous. If it is confirmed to have hazardous characteristics, it would be disposed of consistent with the above requirements.

Per existing policies and procedures as outlined in the applicable federal, state, and local regulations, as well as the EPMs described in Chapter 2 (Description of the Proposed Action and Alternatives), we expect no impacts to hazardous wastes would occur.

4.8.1.3 Environmental Restoration Program

Construction of the concrete landing pad at SLC-4W would occur within the ERP Sites 8 and 9 (Figure 3-15), in an area that has previously been remediated. Additionally, the contaminants were in the groundwater, rather than the soil, and construction activities will not excavate enough soils to reach groundwater levels. Regardless, 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.

4.8.1.4 Contingency Barge Landing

The first contingency action involves the First Stage landing on a barge 31 mi. (50 km) west of VAFB and transported to the Long Beach Harbor for offloading and transport back to SLC-4W. All recovered debris would be transported to the Long Beach Harbor for offloading.

If a barge landing occurs, hazardous materials and waste would be off-loaded after the barge returns the First Stage to Long Beach Harbor. Hazardous waste would be disposed of per existing policies and procedures as outlined in the applicable federal, state, and local regulations, as well the EPMs as described in Chapter 2 (Description of the Proposed Action and Alternatives). For an unsuccessful barge landing, most material would sink. The items that would be recovered would be transported to Long Beach Harbor and any remaining hazardous waste would be disposed of per existing policies and procedures as outlined in the applicable federal, state, and local regulations, as well the EPMs as described in Chapter 2 (Description of the Proposed Action and Alternatives). As a result, we expect no impacts to hazardous materials and wastes would occur under the contingency action.

4.8.2 Alternative 2

Under the Alternative Action, the construction of the landing pad and associated improvements would not occur. The boost-back and landing would occur on a barge located offshore and would be transported to the Long Beach Harbor for offloading and transport back to SLC-4W. Hazardous materials and ordnance would be offloaded from the first state after the barge is docked in Long Beach Harbor.

Per existing policies and procedures as outlined in the applicable federal, state, and local regulations, as well the EPMs as described in Chapter 2 (Description of the Proposed Action and Alternatives), we expect no impacts to hazardous materials and wastes would occur.

4.8.3 No Action Alternative

Under the No-Action Alternative, the concrete landing pad and boost-back and landing would not occur. Therefore, no additional waste would be generated, SLC-4W would remain within acceptable limits, and there would be no impacts on hazardous materials and hazardous waste management.

4.9 Solid Waste Management

Solid waste impacts are evaluated using federal, state, and local laws and regulations, permit conditions, and contract specifications. Adverse impacts would occur from noncompliance with applicable regulatory requirements or an increase in the amount of waste disposal that would exceed available waste management capacities.

4.9.1 Alternative 1 (Proposed Action)

Construction and landing operations associated with the Proposed Action would create pollution in the air and water and would generate hazardous and solid waste. Non-compliance with applicable regulatory requirements or disposal of quantities of solid waste that would cause the proposed project not to meet mandated diversion rates would be considered an adverse impact. Debris from any activities would be segregated to facilitate subsequent pollution prevention options. Pollution prevention options would be exercised in the following order: reuse of materials, recycling of materials, and then regulatory compliant disposal.

Solid waste generated during construction would include packaging from materials (cardboard and plastic), scrap rebar, wood, pipes, and wiring, and miscellaneous waste generated by onsite construction workers. Contractors would be responsible for the disposal or recycling of all waste generated during the scope of the project.

All soil excavated during construction activities would be used as backfill, and any excess materials would be spread throughout the site. Construction debris, along with green waste, used tires and other recyclable materials, would be segregated and diverted for reclamation. All green waste would be disposed of at an appropriate facility. The contractor would meet the applicable state or local diversion requirements in effect at the time of actual disposal.

Under the Proposed Action, solid waste would be minimized by strict compliance with VAFB's Integrated Solid Waste Management Plan. All materials that are disposed of off-base would be reported to the 30 CES/CEA Solid Waste Manager. Additionally, any materials recycled on-base by processes other than the base landfill, would be reported to the 30 CES/CEA Solid Waste Manager at least quarterly, with copies of weight tickets and receipts provided. Compliance with all applicable federal, state, and local laws and regulations would govern all actions associated with implementing the Proposed Action and minimize the potential for adverse effects. Therefore, we expect no significant adverse impacts to solid waste management as a result of SLC-4W infrastructure improvements or the boost-back and landing at SLC-4W under Alternative 1.

For a contingency barge landing, the First Stage would be secured to the barge and transported to the Long Beach Harbor for offloading and transport back to SLC-4W. Through prior experience, SpaceX has discovered that approximately 25 pieces of debris would remain floating after an unsuccessful barge landing and resulting explosion of the First Stage. All other debris sinks to the bottom of the ocean. The 25 pieces of floating debris are made primarily of Carbon over Pressure Vessels, the LOX fill line, and carbon fiber constructed landing legs. SpaceX would recover of all of these floating items and transport them back to Long Beach Harbor for offloading and transport back to SLC-4W.

Compliance with all applicable federal, state, and local laws and regulations would govern all actions associated with implementing the Contingency Action and minimize the potential for adverse effects. Therefore, we expect no significant adverse impacts to solid waste management due to the Contingency Action under Alternative 1.

4.9.2 Alternative 2

Under this alternative, the construction of a landing pad at SLC-4W would not occur. Therefore, there would be no solid waste from construction. The First Stage would be secured onto the barge and transported to the Long Beach Harbor for offloading and transport back to SLC-4W. Hazardous materials and ordnance would be offloaded from the First Stage after the barge is docked in Long Beach Harbor. Non-compliance with applicable regulatory requirements or disposal of quantities of solid waste that would cause the proposed project not to meet mandated diversion rates would be considered an adverse impact. Debris from any activities would be segregated to facilitate subsequent pollution prevention options.

Compliance with all applicable federal, state, and local laws and regulations would govern all actions associated with implementing the Alternative Action and minimize the potential for adverse effects. Therefore, we expect no significant adverse impacts to solid waste management under Alternative 2.

4.9.3 No Action Alternative

Under the No Action Alternative the landing pad construction at SLC-4W and the boost-back and landing of the Falcon 9 First Stage would not occur. Therefore, no additional waste would be generated, SLC-4W would remain within acceptable limits, and we expect no impacts to solid waste management would occur.

4.10 Land Use and Aesthetics

An impact on Land Use and Aesthetics would be considered significant if a project were to conflict with the designated land uses for the project area within the VAFB General Plan (USAF 2014a) or were inconsistent with CZMA policies that protect the visual aesthetics and scenic beauty of the coastal landscape (see Section 3.11, Coastal Zone Management).

4.10.1 Alternative 1 (Proposed Action)

Land use at the proposed project site is currently classified as Launch Operations. Therefore, implementation of the Proposed Action would not conflict with this designation. The Proposed Action would be consistent with existing land use at the project site and would not result in a change to land use or be incompatible with adjacent land uses, such as agricultural land. As no prime agricultural land is present within the immediate vicinity of the Proposed Action, none would be impacted. The existing plans or stated goals of VAFB would not be in conflict with the Proposed Action.

Because the SLC-4W launch complex is already visible from Coast Road and from passing trains, any additional structural modifications or additions within the present limits of the facility due to construction activities, would not alter the existing industrial character of the site. The Proposed Action final product would also be horizontal in nature, and therefore would not be visible from the Coast Road or passing trains. Therefore, we expect impacts to Land Use and Aesthetics would not occur.

Because the barge landing location is at least 31 mi. (50 km) offshore, it would not visible from the coast. In addition, there are no construction activities proposed under the Contingency Action. Therefore, we expect impacts to Land Use and Aesthetics would not occur due to the Contingency Action under Alternative 1.

4.10.2 Alternative 2

Under the Alternative Action, no construction or alteration of SLC-4W would occur. The First Stage would land on and be secured to the barge and transported to the Long Beach Harbor for offloading and transport back to SLC-4W. Therefore, we expect no impacts to Land Use and Aesthetics.

4.10.3 No Action Alternative

Under the No Action Alternative the landing pad construction at SLC-4W and the boost-back and landing of the Falcon 9 First Stage would not occur, and we expect no additional impacts to land use and aesthetics.

4.11 Coastal Zone Management

An impact on coastal resources would be considered significant if a project were inconsistent with the enforceable policies of the CCA of 1972.

4.11.1 Alternative 1 (Proposed Action)

4.11.1.1 SLC-4W Infrastructure Improvements

As required under the CZMA and the CCA of 1972, coordination with the CCC is required for development within the California Coastal Zone of for actions that may impact resources within the Coastal Zone. The location of the Proposed Action at SLC-4W is not within California Coastal Zone and the USAF, however may impact resources within the Coastal Zone. In cooperation with SpaceX, VAFB is responsible for submitting either a Coastal Zone Consistency Determination or an ND.

The proposed construction of the landing pad at SLC-4W is not anticipated to adversely impact the scenic and visual qualities of the coastal area. Construction of the pad would also not affect marine resources, including environmentally sensitive habitat areas, recreational boating use, or agricultural resources, because none of these coastal resources would occur at the proposed construction site. The potential effects on environmentally sensitive terrestrial habitats are expected to be minimal and less than significant (see Section 4.3, Biological Resources). The CCC issued concurrence with a ND (ND-0035-14; Appendix B) on 13 October 2014 that the construction of the landing pad at SLC-4W would not generate new or additional adverse impacts on coastal resources.

4.11.1.2 Boost-Back and Landing at SLC-4W

During descent of the First Stage, a sonic boom would be generated while the booster is supersonic. The overpressure would be directed at the ocean and would reach as high as 2.0 psf. The boom contours are shown in Figure 2-4. The majority of the boom occurs over the ocean. We expect the potential effects on marine resources and environmentally sensitive terrestrial habitats to be minimal and less than significant (see Section 4.3, Biological Resources).

Access to the coast at Wall and Surf Beaches would already be restricted during launches of the Falcon 9 due to security. The addition of the boost-back and landing procedure would not significantly lengthen the closure period. At program maturity, up to six launches per year may occur, with coastal access restricted for a short period of time (5 to 8 hours total). We anticipate no adverse effects to the coastal zone, as defined by the CZMA and CCA.

4.11.1.3 Contingency Barge Landing

The barge landing site would be at least 29 mi. (47 km) beyond the 3 nm seaward limit of the California Coastal Zone and would not affect the scenic and visual qualities of coastal areas; terrestrial resources, including environmentally sensitive habitat areas; or agricultural resources. The U.S. Coast Guard would issue a Local Notice to Mariners that defines a Public Ship Avoidance Area around the contingency landing location.

Potential effects to nearshore marine resources at VAFB, such as haul-out sites for pinnipeds, would not occur, because noise from the First Stage barge landing, including the sonic boom, would not extend to the shoreline of VAFB (see Section 4.3.1.4, Species Protected Under the Marine Mammal Protection Act). Haul-out and pupping sites for pinnipeds on San Miguel Island, Santa Rosa Island, and Santa Cruz Island would be exposed to a maximum 0.2 psf sonic boom, the lowest pressure level predicted for the offshore landing site (Figure 2-10). Anticipated effects on hauled-out pinnipeds would be minor, temporary behavioral effects, as described in Section 4.3.1.4 (Species Protected Under the Marine Mammal Protection Act).

Recreational boating within the coastal zone would only be temporarily delayed during transit of the barge, tug, and support vessel if recreational vessels were encountered. The three vessels would operate within established shipping and boating routes within the coastal zone while in route between the landing site and Long Beach Harbor. In the event of an encounter with a recreational vessel, standard rules of navigation and right-of-way would be followed, and at most, the recreational vessel would be temporarily delayed as the barge, tug, and support vessel transit through the area.

In the event of an unsuccessful landing attempt, the First Stage would explode upon impact with the barge. A debris impact analysis showed that the likelihood of debris striking individual marine mammals was negligible (Table 4-12). The noise resulting from explosion is likely to result in behavioral disruption to some marine mammal species in the exposure zone and SpaceX has applied for an IHA to authorize Level B harassment for these activities.

As described in Section 2.2.3.1.2 (For an Unsuccessful Barge Landing Attempt) at most 2,750 lbs. of RP-1 (or fuel) would be on board at the time of touch-down. Most of this fuel would be consumed during the subsequent explosion; residual fuel would be released onto the barge deck at the location of impact. In cases where the First Stage booster misses the barge entirely, SpaceX's scientists assume that 2,750 lbs. of RP-1 would be released into the ocean. In addition, approximately 25 pieces of floating debris would be present after a First Stage explosion, which SpaceX would remove promptly. The U.S. Coast Guard would keep the Public Ship Avoidance Area in place until all floating debris is removed from the water, typically several hours.

Very light oils, including RP-1, are highly volatile, which means they evaporate quickly when exposed to the air, and are usually completely dissipated within one to two days after a spill. Clean-up following a spill is usually not necessary, or possible, with spills of very light oil, particularly with such a small quantity of oil (USFWS 1998). Therefore, no attempt would be made to boom or recover RP-1, if any of the fuel is released directly into the ocean. Any RP-1 remaining on the barge deck from an unsuccessful landing attempt would be recovered, contained, and handled per federal, state, and local agency requirements. Given a spill would only occur following an explosion, it is unlikely that marine mammals, seabirds, sea turtles, and fish would remain in the immediate area and be subjected to any spill. Avoidance as a behavioral reaction would not be expected to have long-term effects and would therefore not be present when an animal returned to the coastal zone. Any release of RP-1 into the ocean no less than 31 mi. (50 km) from shore would not affect the California Coastal Zone since the spill should evaporate before reaching the coastal zone. Therefore, we anticipate no adverse effects to the coastal zone or coastal resources, as defined by the CZMA and CCA.

4.11.1.4 California Coastal Commission Concurrence

The USAF submitted an ND for both the construction of a concrete landing pad and the boost-back and landing of the Falcon 9 First Stage launch vehicle at SLC-4W to the CCC for review. The USAF also submitted a separate ND for the boost-back and landing of the Falcon 9 First Stage at the contingency landing location. The CCC concurred with both ND's, which found that the Proposed Action would not adversely affect coastal zone resources (ND-0035-14 and ND-0027-15; Appendix B). These findings are made pursuant to 15 C.F.R. 930.35 of NOAA implementing regulations.

4.11.2 Alternative 2

Under Alternative 2, the concrete landing pad at SLC-4W would not be constructed and the Falcon 9 First Stage would land on a barge 320 mi. (515 km) off the coast in the Pacific Ocean. The proposed landing site is well beyond the three nm seaward limit of the California Coastal Zone. Therefore, there would be no impacts to the coastal zone, as defined by the CZMA and CCA.

4.11.3 No Action Alternative

Under the No Action Alternative, the concrete landing pad at SLC-4W would not be constructed and the boost-back and landing of the Falcon 9 First Stage would not occur. Therefore, there would be no additional impacts to the coastal zone, as defined by the CZMA and CCA.

4.12 Transportation

Impacts to transportation resources would be considered significant if:

- A primary roadway could no longer service the traffic demands of that roadway;
- The project access to a primary or local road would require access that would create an unsafe situation or a new traffic signal or major revisions to an existing traffic signal; or
- The project adds traffic to a roadway that has limiting design features or receives use that would be incompatible with substantial increases in traffic, which would become potential safety problems with the addition of project or cumulative traffic. Limiting design features include, but are not limited to narrow width, roadside ditches, sharp curves, poor sight distance, and inadequate pavement structure. Some examples of a roadway receiving incompatible use are large number of heavy trucks on rural roads used by farm equipment, livestock, horseback riding, or on residential roads with heavy pedestrian or recreational use.

4.12.1 Alternative 1 (Proposed Action)

During construction activities at SLC-4W, increases to traffic would occur as a result of commuting by construction workers and the trucks transporting materials and equipment for activities associated with the construction of the landing pad and road expansion. The slight increase in daily truck traffic anticipated under the Proposed Action would not result in adverse impacts to the road capacity in and around VAFB. No new access would be required under Alternative 1, and we anticipate no unsafe roadways conditions.

The transportation of the First Stage from Long Beach Harbor after the barge landing under the first contingency action would involve additional vehicles being operated between the Long Beach Harbor and VAFB. However, this increase in vehicle traffic, which could occur up to six times a year, would not result in adverse impacts to road capacity.

Per existing policies and procedures as outlined in the applicable federal, state, and local regulations, as well as EPMs described in Chapter 2 (Description of Proposed Action and

Alternatives), we expect no significant impacts to transportation would occur as a result of implementation of Alternative 1.

4.12.2 Alternative 2

Under Alternative 2, the construction of the landing pad and associated improvements would not occur. The boost-back and landing of the Falcon 9 First Stage would occur on a barge located offshore and would be transported to the Long Beach Harbor for offloading and transport back to SLC-4W. The transportation of the First Stage from Long Beach Harbor would involve additional vehicles being operated between the Long Beach Harbor and VAFB. However, this increase in vehicle traffic, which could occur up to six times a year, would not result in adverse impacts to road capacity.

Per existing policies and procedures as outlined in the applicable federal, state, and local regulations, as well as EPMs described in Chapter 2 (Description of Proposed Action and Alternatives), under Alternative 2, we expect no significant impacts to transportation would occur.

4.12.3 No Action Alternative

Under the No-Action Alternative, the concrete landing pad and boost-back and landing of the Falcon 9 First Stage would not occur. Therefore, there would be no additional impacts on transportation.

4.13 Department of Transportation Act Section 4(f) Properties

4.13.1 Alternative 1 (Proposed Action)

Construction of the landing pad and associated infrastructure would not result in restricted access to any Section 4(f) property. As discussed in Section 4.2.2.1, 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-4W. Construction noise would be intermittent and last approximately 90 to 120 days. Construction of the landing pad would not result in a use of any 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 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 six times during the year. The closure 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 (6 to 8 hours). There would be no additional closures when landings would occur at the contingency landing site.

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 six landings per year and the closures would be of short duration. Therefore, the Proposed Action would not be considered a constructive use of these Section 4(f) properties and thus would not invoke Section 4(f) of the DOT Act. This means that the FAA does not need to undertake a Section 4(f) Evaluation or determine whether the impacts are *de minimis.*

4.13.2 Alternative 2

Based on the location of the landing (320 mi. offshore), there would be no use of Section 4(f) properties during boost-back and landing.

4.13.3 No Action Alternative

Under the No Action Alternative, there would be no additional use or impacts to Section 4(f) properties.

4.14 Utilities

Impacts associated with utilities are related to changes in the supply or demand of a particular resource. The supply of a utility is also referred to as its capacity. As long as the capacity of a particular utility is higher than the demand for that resource, no impact occurs. However, if the demand exceeds the capacity or if the demand is increased beyond the resource's projected rate of increase, an impact would occur, and the significance of the impact is determined based on the degree to which the capacity is strained.

4.14.1 Alternative 1 (Proposed Action)

Under the Proposed Action, a FireX system would be constructed with 3 or 4 remote controlled water cannons (similar to SLC-4E) mounted on posts above ground to allow for remote firefighting capabilities. Existing underground water lines are sufficient in size and capacity to support the FireX system. A tie into the water system would be required and trenching for new water lines to connect to the FireX system is required.

The pad would be constructed to control all runoff that may occur from implementation of the Proposed Action. A v-ditch surrounding the pad would convey storm water to the appropriate location as well as provide containment for potential spill or firefighting measures. In addition, all stormwater coming off the launch pad would be directed to an infiltration basin designed and sized according to the California State Water Resources Control Board Construction General Permit. Ground based communication, tracking, and video equipment is required and existing infrastructure around the SLC-4W area (existing conduits, camera stands, junction boxes) would be used to the greatest extent possible to reduce requirements for trenching.

Existing utilities (electrical, communications, domestic water supply, and domestic wastewater) at the project site would be extended from their current location. The extensions would occur in areas that are already disturbed. No new utility usage above what has previously been experienced at the project site under the Titan IV launch program would occur. Under the Contingency Action under Alternative 1, no new utility usage above what has previously been experienced at the project site or nearby would occur. Therefore, we expect no impacts to Utilities under Alternative 1.

4.14.2 Alternative 2

Under the Alternative Action, no construction or alteration at SLC-4W would occur. The First Stage would land on and be secured to the barge and transported to the Long Beach Harbor for offloading and transport back to SLC-4W. Therefore, we expect no impacts to Utilities under Alternative 2.

4.14.3 No Action Alternative

Under the No Action Alternative, the landing pad construction at SLC-4W and the boost-back and landing of the Falcon 9 First Stage would not occur. Therefore, there would be no additional impacts to utilities.

4.15 Cumulative Impacts

The effects of Alternative 1 and Alternative 2, in combination with the effects of other relevant past, present, and reasonably foreseeable future projects have been evaluated in this cumulative effects analysis. The No Action Alternative is not analyzed as this alternative would have no cumulative effects on the environment (construction of the landing pad, and boost-back and landing of the Falcon 9 First Stage would not occur). A list of relevant past, present, and reasonably foreseeable projects that have been/would be constructed on VAFB is provided in Table 4-21. The foregoing analysis is based on the same resource thresholds as discussed in Sections 4.1 to 4.14.

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

The region of influence is defined as the area over which effects of the Proposed Action could contribute to cumulative impacts on the environment. Therefore, the region of influence includes both North and South VAFB. Future large projects on VAFB that are currently projected for the next several years have the greatest potential to result in cumulative impacts. VAFB projects 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 reducing overall adverse effects on VAFB environmental resources. Table 4-21 lists the past, present, and reasonably foreseeable future actions that may contribute to cumulative effects of the Proposed Action and may be under construction at the same time as the Proposed Action.

Table 4-16. Federal and Non-Federal Projects.

Federal Projects	Status
Falcon 9 and Falcon 9 Heavy Launch Vehicle Programs from SLC-4E	NEPA document approved. Continuing action.
Evolved Expendable Launch Vehicle Program	NEPA document approved. Continuing action.
Taurus Standard Small Launch Vehicle	NEPA document approved. Continuing action.
Demolition and Abandonment of Atlas and Titan Facilities	Programmatic Environmental Assessment complete. Continuing action.
Narlon Bridge Replacement on San Antonio Creek	NEPA underway.
East Housing Area Solar Energy Project	NEPA document approved. Construction planned for 2015.
Repairs and Replacement of Overhead Electrical Lines, Feeders K1 and K7	NEPA document approved. Construction underway.
Replacement of N5, N9, and N10 Powerlines on South VAFB	NEPA document approved. Construction planned for 2016.
Replacement of N1, N3, N6 Powerlines on South VAFB	NEPA document approved. Construction complete.
13th Street Bridge Replacement at the Santa Ynez River Crossing	NEPA underway. Construction planned for 2015.
Snowy Plover Habitat Restoration	NEPA document approved. Continuing action.
Beach Management for the Western Snowy Plover	NEPA document approved. Continuing action.
Non-Federal Projects	**Status**
City of Lompoc, North Avenue Bridge Preventative Maintenance Project	CEQA completed.

Additionally, other separate but related actions are directly related to the proposed activity and would occur at SLC-4. The environmental impacts of these actions have been documented in other analyses; however, it is important to also examine them collectively. These actions include:

- Demolition of the existing launch pad, launch tower, and mobile service tower (USAF 2005a),
- Construction of a new concrete landing pad (this EA),
- Launch of a Falcon 9 (USAF 2011a), and
- Falcon 9 First Stage boost-back and land at SLC-4W at VAFB (this EA).

This section considers these actions cumulatively, based on the expected timeframe of their execution compared to the Proposed Action. For example, while the demolition of the existing structures would happen before the construction of the concrete pad and before the launch, the launch, IFAT, and boost-back and landing would happen consecutively and in the same general timeframe.

Brief descriptions of each project and the resources impacted are provided below.

Falcon 9 and Falcon 9 Heavy Launch Vehicle Programs from SLC-4E

SpaceX proposed to operate the Falcon 9 and Falcon 9 Heavy launch vehicle programs from SLC-4E on VAFB. To accommodate the Falcon 9 launch program operational requirements, SpaceX proposed modifications and new construction at SLC-4E, which had been decommissioned in 2006 after the last Titan mission. In 2011, an EA was completed and a FONSI was issued (USAF 2011a). The analyses of the affected environment and environmental consequences concluded that with implementation of the environmental protection and monitoring measures, no significant impact or adverse effects would result to cultural resources, hazardous materials and waste management, human health and safety, orbital debris, socioeconomics, solid waste management, transportation, and water resources. In addition, the EA concluded that the project would not affect environmental justice. On 16 November 2010, the CCC concurred with the ND under the CZMA submitted by the USAF for the project. Likewise, on 16 November 2010, the California State Historic Preservation Officer concurred with the finding of No Adverse Effect for the Proposed Action in compliance with Section 106 of the NHPA. No cumulative significant or adverse impacts should result from activities associated with the modifications to SLC-4E and operation of the Falcon 9 and Falcon 9 Heavy launch vehicle programs, when considered in conjunction with past, present, or reasonably foreseeable future agency projects near and on VAFB. Two areas of environmental consequences, air quality and biological resources, evaluated in the EA were determined to have the potential to result in less than significant impacts to the environment. Construction has been completed.

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.

Taurus Standard Small Launch Vehicle Program

This action included the Taurus Standard Small Launch Vehicle (SSLV) program and modifications to Facility 576E, including construction of a launch pad area, guard shacks, and security fencing. We 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.

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 entails 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.

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 that are being analyzed include 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.

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 is expected to be 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.

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

This project included demolition and replacement of approximately 21 mi. (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 2012b). 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 2012b). The project is currently under construction.

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 mi. (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 currently being 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 mi. (32 km) of existing overhead electrical lines on South VAFB and replacing them with approximately 11 mi. (18 km) of new overhead lines. An EA (USAF 2011c) 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 includes 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 is anticipated to begin in 2016 and last approximately 12–20 months. An EA was completed in 2014, and a FONPA was issued in 2014 (USAF 2014d). The Project is expected to begin in 2016.

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.

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 LETE 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.

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 m^2) 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).

4.15.2 Alternative 1 (Proposed Action)

4.15.2.1 Air Quality

VAFB has several other construction or demolition projects in the ROI for the Proposed Action. Air emissions from other projects listed in Table 4-21 would be localized and short-term in nature, except for 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 Proposed Action combined with other concurrent construction projects and launch operations would not exceed the significance thresholds in Santa Barbara County and would not produce any significant cumulative air quality impacts. The incremental contribution of the Proposed Action to GHG emissions is extremely small relative to regional 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 4-21). Therefore, implementation of the Proposed Action in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative impacts to air quality or climate change.

4.15.2.2 Noise (Airborne)

Construction activities at the site of the Proposed Action and for other projects listed in Table 4-21 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 landing pad 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 5 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 6 events per year) and each event would last less than two minutes. Therefore, implementation of the Proposed Action in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative noise impacts.

4.15.2.3 Biological Resources

The Proposed Action 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 the Proposed Action, cause disturbances to special-status species or their habitats. Construction of the landing pad would be limited to a small area within SLC-4W. 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 6 events per year) and would not be expected to have residual effects past each operation.

Although the Proposed Action 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 environmental protection measures would minimize impacts to special-status species. Therefore, implementation of the Proposed Action in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative impacts to biological resources.

4.15.2.4 Water Resources

Cumulative impacts to water resources could occur if concurrent projects were to inadequately address water resources at project locations. However, projects on VAFB, including the Proposed Action, 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 4-21, 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. Erosion and contamination caused by construction activities are not anticipated as a result of the Proposed Action. Therefore, implementation of the Proposed Action in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative impacts to water resources.

4.15.2.5 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). Although a portion of one site (CA-SBA-537/1816) is located in the vicinity of the Proposed Action, VAFB has received concurrence from the California SHPO regarding a determination of no adverse effects.

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-4W 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 the Proposed Action in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative impacts to cultural resources.

4.15.2.6 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 region of influence 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 and road building activities, 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 the Proposed Action in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative impacts to geology and earth resources.

4.15.2.7 Human Health and Safety

The Proposed Action and other concurrent projects on VAFB could result in increased risks to human health and safety. Implementation of the Proposed Action and other similar actions at VAFB would slightly increase the short-term risk associated with construction contractors performing work at project locations. Contractors would be required to establish and maintain safety programs that would provide protection to their workers and limit the exposure of Base personnel to construction hazards. Impacts would be minimal and confined to the immediate project site. The safety program would include coordination with the AFCEC/CZO MMRP manager and contact with the weapons safety specialist for 30 SW/SEW for information on VAFB policies on UXO safety for construction work at VAFB. With appropriate safety measures in place, implementation of the Proposed Action in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative health and safety impacts.

4.15.2.8 Hazardous Materials and Waste Management

Management of any hazardous materials would occur under compliance of VAFB Hazardous Materials Management Plan and emergency responses to spills would follow the Hazardous Materials Emergency Response Plan, for all projects. Projects must also follow the Integrated Solid Waste Management Plan. EPMs would be implemented to minimize hazardous materials or hazardous waste management impacts. The Proposed Action would not contribute to cumulative effects to hazardous materials and wastes in or around VAFB. Therefore, implementation of the Proposed Action in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative impacts associated with hazardous materials and wastes.

4.15.2.9 Solid Waste Management

The cumulative projects listed in Table 4-21, including the Proposed Action would result in an overall increase in solid waste generation resulting from construction, renovation, and demolition. Solid waste would be minimized by compliance with VAFB's Integrated Solid Waste Management Plan and the implementation of EPMs, including segregating, reusing, and recycling waste to the greatest extent practicable, would reduce cumulative impacts of solid waste. Local landfills would be able to process the projected temporary increases in solid waste. We expect no significant cumulative impacts on solid waste management.

4.15.2.10 Land Use and Aesthetics

The Proposed Action would not adversely affect land use or aesthetics. The cumulative projects identified in Table 4-21 are all on VAFB and would conform to USAF regulations and planning principles or comply with County/State requirements. Cumulative projects would be modified if during the project review process to ensure compatibility with existing land uses and consistency with management plans. These projects have been and would be assessed separately under NEPA and the effects would be analyzed and disclosed. Therefore, implementation of the Proposed Action in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative impacts on land use or aesthetics.

4.15.2.11 Coastal Zone Management

The Proposed Action would not adversely affect the Coastal Zone, CZMA, or CCA policies. The cumulative projects identified in Table 4-21 are all on VAFB and would conform to USAF regulations and CZMA and CCA policy. Cumulative projects, if necessary, would be modified during the project review process to ensure consistency with the CZMA and CCA policy. Therefore, implementation of the Proposed Action in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative impacts to coastal zone resources.

4.15.2.12 Transportation

Cumulative construction and demolition projects on VAFB would contribute to increased traffic volumes in the region. Roadways on VAFB and near the installation currently have low ADT volumes and acceptable level of service conditions. Any disruption to these roadways as a result of the Proposed Action would be relatively small with a temporary increase in ADTs during construction activities. No long-term increases in traffic would occur as a result of implementation of the Proposed Action. Therefore, implementation of the Proposed Action in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative impacts to transportation on VAFB.

4.15.2.13 Utilities

Cumulative construction and demolition projects on VAFB would contribute to increases in demand for utility resources; however, utility capacity would be required to be greater than demand. If existing utility capacity is not greater than the anticipated demand, VAFB would increase capacity to exceed demand or extend existing utilities to reach project areas. In addition, several of the cumulative projects listed in Table 4-21 are intended to improve and secure utility capacity (e.g., repairs and replacements to overhead electric lines and feeders) and thus help offset cumulative impacts to utility resources. Therefore, implementation of the Proposed Action in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative impacts to utilities on VAFB.

4.15.3 Alternative 2

Under Alternative 2, the boost-back and landing of the First Stage Falcon 9 would occur as described in Section 2.2.3.1 (Contingency Barge Landing), except that it would land 320 mi. (515 km) offshore and the construction of a landing pad at SLC-4W would not occur. As analyzed above under Alternative 1, no significant cumulative impacts when added to other past, present, and reasonably foreseeable future actions were identified for the boost-back and landing under any resource area. Given the location of the Falcon 9 landing under Alternative 2 (320 mi. [515 km] offshore), no significant cumulative impacts would occur because landing activities would not overlap with those projects listed in Table 4-21 and because the distance to the off shore landing location would not represent additive impacts given the lack of other potential activity in the area. Therefore, implementation of the Alternative 2 in conjunction with other past, present or reasonably foreseeable projects would not result in cumulative impacts.

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