PRIVACY ADVISORY

This Environmental Assessment (EA) is provided for public comment in accordance with the National Environmental Policy Act (NEPA), the President's Council on Environmental Quality NEPA Regulations (40 Code of Federal Regulations [CFR] Parts 1500-1508) and 32 CFR Part 989, Environmental Impact Analysis Process (EIAP).

The EIAP provides an opportunity for public input on U.S. Air Force (USAF) decision making, allows the public to offer inputs on alternative ways for the USAF to accomplish what it is proposing, and solicits comments on the USAF's analysis of environmental effects.

Public commenting allows the USAF to make better, informed decisions. Letters or other written or oral comments provided may be published in the EA. As required by law, comments provided will be addressed in the EA and made available to the public. Providing personal information is voluntary. Any personal information provided will be used only to identify your desire to make a statement during the public comment portion of any public meetings or hearings or to fulfill requests for copies of the EA or associated documents. Private addresses will be compiled to develop a mailing list for those requesting copies of EA; however, only the names of the individuals making comments and specific comments will be disclosed. Personal home addresses and phone numbers will not be published in the EA.

Draft

Supplemental Environmental Assessment

Falcon 9 Cadence Increase

at

Vandenberg Space Force Base, California and Offshore Landing Locations

31 March 2023

Space Launch Delta 30, Installation Management Flight Environmental Assets
1028 Iceland Avenue, Building 11146
Vandenberg Space Force Base, California 93437

TABLE OF CONTENTS

1 PURPOSE OF AND NEED FOR THE PROPOSED ACTION 1-1

1.1 INTRODUCTION AND BACKGROUND 1-1
1.2 PROJECT LOCATION 1-3
1.3 PURPOSE AND NEED FOR THE PROPOSED ACTION 1-6
1.4 SCOPE OF ENVIRONMENTAL REVIEW 1-6
1.5 DOCUMENTS INCORPORATED BY REFERENCE 1-6
1.6 LEAD AND COOPERATING AGENCY ACTIONS 1-7
1.7 INTERAGENCY AND INTERGOVERNMENTAL COORDINATION AND CONSULTATIONS 1-8
1.8 PUBLIC NOTIFICATION AND REVIEW 1-8

2 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES 2-1

2.1 SELECTION STANDARDS AND CRITERIA 2-1
2.2 PROPOSED ACTION 2-1
2.2.1 LAUNCH 2-1
2.2.2 PAYLOAD FAIRING RECOVERY OPERATIONS 2-5
2.2.3 BOOST-BACK AND LANDING 2-6
2.2.4 LAUNCH AND LANDING NOISE 2-9
2.2.5 BOOSTER ROLL-ON-ROLL-OFF 2-18
2.2.6 PAYLOAD PROCESSING, REFURBISHMENT, AND OPERATIONS 2-18
2.2.7 ENVIRONMENTAL PROTECTION MEASURES 2-19
2.2.8 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM FURTHER ANALYSIS 2-36
2.3 NO ACTION ALTERNATIVE 2-37

3 AFFECTED ENVIRONMENT 3-1

3.1 AIR QUALITY AND CLIMATE 3-3
3.1.1 CLIMATE OF THE STUDY AREA 3-3
3.1.2 EXISTING AIR QUALITY 3-3
3.2 NOISE 3-5
3.2.1 SENSITIVE RECEPTORS 3-5
3.2.2 AMBIENT NOISE CONDITIONS 3-6
3.3 TERRESTRIAL BIOLOGICAL RESOURCES 3-6
3.3.1 METHODOLOGY 3-7
3.3.2 WILDLIFE RESOURCES 3-7
3.3.3 SPECIAL STATUS WILDLIFE SPECIES 3-7
3.4 MARINE BIOLOGICAL RESOURCES 3-14
3.4.1 ESA-LISTED FISH SPECIES 3-18
3.4.2 ESA-LISTED SEA TURTLES 3-19
3.4.3 MARINE MAMMALS 3-20
3.4.4 MARINE RESERVES 3-22

3.5 WATER RESOURCES 3-25
3.5.1 SURFACE WATER 3-25
3.5.2 GROUND WATER 3-25
3.5.3 WATERS OF THE UNITED STATES AND WETLANDS 3-27
3.5.4 WATERS OF THE STATE AND WETLANDS 3-27
3.5.5 FLOODPLAINS 3-27
3.6 CULTURAL RESOURCES 3-30
3.6.1 RECORDED CULTURAL RESOURCES 3-31
3.7 COASTAL ZONE MANAGEMENT 3-36
3.8 DEPARTMENT OF TRANSPORTATION SECTION 4(F) 3-36
3.9 UTILITIES 3-39
3.10 SOCIOECONOMICS 3-39
3.11 TRANSPORTATION 3-39

4 ENVIRONMENTAL CONSEQUENCES 4-1

4.1 AIR QUALITY 4-1
4.1.1 ALTERNATIVE 1 4-1
4.1.2 NO ACTION ALTERNATIVE 4-7
4.2 NOISE 4-7
4.2.1 ALTERNATIVE 1 (PROPOSED ACTION) 4-8
4.2.2 NO ACTION ALTERNATIVE 4-14
4.3 TERRESTRIAL BIOLOGICAL RESOURCES 4-15
4.3.1 ALTERNATIVE 1 (PROPOSED ACTION) 4-15
4.3.2 NO ACTION ALTERNATIVE 4-32
4.4 MARINE BIOLOGICAL RESOURCES 4-33
4.4.1 ALTERNATIVE 1 (PROPOSED ACTION) 4-33
4.4.2 NO ACTION ALTERNATIVE 4-42
4.5 WATER RESOURCES 4-42
4.5.1 ALTERNATIVE 1 (PROPOSED ACTION) 4-42
4.5.2 NO ACTION ALTERNATIVE 4-46
4.6 CULTURAL RESOURCES 4-46
4.6.1 ALTERNATIVE 1 (PROPOSED ACTION) 4-46
4.6.2 NO ACTION ALTERNATIVE 4-47
4.7 COASTAL ZONE MANAGEMENT 4-48
4.7.1 ALTERNATIVE 1 (PROPOSED ACTION) 4-48
4.7.2 NO ACTION ALTERNATIVE 4-49
4.8 DEPARTMENT OF TRANSPORTATION SECTION 4(F) PROPERTIES 4-49
4.8.1 ALTERNATIVE 1 (PROPOSED ACTION) 4-50
4.8.2 NO ACTION ALTERNATIVE 4-50
4.9 UTILITIES 4-1
4.9.1 ALTERNATIVE 1 (PROPOSED ACTION) 4-1
4.9.2 NO ACTION ALTERNATIVE 4-1
4.10 SOCIOECONOMICS 4-1

4.10.1 ALTERNATIVE 1 (PROPOSED ACTION) 4-2
4.10.2 NO ACTION ALTERNATIVE 4-2
4.11 TRANSPORTATION 4-2
4.11.1 ALTERNATIVE 1 (PROPOSED ACTION) 4-2
4.11.2 NO ACTION ALTERNATIVE 4-3

5 CUMULATIVE IMPACTS 5-1

5.1 PAST ACTIONS 5-1
5.2 PRESENT ACTIONS 5-1
5.3 REASONABLY FORESEEABLE ACTIONS 5-1
5.4 ALTERNATIVE 1 (PROPOSED ACTION) 5-2
5.4.1 AIR QUALITY 5-2
5.4.2 NOISE 5-2
5.4.3 TERRESTRIAL BIOLOGICAL RESOURCES 5-2
5.4.4 MARINE BIOLOGICAL RESOURCES 5-3
5.4.5 WATER RESOURCES 5-3
5.4.6 CULTURAL RESOURCES 5-3
5.4.7 COASTAL ZONE MANAGEMENT 5-3
5.4.8 DEPARTMENT OF TRANSPORTATION ACT SECTION 4(F) PROPERTIES 5-4
5.4.9 UTILITIES 5-4
5.4.10 SOCIOECONOMICS 5-4
5.4.11 TRANSPORTATION 5-5
5.5 SUMMARY AND CONCLUSION 5-5

6 LIST OF PREPARERS, AGENCIES, AND PERSONS CONSULTED 6-1

6.1 LIST OF PREPARERS 6-1
6.2 LIST OF AGENCIES AND PERSONS CONSULTED 6-2

7 BIBLIOGRAPHY 7-1

APPENDICES

APPENDIX A: UNITED STATES FISH AND WILDLIFE SERVICE CONSULTATION
APPENDIX B: NATIONAL MARINE FISHERIES SERVICE CONSULTATIONS
APPENDIX C: STATE HISTORIC PRESERVATION OFFICE AND NATIVE AMERICAN CONSULTATIONS (PLACEHOLDER)
APPENDIX D: AIR QUALITY
APPENDIX E: SOUND
APPENDIX F: TERRESTRIAL BIOLOGICAL RESOURCES
APPENDIX G: MARINE BIOLOGICAL RESOURCES
APPENDIX H: CULTURAL RESOURCES
APPENDIX I: EVACUATION AND CLOSURE AGREEMENT
APPENDIX J: NOTICE OF AVAILABILITY FOR PUBLIC REVIEW, PROOF OF DELIVERY/PUBLICATION
APPENDIX K: AIRSPACE

APPENDIX L: UNITED STATES SPACE FORCE, SPACE LAUNCH DELTA 30 AND UNITED STATES COAST GUARD MEMORANDUM OF AGREEMENT

APPENDIX M: CALIFORNIA COASTAL COMMISSION CONSULTATION (PLACEHOLDER)

LIST OF FIGURES

FIGURE 1.2-1. REGIONAL LOCATION OF VANDENBERG SPACE FORCE BASE 1-4
FIGURE 1.2-2. SPACE LAUNCH COMPLEX 4-EAST 1-5
FIGURE 1.2-3. APPROVED FALCON 9 LANDING AND FAIRING RECOVERY AREAS 1-5
FIGURE 2.2-1: NORTHERN MISSION LAUNCH AZIMUTHS AND PROPOSED LANDING AND FAIRING RECOVERY AREAS 2-8
FIGURE 2.2-2. MAXIMUM UNWEIGHTED ENGINE NOISE DURING FALCON 9 LAUNCH FROM SLC-4E 2-10
FIGURE 2.2-3. MAXIMUM UNWEIGHTED ENGINE NOISE DURING FALCON 9 FIRST STAGE LANDING AT SLC-4W 2-11
FIGURE 2.2-4. MAXIMUM UNWEIGHTED ENGINE NOISE DURING FALCON 9 STATIC FIRE AT SLC-4W 2-12
FIGURE 2.2-5. SAMPLE SONIC BOOM PROFILE GENERATED DURING LAUNCH OF FALCON 9 FROM SLC-4E 2-14
FIGURE 2.2-6. EXAMPLE OF A TYPICAL SONIC BOOM PROFILE FOR FALCON 9 FIRST STAGE LANDING AT SLC-4W 2-15
FIGURE 2.2-7. EXAMPLE OF A TYPICAL SONIC BOOM PROFILE FOR FALCON 9 FIRST STAGE LANDING ON A DRONESHIP IN THE PROPOSED LANDING AREAS WITH A SOUTHERLY MISSION PROFILE 2-16
FIGURE 2.2-8. EXAMPLE OF A TYPICAL SONIC BOOM PROFILE FOR FALCON 9 FIRST STAGE LANDING ON A DRONESHIP IN THE PROPOSED LANDING AREAS WITH A NORTHERLY MISSION PROFILE 2-17
FIGURE 2.2-9. CALIFORNIA RED-LEGGED FROG OXBOW MITIGATION SITE AND CONTROL MONITORING LOCATION (NOTE: THE DEPICTED DISTRIBUTION OF CRLF LOCALITIES IS A FACTOR OF WHERE PRIOR SURVEY EFFORTS WERE PERFORMED, NOT ACTUAL OCCURRENCE)2-30
FIGURE 2.2-10. AERIAL VIEW OF SAN ANTONIO CREEK "OXBOW" RESTORATION SITE PRIOR TO RESTORATION EFFORTS THAT ARE CURRENTLY BEING CONDUCTED 2-31
FIGURE 2.2-11. CURRENT RESTORATION EFFORTS (BLUE, RED, AND GREEN) AND EXISTING EXPANSION AREA THAT WOULD BE RESTORED AT A 2:1 MITIGATION RATIO 2-32
FIGURE 2.2-12. CONTOURING PLAN AS CURRENTLY BEING CONDUCTED TO SUCCESSFULLY CREATE WETLAND 2-33
FIGURE 3.4-1. STATE MARINE RESERVES AND CHANNEL ISLANDS NATIONAL MARINE SANCTUARY 3-24
FIGURE 3.5-1: SPRING CANYON VEGETATION MANAGEMENT AREA AND FLOODPLAINS 3-29
FIGURE 3.6-1. AREA OF POTENTIAL EFFECTS 3-31
FIGURE 3.8-1. POTENTIAL DEPARTMENT OF TRANSPORTATION ACT SECTION 4(F) PROPERTIES 3-38
FIGURE 3.11-1. MAIN ACCESS AND TRANSPORTATION ROUTES ASSOCIATED WITH THE PROPOSED ACTION 3-41
FIGURE 4.2-1. MAXIMUM A-WEIGHTED ENGINE NOISE DURING FALCON 9 LAUNCH FROM SLC-4E 4-10
FIGURE 4.2-2. MAXIMUM A-WEIGHTED ENGINE NOISE DURING FALCON 9 STATIC FIRE TEST AT SLC-4E 4-11
FIGURE 4.2-3. MAXIMUM A-WEIGHTED ENGINE NOISE DURING FALCON 9 LANDING AT SLC-4W 4-12
FIGURE 4.2-4. COMMUNITY NOISE EQUIVALENT LEVELS FROM THE PROPOSED FALCON 9 LAUNCH AND LANDING OPERATIONS AT SLC-4 4-13
FIGURE 4.3-1. CALIFORNIA RED-LEGGED FROG LOCALITIES, CRITICAL HABITAT, AND ROCKET ENGINE NOISE IMPACT AREAS 4-19
FIGURE 4.3-2. CALIFORNIA RED-LEGGED FROG LOCALITIES, CRITICAL HABITAT (INSET), AND SONIC BOOM IMPACT AREAS 4-20
FIGURE 4.3-3. MARBLED MURRELET OBSERVATION SITES AND ROCKET ENGINE NOISE IMPACT AREAS (SOURCE: EBIRD 2022; NOTE: OBSERVATION SITES ARE NOT LOCALITIES, THEY ARE WHERE THE SURVEYOR WAS LOCATED) 4-22
FIGURE 4.3-4. MARBLED MURRELET NESTING RECORDS AND SAMPLE SONIC BOOM MODEL RESULTS FOR SLC 4W LANDING EVENTS . 4-23
FIGURE 4.3-5. WESTERN SNOWY PLOVER NESTING RECORDS AND ROCKET ENGINE NOISE IMPACT AREAS 4-26
FIGURE 4.3-6. WESTERN SNOWY PLOVER NESTING RECORDS AND SAMPLE SONIC BOOM MODEL RESULTS FOR SLC-4W LANDING EVENTS 4-27
FIGURE 4.3-7. DESIGNATED CRITICAL HABITAT FOR THE WESTERN SNOWY PLOVER AND SAMPLE SONIC BOOM MODEL RESULTS 4-28
FIGURE 4.3-8. CALIFORNIA LEAST TERN FORAGING, ROOSTING, AND NESTING AREAS AND ROCKET ENGINE NOISE IMPACT AREAS ... 4-30

FIGURE 4.3-9. CALIFORNIA LEAST TERN NESTING, FORAGING, AND ROOSTING AREAS AND SAMPLE SONIC BOOM MODEL RESULTS FOR SLC-4W LANDING EVENTS 4-31
FIGURE 4.4-1. 2019 SOUTHERN SEA OTTER DENSITIES AND LAUNCH AND LANDING NOISE IMPACT AREAS (USGS 2020) 4-40
FIGURE 4.4-2. 2019 SOUTHERN SEA OTTER DENSITIES AND SAMPLE SONIC BOOM MODEL RESULTS FOR SLC 4W LANDING EVENTS (USGS 2020) 4-41
FIGURE 4.8-1. POTENTIAL DEPARTMENT OF TRANSPORTATION ACT SECTION 4(F) PROPERTIES AND LAUNCH AND LANDING SOUND PRESSURE LEVELS 52
FIGURE 4.8-2. POTENTIAL DEPARTMENT OF TRANSPORTATION ACT SECTION 4(F) PROPERTIES AND TYPICAL SONIC BOOM LEVELS FOR SLC-4W LANDING 53
FIGURE 4.8-3. POTENTIAL DEPARTMENT OF TRANSPORTATION ACT SECTION 4(F) PROPERTIES AT THE NCI AND SONIC BOOM 54

LIST OF TABLES

TABLE 2.2-1. SUMMARY OF ENVELOPE PAYLOAD CHARACTERISTICS BY SPACECRAFT SUBSYSTEMS 2-19
TABLE 2.2-2. CONTROL MEASURES TO DECREASE EMISSIONS 2-20
TABLE 2.2-3. BIOLOGICAL MONITORING QUALIFICATIONS 2-20
TABLE 2.2-4. GENERAL MEASURES 2-21
TABLE 2.2-5. CALIFORNIA RED-LEGGED FROG MEASURES 2-22
TABLE 2.2-6. WESTERN SNOWY PLOVER MEASURES 2-25
TABLE 2.2-7. CALIFORNIA LEAST TERN MEASURES 2-27
TABLE 2.2-8. CALIFORNIA CONDOR MEASURES 2-28
TABLE 2.2-9: MARBLED MURRELET 2-29
TABLE 3.1-1. ESTIMATED ANNUAL CRITERIA POLLUTANT EMISSIONS UNDER THE CURRENT ENVIRONMENTAL BASELINE CONDITIONS[1] 3-4
TABLE 3.1-2. ESTIMATED ANNUAL GREENHOUSE GAS EMISSIONS UNDER THE CURRENT ENVIRONMENTAL BASELINE CONDITIONS 3-5
TABLE 3.3-1. TERRESTRIAL SPECIAL STATUS SPECIES CONSIDERED 3-8
TABLE 3.3-2. FEDERAL AND STATE SPECIAL STATUS SPECIES OCCURRENCE WITHIN THE PROPOSED ACTION AREA 3-9
TABLE 3.3-3. SPECIAL STATUS FISH SPECIES OCCURRING OR POTENTIALLY OCCURRING WITHIN THE TERRESTRIAL PORTION OF THE PROJECT AREA 3-9
TABLE 3.3-4. SPECIAL STATUS AMPHIBIAN SPECIES OCCURRING OR POTENTIALLY OCCURRING WITHIN THE TERRESTRIAL PORTION OF THE PROJECT AREA 3-9
TABLE 3.3-5. SPECIAL STATUS REPTILE SPECIES OCCURRING OR POTENTIALLY OCCURRING WITHIN THE TERRESTRIAL PORTION OF THE PROJECT AREA 3-10
TABLE 3.3-6. SPECIAL STATUS BIRD SPECIES OCCURRING OR POTENTIALLY OCCURRING WITHIN THE TERRESTRIAL PORTION OF THE PROJECT AREA 3-10
TABLE 3.3-7. SPECIAL STATUS MAMMAL SPECIES OCCURRING OR POTENTIALLY OCCURRING WITHIN THE TERRESTRIAL PORTION OF THE PROJECT AREA 3-12
TABLE 3.4-1. ESA-LISTED INVERTEBRATE SPECIES OCCURRENCE WITHIN THE ROI 3-15
TABLE 3.4-2. ESA-LISTED FISH SPECIES OCCURRENCE WITHIN THE ROI 3-15
TABLE 3.4-3. ESA-LISTED TURTLE SPECIES OCCURRENCE WITHIN THE ROI 3-16
TABLE 3.4-4. ESA-LISTED MARINE MAMMAL SPECIES OCCURRENCE WITHIN THE ROI 3-17
TABLE 3.6-1. NRHP-LISTED OR ELIGIBLE CULTURAL RESOURCES LOCATED WITHIN THE APE 3-33
TABLE 4.1-1. ESTIMATED CRITERIA POLLUTANT EMISSIONS PRODUCED UNDER ALTERNATIVE 1 FROM 36 LAUNCHES AND STATIC FIRE ACTIVITIES 4-1
TABLE 4.1-2. ESTIMATED CRITERIA POLLUTANT EMISSIONS PRODUCED UNDER ALTERNATIVE 1 FROM 36 FAIRING RECOVERY ACTIVITIES 4-2
TABLE 4.1-3. ESTIMATED CRITERIA POLLUTANT EMISSIONS PRODUCED UNDER ALTERNATIVE 1 FROM 36 LANDING ACTIVITIES 4-2

TABLE 4.1-4. ESTIMATED CRITERIA POLLUTANT EMISSIONS PRODUCED UNDER ALTERNATIVE 1 FROM 36 LAUNCH BOOSTER ROLLO-ON-ROLL-OFF ACTIVITIES 4-3
TABLE 4.1-5. ESTIMATED CRITERIA POLLUTANT EMISSIONS PRODUCED UNDER ALTERNATIVE 1 FROM 36 LAUNCH OPERATION ACTIVITIES 4-3
TABLE 4.1-6. ESTIMATED NET CHANGE IN TOTAL ANNUAL AIR POLLUTANT EMISSIONS FROM ACTIVITIES WITHIN 3 NM, ALTERNATIVE 1[1] 4-4
TABLE 4.1-7. ESTIMATED NET CHANGE IN ANNUAL AIR POLLUTANT EMISSIONS FROM ACTIVITIES WITHIN THE SANTA BARBARA COUNTY AIR POLLUTION CONTROL DISTRICT[1] 4-4
TABLE 4.1-8. ESTIMATED NET CHANGE IN ANNUAL AIR POLLUTANT EMISSIONS FROM ACTIVITIES WITHIN THE VENTURA COUNTY AIR POLLUTION CONTROL DISTRICT[1] 4-5
TABLE 4.1-9. ESTIMATED NET CHANGE IN ANNUAL AIR POLLUTANT EMISSIONS FROM ACTIVITIES WITHIN THE SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT[1] 4-5
TABLE 4.1-10. ESTIMATED ANNUAL CRITERIA POLLUTANT EMISSIONS PRODUCED BETWEEN 0 AND 12 NM UNDER ALTERNATIVE 1[1] 4-6
TABLE 4.1-11. ESTIMATED ANNUAL GREENHOUSE GAS EMISSIONS UNDER ALTERNATIVE 1 4-7

ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
ac.	acre(s)
ACAM	Air Conformity Applicability
ac-ft	acre-feet
AFMAN	Air Force Manual
A-hr	Ampere-hour
ADI	Area of Direct Impacts
APE	Area of Potential Effects
BCC	Federal Bird Species of Conservation Concern
BGEPA	Bald and Golden Eagle Protection Act
BO	Biological Opinion
CARB	California Air Resources Board
CATEX	Categorical Exclusion
CCC	California Coastal Commission
CCZ	California Coastal Zone
CDFW	California Department of Fish and Wildlife
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CHNMS	Chumash Heritage National Marine Sanctuary
CHRIS	California Historical Resources Information System
CINMS	Channel Islands National Marine Sanctuary
CNEL	Community Noise Equivalent Level
CO	carbon monoxide
CO_2	carbon dioxide
CO_{2e}	carbon dioxide equivalent
CRLF	California red-legged frog
CSLA	U.S. Commercial Space Launch Act
CWA	Clean Water Act
CWC	California Water Code
CZMA	Coastal Zone Management Act
DAF	Department of the Air Force
DATF	Declining Amphibian Populations Task Force
dB	decibel(s)
dBA	A-weighted decibels
DNL	Day-Night Average Sound Level
DOD	Department of Defense
DOT	Department of Transportation
DPS	Distinct Population Segment
E	East
EA	Environmental Assessment
EIS	Environmental Impact Statement
EO	Executive Order
EPM	Environmental Protection Measure
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FAA	Federal Aviation Administration
FGC	Fish and Game Code
FE	federally endangered
FONSI	Finding of No Significant Impact
FT	federally threatened
ft	foot/feet
ft^2	square feet
GHG	greenhouse gas
GSA	groundwater sustainability agency
GSP	Groundwater Sustainability Plan
GTO	geosynchronous transfer orbit
Hwy	highway
Hz	hertz
IAW	in accordance with
km	kilometer(s)
kW-hr	kilowatt-hour
L_{max}	maximum unweighted sound pressure level
L_{eq}	equivalent sound level
lb(s)	pound(s)
LEO	low Earth orbit
Li-ion	Lithium ion
LiSOCl	Lithium-Thionyl Chloride
LOA	Letter of Agreement or Letter of Authorization
LOX	liquid oxygen
mi	mile(s)
MBTA	Migratory Bird Treaty Act
MMCG	Marine Mammal Consulting Group
MMPA	Marine Mammal Protection Act
MOA	Memorandum of Agreement

MSRS	ManTech SRS Technologies, Inc.
MVac	Merlin Vacuum Engine
N_2O	Nitrous Oxide
NAAQS	National Ambient Air Quality Standards
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NCI	Northern Channel Islands
ND	negative determination
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NiCad	Nickel-Cadmium
Ni-H2	Nickel-hydrogen
nm	nautical mile(s)
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notice to Air Missions
NOTMAR	notice to mariners
NPDES	National Pollutant Discharge and Elimination System
NRHP	National Register of Historic Places
O_3	ozone
OHP	Office of Historic Preservation
P	proposed for listing under the ESA
PBO	Programmatic Biological Opinion
PCWQCA	Porter-Cologne Water Quality Control Act
$PM_{2.5}$	particulate matter less than 2.5 microns (fine particulate matter)
PM_{10}	particulate matter less than 10 microns
POC	point of contact
PSD	Prevention of Significant Deterioration
psf	pound(s) per square foot
PWSA	Ports and Waterways Safety Act
ROI	region of influence
RORO	roll-on-roll-off
RP-1	rocket propellant
RWQCB	Regional Water Quality Control Board
SBCAPCD	Santa Barbara County Air Pollution Control District
SCAB	South Coast Air Basin
SCAQMD	South Coast Air Quality Management District
SCI	Santa Cruz Island
SE	state endangered species
SEA	Supplemental Environmental Assessment
SECDEF	Secretary of Defense
SGMA	Sustainable Groundwater Management Act
SLC	Space Launch Complex
SLD 30	Space Launch Delta 30
SO_2	sulfur dioxide
SMI	San Miguel Island
SpaceX	Space Exploration Technologies Corporation
SPMT	Self-Propelled Modular Transport
SR	State Route
SRI	Santa Rosa Island
SRM	Solid Rocket Motor
SSC	California Species of Special Concern
SWRCB	State Water Resources Control Board (California)
TWG	tidewater goby
UPRR	Union Pacific Railroad
U.S.	United States
USC	United States Code
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USSF	United States Space Force
UTS	unarmored threespine stickleback
VSFB	Vandenberg Space Force Base
VSMR	Vandenberg State Marine Reserve
VOC	volatile organic compounds
W	west
WOTS	Waters of the State
WOTUS	Waters of the United States

1 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

1.1 INTRODUCTION AND BACKGROUND

Space Launch Delta 30 (SLD 30) is proposing to increase the annual cadence for Space Exploration Technologies Corporation (SpaceX) Falcon 9 operations at Vandenberg Space Force Base (VSFB) and include additional downrange offshore landing locations in the Pacific Ocean (Proposed Action). The purpose of the Proposed Action is to provide greater mission capability to the Department of Defense (DOD), National Aeronautics and Space Administration (NASA), and commercial customers by increasing Falcon 9 launch capacity. The Space Transportation section of the National Space Transportation Policy of 1994 addressed the commercial launch sector, stating "assuring reliable and affordable access to space through U.S. space transportation capabilities is fundamental to achieving National Space Policy goals."

SpaceX is a commercial space transportation company headquartered in Hawthorne, California. SpaceX designs, manufactures, and launches advanced rockets and spacecraft. SpaceX developed the Falcon 1 (no longer operational), Falcon 9, and Falcon Heavy vertical orbital launch vehicles, all of which were built with the goal of becoming reusable launch vehicles. SpaceX launches commercial and government payloads from VSFB.

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

In April 2016, the USAF issued the *Final EA for Boost-Back and Landing of the Falcon 9 Full Thrust First Stage at SLC-4 West, Vandenberg Air Force Base, California and Offshore Landing Contingency Option* (hereinafter referred to as the "2016 EA"). The 2016 EA assessed constructing a new concrete landing pad at SLC-4 West (W) and the proposed Falcon 9 in-air boost-back maneuver, return flight, and first stage landing on the new SLC-4W pad up to six times per year. The action also included a conditional landing area on a droneship located approximately 27 nautical miles (nm) offshore of VSFB up to 6 times per year.

In September 2016, the USAF issued the *Final Supplemental Environmental Assessment (SEA) for Boost-Back and Landing of the Falcon 9 Full Thrust First Stage at Iridium Landing Area, Vandenberg Air Force Base, California and Offshore Landing Contingency Option* (hereinafter referred to as the "2016 SEA"). The 2016 SEA assessed the proposed boost-back and landing of the Falcon 9 first stage (up to six times per year) on a barge in the Iridium Landing Area, in the Pacific Ocean.

In January 2018, the USAF issued the *Final SEA for Launch, Boost-Back, and Landing of the Falcon 9 at Vandenberg Air Force Base, California and Offshore Landing Contingency Options* (hereinafter referred to as the "2018 SEA"). The 2018 SEA assessed proposed changes to the launch, boost-back, and landing the Falcon 9 at VSFB. SpaceX proposed to launch the Falcon 9 from SLC-4E, followed by first stage boost-back and landing at SLC-4W or on a downrange droneship up to 12 times per year. The 2018 SEA also assessed using up to 200,000 gallons of water in the flame duct to reduce vibration impacts from noise on payloads, and associated construction.

The United States Space Force (USSF) prepared an Air Force Form 813, *Request for Environmental Impact Analysis,* and issued a Categorical Exclusion (CATEX) for SpaceX's proposed Starlink Group 2 (813 dated July 2021) which required launch and boost-back trajectory updates and additional offshore landing areas at VSFB. VSFB Environmental Planning concluded that proposed harbor activities qualified for CATEX A2.3.7, which states "continuation or resumption of pre-existing actions, where there is no substantial change in existing conditions or existing land uses and where the actions were originally evaluated in accordance with applicable law and regulations, and surrounding circumstances have not changed" and A2.3.11, which states "actions similar to other actions which have been determined to have an insignificant impact in a similar setting as established in an Environmental Impact Statement (EIS) or an EA resulting in a Finding of No Significant Impact (FONSI)." The scope of the proposed harbor activities was similar to actions analyzed in the 2001 EA for *Harbor Activities Associated with the Delta IV Program at Vandenberg Air Force Base*. The Starlink Group 2 landing location was determined to not have a significant impact beyond what was analyzed in the 2016 SEA. Therefore, 30 Civil Engineer Squadron, Installation Management Flight, Environmental Conservation (30 CES/CEIEA) found that the proposed Starlink Group 2 action was categorically excluded from the requirement to prepare wither an EA or EIS.

The USSF prepared an Air Force Form 813 and issued a CATEX for SpaceX's proposed Starlink Group 4 (813 dated August 2021) which also required additional launch and boost-back trajectory updates and additional offshore landing areas at VSFB. VSFB Environmental Planning concluded that the proposed Starlink Group 4 action qualified for CATEX A2.3.11, which states "actions similar to other actions which have been determined to have an insignificant impact in a similar setting as established in an EIS or an EA resulting in a FONSI". The expanded landing and fairing recovery area were determined to not have a significant impact beyond what was analyzed in the 2016 SEA. Therefore, 30 CES/CEIEA found that the proposed Starlink Group 4 action was categorically excluded from the requirement to prepare either an EA or EIS.

After establishing the USSF on 20 December 2019, responsibility for VSFB was turned over to USSF on 13 August 2021. The USSF prepared this SEA to evaluate potential environmental impacts associated with approving the SpaceX increased launch cadence at VSFB from 12 to 36 launches annually, increase the barge landings from 12 to 36, and expand the downrange offshore landing area to include a larger portion of the Pacific Ocean. This SEA also evaluates the potential environmental impacts associated with the Federal Aviation Administration's (FAA's) licensing determinations to continue conducting Falcon launch operations at VSFB and FAA approving related airspace closures.

This SEA was prepared in accordance with (IAW) the National Environmental Policy Act (NEPA) as amended (42 United States Code [USC] 4321 et seq.); the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations [CFR] Parts 1500–1508); the Department of the Air Force's (DAF's) Environmental Impact Analysis Process (32 CFR Part 989). In addition to the USSF's environmental review policies and procedures, this SEA considers the FAA's NEPA-implementing policy, FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*, and FAA Order 1050.1F Desk Reference so that the FAA can adopt, fully or in part, the SEA when conducting their environmental review for licensing determinations, as well as airspace closures for Falcon 9 launches. "The 1050.1F Desk Reference provides explanatory guidance for environmental impact analysis performed to comply with CEQ Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (CEQ Regulations) 40 CFR Parts 1500-1508, U.S. Department of

Transportation (DOT) Order 5610.1C, Procedures for Considering Environmental Impacts, and FAA Order 1050.1F Environmental Impacts: Policies and Procedures."

1.2 PROJECT LOCATION

VSFB occupies 99,604 acres (ac.) of central Santa Barbara County, California, and is approximately halfway between San Diego and San Francisco (**Error! Reference source not found.**). VSFB 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 VSFB into two distinct parts: North Base and South Base. SLC-4 is located on South Base (**Error! Reference source not found.**). SLC-4E is the existing Falcon 9 program launch facility. An aerial view of the facility is depicted in **Error! Reference source not found.** (SpaceX 2021). SLC-4E is approximately 4.0 mi south of the Santa Ynez River and 0.9 mi east of the Pacific Ocean.

SLC-4W is the existing Falcon 9 program landing facility. This facility is located approximately 715 feet (ft) west of SLC-4E and 0.5 mi inland from the Pacific Ocean. The 2018 SEA analyzed up to 12 landings at SLC-4W per year. In addition to landings at SLC-4W, SpaceX also lands Falcon 9 first stages up to 12 times per year offshore on a droneship southwest of VSFB in landing areas which have been approved through a combination of prior EAs and SEAs (**Error! Reference source not found.**; 2011 EA, 2016 EA, 2016 SEA, 2018 SEA).

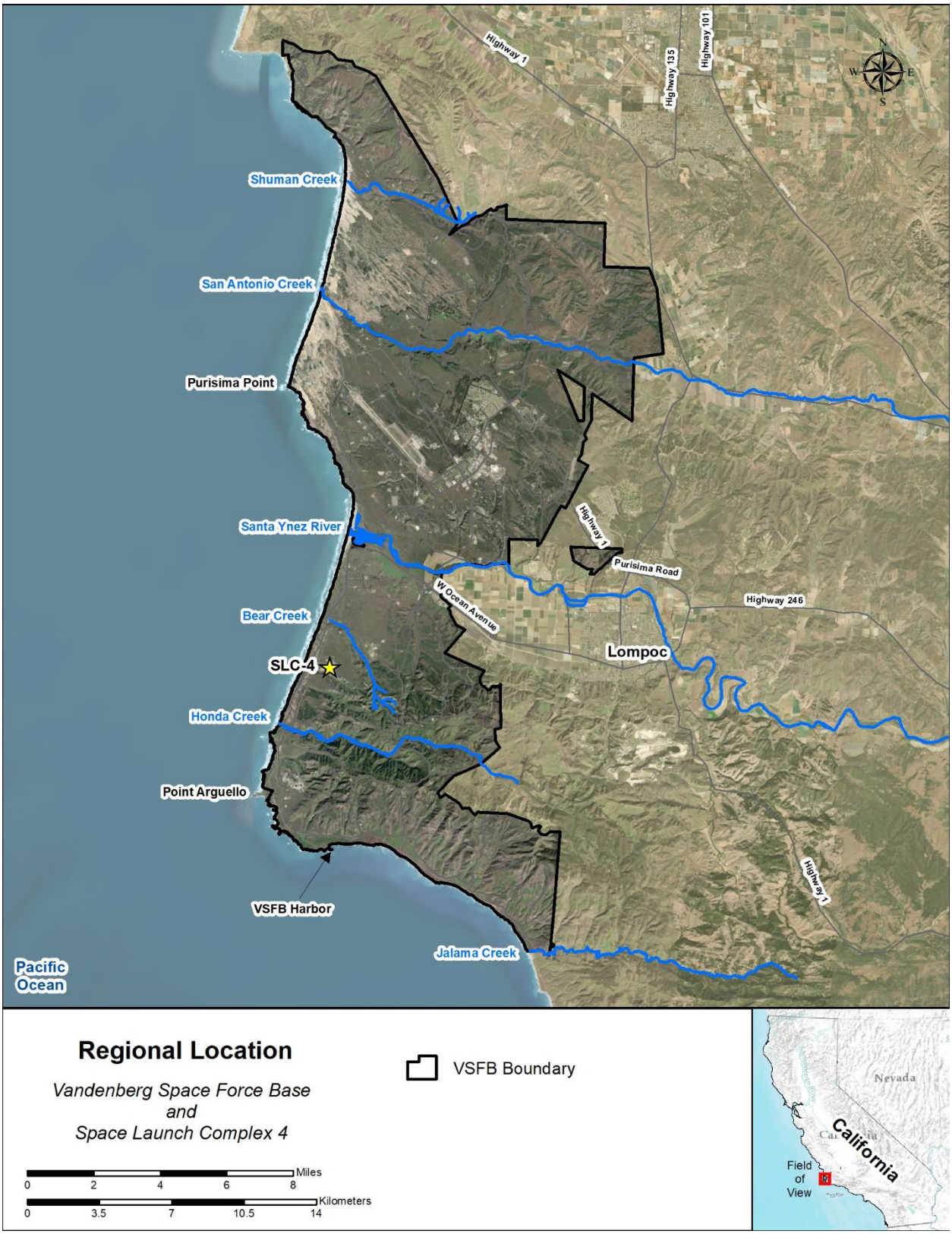

Figure 1.2-1. Regional Location of Vandenberg Space Force Base

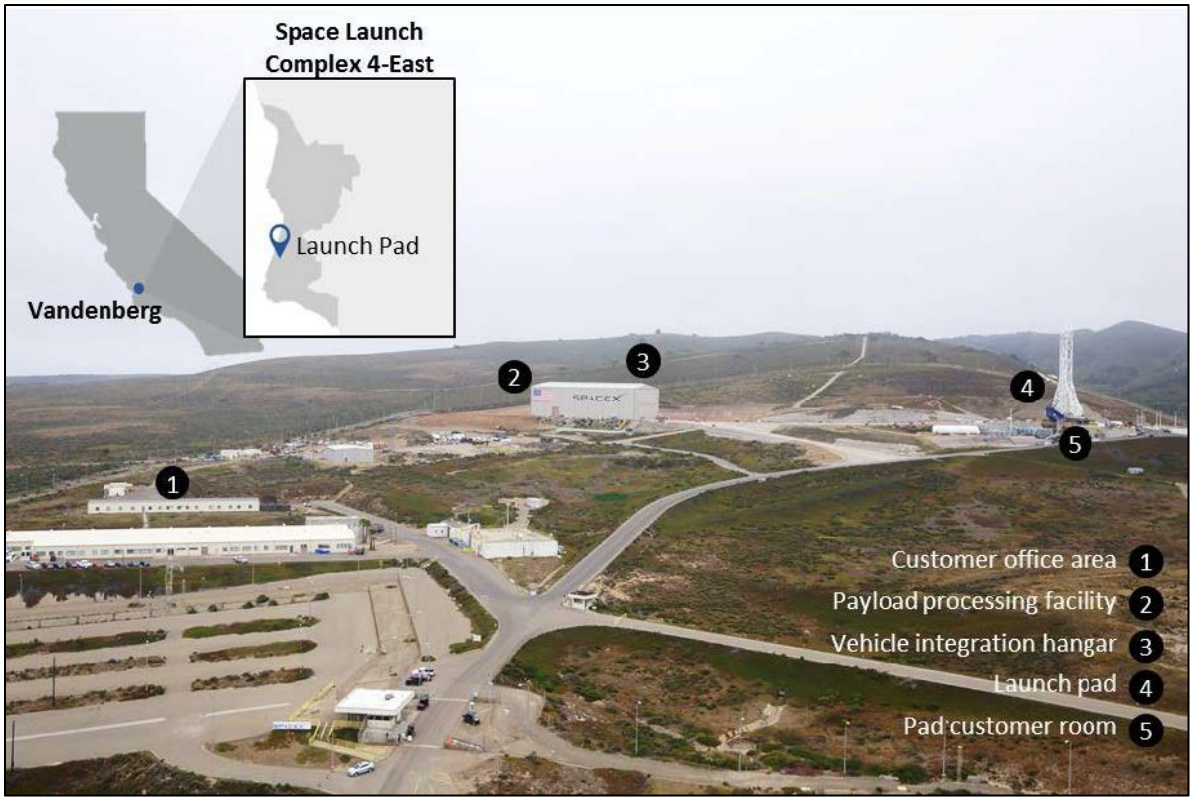

Figure 1.2-2. Space Launch Complex 4-East

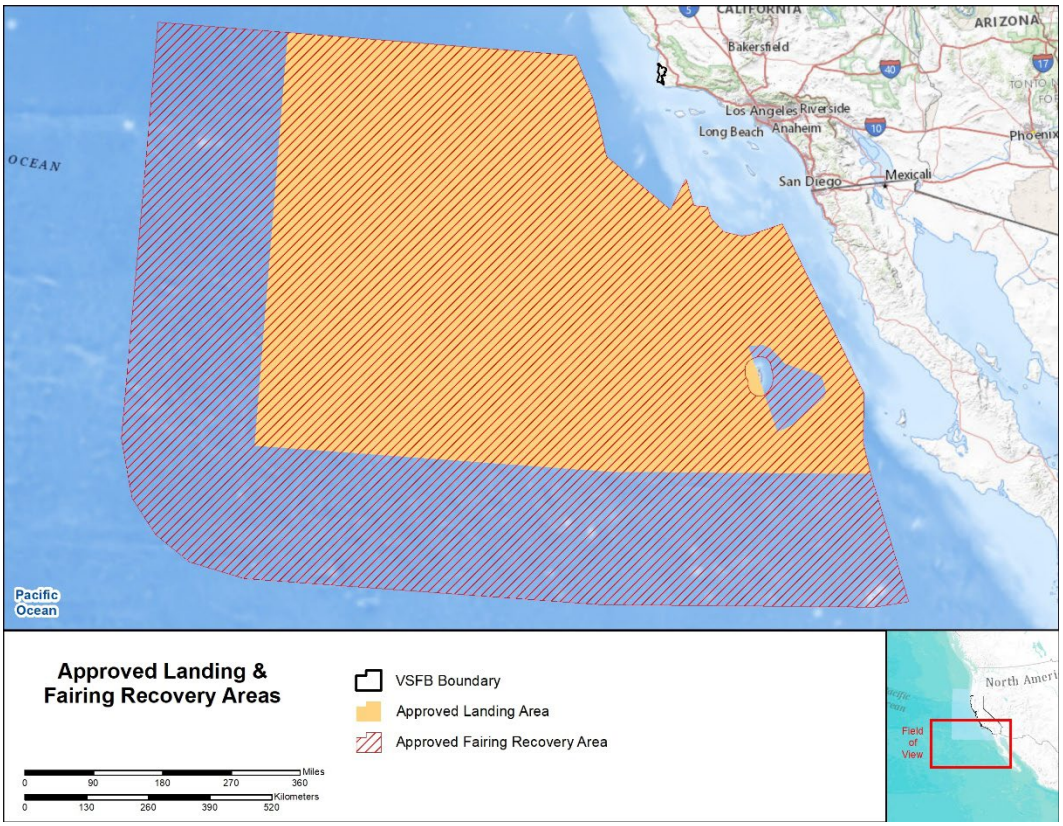

Figure 1.2-3. Approved Falcon 9 Landing and Fairing Recovery Areas

1.3 PURPOSE AND NEED FOR THE PROPOSED ACTION

The purpose of the Proposed Action is to provide greater mission capability to the DOD, NASA, and commercial customers by increasing Falcon 9 launch cadence. The FAA forecasts that commercial launch operations will increase in the United States (U.S.) from an all-time high in 2022 of 87 launches, to up to 186 launches by just 2026. The Proposed Action is needed so that SpaceX can continue to implement missions for the U.S. government while simultaneously meeting its ever-increasing commercial launch demands. Adding new northerly trajectories from VSFB is also needed to allow SpaceX to reach inclinations not currently available through existing trajectories.

The Proposed Action also fulfills Congress's grant of authority to the Secretary of Defense (SECDEF), pursuant to 10 USC § 2276(a), *Commercial Space Launch Cooperation*, that SECDEF is permitted to take action to:

> "(1) maximize the use of the capacity of the space transportation infrastructure of the [DOD] by the private sector in the U.S.;
>
> (2) maximize the effectiveness and efficiency of the space transportation infrastructure of the [DOD];
>
> (3) reduce the cost of services provided by the [DOD] related to space transportation infrastructure at launch support facilities and space recovery support facilities;
>
> (4) encourage commercial space activities by enabling investment by covered entities in the space transportation infrastructure of the [DOD]; and
>
> (5) foster cooperation between the [DOD] and covered entities."

By increasing launch capacity at VSFB, the Proposed Action allows continued fulfillment of the National Space Policy guidance of promoting a "robust commercial space industry and strengthen [U.S.] leadership as the country of choice for conducting commercial space activities."

1.4 SCOPE OF ENVIRONMENTAL REVIEW

This SEA identifies, describes, and evaluates the potential environmental impacts that could result from the Proposed Actions, reasonable alternatives to the Proposed Actions, and the No-Action Alternative for each Proposed Action, as well as possible cumulative impacts from other past, present, and reasonably foreseeable actions on VSFB. Chapter 2 describes the Proposed Action and Alternatives. Chapter 3 describes the existing conditions for each resource area. Chapter 4 analyzes the potential environmental effects of the Proposed Action and Alternatives. Chapter 5 analyzes potential cumulative impacts.

1.5 DOCUMENTS INCORPORATED BY REFERENCE

As 40 CFR Part 1501.12 indicates, agencies shall incorporate relevant material into environmental documents by reference when the effect is to cut down on bulk without impeding agency and public review of the action. The following documents are incorporated by reference:

- *2018 Final SEA for Launch, Boost-Back, and Landing of the Falcon 9 and Vandenberg Air Force Base, California and Offshore Landing Contingency Options* (USAF 2018)

- *2016 Final SEA for Boost-Back and Landing of the Falcon 9 Full Thrust First Stage at Iridium Landing Area, Vandenberg Air Force Base, California and Offshore Landing Contingency Option* (USAF 2016b)
- *2016 Final EA for Boost-Back and Landing of the Falcon 9 Full Thrust First Stage at SLC-4 West, Vandenberg Air Force Base, California and Offshore Landing Contingency Option* (USAF 2016a)
- *2011 Final EA for Falcon 9 and Falcon 9 Heavy Launch Vehicle Programs from Space Launch Complex 4 East, Vandenberg Air Force Base, California* (USAF 2011)

These documents were reviewed to identify any changes that have occurred since their finalization. Any changes that were identified are incorporated into this SEA.

1.6 LEAD AND COOPERATING AGENCY ACTIONS

Pursuant to agreements between the USSF and the FAA, the USSF is the lead agency for preparing and coordinating this SEA (40 CFR Part 1501.7). The FAA and the United States Coast Guard (USCG) are cooperating agencies (40 CFR Part 1501.8). Under 10 USC § 2276, *Commercial Space Launch Cooperation*, and DOD Instruction 3100.12, *Space Support,* the DAF is responsible for conducting activities to support commercial launch and reentry activity. In addition, as the owner and operator of VSFB, the DAF has authority over space-related operations, to include ground-based operations on VSFB. After the public reviews the SEA, if the USSF determines that the Proposed Action would not individually or cumulatively result in significant impacts on the human or natural environment, the USSF would issue a FONSI.

FAA is a cooperating agency because it licenses commercial space launch operations in the U.S. and approves related airspace closures. Under the U.S. Commercial Space Launch Act (CSLA), 51 USC Subtitle V, Chapter 509, Sections 50901-50923, Congress provided the DOT statutory direction to, in part, "protect the public health and safety, safety of property, and national security and foreign policy interests of the United States" while "strengthening and [expanding] that United States space transportation infrastructure, including the enhancement of United States launch sites and launch-site support facilities, and development of reentry sites, with Government, State, and private sector involvement, to support the full range of United States space-related activities." Within the DOT, the Secretary of Transportation's authority under the CSLA has been delegated to the FAA Office of Commercial Space Transportation. FAA Order 1050.1F, contains the FAA's policies and procedures for NEPA compliance. The FAA intends to adopt this SEA to support its environmental reviews when evaluating SpaceX's requests for a new license for Falcon 9 operations at VSFB, along with potential renewals and modifications to licenses within scope of operations analyzed in this SEA. In addition, the FAA intends to adopt this SEA to support its environmental review when evaluating related airspace closures. From this SEA's analysis, the FAA will draw its own conclusions and assume responsibility for its environmental decision and any related mitigation measures. For the FAA to use this SEA analysis to support its licensing determination, the SEA must comply with FAA Order 1050.1F requirements. Successfully completing the environmental review process does not guarantee that the FAA would modify SpaceX's launch license or approve related airspace closures.

The USCG is a cooperating agency because of their regulatory authority over waters subject to jurisdiction of the U.S. pursuant to the Ports and Waterways Safety Act (PWSA), Title 46 USC, chapter 700 (46 U.S.C 700), regulatory authority of U.S. and foreign flag vessels as outlined in 33 and 46 CFR. The USCG also reviews and advises SLD 30 on all launch and reentry site evaluation risk assessments with focus on vessel

navigation safety. The USCG also supports SLD 30 with early warning communication to the maritime industry with notice to mariners (NOTMAR) as outlined in 33 CFR Part 72. SLD 30 and USCG District Eleven have entered into a Memorandum of Agreement (MOA; Appendix L) to assist with maritime safety and space operational review that have a maritime nexus. USCG District Eleven utilizes authorities authorized in the PWSA and CFR to evaluate SpaceX and SLD 30 navigation risk assessments with launch and reentry activities associated with commercial and recreational vessels on the high seas off the California Coast. The USCG evaluates every launch and reentry activity for risk to waterway users and the environment under this process.

1.7 Interagency and Intergovernmental Coordination and Consultations

Under 32 CFR 989.14(l), 30 SLD involved other federal agencies, state, Tribal, and local governments, and the public to prepare this SEA. In meeting this requirement, as well as the Intergovernmental Cooperation Act of 1968 [42 USC 4321] and Executive Order (EO) 12372, *Intergovernmental Review of Federal Programs*, SLD 30 notified and consulted with relevant federal and state agencies on the Proposed Action and alternatives to identify potential environmental issues and regulatory requirements associated with project implementation.

The National Historic Preservation Act (NHPA) implementing regulations at 36 CFR Part 800 require federal agencies to consult with federally-recognized tribes historically affiliated with the area of potential effects for the project to determine the presence of and resolve adverse effects to Traditional Cultural Properties. The SLD 30 Commander appointed Christopher Ryan (30 CES/CEIEA) as the Installation Tribal Liaison Officer. Mr. Ryan designated Josh Smallwood, Base Archeologist, to represent the USSF in this tribal consultation. Mr. Smallwood is carrying out Native American consultation via email with Nakia Zavalla, the Santa Ynez Band of Chumash Indians' (SYBCI) tribal chairman's appointee to SLD 30 for Section 106 consultations. SLD 30 has notified the SYBCI of the Proposed Action and requested tribal comments on the Proposed Action to initiate government-to-government consultation. The SYBCI response will be included in Appendix C of the Final SEA.

1.8 Public Notification and Review

Following the publication of a Notice of Availability (NOA) in the Lompoc Record and Santa Maria Times, the DAF made the Draft SEA and FONSI available for public review and comment for 30 days. The DAF also distributed the Draft SEA and FONSI per the current VSFB NEPA Distribution List (Appendix J), including the State Clearinghouse. The Final SEA will include a copy of the NOA, proofs of publication, proof of library deliveries, public comments, and responses to public comments.

2 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

2.1 SELECTION STANDARDS AND CRITERIA

IAW 32 CFR Part 989.8, SpaceX evaluated sites to increase Falcon annual launch cadence for reasonableness using the following selection criteria:

- **Criterion 1:** Ability to launch payloads to polar and geostationary orbits
- **Criterion 2:** Proximity to existing SpaceX facilities to support Falcon 9 missions
- **Criterion 3**: Availability to support an increased launch cadence

2.2 PROPOSED ACTION

The Proposed Action is to increase the Falcon 9 annual launch cadence at VSFB and include additional downrange offshore landing locations in the Pacific Ocean. Under the Proposed Action, SpaceX would launch the Falcon 9 from SLC-4E up to 36 times per year. Following each launch, SpaceX would perform a boost-back and landing of the first stage up to 36 times, either downrange on a droneship or at SLC-4W at VSFB. As approved in prior EAs and SEAs, no more than 12 first stage landings would occur at SLC-4W per year. There would be no change to the Falcon 9 specifications or launch/landing facilities as presented and analyzed in the 2011 EA and subsequent NEPA documents (2016 EA, 2016 SEA, and 2018 SEA). First stage processing protocols associated with the Proposed Action would remain unchanged; however, they would increase in frequency to support 36 launches per year.

2.2.1 LAUNCH

SpaceX would launch Falcon 9 from SLC-4E up to 36 times per year the same way described in the 2018 EA. One to three days before each launch, an engines static fire test, which lasts a few seconds, may be done. The need to conduct a static fire test depends on the mission, but there would be no more than 36 static fire events per year. Launch operations would occur day or night, at any time during the year. There would be approximately 7 to 14 days between each launch. Following each launch, SpaceX would perform a boost-back and landing of the first stage, either downrange on a droneship or at SLC-4W at VSFB, as described in Section 2.2.3. Mission objectives may occasionally require expending the first stage booster in the Pacific Ocean (Figure 2.2-2), as the 2011 EA (USAF 2011) described. If intentionally expending the first stage, it would break up upon atmospheric re-entry and there would be no residual propellant or explosion upon impact with the Pacific Ocean. The first stage remnants would sink to the bottom of the ocean.

SpaceX, the USSF, the FAA, and the USCG implement numerous protocols and procedures to assess, avoid, mitigate, and minimize potential risks to public safety and the environment during space launch, which are discussed throughout this SEA. The Falcon 9 launch vehicle is proven as one of the most reliable space launch vehicles ever developed, with a 99.1% launch success rate in 218 launches since June 2010. While unlikely, there is an extremely low risk of a launch failure. This represents an off-nominal, very low probability, and worst case scenario, and is not assessed in detail in this SEA for these reasons. SpaceX implements an Operations Safety Plan at SLC-4, and in the event of a launch failure, SpaceX would activate an Emergency Action Plan. Accordingly, the potential impacts on the environment resulting from a launch failure are not expected to be significant.

The Proposed Action does not include altering the dimensions (shape and altitude) of the airspace or shipping lanes. The new launch trajectories included in the Proposed Action can be accomplished with existing airspace designation. USCG District Eleven was granted specific regulatory authority to restrict vessel movement, implement safety and warning zones, and provide early warning advisement, but all responsibility to limit risk to navigation safety is solely on the acting space party. USCG District Eleven will advise SpaceX and SLD 30 when the risk exceeds acceptable levels and the primary applicant will be responsible for minimizing the risk with alternate strategies before formal publications. Federal government agencies, including the USCG, are responsible for ensuring maritime safety as required applicable statutes and regulations, such as the PWSA, 33 CFR Part 1 (*General Provisions*), 14 CFR Part 450 (*Launch and Reentry License Requirements*), and 40 CFR Part 229.3 (*Transportation and Disposal of Vessels*). To comply with the necessary notification requirements, SLD 30 would notify USCG of any upcoming launch operations to ensure safe launches over the high seas and navigable waters of the U.S., consistent with current procedures. Prior to utilizing the new proposed northern trajectories (Section 2.2.1.1), SLD 30 and USCG District Eleven would review the SpaceX trajectory IAW the MOA (Appendix L) to develop risk plots and other materials for 14 CFR Part 450 compliance, including: (1) operating area and impact locations, (2) maritime vessel risk assessment and Ec/Pc plots, and (3) all materials necessary to develop a NOTMAR. The USCG would be responsible for issuing NOTMARs that provide hazard area locations before each mission event with ocean impacts. A NOTMAR provides notice of temporary changes in conditions or hazards in navigable waterways with maritime traffic to assist in mitigating risks for dangers associated with waterway users. This tool provides both an established and reliable line of communication with the maritime public. The NOTMAR would include the operations dates and times and coordinates of the hazardous operation area.

All launch and reentry operations would comply with the necessary notification requirements, including issuing NOTAMs, as defined in agreements required for an FAA issued launch license. Advance notice via Notice to Air Missions (NOTAMs) assist general aviation pilots to schedule around any temporary disruption of flight activities in the area of operation. A NOTAM provides notice of unanticipated or temporary changes to components of, or hazards in, the National Airspace System (FAA Order JO 7930.2S, Notices to Air Missions). The FAA issues a NOTAM at least 72 hours before a launch or reentry activity in the airspace to notify pilots and other interested parties of temporary conditions. Advance notice via NOTAMs and identifying Aircraft Hazard Areas would assist pilots to schedule around any temporary disruption of flight activities in the area of operation. Launches and reentries would be infrequent, of short duration, and SpaceX regularly provides FAA with updates and schedule changes to their notional three-month launch schedule to minimize interruption to air traffic.

To comply with the FAA's licensing requirements, Western Range operations, including SpaceX's launches from VSFB, follow the launch/reentry communication and coordination procedures stated in a Letter of Agreement (LOA) (dated 7 April 2020; Appendix K) between SLD 30 and the FAA. The LOA establishes responsibilities and procedures for Western Range operations within airspace common to the Oakland Center, Los Angeles Center, Santa Barbara Terminal Radar Approach Control Facility, Air Traffic Control System Command Center, and Central Altitude Reservation Function areas of jurisdiction. The LOA defines responsibilities and procedures applicable to operations, which require using Restricted Areas, Warning Areas, Air Traffic Controlled Assigned Airspace, and/or altitude reservations within Western Range airspace. Launches would be several minutes and scheduled in advance to minimize interrupting airspace and waterways.

During launch and landing operations, VSFB Range Safety monitors waterborne vessels in the affected area. Although vessel operators are informed of these operations, there is no requirement for them to alter their routes or change their navigation speed. If vessels are obstructing a launch or reentry phase of the operations, the launch would be delayed or altered within VSFB launch policies. A background on airspace management, the study area, and existing conditions is included in Appendix K (Airspace).

The FAA has never licensed or permitted a launch from VSFB that involved a northern launch trajectory. Similar to the current southerly trajectory launches, the FAA would prepare an Airspace Management Plan before a northern trajectory mission to assess the potential impacts on the National Airspace System (NAS). If the FAA's analysis concludes a northerly trajectory would create an unacceptable limitation on air traffic, the FAA would work with SpaceX to identify appropriate mitigation strategies, such as shortening the requested launch window or shifting the launch time. Since previous FAA analyses for launches occurring at VSFB have typically concluded minor impacts on the NAS, the FAA does not expect northern launches would generate significant environmental impacts. Northern launches would not require a designation of a new special use airspace.

For each licensed launch or reentry operation the FAA analyses the effects on NAS efficiency and capacity. These analyses are documented in Airspace Management Plans, which are completed approximately 3–5 days before a launch. They help the FAA determine if the proposed launch would result in an unacceptable limitation on air traffic. If that were the case, the FAA may need to work with the operator to identify appropriate mitigation strategies, such as shortening the requested launch window or shifting the launch time, if possible. The FAA currently shares data with launch and reentry operators to avoid operations during days with high seasonal aviation traffic volume. These analyses have concluded that the majority of commercial space launch operations result in minor or minimal NAS impacts. This is largely due to the relatively low aircraft traffic density in the oceanic regions where SpaceX operations occur and the ability of the FAA to manage the airspace for all users.

SpaceX would submit a Flight Safety Data Package to the FAA; this typically occurs 60 days before the targeted launch or reentry. The package would include the launch/reentry trajectory and associated Aircraft Hazard Areas. These Aircraft Hazard Areas define the temporarily closed airspace that would be defined and published through a NOTAM before the launch/reentry. FAA Air Traffic Organization Space Operations Office uses the Aircraft Hazard Area information to produce an Airspace Management Plan, which describes the launch/reentry information and any associated NAS impacts. FAA controlled airspace may be restricted through the activating airspace closures. The most common type of airspace closures are Temporary Flight Restrictions and altitude reservations. The FAA generally uses Temporary Flight Restrictions to protect airspace over land up to 12 nm offshore and altitude reservations to protect oceanic airspace beyond 12 nm offshore. The NOTAM would establish a closure window that is intended to warn aircraft to keep out of a specific region throughout the time that a hazard may exist. The length of the window is primarily intended to account for the time needed for the operator to meet its mission objectives. The location and size of the closure area is defined to protect the public. For a launch or reentry, typically the keep-out must begin at the time of launch and ends when the mission has been completed, terminated, or cancelled. Airspace closures are immediately released once the mission has successfully cleared the area and no longer imposes a risk to the public. The actual duration of airspace closure is normally much less than the original planned closure, especially if the launch or reentry window is relatively long and the launch or reentry occurs at the beginning of the window. The FAA typically begins

to clear airspace and reroute aircraft before a launch or reentry and directs aircraft back into the released airspace after the mission to recover to normal flow and volume.

Commercial space operations airspace location and size closures vary with each mission type and are influenced by multiple factors, including vehicle hardware reliability. The size of airspace closures shrink as reliability is established with results and analysis from each launch. For example, airspace closures for past Falcon 9 launches have ranged from several hundred miles in length for early launches to less than 30 miles in length for a recent launch. For a new launch vehicle initial launch, the hazard areas and associated airspace closures are bigger to account for the increased likelihood of a vehicle failure, relative to a mature rocket. Subsequent launches of that launch vehicle include smaller hazard areas compared to the initial launch. Thus, the airspace closure for Falcon 9's initial launches were much larger than subsequent Falcon 9 launches are expected to be.

2.2.1.1 Trajectories

The 2011 EA states that Falcon 9 launch 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. The USSF issued a Categorical Exclusion (813-21-044) in July 2021 to expand the lower limit of the azimuth range to approximately 140 degrees for Starlink G4 missions. In addition to the previously analyzed range of trajectories between 140 and 301 degrees, the Proposed Action includes adding a northerly mission profile with a launch azimuth between 301 and 325 degrees (**Error! Reference source not found.**).

Each trajectory would be provided in SpaceX's Flight Safety Data Package and submitted to the FAA before the launch. Launches from VSFB would not result in more than 12 closures of Jalama Beach each calendar year, as outlined in the closure agreement with Santa Barbara County and the DAF. SLD 30 would manage the manifest for all launch operators out of VSFB to comply with the closure agreement and not exceed more than 12 closures in one year. Closures are determined by USSF Range Safety based on individual mission trajectories; thus, not every launch has the potential for a Jalama Beach closure. SLD 30 has determined that there is no need to close Ocean Beach County Park or Surf Beach during SpaceX launches with downrange droneship landings (including the proposed northern trajectories). Accordingly, launches with downrange landings under the Proposed Action would not exceed 12 closures annually as previously described in the 2018 SEA. Closures are discussed in more detail in Sections 4.7 and **Error! Reference source not found.**.

2.2.1.2 Personnel and Ground Operations

Operations would be similar to those described in the 2018 EA. To support a cadence increase, SpaceX anticipates adding up to 100 personnel to VSFB operations. The existing facilities are adequate to support the staff increase. Ground transportation support during launch campaigns would continue to be minimal. SpaceX would continue to utilize up to four specialized trucks per launch to transport boosters between existing SpaceX facilities, including facilities in Hawthorne, California, Building 398, and the SLC-4E hangar on VSFB. The first stage, second stage, interstage, and payload are each transported by 18-wheel trucks. Fuel and helium are also delivered by 18-wheel trucks on a weekly basis. Personal vehicles would be used by employees to commute locally on and off site. Payload integration and pre-launch

protocols associated with the Proposed Action would remain unchanged. However, these operations would increase in frequency to support 36 launches per year.

2.2.1.3 Utilities

As described in the 2018 EA, SpaceX would utilize a water-filled flame duct to reduce noise vibration impacts on payloads. Since implementation, SpaceX has reduced the amount of water needed in the flame duct per launch from 200,000 gallons or 0.61 acre-feet (ac-ft) to 70,000 or 0.21 ac-ft. Up to 7.67 ac-ft of water per year would be used in the flame duct. Until November 2022, SpaceX used a deluge water system on the pad during each launch operation that used up to 1.01 ac-ft of water per static fire and launch. However, this system has been replaced by a closed loop system for cooling water that eliminates the need to utilize launch pad water for cooling. As a result, water is no longer used for deluge. Landing operations at SLC-4W would continue to utilize approximately 40,000 gallons per landing or up to 1.47 ac-ft per year. In addition to water used for support of launch activities, approximately 6.44 ac-ft per year are used to support general non-launch activities at SLC-4. This general use would increase by approximately 3.92 ac-ft per year under the Proposed Action. Therefore, at maximum cadence, the Proposed Action would use up to 19.5 ac-ft of water per year. The current water source for VSFB, including SLC-4, is the San Antonio Creek Basin via four water wells. There is an existing connection between State water and the VSFB water supply system; however, due to ongoing drought conditions and significant reductions in State water allocations, VSFB will remain on well water from the San Antonio Creek Basin for the foreseeable future. Equipment and facilities at SLC-4 would continue to be powered by existing utility systems.

2.2.1.4 Jettisoned Skirt Rings

The Merlin Vacuum Engine (MVac) skirt ring is a segmented stiffener ring to prevent deformation of the second stage engine nozzle during integration and stage separation. The skirt ring is comprised of four segments that are temporarily bonded to the engine nozzle; each segment is a 102-inch-long curved titanium tube with a 1-inch diameter. Each segment weighs less than 1 pound (lb) and are similar in appearance to a curved shower curtain rod. During a launch, shortly after MVac ignition, the skirt ring/engine nozzle bond releases and the segments are jettisoned. The segments would land downrange in the Pacific Ocean in the area shown in Figure 2.2-1. SpaceX would not recover the MVac skirt ring segments.

2.2.2 Payload Fairing Recovery Operations

The Falcon 9 vehicle payload system includes a fairing cover that protects payloads (e.g., satellites). The fairing consists of two halves which separate, allowing payload deployment at the desired orbit. Each fairing half contains a parachute system for recovery, which consists of one drogue parachute and one parafoil. Following fairing re-entry, the parachute deploys at a high altitude (approximately 50,000 ft) to begin the initial slow down and to extract the parafoil. Following successful parafoil deployment, the parachute cuts away. The parachute system slows the fairing's descent to enable a soft splashdown so that the fairing remains intact. The predicted impact points within desired recovery areas of the fairing, parafoil, and parachute are developed using modeling tools. The parachute canopy area is approximately 110 square feet (ft^2) and the fairing parafoils are approximately 3,000 ft^2.

SpaceX anticipates approximately three recovery attempts per month involving recovery of both halves of the fairing. Up to 72 parachutes and 72 parafoils would land in the ocean annually. SpaceX would

attempt to recover all parafoils over this time period, but it is possible that some of the parafoils would not be recovered due to sea or weather conditions at the time of recovery. Recovery of the parachute assembly would be attempted if the recovery team can get a visual fix on the splashdown location. Because the parachute assembly is deployed at a high altitude, it is difficult to locate. In addition, based on the size of the assembly and the density of the material, the parachute assembly would be saturated and begin to sink. As a result, SpaceX has experienced limited success in recovering the parachutes but will continue to attempt recovery and improve the success rate. However, most parachutes would be deposited in the ocean.

The fairing and parafoil would be recovered by a salvage ship stationed in the Proposed Landing Area near the anticipated splashdown site, but no closer than 12 nm offshore (**Error! Reference source not found.**). The salvage ship would be able to locate the fairing using GPS data from mission control and strobe lights on the fairing data recorders. Upon locating the fairing, a rigid-hulled inflatable boat would be launched. Crew members would hook rig lines to the fairing and connect a buoy to the parafoil. Then the crew would release the parafoil riser lines and secure the canopy by placing it into a storage drum. If sea or weather conditions are poor, recovery of the fairing and parafoil may be unsuccessful, in which case the fairing and/or parafoil would be deposited in the ocean.

2.2.3 Boost-Back and Landing

The Proposed Action includes Falcon 9 first stage booster boost-back and landing, in the same manner as described in the 2018 EA. After the first stage engine cutoff and separation from the second stage, three of the nine first stage engines are restarted to conduct a reentry burn that helps prevent the first stage from breaking apart in the atmosphere and guides it to the landing location. Once the first stage is in position and approaching its landing target, the engines are cut off. A final burn of one to three engines is performed to slow the first stage to a velocity of zero for landing on the droneship or at SLC-4W. For first stage landing events at SLC-4W, access to Ocean Beach County Park and Surf Beach would be restricted. Closures of Surf Beach and Ocean Beach County Park would not exceed 12 closures annually as previously described in the 2018 SEA.

SpaceX's goal is to re-enter and land all first stage boosters for reuse. However, due to mission requirements or operational parameters, on rare cases some boosters may not complete a boost-back burn and landing and would be expended in the broad open ocean. We expect these boosters to break up upon atmospheric reentry or on impact with the ocean surface. Any surviving debris would sink, like the fate of traditional non-reusable first stage boosters. If an anomalous situation when an intentionally expended booster does not break up upon atmospheric reentry and impacts the ocean's surface intact, a residual amount of propellant (rocket propellant 1 [RP-1] and liquid oxygen [LOX]) would remain in the first stage upon impact (less than 1 percent). In this situation, the vehicle would possibility experience an explosive event due to mixing remaining fuel. This represents an off-nominal, low probability, and worst-case scenario and is not assessed for these reasons.

SpaceX measures wind speed in the landing area using weather balloons. Measurements are taken at various intervals before launch and landing events and are used to create the required profiles of expected wind conditions during the landing event. A radiosonde, which is approximately the size of a shoe box and is powered by a 9-volt battery, is attached to a weather balloon and transmits data to SpaceX and to vehicle onboard predictive systems. The balloon, which is made of latex, rises to approximately 12 to

19 miles and bursts. The balloon is shredded into many pieces as it falls back to Earth, along with the radiosonde, and lands in the ocean. The radiosonde does not have a parachute and would not be recovered.

Landing locations are specific to each mission. Accordingly, of the 36 landing attempts after each launch, SpaceX could land downrange in the Pacific Ocean on a droneship up to 36 times per year. Of the 36 total launch activities, no more than 12 landings per year would occur at SLC-4W. The Proposed Action includes expanding the potential landing area in the Pacific Ocean to the Proposed Landing Area, shown in **Error! Reference source not found.**, to accommodate new trajectories.

SpaceX utilizes a tug that tows the droneship into position before launch and a support vessel to house crew and communications equipment. The droneship would be no closer than 12 nm anywhere within the Proposed Landing Area (**Error! Reference source not found.**). Before first stage landing, the support vessel and tug fall back to approximately five nm or more from the droneship.

After landing, safing, and securing operations are completed, the droneship is placed under tow and all vessels return to the Port of Long Beach. The booster and fairings would then be transported to a SpaceX facility for refurbishment (Sections 2.2.5 and 2.2.6).

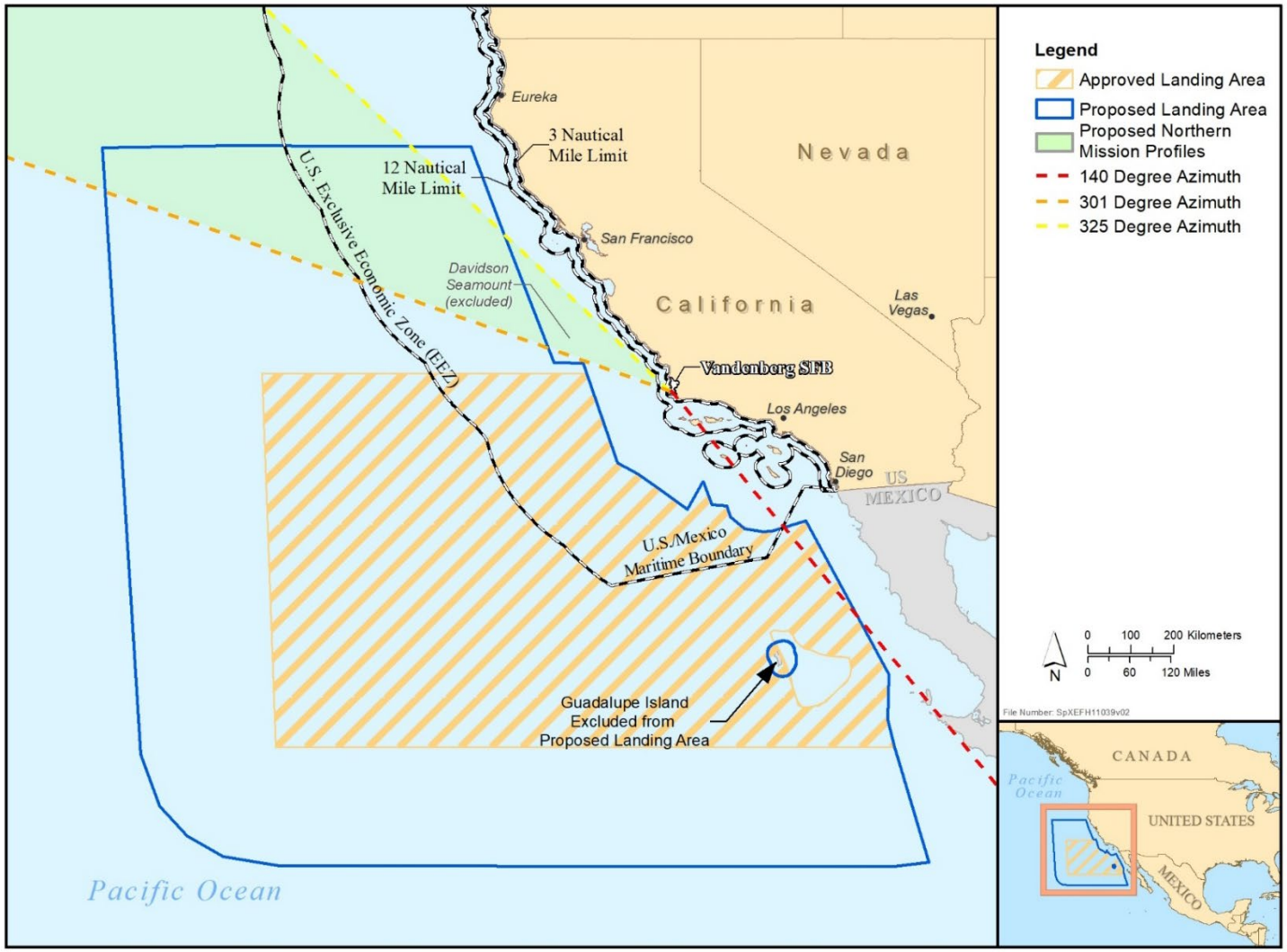

Figure 2.2-1. Northern Mission Launch Azimuths and Proposed Landing and Fairing Recovery Areas

2.2.4 LAUNCH AND LANDING NOISE

2.2.4.1 Rocket Engine Noise

Engine noise was modeled using RUMBLE v. 2.0, a publicly available software tool developed by Blue Ridge Research and Consulting, LLC to model rocket engine noise. This model incorporates numerous components, including the acoustic power of the rocket engine source, forward flight effects, the angle from the source to the receiver (directivity), Doppler effect, propagation between the source and receiver (ray path), atmospheric absorption, and ground interference to estimate received noise levels (Bradley et al. 2018). RUMBLE assumes the surface of the earth is flat and therefore does not account for attenuation due to landforms. Thus, the estimates of engine noise levels below are conservative for areas shielded by hills, bluffs, or other features, such as buildings or dense vegetation.

Engine noise produced during launches would primarily impact most of VSFB and the surrounding area (Figure 2.2-2). Landing noise would impact a substantially smaller area along the coast between Bear Creek and Honda Creek (Figure 2.2-3). Landing noise follows launch and associated launch engine noise by approximately five to seven minutes and typically occurs slightly before the sonic boom impacts land. Static fire engine tests last up to seven seconds and would generate noise across south VSFB and portions of north Base (Figure 2.2-4).

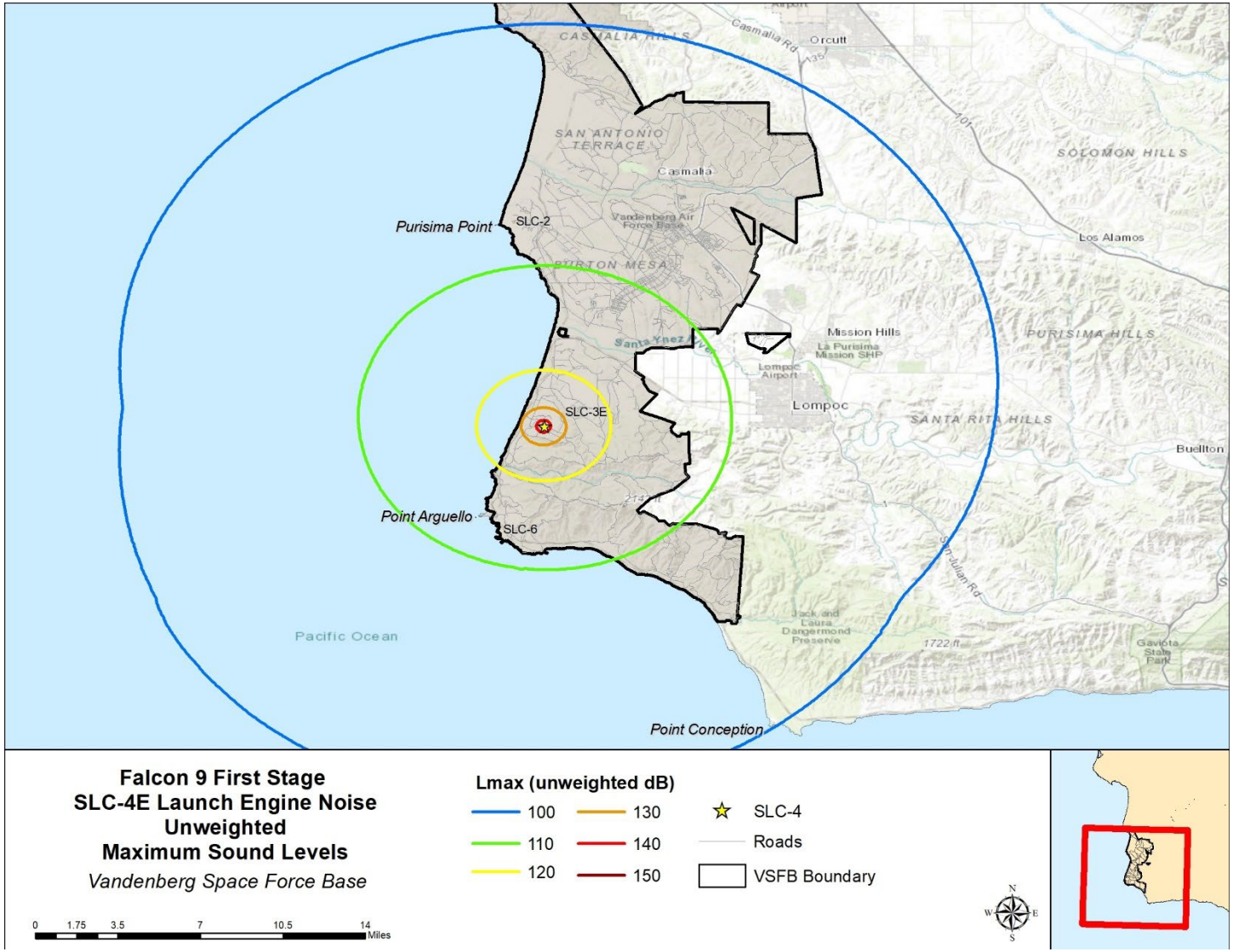

Figure 2.2-2. Maximum Unweighted Engine Noise During Falcon 9 Launch from SLC-4E

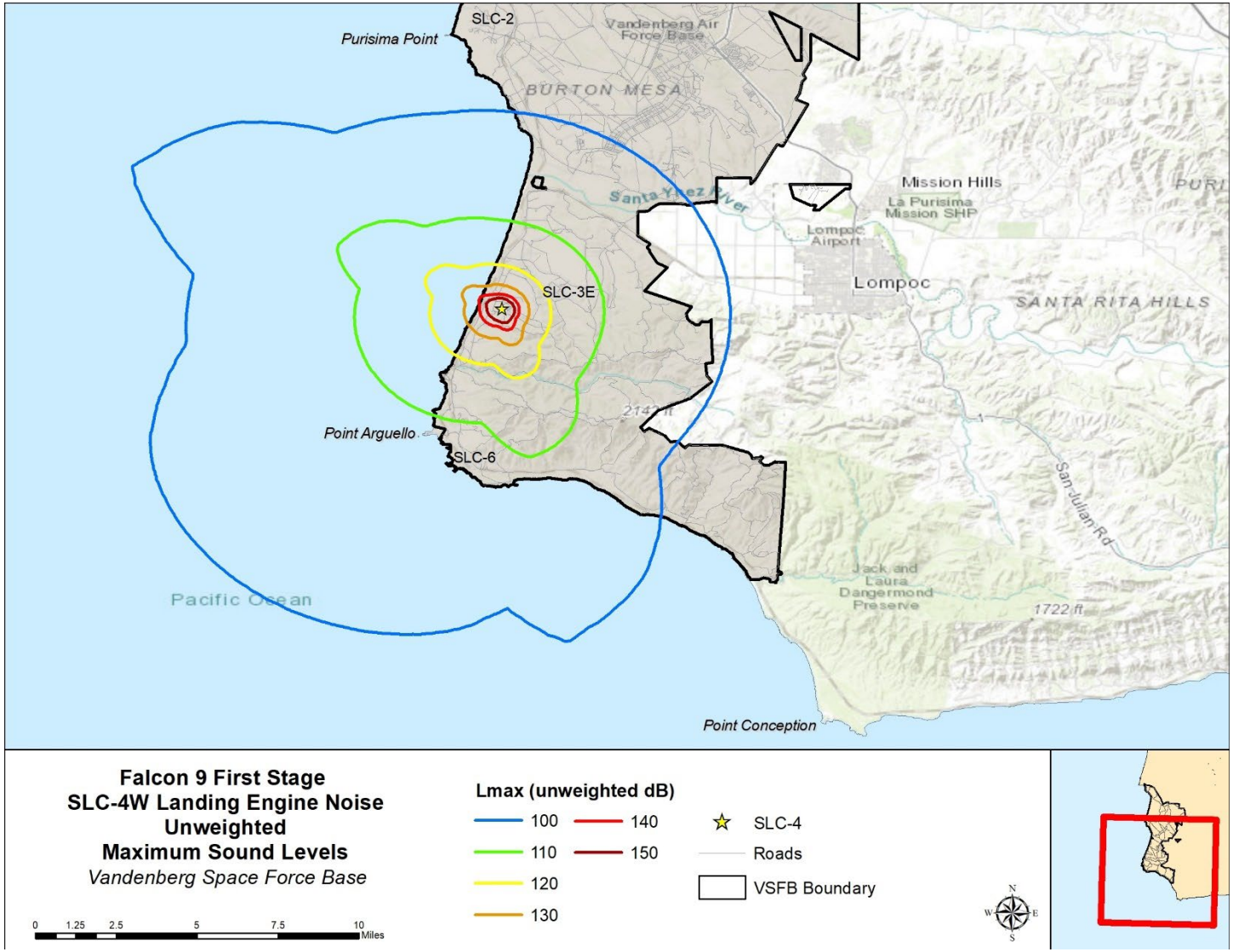

Figure 2.2-3. Maximum Unweighted Engine Noise During Falcon 9 First Stage Landing at SLC-4W

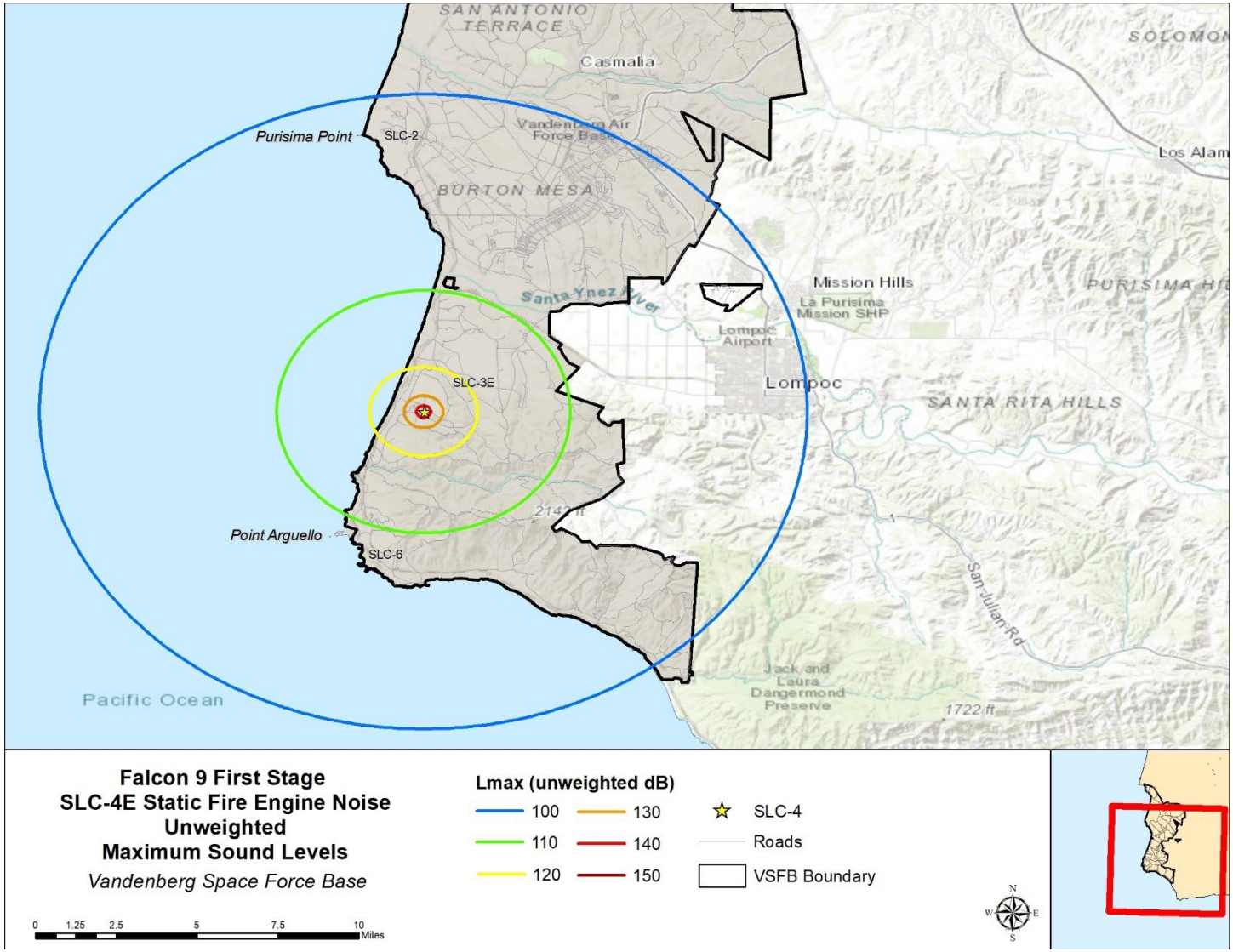

Figure 2.2-4. Maximum Unweighted Engine Noise During Falcon 9 Static Fire at SLC-4W

2.2.4.2 Sonic Boom

PCBoom v4.99 was used to predict the peak overpressures and impact locations of potential sonic booms, as generated by the Falcon 9 vehicle during launches from SLC-4. PCBoom considers the size and shape of the vehicle and the trajectory in relationship to the thrust, drag, and weight of the vehicle, which vary during the flight of the vehicle, to estimate the initial signature of the overpressure. The model then propagates the overpressure through site and seasonally specific meteorological data that is obtained from a 10-year RAWINSONDE database profile that includes the high wind, low wind, low temperature, high temperature, and median profiles sampled evenly throughout each month of the year (National Oceanic and Atmospheric Administration [NOAA] 2022). A full description of the methods used by PCBoom v4.99 can be found in Bradley et al. 2018.

During ascent, a sonic boom (overpressure of impulsive sound) with a peak of approximately 3.0 to 5.0 pounds per square foot (psf) would be generated. Depending on the launch trajectory, the sonic boom may or may not impact the surface of the earth. Approximately 24 percent (seven out of 29) of Falcon 9 launches from SLC-4 since 2017 have not produced sonic booms that impact the surface of the earth because the ascent of the rocket was too steep. When the sonic booms do impact the earth's surface, they primarily impact the Pacific Ocean, but may overlap the Northern Channel Islands (NCI; Anacapa Island, San Miguel Island [SMI], Santa Cruz Island [SCI], and Santa Rosa Island [SRI]) with up to a 5.0 psf sonic boom in some areas (see example shown in Figure 2.2-6). Since 2017, 22 Falcon 9 launches from VSFB have produced sonic booms that impacted the surface of the earth; of those, seven have impacted the NCI. As noted in Section 2.2.1.1, SpaceX proposes to add a northerly mission profile with launch azimuths between 301 and 325 degrees (Figure 2.2-1). Sonic boom modeling determined that launches with these northerly mission profiles would not result in sonic booms impacting the surface of the earth (Appendix E; ManTech SRS Technologies, Inc. 2023).

During descent, a sonic boom would be generated. Modeling of the past nine Falcon 9 missions conducted with first stage landing at SLC-4W have predicted a maximum sonic boom of between 2.0 and 5.0 psf (see example in Figure 2.2-7). During these SLC-4 landing events, sonic boom measurements were collected on south VSFB to meet monitoring requirements set by the National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife Service (USFWS). At the monitoring locations, these measurements have typically been within the range predicted by modeling (see Appendix E; MSRS 2023). Sonic boom levels in Lompoc have typically been predicted to range from 0.5 to 1.5 psf, but may rarely reach as high as 4.0 psf, depending on atmospheric conditions and mission trajectories (Appendix E; MSRS 2023). Since 2020, the measured sonic boom levels have been fairly consistent with the predicted values (Appendix E; MSRS 2023). Although unlikely, sonic booms up to 3.1 psf may also impact the NCI during landing events at SLC-4 or on a droneship located offshore near VSFB. However, during the majority of downrange droneship landings in the proposed landing areas, sonic booms would be directed entirely at the ocean surface without impacting any land (see examples shown in Figures 2.2-8 and 2.2-9).

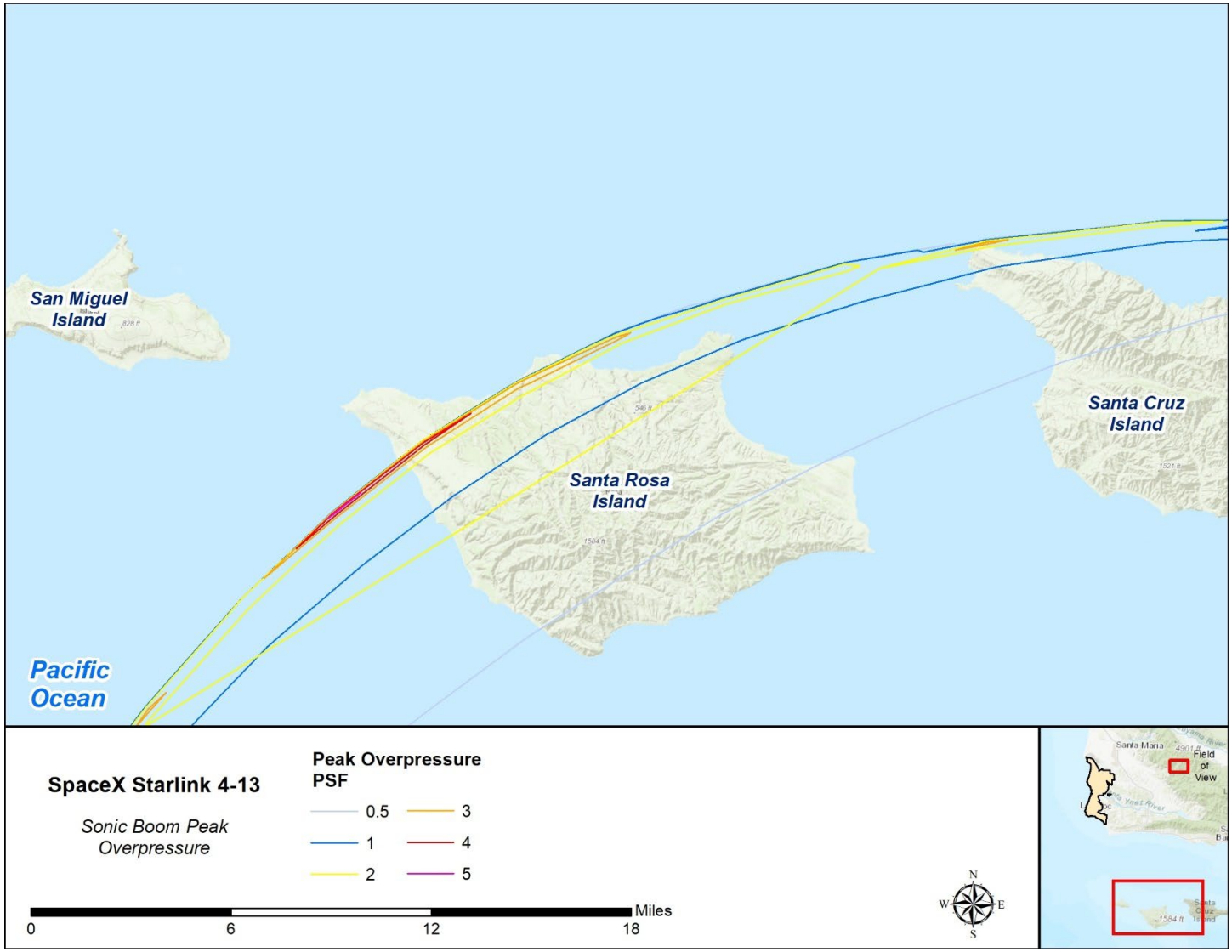

Figure 2.2-5. Sample Sonic Boom Profile Generated During Launch of Falcon 9 from SLC-4E

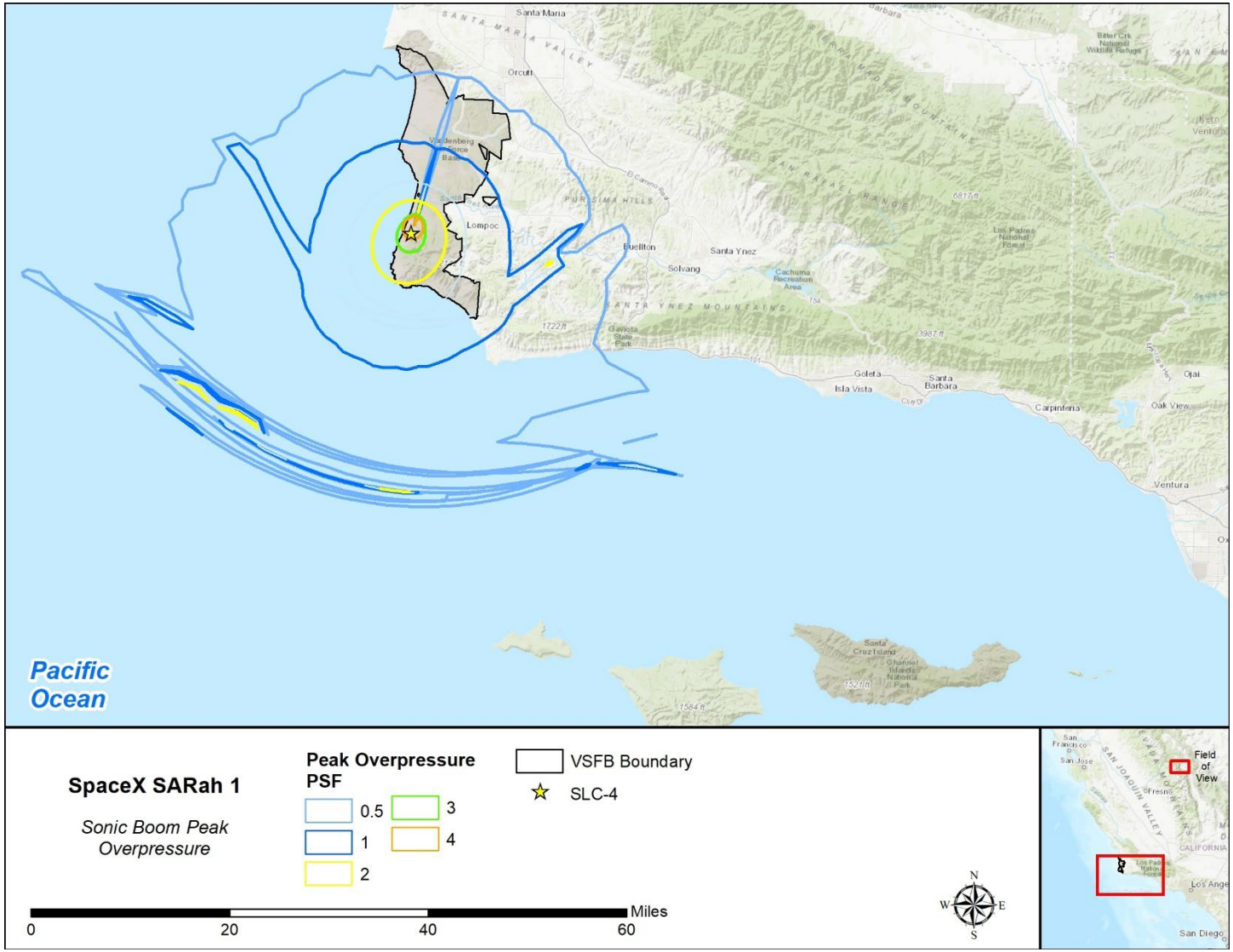

Figure 2.2-6. Example of a Typical Sonic Boom Profile for Falcon 9 First Stage Landing at SLC-4W

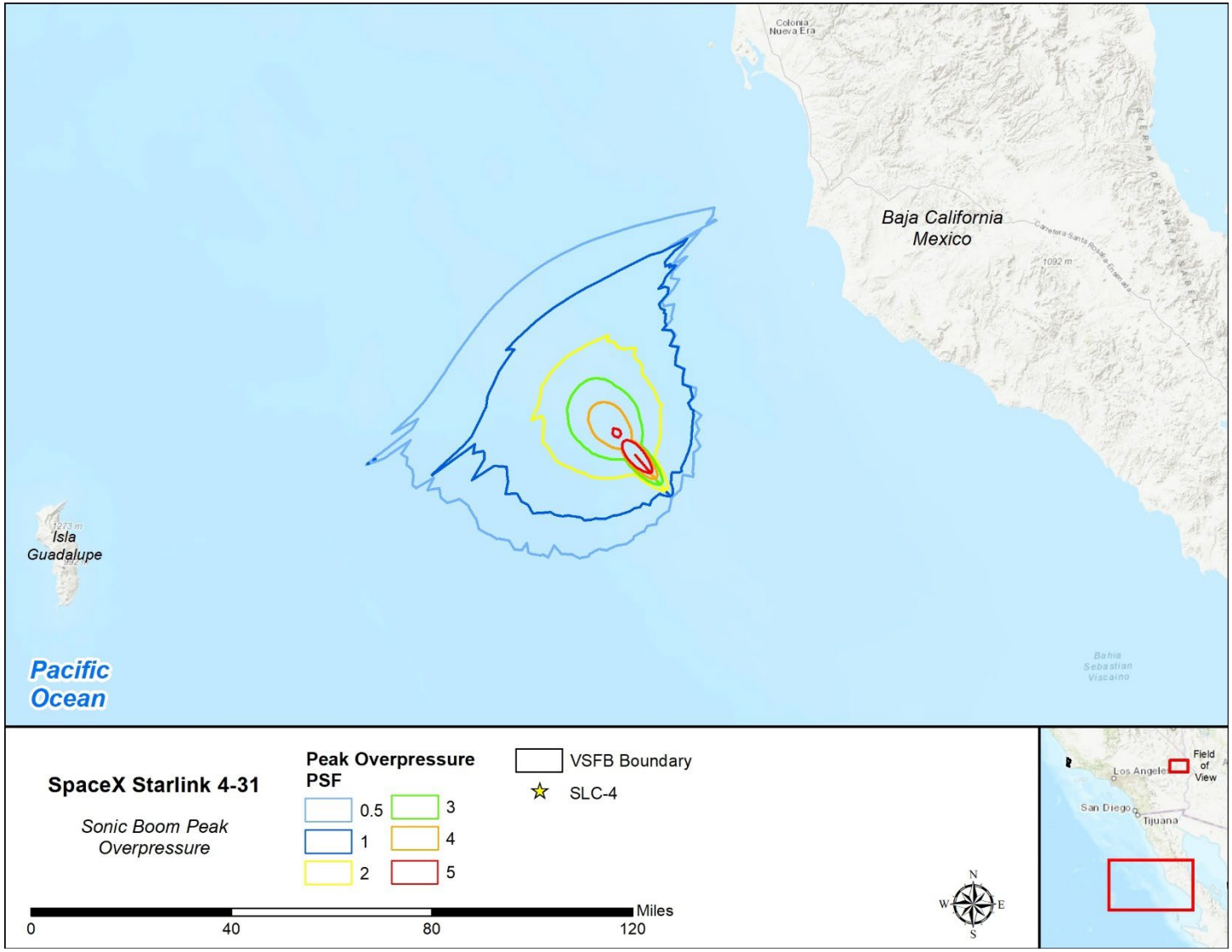

Figure 2.2-7. Example of a Typical Sonic Boom Profile for Falcon 9 First Stage Landing on a Droneship in the Proposed Landing Areas with a Southerly Mission Profile

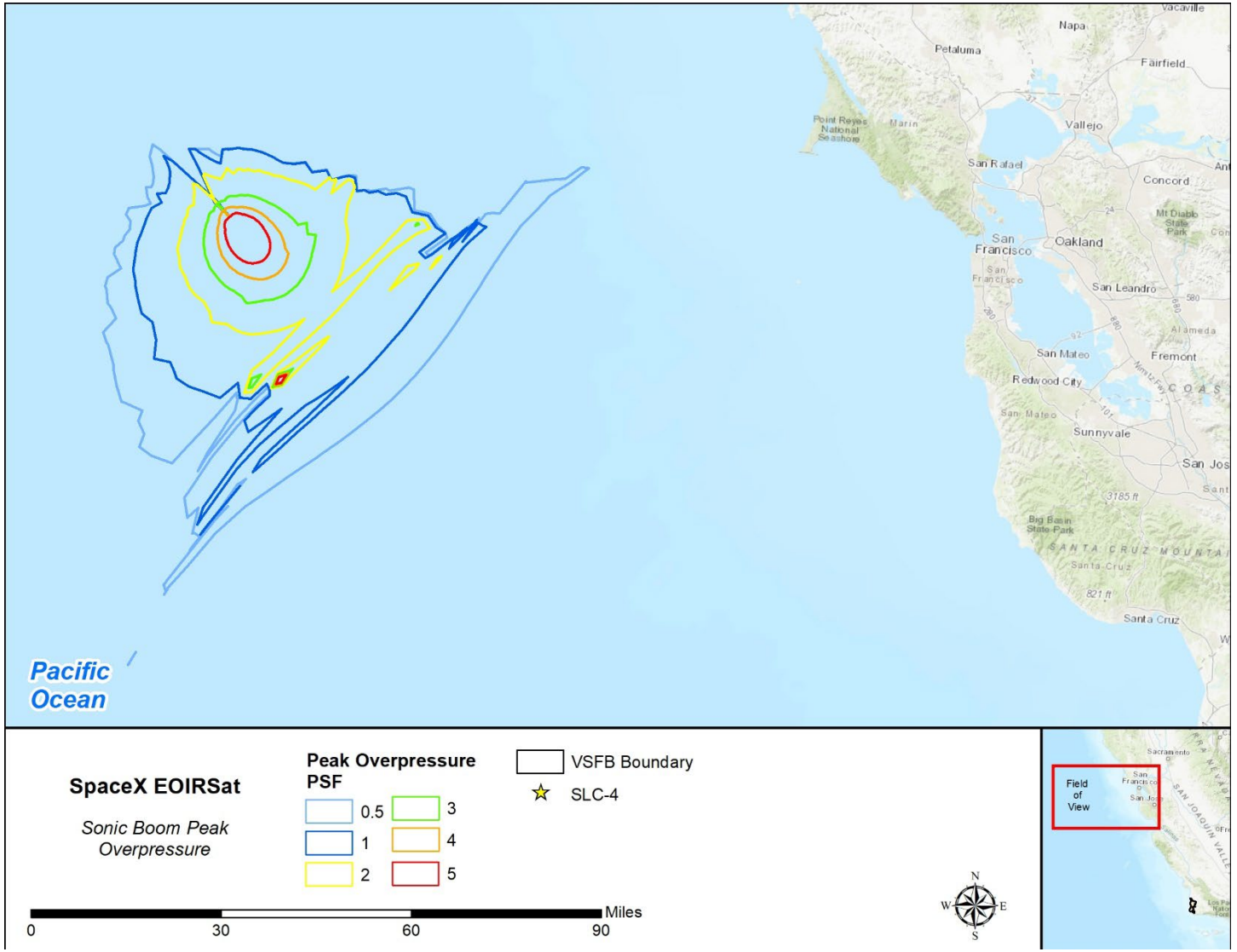

Figure 2.2-8. Example of a Typical Sonic Boom Profile for Falcon 9 First Stage Landing on a Droneship in the Proposed Landing Areas with a Northerly Mission Profile

2.2.5 BOOSTER ROLL-ON-ROLL-OFF

SpaceX proposes to transport first stages and fairings from the Port of Long Beach to the VSFB Harbor via a "roll-on-roll-off" (RORO) barge. The first stage would be transferred from the droneship to SpaceX's Self-Propelled Modular Transport (SPMT) that is positioned on a small, low draft barge. The first stage would be pulled by a tug using a Tier 3 (or higher) engine from the Port of Long Beach into the VSFB Harbor (Figure 1.2-1). The first stage would then be driven off the barge by the SPMT and travel from VSFB Harbor to the hangar at SLC-4E, where it would be unloaded (Figure 3.11-1). A support tug would be launched from the Port of Hueneme and travel up the coast to assist the barge and primary tug in maneuvering into and out of the VSFB Harbor, the exact arrival time would depend on tide. On day two, the support tug would hotel (also known as berthing while producing in-port emissions while moored) at VSFB harbor for 24 hours. On day three, SpaceX would perform the RORO operation, requiring approximately 15 hours for the primary tug to execute the operation. The support tug would assist the operation, then hotel at the VSFB harbor for the remainder of the time. On day four, the support tug would remain hoteling at VSFB harbor for 24 hours. On day five, the support tug would travel back to the Port of Hueneme, with the exact departure time dependent on tide. The Proposed Action would include up to 36 events per year utilizing the RORO barge and tugs.

2.2.6 PAYLOAD PROCESSING, REFURBISHMENT, AND OPERATIONS

Payloads and their associated materials/fuels/volumes are mission dependent but would be similar to current commercial and government payloads. In November 2011, NASA, with the USAF as a cooperating agency, prepared an EA for *Launch of NASA Routine Payloads on Expendable Launch Vehicles* (NASA 2011). This document verified that no new or substantial environmental impacts or hazards were identified for NASA routine payloads.

An initial assessment of potential Falcon 9 payloads determined that anticipated payloads fit within the scope of the 2011 NASA Routine Payload EA using Table 2.2-1, shown below. The 2011 NASA Routine Payload EA is incorporated by reference in this SEA.

SpaceX would continue to process payloads at existing SpaceX facilities, including Building 398 and the SLC-4 hangar. Operations include refurbishing the recovered first stage and fairing for reuse in future missions. Up to four boosters and six fairings may be refurbished concurrently. Up to 36 boosters and 36 fairings would be refurbished each year. Solvents such as isopropyl alcohol, isopar, and Simple Green would be used during these operations, as well for launch pad operations, facility maintenance, and system flushing. An analysis of solvent use and associated impacts are included in Chapters 3 and 4.

Table 2.2-1. Summary of Envelope Payload Characteristics by Spacecraft Subsystems

Characteristic	Description
Structure	Unlimited: aluminum, beryllium, carbon resin composites, magnesium, titanium, and other materials unless specified as limited.
Propulsion [a, b]	Liquid propellant(s); 7,055 lbs combined hydrazine, monomethyl hydrazine and/or nitrogen tetroxide. Solid Rocket Motor (SRM) propellant; 6,614 lbs Ammonium Perchlorate-based solid propellant (examples of SRM propellant that might be on a spacecraft are a Star-48 kick stage, descent engines, an extra-terrestrial ascent vehicle, etc.).
Communications	Various 10–100-Watt (radio frequency) transmitters Unlimited Solar cells; 5 kilowatt-hour (kW-hr) Nickel-Hydrogen (Ni-H2) or Lithium ion (Li-ion) battery, 300 Ampere-hour (A-hr) Lithium-Thionyl Chloride (LiSOCl), or 150 A-hr. Hydrogen, Nickel-Cadmium (NiCad), or Ni-H2 battery.
Power	Unlimited Solar cells; 5 kW-hr NiH2 or Lithium ion. Li-ion battery, 300 A-hr LiSOCl, or 150 A-hr. Hydrogen, NiCad, or Ni-H2 battery.
Science Instruments	10-kilowatt radar. American National Standards Institute safe lasers.
Other	DOT Class 1.4 Electro-Explosive Devices for mechanical systems deployment. Radioactive materials in quantities that produce an A2 mission multiple value of less than 10. Propulsion system exhaust and inert gas venting. Sample returns are considered outside of the scope of this EA.

[a] Propellant limits are subject to range safety requirements. Source: 2011 NASA Routine Payload EA.
[b] Payloads may also include low toxicity green propellants in similar quantities to propellants analyzed in the 2011 NASA Routine Payload EA

2.2.7 ENVIRONMENTAL PROTECTION MEASURES

Implementing the environmental protection measures (EPMs) outlined in Tables 2.2-2 through 2.2-8 would avoid or minimize potential adverse effects to various environmental resources during the Proposed Action. Qualified SpaceX personnel or contractor staff would oversee fulfilling EPMs.

2.2.7.1 Air Quality

The Santa Barbara County Air Pollution Control District (SBCAPCD) and California Air Resources Board (CARB) requires the measures described in Table 2.2-2 to decrease emissions, as applicable to the Proposed Action.

Table 2.2-2. Control Measures to Decrease Emissions

Environmental Protection Measures – Air Quality
✓ Any portable equipment powered by an internal combustion engine with a rated horsepower of 50 brake horsepower (bhp) or greater used for this project shall be registered in the California State-wide Portable Equipment Registration Program or have a valid SBCAPCD Permit to Operate.
✓ Ultra-low sulfur diesel fuel (15 parts per million by volume) will be used for all diesel equipment.
✓ CARB-developed idling regulations will be followed for trucks during loading and unloading.
✓ When feasible, equipment will be powered with Federally mandated "clean" diesel engines.
✓ The size of the engine in equipment and number of pieces of equipment operating simultaneously for the project should be minimized.
✓ Engines should be maintained in tune per manufacturer or operator's specification.
✓ U.S. Environmental Protection Agency (USEPA) or CARB-certified diesel catalytic converters, diesel oxidation catalysts, and diesel particulate filters may be installed on all diesel equipment.
✓ When practicable, diesel equipment should be replaced with electrical equipment.
✓ CARB diesel will be the only fuel combusted in the engines while in California Coastal Waters

2.2.7.2 Terrestrial Biological Resources

The EPMs listed below would be implemented to avoid, minimize, or characterize the effects of the Proposed Action on terrestrial biological resources. These EPMs require various levels of biological competency from personnel completing specific tasks, as defined in Table 2.2-3.

Table 2.2-3. Biological Monitoring Qualifications

Biologist Level	Necessary Qualifications
Permitted Biologist	Biologist with a valid and current USFWS section 10(a)(1)(A) Recovery Permit or specifically named as an approved biologist in a project-specific BO. The USSF will coordinate with the USFWS prior to assigning permitted biologists to this project
USFWS Approved Biologist	Biologist with the expertise to identify species listed under the Endangered Species Act (ESA) and species with similar appearance. The USSF will review and approve the resumes from each individual, and then submit them to the USFWS for review and approval no less than 15 days prior to the start of the Proposed Action. Each resume will list their experience and qualifications to conduct specific actions that could potentially affect listed species and their habitats. A USFWS-approved biologist could train other biologists and personnel during surveys and project work; in some cases, a USFWS-approved biologist could also provide on-site supervision of other biologists.
Qualified Biologist	Biologist trained to accurately identify specific federally listed species and their habitats by either a Permitted or USFWS-approved biologist. This person could perform basic project monitoring but would need to

Biologist Level	Necessary Qualifications
	have oversight from a permitted or USFWS-approved biologist. Oversight will require a permitted or USFWS-approved biologist to be available for phone/email consultation during the surveys and to have the ability to visit during monitoring/survey activities if needed.

2.2.7.2.1 General Measures

The measures described in Table 2.2-4 would be implemented to minimize the potential impacts on terrestrial biological resources.

Table 2.2-4. General Measures

Environmental Protection Measures – Terrestrial Biological Resources
✓ Disturbances shall be kept to the minimum extent necessary to accomplish project objectives.
✓ All erosion control materials used will be from weed-free sources and, if left in place following project completion, constructed from 100 percent biodegradable erosion control materials (e.g., erosion blankets, wattles).
✓ All human-generated trash at the project site shall be disposed of in proper containers and removed from the work site and disposed of properly at the end of each workday. Large dumpsters can be maintained at staging areas for this purpose.
✓ Equipment and vehicles (mowers, etc.) shall be cleaned of weed seeds prior to use in the project area to prevent the introduction of weeds and be inspected by a qualified biological monitor to verify weed free status prior to use. Prior to site transport, any skid plates shall be removed and cleaned. Equipment should be cleaned of weed seeds daily especially wheels, undercarriages, and bumpers. Prior to leaving the project area, vehicles with caked-on soil or mud shall be cleaned with hand tools such as bristle brushes and brooms at a designated exit area; vehicles may subsequently be washed at an approved wash area. Vehicles with dry dusted soil (not caked-on soil or mud), prior to leaving a site at a designated exit area, shall be thoroughly brushed; alternatively, vehicles may be air blasted on site.

2.2.7.2.2 Special Status Species

The USSF and qualified SpaceX personnel or contractor staff would ensure that all non-discretionary measures, listed in Tables 2.2-5 through 2.2-9, would be implemented during operation of SpaceX's launch program at SLC 4.

1 **Table 2.2-5. California Red-legged Frog Measures**

General Measures
✓ The USSF will maintain exhaust ducts and associated v-ditch to be free of standing water to the maximum extent possible between launches to help minimize the potential to attract California red-legged frogs (CRLF; *Rana draytonii*) to SLC-4. ✓ The USSF will require that a biologist survey the SLC-4 v-ditch feature for CRLF prior to any maintenance activities and relocate any encountered individuals. ✓ The USSF will sample water quality in lower Spring Canyon once annually when ponded water is present to ensure no project related biproducts (i.e., launch combustion residue, operations-related run-off, etc.) have entered the waterway in a manner not previously considered in this analysis. The USSF will perform sampling a minimum of once a year for three years of project operations. The USSF will design water quality sampling to detect potential project related biproducts and any resulting associated changes in aquatic habitat (i.e., salinity, pH, etc.). Sampling will consider and utilize the most recent applicable advances in water quality sampling technology. The USSF will include maps depicting sampling locations during annual reporting. The USSF will collect and clearly present data including any associated chemical and nutrient presence, dissolved oxygen, water temperature, turbidity, and any other pertinent observations regarding ecosystem condition for purposes of annual comparison. If the USSF finds that project related water contamination occurs, the USSF will coordinate with the USFWS, address sources of input, and remediate. ✓ The USSF will establish a pre-project baseline for hydrodynamic data within San Antonio Creek. During project operations the USSF will collect hydrodynamic data annually using consistent data collection methodologies for purposes of comparison against the established baseline. The USSF will use this data to ensure that the proposed project's water extraction, when viewed in addition to the unknown total water extraction amount of permitted launch projects, is not measurably affecting flow rate or water level within San Antonio Creek.
Vegetation Management Area
✓ One day prior to vegetation removal from Spring Canyon, a qualified biologist will conduct surveys for CRLF within the area to be mowed. Any CRLF present will be captured by the USFWS-approved or permitted biologist, if possible, and released at the nearest suitable habitat within Spring Canyon outside of the vegetation management area, as determined by the biologist. All biologists will follow the Declining Amphibian Populations Task Force (DATF) fieldwork code of practice (DATF 2019) to avoid conveying diseases between work sites and will clean all equipment between use following protocols that are also suitable for aquatic reptiles. The USFWS-approved or permitted biologist will also be present during vegetation removal to capture and relocate CRLF to the extent that safety precautions allow. This biologist will also search for injured or dead CRLF after vegetation removal to document take. ✓ A qualified biologist will perform one CRLF survey annually during peak breeding season in Spring Canyon when individuals are most likely to be present and detectable. If CRLF are not encountered at the time of this survey, no subsequent pre/post launch surveys would occur. If CRLF is found to

be present during the annual survey, pre- and post-launch surveys and relocation of any CRLF encountered would occur for each subsequent launch event.

- ✓ The annual report will include methodology used (i.e., survey time, date, duration, weather conditions, and a depiction of the survey area).

CRLF Baseline and Launch Monitoring

- ✓ The USSF will implement long-term monitoring of annual population and distribution trends associated with CRLF populations within Honda Creek, Bear Creek, and Santa Ynez River. The USSF will develop a monitoring plan that adequately addresses potential short- and long-term project effects that may result from sensory pollutants. The USSF will coordinate with the USFWS during plan development and provide the USFWS the monitoring plan for review and approval within three months of project implementation to ensure that potential project related short and long-term effects are detectable and clearly defined.
  - ✓ The monitoring plan will clearly establish pre-project baseline of CRLF average population level within each impacted breeding feature (Honda Creek, Bear Creek, and Santa Ynez River) and clearly define the survey area and methodology. Following project implementation, the USSF will conduct annual surveys utilizing the same methodology within each impacted breeding feature during the breeding season when CRLF are most likely to be encountered.
  - ✓ The monitoring plan will include passive bioacoustics monitoring (Wildlife Acoustics Song-Meter 4 or similar technology) and will establish frog calling behavior baseline within each impacted breeding feature (Honda Creek, Bear Creek, and Santa Ynez River) and any necessary appropriate control sites for purposes of signal characteristic comparison. CRLF calling behavior baseline will include applicable call characteristics (e.g., changes in signal rate, call frequency, amplitude, call timing, call duration, etc.). The USSF will ensure that bioacoustic monitoring conducted is designed to best address confounding factors in order to appropriately characterize impacts of launch, static fire, and SLC-4W landing events on calling behavior. Results will be analyzed in conjunction with long term population data to ensure any observed changes in signal characteristics are not resulting in observable declines in population.
- ✓ The USSF will conduct quarterly night surveys for CRLF and spring tadpole surveys of lower Honda Creek to compare baseline CRLF occupancy data collected over the past 10 years and assess if there are any changes in CRLF habitat occupancy, breeding behavior (calling), and breeding success (egg mass and tadpole densities) on lower Honda Creek. The following will be recorded and measured during the surveys:
  - ✓ CRLF detection density (number of frogs per survey hour), following the same survey methods conducted previously at these sites and throughout VSFB.
  - ✓ CRLF locations and breeding evidence (e.g., calling, egg masses).
  - ✓ Environmental data during surveys (temperature, wind speed, humidity, and dewpoint) to determine if environmental factors are affecting CRLF detection or calling rates.
  - ✓ Annual habitat assessments to measure flow rates, stream morphology, depths, and sediment to determine if any changes in CRLF metrics are associated with other environmental factors, such as drought.
- ✓ Bioacoustic monitoring would be conducted annually during CRLF breeding season (typically November through April, depending on rainfall) to characterize the noise environment and determine if there are changes in calling behaviors as the Proposed Action commences. Passive

noise recorders and environmental data loggers (temperature, relative humidity, dew point) would be placed at two suitable breeding locations on lower Honda Creek. Passive bioacoustic recording would occur throughout the entirety of the breeding season using the Wildlife Acoustics Song-Meter 4 (or similar technology) with software that enables autodetection of CRLF calling. The USSF will use bioacoustic monitoring to characterize and analyze impacts of launch, static fire, and SLC-4W landing events on calling behavior during the breeding season to assess whether Falcon 9 noise events affect CRLF calling frequency.

- ✓ To address potential declining trends that may be a result of the proposed project, the specified threshold criteria is described below:
  - ✓ CRLF occupancy, calling rate, or tadpole densities decline from baseline by 15 percent or more and,
  - ✓ the 15 percent decline from baseline is maintained for two consecutive years.
- ✓ If any of these threshold criteria are met and cannot confidently be attributed to other natural- or human-caused catastrophic factors, not related to the Proposed Action, that may eliminate or significantly degrade suitable habitat (see potential scenarios described below), the USSF will mitigate these impacts as discussed under CRLF Mitigation section below. Examples of potential catastrophic scenarios include the following:
  - ✓ Fire, unrelated to project activities or launch operations, that directly impacts Honda Canyon and is demonstrated to degrade or eliminate breeding habitat.
  - ✓ Landslides or significant erosion events, unrelated to project activities or launch operations, in Honda Canyon that result in the elimination or degradation of CRLF breeding habitat.
  - ✓ Drought or climate impacts that quantifiably reduces available aquatic habitat further than what was available during existing baseline.
  - ✓ Flash flood events during the breeding season that are more significant than what was experienced during the existing baseline.
- ✓ The USSF will review the supported cause of decline with the USFWS and reach agreement. If cause of declines is determined to be inconclusive, the USSF will implement proposed mitigation.

CRLF Mitigation

- ✓ The USSF will create new CRLF breeding habitat at a 2:1 ratio (habitat enhanced: habitat affected) for adverse effects to occupied CRLF habitat, as determined above, at the San Antonio Creek Oxbow Restoration Area, an established wetland mitigation site that is located outside of areas impacted by launch noise on VSFB (Figure 2.2-9). Historically occupied by riparian vegetation, restoration efforts will focus on enhancing this abandoned tract of agricultural land (Figure 2.2-10) to improve San Antonio Creek and provide breeding habitat for CRLF.
- ✓ Restoration, which has already been conducted at this site for other projects, will be conducted in the "expansion area" adjacent to the restoration area (Figure 2.2-11), involve digging a channel that reaches ground water, and use the spoils to create a berm that will be planted with willows (Figure 2.2-12). This method is already being used at the site and has proven successful at creating deep water aquatic habitat, suitable for CRLF breeding, and riparian woodland that simulate naturally occurring high-flow channels.
- ✓ Actions taken within this area will include site preparation via herbicide application, plowing, container plant installation, seeding, willow pole planting (via water jet, hand-held power auger, or manually driving a steel rod into the ground), and watering via water truck. The mitigation actions

for CRLF are included under the existing USFWS Programmatic Biological Opinion (PBO 8-8-12-F-49R) and all applicable avoidance, minimization, and monitoring measures required under the PBO would be implemented.

1 **Table 2.2-6. Western Snowy Plover Measures**

SNPL Monitoring
✓ The USSF will implement long-term monitoring of annual population and distribution trends associated with SNPL along Surf Beach. The USSF will develop a monitoring plan that adequately addresses potential short- and long-term project effects that may result from sensory pollutants. The USSF will coordinate with the USFWS during plan development and provide the USFWS the monitoring plan for review and approval within three months of project implementation to ensure that potential project related short and long-term effects are detectable and clearly defined. The SNPL monitoring plan will include a clear, established baseline annual variation and decline threshold that would trigger proposed mitigation (see below). ✓ The USSF will augment the current SNPL monitoring program on VSFB by performing acoustic monitoring and geospatial analysis of nesting activity on South Surf Beach to assess potential adverse effects from Falcon 9 noise events. ✓ The current Base-wide SNPL monitoring program estimates breeding effort, nest fates, and fledging success while recording patterns of habitat use through the season. This program will be augmented for the Proposed Action by placing sound level meters (SLMs) immediately inland of South Surf Beach to characterize the noise environment and any related launch and landing associated disturbance. ✓ The USSF will perform geospatial analysis annually to identify declines in the SNPL population, nesting activity, and reproductive success that may result from cumulative effects of multiple launches and landings from SLC-4. ✓ To address potential declining trends that may be a result of the Proposed Action, the specified threshold criteria is described below. ✓ Geospatial analysis shows a statistically significant decline (defined as a decline greater than the baseline annual variation in these variables over the past 10 years at South Surf Beach) in population or reproductive success, and ✓ the decline from baseline maintains over two consecutive years within the areas impacted by noise from the Falcon 9. ✓ If any of these threshold criteria are met and cannot confidently be attributed to other natural- or human-caused catastrophic factors, not related to the proposed action, that may eliminate or significantly degrade suitable habitat (see potential scenarios described below), the USSF will mitigate for these impacts as discussed under the SNPL Mitigation section below. Examples of potential catastrophic scenarios include the following: ✓ Significantly higher levels of tidal activity, predation, etc. as compared with the existing baseline and demonstrable across remainder of base population. ✓ Significant avian disease demonstrable across the recovery unit. ✓ Separate work activities (i.e., restoration efforts) not related to project.

- ✓ The USSF will review the supported cause of decline with the USFWS and reach agreement. If cause of declines is determined to be inconclusive, the USSF will implement proposed mitigation.
- ✓ Motion triggered video cameras will be used during the breeding season (1 March through 30 September) to determine nest fates and potential impacts to nests due to launches and landings to reduce disturbance associated with human activity within breeding habitat.
  - ✓ .
  - ✓ The USSF will monitor active nests at South Surf Beach with motion triggered video cameras during the breeding season at whichever of the following is greater within the modeled 4.0 psf zone to assess potential novel effects that may result from frequent launching: (i) 10 percent of active SNPL nests, or (ii) 4 active SNPL nests. The USSF will monitor at whichever the following is greater within the modeled 3.0 to 4.0 psf zone: (iii) 10 percent of active SNPL nests, or (iv) 2 active SNPL nests. The USSF will monitor at whichever the following is greater within the modeled 2.0 to 3.0 psf zone: (v) 5 percent of active SNPL nests, or (vi) 4 active SNPL nests.
  - ✓ Cameras will be placed in a manner to minimize disturbance to nesting plovers; this will be determined in the field based on the best judgement of a permitted biologist.
  - ✓ The USSF will employ camera technology that is capable of long-term recording and time marking the moment of disturbance events.
  - ✓ The USSF will implement landscape level camera monitoring in conjunction with individual nest cameras to document SNPL response to launch and sonic boom noise and overpressures. The landscape level camera(s) will be capable of long-term recording, time marking the moment of disturbance events, and deployed adjacent to areas of highest density nesting to best capture population level reaction. The USSF will coordinate camera installation and placement with a USFWS approved biologist to ensure no additional effects would occur (i.e., perching for raptors).
  - ✓ The USSF will review SNPL nest camera recordings as soon as possible.
- ✓ The USSF will rescue any SNPL eggs abandoned on Surf Beach during disturbance events. The USSF will develop and/or fund a program to incubate any rescued abandoned eggs and release fledglings.

SNPL Mitigation

- ✓ The USSF will increase predator removal efforts to include the non-breeding season, particularly focusing on raven removal at and adjacent to VSFB beaches.
- ✓ Given that all available SNPL nesting habitat on VSFB has already or will soon (under current planning) be restored, the biggest factor reducing nesting success is nest predation with significant impacts from ravens. The raven population, which has historically been absent to rare in the region, is now common, and has increased substantially over the past two decades due to human-related factors that have allowed their numbers to increase and range to expand. As documented, the raven population continues to increase each year. Off-season depredation will help reduce the population on Base prior to the breeding season which should increase nest success.
- ✓ Predator control actions will include trapping, shooting, and tracking SNPL predators from VSFB beaches and surrounding areas on Base. The mitigation actions for SNPL are permitted under an existing USFWS Biological Opinion (BO; 8-8-12-F-11R; USFWS 2015a) and all applicable avoidance, minimization, and monitoring measures required under BO 8-8-12-F-11R will be implemented. CEIEA also maintains a USFWS depredation permit.

1 **Table 2.2-7. California Least Tern Measures**

LETE Monitoring
✓ The USSF will implement long-term monitoring of annual population and distribution trends associated with California least tern (LETE; *Sterna antillarum browni*) at Purisima Point. The USSF will develop a monitoring plan that adequately addresses potential short- and long-term project effects that may result from sensory pollutants. The USSF will coordinate with the USFWS during plan development and provide the USFWS the monitoring plan for review and approval within three months of project implementation to ensure that potential project related short and long-term effects are detectable and clearly defined. The LETE monitoring plan will include a clear, established baseline annual variation and decline threshold that would trigger proposed mitigation (see below). ✓ The USSF will augment the current LETE monitoring program on VSFB by performing acoustic monitoring and geospatial analysis of nesting activity at the Purisima LETE colony to assess potential adverse effects from Falcon 9 noise events. ✓ The current Base-wide LETE monitoring program estimates breeding effort, nest fates, and fledging success while recording patterns of habitat use through the season. This program will be augmented for the Proposed Action by placing SLMs immediately inland of the LETE colony at Purisima Point to characterize the noise environment and any related launch and landing associated disturbance. ✓ The USSF will perform geospatial analysis annually to identify declines in the LETE population, nesting activity, and reproductive success that may result from cumulative effects of multiple launches and landings from SLC-4. ✓ To address potential declining trends that may be a result of the Proposed Action, the specified threshold criteria is described below. ✓ Geospatial analysis shows a statistically significant decline (defined as a decline greater than the baseline annual variation in these variables over the past 10 years at Purisima Point) in population or reproductive success, and ✓ the decline from baseline maintains over two consecutive years within the areas impacted by noise from the Falcon 9. ✓ If any of these threshold criteria are met and cannot confidently be attributed to other natural- or human-caused catastrophic factors, not related to the Proposed Action, that may eliminate or significantly degrade suitable habitat (see potential scenarios described below), the USSF will mitigate for these impacts as discussed under the LETE Mitigation section below. Examples of potential catastrophic scenarios include the following: ✓ Significantly higher levels of predation, lower prey availability, etc. as compared with the existing baseline and demonstrable across remainder of base population. ✓ Significant avian disease demonstrable across the recovery unit. ✓ Separate work activities (i.e., restoration efforts) not related to project. ✓ The USSF will review the supported cause of decline with the USFWS and reach agreement. If cause of declines is determined to be inconclusive, the USSF will implement proposed mitigation. ✓ Motion triggered video cameras will be used during the breeding season (typically 15 April to 15 August) to determine nest fates and potential impacts to nests due to launches and landings to reduce disturbance associated with human activity within breeding habitat.

✓ The USSF will monitor at whichever of the following is greater within the Purisima Point colony: (i) 10 percent of active LETE nests, or (ii) 4 active LETE nests.. ✓ Cameras will be placed in a manner to minimize disturbance to nesting terns; this will be determined in the field based on the best judgement of a permitted biologist. ✓ The USSF will employ camera technology that is capable of long-term recording and time marking the moment of disturbance events. ✓ The USSF will implement landscape level camera monitoring in conjunction with individual nest cameras to document LETE response to launch and sonic boom noise and overpressures. The landscape level camera(s) will be capable of long-term recording, time marking the moment of disturbance events, and deployed adjacent to areas of highest density nesting to best capture population level reaction. The USSF will coordinate camera installation and placement with a USFWS approved biologist to ensure no additional effects would occur (i.e., perching for raptors). ✓ The USSF will review LETE nest camera recordings as soon as possible. ✓ The USSF will rescue any LETE eggs abandoned at the Purisima Point colony during disturbance events. The USSF will develop and/or fund a program to incubate any rescued abandoned eggs and release fledglings.
LETE Mitigation
✓ The USSF will increase predator removal efforts to include the non-breeding season, particularly focusing on raven removal at and adjacent to VSFB beaches. ✓ The biggest factor reducing nesting success is nest predation. Off-season depredation will help reduce the population on Base prior to the breeding season which should increase nest success. ✓ Predator control actions will include trapping, shooting, and tracking LETE predators from VSFB beaches and surrounding areas on Base. The mitigation actions for LETE are permitted under an existing USFWS BO (8-8-12-F-11R; USFWS 2015a) and all applicable avoidance, minimization, and monitoring measures required under BO 8-8-12-F-11R will be implemented. CEIEA also maintains a USFWS depredation permit.

Table 2.2-8. California Condor Measures

✓ Prior to any launch, the USSF will determine if any California condors (*Gymnogyps californianus*) are present by coordinating with the USFWS and Ventana Wildlife Society personnel. The USSF will contact the USFWS if California condors appear to be near or within the area affected by a launch from SLC-4. In the unlikely event that a California condor is nearby, qualified biologists will monitor California condor movements in the vicinity of VSFB and coordinate with the USFWS to analyze data before, during, and after launch events to determine whether any changes in movement occur.
✓ The USSF will coordinate with current USFWS personnel, including Arianna Punzalan, Supervisory Wildlife Biologist (arianna_punzalan@fws.gov, (805) 377-5471); Joseph Brandt, Wildlife Biologist (joseph_brandt@fws.gov, 805-677-3324 or 805-644-1766, extension 53324), or Steve Kirkland, California Condor Field Coordinator, USFWS California Condor Recovery Program (steve_kirkland@fws.gov, 805-644-5185, extension 294). The Space Force will also coordinate with current Ventana Wildlife Society personnel, Joe Burnett (joeburnett@ventanaws.org, 831-800-7424).

Table 2.2-9: Marbled Murrelet

✓ Annual marbled murrelet (*Brachyramphus marmoratus*) population surveys would continue to be conducted at the current levels performed by the USSF to monitor the frequency and distribution of marbled murrelet within the action area.

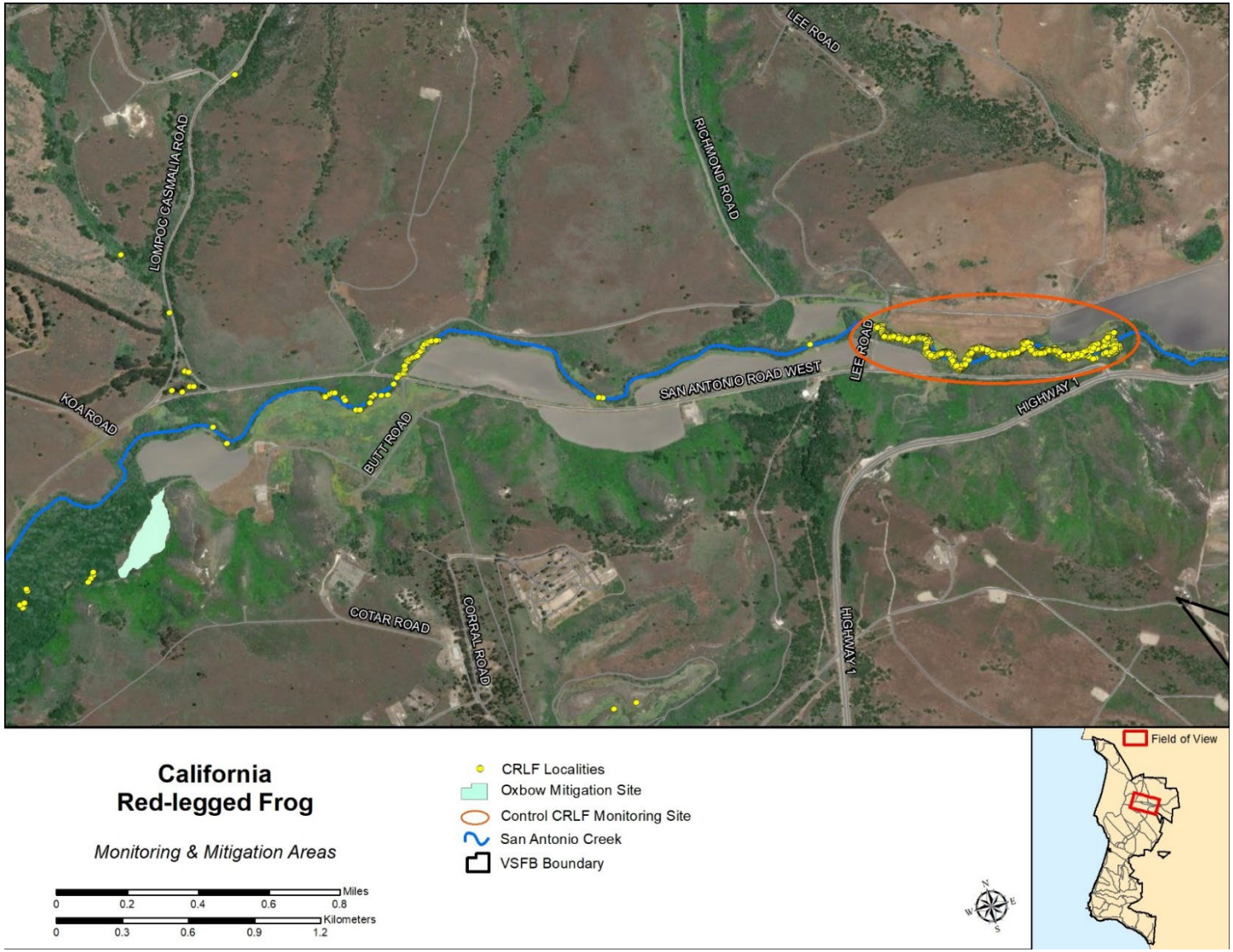

Figure 2.2-9. California Red-Legged Frog Oxbow Mitigation Site and Control Monitoring Location (Note: the depicted distribution of CRLF localities is a factor of where prior survey efforts were performed, not actual occurrence)

Figure 2.2-10. Aerial View of San Antonio Creek "Oxbow" Restoration Site Prior to Restoration Efforts that are Currently Being Conducted

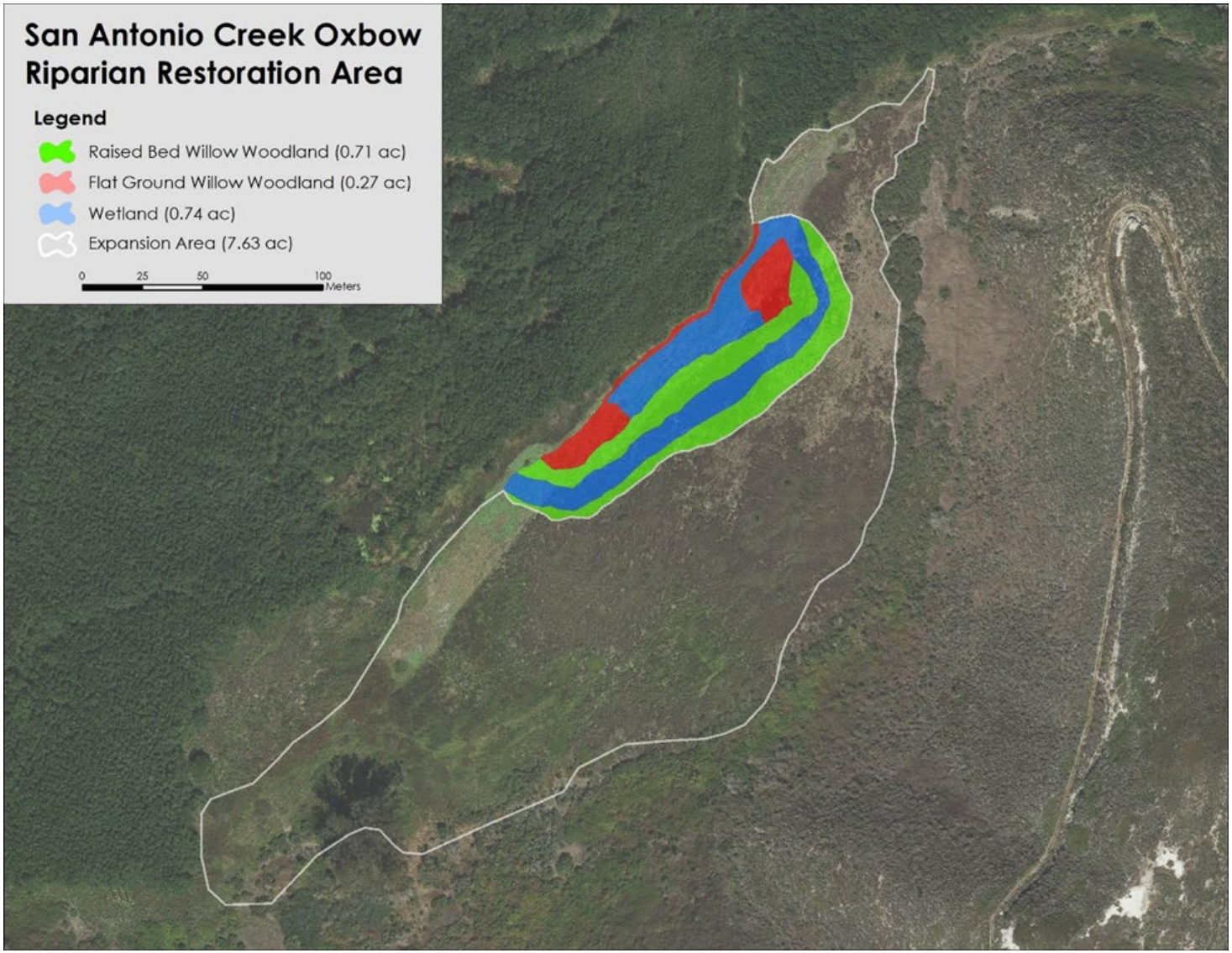

Figure 2.2-11. Current Restoration Efforts (Blue, Red, and Green) and Existing Expansion Area that Would be Restored at a 2:1 Mitigation Ratio

Figure 2.2-12. Contouring Plan as Currently Being Conducted to Successfully Create Wetland

2.2.7.3 Marine Biological Resources

The EPMs listed in Table 2.2-8 would be implemented to avoid, minimize, or characterize the effects of the Proposed Action on marine biological resources. The USSF and qualified SpaceX personnel or contractor staff would ensure that all non-discretionary measures included in the NMFS Letter of Authorization (LOA) issued for launch activities at VSFB (Appendix B), listed in Table 2.2-9, would be implemented during operation of SpaceX's launch program at SLC-4.

Table 2.2-9. Monitoring and Reporting Measures

Environmental Protection Measures – Marine Biological Resources
✓ Sonic boom modeling (commercially available modeling software [PCBoom] or an acceptable substitute) would be completed prior to each launch to verify and estimate the overpressure levels and footprint.
✓ Between 1 January and 31 July, pinniped monitoring at south Base haulout locations would commence at least 72 hours prior to a launch event and continue until at least 48 hours after each event. Monitoring data collected would include multiple surveys each day that record the species, number of animals hauled out, general behavior, presence of pups, age class, and gender. Environmental conditions such as tide, wind speed, air temperature, and swell would also be recorded. ✓ Acoustic and biological monitoring will be conducted on the NCI if the sonic boom model indicates that overpressures from a boom will reach or exceed the psf levels of ≥ 2.0 psf (March–July), ≥ 3.0 psf (August–September), or ≥ 4.0 psf (October–February). Biological monitoring will be conducted at the closest significant haulout site to the modeled sonic boom impact area.
✓ The USSF will ensure that a USFWS-approved biologist monitors southern sea otters from a monitoring location within occupied habitat on VSFB where landing events at SLC-4W generate boost-back sonic booms of 2.0 psf or greater (i.e., Sudden Flats). Upon establishment of any new southern sea otter populations within areas of potential impact from project-related activities, the USSF will consider additional monitoring locations; ✓ A USFWS-approved biologist will conduct daily counts of sea otters from the monitoring location when otters are most likely rafting (between 9:00AM and 12:00PM) beginning 3 days before and continuing 3 days after boost-back and landing events, noting any mortality, injury, or abnormal behavior. Personnel will use both binoculars (10X) and a high-resolution (50–80X) telescope for monitoring; and ✓ Acoustic recording equipment will be deployed at or near the monitoring location to document and quantify sonic boom levels.
✓ The USSF will submit a report, detailing results of the monitoring program, to the Office of Protected Resources, NMFS, and the West Coast Regional Administrator, NMFS, in compliance with the requirements of the current LOA. ✓ Discoveries of injured or dead marine mammals, irrespective of cause, would be reported to the Office of Protected Resources, NMFS, and the West Coast Regional Stranding Coordinator, NMFS. Specific protocol would be followed depending on the cause of the event, if cause is unknown, and whether injury or death was relatively recent.

To reduce the risk of injury or mortality of ESA-listed species in the marine environment, the following EPMs will be implemented during first stage and fairing recovery operations:

- ✓ The USSF will ensure that all personnel associated with vessel support operations are instructed about marine species and any critical habitat protected under the ESA that could be present in the proposed landing area. Personnel will be advised of the civil and criminal penalties for harming, harassing, or killing ESA-listed species.
- ✓ Support vessels will maintain a minimum distance of 150 ft (45 m) from sea turtles and a minimum distance of 300 ft (90 m) from all other ESA-listed species. If the distance ever becomes less, the vessel will reduce speed and shift the engine to neutral. Engines would not be re-engaged until the animal(s) are clear of the area.
- ✓ Support vessels will maintain an average speed of 10 knots or less.
- ✓ Support vessels will attempt to remain parallel to an ESA-listed species' course when sighted while the watercraft is underway (e.g., bow-riding) and avoid excessive speed or abrupt changes in direction until the animal(s) has left the area.
- ✓ The USSF will immediately report any collision(s), injuries, or mortalities to ESA-listed species to the appropriate NMFS contact.

- ✓ To offset the impacts from unrecoverable debris, SpaceX would make an annual contribution to the California Lost Fishing Gear Recovery Project. This includes the weather balloon and radiosonde; parachute and assembly; and parafoil and assembly. For every 3 lbs. of unrecovered debris, SpaceX would make a compensatory donation of $10.00, which is sufficient to recover 1 lb. of lost fishing gear. Based on SpaceX's historic recovery rates for activities in the Pacific Ocean, the estimated maximum donation SpaceX may be obligated to pay for any unrecovered debris annually would be $21,252.

- ✓ Vessels will enter the harbor, to the extent possible, only when the tide is too high for pinnipeds to haul-out on the rocks. The vessel will reduce speed to 1.5 to 2 knots (1.5-2.0 nm/hr) once the vessel is within 3 mi of the harbor. The vessel will enter the harbor stern first, approaching the wharf and mooring dolphins at less than 0.75 knots.

- ✓ Vessels using the harbor will follow a predetermined route that limits crossing kelp beds.

- ✓ No vessels will anchor within kelp beds or hard-bottom habitat outside of the dredge footprint, and no vessel anchors within the dredge footprint will be placed in kelp or hard bottom habitat.

- ✓ If nighttime activities are to occur at any time from dusk to dawn, the required lighting will be turned on before dusk and left on the entire night. Lights will not be turned on or off between dusk and dawn.

- ✓ Activities that could result in the startling of wildlife in the vicinity of the harbor will be allowed so long as they are initiated before dusk and not interrupted by long periods of quiet (in excess of 30 minutes). If such activities cease temporarily during the night, they will not be reinitiated until dawn.

- ✓ Starting-up of activities (either initially or if activities have ceased for more than 30 minutes) will include a gradual increase in noise levels if pinnipeds are in the area.

- ✓ The restrictions on access to the intertidal area will be included in the personnel orientations provided at project startup and for new employees.

- ✓ The tug vessels and barge will be periodically cleaned as necessary to avoid impacts related to the transfer of non-native invasive pests and vegetation to VSFB Harbor.

2.2.7.4 Water Resources

The EPMs listed in Table 2.2-10 would be implemented to avoid, minimize, or characterize the effects of the Proposed Action on water resources.

Table 2.2-10. Water Resources and Stormwater Measures

Environmental Protection Measures – Water Resources
✓ The Proposed Action shall comply with storm water management plans, including Best Management Practices (BMPs) following the latest California Stormwater Quality Association's Stormwater Best Management Practices Handbook.
✓ Spring Canyon will be routinely monitored for erosion where vegetation management occurs. BMPs would be utilized as needed to reduce erosion.
✓ SpaceX will continue to ensure that water ejected from the flame bucket during launches does not result in any overland surface flow reaching Spring Canyon by maintaining current v-ditches within the SLC-4 fenceline and routinely assessing whether any additional diversion structures are necessary.
✓ All equipment will be properly maintained and free of leaks during operation, and all necessary repairs carried out with proper spill containment.
✓ Fueling equipment will only occur in pre-designated areas with spill containment materials placed around the equipment before refueling. Stationary equipment will be outfitted with drip pans and hydrocarbon absorbent pads.
✓ Adequate spill response supplies will be maintained at the site during operation for immediate response and clean-up of any fuel spills.
✓ Hazardous materials will be stored in proper containers, placed in proper containment facilities covered prior to rain events.
✓ Trash disposal containers will be covered at all times.
✓ SpaceX and its contractors will implement best management practices to prepare for and respond to a spill. These practices include fueling equipment at least 100 ft from the water, fueling only in areas designed to capture runoff or spilled fuel, and maintaining spill response kits.

2.2.7.5 Cultural Resources

The EPMs listed in Table 2.2-11 would be implemented to avoid, minimize, or characterize the effects of the Proposed Action on cultural and sensitive archaeological resources.

Table 2.2-11. Cultural Resources Measures

Environmental Protection Measures – Cultural Resources
✓ If previously undocumented cultural resources are discovered during maintenance activities, work would stop, and the procedures established in 36 CFR Part 800.13 and the VSFB Integrated Cultural Resources Management Plan shall be followed.

2.2.8 Alternatives Considered but Eliminated from Further Analysis

CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500–1508) require federal agencies to use the NEPA process to identify and assess the reasonable alternatives to the

Proposed Action that would avoid or minimize adverse effects of those actions on the quality of the human environment. SpaceX and SLD 30 evaluated its existing facilities at Cape Canaveral Space Force Station (CCSFS) and Kennedy Space Center (KSC) for reasonableness. Non-SpaceX sites would not be able to readily provide infrastructure requirements without substantial construction activities and would not support the launch schedule requirements in 2023 and were therefore not considered.

2.2.8.1 Cape Canaveral Space Force Station Space Launch Complex-40

SLC-40 is a SpaceX-leased launch site located on CCSFS. SLC-40 currently supports Falcon 9 launches. Launch azimuths from SLC-40 support low Earth orbit (LEO), including polar orbits and sun-synchronous orbits, geosynchronous transfer orbit (GTO) and Earth escape orbits. SpaceX has authorization to launch 50 vehicles per year from SLC-40. However, SpaceX has determined it cannot accommodate any additional activity at this time because of the turn-around time required to check-out and refurbish infrastructure between launches and the required time for pre-launch operations. Accordingly, SLC-40 at CCSFS cannot support increased launch cadence (Selection Criterion 3) and was therefore eliminated from further consideration.

2.2.8.2 Kennedy Space Center Launch Complex-39A

Launch Complex (LC) 39A is a SpaceX-leased launch site located at KSC. LC-39A currently supports Falcon 9 and Falcon Heavy launches, and is planned to support up to 24 Starship/Super Heavy launches in the near future upon FAA license issuance. Launch azimuths from LC-39A support LEO, GTO, and Earth escape orbits. Up to 20 Falcon 9 launches and 24 Starship/Super Heavy are currently planned per year at LC-39A. The SpaceX launch pad at LC-39A is currently the only location in the world from which NASA can launch astronauts and the only location where SpaceX can launch the Falcon 9 Heavy vehicle. SpaceX has determined it cannot accommodate additional activity at LC-39A because of the overriding need and priority to support Falcon 9 launches, Falcon Heavy launches, and astronaut launches at this location. In addition, the required turn-around time to check-out and refurbish infrastructure between launches and the required time for pre-launch operations precludes additional launches at this site. Accordingly, LC-39A cannot support increased launch cadence (Selection Criterion 3) and was therefore eliminated from further consideration.

2.3 NO ACTION ALTERNATIVE

The CEQ regulations require including a No Action Alternative in an EA. The No Action Alternative serves in part as a baseline against which the impacts of the Proposed Action can be evaluated. Under the No Action Alternative, the USSF would not authorize SpaceX to increase Falcon 9 operations at VSFB and the FAA would not issue a license modification for the additional Falcon 9 launches and landings at SLC-4. SpaceX would continue to conduct up to 12 Falcon 9 launches and landings at VSFB and the currently approved downrange landing locations, as authorized by its current license.

3 AFFECTED ENVIRONMENT

The following resources were considered but not analyzed in this SEA because the resource would not be affected or there would be no change from what was analyzed in previous EAs listed in Section 1.5 (USAF 2011, 2016a, 2016b, 2018):

- ***Geology and Earth Resources.*** The Proposed Action does not require construction and activities are consistent with those already conducted at VSFB. No new ground-disturbing activities would occur, and no land categorized as prime or unique farmland or farmland of statewide importance would be converted. Therefore, this resource was considered but not analyzed in this SEA.

- ***Land Use and Aesthetics.*** The Proposed Action does not require construction and activities are consistent with those already conducted at VSFB. The proposed increase in launch cadence would be consistent with existing land use at the project site, would not result in a change to land use or be incompatible with adjacent land uses, such as agricultural land, and would not alter the existing industrial character of the area. Views along the coastline would not change and no alterations to the visual landscape would occur. Therefore, this resource was considered but not analyzed in this SEA.

- ***Human Health and Safety.*** The Proposed Action does not require construction and activities are consistent with those already conducted at VSFB. All safety precautions and regulations would be followed IAW: Space Launch Vehicle Flight Hazard Zone requirements; Occupational Safety and Health Administration, Air Force Occupational Safety and Health, California Division of Occupational Safety and Health regulations; and other recognized standards and applicable DAF regulations or instructions. Enforcing government and commercial entities requirements to maintain safety programs to protect workers would continue. Therefore, this resource was considered but not analyzed in this SEA.

- ***Hazardous Materials, Waste Management, and Pollution Prevention.*** The Proposed Action does not require construction and activities are consistent with those already conducted at VSFB. All activities associated with the Proposed Action would comply with all pertinent federal, State, and local laws and regulations, and applicable VSFB plans would govern all actions associated with implementing the Proposed Action. Proper protocols for storing and disposing hazardous materials and wastes would continue to be followed, and the amount of hazardous materials needed and the waste generated by the Proposed Action would have little to no impact on waste processing capacity. Any accidental discharges or unauthorized releases would continue to be managed IAW the Hazardous Materials Emergency Response Plan. Therefore, this resource was considered but not analyzed in this SEA.

- ***Solid Waste Management.*** The Proposed Action does not require construction and activities are consistent with those already conducted at VSFB. Solid waste would be minimized by strictly complying with VSFB's Integrated Solid Waste Management Plan, and solid waste associated with the increase of approximately 100 personnel associated with the Proposed Action would be accommodated via the existing solid waste management systems in place (e.g., collecting on-site refuse containers, transporting to an appropriate landfill or recycling center). In addition, SpaceX personnel or contractor staff would continue to ensure that all materials disposed of off base would be reported to the 30 CES, Installation Management Flight (30 CES/CEI) Solid Waste

Manager. Accordingly, solid waste impacts would not be significant; therefore this resource was considered but not analyzed in this SEA.

- ***Environmental Justice*.** Per EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, the potential effects of the Proposed Action on minority communities and low-income communities were considered. Since 1979, an evacuation and closure agreement has been in place between the DAF and Santa Barbara County (Appendix I). For park visitors' safety, upon the DAF's request the County Parks Department and the County Sheriff currently close the parks. This agreement includes closing Surf Beach, Ocean Beach County Park, and Jalama Beach County Park. The Proposed Action would only restrict public access to Ocean Beach County Park and Surf Beach up to 12 times per year as previously described in the 2018 SEA (see Section 4.8.1). Jalama Beach County Park would not close more than 12 times per year; the DAF has received concurrence from the CCC to close Jalama Beach County Park a maximum of 12 times per year. Noise generated due to the proposed action would be of short duration (two to three minutes during launch and 20 to 30 seconds during landing) and consistent with the existing noise environment and land use. Launch noise that would reach the Lompoc Valley would be between 80 and 90 A-weighted decibels (dBA) and be of short duration (less than one minute). Sonic boom levels in Lompoc have typically been predicted to range from 0.5 to 1.5 psf, but may rarely reach as high as 4.0 psf, depending on atmospheric conditions and mission trajectories (Appendix E; MSRS 2023). The Proposed Action would not have disproportionately high and adverse human health or environmental effects on low income or minority populations within the region (Lompoc and Santa Maria Valleys). Therefore, this resource was considered but not analyzed further in this SEA.

- ***Children's Environmental Health and Safety Risks.*** Per EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks* (1997) (as amended by EO 13229 [2001] and EO 13296 [2003]), the potential effects of the Proposed Action on children were considered. The Proposed Action would neither affect nor disproportionately affect children within the ROI, nor result in any health or safety risk that would disproportionately affect children. The Proposed Action would occur within an unpopulated area of VSFB, and potential environmental impacts with the exception of noise would not extend into populated areas. Noise generated due to the proposed action would be of short duration (two to three minutes during launch and 20 to 30 seconds during landing) and consistent with the existing noise environment and land use. Launch noise that would reach the Lompoc Valley would be between 80 and 90 dBA and be of short duration (less than one minute). Sonic boom levels in Lompoc have typically been predicted to range from 0.5 to 1.5 psf, but may rarely reach as high as 4.0 psf, depending on mission trajectories (Appendix E; MSRS 2023). Given the location of the Proposed Action, the existing noise environment, and the temporary nature of increased noise levels during operations, this resource was considered but not analyzed further in this SEA.

- ***Natural Resources and Energy Supply.*** The Proposed Action would not require the use of scarce or unusual materials and would not measurably increase demand on local supplies of energy or natural resources. As defined by the FAA Order 1050.1F Desk Reference (FAA 2020), Falcon 9

launches would not have a measurable effect on natural resources, such as water, asphalt, aggregate, or wood. Therefore, this resource was considered but not analyzed in this SEA.

- ***Wild and Scenic Rivers.*** There are no rivers protected under the Wild and Scenic Rivers Act within the affected environment. Therefore, this resource was considered but not analyzed in this SEA.
- ***Visual Effects, Light Emissions, and Visual Resources/Visual Character.*** The Proposed Action would not change the existing or planned use of VSFB. Launch and landing would occur from existing sites at SLC-4 on VSFB. The Proposed Action would conform to the existing designated land uses. Launch and landing activities would not differ visually from those activities already occurring at VSFB. Therefore, this resource was considered but not analyzed in this SEA.

3.1 AIR QUALITY AND CLIMATE

The approach to analysis under the Clean Air Act and General Conformity Analysis under NEPA are discussed in Appendix D. The ROI for air quality includes the Study Area and adjoining land several miles inland, which may be downwind from emission sources associated with the Proposed Action, and includes Santa Barbara, Ventura, and Los Angeles Counties.

3.1.1 CLIMATE OF THE STUDY AREA

The climate of the Pacific Ocean and adjacent land areas is influenced by surface water temperatures, water currents, and wind. Offshore climates are moderate and seldom have extreme seasonal variations because the ocean is slow to change temperature. Ocean currents influence climate by moving warm and cold water between regions. Adjacent land areas are affected by the wind that is cooled or warmed when blowing over these currents. The wind also moves evaporated moisture from the ocean to adjacent land areas and is a major source of rainfall.

The climate of coastal Southern California and adjacent offshore Pacific Ocean waters consists of warm, dry summers and cool, wet winters, mainly influenced by a semi-permanent high-pressure system (the Pacific High) in the eastern Pacific Ocean. This Pacific High maintains clear skies in Southern California for much of the year. When the Pacific High moves south during the winter, this pattern changes and low-pressure centers migrate into the region, bringing precipitation, falling mainly as rain in October-April. The predominant regional wind directions are westerly and west-southwesterly during all four seasons. Surface winds are typically from the north and west (onshore) during the day and from the east (offshore) at night.

3.1.2 EXISTING AIR QUALITY

Offshore air quality is generally better than adjacent onshore areas because there are few or no large sources of criteria air pollutants offshore. Much of the air pollutants in offshore areas are transported there from adjacent land areas by low-level offshore winds, so concentrations of criteria air pollutants generally decrease with increasing distance from land. No criteria air pollutant monitoring stations are located in offshore areas, so air quality in the Study Area must be inferred from adjacent land areas where air pollutant concentrations are monitored.

The Proposed Action includes activities in the South Central Coast and the South Coast Air Basins (SCAB). Coastal waters within 3 nm of the shore are under the same air quality jurisdiction as the contiguous land areas of the South Central Coast Air Basin. Both the Ventura County Air Pollution Control District and the

South Coast Air Quality Management Districts (SCAQMD) are serious nonattainment areas for the National Ambient Air Quality Standards (NAAQS) eight-hour O_3. Within attainment areas, SpaceX is required to ensure air quality does not significantly deteriorate due to air emissions associated with the Proposed Action. The Proposed Action is required to demonstrate conformity with the approved State Implementation Plan if the net emissions equal or exceed the *de minimis* emission levels in nonattainment and maintenance areas.

3.1.2.1 Criteria Air Pollutants

Air pollutants emitted more than 3,000 ft above ground level are considered to be above the atmospheric inversion layer and, therefore, do not affect ground-level air quality (USEPA 1992). Emissions released above this altitude distance are often too highly dispersed within the atmosphere to impact pollutant concentrations over land and the surface of the water in the lower atmosphere, measured at ground-level monitoring stations, upon which federal, state, and local regulatory decisions are based. However, since all of the sources of pollutants are mobile, and it is difficult to determine where exactly emissions would be released within the Study Area, all emissions occurring under 3,000 ft are considered when comparing against the *de minimis* thresholds. Table 3.1-1 shows annual emissions from SpaceX activities (including launch and landing activities; static firing; booster and fairing recoveries; work transits; vendor deliveries; and generator use) from 12 launch events.

Table 3.1-1. Estimated Annual Criteria Pollutant Emissions Under the Current Environmental Baseline Conditions[1]

Criteria Pollutants	Annual Emissions (tons per year)				
	CO	NO_x	VOC	SO_x	PM_{10}
Emissions (0–3 nm)	2.2149	3.7212	0.4773	0.0178	0.1119
Emissions (3–12 nm)	0.0522	0.1238	0.0246	0.0191	0.0089
Emissions (>12 nm)	3.3522	8.2353	1.5848	1.2275	0.5744
TOTAL	**5.6193**	**12.0803**	**2.0867**	**1.2644**	**0.6952**

[1]Table includes criteria pollutant precursors (e.g., volatile organic compounds [VOCs]). Individual values may not add exactly to total values due to rounding.

Notes: CO = carbon monoxide, NO_X = nitrogen oxides, NO_2 = nitrogen dioxide, PM_{10} = particulate matter ≤ 10 microns in diameter, SO_2 = sulfur dioxide, SO_X = sulfur oxides, TPY = tons per year, VOC = volatile organic compound, nm = nautical miles

3.1.2.2 Climate

Current activities in the Study Area involve mobile sources using fossil fuel combustion. Greenhouse gas (GHG) emissions can persist in the atmosphere from 12 years for methane to up to 200 years for carbon dioxide. Where GHG emissions are released does not affect their contribution to climate change. Emissions generated by specific activities contribute incrementally in combination with past and future emissions from all other sources to the global warming that produces the adverse effects of climate

change. Table 3.1-2 shows the current environmental GHG emissions baseline produced under SpaceX activities (including launch and landing activities; static firing; booster and fairing recoveries; work transits; vendor deliveries; and generator use) from 12 launch events and compares them against total national GHG emissions.

Table 3.1-2. Estimated Annual Greenhouse Gas Emissions Under the Current Environmental Baseline Conditions

Emissions of CO_2e (Metric Tons per Year)	
Current Environmental Baseline GHG Emissions	8,865
National GHG Emissions	5,981,400,000
Percent of National Emissions	0.000148%
California GHG Emissions	369,200,000
Percent of California Emissions	0.002401%

3.2 NOISE

A detailed description of noise/sound, ambient sound guidance documents, Federal Interagency Committee on Urban Noise (1980) criteria, and USEPA noise standards is contained in Appendix E. The sound ROI includes noise-sensitive receptors and ambient noise levels in the area potentially affected by the Proposed Action. Booms with overpressures of about 1.0 psf are generally audible and can startle people, but generally do not cause adverse effects such as damage to structures (Haber and Nakaki 1989; Plotkin et al. 2012). A boom of that magnitude could be heard by someone who is expecting it and listening for it, but usually would not be noticed. The 1.0 sonic boom noise contour will also fully encompass any areas affected by launch and landing engine noise. Therefore, the ROI for noise was determined by examining the 1.0 psf sonic boom contours from model results.

3.2.1 SENSITIVE RECEPTORS

Noise sensitive areas are those areas where noise interferes with normal activities. These include residential, educational, health, and religious sites, parks, recreational areas, wildlife refuges, and cultural sites. "Individual, isolated, residential structures may be considered compatible within the 65 dB Day-Night Average Sound Level (DNL) noise contour where the primary land use is agricultural and adequate noise attenuation is provided" (FAA Order 10501.F). While DNL is the primary metric used to determine noise impacts by the FAA, California has adopted using the Community Noise Equivalent Level (CNEL). Per FAA Order 1050.1F, CNEL may be used in lieu of DNL for FAA actions needing approval in California. CNEL, like DNL, is an energy-averaged sound level measured over a 24-hour period. CNEL, like DNL adds a ten times weighting (equivalent to a 10 dBA "penalty") to each operation between 10:00 p.m. and 7:00 a.m., CNEL also adds a three times weighting (equivalent to an approximately 5 dBA penalty) for each operation during evening hours (7:00 p.m. to 10:00 p.m.). As such, DNL and CNEL are very similar and have been determined to be a reliable measure of long-term community annoyance. Transient residential use such as motels may be considered compatible within the 65 dBA noise contour where adequate noise attenuation is provided. Users of designated recreational areas are considered sensitive receptors.

Noise sensitive land uses on and near VSFB include residential areas, hospitals, schools, and libraries in Lompoc and the Cantonment area. No human sensitive receptors are located on or near the SLC-4 project

site. In addition, there are no human sensitive receptors at Channel Islands National Park which is within the Falcon 9 overflight path.

3.2.2 AMBIENT NOISE CONDITIONS

Existing noise levels on VSFB are quite low due to the large areas of undeveloped landscape and sparse noise sources. Background noise levels are primarily driven by wind noise; louder noise levels can be found near industrial facilities and transportation routes, including the railway. On VSFB, ambient one-hour average sound level measurements range from around 35 to 60 dB (Thorson et al. 2001). Regularly occurring sources of instantaneous noise near the Proposed Action Area include crashing ocean surf, which generates approximately 78 dBA (6.6 ft [2 m] tall waves) and can be louder during high surf events (Bolina & Abom 2010) or passing trains. Ambient sound levels were characterized at Surf Beach, approximately 5.3 mi north of SLC-4 reported at 45.5 dBA Equivalent Sound Level (L_{eq}) at night, 51.8 dBA L_{eq} during the day, and 53.1 dBA L_{eq} during the evening. Rocket launches and aircraft overflights create louder intermittent noise levels, 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. DNLs are typically between 55 and 65 dBA (City of Lompoc 2014b).

3.3 TERRESTRIAL BIOLOGICAL RESOURCES

Vegetation resources were considered but not analyzed in this SEA because the resource would not be affected by the Proposed Action or there would be no change from what was analyzed in previous the EAs (USAF 2011, 2016a, 2016b, 2018).

Under Section 7 of the ESA of 1973, as amended (16 USC § 1531, et seq.), federal agencies must assess project effects on species that are federally listed or proposed for listing based on the best scientific data available. Section 7 consultations with the USFWS and NMFS are required for federal projects that have the potential to directly or indirectly affect listed species or destroy or adversely modify critical habitat. Also, when evaluating project impacts USSF policy is to consider other federal special status species, state-listed protected species, and species protected by state law, e.g., special status species. In California, these include species that the California Department of Fish and Wildlife (CDFW) designates per the California Fish and Game Code (FGC) Sections 3511, 4700, 5050, and 5515 as “fully protected” wildlife species. "Fully protected" designation means the species is at risk of extinction within California. This term was used before California’s Endangered Species Act became law. California also protects species of special concern. Although SLD 30’s Integrated Natural Resource Management Plan is not subject to California’s requirements, SLD 30 protects and conserves these species when practicable and consistent with the military mission. VSFB also must comply with requirements of the Migratory Bird Treaty Act of 1918 (MBTA; 16 USC §§ 703-712) as amended. This Act protects native migratory birds, including their eggs, active nests, and young.

The ROI for terrestrial biological resources includes areas potentially impacted by sonic boom, rocket engine noise, and increased water usage, which includes VSFB and the immediate surrounding region, as well as the NCI. Although species reactions to noise vary depending on their biology, the DAF has monitored various species during launch-related sonic booms during numerous launches over the past two decades and determined that there are generally no significant behavioral disruptions caused to by sonic booms less than 1.0 psf. The 1.0 sonic boom noise contour will also fully encompass any areas

affected by launch and landing engine noise. Therefore, we determined the ROI for terrestrial wildlife by considering the 1.0 psf sonic boom contours from model results with species biology, prior monitoring observations, and scientific literature.

3.3.1 METHODOLOGY

The USSF reviewed prior special status species survey and monitoring data, biological reports, and California Natural Diversity Database records to assess the potential occurrence, distribution, and habitat use of special status species within the region potentially affected by the Proposed Action.

3.3.2 WILDLIFE RESOURCES

Common birds within the ROI include house finch (*Carpodacus mexicanus*), Brewer's blackbird (*Euphagus cyanocephalus*), cliff swallow (*Hirundo pyrrhonota*), barn swallow (*Hirundo rustica*), and California thrasher (*Toxostoma redivivum*). Amphibians within the ROI include the Baja California treefrog (*Pseudacris hypochondriaca*), Monterey ensatina (*Ensatina eschscholtzii*), and black-bellied slender salamander (*Batrachoseps nigriventris*). Reptiles include western fence lizard (*Sceloporus occidentalis*), western skink (*Eumeces skiltonianus*), and southern Pacific rattlesnake (*Crotalus oreganus helleri*). Various mammal species are also expected to occur within the ROI, including brush rabbit (*Sylvilagus bachmani*), coyote (*Canis latrans*), black bear (*Ursus americanus*), and California ground squirrel (*Otospermophilus beecheyi*). Small mammals include kangaroo rats (*Dipodomys* spp.) and pocket gopher (*Thomomys bottae*). Bat species in the area include big brown bat (*Eptesicus fuscus*) and western red bat (*Lasiurus blossevillii*).

The NCI host the island scrub jay (*Aphelocoma insularis*), Channel Islands spotted skunk (*Spilogale gracilis amphialus*), island fox (*Urocyon littoralis*), and the island deer mouse (*Peromyscus maniculatus santacruzae*).

3.3.3 SPECIAL STATUS WILDLIFE SPECIES

Species were considered "special status" if they met at least one of the criteria listed in **Error! Reference source not found.**. Potential occurrence was determined based on past documentation of special status species within the vicinity of the Action Area and suitability of habitat and occurrence within the region (**Error! Reference source not found.** through 3.3-7). Detailed information is contained in Appendices A and F.

1 **Table 3.3-1. Terrestrial Special Status Species 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 endangered, threatened, or rare by the state of California
✓ 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

Table 3.3-2. Federal and State Special Status Species Occurrence Within the Proposed Action Area

Species	Status		Potential Occurrence within the Proposed Action Area
	Federal	California	
Crotch bumble bee (*Bombus crotchii*)	-	SSC	Assumed due to suitable habitat within noise footprint.
Monarch butterfly (*Danaus plexippus*)	P	Special Animal	Documented overwintering stands within noise footprint.

Notes: P = proposed for listing under the ESA; SSC = California State Species of Special Concern; "Special Animals" is a broad term used to refer to all the animal taxa tracked by the CDFW.

Table 3.3-3. Special Status Fish Species Occurring or Potentially Occurring within the Terrestrial Portion of the Project Area

Species	Status		Potential Occurrence within the Proposed Action Area
	Federal	California	
Tidewater goby (*Eucyclogobius newberryi*)	FT	-	Historic occurrence in Honda Creek; surveys have not detected since 2001. Present in San Antonio Creek.
Unarmored Threespine Stickleback (*Gasterosteus aculeatus*)	FE	SE	Currently extirpated; historic introduction in Honda Creek in 1984. No individuals have been detected in Honda Creek since the late 1990's. Present in San Antonio Creek.
Arroyo chub (*Gila orcuttii*)	-	SSC	Not present in Honda Creek; present on San Antonio Creek.

Notes: FE = Federally Endangered Species; FT = Federally Threatened Species; SE = State Endangered Species; SSC = California State Species of Special Concern

Table 3.3-4. Special Status Amphibian Species Occurring or Potentially Occurring within the Terrestrial Portion of the Project Area

Species	Status		Potential Occurrence within the Proposed Action Area
	Federal	California	
California red-legged frog (*Rana draytonii*)	FT	SSC	Documented in adjacent aquatic habitats within noise footprint.

Notes: FT = Federally Threatened Species; SSC = California State Species of Special Concern

Table 3.3-5. Special Status Reptile Species Occurring or Potentially Occurring within the Terrestrial Portion of the Project Area

Species	Status		Potential Occurrence within the Proposed Action Area
	Federal	California	
Southwestern pond turtle (*Actinemys pallida*)	P	SSC	Documented in Honda Creek within noise footprint.
Two-striped garter snake (*Thamnophis hammondii*)	-	SSC	Documented in Honda Creek within noise footprint.

Notes: P = proposed for listing under the ESA; SSC = State Candidate Species

Table 3.3-6. Special Status Bird Species Occurring or Potentially Occurring within the Terrestrial Portion of the Project Area

Species	Status		Potential Occurrence within the Proposed Action Area
	Federal	California	
Allen's hummingbird (*Selasphorus sasin*)	BCC	-	Documented within noise footprint.
Bald eagle (*Haliaeetus leucocephalus*)	BCC; BGEPA	SE; Fully Protected	Documented occasional flyovers; foraging habitat within noise footprint. Unlikely to be present.
Black oystercatcher (*Haematopus bachmani*)	BCC	-	Documented on sandy beaches and rocky coastline within noise footprint.
Black skimmer (*Rynchops niger*)	BCC	-	Documented in nearshore ocean waters within noise footprint.
Brant (*Branta bernicla*)	-	SSC	Documented in nearshore ocean waters within noise footprint.
Burrowing owl (*Athene cunicularia*)	BCC	SSC	Assumed due to suitable wintering habitat in grassland areas within noise footprint.
California brown pelican (*Pelecanus occidentalis californicus*)	-	Fully Protected	Documented in nearshore ocean waters and roosts on beaches and rocks within noise footprint.
California condor (*Gymnogyps californianus*)	FE	SE	One documented brief occurrence on VSFB in 2017 within noise footprint. Unlikely to be present.
California least tern (*Sterna antillarum browni*)	FE	SE	Documented foraging and nesting in noise footprint.
Costa's hummingbird (*Calypte costae*)	BCC	-	Documented in canyon and erosional wash habitat within noise footprint.

Species	Status		Potential Occurrence within the Proposed Action Area
	Federal	California	
Golden eagle (*Aquila chrysaetos*)	BGEPA	Fully Protected	Documented in areas within noise footprint
Lawrence's goldfinch (*Spinus lawrencei*)	BCC	-	Documented in shrub and riparian habitat within noise footprint.
Loggerhead shrike (*Lanius ludovicianus*)	BCC	SSC; Nesting	Documented in shrub and riparian habitat within noise footprint.
Long-billed curlew (*Numenius americanus*)	BCC	-	Documented on rocky coastline at low tide and beaches within noise footprint.
Marbled godwit (*Limosa fedoa*)	BCC	-	Documented on sandy beaches and rocky coastline at low tide within noise footprint.
Marbled murrelet (*Brachyramphus marmoratus*)	FT	SE	Documented in nearshore ocean waters within noise footprint.
Northern harrier (*Circus hudsonius*)	-	SSC; Nesting	Documented in grassland within noise footprint.
Nuttall's woodpecker (*Dryobates nuttallii*)	BCC	-	Documented in riparian habitat within noise footprint.
Oak titmouse (*Baeolophus inornatus*)	BCC	-	Documented in riparian and non-native tree habitat within noise footprint.
Peregrine falcon (*Falco peregrinus anatum*)	BCC; Nesting	Fully Protected; Nesting	Documented in coastal habitat within noise footprint.
Short-billed dowitcher (*Limnodromus griseus*)	BCC	-	Documented on rocky coastline at low tide and beaches within noise footprint.
Whimbrel (*Numenius phaeopus*)	BCC	-	Documented on rocky coastline at low tide and beaches within noise footprint.
Western snowy plover (*Charadrius nivosus nivosus*)	FT; BCC	SSC; Nesting	Documented on rocky coastline at low tide, nests on sandy beaches within noise footprint.
Willet (*Tringa semipalmata*)	BCC	-	Documented on rocky coastline at low tide and beaches impacted by noise.
White-tailed kite (*Elanus leucurus*)	-	Fully Protected; Nesting	Documented in riparian and non-native tree habitat within noise footprint.

Species	Status		Potential Occurrence within the Proposed Action Area
	Federal	California	
Yellow warbler (*Setophaga petechia*)	BCC	SSC; Nesting	Documented in riparian habitat within noise footprint.

Notes: BGEPA = Bald and Golden Eagle Protection Act; FE = Federally Endangered Species; FT = Federally Threatened Species; P = proposed for listing under the ESA; SE = State Endangered Species; SSC = California State Species of Special Concern; BCC = Federal Bird of Conservation Concern

* "Special Animals" is a broad term used to refer to all the animal taxa tracked by the CDFW.

1 **Table 3.3-7. Special Status Mammal Species Occurring or Potentially Occurring within the Terrestrial Portion of the Project Area**

Species	Status		Potential Occurrence within the Proposed Action Area
	Federal	California	
Pallid bat (*Antrozous pallidus*)	-	SSC	Documented within noise footprint.
Townsend's big-eared bat (*Corynorhinus townsendii*)	-	SSC	Documented within noise footprint.
Spotted bat (*Euderma maculatum*)	-	SSC	Documented within noise footprint.
Western red bat (*Lasiurus blossevillii*)	-	SSC	Documented within noise footprint.
Western mastiff bat (*Eumops perotis californicus*)	-	SSC	Documented within noise footprint.
San Diego desert woodrat (*Neotoma lepida intermedia*)	-	SSC	Documented within noise footprint.
American badger (*Taxidea taxus*)	-	SSC	Documented within noise footprint.

Notes: BGEPA = Bald and Golden Eagle Protection Act; FE = Federally Endangered Species; FT = Federally Threatened Species; P = proposed for listing under the ESA; SE = State Endangered Species; SSC = California Species of Special Concern; SSC = State Candidate Species; BCC = Federal Bird of Conservation Concern

* "Special Animals" is a broad term used to refer to all the animal taxa tracked by the CDFW.

2

3.3.3.1 Tidewater Goby (Federally Listed Endangered Species)

Suitable habitat for tidewater goby (TWG) is found in Honda Creek and TWG were recorded in Honda Creek in 1995 (Lafferty et al. 1999). Surveys in 2008, 2015, and 2016 indicated that TWG were not present (MSRS 2009a, 2016, 2018a). No TWG were observed while monitoring for culvert repairs on Honda Creek in 2022 (MSRS, unpubl. data). Between 2008 and 2022, Honda Creek has gone through multiple cycles of drying and rehydration, which would preclude occupancy by and persistence of fish. Although there are historical records, TWG are unlikely to be present in the Action Area. Critical habitat has been designated for TWG but does not include VSFB, since it is owned by the DOD and is exempted under section 4(a)(3) of the ESA.

3.3.3.2 Unarmored Threespine Stickleback (Federally Listed Endangered Species)

Unarmored threespine stickleback (UTS) are found in San Antonio Creek from Barka Slough to the lagoon, mostly in the creek channel rather than the lagoon (MSRS 2009a; Swift et al. 1997). UTS were introduced into Honda Creek in 1984 (MSRS 2009a) but extensive aquatic surveys conducted in 2008, 2016, and 2017 did not detect any fish in Honda Creek (MSRS 2009a, 2016, 2018a). Between 2008 and 2022, Honda Creek has gone through multiple cycles of drying and rehydration, which would preclude occupancy by and persistence of fish. Although there are historical records, UTS are unlikely to be present in the Action Area. Critical habitat has not been finalized.

3.3.3.3 California Red-legged Frog (Federally Listed Threatened Species)

CRLF have been consistently documented in Honda Creek (Christopher 1996, 2004; MSRS 2009b, 2016, 2018a, 2021a) and during SpaceX launch monitoring activities in January 2022 (MSRS 2022). The Santa Ynez River and Bear Creek, to the north of SLC-4, have CRLF populations and suitable breeding habitat (Christopher 2004; MSRS 2009b, 2014a). Spring Canyon does not currently support suitable breeding habitat due to the protracted drought conditions (MSRS 2013, 2017). It is therefore unlikely that CRLF regularly occupy Spring Canyon, other than as transitory habitat. CRLF also occur throughout San Antonio Creek on VSFB from Barka Slough to the estuary (MSRS 2009a, 2009b, 2016). Designated critical habitat occurs in areas potentially impacted by noise along the southeastern (Unit STB-4) and northeastern (Unit STB-2) perimeters of VSFB.

3.3.3.4 Marbled Murrelet (Federally Listed Threatened Species)

There have been three recorded sightings of MAMU off the coast in nearshore waters between the Santa Maria River and offshore of VSFB from on-land observation sites (eBird 2022). MAMU has never been documented breeding on VSFB, nor is any old-growth coniferous forest present on VSFB or in the Action Area. There is no designated critical habitat for this species within or adjacent to the Action Area.

3.3.3.5 Western Snowy Plover (Federally Listed Threatened Species)

VSFB provides breeding and wintering habitat for SNPL (USFWS 2014a; Robinette et al. 2016, 2021). The breeding population of SNPL on VSFB has been highly variable but relatively stable since 2007, with 235 adults and 472 nests initiated in 2021 (Robinette et al. 2021). The nearest SNPL nesting area to SLC-4 is on South Surf Beach, approximately 0.7 mi northwest of SLC-4. The SNPL is also considered a permanent resident of SRI). On SMI, a high count of 61 SNPL was documented during the 2016–2017 winter window survey; however, counts at SMI typically document very few to no individuals (USFWS 2017a). VSFB was exempted from critical habitat designation under section 4(a)(3) of the ESA. Critical habitat occurs on SRI in the area of potential sonic boom impacts.

3.3.3.6 California Least Tern (Federally Listed Endangered Species)

Historically, LETE nested in colonies in several locations along the coastal strand of the north VSFB coastline (Robinette et al. 2016, 2021). After young have fledged in late summer, LETE also disperse to this location to forage in the lagoon and roost on adjacent sandbars before migrating south for the winter (Robinette & Howar 2010). The USFWS has not designated critical habitat for the LETE.

3.3.3.7 California Condor (Federally Listed Endangered Species)

The California condor's current range is not within the Action Area. However, in March 2017, one immature, non-reproductive female was present on VSFB departing approximately one month later, on or about 22 April 2017. Given the wide-ranging nature of this species, individuals may occur on Base in the future. There is no critical habitat within or adjacent to the Action Area.

3.4 MARINE BIOLOGICAL RESOURCES

The ROI for marine biological resources includes areas potentially affected by sonic boom, rocket engine noise, and first stage and fairing recovery activities. The DAF has monitored pinnipeds during launch-related sonic booms on the NCI during numerous launches over the past two decades and determined there are generally no significant behavioral disruptions caused to pinnipeds by sonic booms less than 1.0 psf; therefore, the ROI for marine mammals potentially disturbed by a sonic boom was determined by examining the 1.0 psf sonic boom contours from model results. The ROI also includes the proposed landing and fairing recovery area (Figure 2.2-2), the NCI, and support vessel routes between the Port of Long Beach, the proposed landing area, and VSFB Harbor. Fish, sea turtle, and marine mammal species protected under the ESA or Marine Mammal Protection Act (MMPA), and managed by NMFS, have the potential to occur in the ROI (Tables 3.4-1 through 3.4-4). Additionally, various marine reserves occur within the ROI. Detailed background information on ESA-listed fish, sea turtles, and marine mammals, including status and maps showing occurrence in the project area, can be found in Appendices B and G.

Table 3.4-1. ESA-listed Invertebrate Species Occurrence Within the ROI

Common Name	Scientific Name	DPS or ESU	Federal Status	Presence in Action Area
Black abalone	*Haliotis cracherodii*	-	FE	Documented in rocky substrates in the high to low intertidal zone.

Notes: ESU = Evolutionarily Significant Unit; DPS = Distinct Population Segment; FE = federally endangered

Table 3.4-2. ESA-listed Fish Species Occurrence Within the ROI

Common Name	Scientific Name	DPS or ESU	Federal Status	Presence in Action Area
Steelhead	*Oncorhynchus mykiss*	Southern California Coast	FE	Documented in the nearshore and offshore waters.
Chinook salmon	*Oncorhynchus tshawytscha*	5 ESUs[1]	FT	Specific ESUs present or potentially present in the nearshore and offshore waters.
Coho salmon	*Oncorhynchus kisutch*	4 ESUs[2]	FT	Documented in the nearshore and offshore waters.
Green sturgeon	*Acipenser medirostris*	Southern	FT	Likely present primarily along continental shelf waters of the West Coast
Oceanic whitetip shark	*Carcharhinus longimanus*	-	FT	Present in open ocean waters from Southern California to Peru
Scalloped hammerhead shark	*Sphyrna lewini*	Eastern Pacific	FE	Present in coastal and semi-oceanic water in temperate and tropical regions

Notes: ESU = Evolutionarily Significant Unit, DPS = Distinct Population Segment; FE = federally endangered; FT = federally threatened

[1] Chinook salmon ESUs include California Coastal (FT), Central Valley Spring-Run (FT), Lower Columbia River (FT), and Sacramento River Winter-Run (FT)

[2] Coho salmon ESUs include Central California Coast (FT) and Southern Oregon and Northern California Coasts (FT).

Table 3.4-3. ESA-listed Turtle Species Occurrence Within the ROI

Common Name	Scientific Name	DPS or ESU	Federal Status	Presence in Action Area
Green sea turtle	*Chelonia mydas*	East Pacific	FT	Present in offshore and nearshore subtropical waters
Leatherback sea turtle	*Dermochelys coriacea*	-	FE	Present in offshore and nearshore waters
Olive ridley sea turtle	*Lepidochelys olivacea*	Mexico Pacific coast	FE	Present in offshore and nearshore waters
Hawksbill sea turtle	*Eretmochelys imbricata*	-	FE	Present in offshore and nearshore waters of Mexico
Loggerhead turtle	*Caretta caretta*	North Pacific	FE	Present in small numbers in offshore waters generally north of Point Conception

Notes: ESU = Evolutionarily Significant Unit; DPS = Distinct Population Segment; FE = federally endangered; FT = federally threatened

Table 3.4-4. ESA-listed Marine Mammal Species Occurrence Within the ROI

Common Name	Scientific Name	DPS or ESU	Federal Status	Presence in Action Area
Blue whale	*Balaenoptera musculus*	-	FE; MMPA	High densities in summer/fall; single individuals in winter/spring
Fin whale	*Balaenoptera physalus*	-	FE; MMPA	Higher densities in the summer and fall, present year-round
Gray whale	*Eschrichtius robustus*	Western North Pacific	FE; MMPA	Present during seasonal migration in the winter and spring
Humpback whale	*Megaptera novaeangliae*	Mexico	FT; MMPA	Individuals present year-round with higher seasonal presence during the summer migrations from Mexico and Central America
		Central America	FE; MMPA	
Killer whale	*Orcinus orca*	Southern Resident	FE; MMPA	occasionally present offshore of Central and Southern California
Sei whale	*Balaenoptera borealis*	-	FE; MMPA	Present year round with more likely presence in the winter and spring
Sperm whale	*Physeter macrocephalus*	-	FE; MMPA	Present year round with a preference for deep waters and the continental shelf break and slope
Steller sea lion	*Eumetopias jubatus*	-	MMPA	Documented in coastal waters within the noise footprint
Northern elephant seal	*Mirounga angustirostris*	-	MMPA	Documented in coastal waters within the noise footprint
Pacific harbor seal	*Phoca vitulina richardii*	-	MMPA	Documented in coastal waters within the noise footprint
California sea lion	*Zalophus californianus*	-	MMPA	Documented in coastal waters within the noise footprint
Guadalupe fur seal	*Arctocephalus townsendi*	-	FT; MMPA	Primarily present at NCI and between 50 and 300 kilometers (km) offshore seasonally when not at rookeries in Mexican waters
Southern sea otter	*Enhydra lutris*	-	FT; MMPA	Present along coast of California from Santa Barbara County and north; present along coast of San Nicolas Island

Notes: ESU = Evolutionarily Significant Unit; DPS = Distinct Population Segment; FE = federally endangered; FT = federally threatened

3.4.1 ESA-LISTED FISH SPECIES

3.4.1.1 Steelhead - Southern California DPS (Federally Listed Endangered DPS)

The range of anadromous steelhead includes the Pacific Ocean along the U.S. Pacific Coast to Southern California (Good et al. 2005) and therefore overlaps the Action Area. Designated critical habitat for steelhead in Southern California is restricted to rivers and estuaries and does not overlap with the ROI.

3.4.1.2 Chinook Salmon (Federally Listed Threatened ESUs)

3.4.1.2.1 Lower Columbia River ESU

Lower Columbia River ESU spring-run Chinook, though more common beyond the continental shelf, with most migrating far offshore after their first year of marine residence (Quinn & Myers 2005; Sharma 2009) would be rare in the ROI.

3.4.1.2.2 California Coastal ESU

The California coastal Chinook remain primarily between Pt. Reyes and southern Oregon, with highest abundances in the Fort Bragg and Klamath subareas (Bellinger et al. 2015; Satterthwaite et al. 2015). This ESU occurs within the ROI.

3.4.1.2.3 Sacramento River Winter-Run ESU

The distribution of the Sacramento River Winter-Run ESU is largely in Oregon and California coastal waters (Hendrix et al. 2019; Moyle 2002; Windell et al. 2017) and is therefore likely to occur in the ROI.

3.4.1.2.4 Critical Habitat

Designated critical habitat for Chinook salmon ESUs is restricted to rivers and estuaries and therefore does not overlap with the ROI.

3.4.1.3 Coho Salmon (Federally Listed Threatened ESUs)

3.4.1.3.1 Southern Oregon and Northern California Coast ESU

Due to prevalence of coho in Oregon coastal waters (Fisher et al. 2014; NMFS 2019c), Southern Oregon and Northern California Coast coho salmon are present in the ROI.

3.4.1.3.2 Central California Coast ESU

Due to prevalence of coho in central and northern California coastal waters (Fisher et al. 2014, CDFW 2022), Central California Coast coho salmon occur in the ROI.

3.4.1.3.3 Critical Habitat

Designated critical habitat for Coho salmon ESUs is restricted to rivers and estuaries and therefore does not overlap with the ROI.

3.4.1.4 Green Sturgeon (Federally Listed Threatened Species)

The Southern Distinct Population Segment (DPS) of green sturgeon is likely to be present in the ROI. Critical habitat includes coastal U.S. marine waters within 360 ft depth from Monterey Bay, California north to Cape Flattery, Washington. Green sturgeon critical habitat does not overlap the ROI.

3.4.1.5 Oceanic Whitetip Shark (Federally Listed Threatened Species)

Oceanic whitetips occur throughout the Central Pacific, including the eastern Pacific from Southern California to Peru and the Gulf of California. They are known to occur in Baja California and may be found in surface waters off the continental shelf (Baum et al. 2015) and are therefore expected to occur within the ROI. Critical habitat has not been designated for this species.

3.4.1.6 Scalloped Hammerhead Shark (Federally Listed Endangered Species)

Scalloped hammerhead sharks in the eastern Pacific Ocean range from the coast of southern California to Ecuador (Compagno 1984; Froese & Pauly 2016) and are therefore expected in the ROI. Critical habitat has not been designated for this species.

3.4.2 ESA-LISTED SEA TURTLES

3.4.2.1 Green Sea Turtle (Federally Listed Threatened Species)

Green sea turtles are widely distributed in the subtropical coastal and ocean waters of southern Baja California, Mexico, and Central America (Cliffton et al. 1995; NMFS and USFWS 1998a). The species is occasionally observed in ocean waters off southern California and northern Baja California (Stinson 1984) and is therefore within the ROI. Critical habitat has not been designated in the Pacific Ocean.

3.4.2.2 Loggerhead Turtle (Federally Listed Endangered Species)

Loggerhead turtles are found worldwide mainly in subtropical and temperate regions (Conant et al. 2009). In the eastern Pacific, the loggerheads primary range extends from offshore of Vancouver Island, south to Central America. The loggerhead turtle is known to occur at sea off of southern California, but does not nest on southern California beaches. There is no critical habitat designated for the North Pacific Ocean DPS.

3.4.2.3 Olive Ridley Sea Turtle (Federally Listed Endangered Species)

Most olive ridley turtles lead a primarily open ocean existence (NMFS and USFWS 1998b). Individuals occasionally occur in waters as far north as California (NMFS and USFWS 2007). Critical habitat has not been designated for the olive ridley turtle.

3.4.2.4 Hawksbill Sea Turtle (Federally Listed Endangered Species)

Water temperature in the southern California offshore waters is generally too low for hawksbills, and their occurrence offshore of California would be considered rare. They are more common in nearshore foraging grounds, including coral reefs and mangrove estuaries from Baja California to South America (NMFS and USFWS 2013). However, hatchlings utilize floating algal mats and drift lines in pelagic (open sea) habitat (NMFS and USFWS 2013) and therefore may be found in the ROI. Critical habitat has not been designated for the hawksbill in the Pacific Ocean.

3.4.2.5 Leatherback Sea Turtle (Federally Listed Endangered Species)

Leatherback sea turtles are regularly seen off the west coast of the U.S., with the greatest densities found in waters along Central California during summer and fall when sea surface temperatures are highest (Bailey et al. 2012). In 2012, NMFS designated critical habitat for the leatherback sea turtle in California waters from Point Arena to Point Arguello out to the 3,000-m isobath (77 FR 4169). The Primary Constituent Elements (PCEs) defining leatherback critical habitat are the occurrence of prey species, primarily Scyphomedusae, commonly known as jellies, of the order Semaeostomeae (*Chrysaora*, *Aurelia*,

Phacellophora, and *Cyanea*), of sufficient condition, distribution, diversity, abundance, and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks…" (50 CFR Part 226.207).

3.4.3 MARINE MAMMALS

3.4.3.1 Blue Whale (Federally Listed Endangered Species)

The blue whale inhabits all oceans and typically occurs near the coast, over the continental shelf, though they are also found in oceanic waters. Relatively high densities of blue whales occur off Central and Southern California during the summer and fall (Becker et al. 2016). Blue whales in the eastern north Pacific migrate between higher latitude feeding grounds of the Gulf of Alaska and the Aleutian Islands to lower latitudes, including Southern California and Baja California, Mexico (Palacios et al. 2019). There is no designated critical habitat for this species.

3.4.3.2 Fin Whale (Federally Listed Endangered Species)

Fin whales have frequently been recorded in waters within Southern California and are present year-round (Mizroch et al. 2009). Sightings from surveys off Southern California from 2004 to 2013 show fin whales farther offshore in summer and fall and closer to shore in winter and spring (Douglas et al. 2014; Campbell et al. 2015). No critical habitat has been designated for the fin whale.

3.4.3.3 Western North Pacific Gray Whale (Federally Listed Endangered DPS)

Gray whales of the Western North Pacific DPS primarily occur in shallow waters over the U.S. West Coast, Russian, and Asian continental shelfs and are considered to be one of the most coastal of the great whales (Jefferson et al. 2008; Jones & Swartz 2009). The breeding grounds are in Baja California, Mexico. At least 12 members of the Western North Pacific DPS have been detected in waters off the Pacific Northwest (Weller & Brownell 2012; Mate 2013; Moore & Weller 2018). Although they generally remain mostly over the shelf during migration, some gray whales may be found in more offshore waters to the west of San Clemente Island and the Channel Islands (Guazzo et al. 2019). There has been no designated critical habitat for the Western North Pacific gray whale DPS.

3.4.3.4 Humpback Whale, Mexico Distinct Population Segment (Federally Listed Threatened DPS) and Central American Distinct Population Segment - (Federally Listed Endangered DPS)

Breeding and calving areas for the Mexico DPS and for the Central America DPS are both located within the ROI. While most humpback whale sightings are in nearshore and continental shelf waters, humpback whales frequently travel through deep oceanic waters during migration (Dohl et al. 1983; Forney & Barlow 1998; Campbell et al. 2015). Humpback whales migrating from breeding grounds in Central America to feeding grounds at higher latitudes cross the Action Area.

Critical habitat overlaps the Action Area. Region/Unit 17 extends from 36° 00' to 34° 30' north latitude. Within those north and south boundaries, Region/Unit 17 begins at the 98-ft depth contour out to the 12,139-ft depth contour. The essential feature for the Central America DPS is "Prey species, primarily euphausiids (*Thysanoessa, Euphausia, Nyctiphanes,* and *Nematoscelis*) and small pelagic schooling fishes, such as Pacific sardine (*Sardinops sagax*), northern anchovy (*Engraulis mordax*), and Pacific herring (*Clupea pallasii*), of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth (NMFS 2019d). The Mexico DPS is very similar, but adds capelin

(*Mallotus villosus*), juvenile walleye pollock (*Gadus chalcogrammus*), and Pacific sand lance (*Ammodytes personatus*) to the essential prey species lists.

3.4.3.5 Killer Whale (Federally Listed Endangered DPS)

Southern Resident killer whales occur mainly along the outer coast and inland waters of Washington and British Columbia, Canada. In recent years the population has shifted and expanded its range south as far as central California (Cogan 2015; Dahlheim et al. 2008). Satellite-tag locations found that 95 percent of Southern Resident killer whales were within 18 nm of shore, and 50 percent were within 5 nm of shore Hanson et al. 2018; Hanson et al. 2017). No recovery activities would occur within 12 nm of islands; therefore, relatively few killer whales are expected to occur in areas where these activities would be conducted.

NMFS amended and expanded the critical habitat designation for Southern Resident killer whales to include nearshore waters along the coasts of Washington, Oregon, and California in 2021. The elements of critical habitat essential for conservation of the Southern Resident killer whale are (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging. The amended critical habitat designation extends along the entire Oregon coastline but is outside the ROI.

3.4.3.6 Sei Whale (Federally Listed Endangered Species)

Sei whales are encountered during the summer off California and the North America coast from approximately the Mexican border to Vancouver Island, Canada (Masaki 1976; Horwood 2009; Smultea et al. 2010). Sei whales are expected to be present in offshore waters in the ROI. There is no designated critical habitat for this species.

3.4.3.7 Sperm Whale (Federally Listed Endangered Species)

Sperm whales are found year-round in California waters, but their abundance is temporally variable, most likely due to the availability of prey species (Forney & Barlow 1993; Smultea 2014). They tend to prefer deep waters and the continental shelf break and slope (Barlow 1995; Barlow & Forney 2007). There is no designated critical habitat for this species.

3.4.3.8 Southern Sea Otter (Federally Listed Threatened Species)

Southern sea otters occur regularly off the coast of VSFB, with animals concentrated in the kelp beds offshore of Purisima Point on north VSFB and Sudden Flats on south VSFB. The inshore habitat off of Sudden Flats supports expansive kelp beds and a relatively high density of otters. Transitory otters occasionally move along the coast between SLC-4 and Point Arguello. There is no designated critical habitat for this species.

3.4.3.9 California Sea Lion

California sea lions are common offshore of VSFB and haul out sporadically on rocks and beaches along the coastline of VSFB. They occasionally haul out on south VSFB, but rarely pup on the VSFB coastline (USAF 2021). They are the most abundant pinniped species in the Channel Islands (Lowry et al. 2017a). SMI is the northern extent of the species' breeding range hosting one of the largest breeding colonies of the species in the Channel Islands (Melin et al. 2010; Lowry et al. 2017b).

3.4.3.10 Pacific Harbor Seal

Pacific harbor seals congregate on multiple rocky haulout sites along the VSFB coastline, including Point Conception. Most haulout sites are located between the Boat House and South Rocky Point, where most of the pupping on VSFB occurs (VSFB 2021). Pups are generally present in the region from March through July. Harbor seals also haul out, breed, and pup in isolated beaches and coves throughout the coast of SMI Lowry et al. 2017a).

3.4.3.11 Northern Elephant Seal

Northern elephant seals haul out on rocks and beaches along the coastline of VSFB (USAF 2021). Pupping was observed on south VSFB in January 2017 for the first time in more than 40 years and every year since then. Northern elephant seals also breed and pup at the rookeries found at Point Bennett and Cardwell Point on SMI (Lowry 2002). Northern elephant seals are abundant at the NCI from December to March (Lowry et al., 2017a).

3.4.3.12 Steller Sea Lion

North Rocky Point was used in April and May 2012 by Steller sea lions (Marine Mammal Consulting Group and Science Applications International Corporation [MMCG and SAIC] 2012). This was the first time they had been reported at VSFB over the past two decades. Since 2012, Steller sea lions were observed infrequently in routine monthly surveys, with as many as 16 individuals recorded (MMCG and SAIC 2012). Steller sea lions once had two small rookeries on SMI, 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.

3.4.3.13 Northern Fur Seal

The California stock of Northern fur seal is not considered depleted under the MMPA (Carretta et al. 2020). Animals from the California stock may remain in or near SMI throughout the year but, after the breeding season in November (Melin et al. 2012; Lowry et al. 2017a; Zeppelin et al. 2019). The abundance of northern fur seals at SMI has increased steadily over the past four decades, except for two severe declines associated with El Niño-southern Oscillation events in 1993 and 1998 (Carretta et al. 2020). Live northern fur seals have not been observed at any VSFB haulout location (USAF 2021).

3.4.3.14 Guadalupe Fur Seal (Federally Listed Endangered Species)

Guadalupe fur seals are most common at their primary breeding ground of Guadalupe Island, Mexico (Melin & DeLong 1999). Satellite tracking data have demonstrated movements into the offshore waters between 50 and 300 km from the U.S. West Coast (Norris & Elorriaga-Verplancken 2020). Therefore, the seals are expected to occur in both deeper waters of the open ocean and coastal waters within the project area. The species has occasionally been observed at SMI since the mid-1960s and in the late 1990s, a pup was born on SMI. In NMFS aerial surveys between 2011 and 2015, Guadalupe fur seals were not observed on any of the Channel Islands other than at SMI (Lowry et al. 2017b; Burke 2017; NMFS 2020). Guadalupe fur seals have not been observed at any VSFB haulout locations (USAF 2021).

3.4.4 MARINE RESERVES

Under the National Marine Sanctuaries Act, the NOAA established national marine sanctuaries for marine areas with special conservation, recreational, ecological, historical, cultural, archaeological, scientific, educational, or aesthetic qualities. Figure 3.4-1 shows marine reserves that may be impacted by the

Proposed Action's noise. The Channel Islands National Marine Sanctuary (CINMS) is a collection of marine reserves and marine sanctuaries located at the Channel Islands approximately 40 mi south of SLC-4 (Figure 3.4-1). CINMS regulations listed in 15 CFR Parts 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. Sonic booms created by the Falcon 9 would reach approximately 5.0 psf at CINMS on rare occasions.

The coastline from Purisima Point to just south of Point Arguello has been designated as the Vandenberg State Marine Reserve (VSMR) pursuant to California's Marine Managed Areas Improvement Act (Figure 3.4-1). 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. Launches would produce engine noise up to 130 dB maximum unweighted sound pressure level (L_{max}) within the VSMR. First stage landing events at SLC-4W would produce up to approximately 110 dB L_{max} and sonic booms up to approximately 4.0 psf within the VSMR.

In addition, the Northern Chumash Tribal Council is pursuing designation of the Chumash Heritage National Marine Sanctuary (CHNMS) under the Marine Protection, Research and Sanctuaries Act of 1977. In 2015, NOAA accepted the nomination for future consideration. The CHNMS would encompass an area of the Pacific Ocean from Gaviota Creek to Santa Rosa Creek and out to the western slope of the Santa Lucia Bank. If NOAA designates the CHNMS it would include an exemption for existing activities at VSFB, including SpaceX launches. Because the CHNMS has not been designated at this time, it is not carried forward for analysis.

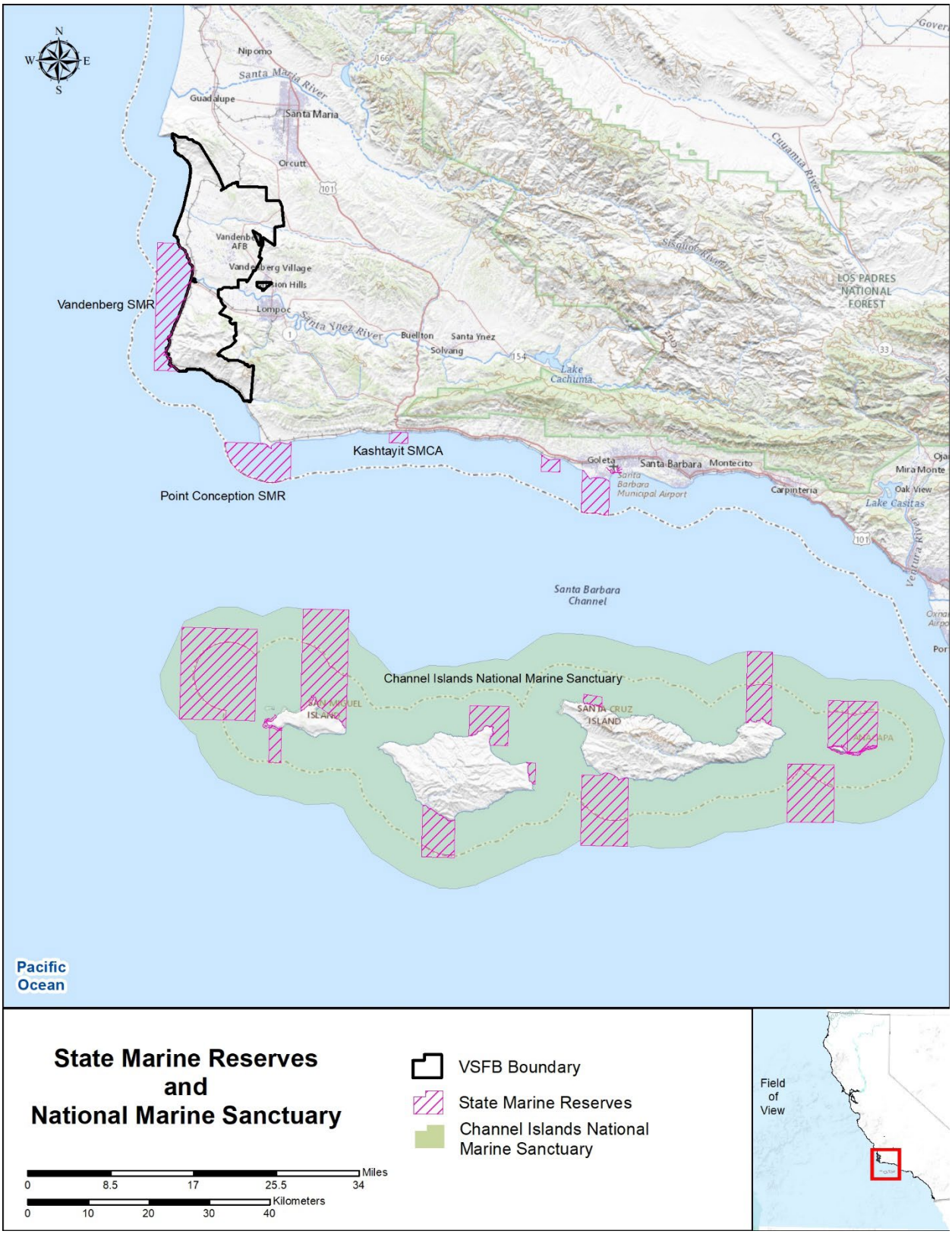

Figure 3.4-1. State Marine Reserves and Channel Islands National Marine Sanctuary

3.5 WATER RESOURCES

The ROI for Water Resources includes Spring Canyon, San Antonio Creek, and the Pacific Ocean.

3.5.1 SURFACE WATER

The Clean Water Act (CWA) mandates the National Pollutant Discharge Elimination System (NPDES) program, which requires a permit for discharging any pollutant to waters of the U.S. (WOTUS) from point (discernible confined and discrete conveyances) and non-point (stormwater runoff from industrial, municipal, and construction sites) sources. The CWA and USEPA implementing regulations provide the authority and framework for state regulations. In California, the State Water Resources Control Board (SWRCB) administers the NPDES program through the California Porter-Cologne Water Quality Control Act (PCWQCA)/California Water Code (CWC). The SWRCB and the Regional Water Quality Control Board (RWQCB) administer the NPDES Program for industrial activities, municipalities, and construction activities through General Permits, although certain discharges are authorized or require individual permits. 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 VSFB. Bear Creek, Cañada Honda Creek, and Jalama Creek are the major drainages on south VSFB, while Shuman Creek, and San Antonio Creek are the major drainages on north VSFB (Figure 1.2-1). There are also numerous unnamed minor drainage basins containing seasonal (intermittent) and ephemeral streams. These basins drain predominantly to the west toward the Pacific Ocean. Surface water resources near SLC-4 include Spring Canyon and the Pacific Ocean.

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

As described in the 2018 SEA, removing riparian vegetation from a portion of Spring Canyon annually within a 3.3-ac area is performed to avoid and minimize impacts to nesting migratory birds. To protect WOTS and meet Basin Plan requirements, the RWQCB required implementing a monitoring and mitigation plan in lower Spring Canyon (MSRS 2017). Mitigation plan implementation is currently in its fifth year.

San Antonio Creek drains an area of approximately 154 square miles flowing westward and discharging into the Pacific Ocean. The San Antonio Creek watershed consists of mostly undeveloped riparian, scrublands, rangelands, and agricultural fields. Flow in San Antonio Creek is seasonal, with higher discharges generally occurring during the rainy season.

3.5.2 GROUND WATER

The Sustainable Groundwater Management Act of 2014 (SGMA), enacted in January 2015, mandates that all California groundwater basins the California Department of Water Resources designates as high- or medium-priority be managed under a Groundwater Sustainability Plan (GSP; Section 10720.7 CWC). GSPs are currently being formed for the medium-priority Santa Ynez and San Antonio groundwater basins by

their associated groundwater sustainability agencies (GSAs). VSFB is a federal institution that is exempt from mandatory SGMA compliance yet has expressed intent to collaborate and assist with pertinent GSAs in their GSP formations per CWC Section 10720.3.

VSFB includes parts of two groundwater basins and at least two sub-basins. The northern third of VSFB is within the San Antonio Creek Basin and the remaining areas are within the Santa Ynez River Basin and associated Lompoc Terrace and Cañada Honda sub-basins. SLC-4 is located in the Santa Ynez River groundwater basin/Lompoc Terrace sub-basin.

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

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

Groundwater in the San Antonio Creek Valley occurs in most of the unconsolidated deposits that have filled the San Antonio Trough (a notch cut through the consolidated Tertiary rocks by San Antonio Creek). The water-bearing deposits in San Antonio Creek include alluvium, Orcutt Sand, the Paso Robles Formation, and Careaga Sand. Groundwater in the area moves from the hills surrounding the San Antonio Creek Valley toward the center of the valley, and then to the Pacific Ocean. At Barka Slough, groundwater rises to the surface, creating a freshwater marsh, and flows into San Antonio Creek as surface flow.

The current water source for VSFB is four water wells located within the San Antonio Creek Basin. There is an existing connection between State water and the VSFB water supply system; however, due to ongoing drought conditions and significant reductions in State water allocations, VSFB will remain on well water from the San Antonio Creek Basin for the foreseeable future. The San Antonio Creek Basin is considered in this SEA due to water extraction requirements to support SLC-4 operations.

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

3.5.3 WATERS OF THE UNITED STATES AND WETLANDS

On 18 January 2023, the USEPA and Department of the Army announced a final rule founded upon the pre-2015 definition of WOTUS effective 20 March 2023 (40 CFR Part 120; 33 CFR Part 328). WOTUS encompass the jurisdictional limits of the authority of the U.S. Army Corps of Engineers (USACE) and include traditional navigable waters, territorial seas, interstate waters, impoundments, tributaries that are relatively permanent or meet a significant nexus standard, and adjacent wetlands and other waters if they are relatively permanent and meet a significant nexus standard (88 FR 3004-3144). The USACE has determined that Spring Canyon has no significant nexus to the navigable waters of the Pacific Ocean and therefore does not qualify as a WOTUS. Spring Canyon originates approximately 1.4 mi inland and flows toward the Pacific Ocean. Spring Canyon has surface waters with flowing or standing water for only a short duration in direct response to significant precipitation (surface flow only occurs during and immediately after rain events and standing water may be present sporadically for hours to days after rainfall events). Surface flow percolates into the groundwater to pass beneath road embankments, but has no connectivity to the navigable waters of the Pacific Ocean; therefore, under the revised 2023 definition, it does not qualify as a WOTUS.

3.5.4 WATERS OF THE STATE AND WETLANDS

Aquatic resources are also protected in California through regulation of activities within inland streams, wetlands, and riparian zones. The RWQCB and the CDFW both have jurisdiction over all wetland and non-wetland WOTUS under USACE jurisdiction, along with riparian zones, ground water, and a broader scope of isolated and ephemeral surface and ground waters. The CWC gives the State broad authority to regulate Waters of the State (WOTS) which are defined as surface water or groundwater, including saline waters. The local RWQCB administers the PCWQCA and determines the exact definition of WOTS within its region.

The State of California also regulates water resources under Sections 1600 to 1603 of the FGC, including ephemeral, intermittent, and perennial watercourses. Jurisdiction is extended to the limit of riparian zones that are contiguous to the water resource and function as part of the watercourse system. The FGC, Section 2785(e), defines “riparian habitat” as, “lands which contain habitat which grows close to and which depends upon soil moisture from a nearby freshwater source.” WOTS include all wetland WOTUS and wetlands that meet the state’s own definition. WOTS include isolated wetlands with no surface connection to a traditionally navigable water, as well as wetlands that are unvegetated, so long as they have hydric soils and wetland hydrology. WOTS also include all non-wetland WOTUS, and some ephemeral streams that do not qualify as WOTUS may qualify as WOTS if they have indicators of an ordinary high water mark, for instance.

To comply with the RWQCB, the USSF is implementing mitigation in lower Spring Canyon to offset impacts to WOTS from vegetation removal activities in Spring Canyon at a 2:1 ratio within the same drainage. The USSF began implementing riparian restoration at a 2.6 ac restoration site in 2018 and is currently in the fourth year of the mitigation plan.

3.5.5 FLOODPLAINS

Vegetation is mowed annually in a 3.3-ac. vegetation management area in Spring Canyon to maintain low stature vegetation and avoid and minimize impacts to nesting migratory birds from water vapor that is

ejected from the flame bucket during launches. The vegetation management area overlaps the 100-year floodplain in Spring Canyon (Figure 3.5-1); therefore, the Proposed Action is subject to EO 11988 (Floodplains Management) and 13690 (Establishing a Federal Flood Risk Management Standard…, reinstated by EO 14030). Spring Canyon is a broad drainage with surface water flow only in direct response to significant precipitation and a short duration, and no connectivity to the Pacific Ocean, as discussed above. EO 11988 requires federal agencies to reduce the risk of flood loss, minimize the impact of flood on human safety, and to restore and preserve the natural and beneficial values served by floodplains and evaluate alternatives prior to proceeding with federal actions that may affect floodplains.

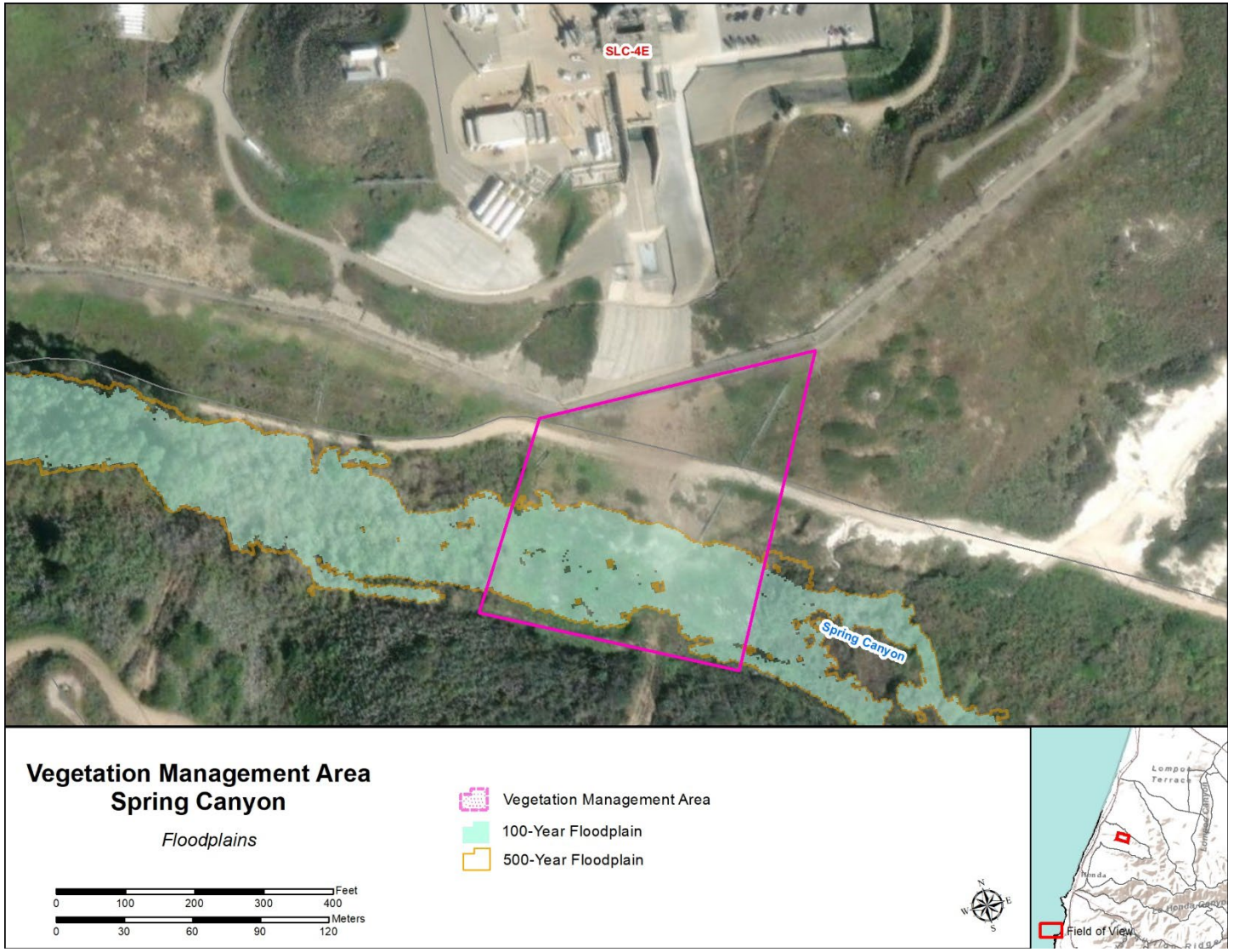

Figure 3.5-1. Spring Canyon Vegetation Management Area and Floodplains

3.6 CULTURAL RESOURCES

Cultural resources are broadly defined as any district, building, site, structure, area of traditional use, or object with historical, architectural, archaeological, cultural, or scientific importance. They include archaeological resources (both precontact and historic), historic architectural resources (physical properties, structures, or other built items), and traditional cultural properties (properties used by living communities of people over generations for religious, spiritual, ancestral, or traditional reasons) (Office of Historic Preservation 1995; National Preservation Institute 2022).

The NHPA establishes national policy for protecting significant cultural resources that are considered "historic properties." Historic properties are defined as "any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in the National Register of Historic Places" (NRHP) (36 CFR Part 800.16).

The ROI for cultural resources includes VSFB's regional setting and the specific Proposed Action study area (the Area of Potential Effects [APE]). The cultural resources within the project area are discussed below. The APE of an undertaking is defined as "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist" (36 CFR Part 800-16(d)). The APE considers any physical, visual, or auditory effects that the project may have on cultural resources. Since no ground-disturbing or landscape-altering actions are proposed, the APE for the current project is limited to auditory effects and was predicated on vibratory impacts. These auditory effects include noise exceeding 120 dB and sonic booms exceeding 2.0 psf based on previous studies that have determined at which levels structures and archaeological resources could potentially be affected by rocket noise and sonic booms.

In 1972, Guest et al. conducted analysis to assess claims that rocket engine thrusts were potentially impacting areas adjacent to a test site located at Marshall Space Flight Center's Mississippi Test Facility. The results of the study established that the potential to damage the most sensitive structural components such as windows and plaster on historic buildings occurred as a result of prolonged noise thresholds greater than 120 dB. 120 dB is the standard threshold reading that launch-related noise has been measured against to determine the potential for effect of proposed projects at VSFB and other test facilities. Accordingly, ManTech (2023) conducted a noise study to determine maximum sound level contours for the Proposed Action and identify where noise levels are expected to exceed 120 dB (Figure 2.2-1). SLC-4E Launch Engine Noise L_{max} defined the APE relating to the 120 dB noise vibration occurrence due to the Proposed Action, which is located entirely within the boundaries of VSFB.

A study conducted to assess the effects of aircraft noise and sonic booms on structures (Haber et al. 1989) determined that potential damage resulting from sonic booms measuring at 2.0 to 4.0 psf were nominal and categorized as failures that occurred due to the poor condition of the structures or elements of the structure. Additionally, a NASA commissioned study reported that only rare and minor damage may occur with overpressures between 2.0 and 5.0 psf and that experimental testing of sonic boom effects has shown structures in good condition remain undamaged by overpressures up to 11.0 psf (Gibbs 2017). The Proposed Action will not result in overpressures any greater than 5.0 psf. Accordingly, the threshold for potential damage resulting from sonic booms (overpressure) for this Proposed Action is established at 2.0 psf or greater. This delineation illustrated in Figure 3.6-1. The 5.0 psf Sonic Boom Composite Contour defined the APE relating to measurements of 2.0 psf or greater resulting from sonic boom occurrence due

to the Proposed Action which encompasses significant portions of the Lompoc Valley and three most northerly NCI – SMI, SRI, and SCI.

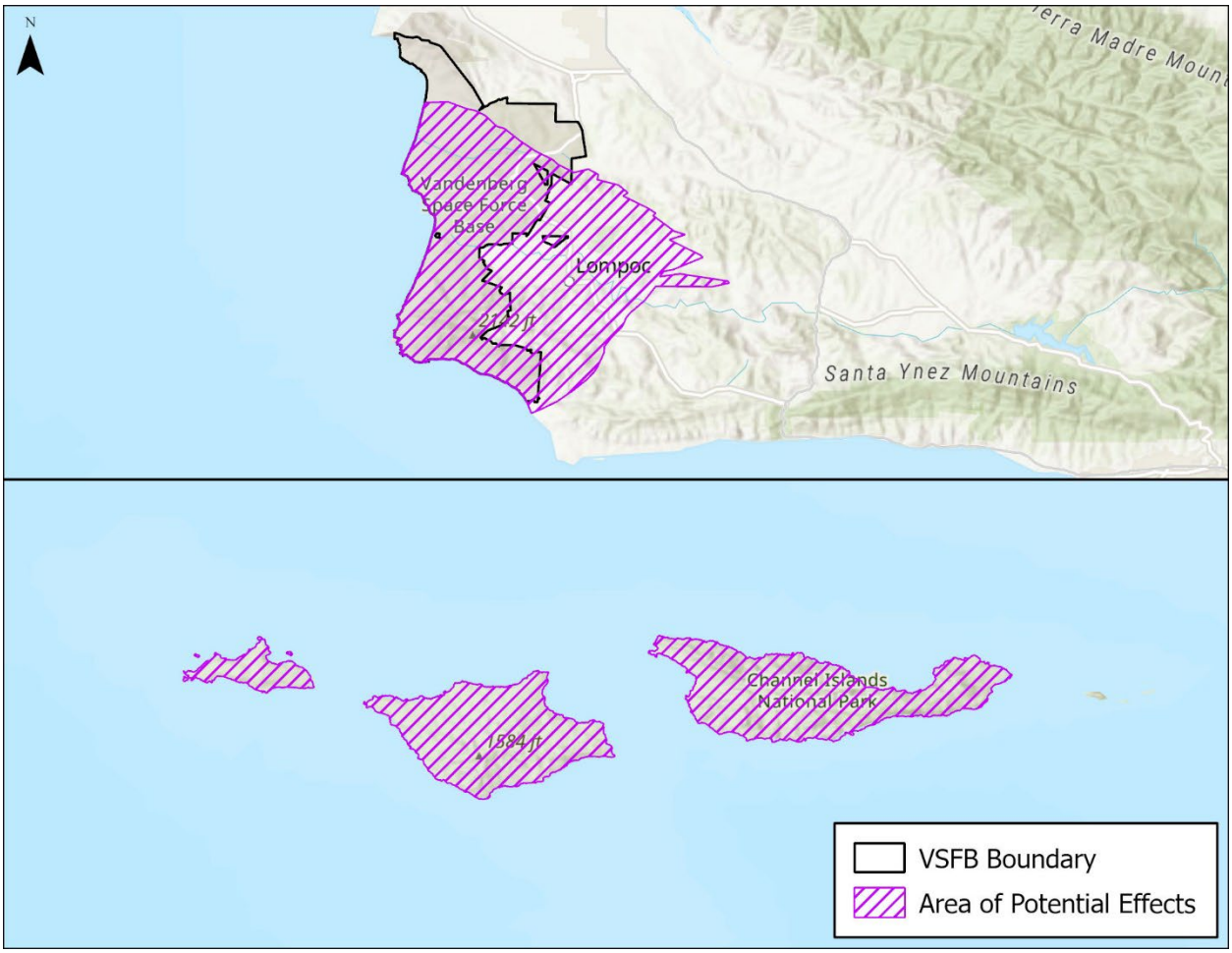

Figure 3.6-1. Area of Potential Effects

In consultation with the 30 CES/CEIEA concerning the Proposed Action and its potential for direct and indirect effects to cultural resources resulting from any related construction, static fire, launches, and boost-back landings, an area of direct impacts (ADI) and subsequent APE was determined (Figure 3.6-1). Since no ground-disturbing or landscape-altering actions are proposed, the ADI for the Proposed Action is limited to auditory effects predicated on vibratory impacts. The ADI for the Proposed Action includes the area within which noise vibration reach levels above 120 dB, as well as sonic booms in excess of 2.0 psf.

The APE for this Project includes the ADI plus all cultural resources which have the potential to be affected by noise vibration levels above 120 dB, as well as sonic boom overpressures of 2.0 psf or greater.

3.6.1 Recorded Cultural Resources

A cultural resource records search of the California Historical Resources Information System (CHRIS) for the study area was conducted at the Central Coast Information Center on 10 and 24 February 2023. 30 CES/CEIEA did a separate cultural resources records search for the on-Base portion of the APE for the

Proposed Action by employing the VSFB cultural resources database. Background research included reviewing archaeological studies, site records and condition assessments for the area within the 120 dB noise study area and 2.0 psf sonic boom study area. A review of the NRHP, the California Register of Historical Resources, the California Historic Property Data File, and the lists of California State Historical Landmarks, California Points of Historical Interest, and Archaeological Determinations of Eligibility, and the VSFB geographic information system was conducted.

In consultation with the 30 CES/CEIEA, project archeologists reviewed available literature to determine what types of resources located within the cultural resource study area have the potential to be impacted by the Proposed Action. Analysis specifically addressing potential impacts on built environment historic properties from rocket engine noise and sonic boom vibrations associated with static tests, launches and boost-back landings at SLC-4 considered previously conducted studies. These studies include those by Guest and Sloane (1972) and Gibbs (2017) that establish the thresholds at which prolonged noise thresholds (static fires) and sonic booms have the potential to impact historic properties. Additionally, project archeologists reviewed a previous study that considered potential impacts to archaeological sites (Nocerino et al. 2021) and consulted with Mr. Josh Smallwood of the 30 CES/CEIEA regarding the results of experimental analysis conducted by the 30 CES/CEIEA at VSFB (Smallwood personal communication 2023). The experimental analysis included the placement and observation of a 12-inch-tall, 45-degree slope sand cone and a 12x12x12-inch midden chunk on a concrete pad located 3,180 ft to the southwest of the SLC-4W pad to determine if noise vibration resulting from two December SpaceX launches/boost-back landings would result in any visual change to the materials. No visual impacts were observed in either the midden chunk or sand cone after the launch/boost-back with the exception of a few fine grains of sand shifting down the cone likely resulting from the samples drying in the wind. Importantly, there was no cracking or crumbling observed, on the midden chunk or sand cones from launch vibrations/sonic boom overpressures (Smallwood personal communication 2023). Smallwood asserted that based on experimental analysis and observations of archaeological sites located on base, VSFB cultural resources staff have established that archaeological sites consisting of only surface artifacts and/or buried archaeological material do not have the potential to be affected by rocket engine noise.

A sheer cliff-face midden deposit present within CA-SBA-530 located in the southern portion of the VSFB between SLC-4 and SLC-6 was monitored for impacts resulting from noise vibrations (Smallwood personal communication 2023). Despite observing significant impacts resulting from natural erosion due to rainfall, wind, and wave compression, no visible effect resulting from noise vibrations due to launch and boost-back events was observed (Smallwood personal communication 2023). As a result, archaeological resources only composed of surface artifacts and buried deposits were excluded from further consideration and those archaeological resources considered were limited to those located above ground including rock art, cairns and rock shelters.

Since the early 2000s, a condition assessment program has occurred continuously at the NRHP-eligible Honda Ridge Rock Art Site (CA-SBA-550), located 7,000 feet east of SLC-6 (Nocerino et al. 2021; Smallwood personal communication 2023). The program has found no evidence of effects to the rock art surfaces from heavy- and medium-payload rocket launches and boost backs or sonic boom overpressure (Smallwood personal communication 2023).

Finally, all but one building located on VSFB and within the cultural resource study area are associated with launch complexes and supporting infrastructure and are built to withstand concussive forces. The

only historic building located on VSFB and within the APE that is not associated with launch complexes or supporting infrastructure is the former USCG Lifeboat Rescue Station (P-42-040495). The Colonial Revival architectural style, wood-frame structure was built in 1936 as administrative barracks and ancillary structures. The buildings have been subjected to many years of medium and heavy launches and boost-back landings at SLC-4 as well as launches conducted at nearby SLC-6 with no reported and observed effect.

Based on these considerations, the resources identified by the records search as NRHP-listed or eligible for listing were categorized IAW the Office of Historic Preservation (OHP) attribute codes (OHP 1995). Those categories identified for consideration of the potential for adverse effects resulting from the Proposed Action were limited to built environment resources including structures, buildings, bridges and dams and archaeological features located above ground including rock art, cairns and rock shelters.

Table 3.6-1 provides both built environment and archaeological cultural resources that are listed on or determined eligible for listing on the NRHP and are, as previously mentioned, identified as including elements that may have the potential for adverse effects resulting from the Proposed Action. For the purpose of this assessment and since the SMI, SRI, and SCI Archaeological Districts encompass all their respective islands, all contributing resources within the districts are assumed eligible for the NRHP for the purposes of this Proposed Action. As such, individual archaeological resources on the NCI are captured in the respective island's archaeological district. Archaeological and built environment resources present on the VSFB provided by the 30 CES/CEIEA are also included in Table 3.6-1 with the exception of built environment resources at VSFB that were built to withstand concussive forces resulting from rocket noise and sonic booms.

Table 3.6-1. NRHP-listed or eligible cultural resources located within the APE

Reference Number	Resource Type	Resource Name or Type	Description	NRHP Evaluation
Lompoc Valley Area of the APE (including VSFB)				
_70000147	Built Environment	La Purisima Mission	Adobe mission buildings	Listed
_90001818	Built Environment	Lompoc Public Library (Carnegie)	Masonry building	Listed
_16000664	Built Environment	Lompoc Veterans Memorial Building	Masonry building	Listed
_78000775	Built Environment	Mission de la Purisima Concepcion de Maria Santisima Site	Adobe mission buildings	Listed
OTIS ID: 488380	Built Environment	Artesia School	Wood-frame building	Eligible

Reference Number	Resource Type	Resource Name or Type	Description	NRHP Evaluation
OTIS ID: 565260	Built Environment	Spanne Building	Wood-frame building	Eligible
OTIS ID: 565254	Built Environment	105 H St Building	Wood-frame building	Eligible
OTIS ID: 689985	Built Environment	U.S. Army Disciplinary Barracks, U.S. Lompoc Prison	Masonry building	Eligible
OTIS ID: 533649	Built Environment	Lompoc Theater	Masonry building	Eligible
P-42-000550	Archaeological	Prehistoric Site CA-SBA-000550	Prehistoric archaeological site	Eligible
P-42-040480	Archaeological	Site of Original Mission and remaining ruins of buildings of Mission de la Purisima Conception de Maria Santisima	Adobe ruins	Eligible
Santa Cruz Island				
_80000405 _100007199	Archaeological	Santa Cruz Island Archeological District	Various types of archaeological sites	Listed
OTIS ID: 529803	Built Environment	Santa Cruz Island Ranching District	Various structure types: wood-frame, masonry, and adobe construction	Eligible
Santa Rosa Island				
_100007896	Archaeological	Santa Rosa Island Archaeological District	Various types of archaeological sites	Listed
OTIS ID: 529721	Built Environment	Santa Rosa Island Ranch – China Camp Cabin	Wood-frame building	Eligible
OTIS ID: 529722	Built Environment	Santa Rosa Island Ranch – Clapp Springs	Wood-frame building	Eligible
OTIS ID: 529725	Built Environment	Santa Rosa Island Ranch – Horse Barn	Wood-frame building	Eligible
OTIS ID: 529726	Built Environment	Santa Rosa Island Ranch – Main Ranch House	Wood-frame building	Eligible

Reference Number	Resource Type	Resource Name or Type	Description	NRHP Evaluation
OTIS ID: 529728	Built Environment	Santa Rosa Island Ranch – Old School House	Wood-frame building	Eligible
OTIS ID: 529738	Built Environment	Santa Rosa Island Ranch – Rope House	Wood-frame building	Eligible
OTIS ID: 529747	Built Environment	Santa Rosa Island Ranch – Army Camp Water System	Wood-frame building	Eligible
OTIS ID: 529748	Built Environment	Santa Rosa Island Ranch – South Point Lighthouse	Wood-frame building	Eligible
San Miguel Island				
_79000258	Archaeological	San Miguel Island Archaeological District	Various types of archaeological sites	Listed
4-SMI-456	Built Environment	Nidever Adobe	Adobe ruins	Eligible
Unknown	Built Environment	Waters Ranch House Site	Wood-frame building	Eligible

On-Base. 30 CES/CEIEA' VSFB cultural resources database records search revealed that all the cultural resources study area located within the VSFB has been previously surveyed for cultural resources, resulting in identifying 350 previously recorded cultural resources within this portion of the APE. Of these resources, four archaeological sites and 103 historic-age buildings fit the criteria previously outlined as those with above-ground buildings, structures, or objects that are NRHP-listed or eligible and could potentially be affected by launch noise vibrations. The four archaeological resources are rock art sites and the 103 historic-age buildings are associated with launch complexes and supporting infrastructure that have been built to withstand concussive forces. A total of 123 other archaeological sites on VSFB were identified within the APE but do not include elements that could potentially be affected by launch noise vibrations and sonic boom overpressure.

Off-Base within Lompoc Valley. The CHRIS cultural resource records search revealed that large portions of the cultural resources study area located within off-base portion of the Lompoc Valley have been previously surveyed for cultural resources, resulting in identifying at least 1,795 previously recorded cultural resources within this portion of the APE. Of these resources, one archaeological site and ten historic-age buildings fit the criteria previously outlined as those with above-ground buildings, structures, or objects that are NRHP-listed or eligible and could potentially be affected by launch noise vibrations and sonic boom overpressure.

Northern Channel Islands (San Miguel Island, Santa Rosa Island, and Santa Cruz Island). The CHRIS cultural resource records search revealed that large portions of the cultural resources study area located within the NCI have been previously surveyed for cultural resources, resulting in identifying at least 2,204 cultural resources. All three islands are NRHP-listed as archaeological districts encompassing all their respective islands. For the purposes of this study, all contributing resources within the districts are assumed eligible for the NRHP. Likewise, the historic buildings present on SCI are NRHP-listed as the SCI

Ranching District. Historic properties on the NCI include historic ranches and archaeological deposits, and prehistoric Native American archaeological sites. Historic buildings and archaeological sites include wood-frame, masonry, adobe construction and adobe ruins. The prehistoric sites consist of Native American shell middens, burials, habitation sites, and lithic scatters.

3.7 COASTAL ZONE MANAGEMENT

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

The ROI for coastal zone management extends to those coastal resources that may be affected by the Proposed Action, including natural resources, land uses, and water uses, public access, and recreation within the California Coastal Zone (CCZ). The CCZ generally extends 1,000 yards inland and up to 3 nm seaward, but may extend up to 5 mi inland for significant coastal estuarine, habitat, and recreational areas and less than 1,000 yards inland in urban areas. SLC-4E and SLC-4W are located on VSFB, which the Federal government owns and operates. As defined in Section 304 of the CZMA, the term "coastal zone" 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, its officers or agents." However, the USSF recognizes that actions outside the coastal zone may affect land or water uses or natural resources along the coast and therefore may be subject to the provisions of the CZMA. Consequently, we analyzed the impacts of the Proposed Action on the coastal zone.

In 1998, the USAF received the California Coastal Commission's (CCC's) concurrence on a CD (CD-049-98) for south Base launch activity. In December 2003, the USAF received concurrence on ND-103-03 for implementing the Falcon 1 launch vehicle program at SLC-3W. In 2005, the USAF received concurrence on ND-088-05 for relocating the Falcon 1 program from SLC-3W to SLC-4. The CCC concurred with the USAF on ND-055-10 for modifying SLC-4 infrastructure to meet SpaceX needs. In 2014, the CCC issued concurrence on ND-0035-14 for the SpaceX Dragon in flight abort test, constructing a SLC-4W boostback pad and a single Falcon 9 rocket launch. In 2015, the USAF received concurrence on ND-0027-15 for 6 Falcon 9 launches per year and boostback to a barge or SLC-4W land. In 2023, the USSF determined that the Proposed Action would not adversely affect coastal uses or resources because measures will be taken to prevent, minimize, and mitigate impacts. Therefore, for this Proposed Action the USSF will request CCC concurrence on a ND.

3.8 DEPARTMENT OF TRANSPORTATION SECTION 4(F)

The DOT Act of 1966 (now codified at 49 USC § 303), Section 4(f), protects significant publicly owned parks, recreational areas, wildlife and waterfowl refuges, and public and private historic sites listed or eligible for listing on the NRHP. Section 4(f) provides that the Secretary of Transportation may approve a transportation program or project requiring the use of publicly owned land of a public park, recreation area, or wildlife and waterfowl refuge of national, State, or local significance, or land of an historic site of

national, State, or local significance, only if there is no feasible and prudent alternative to the use of such land and the program or project includes all possible planning to minimize harm resulting from the use.

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

The ROI for Section 4(f) is defined by launch and landing rocket engine noise, sonic booms, and potential debris impact corridors associated with launch trajectories. Four Section 4(f) properties that might be subject to temporary access restrictions due to closure or other restrictions during launch operations: Wall Beach, Surf Beach, Ocean Beach County Park, and Jalama Beach County Park (Figure 3.8-1). Other nearby potential Section 4(f) properties that are outside of the ROI and would not be closed during launch, landing, or static fire events include Miguelito County Park, Rancho Guadalupe Dunes County Park, Point Sal Beach State Park, and Gaviota Beach State Park (Figure 2.2-3). The Channel Islands National Park is also a Section 4(f) property and part of the ROI but would not be closed during launch and landing activities.

Wall Beach, Surf Beach, and Ocean Beach County Park are located north of SLC-4E. Wall Beach is on VSFB and only accessible to VSFB pass holders and their sponsored guests. Surf Beach is a public access beach on VSFB and the site of the Lompoc-Surf Station Amtrak stop for the Pacific Surfliner. Ocean Beach County Park is a public access, day use park, providing recreational opportunities from 8:00 a.m. to sunset. Jalama Beach County Park offers various recreational options and camping with peak attendance in summer and on holidays. Since 1979, an evacuation and closure agreement has been in place between USSF and Santa Barbara County (Appendix I). This agreement includes closing Surf Beach, Ocean Beach County Park, Jalama Beach County Park, and Point Sal Road for launch activities that SLD 30 Range Safety determines have certain health and safety risks. These closures are communicated at least 72 hours' before closure and can be for 48 hours maximum. We do not anticipate Point Sal Road to be closed for SpaceX launches. The length and frequency of temporary closures are mission dependent and determined by USSF Range Safety; however, typical closures last between 5 to 8 hours. The Proposed Action would only restrict public access to Jalama Beach County Park, Ocean Beach County Park, and Surf Beach up to 12 times per year as previously described in the 2018 SEA. Road blocks would be erected approximately three hours before launch and would be removed approximately two hours after a successful launch/landing. If a launch were to be scrubbed after road blocks have been erected, an additional closure would be required. The Channel Islands National Park consists of five islands (Anacapa Island, SMI, Santa Barbara Island, SCI, and SRI); activities on the islands include hiking, camping, photography, and birdwatching. There are no services on the five islands. Closures of the Channel Islands would not occur during launch or landing activities.

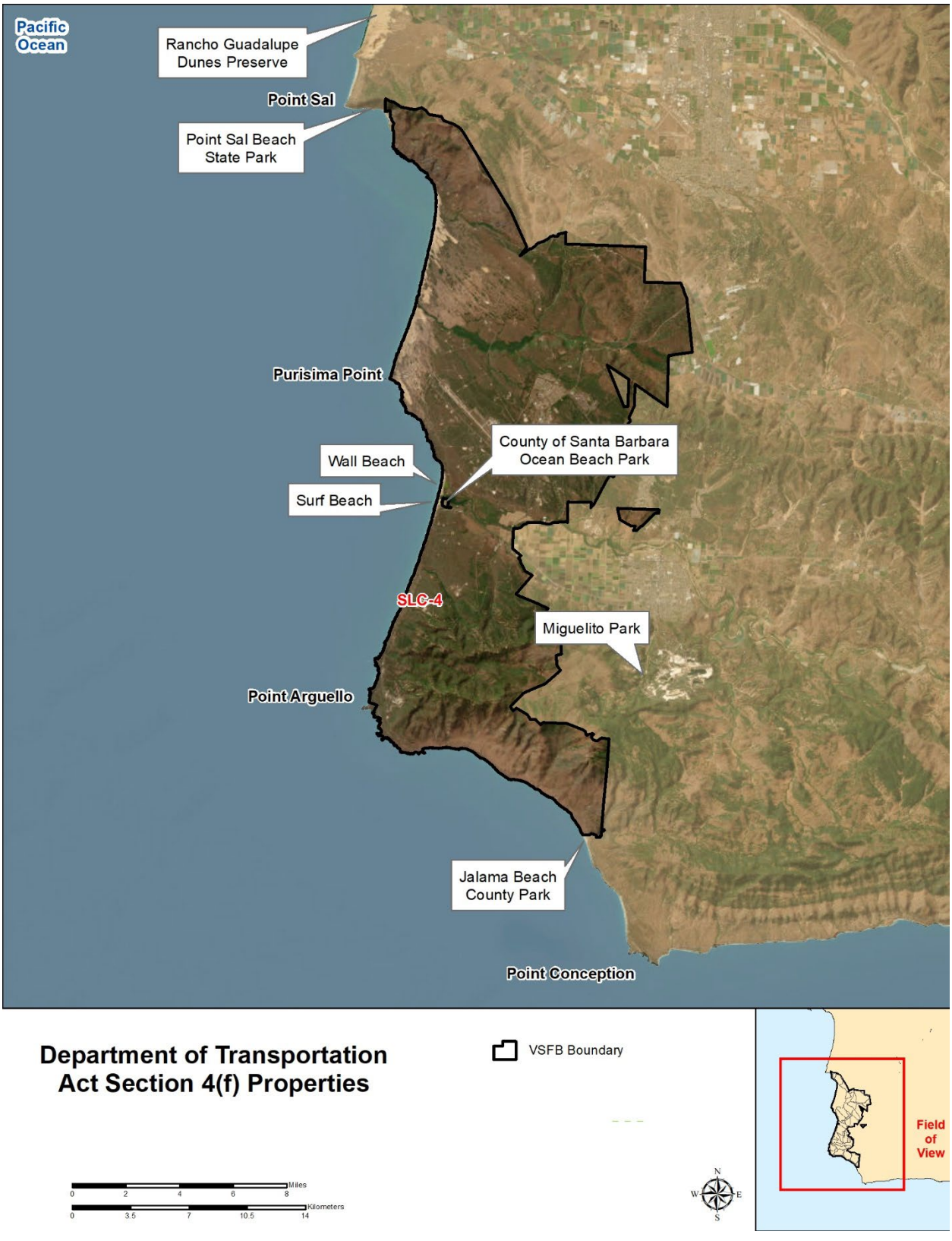

Figure 3.8-1. Potential Department of Transportation Act Section 4(f) Properties

3.9 UTILITIES

The ROI includes SLC-4 and south VSFB utilities (e.g., communications, electricity, domestic water supply, and domestic wastewater). Communications infrastructure at SLC-4 is provided by existing commercial fiber lines. Electrical infrastructure is primarily provided from the Pacific Gas and Electric Company substation north of VSFB, powered by the Diablo Canyon nuclear power plant; to date for fiscal year 2022, SLC-4 has used approximately 3.5 million kW-hr of electricity (SpaceX 2022). Water is extracted via four water wells from the San Antonio Creek Basin, and VSFB is expected to continue extracting from the Basin into the foreseeable future. Domestic wastewater at SLC-4 is managed by an existing septic sewer system.

3.10 SOCIOECONOMICS

Socioeconomic resources include the population, income, employment, and housing conditions of a community or affected environment. VSFB has a large effect on population and employment in northern Santa Barbara County, which encompasses Vandenberg Village, the City of Lompoc, the unincorporated area north of Lompoc, the Santa Maria Valley, and portions of the Santa Ynez Valley. The full economic impact of VSFB on the surrounding communities and the state of California is significant (over $1.75 billion/year). VSFB directly contributes more than $500 million each year to the economies of Santa Barbara County and California and is the largest employer in Santa Barbara County (6,800 employees as of 2014), including 2,924 military personnel, 1,143 civil servants, and 2,822 non-appropriated fund, contractor, and private business personnel (USAF 2020).

In 2019, the U.S. Census Bureau estimated the Santa Barbara County population at 444,829 people. Santa Maria and Lompoc, with 106,224 and 43,232 residents respectively (U.S. Census Bureau 2019), are the first and third largest cities in the County (California Department of Finance 2022). The Bureau of Labor Statistics reported August 2021 results for the Santa Barbara-Santa Maria area of 208,600 total civilians employed. Of those employed, there were approximately 184,800 non-agricultural wage and salary employments. The August 2021 unemployment rate of the area was approximately 5.5 percent, below the state average of 7.5 percent and above national average of 5.2 percent (Bureau of Labor Statistics 2021).

3.11 TRANSPORTATION

The ROI for transportation includes railway, highway, arterial, and local roads that provide service to VSFB, the surrounding area, and the Action Area. Existing roadway conditions are evaluated based on roadway capacity and traffic volume. The capacity reflects the ability of the network to serve the traffic demand of a roadway and depends on the roadway width, number of lanes, intersection control, and other physical factors.

VSFB is a federal military installation located approximately 5 mi west of the City of Lompoc. The main access route is Highway (Hwy) 101, a coastal four-lane divided freeway connecting Northern California to Southern California. Hwy 1, State Route (SR) 135, and SR 246 connect Hwy 101 to VSFB. When used with Hwy 101, SR 246, provides access to Lompoc to the east, and Santa Barbara to the southeast. SR 135 and SR 246 are primarily two-lane highways with four-lane expressway portions.

Most of VSFB can only be accessed by authorized military personnel and their families, Base civilian employees with approved identification, visitors with pre-approved authorization, and authorized contractors. There is no public access to the roadways within the Action Area. Most roads on VSFB are

in good operating condition or better with zero to minor, tolerable delays experienced by motorists. The Action Area is located on south VSFB and is accessible by paved roads from the Solvang Gate. Project personnel would access the location by entering VSFB through the Solvang Gate from West Ocean Avenue, travel south on Arguello Road, west on Bear Creek Road, south on Coast Road, and to the destination on Kelp Road (Figure 3.11-1). There are no readily accessible alternate routes to SLC-4, although Surf Road would be a suitable egress road to the east during emergencies.

The Union Pacific Railroad (UPRR) operates a railway line that runs through VSFB and under the proposed flight path of the Falcon 9 launch vehicle. Up to 12 freight trains and 6 Amtrak passenger lines travel through VSFB daily (Envicom Corporation 2012; Amtrak 2022). Trains that would pass through a launch vehicle's flight path from VSFB are temporarily stopped at safety hold points during launches to reduce potential risk to people and property. The SPMT's route from the VSFB Harbor to SLC-4 crosses the UPRR railway at the intersection of Tow Road and Coast Road (Figure 3.11-1).

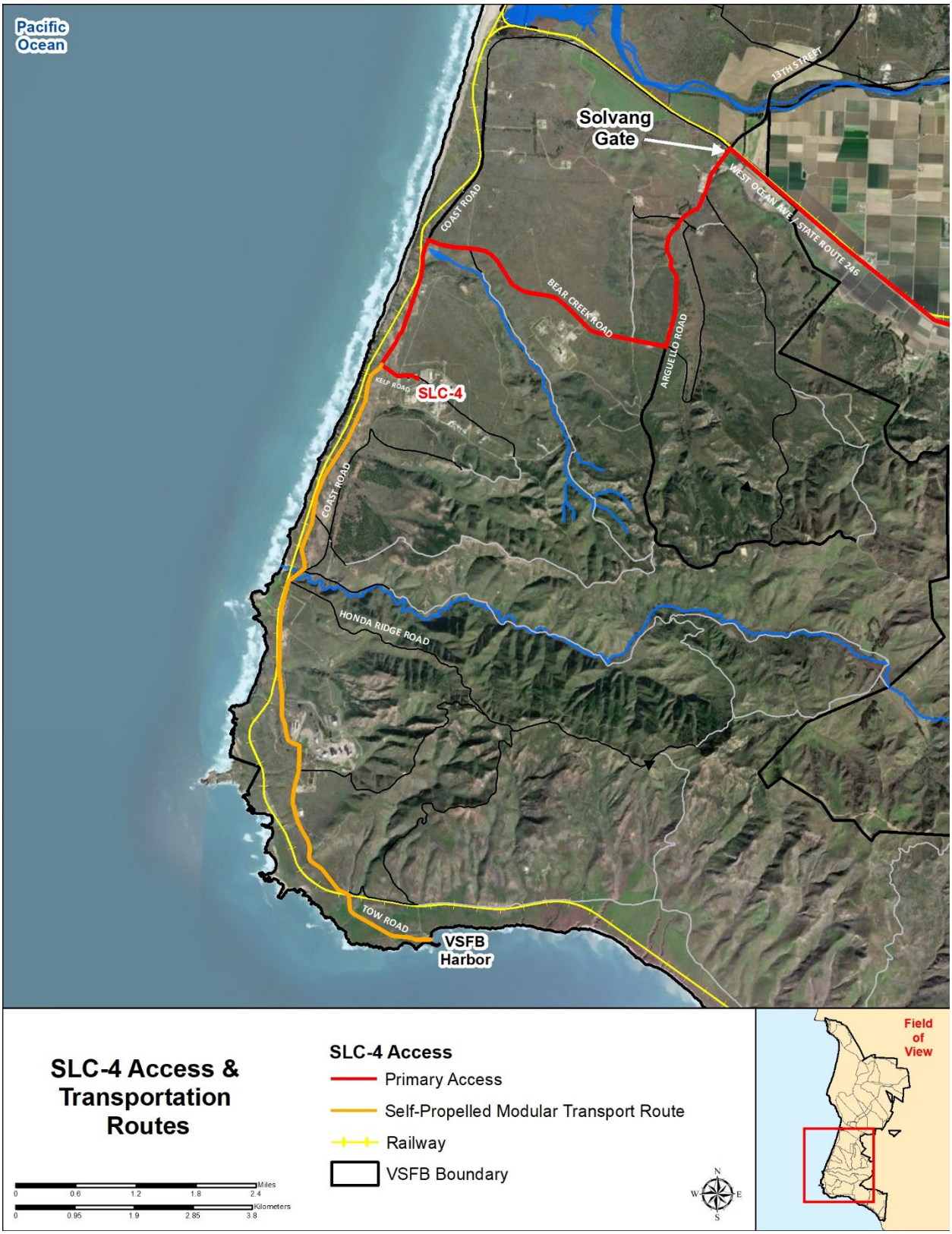

Figure 3.11-1. Main Access and Transportation Routes Associated with the Proposed Action

4 ENVIRONMENTAL CONSEQUENCES

4.1 AIR QUALITY

4.1.1 ALTERNATIVE 1

A comparison of operational tempo proposed for each alternative, and proposed types and level of activities, are provided in Section 2.2. With the exception of launch activities, emissions were calculated using the USAF Air Conformity Applicability Model (ACAM). ACAM does not provide functionality for launch activities; these emissions were calculated using known methods and using engine-specific emissions factors provided by SpaceX. Emission estimates were also calculated using the California Emissions Estimator Model, which are presented in Appendix D. While this section presents summary tables of each component activity, Appendix D includes detailed calculation tables and air modeling output reports.

4.1.1.1 Launch

SpaceX would launch Falcon 9 from SLC-4E up to 36 times per year in the same manner as described in the 2020 EA (*EA for SpaceX Falcon Launches at Kennedy Space Center and Cape Canaveral Air Force Station*). Although the exhaust is fuel-rich and contains high concentrations of CO, subsequent entrainment of ambient air results in complete conversion of the CO into CO_2 and oxidation of the soot from the gas generator exhaust. A small amount of thermal NOx is formed as NO. Each takeoff may be preceded by a static fire test of the engines, which lasts a few seconds. The need to conduct a static fire test is mission dependent, but there would be no more than 36 static fire events per year.

Table 4.1-1. Estimated Criteria Pollutant Emissions Produced Under Alternative 1 from 36 Launches and Static Fire Activities

Criteria Pollutant	Annual Emissions (tons per year)						
	CO	NO_x	VOC	SO_x	PM_{10}	PM2.5	Pb
0–3 nm							
Launches	0.000	3.901	0.000	0.000	0.000	0.000	0.000
Static Fires	0.000	1.187	0.000	0.000	0.000	0.000	0.000
TOTAL 0–3 nm	**0.000**	**5.088**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

Notes: (1) Table includes criteria pollutant precursors (e.g., VOCs). Ozone is a secondary pollutant tracked by its precursor. (2) CO = carbon monoxide, NO_X = nitrogen oxides, Pb = lead, PM_{10} = particulate matter ≤ 10 microns in diameter, $PM_{2.5}$ = particulate matter ≤ 2.5 microns in diameter, SO_X = sulfur oxides, VOC = volatile organic compounds, nm = nautical miles, (3) Individual values may not add up exactly to total values due to rounding.

4.1.1.2 Payload Fairing Recovery

Table 4.1-2 presents the estimated criteria pollutant emissions that would be produced during the proposed fairing recovery activities, described in Section 2.2.2..

Table 4.1-2. Estimated Criteria Pollutant Emissions Produced Under Alternative 1 from 36 Fairing Recovery Activities

Criteria Pollutant	Annual Emissions (tons per year)						
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$	Pb
0–3 nm							
Support Boat	0.0215	0.0508	0.0103	0.0080	0.0036	0.0034	0.0000
TOTAL 0–3 nm	**0.0215**	**0.0508**	**0.0103**	**0.0080**	**0.0036**	**0.0034**	**0.0000**
3–12 nm							
Support Boat	0.0472	0.1117	0.0226	0.0175	0.0080	0.0074	0.0000
TOTAL 3–12 nm	**0.0472**	**0.1117**	**0.0226**	**0.0175**	**0.0080**	**0.0074**	**0.0000**

Notes: (1) Table includes criteria pollutant precursors (e.g., VOCs). Ozone is a secondary pollutant tracked by its precursor. (2) CO = carbon monoxide, NO_X = nitrogen oxides, Pb = lead, PM_{10} = particulate matter ≤ 10 microns in diameter, $PM_{2.5}$ = particulate matter ≤ 2.5 microns in diameter,, SO_X = sulfur oxides, VOC = volatile organic compounds, nm = nautical miles, (3) Individual values may not add up exactly to total values due to rounding.

4.1.1.3 Landings

Table 4.1-3 presents the estimated criteria pollutant emissions that would be produced during the proposed 36 annual Falcon 9 first stage landings, described in Section 2.2.3.

Table 4.1-3. Estimated Criteria Pollutant Emissions Produced Under Alternative 1 from 36 Landing Activities

Criteria Pollutant	Annual Emissions (tons per year)						
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$	Pb
0–3 nm							
Boostback (offshore)	-	-	-	-	-	-	-
Boostback (VSFB)	0.0000	0.6780	0.0000	0.0000	0.0000	0.0000	0.0000
Booster Recovery	0.0497	0.0974	0.0066	0.0051	0.0023	0.0118	0.0000
Booster Transport	0.8063	0.8577	0.1831	0.0038	0.0276	0.0275	0.0000
TOTAL 0–3 nm	**0.856**	**1.6331**	**0.1897**	**0.0089**	**0.0299**	**0.0393**	**0.0000**
3–12 nm							
Boostback (offshore)	-	-	-	-	-	-	-
Boostback (VSFB)	-	-	-	-	-	-	-
Booster Recovery	0.1093	0.2142	0.0146	0.0113	0.0052	0.0260	0.000
Booster Transport	-	-	-	-	-	-	-
TOTAL 3–12 nm	**0.1093**	**0.2142**	**0.0146**	**0.0113**	**0.0052**	**0.0260**	**0.000**

Notes: (1) Table includes criteria pollutant precursors (e.g., VOCs). Ozone is a secondary pollutant tracked by its precursor. (2) CO = carbon monoxide, NO_X = nitrogen oxides, Pb = lead, PM_{10} = particulate matter ≤ 10 microns in diameter, $PM_{2.5}$ = particulate matter ≤ 2.5 microns in diameter, SO_X = sulfur oxides, VOC = volatile organic compounds, nm = nautical miles, (3) Individual values may not add up exactly to total values due to rounding.

4.1.1.4 Booster Roll-On-Roll-Off

The estimated criteria pollutant emissions for RORO operations, described in Section 2.2.5, are presented in Table 4.1-4.

Table 4.1-4. Estimated Criteria Pollutant Emissions Produced Under Alternative 1 from 36 Launch Booster Rollo-On-Roll-Off Activities

Criteria Pollutant	Annual Emissions (tons per year)						
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$	Pb
0–3 nm							
Ocean Transport	0.2333	1.4834	0.1173	0.0683	0.0341	0.0469	0.0000
Land Transport	0.0228	0.0314	0.0046	0.0001	0.0014	0.0014	0.0000
TOTAL 0–3 nm	**0.2561**	**1.5148**	**0.1219**	**0.0684**	**0.0355**	**0.0483**	**0.0000**
3–12 nm							
Ocean Transport	0.3500	2.2250	0.1760	0.1024	0.0511	0.0704	0.000
Land Transport	-	-	-	-	-	-	-
TOTAL 3–12 nm	**0.3500**	**2.2250**	**0.1760**	**0.1024**	**0.0511**	**0.0704**	**0.000**

Notes: (1) Table includes criteria pollutant precursors (e.g., VOCs). Ozone is a secondary pollutant tracked by its precursor. (2) CO = carbon monoxide, NO_X = nitrogen oxides, Pb = lead, PM_{10} = particulate matter ≤ 10 microns in diameter, $PM_{2.5}$ = particulate matter ≤ 2.5 microns in diameter, SO_X = sulfur oxides, VOC = volatile organic compounds, nm = nautical miles, (3) Individual values may not add up exactly to total values due to rounding.

4.1.1.5 Operations

Table 4.1-5 presents the estimated criteria pollutant emissions that would be produced during operational activities under the Proposed Action.

Table 4.1-5. Estimated Criteria Pollutant Emissions Produced Under Alternative 1 from 36 Launch Operation Activities

Criteria Pollutant	Annual Emissions (tons per year)						
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$	Pb
0–3 nm							
Daily Operations (Worker Transits)	1.2057	0.1020	0.1872	0.0021	0.0107	0.0038	0.0000
Solvent Use	0.0000	0.0000	7.4200	0.0000	0.0000	0.0000	0.0000
Vendor Deliveries	5.3678	5.6348	1.2111	0.0252	0.3128	0.1805	0.0000
Generator Use	0.0440	0.1419	0.0073	0.0033	0.0074	0.0074	0.0000
TOTAL 0–3 nm	**6.6175**	**5.8786**	**8.8257**	**0.0306**	**0.3309**	**0.1917**	**0.0000**

Notes: (1) Table includes criteria pollutant precursors (e.g., VOCs). Ozone is a secondary pollutant tracked by its precursor. (2) CO = carbon monoxide, NO_X = nitrogen oxides, Pb = lead, PM_{10} = particulate matter ≤ 10 microns in diameter, $PM_{2.5}$ = particulate matter ≤ 2.5 microns in diameter, SO_X = sulfur oxides, VOC = volatile organic compounds, nm = nautical miles, (3) Individual values may not add up exactly to total values due to rounding, 4) emissions for vendor deliveries include the entire transport length as an extremely conservative estimate. Given this value is less than *de minimis* levels, we assumed that any portion of the trip in a county with non-attainment values (a fraction of the total trip time) would generate much smaller amounts of NOx.

4.1.1.6 General Conformity Impacts

Emissions could occur on land and within 3 nm of shore, which is within the South Central Coast and SCAB. Transit activities between the Port 3 nm offshore would generate potential emissions which could impact air quality within the air basin. The subsections that follow evaluate the nearshore emissions within regional areas that include attainment, nonattainment, or maintenance areas. These areas are based on the definition of State waters and represent the area within which emissions would be most likely to

migrate onshore due to proximity. The net emissions associated with the Proposed Action are then compared to the General Conformity *de minimis* thresholds for nonattainment/maintenance areas, or with the Prevention of Significant Deterioration (PSD) thresholds for attainment areas.

Both the Ventura County Air Pollution Control District and the SCAQMD are classified as a serious (Ventura) and extreme (South Coast) nonattainment area for ozone (eight-hour average concentration). Table 4.1-6 presents the estimated nearshore emissions under Alternative 1 as compared with baseline nearshore emissions. The net emissions increases were compared with the applicable General Conformity Rule *de minimis* thresholds. The net change between the environmental baseline and Alternative 1 is small, as the differences in vessel operations between the two alternatives is minimal. The number of contract support vessels decreases under Alternative 1 while the number of other support vessel transits increases, resulting in a net difference in vessel transits by a single operation.

Table 4.1-6. Estimated Net Change in Total Annual Air Pollutant Emissions from Activities Within 3 nm, Alternative 1[1]

Criteria Pollutant	Annual Emissions (tons per year)						
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$	Pb
Total 0–3 nm Emissions	7.7511	13.8268	9.1476	0.1158	0.4000	0.2827	0.0000
Baseline	2.2149	3.7212	0.4773	0.0178	0.1119	0.0739	0.0000
Net Increase (Decrease)	**5.5362**	**10.1056**	**8.6703**	**0.098**	**0.2881**	**0.2088**	**0.0000**

[1]Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.
Notes: CO = carbon monoxide, NO_X = nitrogen oxides, NO_2 = nitrogen dioxide, Pb = lead, PM_{10} = particulate matter ≤ 10 microns in diameter, $PM_{2.5}$ = particulate matter ≤ 2.5 microns in diameter, SO_2 = sulfur dioxide, SO_X = sulfur oxides, VOC = volatile organic compound, nm = nautical miles

Air pollutant emissions under Alternative 1 would not result in violations of federal air quality standards because they would not have a measurable impact on air quality in land areas.

Table 4.1-7. Estimated Net Change in Annual Air Pollutant Emissions from Activities Within the Santa Barbara County Air Pollution Control District[1]

Criteria Pollutant	Annual Emissions (tons per year)						
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$	Pb
Total 0–3 nm Emissions	2.8931	8.0109	8.0159	0.0466	0.0951	0.1219	0.0000
Baseline	0.8169	2.3120	0.1529	0.0057	0.0260	0.0210	0.0000
Net Increase (Decrease)	2.0762	5.6989	7.863	0.0409	0.0691	0.1009	0.0000

[1]Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.
Notes: CO = carbon monoxide, NO_X = nitrogen oxides, NO_2 = nitrogen dioxide, Pb = lead, PM_{10} = particulate matter ≤ 10 microns in diameter, $PM_{2.5}$ = particulate matter ≤ 2.5 microns in diameter, SO_2 = sulfur dioxide, SO_X = sulfur oxides, VOC = volatile organic compound, nm = nautical miles

Table 4.1-8. Estimated Net Change in Annual Air Pollutant Emissions from Activities Within the Ventura County Air Pollution Control District[1]

Criteria Pollutant	Annual Emissions (tons per year)						
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$	Pb
Total 0–3 nm Emissions	0.8459	0.8811	0.1902	0.0040	0.0329	0.0282	0.0000
Baseline	0.2087	0.2157	0.0467	0.0010	0.0085	0.0069	0.0000
Net Increase (Decrease)	**0.6372**	**0.6654**	**0.1435**	**0.0030**	**0.0244**	**0.0213**	**0.0000**
De minimis Threshold	-	50	50	-	-	-	-
Exceeds *de minimis* Threshold		No	No				

[1]Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

Notes: CO = carbon monoxide, NO_X = nitrogen oxides, NO_2 = nitrogen dioxide, Pb = lead, PM_{10} = particulate matter ≤ 10 microns in diameter, $PM_{2.5}$ = particulate matter ≤ 2.5 microns in diameter, SO_2 = sulfur dioxide, SO_X = sulfur oxides, VOC = volatile organic compound, nm = nautical miles

Table 4.1-9. Estimated Net Change in Annual Air Pollutant Emissions from Activities Within the South Coast Air Quality Management District[1]

Criteria Pollutant	Annual Emissions (tons per year)						
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$	Pb
Total 0–3 nm Emissions	1.3484	2.0951	0.3361	0.0526	0.0684	0.7730	0.0000
Baseline	0.3454	0.3887	0.0833	0.0102	0.0170	0.0157	0.0000
Net Increase (Decrease)	**1.003**	**1.7064**	**0.2528**	**0.0424**	**0.0514**	**0.7573**	**0.0000**
De minimis Threshold	-	10	10	-	-	-	-
Exceeds *de minimis* Threshold		No	No				

[1]Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

Notes: CO = carbon monoxide, NO_X = nitrogen oxides, NO_2 = nitrogen dioxide, Pb = lead, PM_{10} = particulate matter ≤ 10 microns in diameter, $PM_{2.5}$ = particulate matter ≤ 2.5 microns in diameter, SO_2 = sulfur dioxide, SO_X = sulfur oxides, VOC = volatile organic compound, nm = nautical miles

As shown in Tables 4.1-8 and 4.1-9, the emissions are below the applicable *de minimis* levels. A Conformity Determination is not required, and a Record of Non-Applicability has been prepared.

4.1.1.7 Airspace Impacts

Airspace closures associated with commercial space operations would result in additional aircraft emissions mainly from aircraft being re-routed and expending more fuel. Minimal, if any, additional emissions would be generated from aircraft departure delays because the FAA has rarely, if ever, received reportable departure delays associated with launches at VSFB. Based on SpaceX's proposal, airspace-related impacts could increase up to a maximum of 36 times per year. Any delays in aircraft departures from affected airports would be short-term. Therefore, these emissions increases are not expected to result in an exceedance of a NAAQS for any criteria pollutant. Emissions from aircraft being re-routed would occur above 3,000 ft (the mixing layer) and thus would not affect ambient air quality. Therefore, airspace closures associated with commercial space operations are not expected to result in significant air quality impacts.

4.1.1.8 Summary of Impacts on Air Quality

Table 4.1-10 presents the total estimated emission results under Alternative 1 within the Study Area and includes all emissions generated, regardless of proximity to the coastline.

Pollutants emitted in the Study Area under Alternative 1 could be carried ashore by winds. However, the majority of offshore activities would occur more than 12 nm offshore, and natural mixing would substantially disperse pollutants before they reach the coastal land mass. When using the PSD major emitting facility numbers as screening thresholds (250 tons/year), any relevant increases would be below the thresholds. In addition, the total quantity of criteria pollutants is very small in relation to the vastness of the Study Area. Therefore, no significant impacts on air quality as a result of criteria pollutants emissions from activities beyond territorial activities would occur.

Table 4.1-10. Estimated Annual Criteria Pollutant Emissions Produced Between 0 and 12 nm Under Alternative 1[1]

Criteria Pollutant	Annual Emissions (tons per year)						
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$	Pb
Emissions (0–3 nm)	7.7511	13.8268	9.1476	0.1158	0.4000	0.2827	0.0000
Emissions (3–12 nm)	0.5065	2.5509	0.2132	0.1312	0.0643	0.1038	0.0000
Total Alternative 1 Emissions	**8.2576**	**16.3777**	**9.3608**	**0.247**	**0.4643**	**0.3875**	**0.0000**
PSD Major Source Threshold	**250**	**250**	**250**	**250**	**250**	**250**	**25**
Current Environmental Baseline Emissions	2.2671	3.8450	0.5019	0.0369	0.1208	0.0850	0.0000
Increase in Emissions from the Current Environmental Baseline	5.9905	12.5327	8.8589	0.2101	0.3435	0.3025	0.0000

[1]Table includes criteria pollutant precursors (e.g., VOCs). Individual values may not add exactly to total values due to rounding.

Notes: CO = carbon monoxide, NO_X = nitrogen oxides, NO_2 = nitrogen dioxide, Pb = lead, PM_{10} = particulate matter ≤ 10 microns in diameter, $PM_{2.5}$ = particulate matter ≤ 2.5 microns in diameter, PSD = Prevention of Significant Deterioration; SO_2 = sulfur dioxide,

SO_X = sulfur oxides, TPY = tons per year, VOC = volatile organic compound, nm = nautical miles

4.1.1.8.1 Climate

Table 4.1-11 shows the GHG emissions that would be produced under Alternative 1 and compares them against total national GHG emissions. Emissions produced under Alternative 1 would be approximately 23,565 metric tons of CO_2e per year which is comparable to approximately 5,100 passenger vehicles driving for a year, or one year's worth of electricity for just over 4,500 homes, using the USEPA's GHG equivalency calculator. These emissions would make up approximately 0.00394 percent of national GHG emissions, which is an increase of 0.000246 percent from the baseline condition. Therefore, it is unlikely that the implementation of Alternative 1 would significantly contribute to climate change or global warming.

Table 4.1-11. Estimated Annual Greenhouse Gas Emissions Under Alternative 1

Emissions of CO_2e (Metric Tons per Year)	
Alternative 1 GHG Emissions	23,565
Baseline Greenhouse Emissions	8,865
National GHG Emissions	5,981,400,000
Percent of National Emissions	0.000394%
Percent Increase of National Emissions	0.000246%
California GHG Emissions	369,200,000
Percent of California Emissions	0.006383%
Percent Increase of California Emissions	0.003982%

Airspace closures associated with commercial space operations would result in additional aircraft emissions mainly from aircraft being re-routed and expending more fuel, including CO_2. These temporary increases in aircraft emissions could increase up to a maximum of 36 times per year. The amount of time that affected aircraft spend being re-routed would be short-term and the number of aircraft that would be impacted per launch would not be expected to produce additional emissions that would have a notable impact on climate. Therefore, the increases in GHGs caused by short-term airspace closures during commercial space operations is not expected to result in significant climate-related impacts.

The FAA has not established a significance threshold for climate, nor has the FAA identified specific factors to consider in making a significance determination for GHG emissions. The scientific community is continuing efforts to better understand the impact of aviation emissions on the global atmosphere. The FAA is leading and participating in a number of initiatives intended to clarify the role that commercial aviation plays in GHG emissions and climate. The FAA, with support from the U.S. Global Change Research Program and its participating federal agencies, has developed the Aviation Climate Change Research Initiative in an effort to advance scientific understanding of regional and global climate impacts of aircraft emissions.

4.1.2 No Action Alternative

Under the No Action Alternative, proposed activities would not occur. SpaceX would continue to conduct Falcon 9 operations as authorized by its current license with an annual cadence of 12 launches. Emissions from the No Action Alternative would be the same as presented for the baseline conditions as described in Section 3.1.2.3.

4.2 Noise

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

Special consideration is given to evaluating the significance of noise impacts on noise sensitive areas within Section 4(f) properties where the land use compatibility guidelines in 14 CFR Part 150 are not relevant to the value, significance, and enjoyment of the area in question. For example, the DNL 65 dB threshold does not adequately address the impacts of noise on visitors to areas within a national park or

national wildlife and waterfowl refuge where other noise is very low and a quiet setting is a generally recognized purpose and attribute.

4.2.1 ALTERNATIVE 1 (PROPOSED ACTION)

The scope of this noise analysis is limited to the launch, boost-back, and landing of the Falcon 9 as described in Chapter 2. Vessel transit activities are excluded from the noise analysis as their activity is removed from sensitive receptors. There are four main noise components to Falcon 9 activities: 1) continuous engine noise created by the launch vehicle during static fire tests (lasting several seconds); 2) continuous engine noise created during ascent (lasting several minutes); 3) impulsive sonic boom created by the launch of the rocket as well as returning first stage (both lasting less than one second); and 4) continuous engine noise as the first stage lands (lasting approximately 60 seconds). Launch noise and landing noise and impacts on human sensitive receptors is presented in units of dBA. Sonic booms are presented in terms of psf. CNEL is a weighted average of noise levels over time used in the State of California to assess the potential annoyance of airport noise on surrounding communities. While the FAA's primary metric used to determine noise impacts on communities is the DNL, the FAA accepts the CNEL in California since California adopted using CNEL before the FAA adopted DNL.

4.2.1.1 Launch and Static Fire Rocket Engine Noise

The Falcon 9 would produce engine noise of up to 150 dBA during launch operations near the launch pad (Figure 4.2-1). Engine noise between 80 and 90 dBA may be heard off VSFB in the Lompoc Valley and City of Lompoc (Figure 4.2-1). During static fire tests, engine noise in the Lompoc Valley and City of Lompoc may reach between 70 and 80 dBA (Figure 4.2-2). Given the short duration (typically 2–3 minutes) of the launch noise and the relatively low received noise levels at sensitive receptors, the launch noise contribution would be minimal and unlikely that CNEL levels would be elevated above 65 dBA from a single launch, landing, or static fire event. Conservatively speaking, if a 1-hour L_{eq} without a rocket launch was 60 dBA (a typical daytime noise level in rural areas), a 60-second period of noise at 90 dBA (with another 120 seconds at 80 dBA as the rocket gained altitude and distance from the launch pad), that hour's L_{eq} would rise to approximately 72 dBA. However, this 1-hour L_{eq} would need to be integrated with the other 23 hourly L_{eq} values from that day to determine the CNEL. Assuming typical daytime L_{eq}s of 60 dBA and nighttime L_{eq}s of 40 dBA, we anticipate that the resultant DNL for a day with a rocket launch could reach approximately 61 dBA. Additionally, rocket launches have previously been analyzed as having less than significant impacts on the noise environment (USAF 2011).

4.2.1.2 Landing Rocket Engine Noise

Noise would be produced during landing of the Falcon 9 first stage booster at SLC-4W, which takes place below an altitude of about 12,000 ft for approximately 60 seconds. The maximum sound levels nearby SLC-4W would reach 150 dBA (Figure 4.2-3). The Lompoc Valley and City of Lompoc would receive a maximum of between 70 and 80 dBA (Figure 4.2-3). Given the short duration (typically 60 seconds) of the landing noise and the relatively low received noise levels at sensitive receptors, the contribution of landing noise would be minimal and it is unlikely that CNEL levels would be elevated from 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 on the noise environment (USAF 2011).

Similar engine noise and noise impacts would occur during landing of the Falcon 9 first stage booster offshore of California (minimum distance of 12 nm within the Proposed Landing Area; Figure 2.2-2). Since that noise from offshore landing activities would occur far from sensitive receptors, there would be no significant impacts associated with implementing the landings at the offshore locations.

4.2.1.3 Community Noise Equivalent Level

The model for CNEL from the Proposed Action was constructed assuming there would be 24 missions with droneship landing per year and 12 missions per year with first stage landing at SLC-4W. Since operations may occur at any time of day, the model conservatively assumed that all launches, landings, and static fire events would occur between 10:00 p.m. and 7:00 a.m. A CNEL exceeding 65 dBA is generally considered unacceptable for a residential neighborhood and the CNEL 60 dBA contour is used to define the area of potentially significant noise impacts to communities (FAA 2015). The 60 dBA CNEL extends up to approximately 2.9 mi from SLC-4 and is entirely contained within VSFB (Figure 4.2-4).

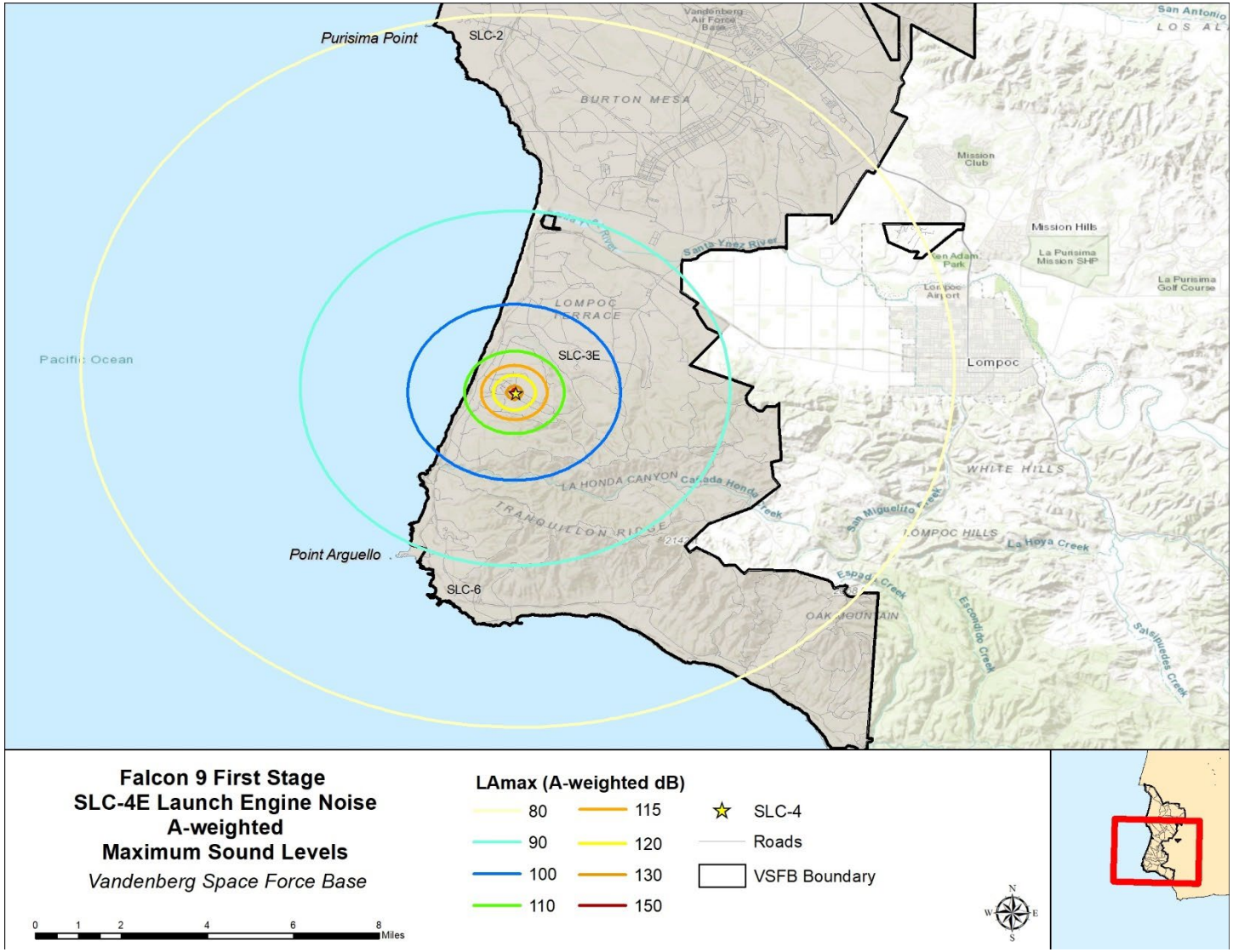

Figure 4.2-1. Maximum A-weighted engine noise during Falcon 9 launch from SLC-4E

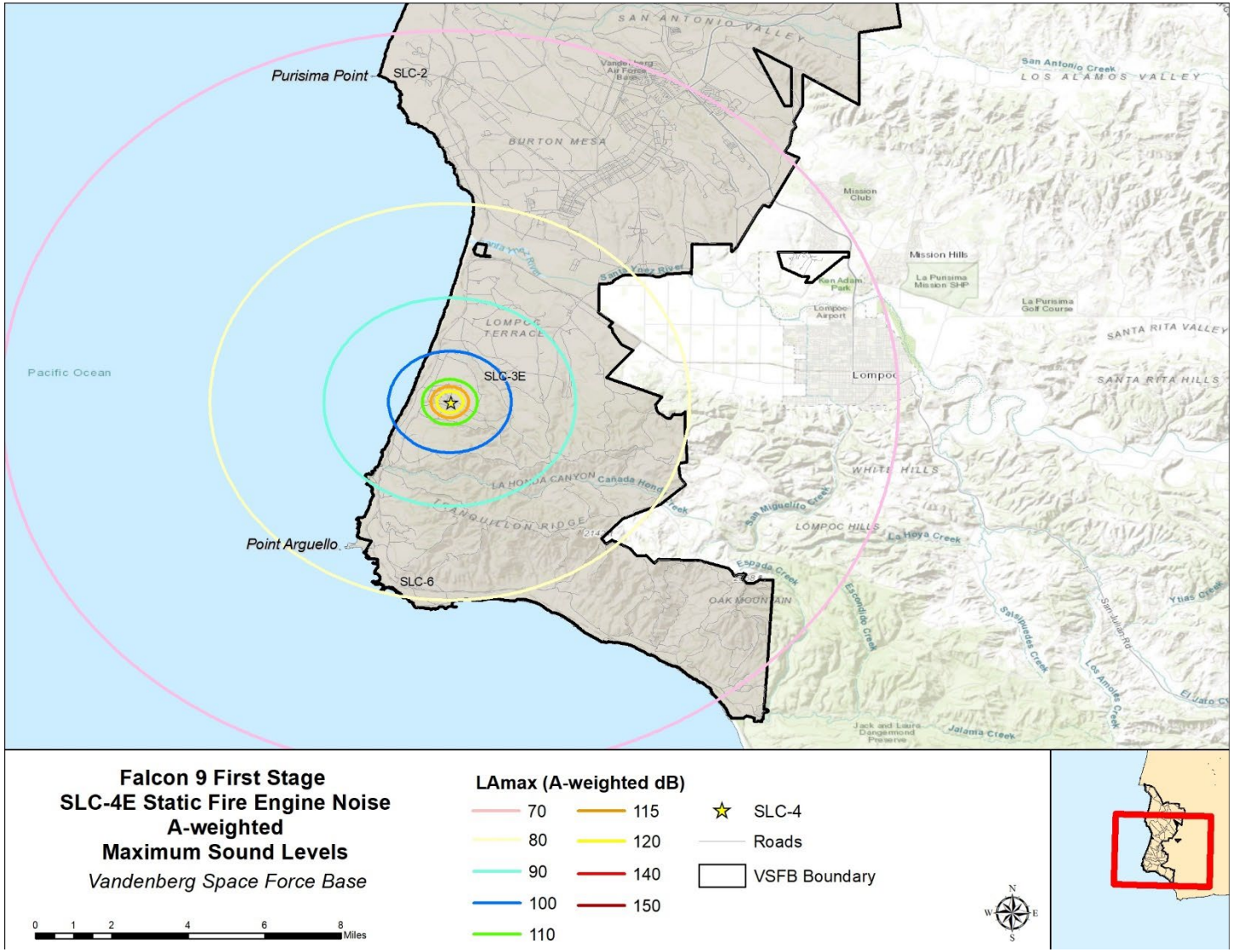

Figure 4.2-2. Maximum A-weighted engine noise during Falcon 9 static fire test at SLC-4E

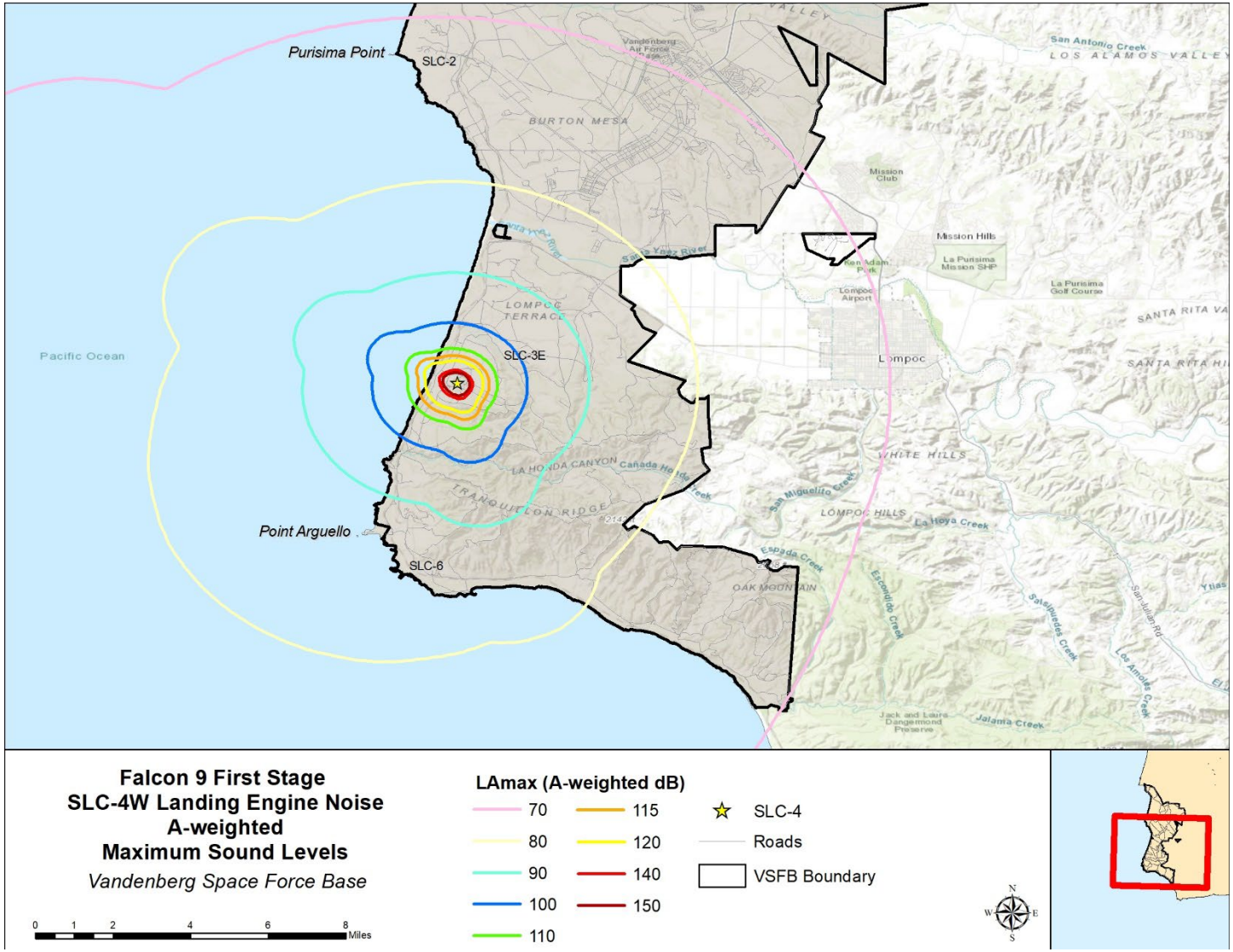

Figure 4.2-3. Maximum A-weighted engine noise during Falcon 9 landing at SLC-4W

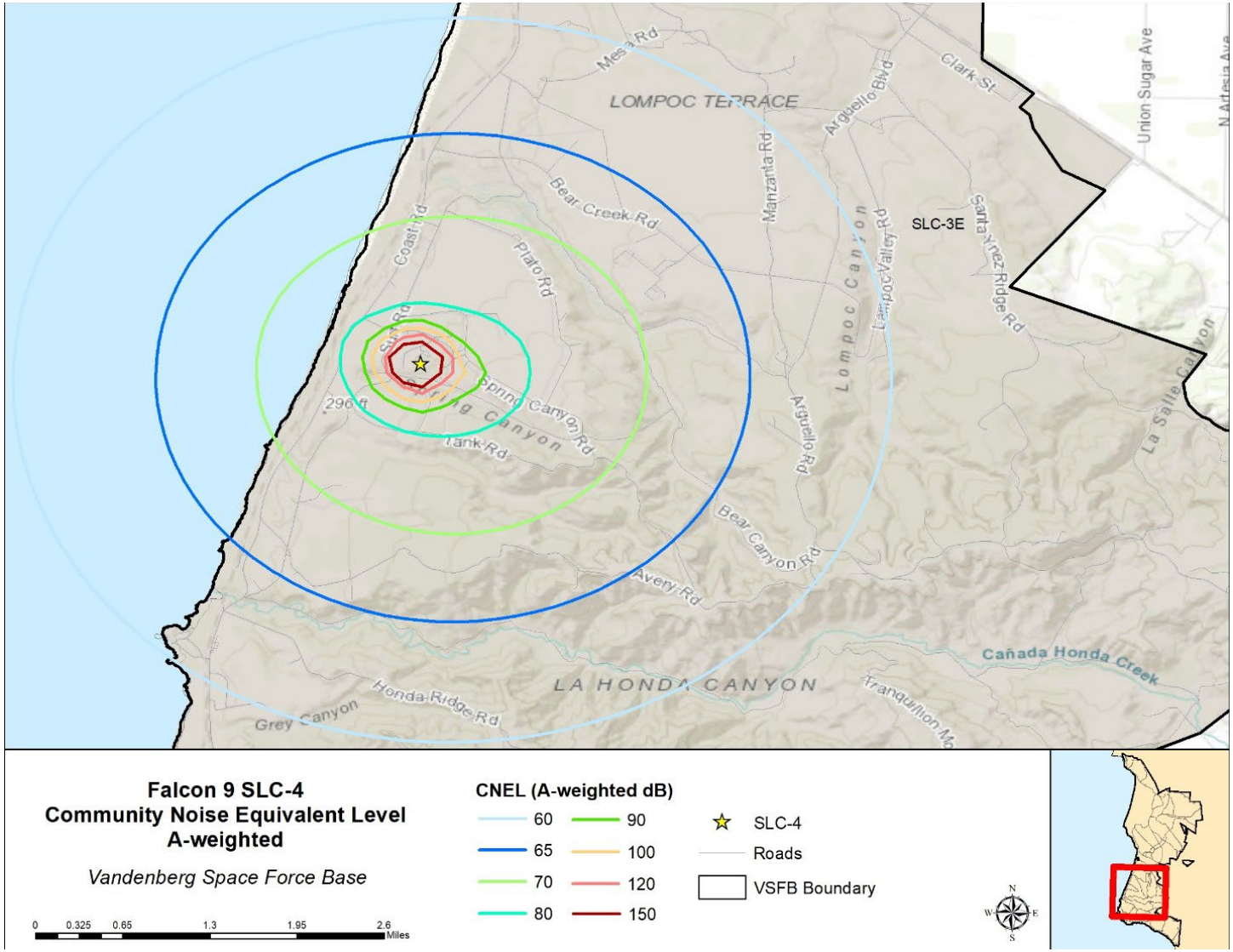

Figure 4.2-4. Community noise equivalent levels from the proposed Falcon 9 launch and landing operations at SLC-4

4.2.1.4 Sonic Boom

Sonic booms are predicted from rocket launches using the southern trajectories (Figure 2.2-6) and the boom contours from the far-field models are generally broad forward-facing crescents. Peak psf overpressures have been modeled above 4.0 psf for portions of the NCI.

The USSF predicts overpressures up to 5.0 psf at the SLC-4 landing location, which would typically attenuate to levels between 0.5 and 1.5 psf in Lompoc (Figure 2.2-7). However, sonic boom levels in Lompoc may rarely reach as high as 4.0 psf, depending on mission trajectories. Depending on the distance the observer is from the landing pad or droneship, a sonic boom may be heard before or within a few seconds following the landing of the first stage. Booms with overpressures of about 1.0 psf or greater are generally audible and can startle people, especially at night. Materials in good condition do not normally fail under sonic boom levels below 6 psf (Haber and Nakaki 1989). Booms up to 4.0 psf are highly unlikely to cause structural damage. Based on probabilities presented in Haber and Nakaki (1989) damage to wall and ceiling plaster from a sonic boom of 4.0 psf ranged between 0.05 percent and 0.45 percent and the probability of damage to a window in poor condition was estimated at 0.01 percent. Sonic booms above 1.5 psf in the City of Lompoc are expected to be rare events. Additionally, there have been no reports of damage to structures in the City of Lompoc during past sonic booms. Therefore, there would be no significant impacts from the boost-back and landing at SLC-4.

Figure 2.2-8 illustrates the potential sonic boom footprint that would be anticipated from a boost-back with a downrange droneship landing on the Pacific Ocean following a southerly trajectory. While the area immediately near the landing site could experience psf levels above 5.0 psf, these locations are on the open ocean, far removed from any terrestrial sensitive receptors and we anticipate will not be audible on land.

4.2.1.5 Airspace

Airspace closures associated with commercial space operations could result in temporarily grounded aircraft at affected airports and re-routing en-route flights on established alternate flight paths. The FAA has rarely, if ever, received reportable departure delays associated with launches at VSFB. Aircraft could be temporarily grounded if airspace above or around the airport is closed. Ground delays are also used under some circumstances to avoid airborne reroutes. If aircraft were grounded, noise levels at the airport could temporarily increase as the planes sit idling waiting for takeoff. Also, depending on the altitude at which aircraft approach an airport, there could be temporary increases in noise levels in communities around the airports. However, aircraft would travel on existing en-routes and flight paths that are used daily to account for weather and other temporary restrictions. Also, not all launch and reentry missions would affect the same aircraft routes or the same airports and re-routing associated with launch-related closures represents a small fraction of the total amount of re-routing that occurs from all other reasons in any given year. Any incremental increases in noise levels at individual airports would only last the duration of the airspace closure periodically and we do not expect to meaningfully change existing DNL at the affected airports and surrounding areas. Therefore, we do not expect airspace closures due to commercial space operations to result in significant noise impacts.

4.2.2 NO ACTION ALTERNATIVE

Under the No Action Alternative, Falcon 9 cadence at VSFB would not increase and there would be no additional noise-related impacts beyond those described in the previous EAs and SEAs (USAF 2011, 2016a,

2016b, and 2018). Therefore, there would be no significant impacts as a result of the No Action Alternative.

4.3 TERRESTRIAL BIOLOGICAL RESOURCES

4.3.1 ALTERNATIVE 1 (PROPOSED ACTION)

The following factors were used to determine if a significant impact on biological resources would result from implementing each alternative:

- unmitigable loss of important quantities of declining vegetation communities (including wetlands) that are considered rare;
- impacts on special status species; or
- altering regionally and locally important wildlife corridors that would severely and permanently limit their use.

Per FAA Order 1050.1F, impacts would be significant if the USFWS or NMFS determines that the action would be likely to jeopardize the continued existence of a federally listed threatened or endangered species or would result in destroying or adversely modifying federally designated critical habitat.

Impacts on biological resources would occur if project-related activities directly or indirectly affect special status species or their habitats. These impacts can be short- or long-term impacts. For example, short-term or temporary impacts can be from noise and long-term impacts can be from the lost habitat supporting wildlife populations.

Potential impacts on biological resources from the Proposed Action include the following:

- Indirect impacts resulting from water use, which is currently extracted from the San Antonio Creek Basin;
- Project-related noise disrupting breeding, foraging, or roosting behaviors and
- Project-related noise causing habitat abandonment, including breeding or roosting sites.

4.3.1.1 Wildlife Resources

Temporary disturbances to terrestrial wildlife species within the Action Area would occur during the launch, landing, and static fire events. Wildlife responses to noise can be behavioral or physiological—ranging from mild, such as an increase in heart rate, to more damaging effects on metabolism and hormone balance. Because responses to noise are species specific, exact predictions of the effects on each species are unreliable without data pertaining to those species or similar species.

During launches, landing, and static firings, noise levels up to 150 dB L_{max} with sonic booms up to 5.0 psf would be produced at SLC-4. Although we cannot make exact predictions, we expect these noises to elicit a startle response in terrestrial wildlife species with developed hearing abilities. Potentially, wildlife hearing thresholds could shift either permanently or temporarily in wildlife if they are active on the surface close to SLC-4 during launch, landing, or static fire events. 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). Because the affected area is relatively small and the noise events are temporary, we expect behavioral disruptions and potential hearing threshold shifts would not have population-level impacts and, therefore, would not have a significant effect on wildlife resources.

4.3.1.2 Special Status Terrestrial Species

4.3.1.2.1 Tidewater Goby

Noise Impacts

During up to 36 launch events per year, engine noise produced during Falcon 9 launches would reach approximately 123 dB L_{max} at potential TWG habitat in Honda Creek (Figure 4.3-1). During up to 12 SLC-4W landing events per year, noise would be less than 100 dB L_{max} at Honda Creek (Figure 4.3-2). Static fire events produce approximately 115 dB L_{max} at Honda Creek (Figure 4.3-3). As described in Appendix A , TWG are unlikely to be present during the proposed launch and static fire activities. If present, we do not expect in-air sound to cause more than a temporary behavioral disruption to fish in Honda Creek.

Water Use

At maximum cadence, the Proposed Action would use up to 19.5 ac-ft of water per year. This would represent approximately 0.7 percent of the total annual water usage on VSFB. The Proposed Action's water usage would therefore be negligible and not result in any measurable impacts to flow rates, hydration periods, or water levels in San Antonio Creek.

Conclusion

Because of the low likelihood of TWG presence in Honda Creek and the minimal transfer of in-air noise into underwater noise, and the negligible increase in water extraction from the San Antonio Creek Basin, we anticipate the level of disturbance from the Proposed Action would be discountable. Therefore, the USSF has determined that the Proposed Action may affect but is not likely to adversely affect the TWG. The USSF completed Section 7 consultation with the USFWS for potential impacts on TWG and would implement all applicable minimization, monitoring, and avoidance measures in the BO (Appendix A). The ROI does not overlap TWG critical habitat. Therefore, the Proposed Action would have no effect on critical habitat for this species. Thus, potential effects to TWG would be less than significant.

4.3.1.2.2 Unarmored Threespine Stickleback

Noise Impacts

As described in Appendix A , Honda Creek has gone through multiple cycles of drying and rehydration, which would preclude occupancy by and persistence of fish. In addition, UTS in San Antonio Creek would be outside areas where launch noise would occur. Therefore, the Proposed Action would not have any noise impacts on UTS.

Water Use

At maximum cadence, the Proposed Action would use up to 19.5 ac-ft of water per year. This would represent approximately 0.7 percent of the total annual water usage on VSFB. The Proposed Action's water usage would therefore be negligible and not result in any measurable impacts to flow rates, hydration periods, or water levels in San Antonio Creek.

Conclusion

The increase in water extraction from the San Antonio Creek Basin under the Proposed Action would be discountable. Therefore, the USSF has determined that the Proposed Action may affect but is not likely to adversely affect the UTS. The USSF completed Section 7 consultation with the USFWS for potential

impacts on UTS and would implement all applicable minimization, monitoring, and avoidance measures in the BO (Appendix A). The ROI does not overlap UTS critical habitat. Therefore, the Proposed Action would have no effect on critical habitat for this species. Thus, potential effects to UTS would be less than significant.

4.3.1.2.3 California Red-Legged Frog

Physical Impacts

As described in Appendix A, no suitable habitat has been found within Spring Canyon or downstream of the vegetation management area, likely from the protracted regional drought conditions. Therefore, CRLF are unlikely to regularly occupy this area and we anticipate no direct impacts during vegetation management activities.

The risk of impacts on CRLF would be reduced because before vegetation clearing activities qualified biologists would capture and relocate all individuals detected within the vegetation management area to nearby suitable habitat. The biologist would also be present to monitor vegetation-clearing activities to move any CRLF encountered out of harm's way.

Noise Impacts

During up to 36 launch events of the Falcon 9 per year, engine noise would reach approximately 128 dB L_{max} at Bear Creek, 123 dB L_{max} at Honda Creek, and 118 dB L_{max} at the Santa Ynez River (Figure 4.3-1). Up to 36 static fire tests per year would produce noise of approximately 125 dB L_{max} at Bear Creek, approximately 118 dB L_{max} at Honda Creek, and 110 dB L_{max} at the Santa Ynez River (Figure 4.3-1). During up to 12 SLC-4W first stage landing events per year, landing engine noise in these locations would be approximately 100 dB L_{max} at Bear Creek, less than 100 dB L_{max} at Honda Creek, and less than 85 dB L_{max} at the Santa Ynez River (Figure 4.3-1). Up to 12 SLC-4 landing events per year would also produce sonic booms that would impact the Santa Ynez River (estimated between 1.5 and 2.0 psf), Honda Creek (estimated between 2.0 and 3.0 psf), and Bear Creek (estimated between 4.0 and 5.0 psf; Figure 4.3-2). Landing noise follows launch by approximately 5 to 7 minutes and typically occurs slightly before (seconds) the sonic boom impacts land.

A full discussion of maximum noise level estimates, modeling assumptions, and factors in determining the amount of noise energy that would be perceived by CRLF is contained in Appendix A. Also included is a description of data used to produce graphical depictions of a mean Ranidae hearing sensitivity curve, associated noise weighting function, and launch peak noise estimates.

While we assume that the sonic boom would likely trigger a startle response in CRLF, causing them to flee to water or attempt to hide in place (resulting in a temporary disruption of behaviors including foraging, calling, and mating), there are no data on what level of sonic boom would cause this reaction. To date, one SpaceX landing event at SLC-4W has occurred during CRLF breeding season, the NROL-87 on 2 February 2022. MSRS performed bioacoustic monitoring (MSRS 2022) at two locations within the predicted boom impact area, following the monitoring requirements of the 2017 BO (USFWS 2017b). Though the landing occurred during daylight hours, CRLF were detected calling at both monitoring locations, a drainage near the VSFB Recreation Center and lower Honda Creek. The sonic boom did not cause a measurable reduction in CRLF calling frequency at either of the two locations where the received overpressures were between 1 (VSFB Recreation Center) and 2.4 psf (lower Honda Creek). Of the four

calls that occurred during the hour period when the boom was received, all four were detected after the boom, at 32, 37, 47, and 48 minutes following the sonic boom (MSRS 2022). See Appendix A for additional details of monitoring results.

As described in Appendix A, CRLF would likely exhibit a startle response to noise, vibrations, and visual disturbance during launch, landing, and static fire, causing them to flee to water or attempt to hide in place. Any reaction would likely depend on the sensitivity of the individual, the behavior that it is engaged in when it experiences the noise, and past exposure to similar noise. Regardless, we expect the reaction to be the same—the frog's behavior would likely be disrupted and it may flee to cover in a similar way a frog reacts to a predator. As a result, CRLF behaviors could be temporarily disrupted, including foraging, calling, and mating (during the breeding season). However, as numerous studies indicate (Appendix A), after being disturbed frogs tend to quickly return to normal behavior. In addition, USFWS-permitted biologists working on VSFB and elsewhere in CRLF occupied habitat have also routinely observed a similar response in this species after disrupting individuals while conducting frog surveys (A. Abela, M. Ball, and J. LaBonte, pers. obs.). Therefore, once the disturbance from the noise event has ended we expect CRLF would resume normal activities quickly, and any behavioral response to individual noise events would be short term.

Previous studies on the effects of anthropogenic noise disturbance on anurans (see Appendix A) examined sustained traffic noise and multiple daily airplane flights and are not directly comparable to the Proposed Action impacts. The Proposed Action's noise is likely to be minimally perceptible to the CRLF's hearing range but would likely cause perceptible vibrations that are non-sustained and infrequent compared to the available literature. Additionally, no thresholds in the literature quantify what level of noise or frequency of disturbance would elicit stress hormone responses, impacts to breeding and reproduction, or negative population level effects. While these studies show effects on behavior and physiology that could have impacts on fitness and populations, none of them present direct evidence of population impacts, so the long-term effects of chronic exposure to anthropogenic noise on populations is unknown for these species.

The USSF will implement a monitoring program (Section 2.2.7.2) to track CRLF habitat occupancy, breeding behaviors, and tadpole densities in Lower Honda Creek (the area to receive the highest noise levels), Bear Creek, and the Santa Ynez River as the frequency of launch and static fire under the Proposed Action. As full tempo under the Proposed Action is reached, the USSF will be able to assess incremental changes in the acoustic environment at Lower Honda Creek by using passive bioacoustic recorders and analyze these data to assess any associated impacts on the CRLF population. If CRLF occupancy, calling frequency, or tadpole densities decline from baseline by 15 percent or more, the 15 percent decline from baseline is maintained for two consecutive years, and the decline is not attributable to other non-launch-related factors, SLD 30 would offset for these impacts by creating new CRLF breeding habitat at the San Antonio Creek Oxbow Restoration Area, an established wetland mitigation site that is located outside of areas currently impacted by most launch noise on VSFB. Historically occupied by riparian vegetation, restoration efforts would focus on enhancing this abandoned tract of agricultural land to improve San Antonio Creek and provide CRLF breeding habitat, thus offsetting any population level impacts at Honda Creek within an area that is not impacted by launch noise.

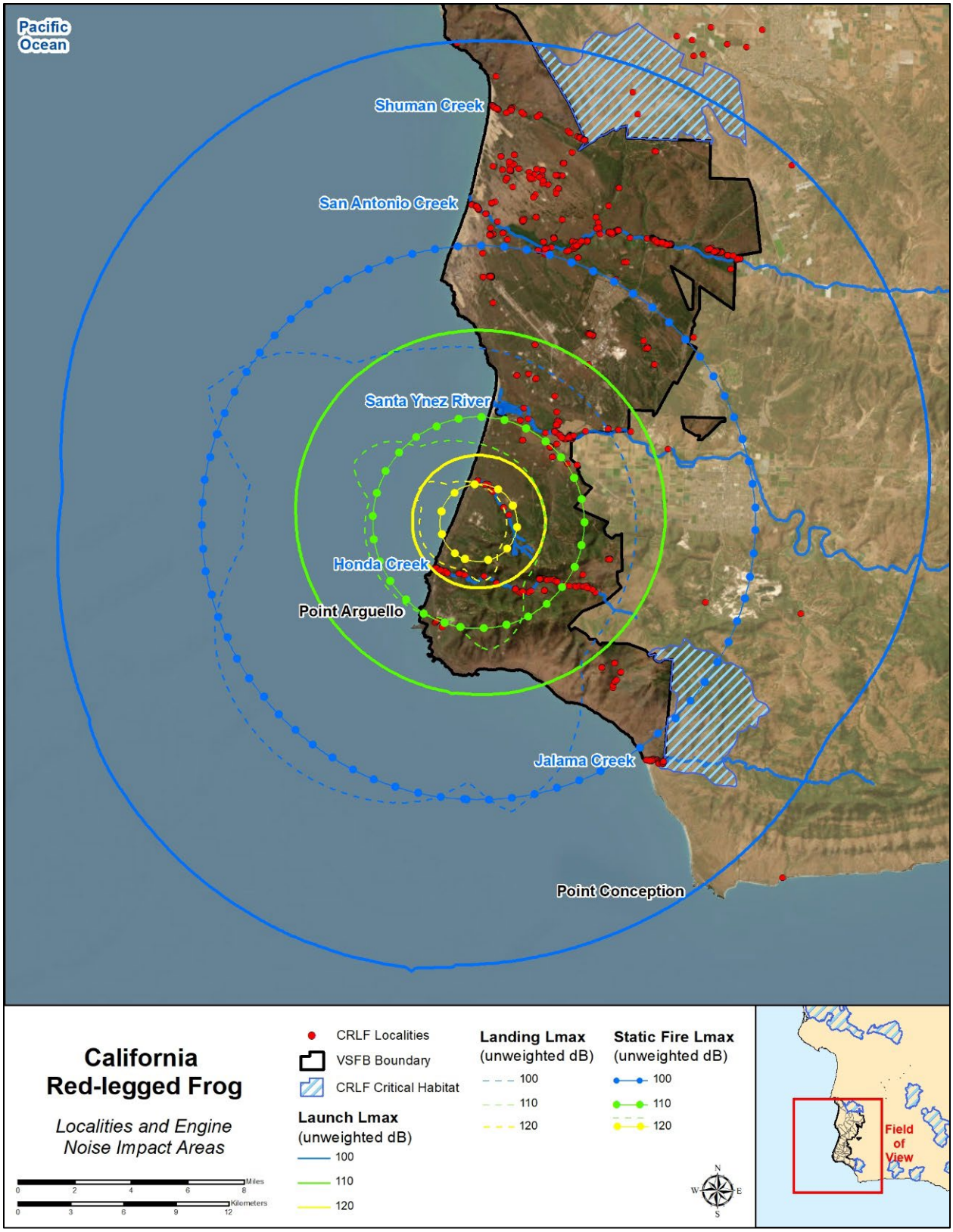

Figure 4.3-1. California Red-Legged Frog Localities, Critical Habitat, and Rocket Engine Noise Impact Areas

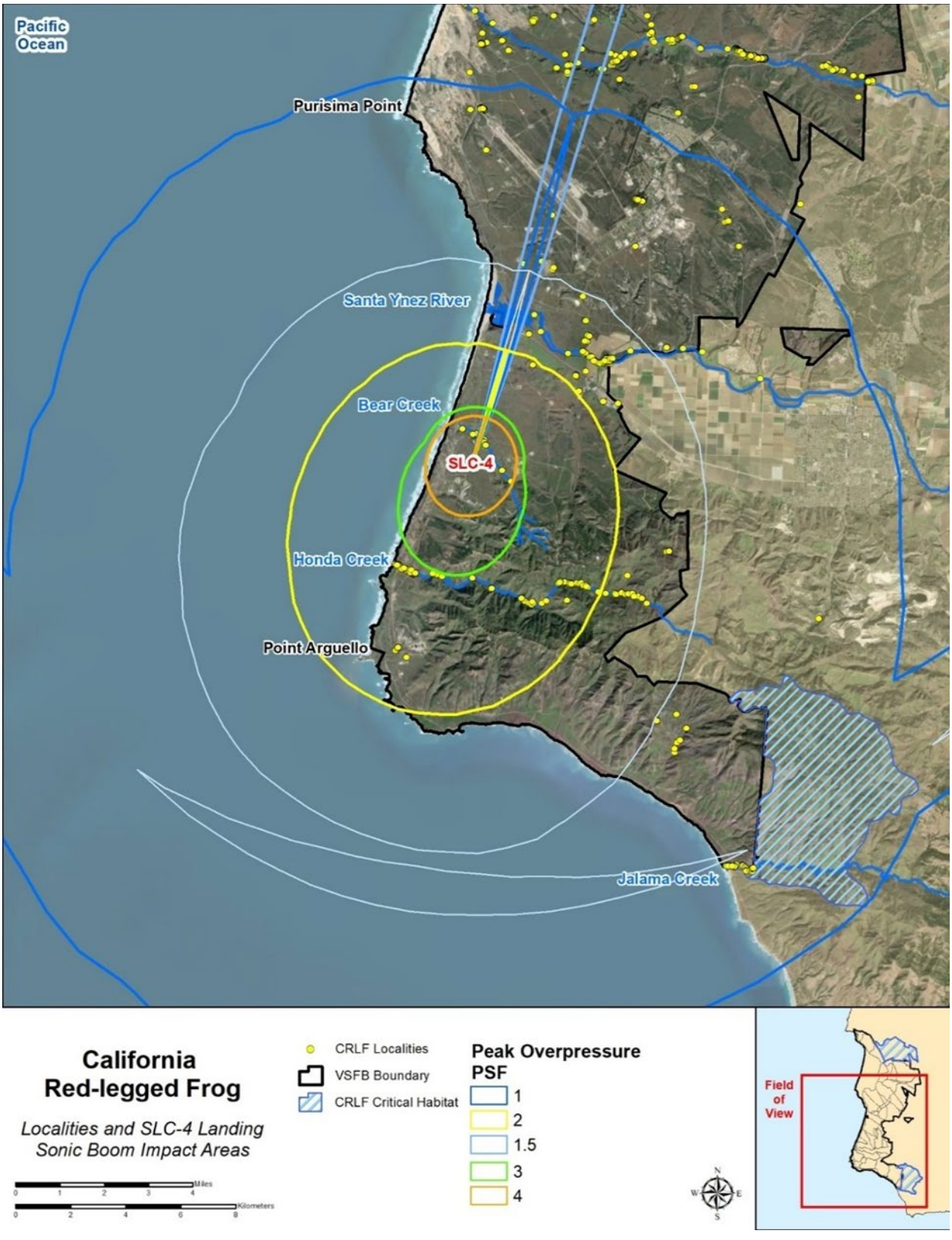

Figure 4.3-2. California Red-Legged Frog Localities, Critical Habitat (inset), and Sonic Boom Impact Areas

Water Use

At maximum cadence, the Proposed Action would use up to 19.5 ac-ft of water per year. This would represent approximately 0.7 percent of the total annual water usage on VSFB. The Proposed Action's water usage would therefore be negligible and not result in any measurable impacts to flow rates, hydration periods, or water levels in San Antonio Creek.

Critical Habitat

The ROI includes the following designated critical habitat units for the CRLF: STB-2 and STB-4. The Proposed Action would have no ground disturbing activities or impacts on water quality within critical habitat; therefore, no measurable impacts on vegetation, hydrology, habitat structure, or any other physical features of habitat would occur. Unit STB 4 would receive landing noises in excess of 70 dB and units STB-2 and STB-4 would potentially receive infrequent sonic booms of 1.0 to 2.0 psf, which we do not expect to appreciably diminish habitat quality, including vegetation, prey base, or degrade habitat structure. Therefore, the Proposed Action would have no effect on critical habitat for this species.

Conclusion

The USSF has determined that potential physical impacts from water release and vegetation clearing in Spring Canyon, rocket engine noise, and sonic booms resulting from the Proposed Action may affect, and is likely to adversely affect, the CRLF. The USSF completed Section 7 consultation with the USFWS for potential impacts on CRLF and would implement all applicable minimization, monitoring, and avoidance measures in the BO (Appendix A). Potential effects to CRLF would therefore be less than significant.

4.3.1.2.4 Marbled Murrelet

Noise and Visual Disturbance

MAMU do not nest on VSFB so exposure to noise impacts would be limited to foraging adults that have occasionally been observed between the late summer through winter foraging off the coast of VSFB (eBird 2022). Although unlikely, if MAMU were present immediately off the coast they would experience engine noise of less than 130 dB L_{max} during launch, less than 115 dB L_{max} during SLC-4 landing, approximately 125 dB L_{max} during static fire events (Figure 4.4-3), and sonic booms up to 4.0 psf during SLC 4 landings (Figure 4.3-4). Additionally, the majority of MAMU are found in a band about 984 to 6,561 ft from shore (Strachan et al. 1995) where noise levels would be much lower.

Based on limited data available regarding MAMU's response to noise and visual disturbances (Appendix A), the dominant response of MAMU to approach by boats is to dive and resurface a short distance away. MAMU are, therefore, expected to exhibit a startle response that would cause birds to dive and resurface, but they are expected to return to normal behavior soon after each launch, landing, or static fire event has been completed.

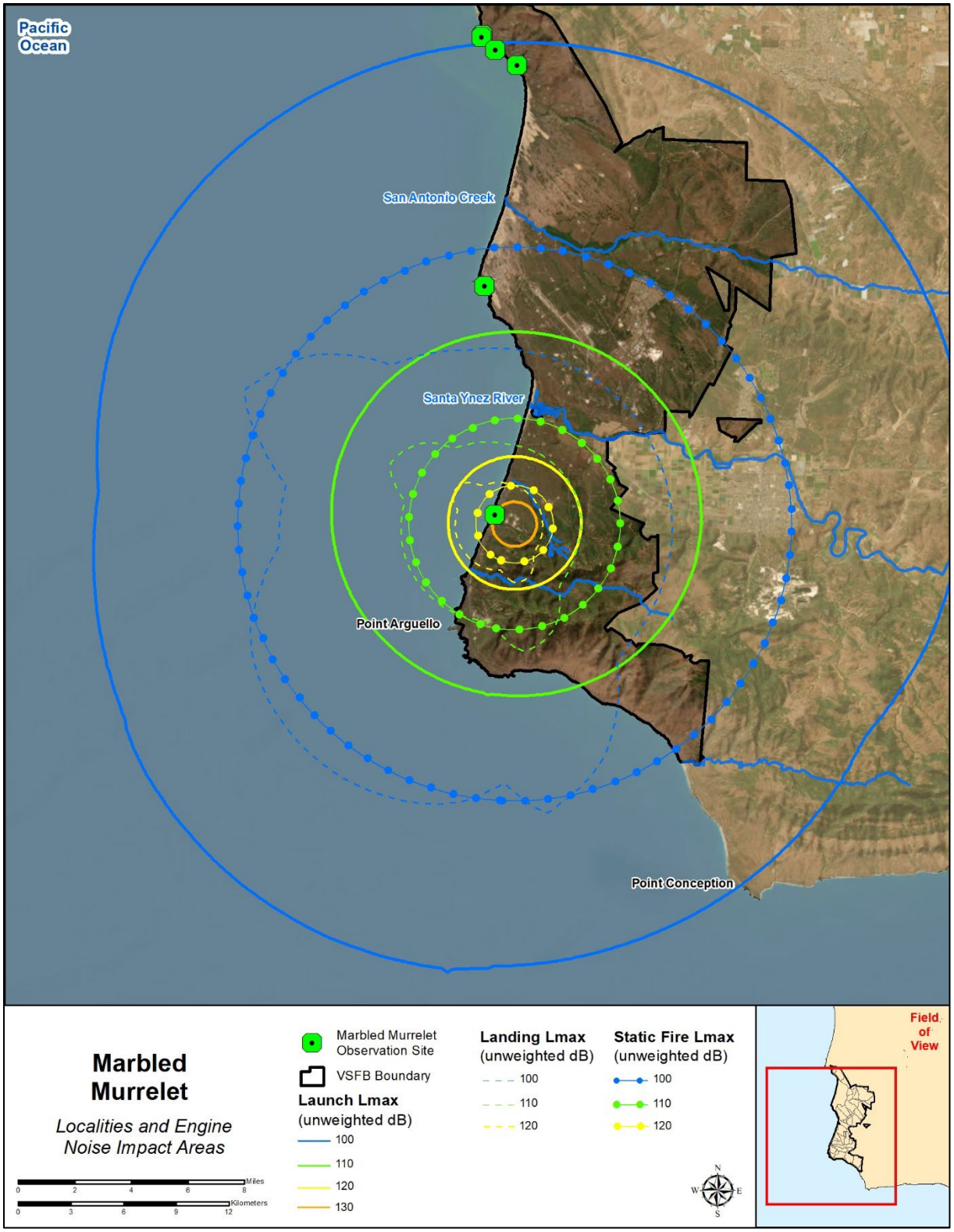

Figure 4.3-3. Marbled Murrelet Observation Sites and Rocket Engine Noise Impact Areas (Source: eBird 2022; Note: observation sites are not localities, they are where the surveyor was located)

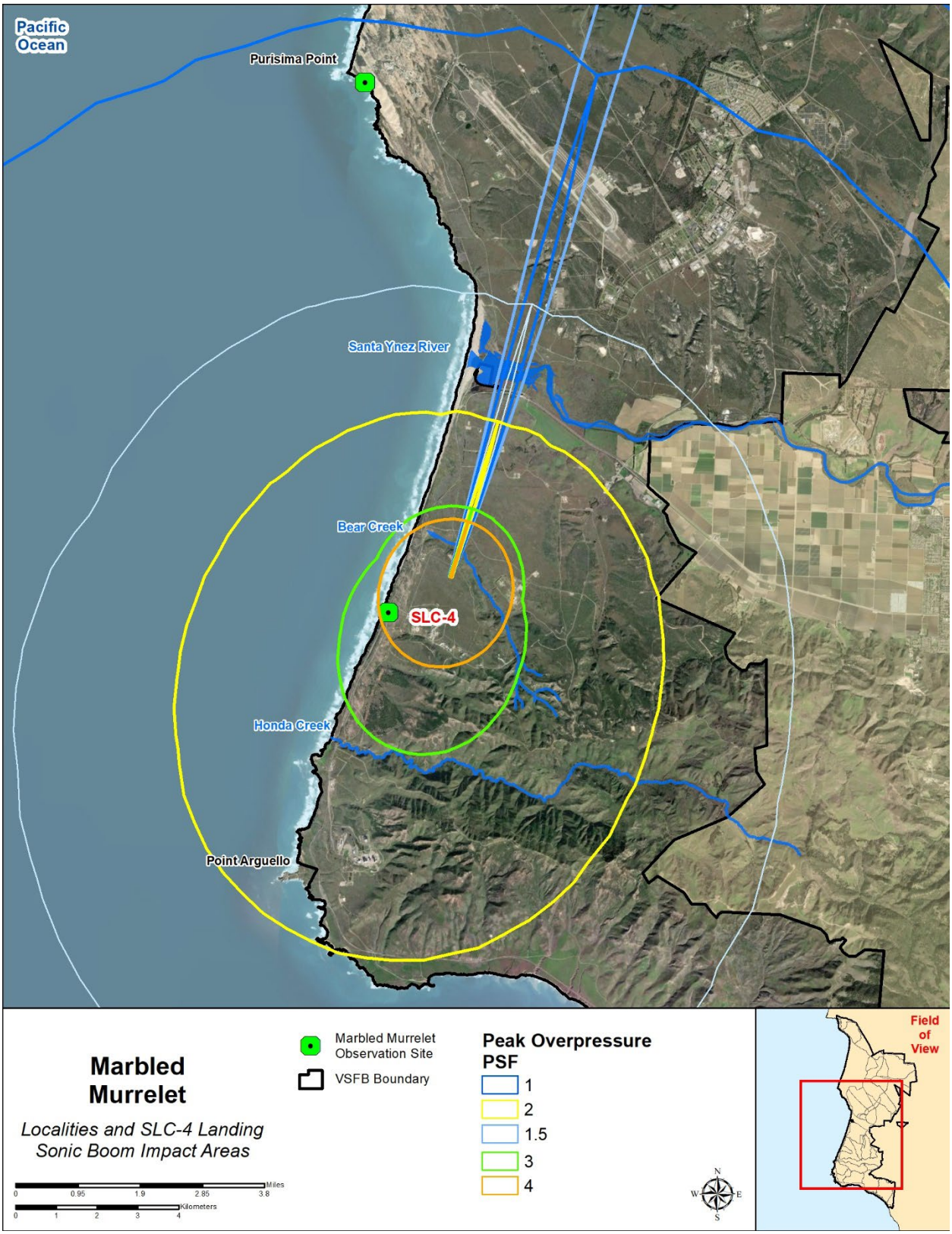

Figure 4.3-4. Marbled Murrelet Nesting Records and Sample Sonic Boom Model Results for SLC 4W Landing Events

Conclusion

Because MAMU would be unlikely to be present during a launch, landing, or static fire event, and the expected impact would be a temporary behavioral reaction in response to noise, the Proposed Action would have a discountable effect on MAMU. Therefore, the USSF determined that the Proposed Action may affect, but is not likely to adversely affect, the MAMU. The Action Area does not overlap MAMU critical habitat. Therefore, the Proposed Action would have no effect on critical habitat for this species. The USSF completed Section 7 consultation with the USFWS for potential impacts on MAMU and would implement all applicable minimization, monitoring, and avoidance measures in the BO (Appendix A). Potential effects to MAMU would therefore be less than significant.

4.3.1.2.5 Western Snowy Plover

Noise and Visual Disturbance

SNPL on VSFB beaches would experience noise levels between 100 and 130 dB L_{max} during launches, between approximately 100 and 110 dB L_{max} during SLC-4 landing, between 100 and 125 dB L_{max} during static fire events (Figure 4.3-5), and sonic booms between 1.5 and 5.0 psf during SLC-4 landing (Figure 4.3-6). Sonic booms on the NCI may reach 5.0 psf (Figure 4.3-7). Launch noise events would last less than one minute and static fire noise would last less than 7 seconds (static fire noise would never reach the NCI).

Determining the amount of noise energy that overlaps with the hearing sensitivity of SNPL is critical to understanding the potential effects that the noise disturbances would have. With the lack of SNPL-specific audiograms or other data on this species' hearing sensitivity, a weighted noise function for SNPL was deduced based on call frequency. In Appendix A we provide background on developing the weighted noise function, as well as narrative and graphical descriptions of SNPL call frequency, and analogous species' hearing sensitivity curve and weighting function. The weighting function was applied to a timewave form recording of the June 2022 Falcon 9 SARah-1 launch, resulting in a peak level of approximately 60 dB L_{max} (Appendix A). In comparison to human hearing sensitivity, 60 dBA is equivalent to the noise level of typical conversation. The very low incidence of behavioral responses to launch noise and lack of evidence of changes in SNPL abundance, nesting behavior, and distribution on VSFB beaches in response to launches is likely because SNPL perceive very little of the noise produced by rocket engine noise.

SNPL monitoring for impacts from launch-related engine noise and visual disturbance has been conducted during numerous launches on VSFB over the past two decades during the breeding and non-breeding seasons, and has routinely demonstrated that SNPL behavior is not adversely affected by launch noise or vibrations. In addition, no incidents of injury or mortality to adults, young, or eggs attributable to launch noise have been documented, and SNPL monitoring during prior Falcon 9 launches and landing events has not shown evidence of injury, mortality, or abnormal behavior. Direct observations of SNPL during launches have also shown little to no reaction to launch-related noise (Appendix A).

Historical data from monitoring efforts documenting SNPL responses to noise impacts are described in detail in Appendix A. Most recently, SNPL were monitored for the 18 June 2022 Falcon 9 SARah-1 mission with boost-back and first stage recovery at SLC-4 (Robinette & Rice 2022a). There were no differences in overall bird abundance or nest attendance before and after the launch and landing. Video footage

showed that the incubating adults reacted to both the launch and the sonic boom produced by the return flight of the first stage, with more intense reactions to the sonic boom. Scientific literature, described in Appendix A, shows that the effects of frequent noise disturbance on bird species varies greatly. None of the scientific literature studies are directly comparable to the noise impacts of the Proposed Action, and there are no relevant studies on rocket launch effects on birds. Launch engine noise and sonic booms are acute, non-sustained, and unpredictable; they are most similar to aircraft noise disturbance, yet relatively much less frequent.

SLD 30 would augment the existing on Base SNPL monitoring program, which records habitat use, nesting efforts, nest fates, fledgling survival, and population size through each breeding season, with geospatial analysis of SNPL nesting and the noise environment, as presented in Section 2.2.7.2.2. SLMs would be deployed immediately inland of South Surf Beach to characterize the noise environment during the breeding season within Falcon 9's 100 dB L_{max} footprint. Geospatial analysis would be performed annually to assess whether patterns of nesting activity, nest fates, or fledgling success are negatively impacted by noise from the Proposed Action or other launch programs on VSFB. If geospatial analysis shows that a statistically significant decline in breeding effort or nest success over two consecutive years is not attributable to other factors, SLD 30 would offset this impact by increasing predator removal efforts on Base to include the non-breeding season, particularly focusing on raven removal at and adjacent to VSFB beaches.

On the NCI, impacts on SNPL would be substantially less (Figure 4.3-7). Over the past 29 Falcon 9 launches, only 7 have impacted the NCI, and only 4 have impacted SRI where SNPL is considered a permanent resident. Additionally, there would not be any exposure to launch or landing noise or any associated visual stimuli. Any behavioral reactions would likely be short term and would be unlikely to cause long-term consequences for individuals or populations. Because of the infrequent, short-term, and transient nature of the sonic booms and the relatively few numbers of individuals occurring on the NCI, the impacts would be insignificant and discountable to SNPL on the NCI.

Critical Habitat

The Action Area includes portions of SRI which are designated critical habitat for the SNPL (Figure 4.3-7). Although the frequency of booms impacting SRI has been low (4 of last 29 launches), these areas may potentially receive sonic booms of up to 5.0 psf. The Proposed Action does not include any ground disturbance within critical habitat nor would it appreciably diminish the species' prey base or any other physical features of habitat. Therefore, the Proposed Action would have no effect on critical habitat for this species.

Conclusion

The USSF has determined that the Proposed Action may affect, and is likely to adversely affect, the SNPL on VSFB. SLD 30 would perform geospatial analysis to monitor the impacts of noise from the Proposed Action and other launch programs on Base to assess any potential adverse impacts on the species at VSFB as the launch frequency gradually increases and reaches full tempo (Section 2.2.7.2.2). If adverse effects are found, SLD 30 would offset those effects by increasing predator management efforts on VSFB (Section 2.2.7.2.2). The USSF completed Section 7 consultation with the USFWS for potential impacts on SNPL and would implement all applicable minimization, monitoring, and avoidance measures in the BO (Appendix A). Potential effects to SNPL would therefore be less than significant.

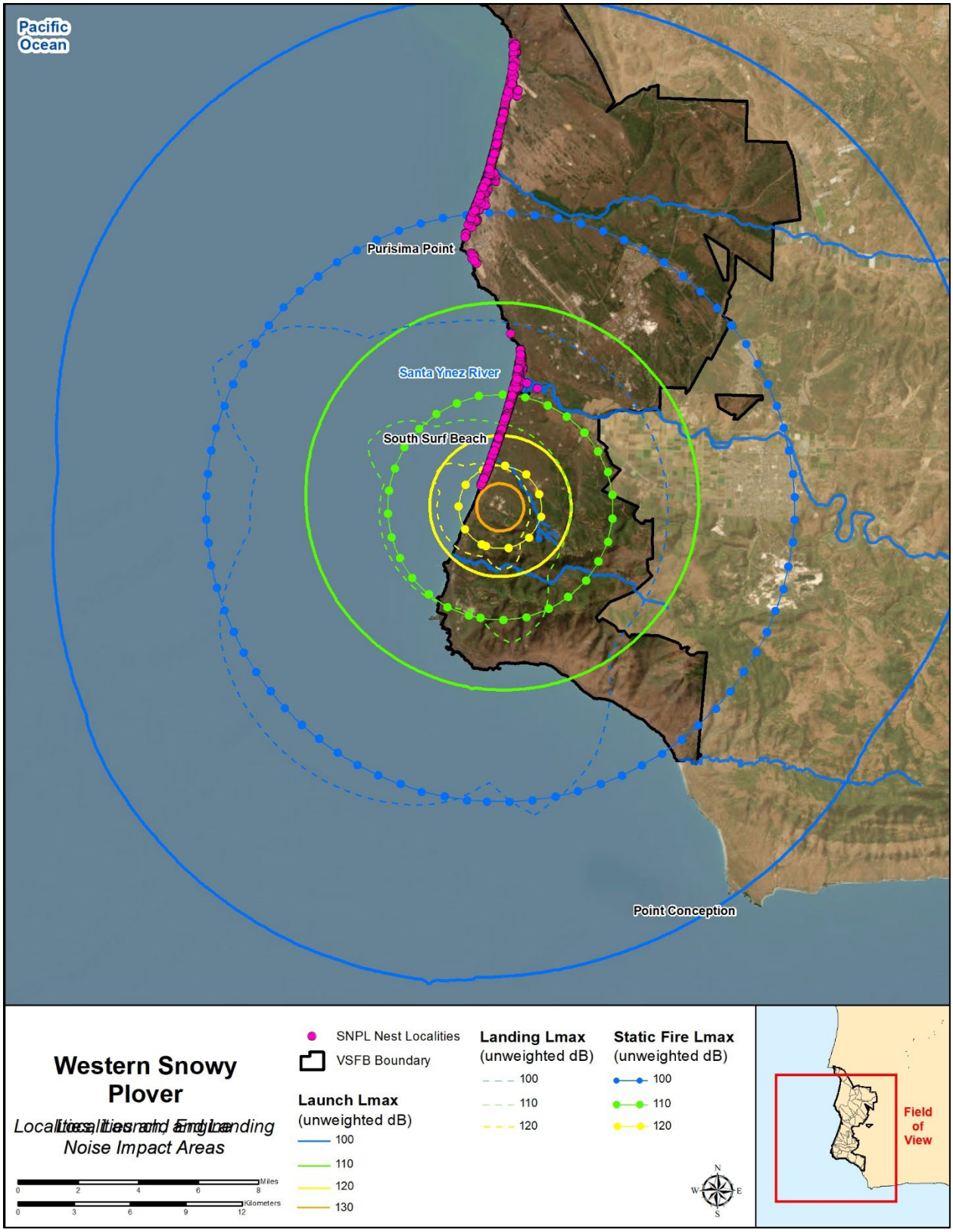

Figure 4.3-5. Western Snowy Plover Nesting Records and Rocket Engine Noise Impact Areas

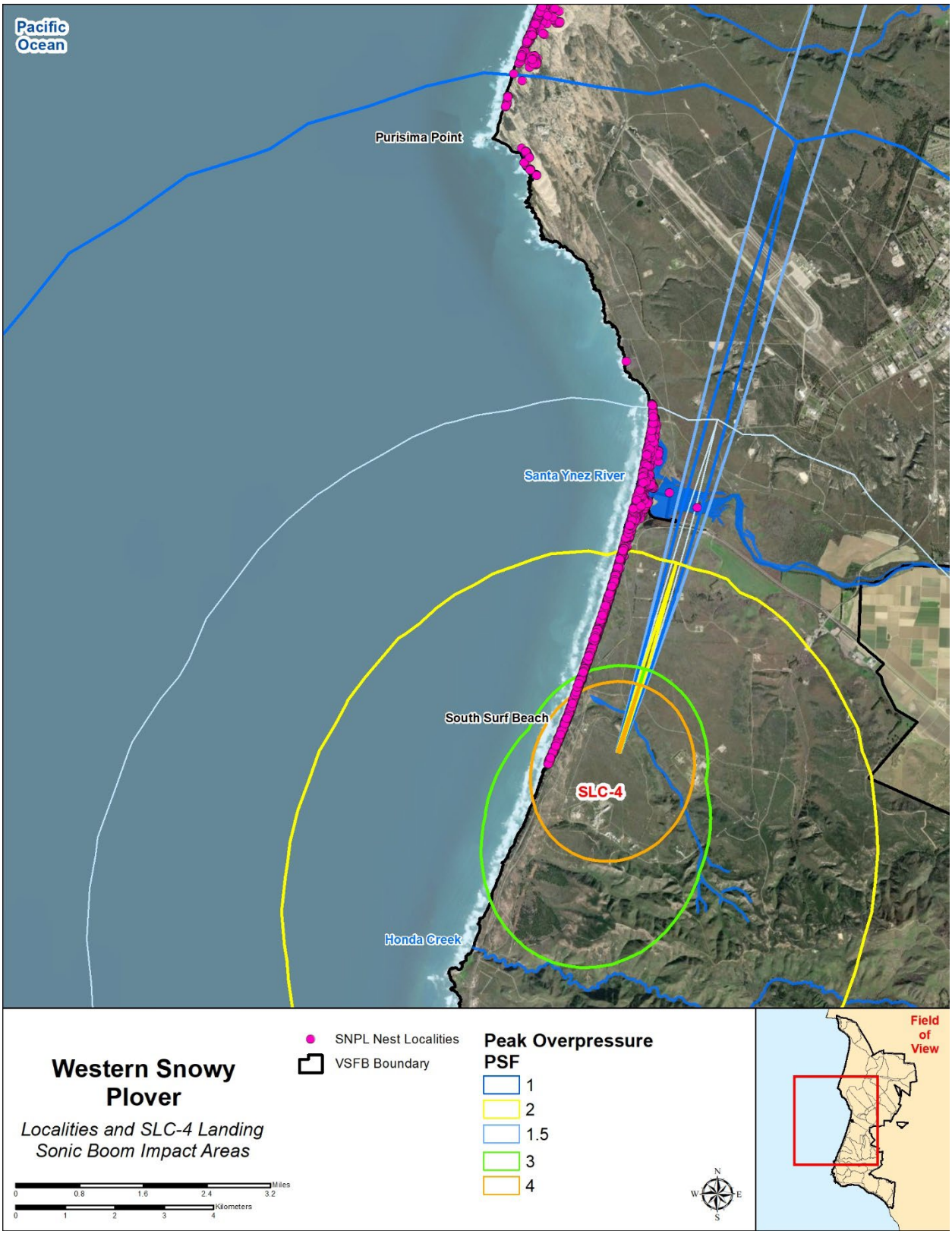

Figure 4.3-6. Western Snowy Plover Nesting Records and Sample Sonic Boom Model Results for SLC-4W Landing Events

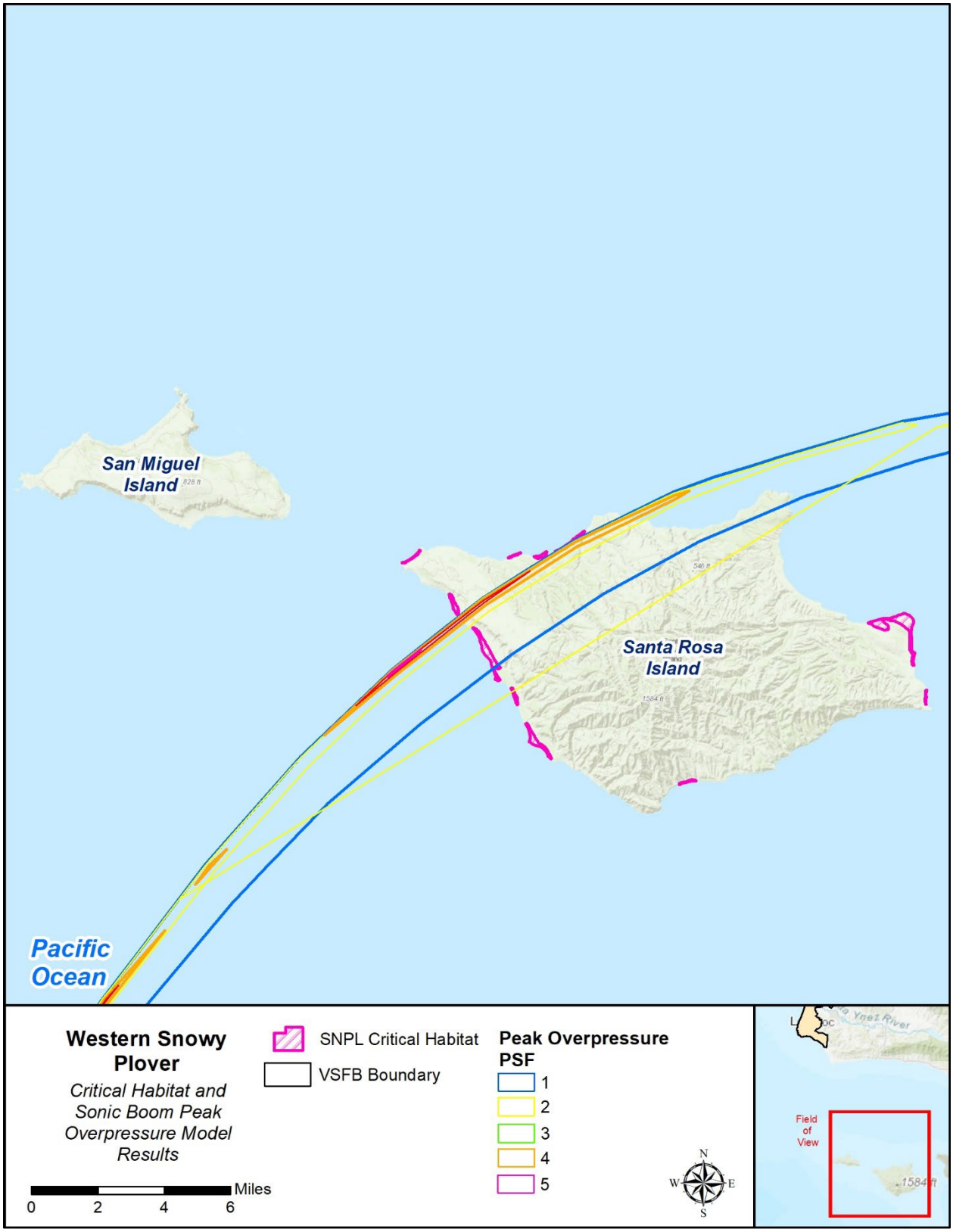

Figure 4.3-7. Designated Critical Habitat for the Western Snowy Plover and Sample Sonic Boom Model Results

4.3.1.2.6 California Least Tern

Noise and Visual Disturbance

If missions are performed when LETE are present (approximately 15 April through 15 August), LETE at the Purisima colony would receive launch engine noise of approximately 108 dB L_{max} up to 36 times per year, landing engine noise less than 80 dB L_{max}, and static fire noise levels at approximately 102 dB Lmax (Figure 4.3-8). During landing events, overpressures would be between 1.0 and 3.0 psf from a sonic boom (Figure 4.3-9). If LETE are present at the Santa Ynez River mouth, they may experience 115 dB L_{max} during launches and less than 80 dB L_{max} engine noise and a 1.5 to 4.0 psf sonic boom during SLC-4 landing events. Static fire tests would produce approximately 110 dB L_{max} at the Santa Ynez River mouth. Due to time requirements for refurbishing vehicle components, payload preparation, and site preparation, only approximately one third of the proposed 36 annual launches would overlap the time period when LETE are typically present at VSFB (15 April and 15 August).

Appendix A presents historical data from monitoring launch and landing noise. Data implied that LETE response to noise relates to timing with the nesting cycle. For instance, at the beginning of the nesting season when LETE are arriving at the breeding colony, the adults seem to be more disturbed, but once courtship and nest-tending begins, the adults are more tenacious. Most recently, monitoring of a LETE colony was performed for the 12 June 2022 SpaceX Falcon 9 launch with first stage landing at SLC-4W. A 1.1 psf sonic boom was recorded at the colony. There were no differences in overall bird abundance or nest attendance before and after the launch and landing. Video footage showed that the reaction of incubating LETE ranged from alert and minor looking around to a startle effect (i.e., calm before the boom, with a jolt and quick head movements looking around when the boom hit; Robinette & Rice 2022b).

Based on the existing monitoring observations, the audible and visual components of the Proposed Action could cause LETE to respond behaviorally. This stimulus could trigger a startle response that alerts predators to nest locations and causes temporary (minutes) abandonment of nests. The proposed EPMs (Section 2.2.7.2.2) would be employed to characterize impacts on LETE from launch-related noise events.

The effect of increasing noise disturbances on LETE will be uncertain based on the scientific literature. However, none of these studies in the scientific literature are directly comparable to the noise impacts of the Proposed Action. Launch engine noise and sonic booms are acute, non-sustained, and unpredictable. It is more similar to aircraft noise disturbances studied in the literature, yet would be relatively much less frequent. Beyond the launch monitoring efforts discussed above, there are almost no studies on the effects of rocket launch on birds.

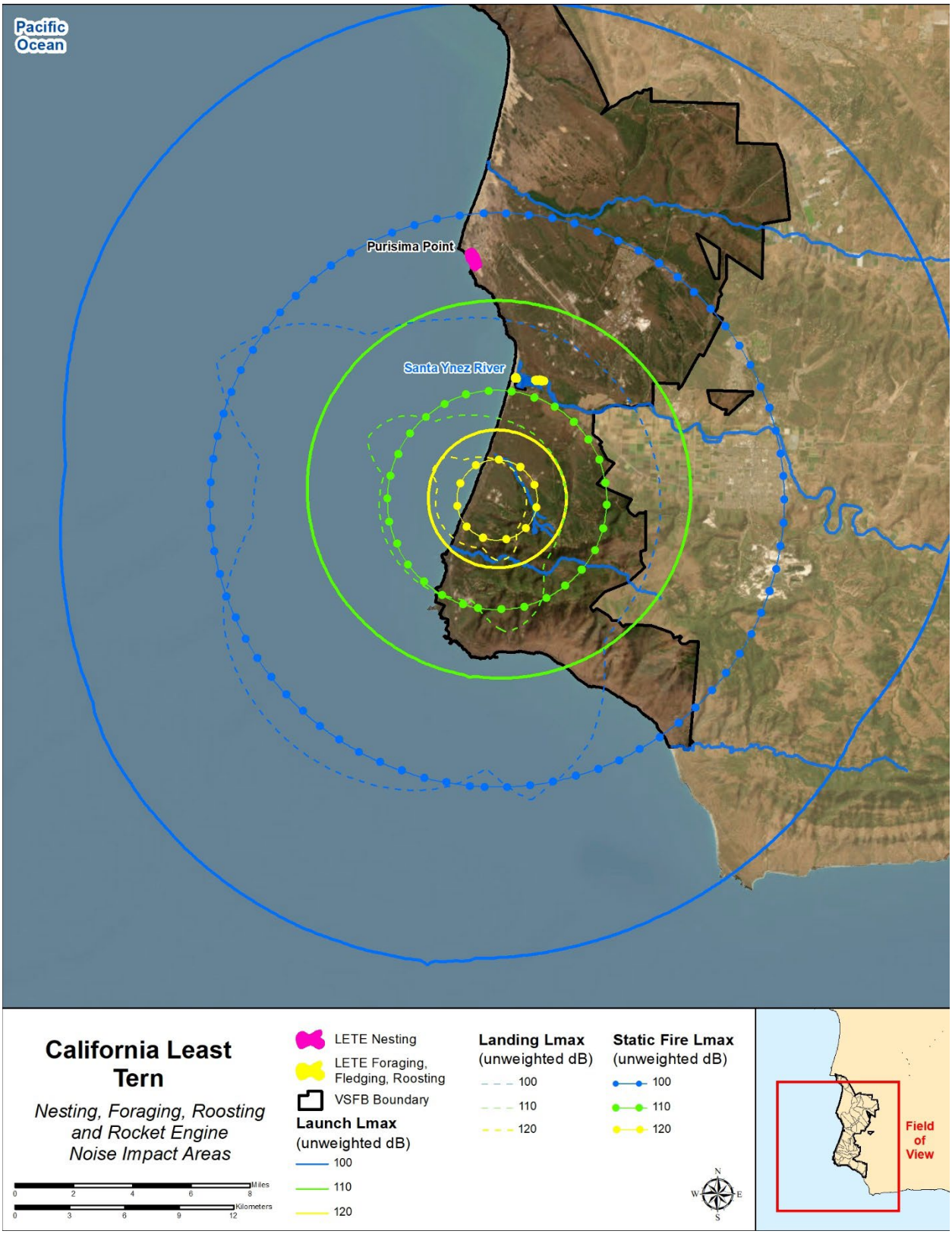

Figure 4.3-8. California Least Tern Foraging, Roosting, and Nesting Areas and Rocket Engine Noise Impact Areas

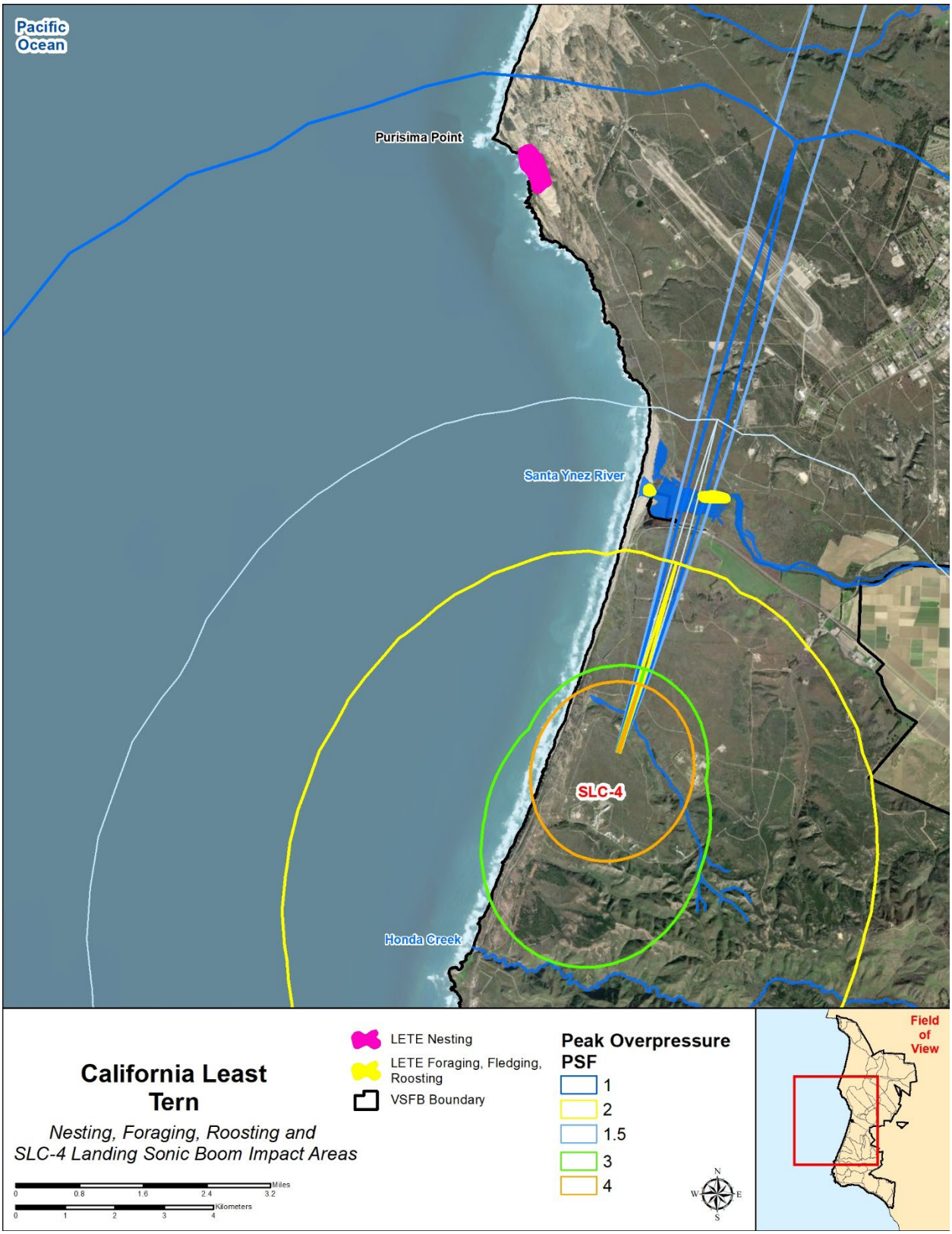

Figure 4.3-9. California Least Tern Nesting, Foraging, and Roosting Areas and Sample Sonic Boom Model Results for SLC-4W Landing Events

Conclusion

The USSF has determined that the Proposed Action may affect, and is likely to adversely affect, the LETE on VSFB. The USFWS has not designated critical habitat for the LETE. SLD 30 would perform geospatial analysis to monitor the Proposed Action's noise impacts to assess any potential adverse impacts on the species at VSFB as the launch frequency increases and reaches full tempo (Section 2.2.7.2.2). If adverse effects are found, SLD 30 would offset those effects by increasing predator management efforts on VSFB (Section 2.2.7.2.2). The USSF completed Section 7 consultation with the USFWS for potential impacts on LETE and would implement all applicable minimization, monitoring, and avoidance measures in the BO (Appendix A). Potential effects to LETE would therefore be less than significant.

4.3.1.2.7 California Condor

Generally, California condors are less tolerant of human disturbances near nesting sites than at roosting sites. The species is described as being "keenly aware of intruders" and may be alarmed by loud noises from distances greater than 1.6 mi. In addition, the greater the disturbance in either noise level or frequency, the less likely the condor would nest nearby. As such, USFWS typically requires isolating roosting and nesting sites from human intrusion (USFWS 1996). Noise from a launch coupled with visual disturbance could cause a startle response and disrupt behavior if a condor is within the Action Area.

There is no nesting habitat within the ROI and there has only been one condor observed on VSFB, in 2017. Although launch noise, sonic booms, and visual disturbance may cause a startle response and disrupt behavior, the likelihood of a condor being present during these activities is extremely low and, therefore, the effect of the Proposed Action would be discountable. Therefore, the USSF has determined that Proposed Action may affect, but is not likely to adversely affect, the California condor. The USSF will coordinate with the USFWS and Ventana Wildlife Society to monitor for condor presence before launches.

Conclusion

Although launch noise, landing noise, visual disturbance, and sonic boom may cause a startle response and disrupt behavior if a condor is within the ROI during a launch and landing at SLC-4, the likelihood of a condor being present during these activities is extremely low and the effect of the proposed project on California condors would be discountable. The proposed activities may affect, but are not likely to adversely affect the California condor. The USSF completed Section 7 consultation with the USFWS for potential impacts on California condor and would implement all applicable minimization, monitoring, and avoidance measures in the BO (Appendix A) and the EPMs described in Section 2.2.7.2. Critical habitat for the California condor does not occur within or near the Action Area. Therefore, the Proposed Action would have no effect on this species' critical habitat. Potential effects to California condor would therefore be less than significant.

4.3.2 NO ACTION ALTERNATIVE

Under the No Action Alternative, Falcon 9 cadence at VSFB would not increase and there would be no additional impacts on terrestrial biological resources beyond those described in the previous EAs and SEAs (USAF 2011, 2016a, 2016b, and 2018). Therefore, the No Action Alternative would not significantly impact terrestrial biological resources.

4.4 MARINE BIOLOGICAL RESOURCES

4.4.1 ALTERNATIVE 1 (PROPOSED ACTION)

4.4.1.1 ESA-listed Fish

This section evaluates how, and to what degree, the Proposed Action potentially impacts ESA-listed fishes (Southern California DPS steelhead, lower Columbia River Chinook ESU, Southern Oregon and Northern California Coast Coho ESU, Central California Coast Coho ESU, green sturgeon, oceanic whitetip shark, and scalloped hammerhead shark) occurring within the ROI. The stressors considered for the ESA-listed fishes are physical disturbance and impacts by fallen objects, entanglement, and ingestion of expended materials.

Physical Disturbance and Impacts by Fallen Objects

If unrecovered fairings or radiosondes struck a fish, it could result in injury or death. Once within the water column, disturbance or strike from an item falling through the water is possible, but its velocity would be greatly reduced (reducing the potential for serious injury) and the falling object could potentially be avoided by marine species once detected. A very low possibility exists that a ESA-listed fish would be at or just under the surface in the impact area at the time of splashdown, but population-level impacts would not occur. In addition, ESA-listed fish species occur in very low densities throughout the proposed landing area (U.S. Department of the Navy 2017), therefore, the probability of a strike would be very unlikely and discountable.

Entanglement

Unrecovered parafoils, parachutes, and weather balloons could potentially become entangled with a fish, causing injury or death. While individual fish could encounter expended materials that may pose a risk of entanglement, the likelihood of entanglement is extremely small because: (1) the encounter rate for these expended materials is low, (2) there is restricted overlap with susceptible fishes, and (3) the physical characteristics of the expended materials reduce entanglement risk to fishes compared to abandoned fishing gear. For example, latex weather balloons burst after reaching its elastic limit at an altitude of 12 to 19 mi. The temperature at this altitude range can reach -40 degrees Fahrenheit (^{o}F) and even colder. Under these conditions of extreme elongation and low temperature, the balloon undergoes "brittle fracture" where the rubber shatters along grain boundaries of crystallized segments. The resultant pieces of rubber are small strands comparable to the size of a quarter (Burchette 1989). The balloon fragments would be positively buoyant, float on the surface, and begin to photo-oxidize due to UV light exposure. In addition, unrecovered parafoils and parachutes would sink quickly through the water column, at 7 ft and 22 ft per minute, respectively, and settle (NMFS 2022). These activities will typically occur far offshore in deep waters where ESA-listed fish densities are low, therefore they are not expected to be encountered by fish potentially affected by the Proposed Action. Entanglement with parachutes, unrecovered parafoils, or weather balloons is therefore extremely unlikely and therefore the risk of entanglement is very low.

Ingestion

Pieces of weather balloons, parachutes, or parafoils may pose an ingestion stressor to ESA-listed fish. Ingestion of expended materials by fishes could occur at or just below the surface, in the water column, or at the seafloor depending on the size and buoyancy of the expended object and the feeding behavior

of the fish. Floating material is more likely to be eaten by fishes that feed at or just under the water's surface (e.g., ocean sunfish, basking sharks, or flying fishes), while materials that sink to the seafloor present a higher risk to bottom-feeding fishes (e.g., rockfishes, skates, and flatfishes).

Parachutes and parafoils are made of nylon and Kevlar and thus do not degrade quickly. Photooxidation would break down nylon, however, the parachutes and parafoils would sink rapidly (discussed above) and settle on the ocean floor, typically far from shore at depths greater than the ESA-listed species discussed herein are expected to occur and where ultraviolet light would not penetrate. Because the degradation of these materials would be very slow and the presence of the ESA-listed fish species at these depths is unlikely the risk of ingestion of parachute or parafoil materials by ESA-listed fish would be very low and discountable.

Weather balloons would burst after an altitude of 12 to 19 mi where temperatures can reach -40 ^{o}F and even colder. As discussed above, the balloon would undergo "brittle fracture", and shatter into pieces approximately the size of a quarter (Burchette 1989). These pieces would become dispersed over a broad area as they fall to the surface of the ocean. The balloon fragments would be positively buoyant, float on the surface, and degrade over approximately 6 weeks as they photo-oxidize due to UV light exposure (Burchette 1989). After several weeks, the pieces of latex would be smaller and become neutrally buoyant (Ye & Andrady 1991; Lobelle & Cunliffe 2011). Because of the small amount of latex material expended, the dispersion of fragments as they descend to the ocean, and their limited amount of time on the surface, and low densities of ESA-listed species in the ROI, the risk of ingestion by ESA of weather balloon material is very low and discountable.

Conclusion

The potential for physical disturbance and potential strike, risk of entanglement, and ingestion of expended materials as a result of the Proposed Action would be discountable. The USSF has determined that the Proposed Action may affect, but is not likely to adversely affect the ESA-listed fish. The USSF completed Section 7 consultation with the NMFS for potential impacts on ESA-listed fish species on 20 January 2023 (Appendix B) and would implement all applicable minimization, monitoring, and avoidance measures in the BO and the EPMs included in Table 2.2-8. Potential effects to ESA-listed fish would therefore be less than significant.

4.4.1.2 ESA-listed Sea Turtles

This section evaluates how, and to what degree, the Proposed Action potentially impacts ESA-listed sea turtles (green, loggerhead, olive ridley, hawksbill, and leatherback) occurring within the ROI. The stressors considered for the ESA-listed sea turtles are physical disturbance and impacts by fallen objects, entanglement, and ingestion of expended materials.

Physical Disturbance and Impacts by Fallen Objects

If unrecovered fairings or radiosondes struck a sea turtle, it could result in injury or death. Once within the water column, disturbance or strike from an item falling through the water is possible, but its velocity would be greatly reduced (reducing the potential for serious injury) and the falling object could potentially be avoided by marine species once detected. A low possibility exists that a sea turtle would be at or just under the surface in the impact area at the time of splashdown, but population-level impacts would not occur. In addition, ESA-listed sea turtles occur in very low densities throughout the proposed landing area

(U.S. Department of the Navy 2017), therefore, the probability of a strike would be very unlikely and discountable.

Entanglement

Unrecovered parafoils, parachutes, and weather balloons can potentially become entangled with an ESA-listed sea turtles, causing injury or death. While individual turtles could encounter expended materials that may pose a risk of entanglement, the likelihood of entanglement is extremely small because: (1) the encounter rate for these expended materials is low, (2) there is restricted overlap with susceptible turtles, and (3) the physical characteristics of the expended materials reduce entanglement risk to sea turtles compared to abandoned fishing gear. For example, latex weather balloons burst after reaching its elastic limit at an altitude of 12 to 19 mi. The temperature at this altitude range can reach -40 ^{o}F and even colder. Under these conditions of extreme elongation and low temperature, the balloon undergoes "brittle fracture" where the rubber shatters along grain boundaries of crystallized segments. The resultant pieces of rubber are small strands comparable to the size of a quarter (Burchette 1989). The balloon fragments would be positively buoyant, float on the surface, and begin to photo-oxidize due to UV light exposure. In addition, unrecovered parafoils and parachutes would sink quickly through the water column, at 7 ft and 22 ft per minute, respectively, and settle (NMFS 2022). These activities will typically occur far offshore in deep waters where they are not expected to be encountered by ESA-listed sea turtles potentially affected by the Proposed Action. Entanglement with parachutes, unrecovered parafoils, or weather balloons is therefore extremely unlikely and therefore the risk of entanglement is very low.

Ingestion

Pieces of weather balloons, parachutes, or parafoils may pose an ingestion stressor to ESA-listed sea turtles. Ingestion of expended materials by turtles could occur at or just below the surface, in the water column, or at the seafloor depending on the size and buoyancy of the expended object and the feeding behavior of the turtle. Floating material is more likely to be eaten by a turtle that is feeding at or just under the water's surface.

Parachutes and parafoils are made of nylon and Kevlar and thus do not degrade quickly. Photooxidation would break down nylon, however, the parachutes and parafoils would sink rapidly (discussed above) and settle on the ocean floor, typically far from shore at depths greater than the ESA-listed sea turtles discussed herein are expected to occur and where ultraviolet light would not penetrate. Because the degradation of these materials would be very slow and the presence of the ESA-listed sea turtle species at these depths is unlikely the risk of ingestion of parachute or parafoil materials by ESA-listed sea turtle would be very low and discountable.

Weather balloons would burst after an altitude of 12 to 19 mi where temperatures can reach -40 ^{o}F and even colder. As discussed above, the balloon would undergo "brittle fracture", and shatter into pieces approximately the size of a quarter (Burchette 1989). These pieces would become dispersed over a broad area as they fall to the surface of the ocean. The balloon fragments would be positively buoyant, float on the surface, and degrade over approximately 6 weeks as they photo-oxidize due to UV light exposure (Burchette 1989). After several weeks, the pieces of latex would be smaller and become neutrally buoyant (Ye & Andrady 1991; Lobelle & Cunliffe 2011). Because of the small amount of latex material expended, the dispersion of fragments as they descend to the ocean, and their limited amount of time on the surface,

and low densities of ESA-listed sea turtle in the ROI, the risk of ingestion by ESA of weather balloon material is very low and discountable.

Conclusion

The potential for physical disturbance and potential strike, risk of entanglement, and ingestion of expended materials as a result of the Proposed Action would be discountable. The USSF has determined that the Proposed Action may affect, but is not likely to adversely affect the ESA-listed sea turtles. The USSF completed Section 7 consultation with the NMFS for potential impacts on ESA-listed sea turtle species on 20 January 2023 (Appendix B) and would implement all applicable minimization, monitoring, and avoidance measures in the BO and the EPMs included in Table 2.2-8. Potential effects to ESA-listed sea turtles would therefore be less than significant.

4.4.1.3 MMPA-protected and ESA-listed Cetaceans

Physical Disturbance and Impacts by Fallen Objects

If unrecovered fairings or radiosondes struck a cetacean, it could result in injury or death. Once within the water column, disturbance or strike from an item falling through the water is possible, but its velocity would be greatly reduced (reducing the potential for serious injury) and the falling object could potentially be avoided by marine species once detected. A very low possibility exists that a whale would be at or just under the surface in the impact area at the time of splashdown, but population-level impacts would not occur. In addition, whales occur in very low densities throughout the proposed landing area (U.S. Department of the Navy 2017), therefore, the probability of a strike would be very unlikely and discountable.

Entanglement

Unrecovered parafoils, parachutes, and weather balloons could potentially become entangled with a whale, causing injury or death. While individual whales could encounter expended materials that may pose a risk of entanglement, the likelihood of entanglement is extremely small because: (1) the encounter rate for these expended materials is low, (2) there is restricted overlap with susceptible whales, and (3) the physical characteristics of the expended materials reduce entanglement risk to whales compared to abandoned fishing gear. For example, latex weather balloons burst after reaching its elastic limit at an altitude of 12 to 19 mi. The temperature at this altitude range can reach -40 ^{o}F and even colder. Under these conditions of extreme elongation and low temperature, the balloon undergoes "brittle fracture" where the rubber shatters along grain boundaries of crystallized segments. The resultant pieces of rubber are small strands comparable to the size of a quarter (Burchette 1989). The balloon fragments would be positively buoyant, float on the surface, and begin to photo-oxidize due to UV light exposure. In addition, unrecovered parafoils and parachutes would sink quickly through the water column, at 7 ft and 22 ft per minute, respectively, and settle (NMFS 2022). These activities will typically occur far offshore in deep waters where cetacean densities are low, therefore they are not expected to be encountered by whales potentially affected by the Proposed Action. Entanglement with parachutes, unrecovered parafoils, or weather balloons is therefore extremely unlikely and therefore the risk of entanglement is very low.

Noise

NMFS has previously determined that noise produced during launch activities (i.e., rocket engine noise, sonic booms) only have the potential to result in harassment of marine mammals that are hauled out of

the water (NMFS 2019a). Cetaceans spend their entire lives in the water and spend most of their time (>90 percent for most species) entirely submerged below the surface. Additionally, when at the surface, cetacean bodies are almost entirely below the water's surface, with only the blowhole exposed to allow breathing. This minimizes in-air noise exposure, both natural and anthropogenic, essentially 100 percent of the time because their ears are nearly always below the water's surface. As a result, the likelihood of the specified activities resulting in the harassment of any cetacean is so low that it is discountable.

Conclusion

Physical disturbance and potential strike, risk of entanglement, and noise impacts as a result of the Proposed Action would be discountable and would not result in harassment of cetaceans protected under the MMPA. The USSF has determined that the Proposed Action may affect, but is not likely to adversely affect the ESA-listed cetaceans. The USSF completed Section 7 consultation with the NMFS for potential impacts on ESA-listed cetaceans on 20 January 2023 (Appendix B) and would implement all applicable minimization, monitoring, and avoidance measures in the BO and the EPMs included in Table 2.2-8. Potential effects to MMPA-protected and ESA-listed cetaceans would therefore be less than significant.

4.4.1.4 MMPA-Protected Pinnipeds

Noise and visual disturbance can cause variable levels of disturbance to pinnipeds that may be hauled out within the areas of exposure, depending on the species exposed and the level of the sonic boom. NMFS has previously determined that the only potential stressors associated with the specified activities that could cause harassment of marine mammals (i.e., rocket engine noise, sonic booms) only have the potential to result in harassment of marine mammals that are hauled out of the water (NMFS 2019a). As a result, not all Falcon 9 first stage recoveries are expected to result in harassment of marine mammals. First stage recoveries throughout the majority of the proposed landing area will not result in landing engine noise or sonic booms greater than 1.0 psf impacting mainland or islands. The USSF has monitored pinnipeds during launch-related sonic booms on the NCI during numerous launches over the past two decades and determined that there are generally no significant behavioral disruptions caused to pinnipeds by sonic booms less than 1.0 psf. Generally, only a portion of the animals present tend to react to sonic booms.

The USSF has also monitored pinnipeds on VSFB during many launches to characterize the effects of noise and visual disturbance on pinnipeds during numerous launches over the past two decades and determined there are generally no substantial behavioral disruptions or anything more than temporary affects to the number of pinnipeds hauled out on VSFB. 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. Normal behavior and numbers of hauled out pinnipeds typically return to normal within 24 hours or less (often within minutes) after a launch event. No observations of injury or mortality to pinnipeds during monitoring have been attributed to past launches. As a result, the Proposed Action's potential impacts on MMPA-protected pinnipeds are expected to be limited to brief behavioral reactions.

Under the MMPA, NMFS issued a Final Rule for taking marine mammals incidental to VSFB launches (NMFS 2019a), and a LOA (NMFS 2019b; Appendix B). The LOA expires in April 2024, but the USSF requested its renewal in November 2022. The LOA allows launch programs to unintentionally take small numbers of marine mammals during launches. The USSF is required to comply with the LOA listed conditions and address NMFS concerns regarding marine mammals at VSFB. Under the current LOA,

monitoring of marine mammals at VSFB is required each year during launches between 1 January and 31 July.

MMPA-protected marine mammals have the potential to be disturbed during RORO operations. However, we do not anticipate adverse effects because the EPMs listed in Table 2.2-8, including entering the harbor to the extent possible at high tides when pinnipeds are not present, limiting and restricting nighttime activities and using artificial lighting, and slowly starting any noisy activities, would help minimize and avoid any behavior disruptions.

Considering the authorizations and EPMs in place (Section 2.2.7.3, Marine Biological Resources), including the required monitoring, the Proposed Action would not result in significant impacts on MMPA protected pinnipeds.

4.4.1.5 Guadalupe Fur Seal

Noise Impacts

Sonic boom modeling of the planned trajectories predicts a maximum sonic boom up to 5.0 psf infrequently impacting the NCI. Noise and visual disturbance can cause variable disturbance levels to pinnipeds that may be hauled out within the areas of exposure, depending on the species exposed and the level of the sonic boom. Typical reactions range from no response to raising a head and moving from a resting position to flushing to water. Behavioral reactions to noise can be dependent on relevance and association to other stimuli, with competing stimuli tending to suppress behavioral reactions. Appendix B contains a more detailed Guadalupe fur seals behavioral reaction discussion. In general, Guadalupe fur seals are relatively insensitive to disturbance, occur in low numbers at SMI in isolated locations, and are adept at jumping into the water if they do flee from a disturbance (Harris 2015).

Conclusion

We do not expect Proposed Action noise to cause more than Guadalupe fur seals temporary startle-responses. Therefore, the USSF determined that the Proposed Action may affect, but is not likely to adversely affect the Guadalupe fur seal. The USSF completed Section 7 consultation with the NMFS for potential impacts on Guadalupe fur seals on 20 January 2023 (Appendix B) and would implement all applicable minimization, monitoring, and avoidance measures in the BO and the EPMs included in Table 2.2-8. Potential effects to Guadalupe fur seals would therefore be less than significant.

4.4.1.6 Southern Sea Otter

Noise and Visual Disturbance

Areas present directly offshore of SLC-4 would receive visual disturbance and noise levels of less than 130 dB L_{max} during a Falcon 9 launch, approximately 110 dB L_{max} during a first stage landing at SLC-4W (Figure 4.4-1). During static fire events, noise directly off the coast of SLC-4 would be less than 125 dB L_{max} (Figure 4.4-1) and there would be no associated visual disturbance. Landing at SLC-4W would also generate a sonic boom directly offshore that would range from 1.0 to 5.0 psf (Figure 4.4-2). Noise levels would reach between 100 and 110 dB L_{max} during a Falcon 9 launch and less than 80 dB L_{max} during first stage landing at SLC-4W in these areas (Figure 4.4-1). Sonic booms during SLC-4W landing would range from 1.0 to 3.0 psf along Sudden Flats (Figure 4.4-2).

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

Appendix A contains information regarding past launch and landing monitoring, most recently for the 7 October 2018 SpaceX Falcon 9 SAOCOM launch and landing. No sea otter abnormal behavior, mortality, or injury effects was documented from launch-related noise and visual disturbance, and pups and adults count totals were similar before and after the 2018 launch, with no discernable impact on otters on south VSFB.

As noted in Appendix A, most of the sonic boom energy is less than 250 hertz (Hz), well below the region of best sensitivity of the sea otter (2–22.6 kilohertz). While the sea otter would likely hear the sonic boom, it would only be responding to acoustic energy that is above 250 Hz and total sound levels much less than 135 dB. As the sonic boom increases in pressure, it is likely that the sea otter would detected more energy, most notably in frequencies higher than 250 Hz. Appendix A presents a sonic boom spectrum and sea otter hearing sensitivity curve, along with an audiogram used to derive an auditory weighting function. The otter weighting function was applied to a timewave form recording of the June 2022 Falcon 9 SARah-1 launch and resulted in a peak level of approximately 70 dB L_{max} (see Appendix A), which by comparison to human hearing sensitivity is equivalent to the sound level of a household washing machine.

Otters have also been shown to quickly acclimate to disturbances from boats, people, and harassment devices (air horns). A summary of studies related to sea otters and disturbance can is in Appendix A. Extensive launch monitoring of sea otters on VSFB has shown that rocket disturbance is not a primary driver of sea otter behavior or using the habitat along Sudden Flats and has not had any apparent long term consequences on populations, potentially indicating that this population has acclimated to launch activities. Therefore, we expect any noise or visual disturbance impacts to be limited to minor behavioral disruption and insignificant.

Conclusion

Because there is very little overlap in the hearing sensitivity of otters and noise produced during rocket launches, otters would perceive very little noise during launch activities and the USSF has determined that impacts on southern sea otter would be insignificant as a result of the Proposed Action, including the collective effects of increased launch activities at VSFB. Therefore, the USSF determined that the Proposed Action may affect, but is not likely to adversely affect, the southern sea otter off VSFB's coast. The USSF completed Section 7 consultation with the USFWS for potential impacts on southern sea otter and would implement all applicable minimization, monitoring, and avoidance measures in the BO (Appendix A) and the EPMs included in Table 2.2-8. Potential effects to southern sea otter would therefore be less than significant.

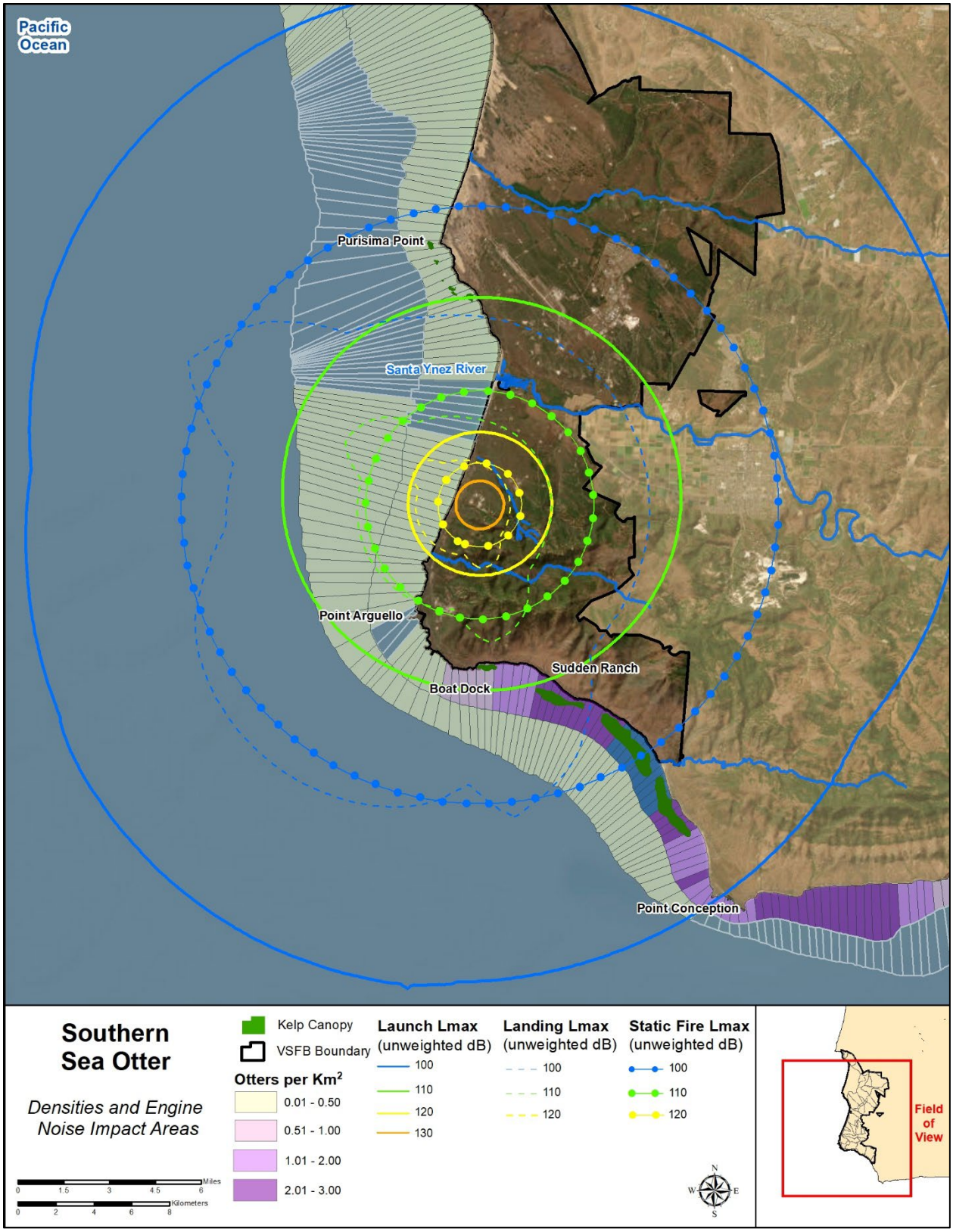

Figure 4.4-1. 2019 Southern Sea Otter Densities and Launch and Landing Noise Impact Areas (USGS 2020)

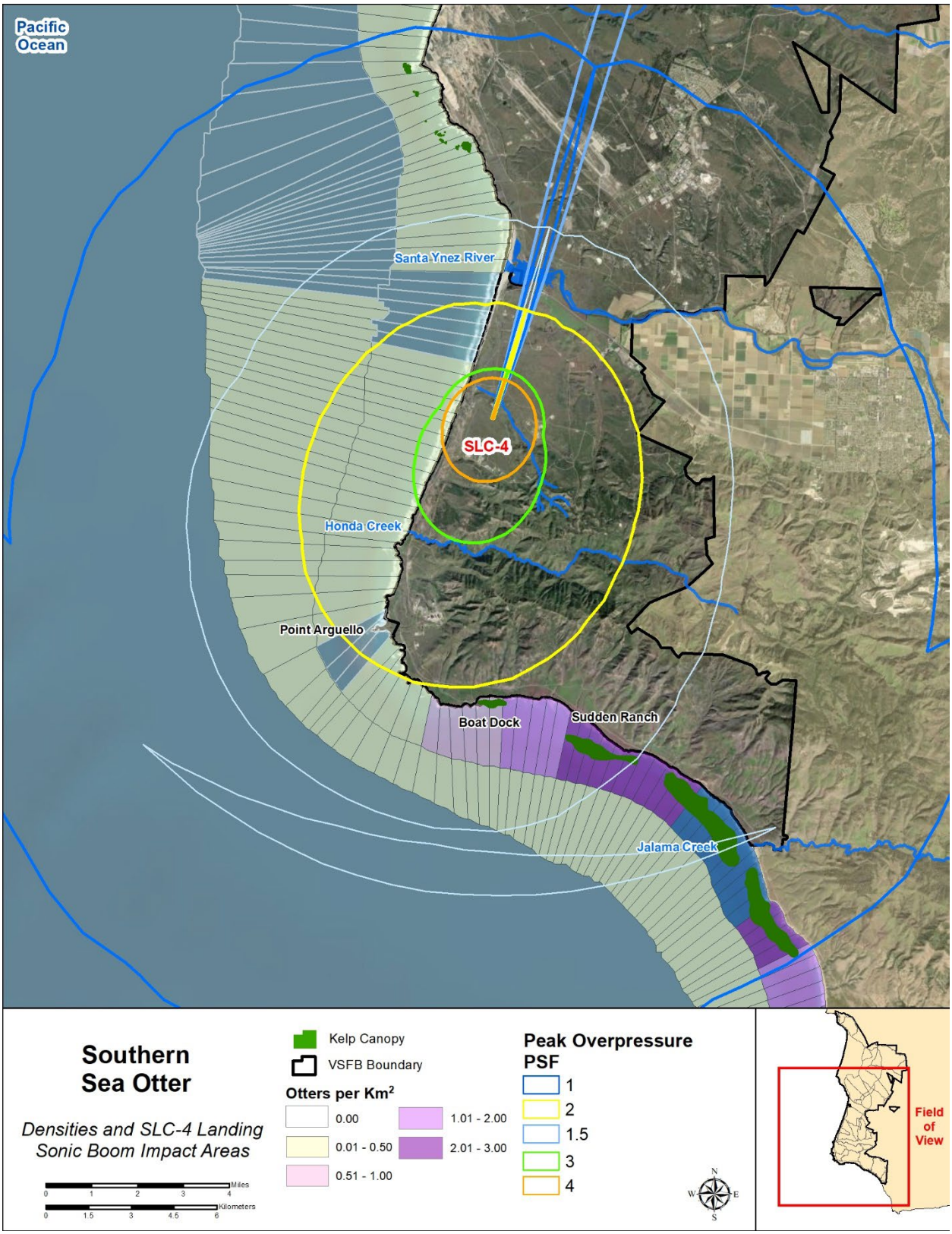

Figure 4.4-2. 2019 Southern Sea Otter Densities and Sample Sonic Boom Model Results for SLC 4W Landing Events (USGS 2020)

4.4.1.7 Marine Reserves

Under the Proposed Action, northern trajectories would not result in any impacts to marine reserves. The CINMS prohibitions do not apply to military activities carried out by the DOD, according to Section 3.5.9 of the CINMS Final EIS, entitled "Department of Defense Activities" ("preexisting activities") as indicated in Section 922.72(b)(1). Section 3.5.9.1 of the CINMS Final EIS describes spacelift operations originating from VSFB and potential sonic booms from these activities as "pre-existing activities" (NMFS 2007). In addition, impacts to the CINMS would be temporary. Therefore, the Proposed Action would not result in significant impacts on the CINMS.

The CDFW and the USSF established a mutual Memorandum of Understanding for the VSMR. Within the VSMR, no take of living marine resources is permitted except take incidental to the mission critical activities of VSFB. Those activities include ones that are important for supporting and defending U.S. launch, range, expeditionary, exercise, test, training, and installation operations, including, but not limited to, space-launch vehicles. Impacts on marine resources within the VSMR would be temporary and limited to sonic boom and landing noise. Therefore, the Proposed Action would not result in significant impacts on VSMR.

4.4.2 No Action Alternative

Under the No Action Alternative, Falcon 9 cadence at VSFB would not increase and there would be no additional impacts on marine biological resources beyond those described in the previous EAs and SEAs (USAF 2011, 2016a, 2016b, and 2018). Therefore, the No Action Alternative would not significantly impact marine biological resources.

4.5 Water Resources

4.5.1 Alternative 1 (Proposed Action)

4.5.1.1 Surface Water

Activities during launch operations would include using hazardous materials and generating wastewater that if not properly controlled and managed could result in an adverse impact to water resources. BMPs would continue to be implemented to properly manage materials, and to reduce or eliminate project-associated runoff, which reduces the potential for adverse effects. Wastewater discharges would continue to follow the conditions of the RWQCB letter for Enrollment in the General Waiver of Waste Discharge Requirements for SLC-4E Process Water Discharges to eliminate potential adverse effects to water quality.

Spring Canyon

As was described in the Falcon 9 EA (USAF 2011), surface waters near SLC-4E could be affected by the exhaust cloud that would form near the launch pad at lift-off from the exhaust plume and evaporation and subsequent condensation of deluge water. The launch exhaust cloud formed from the exhaust plume and evaporation and subsequent condensation of deluge water could affect surface water drainage from the launch complexes. However, the exhaust cloud would consist largely of steam with insignificant amounts of hazardous materials from LOX and RP-1 propellants. As the volume of water expected to condense from the exhaust cloud is expected to be minimal, the exhaust cloud would generate less than significant impacts on surface water quality near SLC-4E.

Although the 2018 SEA described that the flame bucket system would discharge approximately 30,000 gallons of water, some of which reaches Spring Canyon in the form of surface flow and steam, there is no longer overland flow of water into Spring Canyon, as it is diverted by v-ditches and collected before leaving the SLC-4 fenceline. Only a *de minimis* amount of water reaches Spring Canyon in the form of steam and water droplets. The Proposed Action would increase the number of events per year to 36; however, it would not result in exceeding any federal, State, or local regulatory agencies water quality standards. In addition, SpaceX would monitor for potential erosion after launches and continue to implement the EPMs described in Section 2.2.7.4 (Water Resources) as necessary to ensure that surface waters in Spring Canyon are not negatively impacted.

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

San Antonio Creek

At 36 launches, 36 static fire tests, and 12 SLC-4W landings per year, the annual water usage in the flame duct would be up to 9.2 ac-ft. In addition, a maximum of 3.92 ac-ft per year would be required to support SLC-4 personnel and operational activities. Therefore, at maximum cadence, the Proposed Action would use up to 19.5 ac-ft of water per year. The current water source for VSFB, including SLC-4, is the San Antonio Creek Basin via four water wells. There is an existing connection between State water and the VSFB water supply system; however, due to ongoing drought conditions and significant reductions in State water allocations, VSFB would remain on well water from the San Antonio Creek Basin for the foreseeable future.

SpaceX's proposed water use of up to 19.5 ac-ft per year would represent approximately 0.7 percent of the total annual water usage on VSFB. The Proposed Action's water usage would therefore be negligible and not result in any measurable impacts to flow rates, hydration periods, or water levels in San Antonio Creek and not contribute in any measurable way to the collective effects of water extraction requirements for all VSFB operations. Therefore, impacts to surface water in San Antonio Creeks under the Proposed Action would not be significant.

Broad Ocean Area

The first stage boosters and payload fairings would separate and be recovered in the proposed landing area. SpaceX has achieved a very high first stage recovery success rate, such that failed landings are considered anomalies. In addition, first stages and fairings are composed of inert materials that would not affect water quality.

For an anomalous first stage explosion, a de minimis amount of propellent would remain in the first stage upon impact (less than 1 percent). RP-1 and Jet-A are classified as 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, Type 1 oil evaporates quickly when exposed to the air, and would completely dissipate within one to two days 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 (USFWS 1998). Since Type 1 oil is lighter than water and almost completely immiscible (i.e., very little will dissolve into the

water column), it 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 rapid spreading of Type 1 oil would reduce its concentration on the water surface and expose more fuel surface area to the atmosphere, thus increasing evaporation rate. Although it would require one to two days for the propellant to completely dissipate, over 90 percent of its mass would evaporate within the first seven minutes and 99 percent of its mass would evaporate within the first hour (Fingas 2013). For adverse ocean conditions (e.g., large swells, large waves) and/or weather conditions (e.g., fog, rain, high winds), the propellant would be volatilized more rapidly due to increased agitation and dissipate more quickly than under calm condition. This further reduces the likelihood of exposure. Given the relatively small volume of propellant that would be expended (between 270 and 1,100 lbs) and rapid evaporation, impacts to surface water in the broad ocean area under the Proposed Action would not be significant.

4.5.1.2 Ground Water

SLC-4 and Spring Canyon

Wastewater discharges that may occur during project activities, including accumulated stormwater and non-stormwater discharges, would continue to be managed IAW the RWQCB letter for Enrollment in the General Waiver of Waste Discharge Requirements for SLC-4E Process Water Discharges. After a launch, approximately 9,000 gallons of deluge water per Falcon 9 launch would remain in the existing retention basin after evaporation. Samples of the deluge water would be collected and analyzed. If the water is clean enough to discharge to grade, it would be discharged from the retention basin via the spray field as described in prior EAs and SEAs. It would then percolate into the groundwater system and flow down gradient into Spring Canyon. With adherence to federal, State, and local laws and regulations, impacts on groundwater would be less than significant.

San Antonio Creek

The 36 launches, 36 static fire tests, and 12 SLC-4W landings per year would use 9.2 ac-ft per year in the flame duct. In addition, a maximum of 3.92 ac-ft per year would be required to support SLC-4 personnel and operational activities. Therefore, at maximum cadence, the Proposed Action would use up to 19.5 ac-ft of water per year. The current water source for VSFB, including SLC-4, is the San Antonio Creek Basin via four water wells. There is an existing connection between State water and the VSFB water supply system; however, due to ongoing drought conditions and significant reductions in State water allocations, VSFB would remain on well water from the San Antonio Creek Basin for the foreseeable future.

As described in Appendix A, SpaceX's proposed use of up to 19.5 ac-ft per year would represent approximately 0.7 percent of the total annual water usage on VSFB. The Proposed Action's water usage would therefore be negligible and not result in any measurable impacts to ground water levels in the San Antonio Creek basin.

Therefore, the Proposed Action's water usage would be negligible and not contribute in any measurable way to the collective effects of water extraction requirements for all VSFB operations. Thus, impacts to groundwater in the San Antonio Creek Basin under the Proposed Action would not be significant.

4.5.1.3 Wetlands

The flame bucket system would not discharge any water to Spring Canyon via overland flow since it is diverted and captured by v-ditches before leaving the SLC-4 fenceline. The *de minimis* amount of water droplets and steam may fall into Spring Canyon during a launch, but would not contain any hazardous materials. Prior and ongoing impacts to Spring Canyon from vegetation management are being offset by USSF implementing mitigation at a 2:1 ratio in lower Spring Canyon. This mitigation includes over 2.5 ac. of the riparian restoration area at the base of Spring Canyon drainage near Coast Road beyond SLC-4 (MSRS 2017). Therefore, the Proposed Action would not significantly impact wetlands.

4.5.1.4 Floodplains

Vegetation maintenance within the 100-year floodplain of Honda Creek has the potential for short term effects on the floodplain in Spring Canyon, including increased erosion and sedimentation and alteration of flow patterns. However, the vegetation in this area is only mowed to a height of approximately three to five inches, ensuring that adequate ground cover remains to minimize or prevent any loss of surface soils to erosion. Additionally, the vegetation management area has been mowed annually since 2018 without any signs of impacts to scour or flow patterns in the area. Following EPMs, described in Section 2.2.7.4 (Water Resources), Spring Canyon would continue to be routinely monitored for erosion and BMPs would be deployed as needed to prevent and reduce any erosion that is observed. SpaceX would also continue to ensure that there is no overland flow reaching Spring Canyon as a result of water ejected from the flame bucket during launches. These measures would further reduce the potential for erosion that could affect floodplains.

Alternatives to vegetation maintenance in Spring Canyon were considered, including installing diversion systems to block overland water flow, as described in the 2018 SEA. This diversion system was installed and is successful at blocking overland flow of water into Spring Canyon by diverting and capturing it in a series of v-ditches. However, water vapor still reaches the canyon during launches and there was no reasonable alternative that would prevent impacts to MBTA bird species in the impacted area. The only practicable alternative was to remove nesting habitat and manage the vegetation at a low stature annually, which began in 2018. Therefore, the Proposed Action is consistent with EO 11988 because it seeks to meet MTBA requirements, while also ensuring that adverse effects to the floodplains are minimized. Because the Proposed Action only includes minimal vegetation maintenance and maintains vegetation at a low stature, rather than denuding the area, there would not be notable adverse impacts to floodplains. Static fire engine tests and SLC-4W landings would not impact floodplains. Therefore, the Proposed Action is not likely to result in significant impacts to floodplains.

4.5.1.5 Conclusion

The Proposed Action would continue to implement best management practices and EPMs described in Section 2.2.7.4 (Water Resources) that would protect surface and ground water from exceeding any federal, State, or local regulatory agencies water quality standards. Wastewater discharges would continue to follow conditions of the RWQCB letter for Enrollment in the General Waiver of Waste Discharge Requirements for SLC-4E Process Water Discharges that would protect ground water quality. In addition, the Proposed Action would continue to implement mitigation in lower Spring Canyon. Therefore, the Proposed Action would not significantly impact water resources.

4.5.2 NO ACTION ALTERNATIVE

Under the No Action Alternative, Falcon 9 cadence at VSFB would not increase and there would be no additional impacts on water resources beyond those described in the previous EAs and SEAs (USAF 2011, 2016a, 2016b, and 2018). The No Action Alternative would not result in any direct or indirect impacts on water quality that were not previously analyzed in these documents. Therefore, the No Action Alternative would not significantly impact water resources.

4.6 CULTURAL RESOURCES

The Proposed Action is subject to NHPA, Section 106, compliance and Air Force Manual (AFMAN) 32-7003, *Environmental Conservation*. Section 106 compliance is subsumed under NEPA's penumbra responsibilities. The NHPA, Section 106, requires federal agencies to consider the effects of proposed federal undertakings on historic properties that are listed in or eligible for listing in the NRHP and afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment. If a cultural resource is listed in, or eligible for, the NRHP it is considered a "historic property" for purposes of Section 106 and is significant. Compliance with Section 106 requires the federal agency to determine that the undertaking would have no effect, no adverse effect, or an adverse effect to historic properties (that is, to significant cultural resources). The Section 106 implementing regulations (36 CFR Part 800) prescribe the process for making these determinations. The FAA has not established a significance threshold for cultural resources.

4.6.1 ALTERNATIVE 1 (PROPOSED ACTION)

Since no ground-disturbing or landscape-altering actions are proposed, the ADI (Area of Potential Effects for the NHPA) for the Proposed Action is limited to auditory effects predicated on vibratory impacts. Based on standard thresholds for potential effects resulting from launch noise and sonic booms, the ADI was delineated as those areas where noise vibration levels exceed 120 dB and the sonic boom arc exceeds 2.0 psf as a result of the Proposed Action. The 120 dB launch noise contour would not be experienced outside of VSFB. All but one building located on VSFB are associated with launch complexes and supporting infrastructure and are built to withstand concussive forces. The only historic building located on VSFB that is not associated with launch complexes or supporting infrastructure is the former USCG Lifeboat Rescue Station (P-42-040495). The Colonial Revival architectural style, wood-frame structure was built in 1936 as administrative barracks and ancillary structures. The structures have been subjected to many years of medium and heavy launches and boost-back landings at SLC-4 as well as launches conducted at nearby SLC-6 with no reported and observed effect. Accordingly there would be no effect to any NRHP eligible resources in the built environment at VSFB from launch noise exceeding 120 dB.

Built environment and archaeological resources located within the ADI could be subject to sonic booms of up to 4.0 and 5.0 psf. Specifically, the sonic boom impact area encompasses all of SCI, SRI, and SMI and may reach an overpressure of as much as 5.0 psf over a very narrow portion of land on the NCI; however, a large portion of the NCI will be exposed to an overpressure no more than 2.0 to 3.0 psf. Sonic booms are dependent on launch trajectory, inclination, and atmospheric conditions. The Proposed Action is not expected to result in a repeated alignment of the sonic boom overpressure footprint within specific areas of the APE and the duration of the overpressure effects are estimated to last less than one second per sonic boom (personal communication with SpaceX staff 2023). NASA reports that rare minor damage may occur with overpressures between 2.0 and 5.0 psf and that testing has shown structures in good condition

undamaged by overpressures up to 11.0 psf (NASA 2017). Furthermore, sonic booms have been occurring in these areas for decades due to launches from VSFB and have resulted in no reports of effects to NRHP eligible built environment resources anywhere within the ADI.

As mentioned previously, experimental analysis conducted by the 30 CES/CEIEA at VSFB involving placement and observation of a 12-inch-tall, 45-degree slope sand cone and a 12x12x12-inch midden chunk on a concrete pad located 3,180 ft to the southwest of the SLC-4W pad was conducted to determine if noise vibration resulting from two December SpaceX launches/boost-back landings would result in any visual change to the materials. No visual impacts were observed in either the midden chunk or sand cone after the launch/boost-back except a few fine grains of sand shifting down the cone, likely resulting from the samples drying in the wind. Importantly, there was no cracking or crumbling observed on the midden chunk or sand cones from launch vibrations/sonic boom overpressures (Smallwood personal communication 2023). As a result, the VSFB cultural resources staff have established that archaeological sites consisting of only surface artifacts and/or buried archaeological material do not have the potential to be affected by rocket engine noise. Additionally, a condition assessment program has occurred continuously on VSFB, assessing impacts to NRHP eligible archaeological resources located above ground as well as an exposed midden deposit. The program has found no evidence of effects to the rock art surfaces or the midden deposit from heavy- and medium-payload rocket launches and boost-back landings at SLC-4 as well as launches conducted at nearby SLC-6. Furthermore, both archaeological and built environment resources within the entire ADI have been subjected to many years of rocket noise exceeding 120 dB and sonic booms exceeding 2.0 psf with no reported and observed effect.

A reasonable and good-faith effort to identify historic properties within the APE pursuant to 36 CFR Part 800.4(a)-(d) and 36 CFR Part 800.5(a)-(d) was conducted. A desktop analysis of archaeological sites and historic-age buildings in the launch noise/sonic boom study area, and identifying all NRHP eligible cultural resources in the APE was conducted and historic properties were assessed for their potential to be adversely affected by the Proposed Action. Based on thresholds established by previous studies and the results of previous experiments and observational assessments (Gibbs 2017; Guest and Sloane 1972; Haber et al. 1989; NASA 2017; Nocerino et al. 2021; and Smallwood personal communication 2023) the identified historic properties located within the ADI are highly unlikely to have the potential to be affected by the Proposed Action and the undertaking will have no effect on any known historic properties.

The Proposed Action would comply with all relevant authorities governing cultural resources, including Section 106 of the NHPA and AFMAN 32-7003. To comply with Section 106 of the NHPA and 36 CFR Part 800, SLD 30 will consult with the California SHPO. SLD 30 has notified the SYBCI of the Proposed Action and requested tribal comments on the Proposed Action to initiate government-to-government consultation. The California SHPO and SYBCI responses will be included in Appendix C of the Final Draft SEA.

4.6.2 NO ACTION ALTERNATIVE

Under the No Action Alternative, Falcon 9 cadence at VSFB would not increase and there would be no additional impacts on cultural resources beyond those described in the previous EAs and SEAs (USAF 2011, 2016a, 2016b, and 2018). Therefore, the No Action Alternative would not significantly impact cultural resources.

4.7 COASTAL ZONE MANAGEMENT

4.7.1 ALTERNATIVE 1 (PROPOSED ACTION)

Alternative 1 would increase the number of Falcon 9 launches to up to 36 per year. For the purposes of public safety, coastal access would be restricted at Surf Beach, Wall Beach, and Ocean Beach County Park up to 12 times per year for up to 5 to 8 hours per event during SLC-4W landing events that occur during hours and times of year when these are normally open. Launch and boostback actions were previously documented in ND-0027-15. The USSF determined that the Proposed Action would not adversely affect coastal uses or resources because measures will be taken to prevent and minimize impacts. However, due to the potential impacts from restrictions to public access of parks discussed above and increased potential for marine debris, the USSF will request CCC concurrence on a ND for the Proposed Action. The DAF has received concurrence from the CCC to close Jalama Beach County Park a maximum of 12 times per year. Launches from SLC-4E due to the Proposed Action would not cause an exceedance of this limit. For missions that have the potential to close Jalama Beach County Park, SpaceX would coordinate with SLD 30 to reduce the potential for park closures over a scrubbed launch. Under the Proposed Action, Ocean Beach County Park and Surf Beach would not exceed 12 closures as previously described in the 2018 SEA.

Potential impacts on special status species include indirect impacts resulting from water use, disruption of breeding, foraging, or roosting behaviors, and abandonment of habitat including breeding or roosting sites, due to project related noise (Sections 4.3 and 4.4). The USSF has worked with the USFWS and NMFS to develop the EPMs described in Section 2.2.7 that are included as part of the Proposed Action to reduce impacts on biological resources. The impacts to special status marine species associated with launch activities is permitted under an independent NMFS Section 7 consultation and the current LOA (Appendix B).

No construction would occur under the Proposed Action; therefore, no wetlands or surface waters would be filled. Water-usage from the San Antonio Creek Basin would increase to 19.5 ac-ft of water per year, representing approximately 0.7 percent of the total annual water usage at VSFB. Wastewater discharges that may occur during project activities, including accumulated stormwater and non-stormwater discharges, would continue to be managed IAW the RWQCB letter for Enrollment in the General Waiver of Waste Discharge Requirements for SLC-4E Process Water Discharges. After a launch, approximately 9,000 gallons of deluge water per Falcon 9 launch would remain in the existing retention basin after evaporation. Samples of the deluge water would be collected and analyzed. If the water is clean enough to discharge to grade, it would be discharged from the retention basin via the spray field. It would then percolate into the groundwater system and flow down gradient into Spring Canyon. Additionally, EPMs (Section 2.2.7) would be implemented to further reduce and avoid impacts to water resources.

It is SpaceX's goal to re-enter and land all first stage boosters for reuse. However, due to mission requirements, on rare occasions some boosters may be unable to complete a boost-back burn and landing and would be expended in the broad open ocean. We expect these boosters to break up upon atmospheric reentry. Any surviving debris would sink, like the fate of traditional non-reusable first stage boosters. However, these boosters would not have the potential to affect coastal water resources because they are made of inert materials that would not impact water quality, and they would be expended well outside of the coastal zone. When a first stage booster is intentionally expended, we

expect the first stage to break up upon atmospheric reentry, and any residual fuel to disperse and evaporate such that there is none left when the vehicle debris hits the ocean.

SpaceX attempts to recover potential debris where and when practicable. SpaceX successfully completed all landing attempts in 2022, all attempted fairing recoveries (110 fairing halves), and recovered approximately 50 percent of parafoils. However, due to weather conditions, sea state, or other factors, a recovery attempt may be unsuccessful. Parachutes, parafoils, and their assemblies are made of Kevlar and nylon, and sink quickly as they become waterlogged. Weather balloons are made of latex and would split into pieces and quickly sink, along with the plastic radiosonde. The fairings, parachutes/parafoils and their assemblies, and weather balloon with radiosonde are all inert.

SpaceX's recovery efforts have reduced marine debris by approximately 74,804 lbs per launch. For 2022 missions originating from VSFB, SpaceX achieved a 54 percent recovery rate for parafoils and recovered three drogue parachutes. Continuing to recovery the vast majority of the first stages and fairings offsets the rare occurrence that an ocean landing would occur. Based on the assumption that the weather balloon, radiosonde, drogue parachutes, parafoil, and MVac skirt ring are not recovered, approximately 177 lbs of debris would be expended during each launch event. To offset impacts from marine debris, SpaceX proposes to participate in the SLD 30 Adopt-A-Beach Program and conduct quarterly beach cleanups at Surf Beach. SpaceX also proposes to make an annual contribution to the California Lost Fishing Gear Recovery Project to offset the impacts from unrecoverable debris (weather balloon/radiosonde, drogue parachute, parafoil, and skirt ring). Through complete and effective cleanup of recoverable debris and the offset of unrecoverable debris through removal of other marine debris, the Proposed Action would not adversely impact coastal uses or resources.

The USSF has determined, based on measures within the project design to prevent and minimize impacts, the Proposed Action would not adversely affect the coastal zone and does not require a consistency determination. Therefore, the USSF will request CCC concurrence on a ND for the Proposed Action.

4.7.2 No Action Alternative

Under the No Action Alternative, Falcon 9 cadence at VSFB would not increase and there would be no additional use of or impacts on the coastal zone beyond those described in the previous EAs and SEAs (USAF 2011, 2016a, 2016b, and 2018). The EA and SEA analyses, and related consultations, determined these activities would not significantly impact coastal resources.

4.8 Department of Transportation Section 4(f) Properties

Impacts on Section 4(f) properties would be significant if the FAA's Proposed Action involves more than a minimal physical *use* of a Section 4(f) resource or constitutes a *constructive use* based on an FAA determination that the project would substantially impair the Section 4(f) resource. The concept of *constructive use* is that a project that does not physically use land in a park, for example, may still, by means of noise, air pollution, water pollution, or other impacts, dissipate its aesthetic value, harm its wildlife, restrict its access, and take it in every practical sense. *Constructive use* occurs when the impacts of a project on a Section 4(f) property are so severe that the activities, features, or attributes that qualify the property for protection under Section 4(f) are substantially impaired. Substantial impairment occurs only when the protected activities, features, or attributes of the Section 4(f) property that contribute to its significance or enjoyment are substantially diminished. This means that the value of the Section 4(f) property, in terms of its prior significance and enjoyment, is substantially reduced or lost. For example,

noise would need to be at levels high enough to have negative consequences of a substantial nature that amount to a taking of a park or portion of a park for transportation purposes.

4.8.1 ALTERNATIVE 1 (PROPOSED ACTION)

Alternative 1 does not include any construction activities within, or actual physical taking of, a Section 4(f) property through the purchase of land or a permanent easement, physical occupation of a portion or all of Section 4(f) property, or alteration of structures or facilities on Section 4(f) property, nor would any new Section 4(f) properties be potentially impacted other than those analyzed in prior EAs and SEAs.

Impacts on Wall Beach, Surf Beach, County of Santa Barbara Ocean Beach County Park, and Jalama Beach County Park would result from their closure to the public during launch/landing events. For the safety of park visitors, the County Parks Department and the County Sheriff currently close the parks upon request from VSFB and under agreement between DAF and Santa Barbara County. The DAF has received concurrence from the CCC to close Jalama Beach County Park a maximum of 12 times per year. The Proposed Action would not increase the annual number of closures of Jalama Beach County Park. For first stage landing events at SLC-4W, access to Ocean Beach County Park and Surf Beach would be restricted. The Proposed Action would only restrict public access to the coastline from Ocean Beach County Park up to 12 times per year during daytime SLC-4W landing events. Given the formal evacuation agreement in place and the temporary nature of the closures, and that the Proposed Action would not result in increasing the annual number of closures of Jalama Beach County Park, implementation of Alternative 1 would not substantially diminish the protected activities, features, or attributes of any Section 4(f) properties and therefore would not result in substantial impairment of the properties.

All potential Section 4(f) properties in the ROI would experience sound levels less than 120 dB L_{max} during launch, SLC-4W landing, and static fire events (Figure 4.8-1). Miguelito Park and Jalama Beach County Park would experience sound levels less than 110 dB L_{max} during a launch, SLC-4W landing, and static fire events. SLC-4 landings could potentially create a sonic boom up to 5.0 psf (MSRS 2023; Appendix E); however, the dominant over ocean peak overpressure would be in the 1.0 to 1.5 psf range (Figure 4.8-2). Peak overpressures in the Channel Islands National Park could reach up to 5.0 psf (Figure 4.8-3). Although the launch trajectory could overfly the Channel Islands National Park, impacts would not be so severe that the activities, features, or attributes that qualify the Channel Island National Park for protection under Section 4(f) are substantially impaired. The proposed northern mission profile (Figure 2.2 1) would not result in noise impacts to land as there would be no audible sonic boom on launch; thus, associated trajectories would not result in new impacts to Section 4(f) properties.

Given the history of beach and park closures for VSFB launches, the formal evacuation agreement in place, and the temporary nature of the closures, the FAA made the preliminary determination that the Proposed Action would not substantially diminish the protected activities, features, or attributes of any of the potential Section 4(f) properties. Therefore, the Proposed Action would not result in a *constructive use* of any Section 4(f) property. Thus, the FAA's Proposed Action of issuing SpaceX a license would not result in significant impacts. The FAA will make a final determination based on any public input received during the Draft SEA comment period and include the final determination in the Final SEA.

4.8.2 NO ACTION ALTERNATIVE

Under the No Action Alternative, Falcon 9 cadence at VSFB would not increase and there would be no additional use of or impacts on Section 4(f) properties beyond those described in the previous EAs and

SEAs (USAF 2011, 2016a, 2016b, and 2018). Closures of Wall Beach, Surf Beach, County of Santa Barbara Ocean Beach County Park, and Jalama Beach County Park would continue to potentially occur up to 12 times per year. As no additional impacts would be associated with the No Action Alternative, there would be no impacts on Section 4(f) properties.

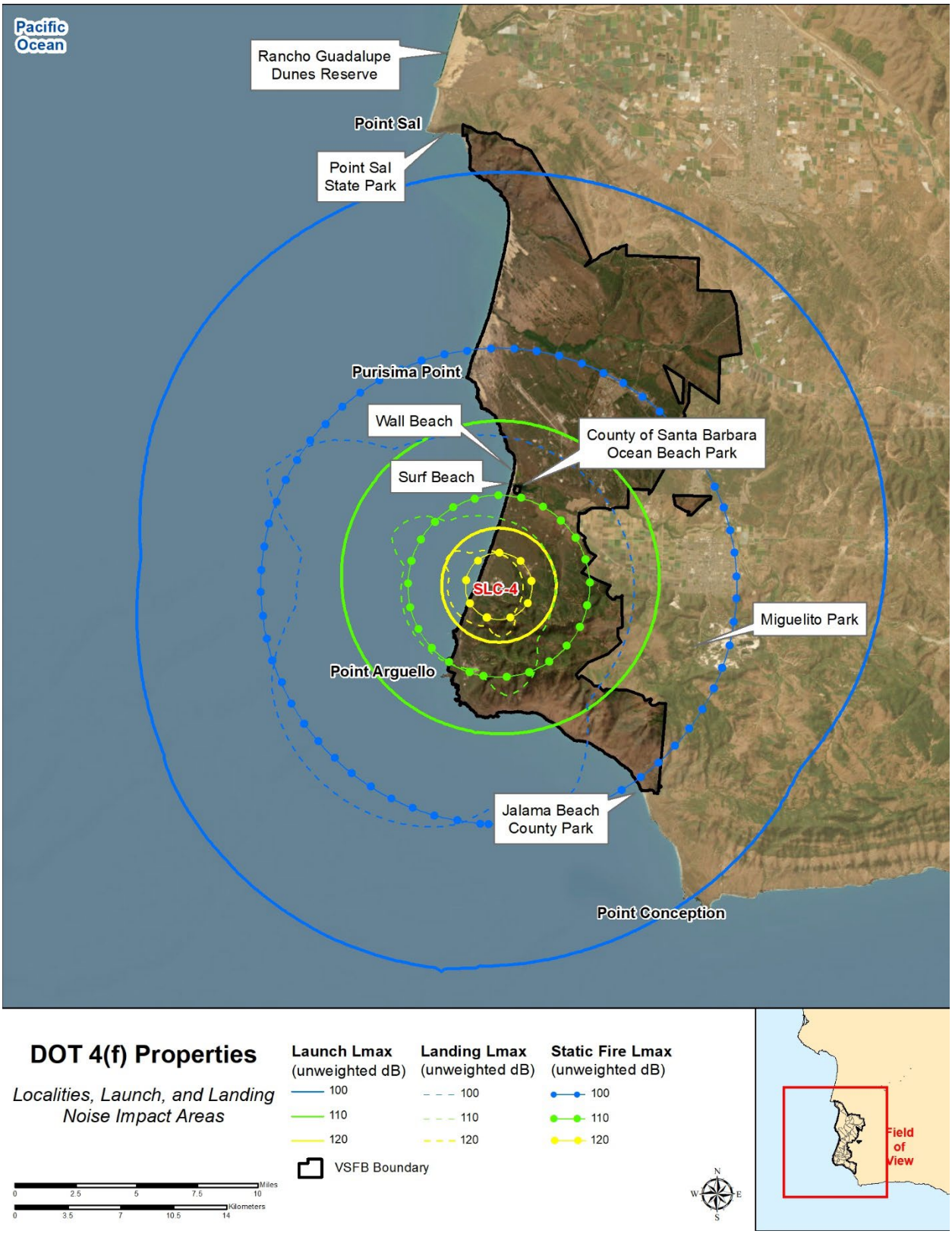

Figure 4.8-1. Potential Department of Transportation Act Section 4(f) Properties and Launch and Landing Sound Pressure Levels

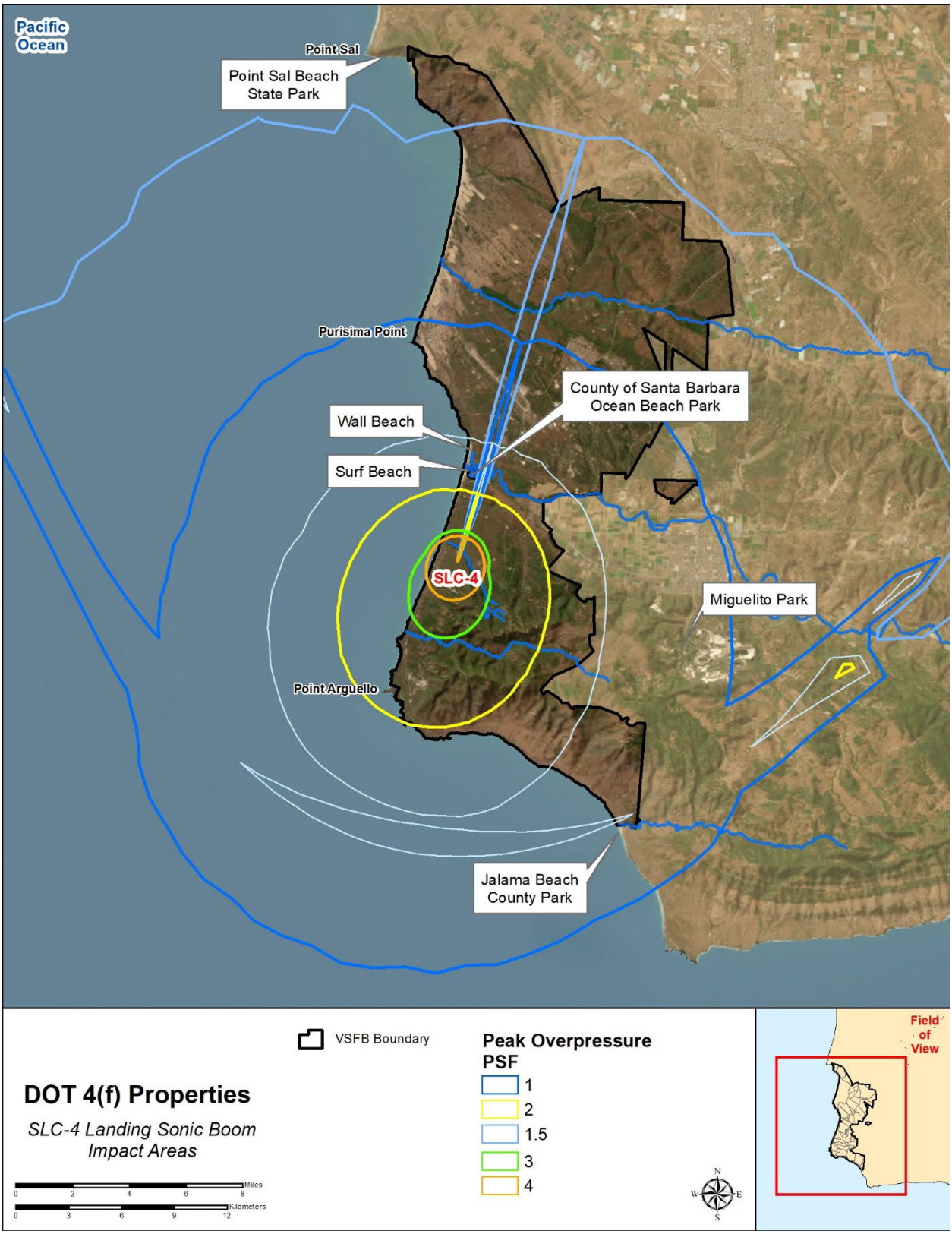

Figure 4.8-2. Potential Department of Transportation Act Section 4(f) Properties and Typical Sonic Boom Levels for SLC-4W Landing

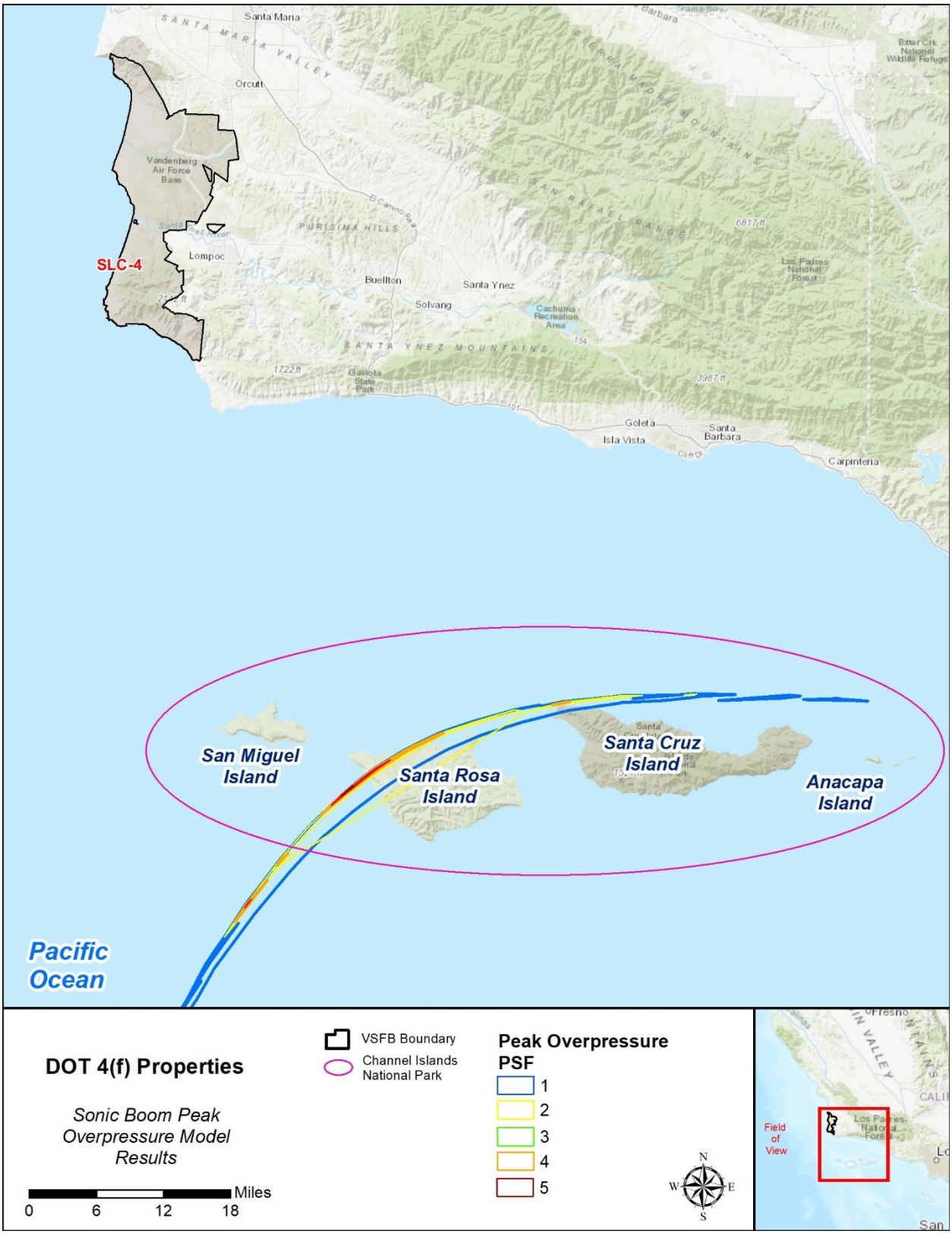

Figure 4.8-3. Potential Department of Transportation Act Section 4(f) Properties at the NCI and Sonic Boom

4.9 UTILITIES

Impacts associated with utilities are related to changes in the supply (also referred to as capacity) or demand of a particular resource. 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.

4.9.1 ALTERNATIVE 1 (PROPOSED ACTION)

The Proposed Action would have similar impacts on utilities as those analyzed in prior EAs and SEAs. There is no new proposed installation of utilities or use of utilities that would exceed those available on VSFB. Existing lines would provide communication and electricity to SpaceX facilities. The Proposed Action would add approximately 100 personnel which would increase demand for electricity, water, and the septic system. The current utilities are able to support this increase and no capacity issues would result due to the Proposed Action. For inadequate power supply, SpaceX would rely on existing portable backup generators for electricity for SLC-4 and Building 398.

At 36 launches, 36 static fire tests, and 12 SLC-4W landings per year, the annual water usage in the flame duct would be up to 9.2 ac-ft. In addition, a maximum of 3.92 ac-ft per year would be required to support the personnel and operational activities at SLC-4. Therefore, at maximum cadence, the Proposed Action would use up to 19.5 ac-ft of water per year. Annual VSFB water use over the past three years (2019 through 2021) has averaged 2,794 ac-ft per year with an infrastructure pumping capacity of approximately 2,700 gallons per minute or 4,355 ac-ft per year. SpaceX's proposed use of up to 19.5 ac-ft per year would represent approximately 0.7 percent of the total annual water usage on VSFB and is well within the capacity of existing water utilities. The Proposed Action's water usage would therefore be negligible and not contribute in any measurable way to the collective effects of water extraction requirements for all VSFB operations.

The existing septic sewer system has sufficient capacity to support the increase in domestic wastewater associated with the Proposed Action. There would be no need to upgrade current sewer systems as a result of implementation of the Proposed Action. Therefore, impacts on the domestic wastewater system would be negligible.

4.9.2 NO ACTION ALTERNATIVE

Under the No Action Alternative, Falcon 9 cadence at VSFB would not increase and there would be no additional use of or impacts on utilities beyond those described in the previous EAs and SEAs (USAF 2011, 2016a, 2016b, and 2018). As no additional impacts would be associated with the No Action Alternative, there would be no impacts on communications, electricity, domestic water supply, or domestic wastewater.

4.10 SOCIOECONOMICS

Socioeconomic impacts would be considered significant if they substantially altered the location and distribution of the local population, caused the population to exceed historic growth rates, decreased jobs so as to substantially raise the regional unemployment rates or reduced income generation. They would also be considered significant if they substantially affected the local housing markets and vacancy rates,

or resulted in the need for new social services and support facilities. The FAA has not established a significance threshold for socioeconomics.

4.10.1 Alternative 1 (Proposed Action)

SpaceX plans to add 100 permanent staff to support the launch cadence increase at VSFB under the Proposed Action. This minor increase in permanent personnel is a small fraction of the civilian workforce of VSFB and Santa Barbara County and would not be expected to alter the existing levels of service for housing and social services on VSFB and the surrounding communities. While the Proposed Action would not significantly affect the demand for local housing and the need for social services and support facilities, the addition of added economic activity would result in a small but positive impact to the local economy. Additionally, the indirect effects of material purchases and sub-contract labor force growth would also be a positive impact.

Potential socioeconomic impacts from re-routing aircraft due to commercial space operations would be similar to re-rerouting aircraft for other reasons (e.g., weather, runway closures, wildfires, military exercises, etc.). These include additional airline operating costs for increased flight distances and times resulting from re-routing aircraft and increased passenger costs as a result of impacted passenger travel, including time lost from delayed flights, flight cancellations, and missed connections. Alternatively, restricting or preventing a launch event would have socioeconomic impacts on SpaceX, commercial payload providers, and consumers of payload services. Operations would not result in closing any public airport or so severely restrict using surrounding airspace to prevent access to an airport for extended time. Given existing airspace closures for SpaceX operations are temporary and the FAA's previous analyses related to the NAS have concluded minor or minimal impacts on the NAS from commercial space launches, the FAA does not expect airspace closures would result in significant socioeconomic impacts. Local air traffic controls would coordinate with airports and aircraft operators to minimize launch operations effects on airport traffic flows, as well as traffic flows in en-route airspace. Therefore, the Proposed Action would not generate negative socioeconomic impacts on the region and would generate a small positive impact.

4.10.2 No Action Alternative

Under the No Action Alternative, Falcon 9 cadence at VSFB would not increase and there would be no impact to the socioeconomic outlook for the affected area.

4.11 Transportation

4.11.1 Alternative 1 (Proposed Action)

Given the short duration, low traffic volumes, good level of service currently experienced on the roadways that would be affected by project activities on VSFB and nearby, and the relatively small increase in daily vehicle traffic that the Proposed Action would generate, no adverse effects to capacity would occur in the study-area roadways. Increased vehicle activity affects the integrity of roadway sections by increasing the flexures of the pavement. The design life for asphalt pavement, generally selected as either 10 or 20 years, drives engineering specifications for the road based upon the strength of the base soil and estimated number of truck trips that are expected during the design life of the pavement. If the number of truck trips is increased, the life of the pavement is shortened. While the current pavement condition on all affected roads is fair to good, added project-related vehicle traffic could cause faster-than-

estimated pavement surface deterioration and require additional maintenance. Although an adverse effect, it would not be considered significant given that the number of vehicle trips per day anticipated from the Proposed Action is not high.

Trains that would pass through a launch vehicle flight path from VSFB would be temporarily stopped at safety hold points during launches to reduce potential risk to people and property. SLD 30 2 ROPS/DON, notifies a dedicated UPRR point of contact (POC) of launch date, times, and train hold point locations, typically 10 days before launch. At approximately 3 days prior to launch, UPRR's POC provides 2 ROPS/DON a schedule of impacted trains and in collaboration discusses if the trains must hold or can continue through. At 3 hours before launch, 2 ROPS/DON establishes phone communication with the UPRR POC to provide updates to the train schedule. After a launch has been completed 2 ROPS/DON notifies the UPRR POC that trains may continue on the route. The UPRR POC is on standby during each launch for any notifications needed for a launch anomaly that may impact the railroad track system. UPRR attempts to adjust schedules to avoid train delays due to launches; however, launch windows are typically minimal (typically instantaneous or several minutes) and during longer launch delays 2 ROPS/DON communicates with the UPRR POC to allow trains to move through the affected area; thereby minimizing potential impacts to train schedules.

The SPMT would need to cross the UPRR railway at the Tow Road and Coast Road intersection. The SLD 30 easement to cross the railway (DACA-09-5-82-35) states that crossing "will not obstruct or interfere with the passage of Railroad trains." The UPRR requires a UPRR employee to contact approaching train engineers via radio to alert the engineer of the Tow Road crossing. SpaceX would coordinate with the UPRR to ensure easement proper procedures are followed for each railway crossing event.

Therefore, the Proposed Action will not create any significant impacts to transportation during under Alternative 1.

4.11.2 No Action Alternative

Under the No Action Alternative, Falcon 9 cadence at VSFB would not increase and there would be no impact to transportation resources associated with the No Action Alternative.

5 CUMULATIVE IMPACTS

Cumulative impacts are defined by CEQ as "are effects on the environment that result from the incremental effects of the action when added to the effects of other past, present, and reasonably foreseeable actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR Part 1508.1). The FAA analyzes the potential cumulative impacts IAW CEQ regulations and FAA Order 1050.1F.

The effects of the Proposed Action in combination with the effects of other relevant past, present, and reasonably foreseeable future projects are evaluated in this cumulative effects analysis. The depth of this analysis is commensurate with the potential for significant impacts and focuses only on impacts that are truly meaningful to decision-makers.

5.1 PAST ACTIONS

Past actions at VSFB and the NCI are primarily tied to commercial and military rocket launches (including first stage boost-back and landing), VSFB construction and maintenance activities, VSFB regular military and commercial use, and regional energy development projects. VSFB regular military and commercial use includes aircraft takeoffs and landings, as well as launches. Actions recently completed at or around VSFB include the following:

- Completed 22.5 megawatts solar farm on VSFB (30 SW Public Affairs 2017)
- Completed Building 7000 on VSFB with LEED Gold certified
- Military and commercial rocket launches on VSFB
- Regular aircraft takeoffs and landings at VSFB
- Honda Canyon Culvert Repair

5.2 PRESENT ACTIONS

Present actions at VSFB include military and commercial rocket launch programs and several residential developments in the adjacent City of Lompoc. Off shore and ocean-related present activities include vessels at sea. Present actions at or around VSFB include the following:

- SpaceX commercial rocket launches and landings
- Firefly commercial rocket launches
- Boeing X-37B Spaceplane landings by USSF
- Constructing Strauss Wind Energy Project in Lompoc
- Routine DOD mission activities on VSFB
- Regular aircraft takeoffs and landings at VSFB
- Maritime traffic (e.g., pleasure craft, cargo shipping, cruise ships/marine tourism)
- Commercial and recreational fishing (supported by 11 ports and supporting 39 fisheries in Southern California; fishing vessel, dealer, and commercial operator permits and fishing authorizations are issued by NMFS under Federal Fishery Regulations)

5.3 REASONABLY FORESEEABLE ACTIONS

Reasonably foreseeable future actions at VSFB include continued launches of both commercial and military launch vehicles, regular military aircraft takeoffs and landings, and construction and maintenance projects. Reasonably foreseeable future actions at or around VSFB include the following:

- Further infrastructure development for expanded space launch capabilities at VSFB
- DOD missile launches from VSFB
- Up to 110 space vehicle launches annually with DOD and commercial payloads from VSFB, including Blue Origin, Northrop Grumman, ABL Space Systems, United Launch Alliance, Phantom Space, and Relativity programs.
- Regular aircraft takeoffs and landings at VSFB

5.4 ALTERNATIVE 1 (PROPOSED ACTION)

The Proposed Action's impacts were analyzed for their potential to result in cumulative impacts when added to other past, present, and reasonably foreseeable future actions. The Proposed Action would result in less than significant impacts related to the resources analyzed in this SEA. The potential cumulative impacts on those resources are described below.

5.4.1 AIR QUALITY

Past, present, and reasonably foreseeable future actions have resulted and will result in air emissions in the ROI. Construction in and around VSFB, along with air and space operations, would result in increased emissions. All emissions would be temporary and not likely to result in exceeding air quality standards. Additionally, ecological restoration projects and renewable energy projects, including the Strauss Wind Energy Project, in and around VSFB would result in improved air quality and net-negative GHG emissions.

The Proposed Action would result in temporary air emissions. When combined with other past, present, and reasonably foreseeable future actions, the Proposed Action is not expected to result in exceedance of any air quality standards, including the NAAQS thresholds, because of the low amount of emissions and the temporary nature of the emissions. Therefore, the Proposed Action, with other past, present, or reasonably foreseeable projects, would not result in cumulative air quality impacts.

5.4.2 NOISE

Noise effects associated with launch and missile activities on VSFB are relatively short (typically no more than five minutes per event). Appropriate environmental analyses are conducted for these activities. Noise produced during the 24 additional launches under the Proposed Action would not contribute a significant cumulative impact to the noise setting within the ROI. The anticipated sonic boom events would be infrequent (no more than 36 events per year) and each event would last less than two minutes. Therefore, the Proposed Action with other past, present, or reasonably foreseeable projects would not result in cumulative noise impacts.

5.4.3 TERRESTRIAL BIOLOGICAL RESOURCES

The Proposed Action would not create any new impacts on vegetation resources within the ROI. Although the Proposed Action would potentially impact some wildlife and special status resources within the ROI, these impacts would not be significant and overall long-term consequences are unlikely. All avoidance and minimization measures would continue to be implemented as required. Therefore, the incremental contribution of the Proposed Action, when added to the impacts of all other past, present, and reasonably foreseeable future actions, would not result in cumulative impacts on terrestrial biological resources, including impacts on ESA-listed species.

5.4.4 MARINE BIOLOGICAL RESOURCES

General threats to marine mammals include water quality degradation (chemical pollution), commercial industries (fisheries bycatch, explosive pest deterrents, and other interactions), noise, hunting, vessel strike, marine debris, disease and parasites, power plant entrainment, and climate change. Potential impacts of actions that affect marine mammals include mortality, injury, disturbance, and reduced fitness, including reproductive, foraging, and predator avoidance success.

The Proposed Action would potentially impact pinnipeds hauled out within the ROI; however, overall long-term consequences for pinnipeds are unlikely given the long history of monitoring that has documented pinniped reactions to similar events. Therefore, the incremental contribution of the Proposed Action, when added to the impacts of all other past, present, and reasonably foreseeable future actions, would not result in cumulative impacts on marine biological resources, including impacts on ESA-listed species.

5.4.5 WATER RESOURCES

Cumulative impacts on water resources could occur if other projects were to inadequately address effects on water resources at project locations. However, projects on VSFB, including the Proposed Action, are required to utilize site-specific BMPs and conduct site restoration, as necessary, to minimize impacts on water quality. Any impacts tend to be localized and temporary during the project duration. Any potential adverse effects should be avoided or minimized through implementing measures described in Section 2.2.7.4, identified in environmental documents completed for other projects, in environmental documents for future projects, and/or identified and established by VSFB for Operations and Maintenance projects. Therefore, the Proposed Action would not result in cumulative impacts on water resources.

5.4.6 CULTURAL RESOURCES

General threats to cultural resources in the ROI include construction, demolition, infrastructure development, and maintenance projects. Cumulative impacts would result if project activities caused major ground disturbances in areas of high paleontological sensitivity, or that may contain intact subsurface prehistoric or historic archaeological resources, or incremental changes that collectively and over time impact the NRHP eligibility or listing status of a historic property. All projects on VSFB are evaluated for potential cultural resources impacts. Evaluation for NRHP eligibility, section 106 consultation, and Native American consultation are conducted. These processes stipulate avoidance and minimization measures to protect sensitive archaeological resources. In addition, the Proposed Action includes no construction, demolition, or new ground-disrupting activities. Therefore, the incremental contribution of the Proposed Action, when added to the impacts of all other past, present, and reasonably foreseeable future actions, would not result in cumulative impacts on cultural resources.

5.4.7 COASTAL ZONE MANAGEMENT

The Proposed Action would not adversely affect land use or CZMA and CCA policies. Past, present, and reasonably foreseeable actions would conform to DAF regulations and planning principles or comply with County and State requirements. Cumulative projects would be modified 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, implementing the Proposed Action with other past, present, or reasonably foreseeable projects would not result in cumulative impacts on the coastal zone.

5.4.8 Department of Transportation Act Section 4(f) Properties

Under the Proposed Action, the USSF would comply with the closure agreement with Santa Barbara County and would not exceed or increase the current cumulative allowable annual closures of Jalama Beach County Park 12 times per year across all present and reasonably foreseeable launch programs on VSFB.

SLD 30 Range Safety would individually review future launch programs to determine if additional closures are necessary and what areas would be affected since the hazard risk analysis is unique to each vehicle, launch location, and mission trajectory. SLD 30 is working to avoid restrictions to public access while accounting for risk to human health and safety and has determined there is no need to restrict access to Ocean Beach County Park or Surf Beach for launches with downrange first stage landing on a droneship and launches with first stages expended in the Pacific Ocean that do not fly over or pass within close proximity these locations. Ocean Beach County Park closures would not exceed 12 times per year as previously described in the 2018 SEA. Therefore, implementing the Proposed Action with other past, present, or reasonably foreseeable projects would not result in cumulative impacts on Section 4(f) properties.

5.4.9 Utilities

Current and future projects on VSFB will or may increase demands for utility resources, although utility capacities can be expanded to meet or exceed that demand. Several cumulative projects on base are in planning to improve and secure that utility expansion capacity (e.g., completion of solar farm on VSFB and infrastructure development and expansion) to help offset cumulative impacts on utility resources. Additionally, American Water Operations & Maintenance, which operates the water treatment, distribution, and wastewater collection systems at VSFB, is saving approximately 22 million drinking water gallons/year through different water conservation approaches, including a mobile in-situ treatment system that boosts disinfectant residuals, and by tailoring adjustments to their water flushing program requirements. Therefore, implementing the Proposed Action with other past, present, or reasonably foreseeable projects would not result in cumulative impacts on utilities.

5.4.10 Socioeconomics

The long-term employment for personnel supporting the Proposed Action would be considered positive and would augment other local community businesses and industries. SpaceX and VSFB are major employers and the presence of these employers can cause a chain of economic reactions throughout the local region. VSFB launch operations would not result in closing any public airport or so severely restricting using surrounding airspace to prevent access to an airport for extended time. Given existing closed airspace surrounding VSFB and the FAA's previous analyses related to the NAS have concluded minor or minimal impacts on the NAS from commercial space launches, the effects from airspace closures would result in insignificant socioeconomic impacts. As a result, the overall cumulative effect of the Proposed Action, when considered with other past, present, and reasonably foreseeable future actions on socioeconomics is considered beneficial and less than significant.

5.4.11 TRANSPORTATION

Past, present, and reasonably foreseeable projects in the ROI would contribute to increased traffic volumes in the region. However, traffic volumes in the ROI are low and the roadways have good levels of service. The Proposed Action would generate a relatively small and temporary increase in daily vehicle traffic that would not have a cumulative adverse effect on capacity. Trains that would be stopped at safety hold points for launch activities or railway crossings would only experience minor delays of short duration that are relatively infrequent. Launch windows are typically minimal (typically instantaneous or several minutes but could last a few hours) and during longer launch delays 2 ROPS/DON communicates with the UPRR POC to allow trains to move through the affected area; thereby minimizing potential impacts to train schedules. As a result, we expect no cumulative adverse effects to capacity to occur as a result of the Proposed Action.

5.5 SUMMARY AND CONCLUSION

To ensure that no significant cumulative impacts result from projects on VSFB that occur either concurrently or sequentially with Alternative 1, SLD 30 includes environmental contract specifications and protective measures, when necessary, in all projects. Preventive measures are identified and defined by resource managers and project proponents and SLD 30 take actions during the planning process to ensure adverse impacts are minimized, or avoided all together, as projects are reviewed under NEPA. Prior projects are also considered to ensure no levels of acceptable impacts are exceeded.

All projects on VSFB are designed and implemented to fully comply with applicable statutes and regulations. SLD 30 develops EPMs in coordination with appropriate regulatory agencies throughout the NEPA process. With these practices in place, the activities included under Alternative 1, with other foreseeable projects in the ROI, would not result in significant cumulative impacts.

6 LIST OF PREPARERS, AGENCIES, AND PERSONS CONSULTED

6.1 LIST OF PREPARERS

Alice Abela (ManTech SRS Technologies, Inc.), Senior Biologist
B.S., Biology, California Polytechnic State University, San Luis Obispo
Years of Experience: 22

Danny Heilprin (ManTech SRS Technologies, Inc.), Senior Marine Scientist
M.S., Marine Science, San Jose State University
B.S., Aquatic Biology, University of California, Santa Barbara
Years of Experience: 33

John LaBonte, Ph.D. (ManTech SRS Technologies, Inc.), Senior Biologist, Project Manager
Ph.D., Biology, University of California, Santa Barbara
B.S., Ecology, Behavior, and Evolution, University of California, San Diego
Years of Experience: 27

Jon Miclot (ManTech SRS Technologies, Inc.), Senior Military Operations Analyst
M.A., National Security and Strategic Studies, U.S. Naval War College
M.S., Systems Management, University of Southern California
B.S., Systems Engineering, U.S. Naval Academy
Years of Experience: 41

Karyn Palma (ManTech SRS Technologies, Inc.), Technical Editor
B.A., Environmental Studies, University of California, Santa Barbara
Years of Experience: 26

Marya Samuelson (ManTech SRS Technologies, Inc.), Environmental Scientist
M.B.A., Project Management, Capella University
B.A., Environmental Studies: Biology/Ecology, Washington University in St. Louis
Years of Experience: 10

Lawrence Wolski (ManTech SRS Technologies, Inc.), Senior Marine Scientist, Acoustic Specialist
M.S., Marine Sciences, University of San Diego
B.S., Biology, Loyola Marymount University
Years of Experience: 27

Katy Groom, P.E. (SpaceX) Manager, Environmental Regulatory Affairs
B.S., Environmental Engineering, University of Florida
Years of Experience: 12

Kyle Meade (SpaceX) Director, Environmental Health and Safety
B.S., Geological Sciences, California State University-San Bernardino
Years of Experience: 12

Brian Pownall, P.E. (SpaceX) Environmental Engineer
B.S., Civil Engineering, North Carolina State University
Years of Experience: 6

Elyse Procopio (SpaceX) Senior Environmental Engineer
B.S., Natural Resources and Conservation, North Carolina State University
Years of Experience: 13

Heather McDaniel McDevitt, RPA (Dudek) Senior Archaeologist
M.A., Anthropology - Public Archaeology, California State University Northridge
M.A. (ABT), Geographical Information Science, California State University Northridge
B.A., Anthropology, California State University Northridge
Years of Experience: 17

Micah Hale, RPA (Dudek) Senior Archaeologist
Ph.D., Anthropology, University of California, Davis
M.A., Anthropology, California State University Sacramento
B.S., Anthropology, University of California, Davis
Years of Experience: 23

6.2 LIST OF AGENCIES AND PERSONS CONSULTED

Aaron Allen, U.S. Army Corps of Engineers, Regulatory Division, Los Angeles District

Lucille Breese, Economic & Community Development, City of Lompoc

California Environmental Protection Agency

California Native Plant Society, Channel Islands Chapter

Mark Cassady, Central Coast Regional Water Quality Control Board

Gerry Ching, Los Padres Chapter, Sierra Club

Sam Cohen, Elders Council, Santa Ynez Band of Chumash Indians Elder's Council, Santa Ynez, California

Tyrone Conner, Deputy Chief, Waterways Management, Eleventh Coast Guard District

Daniel Czelusniak, Operations Support Branch, Office of Commercial Space Transportation, FAA

Chris Diel, Assistant Field Supervisor, Ventura Field Office, United States Fish and Wildlife Service

Rhys Evans, VSFB, Natural Resources, 30 CES/CEIEA

Leslie Grey, Operational Support Branch, Office of Commercial Space Transportation, Federal Aviation Administration

Brian Halvorson, Economic & Community Development, City of Lompoc

Mary Hamilton, Central Coast RWQCB - Central Coast Ambient Monitoring Program

David Harris, Santa Barbara County Air Pollution Control District

Steve Henry, Ventura Fish and Wildlife Office, United States Fish and Wildlife Service

David A. Jorgenson, U.S. Army Corps of Engineers

Samantha Kaisersatt, Conservation Chief, 30 CES/CEIEA

David Lackie, Santa Barbara County Planning & Development

Daniel Lawson, Long Beach Branch Chief, Protected Resource Division, National Marine Fisheries Service

Lompoc Public Library

Luanne Lum, VSFB, Natural Resources, 30 CES/CEIEA

David Magney, Channel Islands Chapter, California Native Plant Society

Russell Marlow, California Trout

Chris Mobley, Channel Islands National Marine Sanctuary, National Oceanic and Atmospheric Administration

Molly Pearson, Santa Barbara County Air Pollution Control District

National Park Service, Channel Islands National Park

NOAA - National Marine Fisheries Service, Southwest Regional Office

Office of the Governor, Office of Planning and Research, State Clearing House

Molly Pearson, Santa Barbara County Air Pollution Control District

Julianne Polanco, California SHPO, Office of Historic Preservation, Department of Parks and Recreation, Sacramento, California

Freddie Romero, Elders Council, Santa Ynez Band of Chumash Indians

Scott Rumsey, Southwest Region, National Marine Fisheries Service

Carol Sachs, U.S. Environmental Protection Agency, Region 9, Environmental Review Office

Santa Barbara Public Library

Santa Maria Public Library

William Sarraf, Santa Barbara County Air Pollution Control District

Kelly Schmoker-Stanphill, California Department of Fish & Wildlife South Coast Region

Sheila Soderberg, Central Coast Regional Water Quality Control Board

State Clearinghouse, Office of Planning and Research, Office of the Governor

Superintendent, Channel Islands National Park, National Park Service

Luke Swetland, Santa Barbara Museum of Natural History

Tamarah Taaffe, La Purisima Audubon Society

Cassidy Teufel, Federal Consistency Coordinator, Energy, Ocean Resources and Federal Consistency Division, California Coastal Commission

Brian Trautwein, Environmental Defense Center

Luke J. Swetland, Santa Barbara Museum of Natural History

U.S. Department of Transportation, Federal Aviation Administration, Planning and Environmental Division

Emily Waddington, Santa Barbara County Air Pollution Control District

Cherridah Weigel, Economic & Community Development, City of Lompoc

Tiffany Whitsitt-Odell, Environmental Planner, Vandenberg Space Force Base, United States Space Force

U.S. Coast Guard District Eleven, Waterways Management Branch, Alameda, California

U.S. Coast Guard Sector Los Angeles / Long Beach, Prevention, San Pedro, California

U.S. Coast Guard Sector San Francisco, Yerba Buena Island, California

Vandenberg Library, Vandenberg Space Force Base, California

David Villalobos, Santa Barbara County Planning & Development, Santa Barbara County Board of Supervisors

Karen Vitulano, Environmental Review Branch, U.S. Environmental Protection Agency, Region 9

Darryl York, VSFB, Chief, Environmental, 30 CES/CEIEA

7 BIBLIOGRAPHY

Amtrak. 2022. Amtrak schedules. Available at: https://www.amtrak.com/. As assessed on 2 December 2022.

Bailey, H., S.R. Benson, G.L. Shillinger, S.J. Bograd, P.H. Dutton, S.A. Eckert, S.J. Morreale, F.V. Paladino, T. Eguchi, D.G. Foley, B.A. Block, R. Piedra, C. Hitipeuw, R.F. Tapilatu, and J.R. Spotila. 2012. Identification of distinct movement patterns in Pacific leatherback turtle populations influenced by ocean conditions. Ecological Applications 22(3): 735–747.

Barlow, J. 1995. The abundance of cetaceans in California waters. Part I: Ship surveys in summer and fall of 1991. Fishery Bulletin 93: 1–14.

Barlow, J., and K. A. Forney. 2007. Abundance and population density of cetaceans in the California Current ecosystem. Fishery Bulletin 105: 509–526.

Baum, J., E. Medina, J.A. Musick, and M. Smale. 2015. *Carcharhinus longimanus*. The International Union for Conservation of Nature Red List of Threatened Species 2015: e.T39374A85699641.

Becker, E.A., K.A. Forney, P.C. Fiedler, J. Barlow, S.J. Chivers, C.A. Edwards, A.M. Moore, and J.V. Redfern. 2016. Moving Towards Dynamic Ocean Management: How Well Do Modeled Ocean Products Predict Species Distributions? Remote Sensing 8(2): 149.

Bellinger, M.R., M.A. Banks, S.J. Bates, E.D. Crandall, C.G. Garza, and P.W. Lawson. 2015. Geo-Referenced, Abundance Calibrated Ocean Distribution of Chinook Salmon (*Oncorhynchus tshawytscha*) Stocks across the West Coast of North America. PLoS One 10(7): e0131276.

Bradley, K.A, C. Wilmer, V. San Miguel, M.M. James, A.R. Salton, and M.F. Calton. 2018. User guides for noise modeling of commercial space operations – RUMBLE and PCBoom. Airport Cooperative Research Program Research Report 183. Produced by Wyle Laboratories, Inc., Arlington, VA and Blue Ridge Research and Consulting, LLC, Asheville, NC. Available at: https://www.trb.org/Publications/Blurbs/177510.aspx.

Burchette, D.K. 1989. A Study of the Effect of Balloon Releases on the Environment. Latex Rubber Institute of Malaysia: Environmental Committee of the National Association of Balloon Artists.

Burke, J.H. 2017. Pinniped Monitoring During Missile Launches on San Nicolas Island, California, December 2016–November 2017. Point Mugu, CA: Naval Air Warfare Center Weapons Division.

National Cooperative Highway Research Program. 2012. NCHRP 25-25/Task 72: Current Practices to Address Construction Vibration and Potential Effects to Historic Buildings Adjacent to Transportation Projects. Electronic document, https://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP25-25(72)_FR.pdf, accessed 9 December 2022.

California Department of Fish and Wildlife. 2022. Coho Salmon. Retrieved 6 October 2022, from https://wildlife.ca.gov/Conservation/Fishes/Coho-Salmon

Campbell, G.S., L. Thomas, K. Whitaker, A.B. Douglas, J. Calambokidis, and J.A. Hildebrand. 2015. Inter-annual and seasonal trends in cetacean distribution, density and abundance off southern California. Deep Sea Research Part II: Topical Studies in Oceanography 112: 143–157.

Carretta, J.V., K.A. Forney, E.M. Oleson, D.W. Weller, A.R. Lang, J. Baker, M.M. Muto, B. Hanson, A.J. Orr, H. Huber, M.S. Lowry, J. Barlow, J.E. Moore, D. Lynch, L. Carswell, and R.L. Brownell Jr. 2020. U.S. Pacific Marine Mammal Stock Assessments: 2019 (NOAA-TM-NMFS-SWFSC-629). La Jolla, CA: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center

Christopher, S.V. 1996. Reptiles and amphibians of Vandenberg Air Force Base. A focus on sensitive aquatic species. Prepared for CES/CEV Natural Resources, Vandenberg Air Force Base and U.S. Department of Interior, National Biological Services, California Science Center, Piedras Blancas Research Station, San Simeon, CA. University of California, Museum of Systematics and Ecology, Report No. 4. + Appendices. 145 pp.

Christopher, S.V. 2004. Distribution and abundance of California red-legged frogs on Vandenberg Air Force Base: Responses to El Nino and Drought Conditions. Prepared for: CES/CE Natural Resources, Vandenberg Air Force Base.

Cliffton, K., D.O. Cornejo, and R.S. Felger. 1995. Sea turtles of the Pacific coast of Mexico. In K. A. Bjorndal (Ed.), Biology and Conservation of Sea Turtles (Revised ed., pp. 199-209). Washington, DC: Smithsonian Institution Press.

Cogan, J. 2015. 2015 Whale Sightings in the Salish Sea: Central Salish Sea and Puget Sound (Southern Resident Killer Whale Project). Friday Harbor, WA: Center for Whale Research.

Compagno, L.J.V. 1984. FAO Species Catalogue. Sharks of the World. An Annotated and Illustrated Catalogue of Shark Species Known to Date. Part 2. Carcharhiniformes (FAO Fisheries Synopsis No. 125). Tiburon, CA: San Francisco State University.

Conant, T.A., P.H. Dutton, T. Eguchi, S. P. Epperly, C.C. Fahy, M. H. Godfrey, S.L. MacPherson, E.E. Possardt, B.A. Schroeder, J.A. Seminoff, M.L. Snover, C.M. Upite, and B.E. Witherington. 2009. Loggerhead sea turtle (*Caretta caretta*) 2009 status review under the U.S. Endangered Species Act (Report of the loggerhead biological review team to the National Marine Fisheries Service, August 2009). Silver Spring, MD: Loggerhead Biological Review Team.

Dahlheim, M.E., A. Schulman-Janiger, N. Black, R. Ternullo, D.K. Ellifrit, and K.C. Balcomb, III. 2008. Eastern temperate North Pacific offshore killer whales (*Orcinus orca*): Occurrence, movements, and insights into feeding ecology. Marine Mammal Science 24(3): 719–729.

Declining Amphibian Task Force. 2019. Fieldwork Code of Practice. Available online: https://www.fws.gov/ventura/docs/species/protocols/DAFTA.pdf.

DeLong, R.L., and S.R. Melin. 2000. Thirty years of pinniped research at San Miguel Island. Proceedings of the Fifth California Islands Symposium. U.S. Department of the Interior, Minerals Management Service, Pacific OCS Region. February 2000, pp. 401-406.

Dohl, T.P., R.C. Guess, M.L. Duman, and R.C. Helm. 1983. Cetaceans of Central and Northern California, 1980-1983: Status, Abundance, and Distribution (OCS Study MMS 84–005). Los Angeles, CA: U.S. Department of the Interior, Minerals Management Service, Pacific Outer Continental Shelf Region.

Douglas, A.B., J. Calambokidis, L.M. Munger, M.S. Soldevilla, M.C. Ferguson, A.M. Havron, D.L. Camacho, G.S. Campbell, and J.A. Hildebrand. 2014. Seasonal distribution and abundance of cetaceans off Southern California estimated from CalCOFI cruise data from 2004 to 2008. Fishery Bulletin 112(2–3): 198–220.

eBird. 2022. eBird: An online database of bird distribution and abundance [web application]. eBird, Cornell Lab of Ornithology, Ithaca, New York. Available: http://www.ebird.org. (Accessed: 15 October 2022).

Envicom Corporation. 2012. Final Environmental Impact Report. Willow Springs II. Prepared for the City of Goleta Planning and Environmental Services. May 2012. Available at: https://www.cityofgoleta.org/city-hall/planning-and-environmental-review/ceqa-review/willow-springs-ii-feir

Erlandson, J.M., T.C. Rick, R.L. Vellanoweth, and D.J. Kennett. 1999. Maritime Subsistence at a 9300 Year Old Shell Midden on Santa Rosa Island. Journal of Field Archaeology, Vol. 26, No. 3: 255-265.

Fenton, R., and R. Methold. 2016. Mod Shoeburyness and Pendine noise and vibration study criteria for the assessment of potential building damage effects from range activities. June 2016. Southdowns Environmental Consultants, Lewes, East Sussex, UK. 55 pp.

Fingas, M.F. 2013. Modeling Oil and Petroleum Evaporation. Journal of Petroleum Science Research 2(3): 104-115.

Fisher, J.P., L.A. Weitkamp, D.J. Teel, S.A. Hinton, J.A. Orsi, E.V. Farley Jr., J.F.T. Morris, M.E. Thiess, R.M. Sweeting, and M. Trudel. 2014. Early Ocean Dispersal Patterns of Columbia River Chinook and Coho Salmon. Transactions of the American Fisheries Society 143(1): 252–272.

Forney, K.A., and J. Barlow. 1993. Preliminary winter abundance estimates for cetaceans along the California coast based on a 1991 aerial survey. Reports of the International Whaling Commission 43: 407–415.

Forney, K.A., and J. Barlow. 1998. Seasonal patterns in the abundance and distribution of California cetaceans, 1991–1992. Marine Mammal Science 14(3): 460–489.

Froese, R., and D. Pauly. 2016. FishBase. World Wide Web electronic publication. Retrieved from www.fishbase.org.

Ghoul, A., and C. Reichmuth. 2014. Hearing in the sea otter (*Enhydra lutris*): auditory profiles for an amphibious marine carnivore. Journal of Comparative Physiology. doi:10.1007/s00359-014-0943-x.

Gibbs, Y. 2017. NASA Armstrong Fact Sheet: Sonic Booms. Found at: https://www.nasa.gov/centers/armstrong/news/FactSheets/FS-016-DFRC.html.

Godin, O.A. 2008. Sound transmission through water-air interfaces: new insights into an old problem. Contemporary Physics 49(2): 105-123.

Good, T.P., R.S. Waples, and P. Adams, (Eds.). 2005. Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead. Seattle, WA: U.S. Department of Commerce, National Oceanic and

Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center.

Guazzo, R.A., A. Schulman-Janiger, M.H. Smith, J. Barlow, G.L. D'Spain, D.B. Rimington, and J.A. Hildebrand. 2019. Gray whale migration patterns through the Southern California Bight from multi-year visual and acoustic monitoring. Marine Ecology Progress Series 625: 181–203.

Guest, S., and R.M. Slone, Jr. 1972. *Structural Damage Claims Resulting from Acoustic Environments Developed During Static Firing of Rocket Engines.* Paper presented at the NASA Space Shuttle Technology Conference.

Haber, J., D. Nakaki, C. Taylor, G. Knipprath, V. Kopparam, and M. Legg. 1989. Effects of Aircraft Noise and Sonic Booms on Structures: An Assessment of the Current State-of-Knowledge. BBN Systems and Technologies Corp., Canoga Park, Ca.

Hanson, M.B., E.J. Ward, C.K. Emmons, and M.M. Holt. 2018. Modeling the occurrence of endangered killer whales near a U.S. Navy Training Range in Washington State using satellite-tag locations to improve acoustic detection data. Seattle, WA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center.

Hanson, M.B., E.J. Ward, C.K. Emmons, M.M. Holt, and D.M. Holzer. 2017. Assessing the Movements and Occurrence of Southern Resident Killer Whales Relative to the U.S. Navy's Northwest Training Range Complex in the Pacific Northwest. Seattle, WA: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northwest Fisheries Science Center.

Harris, J. 2015. Personal communication via email between J. Harris (National Marine Fisheries Service) and John LaBonte (ManTech SRS Technologies, Inc.) on Guadalupe fur seal behavior, abundance, and distribution on San Miguel Island.

Hendrix, N., A.-M. K. Osterback, E. Jennings, E. Danner, V. Sridharan, C. M. Greene, and S.T. Lindley. 2019. Model Description for the Sacramento River Winter-run Chinook Salmon Life Cycle Model. Seattle, WA: National Marine Fisheries Service.

Horwood, J. 2009. Sei whale, *Balaenoptera borealis*. In W. F. Perrin, B. Wursig, & J. G. M. Thewissen (Eds.), Encyclopedia of Marine Mammals (2nd ed., pp. 1001–1003). Cambridge, MA: Academic Press.

Jefferson, T.A., M.A. Webber, and R.L. Pitman. 2008. Marine Mammals of the World: A Comprehensive Guide to Their Identification. London, United Kingdom: Elsevier.

Jones, M.L., and S.L. Swartz. 2009. Gray whale, *Eschrichtius robustus*. In W. F. Perrin, B. Wursig, & J. G. M. Thewissen (Eds.), Encyclopedia of Marine Mammals (2nd ed., pp. 503–511). Cambridge, MA: Academic Press.

Lafferty, K.D., C.C. Swift, and R.F. Ambrose. 1999. Extirpation and recolonization in a metapopulation of an endangered fish, the tidewater goby. U. S. Geological Survey, University of California, Marine Science Institute, Santa Barbara, California.

Livingston, D.S. 2016. Island Legacies: A History of the Islands Within Channel Islands National Park: San Miguel Island--Santa Rosa Island--Santa Cruz Island--Anacapa Island--Santa Barbara Island. Department of the Interior, National Park Service.

Lobelle, D., and M. Cunliffe. 2011. Early microbial biofilm formation on marine plastic debris. Marine Pollution Bulletin 62(1): 197–200.

Lowry, M.S., S.E. Nehasil, and E.M. Jaime. 2017b. Distribution of California Sea Lions, Northern Elephant Seals, Pacific Harbor Seals, and Steller Sea Lions at the Channel Islands During July 2011–2015 (National Oceanic and Atmospheric Administration Technical Memorandum NMFS-SWFSC-578). Springfield, VA: Southwest Fisheries Science Center.

Lowry, M.S. 2002. Counts of northern elephant seals at rookeries in the Southern California Bight: 1981-2001. NOAA Technical Memorandum NMFS. NOAA-TM-NMFS-SWFSC-345. 63 pp.

Lowry, M.S., S.E. Nehasil, and E.M. Jaime. 2017a. Distribution of California Sea Lions, Northern Elephant Seals, Pacific Harbor Seals, and Steller Sea Lions at the Channel Islands during July 2011-2015. NOAA-TM-NMFS-SWFSC-578. May 2017.

ManTech SRS Technologies, Inc. 2009a. Status of the unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*) in San Antonio and Cañada Honda creeks, Vandenberg Air Force Base, California. 10 February 2009.

ManTech SRS Technologies, Inc. 2009b. Occurrence of the Amphibian Pathogen, *Batrachochytrium dendrobatidis*, in Ranids of Vandenberg Air Force Base, California. 29 February 2009. Prepared for 30 CEV/CEVNN. 31 pp.

ManTech SRS Technologies, Inc. 2013. Spring Canyon – California Red-Legged Frog Habitat Assessment, Vandenberg Air Force Base, California. ManTech SRS Technologies Mission Services Division, Lompoc, California. 16 October 2013. 34 pp.

ManTech SRS Technologies, Inc. 2014a. Assessment of California Red-Legged Frog Habitat, Population Status, and Chytrid Fungus Infection on Vandenberg Air Force Base, California. Prepared for 30

ManTech SRS Technologies, Inc. 2016. California Red-Legged Frog Habitat Assessment, Population Status, and Chytrid Fungus Infection in Cañada Honda Creek and San Antonio West Bridge Area on Vandenberg Air Force Base, California. Unpublished report. 51 pp.

ManTech SRS Technologies, Inc. 2017. Biological Assessment for Launch, Boost-Back and Landing of the Falcon 9 First Stage at SLC-4, Vandenberg Air Force Base, California. ManTech SRS Technologies, Lompoc, California. 65 pp.

ManTech SRS Technologies, Inc. 2018a. California red-legged frog habitat assessment, population status, and chytrid fungus infection in Cañada Honda Creek, Cañada del Jolloru, and seasonal pools on Vandenberg Air Force Base, California. Submitted to 30th Civil Engineer Squadron, Environmental Flight, Natural Resources Section (30 CES/CEIEA), Vandenberg Air Force Base, California.

ManTech SRS Technologies, Inc. 2021a. California Red-Legged Frog Habitat Assessment, and Population Status on San Antonio Terrace and Assessment of Select Aquatic Features on Vandenberg Space Force Base, California in 2020. October 2021. 85 pp.

ManTech SRS Technologies, Inc. 2022. Biological Monitoring of California Red-legged Frogs for the 2 February 2022 SpaceX Falcon 9 NROL-87 Mission at Vandenberg Air Force Base, California.

ManTech SRS Technologies, Inc. 2023. Noise Study for SpaceX Falcon 9 Launch and Landing Operations at Vandenberg Space Force Base, California. Prepared for Space Exploration Technologies Corporation. 41 pp.

Marine Mammal Consulting Group and Science Applications International Corporation (MMCG and SAIC). 2012. Technical report: population trends and current population status of harbor seals at Vandenberg Air Force Base, California. 1993-2012. September 2012.

Masaki, Y. 1976. Biological studies on the North Pacific sei whale. Bulletin of the Far Seas Fisheries Research Laboratory 14: 1–104.

Mate, B. 2013. Offshore Gray Whale Satellite Tagging in the Pacific Northwest. Silverdale, WA: Naval Facilities Engineering Command Northwest.

Melin, S.R., A.J. Orr, J.D. Harris, J.L. Laake, and R.L. Delong. 2010. Unprecedented Mortality of California Sea Lion Pups. CalCOFI Rep, Vol. 51, 182-194.

Melin, S.R., and R.L. DeLong. 1999. Observations of a Guadalupe fur seal (*Arctocephalus townsendi*) female and pup at San Miguel Island, California. Marine Mammal Science 15(3): 885–887.

Melin, S.R., J.T. Sterling, R.R. Ream, R.G. Towell, T. Zeppelin, A.J. Orr, B. Dickerson, N. Pelland, and C.E. Kuhn. 2012. A Tale of Two Stocks: Studies of Northern Fur Seals Breeding at the Northern and Southern Extent of the Range. (0008-4301; 1480-3283). Seattle, WA: Alaska Fisheries Science Center.

Mizroch, S.A., D.W. Rice, D. Zwiefelhofer, J.M. Waite, and W.L. Perryman. 2009. Distribution and movements of fin whales in the North Pacific Ocean. Mammal Review 39(3): 193–227.

Moore, J.E., and D.W. Weller. 2018. Updated Estimates of the Probability of Striking a Western North Pacific Gray Whale during the Proposed Makah Hunt (Technical Memorandum NOAA-TM-NMFS-SWFSC-605). Silver Spring, MD: National Oceanic and Atmospheric Administration.

Moyle, P.B. 2002. Inland Fishes of California. Los Angeles, CA: University of California Press.

National Aeronautics and Space Administration. 2011. Environmental Assessment for Launch of NASA Routine Payloads on Expendable Launch Vehicles. National Aeronautics and Space Administration, Washington, D.C. 366 pp.

National Marine Fisheries Service. 2007. Final Environmental Impact Statement for the Establishment of Marine Reserves and Marine Conservation Areas, Channel Islands National Marine Sanctuary. April.

National Marine Fisheries Service. 2019a. Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to U.S. Air Force Launches and Operations at Vandenberg Air Force Base, California. Dated 10 April 2019. Federal Register Vol. 84, No. 69, pp 14314-14335.

National Marine Fisheries Service. 2019b. Letter of Authorization, issued to the U.S. Air Force, 30th Space Wing. Valid 10 April 2019 to 9 April 2024. Dated 10 April 2019. 8 pp.

National Marine Fisheries Service. 2019c. Life History Information for Pacific Salmonids. Seattle, WA: National Marine Fisheries Service, Office of Science and Technology.

National Marine Fisheries Service. 2019d. Draft Biological Report for the Proposed Designation of Critical Habitat for the Central America, Mexico, and Western North Pacific Distinct Population Segments of Humpback Whales (Megaptera novaeangliae). Silver Spring, MD: National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

National Marine Fisheries Service. 2020. 2015–2020 Guadalupe Fur Seal Unusual Mortality Event in California, Oregon, and Washington. Accessed On: October 14, 2020. Retrieved from https://www.fisheries.noaa.gov/national/marine-life-distress/2015-2020-guadalupe-fur-seal-unusual-mortality-event-california.

National Marine Fisheries Service. 2022. Programmatic Concurrence Letter for Launch and Reentry Vehicle Operations in the Marine Environment and Starship/Super Heavy Launch Vehicle Operations at SpaceX's Boca Chica Launch Site, Cameron County, TX. Office of Protected Resources, Silver Spring, MD.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998a. Recovery Plan for U.S. Pacific Populations of the Green Turtle (*Chelonia mydas*). Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998b. Recovery Plan for U.S. Pacific Populations of the Olive Ridley Turtle (*Lepidochelys olivacea*). (pp. 52). Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 2007. Olive Ridley Sea Turtle (*Lepidochelys olivacea*) 5-year Review: Summary and Evaluation. (pp. 64). Silver Spring, MD: National Marine Fisheries Service.

National Marine Fisheries Service, and U.S. Fish and Wildlife Service. 2013. Hawksbill sea turtle (*Eretmochelys imbricata*) 5-year review: summary and evaluation. Jacksonville, FL: Jacksonville Ecological Services Field Station.

National Preservation Institute. 2022. What are "Cultural Resources"?. National Preservation Institute. Available at: https://www.npi.org/what-are-cultural-resources

Nocerino, E.S., J. Smallwood, and E.B. Yarborough. 2021. Rocket Engine Noise Effects on Cultural Resources: Addendum to the Section 106 Compliance Report for the Blue Origin Orbital Launch Site Project, Vandenberg Space Force Base, Santa Barbara, California. Prepared by Applied Earth Works, Inc. for Tetra Tech, November 2021

Norris, T.A., and F.R. Elorriaga-Verplancken. 2020. Guadalupe Fur Seal Population Census and Tagging in Support of Marine Mammal Monitoring Across Multiple Navy Training Areas in the Pacific Ocean. Sausalito, CA: The Marine Mammal Center.

Office of Historic Preservation. 1995. Instructions for Recording Historical Resources. Prepared by California Department of Transportation. Prepared for California Office of Historic Preservation.

Palacios, D.M., H. Bailey, E.A. Becker, S.J. Bograd, M.L. DeAngelis, K.A. Forney, E.L. Hazen, L.M. Irvine, and B.R. Mate. 2019. Ecological correlates of blue whale movement behavior and its predictability in the California Current Ecosystem during the summer-fall feeding season. Movement Ecology 7(1).

Quinn, T.P., and K.W. Myers. 2005. Anadromy and the marine migrations of Pacific salmon and trout: Rounsefell revisited. Reviews in Fish Biology and Fisheries 14: 421–442.

Robinette, D., and J. Howar. 2010. Monitoring and management of the California Least Tern colony at Purisima Point, Vandenberg Air Force Base, 2009. Petaluma, California: Unpublished Report, PRBO Conservation Science.

Robinette, D., and E. Rice. 2022a. Monitoring of California Least Terns and Western Snowy Plovers on Vandenberg Space Force Base during the 18 June 2022 SpaceX Falcon 9 Launch and First Stage Landing at SLC-4. Petaluma, California: Point Blue Conservation Science.

Robinette, D., and E. Rice. 2022b. Monitoring of Western Snowy Plovers on Vandenberg Space Force Base during the 17 April 2022 SpaceX Falcon 9 NROL-85 Launch with "Boost-Back". Petaluma, California: Point Blue Conservation Science.

Robinette, D., E. Rice, A. Fortuna, J. Miller, L. Hargett, and J. Howar. 2021. Monitoring and management of the endangered California least tern and the threatened western snowy plover at Vandenberg Space Force Base, 2021. Unpublished Report, Point Blue Conservation Science, Petaluma, CA.

Robinette, D.P., J.K. Miller, and A.J. Howar. 2016. Monitoring and Management of the Endangered California Least Tern and the Threatened Western Snowy Plover at Vandenberg Space Force Base, 2016. Petaluma, California: Point Blue Conservation Science.

Satterthwaite, W.H., J. Ciancio, E.D. Crandall, M.L. Palmer-Zwahlen, A.M. Grover, M.R. O'Farrell, E.C. Anderson, M.S. Mohr, and C. Garza. 2015. Stock composition and ocean spatial distribution inference from California recreational Chinook salmon fisheries using genetic stock identification. Fisheries Research 170: 166-178.

Sharma, R. 2009. Survival, Maturation, Ocean Distribution and Recruitment of Pacific Northwest Chinook Salmon (*Oncorhynchus tshawytscha*) in Relation to Environmental Factors, and Implications for Management. (Unpublished doctoral dissertation). University of Washington, Seattle, WA.

Smultea, M. 2014. Changes in Relative Occurrence of Cetaceans in the Southern California Bight: A Comparison of Recent Aerial Survey Results with Historical Data Sources. Aquatic Mammals 40(1): 32–43.

Smultea, M.A., T.A. Jefferson, and A.M. Zoidis. 2010. Rare sightings of a Bryde's whale (*Balaenoptera edeni*) and Sei whales (*B. borealis*) (Cetacea: Balaenopteridae) northeast of Oahu, Hawaii. Pacific Science 64(3): 449–457.

SpaceX. 2021. Falcon User's Guide. El Segundo, CA; September, 2021.

Stinson, M.L. 1984. Biology of Sea Turtles in San Diego Bay, California, and in the Northeastern Pacific Ocean. San Diego State University, San Diego, CA.

Strachan, G., M. McAllister, and C.J. Ralph. 1995. Marbled murrelet at-sea and foraging behavior. Chapter 23 in Ralph, C. J., Hunt, G.L., Jr., Raphael, M.G., Piatt, J.F. (eds.): Ecology and conservation of the marbled murrelet. USDA Forest Service General Technical Report PSW-152.

Swift, C.C., P. Duangsitti, C. Clemente, K. Hasserd, and L. Valle. 1997. Final Report Biology and Distribution of the Tidewater Goby, *Eucyclogobius newberryi*, on Vandenberg Air Force Base, Santa Barbara

County, California. Department of Biology Loyola Marymount University, Los Angeles, California. 76 pp.

Tetra Tech Inc. 2009. Final Technical Memorandum for Perchlorate in Soil Data Gap Sampling, Site 8 – Space Launch Complex 4 East, Vandenberg Air Force Base, California.

Thorson, P.H., J.K. Francine, E.A. Berg, L.E. Fillmore, and D.A. Eidson. 2001. Acoustic Measurement of the 21 September 2000 Titan II G-13 Launch and Quantitative Analysis of Behavioral Responses for Selected Pinnipeds on Vandenberg Air Force Base, CA. SRS Technologies technical report submitted to the United States Air Force and the National Marine Fisheries Service.

U.S. Air Force. 2011. Environmental Assessment. Falcon 9 and Falcon 9 Heavy Launch Vehicle Programs from Space Launch Complex 4 East, Vandenberg Air Force Base, California.

U.S. Air Force. 2016a. Environmental Assessment Boost-Back and Landing of Falcon 9 Full Thrust at SLC-4W Vandenberg Air Force Base, California and Offshore Landing Contingency Option. 25 April 2016.

U.S. Air Force. 2016b. Final Supplemental Environmental Assessment for Boost-Back and Landing of the Falcon 9 Full Thrust First Stage at Iridium Landing Area, Vandenberg Air Force Base, California and Offshore Landing Contingency Option. 20 September 2016.

U.S. Air Force. 2018. Final Supplemental Environmental Assessment for Launch, Boost-Back, and Landing of the Falcon 9 at Vandenberg Air Force Base, California and Offshore Landing Contingency Options. 24 January 2018.

U.S. Air Force. 2020. Installation Development Plan Vandenberg Air Force Base, California. June 2020.

U.S. Air Force. 2021. Annual Report. Letters of Authorization: Taking marine mammals incidental to space vehicle and missile launches and aircraft test flight and helicopter operations at Vandenberg Air Force Base, California. 1 January to 31 December 2020. Vandenberg Space Force Base, CA: U.S. Department of the Air Force.

U.S. Department of the Navy. 2017. U.S. Navy Marine Species Density Database Phase III for the Hawaii-Southern California Training and Testing Study Area (Naval Facilities Engineering Command Pacific Technical Report). Pearl Harbor, HI: Naval Facilities Engineering Command Pacific.

U.S. Geological Survey Western Ecological Resource Center. 2020. Annual California Sea Otter Census: 2019 Census Summary Shapefile. Retrieved 16 October 2020, from https://www.sciencebase.gov/catalog/item/5601b6dae4b03bc34f5445ec.

Ventana Wildlife Society. 2017. California Condor #760 aka "Voodoo". Retrieved 28 March 2017, from MYCONDOR.ORG: http://www.mycondor.org/condorprofiles/condor760.html

Weller, D.W., and R.L. Brownell, Jr. 2012. A re-evaluation of gray whale records in the western North Pacific (SC/64/BRG10). La Jolla, CA: Southwest Fisheries Science Center.

Windell, S., P.L. Brandes, J.L. Conrad, J.W. Ferguson, P.A.L. Goertler, B.N. Harvey, J. Heublein, J.A. Israel, D.W. Kratville, J.E. Kirsch, R.W. Perry, J. Pisciotto, W.R. Poytress, K. Reece, B.G. Swart, and R.C. Johnson. 2017. Scientific framework for assessing factors influencing endangered Sacramento

River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) across the life cycle. National Marine Fisheries Service.

Ye, S., and A.L. Andrady. 1991. Fouling of floating plastic debris under Biscayne Bay exposure conditions. Marine Pollution Bulletin 22(12): 608–613.

Zeppelin, T., N. Pelland, J. Sterling, B. Brost, S. Melin, D. Johnson, M.A. Lea, and R. Ream. 2019. Migratory strategies of juvenile northern fur seals (*Callorhinus ursinus*): Bridging the gap between pups and adults. Scientific Reports 9.