

Federal Aviation Administration

Environmental Assessment and Finding of No Significant Impact for Issuing Firefly Aerospace a Launch License for the Alpha Launch Vehicle at Space Launch Complex 2 West, Vandenberg Air Force Base, Vandenberg, California

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#### Environmental Assessment and Finding of No Significant Impact for Issuing Firefly Aerospace a Launch License for the Alpha Launch Vehicle at Space Launch Complex 2 West, Vandenberg Air Force Base, Vandenberg, California

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

**DEPARTMENT OF TRANSPORTATION, FEDERAL AVIATION ADMINISTRATION:** The FAA is evaluating Firefly Aerospace's (Firefly's) proposal to launch Alpha launch vehicles (Alpha) from Space Launch Complex 2 West (SLC-2W) and make facility modifications to associated support facilities at Vandenberg Air Force Base, Vandenberg, California. To operate Alpha at SLC-2W, Firefly must obtain a launch license from the FAA. Issuing a license is considered a major federal action subject to environmental review under NEPA. Under the Proposed Action, the FAA would issue a launch license to Firefly that would allow Firefly to operate Alpha from SLC-2W. Firefly is proposing to conduct 11 launches per year (each preceded by a static fire engine test) over the next five years (2020–2024).

The Environmental Assessment evaluates the potential environmental impacts from the Proposed Action and No Action Alternative on air quality; biological resources; climate; coastal resources; Department of Transportation Act, Section 4(f); hazardous materials, solid waste, and pollution prevention; noise and noise-compatible land use; socioeconomics, environmental justice, and children's environmental health and safety risks; and water resources.

**CONTACT INFORMATION:** For questions, please contact: Ms. Leslie Grey, Environmental Protection Specialist, Federal Aviation Administration, 800 Independence Avenue, SW, Suite 325, Washington, DC 20591; email Leslie.Grey@faa.gov.

This Environmental Assessment becomes a Federal document when evaluated, signed, and dated by the responsible FAA Official.

Responsible FAA Official:

DANIEL P MURRAY Date: 2020.05.18 11:47:59 -04'00'

Date: \_\_\_\_\_

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## **DEPARTMENT OF TRANSPORTATION**

## Federal Aviation Administration Office of Commercial Space Transportation

## **Finding of No Significant Impact**

for

## Issuing Firefly Aerospace a Launch License for the Alpha Launch Vehicle at Space Launch Complex 2 West, Vandenberg Air Force Base, Vandenberg, California

#### Summary

The Federal Aviation Administration (FAA) prepared the attached Environmental Assessment (EA) to analyze the potential environmental impacts of issuing a launch license to Firefly Aerospace (Firefly) to operate Alpha launch vehicles (Alpha) from Space Launch Complex 2 West (SLC-2W) and make facility modifications to associated support facilities at Vandenberg Air Force Base (VAFB), Vandenberg, California. The EA was prepared in accordance with the National Environmental Policy Act of 1969, as amended (NEPA; 42 United States Code [U.S.C.] § 4321 et seq.); Council on Environmental Quality (CEQ) NEPA-implementing regulations (40 Code of Federal Regulations [CFR] parts 1500 to 1508); and FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*.

After reviewing and analyzing available data and information on existing conditions and potential impacts, the FAA has determined the Proposed Action would not significantly affect the quality of the human environment. Therefore, the preparation of an Environmental Impact Statement (EIS) is not required, and the FAA is issuing this Finding of No Significant Impact (FONSI). The FAA has made this determination in accordance with applicable environmental laws and FAA regulations. The EA is incorporated by reference into this FONSI.

For any questions or to request a copy of the EA, contact the following FAA Environmental Specialist.

Leslie Grey Environmental Specialist Federal Aviation Administration 800 Independence Ave., SW, Suite 325 Washington, DC 20591 Leslie.Grey@faa.gov 907-227-2113

A copy of the EA may also be obtained from the FAA's website: https://www.faa.gov/space/environmental/nepa\_docs/.

#### **Purpose and Need**

The purpose of FAA's Proposed Action is to fulfill the FAA's responsibilities as authorized by the Commercial Space Launch Act (51 U.S.C. Subtitle V, ch. 509, §§ 50901-50923) for oversight of commercial space launch activities, including licensing launch activities. The need for FAA's Proposed Action results from the statutory direction from Congress under the Commercial Space Launch Act, 51 U.S.C. 50901(b), to, in part, "protect the public health and safety, safety of property, and national security and foreign policy interests of the United States" while "strengthening and [expanding] the United States space transportation infrastructure, including the enhancement of United States launch sites and launch-site support facilities, and development of reentry sites, with Government, State, and private sector involvement, to support the full range of United States space-related activities."

#### **Proposed Action**

The FAA's Proposed Action is to issue a launch license to Firefly that would allow Firefly to launch Alpha rockets from SLC-2W at VAFB. Firefly is proposing to conduct 11 launches per year over the next five years (2020–2024). Each launch would be preceded by a static fire engine test. The Proposed Action also includes the connected action of facility modifications at SLC-2W to support Alpha launch operations.

#### Alternatives

Alternatives analyzed in the EA include (1) the Proposed Action and (2) the No Action Alternative. Under the No Action Alternative, the FAA would not issue a launch license to Firefly for Alpha launches at SLC-2W and Firefly would not conduct facility modifications at SLC-2W. There would be no launch operations at SLC-2W. The No Action Alternative provides the basis for comparing the environmental consequences of the Proposed Action.

#### **Environmental Impacts**

The potential environmental impacts from the Proposed Action and No Action Alternative were evaluated in the attached EA for each environmental impact category identified in FAA Order 1050.1F. Chapter 3 of the EA describes the affected environment, regulatory setting, and potential environmental consequences for each of the environmental impact categories analyzed in detail. In addition, Chapter 3 identifies those environmental impact categories that are not analyzed in detail, explaining why the Proposed Action would have no potential impact on those impact categories. Those categories are farmlands; historical, architectural, archeological, and cultural resources; land use; natural resources and energy supply; and visual effects (including light emissions).

A summary of the documented findings for each impact category analyzed in detail, including requisite findings with respect to relevant special purpose laws, regulations, and executive orders, is presented below.

- Air Quality, EA Section 3.3. A summary of annual emissions from all aspects of the Proposed Action is provided in EA Table 3-4. Annual Alpha emissions would not result in an exceedance of the National Ambient Air Quality Standards (NAAQS), even when combined with facility modification emissions. Therefore, the Proposed Action would not result in significant impacts on air quality.
- Biological Resources (including Fish, Wildlife, and Plants), EA Section 3.9. Botanical resources would not be affected because all facility modifications would occur in already developed or disturbed areas within the perimeter fence of SLC-2W. Temporary impacts on wildlife species might occur within adjacent wildlife habitat due to an increase in noise, dust, and other construction-related disturbances during facility modifications. Temporary and infrequent impacts on wildlife species would also occur as a result of launch noise and sonic booms. The U.S. Air Force (USAF; 30th Space Wing) conducted programmatic Endangered Species Act (ESA) consultation with the U.S. Fish and Wildlife Service (USFWS) in 2015 for routine mission operations, including launches, and maintenance activities at VAFB. The USFWS issued a Programmatic Biological Opinion (PBO). The USFWS determined that the actions covered in the consultation would not jeopardize the continued existence of any federally listed species or destroy or adversely modify any critical habitat. After reviewing the description of Firefly's proposed Alpha launches, the USFWS determined Firefly's proposal is commensurate with prior

activities at SLC-2W and that the USAF did not need to reinitiate ESA consultation for potential effects to ESA-listed species. VAFB and Firefly must comply with all relevant terms and conditions in the PBO, including avoidance and minimization measures and reporting requirements, during Alpha launches at SLC-2W. Regarding marine species, monitoring of past sonic booms has shown that normal behavior and numbers of hauled out pinnipeds typically return to normal within 24 hours or less after a launch event. Any observations of injury or mortality of pinnipeds during monitoring have not been attributable to past launches. Under the Marine Mammal Protection Act, the National Marine Fisheries Service (NMFS) issued a Final Rule for taking marine mammals incidental to USAF launches and a Letter of Authorization (LOA). The LOA allows launch programs to unintentionally take small numbers of marine mammals during launches. VAFB is required to comply with the conditions listed in the LOA and address NMFS concerns regarding marine mammals at VAFB and the Northern Channel Islands. Under the LOA, monitoring of marine mammals at VAFB and the Northern Channels Islands is required during launches, including the proposed Alpha launches. Given the authorizations in place and the required monitoring, the Proposed Action would not result in significant impacts on biological resources.

- Climate, EA Section 3.4. EA Table 3-5 shows a summary of total greenhouse gas emissions from the Proposed Action. The total carbon dioxide equivalent (CO<sub>2</sub>e) values are less than the county's significance threshold of 10,000 metric tons of CO<sub>2</sub>e per year and less than a previous threshold of 25,000 metric tons per year proposed by the CEQ in 2014. Therefore, the Proposed Action would not have a significant impact related to climate.
- Coastal Resources, EA Section 3.5. The proposed facility modifications would not affect coastal resources because the area is already developed and is far enough away from the coastline such that there is no potential to affect coastal resources, including beaches. During an Alpha launch, a sonic boom would be generated that could impact natural resources (including wildlife and habitat) and likely result in temporary wildlife behavioral disruptions (e.g., a startle response). The USAF consulted the California Coastal Commission (CCC) regarding the proposed changes to SLC-2W to ensure the project is consistent with the California Coastal Management Program (CMP). The CCC stated there is no need for the USAF to submit a negative determination or consistency determination for the changes. Therefore, the Proposed Action is consistent with the California CMP and would not result in significant impacts on coastal resources.

- Department of Transportation (DOT) Act, Section 4(f), EA Section 3.6. Facility modifications at SLC-2W would not result in a use of any potential Section 4(f) property. Alpha launches would close public access to potential Section 4(f) properties, including local beaches and parks. Since 1979, an evacuation and closure agreement had been in place between USAF and Santa Barbara County. The agreement recently expired and the parties are in the process of renewing it. The renewed agreement is expected to be executed by July 1, 2020. This agreement is expected to be executed prior to the commencement of Firefly's launch events. The agreement will include closing public access to Surf Beach, Ocean Beach, and Jalama Beach County Parks during launches. Under this agreement, USAF will send an evacuation notice to the listed county parks at least 72 hours prior to the closure, and the closure is not to exceed 48 hours. The notice will state a hazardous operation will occur. Given the history of beach and park closures for launches at VAFB, the formal evacuation agreement that had been in place since 1979 (and for which is expected to be renewed in July 2020), and the temporary nature of the closures, the FAA has determined the Proposed Action would not substantially diminish the protected activities, features, or attributes of any of the potential Section 4(f) properties, and therefore the Proposed Action would not result in a constructive use of any Section 4(f) property. Therefore, the Proposed Action would not result in significant Department of Transportation Act Section 4(f) impacts.
- Hazardous Materials, Solid Waste, and Pollution Prevention, EA Section 3.10. Compliance with all applicable federal, state, and local laws and regulations, and applicable VAFB plans, would govern all actions associated with facility modifications and Alpha launches, which would avoid or minimize potential impacts related to this impact category. Therefore, significant impacts related to hazardous materials, solid waste, and pollution prevention are not expected.
- Noise and Noise-Compatible Land Use, EA Section 3.7. Noise modeling shows the Proposed Action's Community Noise Equivalent Level 65 A-weighted decibel contour extends approximately 0.4 miles from the launch site and is located entirely within the VAFB boundary (see EA Figure 3-5). Therefore, the Proposed Action would not result in significant impacts related to noise and noise-compatible land use.
- Socioeconomics, Environmental Justice, and Children's Environmental Health and Safety Risks, EA Section 3.8. At peak operational activity, roughly 30 additional people would be working at SLC-2W. With the exception of approximately 10 people permanently moving to the VAFB area,

many of these individuals would be associated with specific missions for short durations, and Firefly does not expect that they would move to the VAFB area. Construction workers would be hired from the local labor pool. There might be a slight increase in local revenues; however, any increase is not likely to be statistically noticeable. Environmental justice populations do not occur in the area where construction or launch noise levels would be detectable above ambient noise levels. The Proposed Action would not result in any air emissions or water discharges that would adversely affect minority or low-income communities in a manner that would be greater than the comparison groups. The Proposed Action would not cause a disproportionate high and adverse impact on an environmental justice population. Neither adults nor children would be exposed to hazardous conditions because Firefly would establish debris impact corridors and coordinate the closure of areas within the hazard area. There would be no known environmental health or safety risks that would disproportionately affect children. Therefore, the Proposed Action would not result in significant impacts related to socioeconomics, environmental justice, and children's environmental health and safety risks.

 Water Resources (including Wetlands, Floodplains, Surface Waters, Groundwater, and Wild and Scenic Rivers), EA Section 3.11. There are no waters of the United States (including wetlands), floodplains, or wild and scenic rivers within the study area. Therefore, the Proposed Action would not impact wetlands, floodplains, or wild and scenic rivers. Firefly would implement Best Management Practices (BMPs) to properly manage materials and eliminate pollutants in stormwater and non-stormwater discharges. The Proposed Action would not adversely affect groundwater, including a sole source or other aquifer, because facility modifications would not require deep excavations and environmental protection measures would be implemented to prevent water quality impacts. Therefore, the Proposed Action would not result in significant impacts on water resources.

Please refer to Chapter 3 of the EA for a full discussion of the determination for each environmental impact category.

Chapter 4 of the EA provides an analysis of the potential cumulative impacts of the Proposed Action when added to other past, present, and reasonably foreseeable future actions. The FAA has determined that the Proposed Action would not result in significant cumulative impacts in any environmental impact category.

## **Conditions and Mitigation**

As prescribed by 40 CFR § 1505.3, the FAA shall take steps as appropriate to the action, through mechanisms such as the enforcement of licensing conditions, and shall monitor as necessary to ensure that Firefly implements avoidance, minimization, and/or mitigation measures as set forth in Chapter 3 of the EA under the various impact categories. These avoidance, minimization, and mitigation measures include:

- Compliance with the PBO's terms and conditions and the LOA's monitoring requirements
- Compliance with all applicable federal, state, and local laws and regulations, and applicable VAFB plans, related to handling and managing hazardous materials and solid waste
- . Implementation of BMPs for construction and operations to properly manage all stormwater and non-stormwater discharges

Additionally, the FAA will monitor the status of an evacuation agreement between USAF and Santa Barbara County that will restrict public access to Surf Beach, Ocean Beach, and Jalama Beach County Parks during launch events.

## Agency Finding and Statement

The FAA has determined that no significant impacts would occur as a result of the Proposed Action and, therefore, that preparation of an EIS is not warranted and a FONSI in accordance with 40 CFR Section 1501.4(e) is appropriate.

After careful and thorough consideration of the facts contained herein, the undersigned finds that the proposed federal action is consistent with existing national environmental policies and objectives as set forth in Section 101 of NEPA and other applicable environmental requirements and will not significantly affect the quality of the human environment or otherwise include any condition requiring consultation pursuant to Section 102(2)(C) of NEPA.

Digitally signed by DANIEL P MURRAY

DANIEL P MURRAY Date: 2020.05.18 11:48:54 -04'00' **APPROVED:** 

DATE: \_\_\_\_\_

Daniel Murray Manager, Safety Authorization Division

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## ACRONYMS AND ABBREVIATIONS

2 ROP	2nd Range Operations Squadron	FE	Federal Endangered Species
30 SW	30th Space Wing	Firefly	Firefly Aerospace
30 SW/SEL	30th Space Wing Launch Safety	FONSI	Finding of no significant impact
30 SWI	30th Space Wing Instruction	FR	Federal Register
30 SWP	30th Space Wing Plan	FT	Federal Threatened Species
AFI	Air Force Instruction	GHG	Greenhouse Gas(es)
AFOSH	Air Force Occupational	GWP	Global Warming Potential
	Safety and Health	LCZ	Lateral Clear Zone
Alpha	Alpha Launch Vehicle	LEED	Leadership in Energy and
APZ	Accident Potential Zone		Environmental Design
BGEPA	Bald and Golden Eagle	LETE	California least tern
-	Protection Act	LNM	Local Notice to Mariners
BMP	Best Management Practice	LOA	Letter of Authorization
CAA	Clean Air Act		Liquid Oxygen
CAAOS	California Ambient Air	MBTA	Migratory Bird Treaty Act
	Quality Standards	MMPA	Marine Mammal Protection Act
CalEEMod	California Emissions	N <sub>2</sub> O	Nitrous Oxide
Callennoa	Estimator Model	NAAOS	National Ambient Air Quality
CATEX	Categorical Exclusion	10,0,00	Standards
	California Coastal Commission	ΝΔSΔ	National Aeronautics and Snace
CEO	Council on Environmental Quality	11/13/1	Administration
CER	Code of Federal Regulations	ΝΕΡΔ	National Environmental Policy Act
СН	Methane	NMES	National Marine Fisheries Service
	Channel Islands National	ΝΜSΔ	National Marine Sanctuaries Act
CINING	Marine Sanctuary		National Oceanic and
CMP	Coastal Management Program	NOAA	Atmospheric Administration
CNFL		NO.	Nitrogen Oxide
CO	Carbon		Nitrogen Dioxide
	Carbon Dioxide		National Pollutant Discharge
	Carbon Dioxide Equivalent	NI DES	Flimination System
	California red-legged frog	0.	Cinimation System
CSC	California Species of CWA		Occupational and
CSC	Clean Water Act	OLLL	Environmental Exposure
C7N4A	Coastal Zone Management Act	ОСНА	Occupational Safety and Health
		USHA	
	A Weighted Decibel(s)	Dh	Administration
	A-Weighted Decider(s)		Brogrammatic Piological Opinion
	Department of Defense		Programmatic biological Opinion
DOD	Department of Transportation	PIVI <sub>10</sub>	Particulate matter less than of equal to
			Dorticulate matter less than or equal to
EA		P1V12.5	Particulate matter less than of equal to
EIS	Environmental impact Statement	in of	2.5 microns
EU	Executive Order	psr	pounds per square foot
EPA	Environmental Protection Agency	KP-1	ROCKET Propellant 1
ESA	Endangered Species Act	SBCAPC	D Santa Barbara County
F2RR	El Segundo blue butterfly		Air Pollution Control District
FAA	Federal Aviation Administration	SCCAB	South Central Coast

SE	Air Basin of California State Endangered Species
SLC-2W	Space Launch Complex 2 West
SNPL	snowy plover
SO <sub>2</sub>	Sulfur Dioxide
SSC	State Candidate Species
TCE	Trichlorethylene
THC	Toxic Hazard Corridors
U.S.	United States
USAF	U.S. Air Force
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
VAFB	Vandenberg Air Force Base
VOC	Volatile Organic Compound
VSMR	Vandenberg State Marine Reserve

## CHAPTER 1 PURPOSE AND NEED

#### SECTION 1.1 INTRODUCTION

Firefly Aerospace (Firefly) proposes to operate Alpha launch vehicles (Alpha) at Space Launch Complex 2 West (SLC-2W) and to modify SLC-2W support facilities at Vandenberg Air Force Base (VAFB), Vandenberg, California, for purposes of launching small spacecraft into orbit. To operate Alpha at SLC-2W, Firefly must obtain a launch license from the Federal Aviation Administration (FAA) Office of Commercial Space Transportation. The FAA's Proposed Action is the issuance of a launch license to Firefly at SLC-2W (see Section 2.1 for a more detailed description). Issuing launch licenses is considered a major federal action subject to environmental review under the National Environmental Policy Act (NEPA) of 1969, as amended (NEPA; 42 United States Code [U.S.C.] 4321, et seq.). The FAA is the lead federal agency and is preparing this Environmental Assessment (EA) in accordance with NEPA, Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations [CFR] parts 1500-1508), and FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*. This EA evaluates the potential environmental impacts of activities associated with the Proposed Action. The completion of the environmental review process does not guarantee that the FAA will issue a launch license to Firefly for Alpha launches at SLC-2W. Firefly's license application must also meet FAA safety, risk, and financial responsibility requirements per 14 CFR part 400.

The U.S. Air Force (USAF) prepared an Environmental Impact Analysis of the modifications to SLC-2W support facilities at VAFB and determined that the program qualified for the following Categorical Exclusions (CATEX) under 32 CFR 989, Appendix B:

- A2.3.11. 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).
- A2.3.7. 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.
- A2.3.14. Installing on previously developed land, equipment that does not substantially alter land use.

The USAF documented the application of these CATEX's on USAF Form 813 (USAF, 2019a) and identified the following EA's, which provided the basis for this determination:

- National Aeronautics and Space Administration (NASA). 1991. Environmental Assessment for the Modification of Space Launch Complex 2 West Medium Expendable Launch Vehicle Services, Vandenberg Air Force Base California.
- McDonnell Douglas Aerospace. 1996. Environmental Assessment for Launch Rate Increase at Delta II Program at Vandenberg Air Force Base. Prepared by ENSR Consulting and Engineering.

#### SECTION 1.2 FEDERAL AGENCY ROLES

#### 1.2.1 FAA OFFICE OF COMMERCIAL SPACE TRANSPORTATION

As the lead federal agency, the FAA is responsible for analyzing the potential environmental impacts of the Proposed Action. As authorized by Chapter 509 of Title 51 of the U.S. Code, the FAA licenses and regulates U.S. commercial space launch and reentry activity, as well as the operation of non-federal launch and reentry sites. The mission of the Office of Commercial Space Transportation is to ensure protection of the public, property, and the national security and foreign policy interests of the United

States during commercial launch or reentry activities, and to encourage, facilitate, and promote U.S. commercial space transportation.

#### **1.2.2** COOPERATING AGENCIES

The FAA requested the USAF (30<sup>th</sup> Space Wing; 30 SW) and NASA to participate in the NEPA process as cooperating agencies<sup>1</sup> due to their jurisdiction by law and special expertise. SLC-2W is located on VAFB property and the VAFB Center Director has ultimate responsibility for all operations that occur on VAFB property. Additionally, NASA provides special expertise with respect to environmental issues concerning space launch vehicles.

#### SECTION 1.3 PURPOSE AND NEED FOR FEDERAL ACTION

#### 1.3.1 FAA'S PURPOSE AND NEED

The purpose of FAA's Proposed Action is to fulfill the FAA's responsibilities as authorized by the Commercial Space Launch Act (51 U.S.C. Subtitle V, ch. 509, §§ 50901-50923) for oversight of commercial space launch activities, including licensing launch activities. The need for FAA's Proposed Action results from the statutory direction from Congress under the U.S. Commercial Space Launch Act, 51 U.S.C 50901(b), to, in part, "protect the public health and safety, safety of property, and national security and foreign policy interests of the United States" while "strengthening and [expanding] the United States space transportation infrastructure, including the enhancement of United States launch sites and launch-site support facilities, and development of reentry sites, with Government, State, and private sector involvement, to support the full range of United States space-related activities."

#### 1.3.2 FIREFLY'S PURPOSE AND NEED

The purpose of Firefly's proposal is to launch small satellites into polar low earth orbit using a small launch vehicle that performs with higher payload capacities than competitors. Firefly believes that the space satellite launch environment is evolving from medium- and heavy-lift orbital launches to small commercial orbital satellite launches. The shift to smaller launches is largely due to the development of an emerging market for smaller commercially used satellites, and a national security environment that demands quick launch capabilities. Firefly's stated need for its proposal is to fulfill the needs of clients in the small satellite commercial launch market. The space satellite industry has changed and led to an interest in small, responsive, and commercially focused vehicles that are low-cost solutions for private and government clients.

<sup>&</sup>lt;sup>1</sup> A cooperating agency is any federal agency other than the lead agency which has jurisdiction by law or special expertise regarding any environmental impact involved in a proposal or reasonable alternative (40 CFR §1508.5).

## CHAPTER 2 DESCRIPTION OF PROPOSED ACTION AND NO ACTION ALTERNATIVE

#### SECTION 2.1 PROPOSED ACTION

The FAA's Proposed Action is to issue a launch license to Firefly that would allow Firefly to launch Alpha rockets from SLC-2W at VAFB. Firefly is proposing to conduct 11 vertical launches per year over the next five years (2020–2024). Each launch would be preceded by a static fire engine test. The Proposed Action also includes the connected action of facility modifications at SLC-2W to support Alpha launch operations.<sup>2</sup> The following subsections provide a description of the project's location, the Alpha launch vehicle, proposed launch operations, and proposed facility modifications.

#### 2.1.1 LOCATION

VAFB consists of 98,000 acres and is located in Santa Barbara County, California (Figure 2-1 and Figure 2-2). VAFB is the only military base in the United States from which unmanned government and commercial satellites are launched into polar orbit (Military Advantage, 2019). Operations at VAFB are conducted by the USAF and other commercial parties.

Firefly's proposed Alpha flight trajectories from SLC-2W are shown on Figure 2-3. Alpha would launch over southern VAFB, the exclusive economic zone off central California, and near the Northern Channel Islands. The three proposed flight trajectories shown in Figure 2-3 (172-, 180-, and 193-degree azimuths) represent the easternmost and westernmost trajectories, as well as a due south launch trajectory.

#### 2.1.2 FACILITY MODIFICATIONS

Firefly is proposing minor modifications to SLC-2W that would occur over a period of four to six months. These modifications would be to existing equipment and structures at SLC-2W. All modifications would occur in already developed or disturbed areas within the perimeter fence of SLC-2W. A maximum daily workforce of 30 people would be present at SLC-2W during refurbishment activities.

The main facility modification is the installation of the launch pad pedestal, which would include the hydraulic lift system to raise the transport erector launcher to the vertical launch position. Firefly expects to be able to tie into the existing pedestal anchorage system that was used for Delta II launches. If third-party civil engineering research proves otherwise, boring and installation of concrete pylons may be necessary around the flame duct area.

#### 2.1.3 ALPHA LAUNCH VEHICLE

Alpha is a small, unmanned, light-lift, two-stage, liquid fueled vehicle with a gross lift-off weight of approximately 119,019 pounds and can carry payloads between 1,300 and 2,200 pounds depending on the orbit (Figure 2-4). At 95 feet in length with a diameter of 6 feet, Alpha is much smaller than many other space launch vehicles launched from VAFB.

Both the first and second stages use only liquid propellants (liquid oxygen [LOX] and rocket propellant-1 [RP-1]). Both stages use a turbo pump to feed the propellant to their respective engines. Composite over wrapped cylinders are used to store the helium that pressurizes the propellant tanks. Propellant use and specifications for each stage are described below.

<sup>&</sup>lt;sup>2</sup> Note that the FAA does not license an applicant's proposed construction or facility modifications. The USAF is responsible for authorizing the proposed facility modifications. However, the proposed facility modifications are analyzed in this EA because they are a connected action.



Figure 2-1: Regional Area Surrounding Vandenberg Air Force Base



Figure 2-2: Local Area Surrounding Vandenberg Air Force Base



Figure 2-3: Approximate Alpha Launch Vehicle Trajectories

	architecture	
Payload Fairing Carbon Composite Structure 2.2 m [7.2 ft] Diameter 12.5 m <sup>3</sup> [441.4 ft <sup>3</sup> ] of Internal Volume All Pneumatic Low Shock Fairing Separation	Payload 1,000 kg LEO 28.5°, 200 km 850 kg LEO 45°, 500 km 600 kg to 600 km SSO Standardized Secondary Payload Adapter 6 Ports @ 15″ bolt interface	
Payload Attach Fitting (PAF) 38.81" bolt interface, compatible with 937 clamp-band Stage 2 Avionics Flight Computer Multi-Band Path Array Antennae GPS/IMU Navigation Power Conditioning & Distribution Unit (PCDU) Sciencial Duino	Stage 2 LOX Tank All Composite Construction Design MEDP 80 psi Stage 2 Fuel Tank All Composite Construction Design MEDP 80 psi	
Data Acquisition Chassis (DAC) Telemetry Transmitter Lithium Polymer Batteries Flight Termination System Interstage Houses Second Stage Engine Hot Gas Stage Separation Carbon Composite	Stage 2 Helium Tank     Aluminum Liner     Design MEDP 5500 psi      Stage 2 Engine     Lightning 1     Qty Engines: 1     Propellant: L0X/RP-1     Thrust: 70 kN [15.7 klb <sub>t</sub> ] (vac)     Isp: 322.0 seconds (vac)      Stage 1 LOX Tank	
Stage 1 Avionics Power Conditioning & Distribution Unit (PCDU) Solenoid Drive Data Acquisition Chassis (DAC) Lithium Polymer Batteries	All Composite Construction Design MEDP 80 psi Stage 1 Helium Tanks Aluminum Liner Design MEDP 5500 psi Stage 1 Fuel Tank All Composite Construction Design MEDP 80 psi	
<b>Alpha LV</b> GLOW 54.120 kg (119,314 lbm) Height 29.75 m (97.6 ft) Stage 1 Dry Mass- 2.895 kg (6.382 lbm) Stage 2 Dry Mass- 909 kg (2.006 lbm)	Stage 1 Engine Reaver 1 Uty Engines: 4 Propellant: LOX/RP-1 Thrust: 736 kN (165.5 klb <sub>t</sub> ] (vac) Isp: 295.6 seconds (vac)	

Source: Firefly Aerospace (2019) Figure 2-4: Depiction of the Alpha Launch Vehicle

#### 2.1.3.1 First Stage

The first stage consists of carbon composite structure LOX and RP-1 tanks separated by an intertank. The stage is powered by four Reaver engines that produce a total thrust of approximately 165,459 pounds. Roll control and thrust vector control use hydraulic actuators and the on-board RP-1. The propellant tanks hold 6,715 gallons (63,792 pounds) of LOX and 4,346 gallons (29,552 pounds) of RP-1. During a launch, the first stage and fairing would separate and fall to the ocean and would not be recovered.

Alpha launch trajectories would vary by mission to support a specific customer need. They would fall within the upper and lower allowable launch azimuths (153 degrees to 301 degrees), as defined per Section 1.3.2 for the Western Range in AFSPCMAN 91-710 Vol 1 (3 November 2016), Range Safety Requirements. Approved launch azimuths would be based on risk analysis for a specific mission. Typical trajectories from SLC-2W would be for polar and sun-synchronous orbits. The first stage would splash down in the open ocean approximately 575 miles downrange on the approved launch trajectory.

#### 2.1.3.2 Second Stage

The second stage consists of carbon composite structure LOX and RP-1 tanks separated by an intertank. The stage is powered by a Lightning engine that produces 15,737 pounds of thrust and uses helium for attitude control and hydraulic actuators for thrust vector control. The propellant tanks hold 1,065 gallons (10,117 pounds) of LOX and 670 gallons (4,556 pounds) of RP-1. The second stage would remain in orbit for its mission life.

#### 2.1.3.3 Payload Fairing

The Alpha payload fairing is 16.4 feet tall with a diameter of 6.6 feet. The fairing separates into two pieces prior to deploying the payload. An acoustical foam system inside the fairing provides environmental protection for the spacecraft during vehicle ascent.

#### 2.1.3.4 Flight Termination System

Alpha would be equipped with a destructive flight termination system in the event Alpha varies from the planned flight trajectory. The destructive termination system would include two linear-shaped charges that would be intended to rupture the vehicle tanks when commanded to destruct, thus dispersing propellants and breaking up the vehicle to minimize the impact on ground assets and protect the public.

#### 2.1.3.5 Pre-Flight and Post-Flight Activities

Alpha's stages and fairing are manufactured in Texas and shipped by diesel truck to SLC-2W for final assembly. Final assembly requires the use of solvents for cleaning electrical contacts and bonding surfaces, adhesives for joining and securing equipment and covers, and paints and other surface coatings to protect specialized parts. Because the component parts are manufactured offsite and arrive nearly ready for launch, the quantities of material used for assembling the parts are minimal. Any hazardous waste generated would be processed in accordance with hazardous materials procedures approved by the 30 SW (see Section 3.10 for more information regarding hazardous materials).

Once Alpha is fully assembled with the payload, final preparation for launch begins, including propellant loading and checking systems for proper operation. Just before the engines are ignited, water is sprayed from a ring below the main engine into the flame duct for purposes of minimizing the back pressure from engine ignition. The water flows for about 1 to 2 minutes and is collected in a basin at the bottom of the flame trough adjacent to the launch pad. Following a launch, the launch pad is washed down, and the water is captured in the basin associated with the flame trough. All of the water used during launch activities would be analyzed to determine if it meets the local water board's standards that would allow the water to be discharged to grade. Firefly would apply for a conditional permit from the local water

board. Upon conditionally approving the permit for launch water activities, the water board would notify Firefly of the specific threshold limits for contaminants in launch water for release to grade. Those threshold limits would determine the specific laboratory methods used to analyze the water samples. Water containing prohibited chemical levels would be removed and hauled to an approved industrial wastewater treatment facility outside VAFB.

In the event a launch is aborted after the fuel and oxidizer have been loaded, the propellants would be removed from Alpha and returned to their original storage vessels.

#### SECTION 2.2 NO ACTION ALTERNATIVE

Under the No Action Alternative, the FAA would not issue a launch license to Firefly for Alpha launches at SLC-2W and Firefly would not conduct facility modifications at SLC-2W. There would be no launch operations at SLC-2W. This alternative provides the basis for comparing the environmental consequences of the Proposed Action.

# CHAPTER 3 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

#### SECTION 3.1 INTRODUCTION

This chapter provides a description of the affected environment and potential environmental consequences for the environmental impact categories that have the potential to be affected by the Proposed Action and No Action Alternative. The environmental impact categories assessed in this EA include air quality; climate; coastal resources; Department of Transportation (DOT) Act, Section 4(f); noise and noise-compatible land use; socioeconomics, environmental justice, and children's environmental health and safety risk; biological resources; hazardous materials, solid waste, and pollution prevention; and water resources.

The study area varies based on the environmental impact category being analyzed and is defined for each environmental impact category in this chapter. For some environmental impact categories, such as biological resources, the study area includes all areas where sonic boom overpressures could be experienced. To determine this area, 30 different meteorological conditions were used for each launch trajectory to determine a composite "footprint" of where sonic booms could be experienced. Figure 3-1 shows the general study area that includes SLC-2W, the westernmost and easternmost flight trajectories, and predicted downrange sonic boom overpressures for all proposed launch trajectories and meteorological conditions. Figure 3-2 represents the potential sonic boom overpressures (>0.5 pounds per square foot [psf]) from one launch trajectory and one meteorological condition. These figures are referred to in the affected environment discussion below as appropriate.

The level of detail provided in this chapter is commensurate with the importance of the potential impact on the environmental impact categories (40 CFR § 1502.15). The following environmental impact categories are not analyzed in detail for the reasons stated.

- **Farmlands:** The Proposed Action does not involve construction activities on undisturbed lands or farmlands. Additionally, there would be no conversion of prime agricultural land to other uses and no decrease in agricultural productivity. Therefore, the Proposed Action would not impact farmlands.
- Historical, Architectural, Archeological, and Cultural Resources: Portions of SLC-2W and the
  adjacent area have been surveyed on several occasions for cultural resources (USAF, 2008). There
  are no archeological resources or historic properties listed on the National Register of Historic Places
  present at SLC-2W. The USAF consulted the California State Historic Preservation Officer (SHPO)
  regarding Firefly's proposal regarding facility modifications as well as the action of ceasing NASA
  operations at SLC-2 (East and West). The USAF made a finding of no adverse effect. The SHPO
  concurred with this finding (see Appendix B). The FAA also consulted the SHPO for the FAA's
  undertaking regarding the launches themselves. The SHPO concurred with the FAA's finding of no
  adverse effect (see Appendix B). Thus, the Proposed Action would not impact historical,
  architectural, archeological, and cultural resources.
- Land Use: The Proposed Action would not change land use or affect land use planning at VAFB. The Proposed Action would not conflict with 30 SW environmental plans or goals, USAF regulations, permit requirements, or existing uses of the proposed project area or other facilities nearby. Therefore, the Proposed Action would not impact land use.
- Natural Resources and Energy Supply: The Proposed Action would not result in any measurable effect on local supplies of energy or natural resources. The Proposed Action would not result in the development of new facilities or result in notable changes in local energy demands or consumption of other natural resources. The Proposed Action would not require additional sources of power or

other public utilities. Therefore, the Proposed Action would not impact natural resources and energy supply.

• Visual Effects (including Light Emissions): The Proposed Action would not require any additional light sources at SLC-2W for launch operations. Launch lighting would not create annoyance or interfere with normal activities from light emissions and would not affect the visual character of the area due to light emissions because VAFB is a federal launch site with a long history of rocket launches. For the same reason, Alpha launches would not affect the nature of the visual character of the area, contrast with the visual resources and/or visual character of VAFB, or block or obstruct the views of visual resources. Therefore, the Proposed Action would not result in impacts related to visual effects.



Figure 3-1: General Study Area and Sonic Boom Peak Overpressure Footprint



Figure 3-2: General Study Area and Sonic Boom Peak Overpressure from One Launch

#### SECTION 3.2 NO ACTION ALTERNATIVE

Under the No Action Alternative, the FAA would not issue a launch license to Firefly for Alpha launches at SLC-2W and Firefly would not conduct facility modifications at SLC-2W. There would be no launch operations at SLC-2W. Thus, under the No Action Alternative, there would be no impacts related to air quality; climate; coastal resources; DOT Act, Section 4(f); noise and noise-compatible land use; socioeconomics, environmental justice, and children's environmental health and safety risks; biological resources; hazardous materials, solid waste, and pollution prevention; or water resources.

#### SECTION 3.3 AIR QUALITY

#### 3.3.1 DEFINITION OF RESOURCE AND REGULATORY SETTING

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

Under the Clean Air Act (CAA), the U.S. Environmental Protection Agency (EPA) developed the National Ambient Air Quality Standards (NAAQS) for six common air pollutants (EPA, 2016). These criteria air pollutants are carbon monoxide (CO), nitrogen dioxide ( $NO_2$ ), ozone ( $O_3$ ), particulate matter, sulfur dioxide ( $SO_2$ ), and lead (Pb) (FAA, 2015). The EPA determined that these criteria air pollutants may harm human health and the environment, and cause property damage. The EPA regulates these pollutants to permissible levels through human health-based (primary standards) and environmental-based (secondary standards) criteria (EPA, 2016). Additional information on the CAA and the NAAQS can be found in the FAA Order 1050.1F Desk Reference (FAA, 2015).

The State of California has also established California Ambient Air Quality Standards (CAAQS) and identified four additional pollutants for ambient air quality standards: visibility reducing particles, sulfates, hydrogen sulfide, and vinyl chloride (CARB, 2019). Areas within California in which ambient air concentrations of a pollutant are higher than the state or federal standard are considered to be non-attainment for that pollutant.

Toxic air pollutants, also called hazardous air pollutants, are a class of pollutants that do not have ambient air quality standards but are examined on an individual basis when there is a significant source of these pollutants. These emissions are typically one or more orders of magnitude smaller than concurrent emissions of criteria air pollutants and only become a concern when large amounts of fuel, explosives, or other materials are consumed during a single activity or in one location. Because only small quantities of hazardous air pollutants would be emitted into the lower atmosphere from construction activities, the potential for exposure is very low and the risk presented by the emissions is similarly very low. A quantitative evaluation of hazardous air pollutant emissions is thus not warranted and was not conducted. The sources associated with the Proposed Action, including equipment associated with facility modifications and the launches of the Alpha rockets themselves, would emit only minor quantities of air toxics, and accordingly air toxics are not assessed further.

#### 3.3.2 STUDY AREA

The study area for air quality includes SLC-2W and the surrounding area that would receive air emissions from facility modifications and Alpha launches, and extends up to 3,000 feet above ground level (i.e., the mixing height). The mixing height is defined as the vertical region of the atmosphere where pollutant mixing occurs. Above this height, pollutants that are released generally do not mix with ground level emissions and do not have an effect on ground level concentrations in the local area. The study area is

located in Santa Barbara County and lies within the South Central Coast Air Basin of California (SCCAB). The Santa Barbara County Air Pollution Control District (SBCAPCD) is the agency responsible for the federal and state air quality laws, regulations, and policies in this county.

#### **3.3.3** EXISTING CONDITIONS

Santa Barbara County is in attainment with the NAAQS for all criteria pollutants (EPA, 2019). Santa Barbara County is currently in non-attainment with the CAAQS for  $O_3$  and  $PM_{10}$  and in attainment with the CAAQS for all other air pollutants regulated by California (SBCAPCD, 2019).

#### 3.3.4 ENVIRONMENTAL CONSEQUENCES

Air quality impacts would be significant if the action would cause pollutant concentrations to exceed one or more of the NAAQS, as established by the EPA under the CAA, for any of the time periods analyzed, or to increase the frequency or severity of any such existing violations.

The Proposed Action includes minor modifications to SLC-2W that would occur over a period of four to six months. Table 3-1 lists the equipment type, quantity, make/model, and horsepower for each piece of equipment scheduled for construction, and the estimated number of days the equipment would operate.

Equipment Description	Quantity	Make/Model	Horse Power	Estimated Usage (days) <sup>a</sup>
Excavator	1	2017/Cat 326 F L	204	10
Excavator with Breaker	1	2017/Cat 326 F L	204	5
Super 10-wheel dump trucks	4	2014/PETERBILT 348	300	2
Skip Loader	1	2017/Deere 210	93	5
Backhoe	1	2017/Deere 310	93	5
Smooth Drum Roller	1	2017/Cat CB34B	48.8	5
Transfer dump trucks	3	2014/PETERBILT 348	300	3
Cement truck	13	2005/PETERBILT mixer	335	4

#### Table 3-1: Estimated Equipment Usage Under the Proposed Action

<sup>a</sup> Estimated usage is based on 5 working days per week at 8 hours per day.

To calculate criteria pollutant emissions associated with facility modifications, emissions factors were taken from the California Emissions Estimator Model (CalEEMod) website for all criteria pollutants (BREEZE Software, 2017). These emissions factors were analyzed with the construction schedule to produce emissions estimates. This analysis uses the USEPA General Conformity thresholds (40 CFR 93.153[b]) as screening thresholds. If the estimated emissions are less than the screening thresholds, then the emissions are considered not to have the potential to lead to an exceedance of the NAAQS or CAAQS. As shown in Table 3-2, facility modification emissions would not exceed the screening thresholds for any criteria pollutant. Nevertheless, dust mitigation measures would be implemented as required by the State of California's 1979 Air Quality Attainment Plan. Note that emissions of less than 0.049 ton per year are reported as 0 for all tables in this section.

Emissions (tons/year)							
Construction Phase	VOC	NO <sub>x</sub>	со	SO <sub>x</sub>	PM <sub>10</sub>		
Demolition							
Fugitive Dust	-	-	-	-			
Heavy Construction Equipment	0.01	0.10	0.03	0	0		
On-road Diesel	0.01	0.10	0.04	0	0		
Construction Worker Travel	0	0	0	0	0		
Subtotal	0.02	0.20	0.08	0	0.01		
		Gra	ding				
Fugitive Dust	-	-	-	-			
Heavy Construction Equipment	0.01	0.05	0.04	0	0		
On-road Diesel	0.01	0.14	0.07	0	0		
Construction Worker Travel	0	0	0	0	0		
Subtotal	0.02	0.19	0.11	0	0.01		
Paving - Pad Construction							
On-road Diesel	0.06	0.58	0.20	0	0.02		
Construction Worker Travel	0	0	0	0	0		
Subtotal	0.06	0.58	0.20	0	0.02		
Total Annual Emissions							
Total Annual Emissions	0.09	0.96	0.38	0.01	0.04		
Screening threshold	100	100	100	100	100		
Exceeds threshold?	No	No	No	No	No		

#### Table 3-2: Proposed Action Construction Emissions (tons/year)

Notes: CO = carbon monoxide;  $NO_x$  = nitrogen oxide;  $PM_{10}$  = particulate matter less than 10 microns;  $SO_x$  = sulfur dioxide; VOC = volatile organic compound.

To calculate criteria pollutant emissions associated with a launch, emissions factors were taken from Appendix D of the FAA's *Final Programmatic Environmental Impact Statement for Streamlining the Processing of Experimental Permit Applications* (FAA, 2009). Alpha uses a mixture of RP-1 and LOX in the first stage. Criteria pollutant emissions were only calculated while Alpha is below the mixing height (i.e., 3,000 feet or less).

The majority of emissions from burning RP-1 and LOX would be nitrogen gas and oxygen gas, while a smaller amount of carbon dioxide (CO<sub>2</sub>), CO, and argon would also be released. Trace amounts of other criteria pollutants could be released from the launch, but their total amounts would be insignificant and are reported as zero (USAF, 2016b). Total estimated criteria pollutant emissions for an individual Alpha launch are shown in Table 3-3.

Emissions (tons/launch)						
Operations	VOC	NOx	СО	SOx	<b>PM</b> <sub>10</sub>	
Alpha Launch	0	0	0.09	0	0	

#### Table 3-3: Emissions per Alpha Launch

Notes: CO = carbon monoxide; NO<sub>x</sub> = nitrogen oxide;  $PM_{10}$  = particulate matter less than 10 microns; SO<sub>x</sub> = sulfur dioxide; VOC = volatile organic compound.

A summary of annual emissions from all aspects of the Proposed Action is provided in Table 3-4. Emissions for all criteria pollutants would be below the screening threshold, and therefore would not lead to exceedance of the NAAQS. For those pollutants currently in non-attainment with the CAAQS (O<sub>3</sub> and PM<sub>10</sub>), the analysis shows that neither would exceed the screening thresholds. Therefore, the Proposed Action would not result in significant impacts on air quality.

Total Emissions (tons) for Launch and Construction						
Operations	VOC	NOx	СО	SOx	PM10	
Construction	0.09	0.96	0.38	0.01	0.04	
55 Launches	0	0	5.06	0	0	
Total	0.09	0.96	5.44	0.01	0.04	
Screening	100	100	100	100	100	

#### Table 3-4: Summary of All Emissions from Proposed Action

Notes: CO = carbon monoxide;  $NO_x$  = nitrogen oxide;  $PM_{10}$  = particulate matter less than 10 microns;  $SO_x$  = sulfur dioxide; VOC = volatile organic compound.

No

No

No

No

#### SECTION 3.4 CLIMATE

Threshold Exceeds

threshold?

#### 3.4.1 DEFINITION OF RESOURCE AND REGULATORY SETTING

No

Climate change is a global phenomenon that can have local impacts. Scientific measurements show that Earth's climate is warming, with concurrent impacts including warmer air temperatures, increased sea level rise, increased storm activity, and an increased intensity in precipitation events. Research has shown there is a direct correlation between fuel combustion and greenhouse gas (GHG) emissions. GHGs are defined as including carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF<sub>6</sub>). CO<sub>2</sub> is the most important anthropogenic GHG because it is a long-lived gas that remains in the atmosphere for up to 100 years.

GHGs have varying global warming potential (GWP). The GWP is the potential of a gas or aerosol to trap heat in the atmosphere; it is the "measure of the total energy that a gas absorbs over a particular period of time (usually 100 years), compared to carbon dioxide" (EPA, 2016). The reference gas for GWP is CO<sub>2</sub>; therefore, CO<sub>2</sub> has a GWP of 1. The other main GHGs that have been attributed to human activity include CH<sub>4</sub>, which has a GWP of 28, and N<sub>2</sub>O, which has a GWP of 265 (Myhre et al. 2013). CO<sub>2</sub>, followed by CH<sub>4</sub> and N<sub>2</sub>O, are the most common GHGs that result from human activity. CO<sub>2</sub>, and to a lesser extent, CH<sub>4</sub> and N<sub>2</sub>O, are products of combustion and are generated from stationary combustion sources as well as vehicles. The following formula is used to calculate the Carbon Dioxide Equivalent (CO<sub>2</sub>e).

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

The FAA has developed guidance for considering GHGs and climate under NEPA, as published in the Desk Reference to Order 1050.1F.<sup>3</sup> An FAA NEPA review should follow the basic procedure of considering the potential incremental change in CO<sub>2</sub> emissions that would result from the proposed action and alternative(s) compared to the no action alternative for the same timeframe, and discussing the context for interpreting and understanding the potential changes. For such reviews, this consideration could be qualitative (e.g., explanatory text), but may also include quantitative data (e.g., calculations of estimated project emissions).

There are local GHG emissions requirements as well. On April 30, 2015, the SBCAPCD adopted revisions to their Environmental Review Guidelines to the California Environmental Quality Act by adding significance thresholds for GHG cumulative impacts. The District has adopted a screening threshold of 10,000 metric tons of CO<sub>2</sub>e per year.

#### 3.4.2 STUDY AREA

The study area for climate includes the SCCAB. However, GHG emissions for this project are considered globally since climate change is a global issue. This means GHG emissions are calculated for all proposed facility modifications at SLC-2W and considered at all altitudes for an Alpha launch.

#### 3.4.3 EXISTING CONDITIONS

In 2018, the reported GHG emissions for VAFB was 18,173.24 metric tons. The 30 SW is working to reduce its carbon footprint. In 2018, a 22.5-megawatt solar farm was unveiled and Building 7000 is expected to be certified at a minimum of Silver by the Leadership in Energy and Environmental Design (LEED) rating system. Overall, the 30 SW is trying to be more energy independent and reduce their carbon footprint in a sustainable way (30th Space Wing Public Affairs, 2017).

#### 3.4.4 ENVIRONMENTAL CONSEQUENCES

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

Because facility modifications at SLC-2W and Alpha launches themselves are connected actions, GHG emissions from both activities are included in the analysis. To calculate GHG emissions associated with facility modifications, all emissions factors other than those for N<sub>2</sub>O were taken from the CalEEMod website (BREEZE Software, 2017). The emissions factors for N<sub>2</sub>O were taken from the *Federal Register* (FR) (78 FR 71903). To calculate GHG emissions associated with an Alpha launch, emissions factors for CO<sub>2</sub> were taken from Appendix D of the FAA's *Final Programmatic Environmental Impact Statement for Streamlining the Processing of Experimental Permit Applications* (FAA, 2009).<sup>4</sup> Emissions factors for CH<sub>4</sub> and N<sub>2</sub>O were taken from the EPA's *Emission Factors for Greenhouse Gas Inventories* (EPA, 2018).

Table 3-5: shows a summary of total GHG emissions from the Proposed Action. Facility modifications would produce approximately 66.78 metric tons (73.62 tons) of  $CO_2$ , 0.01 metric tons (0.01 tons) of  $CH_4$ , and insignificant amounts (less than 0.0049 metric tons) of  $N_2O$  (reported as 0 in the table). A single

3

https://www.faa.gov/about/office\_org/headquarters\_offices/apl/environ\_policy\_guidance/policy/faa\_nepa\_order/desk\_ref/m edia/desk-ref.pdf

<sup>&</sup>lt;sup>4</sup> Although Section 3.3.2 of the FAA Order 1050.1F Desk Reference contains conversions factors to use in an FAA climate-related analysis, these conversion factors are for jet fuel and not rocket propellant.

Alpha launch would produce approximately 2.60 metric tons (2.86 tons) of CO<sub>2</sub> and insignificant amounts of CH<sub>4</sub> and N<sub>2</sub>O. Under the Proposed Action, there will be 11 launches per year for 5 years. During these 55 launches, approximately 134.57 metric tons (148.36 tons) of CO<sub>2</sub>, 0.10 metric tons (0.11 tons) of CH<sub>4</sub>, and 0.02 metric tons (0.02 tons) of N<sub>2</sub>O would be emitted. Overall, the Proposed Action would produce a maximum of approximately 67.22 metric tons (74.12 tons) of CO<sub>2</sub>e during facility modifications and a maximum of approximately 142.61 metric tons (157.24 tons) from all launches. These CO<sub>2</sub>e values combined are less than the SBCAPCD's significance threshold of 10,000 metric tons of CO<sub>2</sub>e per year and significantly less than a previous threshold of 25,000 metric tons per year proposed by the CEQ in 2014. Therefore, emissions from the Proposed Action would not have a significant impact related to climate.

Sconorio (Activity	Total Metric Tons			
Scenario/Activity	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	CO <sub>2</sub> e
Total GHG Emissions associated with Facility	66.78	0.01	0	67.22
Modifications				
GHG Emissions for Launch Events	134.57	0.10	0.02	142.61
Maximum Total Annual GHG Emissions from the	201.34	0.11	0.02	209.84
Proposed Action				
2018 Annual GHG Emissions at VAFB	-	-	-	18,173.24

#### Table 3-5: Summary of Total Greenhouse Gas Emissions from the Proposed Action

Notes:  $CH_4$  = methane;  $CO_2$  = carbon dioxide;  $CO_2e = (CO_2 * 1) + (CH_4 * 28) + (N_2O * 265)$ ; GHG = greenhouse gas;  $N_2O$  = nitrous oxide, VAFB = Vandenberg Air Force Base.

#### SECTION 3.5 COASTAL RESOURCES

#### 3.5.1 DEFINITION OF RESOURCE AND REGULATORY SETTING

Coastal resources include natural resources occurring within coastal waters and their adjacent shorelands. Coastal resources include islands, transitional and intertidal areas, salt marshes, wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as fish and wildlife and their respective habitats within these areas. Coastal resources include the coastlines of the Atlantic and Pacific oceans, the Great Lakes, and the Gulf of Mexico.

Relevant laws pertaining to coastal resources that are applicable to this project include the Coastal Zone Management Act (CZMA) and National Marine Sanctuaries Act (NMSA). Per the CZMA and its regulations (15 CFR 930), an applicant seeking a permit, license, or other authorization from a federal agency must consult the relevant state agency to ensure its project is consistent with the state's coastal management program. The NMSA protects areas of the marine environment with special national significance, and requires federal agencies whose actions could impact sanctuary resources to consult with the National Oceanic and Atmospheric Administration before taking action. More information on coastal resources can be found in the FAA Order 1050.1F Desk Reference (FAA, 2015).

As defined by the CZMA at 16 U.S.C. § 1453(1), 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." Firefly's proposed launch activities, including facility modifications, would occur at VAFB, which is wholly owned and operated by the Department of Defense and is therefore excluded from the coastal zone. However, the USAF is required to maintain consistency with the CZMA and is responsible for making final coastal zone determinations for its activities occurring within the state coastal zone or having effects on it.
Similarly, although FAA licenses are not subject to certification for consistency with the California Coastal Management Program (CMP),<sup>5</sup> as a matter of policy, the FAA will not issue a license, permit, or authorization to an applicant unless the applicant's proposed action meets the consistency requirements of the state's coastal management program. The California Coastal Commission (CCC) reviews federally authorized projects for consistency with the California CMP.

## 3.5.2 STUDY AREA

The study area for coastal resources includes California's coastal zone, which extends 3,000 feet inland and up to 3 nautical miles seaward, as well as the Channel Islands National Marine Sanctuary (CINMS), which could be exposed to a sonic boom during a launch (see Figure 3-1). The study area includes SLC-2W.

## 3.5.3 EXISTING CONDITIONS

Coastal resources in the study area include coastal and marine wildlife and their respected habitats, intertidal areas, beaches, and the CINMS. Wildlife and habitats in the study area are discussed in Section 3.9.3. Beaches in the study area are discussed in Section 3.6.3 as part of the Section 4(f) analysis.

The CINMS is a collection of marine reserves and marine sanctuaries located at the Channel Islands, approximately 40 miles south of SLC-2W (Figure 3-3). CINMS regulations (15 CFR § 922.72(a)(1)) prohibit taking any marine mammal, sea turtle, or seabird within or above the CINMS, except as authorized by the Marine Mammal Protection Act (MMPA), Endangered Species Act (ESA), Migratory Bird Treaty Act (MBTA), or any regulation promulgated under the MMPA, ESA, or MBTA.

In addition, the coastline from Purisima Point to just north of Point Arguello (see Figure 3-3) has been designated as the Vandenberg State Marine Reserve (VSMR) pursuant to the Marine Managed Areas Improvement Act. The VSMR management objectives include providing for complete protection of a diverse area containing shallow hard and soft habitats, kelp beds, and associated marine life. A Memorandum of Understanding regarding the VSMR was established between the California Department of Fish and Wildlife and the 30 SW. Within the VSMR, no take of living marine resources is permitted except take incidental to the mission-critical activities of the 30 SW. Mission critical activities include, but are not limited to, all those activities that are important for the support and defense of U.S. launch, range, expeditionary, exercise, test, training, and installation operations, including, but not limited to, commercial space launch vehicles.

<sup>&</sup>lt;sup>5</sup> See: https://www.coastal.ca.gov/fedcd/listlic\_2015.pdf.



#### Figure 3-3: Sensitive Marine Habitats

## 3.5.4 ENVIRONMENTAL CONSEQUENCES

The FAA has not established a significance threshold for coastal resources, but has identified factors to consider when assessing the significance of potential impacts on coastal resources. These include situations in which the action would have the potential to:

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

The Proposed Action would not impact a coastal barrier resources system unit or coral reef system because neither is located within the study area. Per FAA regulations, the FAA would not issue Firefly a launch license if the FAA determined the project would cause an unacceptable risk to human safety or property.

The proposed facility modifications at SLC-2W would not affect coastal resources because the area is already developed and is far enough away from the coastline such that there is no potential to affect coastal resources, including any nearby beaches. Refer to Sections 3.6.4 and 3.9.4 for a discussion of potential impacts to nearby beaches and coastal and marine wildlife and habitats, respectively, from Alpha launches. The analysis concludes the Proposed Action would not result in significant impacts on these resources.

Impacts on marine resources within the VSMR would be limited to engine noise, which would be temporary and commensurate with prior activities at VAFB. During an Alpha launch, a sonic boom would be generated and could impact the Northern Channel Islands, including the CINMS (see Figure 3-1 and Section 3.7 for a discussion of noise). On these islands, the predicted maximum overpressure that could be experienced is 2 psf. The majority of the sonic boom would impact the open ocean. A sonic boom could impact the Northern Channel Islands up to 11 times per year. The potential impacts on the islands and associated natural resources (including wildlife and habitat) would be acoustic in nature and likely result in temporary wildlife behavioral disruptions (e.g., a startle response). Any potential take of federally protected species is addressed through consultation with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). Refer to Section 3.9 for further discussion regarding protected species.

The USAF consulted the CCC regarding the proposed changes to SLC-2W to ensure the project is consistent with the California CMP. The CCC stated there is no need for the USAF to submit a negative determination or consistency determination for the changes. Therefore, the Proposed Action is consistent with the California CMP and would not result in significant impacts on coastal resources.

# SECTION 3.6 DEPARTMENT OF TRANSPORTATION ACT, SECTION 4(f)

## 3.6.1 DEFINITION OF RESOURCE AND REGULATORY SETTING

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

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

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 (FHWA) 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 on the FAA; however, the FAA may use them as guidance to the extent relevant to FAA projects. More information on DOT Act, Section 4(f) can be found in the FAA Order 1050.1F Desk Reference (FAA, 2015).

# 3.6.2 STUDY AREA

The study area for Section 4(f) is defined by the debris impact corridor and noise footprint of the Proposed Action, including noise generated by Alpha's engines during launch and the downrange sonic boom footprint that could impact the Northern Channel Islands (see Figures 3-1, 3-2, and 3-5).

# 3.6.3 EXISTING CONDITIONS

Potential Section 4(f) properties within the study area include Jalama Beach County Park, Surf Beach, County of Santa Barbara Ocean Beach Park, Miguelito Park, Rancho Guadalupe Dunes County Park, Point Sal Beach State Park, Gaviota Beach State Park, and the Channel Islands National Park (see Figure 3-4). Surf Beach, Ocean Beach, and Jalama Beach are closest to SLC-2W. Surf Beach is located southwest of SLC-2W at the end of Ocean Avenue. This is the only public access beach on VAFB and is the site of the Lompoc-Surf Station Amtrak stop for the Pacific Surfliner. Areas north and south of the beach are closed March through September for western snowy plover nesting season. From October to February, the beach is accessible by walking from Ocean Beach County Park, which is located south of SLC-2W. Ocean Beach County Park is a day use-only park, providing recreational opportunities such as bird watching, nature photography, and picnic facilities, from 8:00 a.m. to sunset. Jalama Beach County Park is located south of SLC-2W. A popular camping spot, Jalama Beach maintains 98 campsites overlooking the ocean or beachfront with peak attendance over the summer and holiday weekends. In addition to camping facilities, Jalama Beach offers picnicking, surfing, whale watching, bird watching, nature photography, and fishing.

Miguelito Park offers hiking trails, playground, horseshoes, BBQ grills, and group picnic area. The park is small and located inland of SLC-2W, outside of any noise contour or debris impact areas. The Rancho Guadalupe Dunes County Park is situated north of SLC-2W and VAFB. It is outside of any noise contour or debris impact areas. The park contains miles of pristine sand dunes and sensitive plants and animals such as western snowy plover and California least tern. Point Sal Beach State Park is located to the north of SLC-2W on VAFB, outside of any noise contour or debris impact area. Recreational activities at the beach include fishing, beach combing, hiking, nature study, photography, picnicking, and sunbathing. Swimming is not recommended. Gaviota Beach State Park is located southwest of SLC-2W and VAFB, outside of any noise contour or debris impact area. The state park offers camping and beach activities.

The Channel Islands National Park is within the noise footprint of Alpha. There are no services such as food or gear stores or rental shops on the five islands off of the west coast. Activities on the island include hiking, camping, snorkeling, kayaking, whale watching, birdwatching, and taking photographs, among others.



Figure 3-4: Potential Section 4(f) Properties in the Study Area

## 3.6.4 ENVIRONMENTAL CONSEQUENCES

Impacts on Section 4(f) properties would be significant if the 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, 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.

Associated facility modifications at SLC-2W would not result in restricted access to any potential Section 4(f) property. As discussed in Section 3.7.4, noise levels from construction activities would not be audible above typical ambient noise levels at the closest noise-sensitive areas, including the beaches and parks identified above and shown in Figure 3-4. Construction noise would be intermittent and last approximately four to six months. Therefore, facility modifications at SLC-2W would not result in a use of any potential Section 4(f) property.

Alpha launches temporarily would close public access to Surf Beach, Ocean Beach, and Jalama Beach County Parks, because these beaches and parks fall within the launch hazard area. Although the beaches and parks would not be directly over flown by Alpha, a launch anomaly could impact them. Therefore, for public safety reasons, the County Parks Department and the County Sheriff close public access upon request from the 30 SW. Since 1979, an evacuation and closure agreement had been in place between USAF and Santa Barbara County (see Appendix B). The agreement recently expired and the parties are in the process of renewing it. The renewed agreement is expected to be executed by July 1, 2020.<sup>6</sup> The agreement will include closing public access to Surf Beach, Ocean Beach, and Jalama Beach County Parks during launches. Under this agreement, USAF will send an evacuation notice to the listed county parks at least 72 hours prior to the closure, and the closure is not to exceed 48 hours. The notice will state a hazardous operation will occur. Under the Proposed Action, closure of the beaches and parks would have the potential to occur up to 11 times per year. The closure would only last as long as necessary to assure the public is safe during a launch (approximately six to eight hours).

Surf Beach and County of Santa Barbara Ocean Beach Park may experience up to 60 A-weighted decibels (dBA) during the Alpha launch activities. The other Section 4(f) properties would experience sound at lower levels during Alpha launches. Alpha launches would potentially create a sonic boom over small portions of the Channel Islands National Park at a maximum of 1.51 to 2.0 psf (see Figure 3-1). Both launch noise and sonic booms are classified as short-duration events. Given the small area of potential impact over the Channel Islands, and the short-duration of the event, impacts as a result of the sonic boom overpressure would not result in significant impacts to the Channel Islands National Park.

Given the history of beach and park closures for launches at VAFB, the formal evacuation agreement that had been in place since 1979 (and for which is expected to be renewed in July 2020), and the temporary nature of the closures, the FAA has determined the Proposed Action would not substantially

<sup>&</sup>lt;sup>6</sup> This agreement is expected to be executed prior to the commencement of Firefly's launch events. The FAA will monitor the status of an evacuation agreement between USAF and Santa Barbara County.

diminish the protected activities, features, or attributes of any of the potential Section 4(f) properties, and therefore the Proposed Action would not result in a constructive use of any Section 4(f) property. Therefore, the Proposed Action would not result in significant DOT Act Section 4(f) impacts.

# SECTION 3.7 Noise and Noise-Compatible Land Use

## 3.7.1 DEFINITION OF RESOURCE AND REGULATORY SETTING

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

The compatibility of existing and planned land uses with proposed FAA actions is usually determined in relation to the level of aircraft (or launch vehicle) noise. Federal compatible land use guidelines for a variety of land uses are provided in Table 1 in Appendix A of 14 CFR part 150, *Land Use Compatibility with Yearly Day-Night Average Sound Levels*.

The FAA has determined that the cumulative noise energy exposure of individuals to noise resulting from FAA actions must be established in terms of yearly Day-Night Average Sound Level (DNL), the FAA's primary noise metric. The Community Noise Equivalent Level (CNEL) may be used in lieu of DNL for FAA actions needing approval in California. DNL and CNEL account for the noise levels of all individual aircraft/launch vehicle events, the number of times those events occur, and the period of day/night in which they occur. Both noise metrics logarithmically average aircraft sound levels at a location over a complete 24-hour period, with a 10-decibel (dB) adjustment added to those noise events occurring from 10:00 p.m. to 7:00 a.m. The 10-dB adjustment is added because of the increased sensitivity to noise during normal night time hours and because ambient (without aircraft/launch vehicles) sound levels at 4.77-dB adjustment added to noise events occurring from 7:00 p.m. to 10:00 p.m. More information on noise and noise-compatible land use can be found in the FAA Order 1050.1F Desk Reference (FAA, 2015).

## 3.7.2 STUDY AREA

The study area for noise and noise-compatible land use is defined by the noise footprint of the Proposed Action, including noise generated by Alpha's engines during launch and the downrange sonic boom footprint (see Figures 3-1 and 3-4).

## 3.7.3 EXISTING CONDITIONS

Existing noise levels at VAFB are generally quite low due to the large areas of undeveloped landscape and relatively sparse noise sources. Background noise levels are primarily driven by wind noise; however, louder noise levels can be found near industrial facilities and transportation routes. On VAFB, general ambient one-hour average sound level measurements have been found to range from around 35–60 dB (Thorson et al., 2001). Rocket launches and aircraft overflights create louder intermittent noise levels. Noise levels in the adjacent city of Lompoc are primarily driven by transportation noise and regional aircraft activities. Depending on regional airport activity, DNLs are typically between 55 and 65 dBA (City of Lompoc, 2014). Noise-sensitive areas<sup>7</sup> near VAFB include residential areas, hospitals, schools, and libraries. These areas are located in the Cantonment Area of VAFB, which is located over 5 miles north of SLC-2W. No sensitive areas are located at or near SLC-2W. There are numerous noise sensitive areas in the city of Lompoc, including residential areas, hospitals, schools, parks, and libraries. Offshore, the Channel Islands National Park is within the overflight path of the launch vehicle and could be exposed to a sonic boom during launch.

## 3.7.4 ENVIRONMENTAL CONSEQUENCES

Noise impacts would be significant if the action would increase noise by DNL 1.5 dB or more for a noisesensitive area that is exposed to noise at or above the DNL 65 dB noise exposure level, or that will be exposed at or above the DNL 65 dB level due to a DNL 1.5 dB or greater increase, when compared to the no action alternative for the same timeframe. For example, an increase from DNL 65.5 dB to 67 dB is considered a significant impact, as is an increase from DNL 63.5 dB to 65 dB.

Construction activities would be a temporary source of local daytime sound. Given the distance from the construction location to noise sensitive areas, noise levels from construction activities would not be audible above typical background noise levels at the noise sensitive areas. The construction noise-generating events would be intermittent and last approximately four to six months. Sound levels up to 65 dBA DNL are considered to be compatible with land uses such as residences, transient lodging, and medical facilities. Noise in excess of 65 dBA from construction activities would occur only on an intermittent basis, and only in areas immediately adjacent to the construction activities. Therefore, construction noise would not result in significant noise impacts.

Firefly is proposing to conduct up to 11 pre-launch static fire engine tests and 11 Alpha launches per year. Noise would be generated during an Alpha's ascent, which would last a few minutes. Pre-launch static fire engine tests of all four engines would last five seconds.

Blue Ridge Research and Consulting, LLC conducted the noise analysis for Firefly's proposal using a model that was approved by the FAA's Office of Environment and Energy (see Appendix C). The modeling predicts an Alpha launch would generate noise levels at or above an A-weighted maximum sound level  $(LA_{max})^8$  of 115 dBA within 0.3 miles of SLC-2W. During a static fire engine test, a receptor located along the peak directivity angle may experience an LA<sub>max</sub> of 115 dBA at approximately 0.2 miles away from SLC-2W. The noise levels produced by static fire engine tests would remain constant over the duration of the event, whereas the noise levels produced by launch events would decrease as the rocket moves further away from the receptor.

An upper limit noise level of 115 dBA is used as a guideline to protect human hearing from long-term continuous daily exposures to high noise levels and to aid in the prevention of noise-induced hearing loss. The noise modeling shows the 115 dBA contours associated with launch and static fire events are entirely within the boundaries of VAFB. Thus, the potential for impacts on people in the community with regards to hearing conservation is negligible.

The noise modeling shows the Proposed Action's CNEL 65 dBA contour extends approximately 0.4 miles from the launch site and is located entirely within the VAFB boundary (see Figure 3-5). Therefore, the Proposed Action would not result in significant impacts related to noise and noise-compatible land use.

<sup>&</sup>lt;sup>7</sup> A noise sensitive area is an area where noise interferes with normal activities associated with its use. Normally, noise sensitive areas include residential, educational, health, and religious structures and sites, and parks, recreational areas, areas with wilderness characteristics, wildlife refuges, and cultural and historical sites (FAA Order 1050.1F).

<sup>&</sup>lt;sup>8</sup> Maximum sound level is a single event metric that is the highest A-weighted sound level measured during an event.



Figure 3-5: CNEL Contours for Launch and Static Fire Operations at SLC-2W

# SECTION 3.8 Socioeconomics, Environmental Justice, and Children's Environmental Health and Safety Risk

## 3.8.1 DEFINITION OF RESOURCE AND REGULATORY SETTING

Socioeconomics is an umbrella term used to describe aspects of a project that are either social or economic in nature. A socioeconomic analysis evaluates how elements of the human environment such as population, employment, housing, and public services might be affected by the Proposed Action.

Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental, and commercial operations or policies. Meaningful involvement means that people have an opportunity to participate in decisions about activities that may affect their environment and/or health; the public's contribution can influence the regulatory agency's decision; their concerns will be considered in the decision making process; and the decision makers seek out and facilitate the involvement of those potentially affected.

EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income *Populations*, directs each federal agency to "make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." Subsequent orders at the federal level, including DOT Order 5610.2(a), Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, have reinforced the

directives outlined in EO 12898. CEQ also developed guidelines (CEQ, 1997) to assist federal agencies in incorporating the goals of EO 12898 into the NEPA process.

Impacts to children are considered separately in NEPA reviews because children may experience a different intensity of impact as compared to an adult exposed to the same event. EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, requires federal agencies to identify disproportionately high and adverse impacts on children. Children may suffer disproportionately more environmental health and safety risks than adults because they are still developing their neurological, digestive, immunological, and other bodily systems; they eat more food, drink more fluids, and breath more air in proportion to their body weight than adults; their behavior patterns may make them more susceptible to accidents because they are less able to protect themselves; and their size and weight may diminish their protection from standard safety features.

More information on socioeconomics, environmental justice, and children's environmental health and safety risk and regulations can be found in the FAA Order 1050.1F Desk Reference (FAA, 2015).

## 3.8.2 STUDY AREA

The study area for socioeconomics, environmental justice, and children's environmental health and safety risks includes VAFB and Lompoc.

## 3.8.3 EXISTING CONDITIONS

All activities on VAFB are subject to the requirements of the federal Occupational Safety and Health Administration (OSHA), Air Force Occupational Safety and Health (AFOSH), and California Division of OSHA regulations and procedures. The affected environment includes all established regulations to minimize or eliminate potential risk to the general public and personnel involved in the proposed project. The Proposed Action would involve facility modifications where additional temporary workers would be hired and would potentially be exposed to conditions that could adversely impact their health and safety.

Hazards associated with launch operations influences where projects can be sited to ensure the health and safety of workers. The USAF has established hazard zones at VAFB to protect workers, including, but not limited to, the following:

- Toxic hazard zones are areas established downwind of launch site operations to protect workers from exposure to toxic vapors emitted during the transfer or loading of liquid propellants or maintenance of launch systems. These zones can extend 20,000 feet or more from a launch site. Closures due to safety hazards are dependent upon the risk assessment performed by the USAF Range Safety office using the specific launch trajectory and fuel loads on the rocket prior to launch. There are no anticipated toxic hazard zones associated with launch activities described in this EA.
- Missile/Space Launch Vehicle Flight Hazard Zones and Explosive Safety Zones are established under the flight path of missiles or launch vehicles to protect personnel from potential debris fall-out. Explosive safety zones are established from 75 to 5,000 feet around launch sites and buildings where rocket propellants are stored to protect personnel from potential explosive hazards. Both of these hazard zones must be evacuated before any launch.

## 3.8.3.1 Population and Income

The U.S. Census Bureau estimates the population at Lompoc to be approximately 42,760 individuals. Approximately 64.4 percent of the population of Lompoc identifies as White, 5.1 percent identify as Black or African American, 3.3 percent identify as Asian, 1.9 percent identifies as American Indian and

Alaska Native, 0.3 percent identify as native Hawaiian or other Pacific Islander, 56.7 percent identify as Hispanic or Latino, and 7.4 percent identify as two or more races. The median household income for Lompoc in 2017 dollars between 2013 and 2017 is estimated to be \$49,074, and the percentage of residents living below the poverty level is approximately 20.8 percent. As of 2012, there were 2,420 businesses in Lompoc, and 75.9 percent of the population is a high school graduate or higher. Approximately 27.6 percent of the population is below the age of 18 (U.S. Census Bureau, 2018).

## 3.8.3.2 Schools

Vandenberg Child Development Center, Crestview Elementary School, Vandenberg Middle School, Manzanita Carter School, Cabrillo High School, Buena Vista Elementary School, Children's Montessori School, Maple High School, and Fountain of Life Christian Academy are located within 10 miles of SLC-2W on and near VAFB. The Vandenberg Child Development Center and Youth Center provides child care for infants to five-year-olds, and for six-year-olds to school age (up to seventh grade) children respectively; the number of children at the center varies (Military Childcare, 2019). Crestview Elementary School is within the main gate of VAFB and is attended by approximately 500 students (Crestview Elementary, 2019). In 2015, the enrollment at Vandenberg Middle School was 788 students. Lompoc Unified School District serves the city of Lompoc and surrounding communities, such as Vandenberg Village, Mesa Oaks, Mission Hills and VAFB (Jory, 2016). The Manzanita Public Charter School serves approximately 425 students (Nicastro, 2019).

## 3.8.3.3 Community Services

Emergency response services at VAFB consist of its own Fire Department, Disaster Control Group, and Security Police Force, as well as contracted support for handling accidental releases of regulated, hypergolic propellants and other hazardous substances. The overall base emergency response program is managed by the Readiness Flight and develops and updates 30 SW's Hazardous Material Emergency Response Plan (Missile Defense Agency, 2003). Emergency medical services are provided by the Fire Department at VAFB, the Lompoc Valley Medical Center, and 30 SW Medical Group on VAFB.

## 3.8.3.4 Economics/Employment

Major industries in Lompoc include VAFB, the wine industry, higher education, healthcare, and city services (e.g., police, fire, electric, water, wastewater). VAFB provides over 6,700 jobs to the people of Lompoc and is a major part of the economy of the city. Approximately \$1.7 billion is contributed to the regional economy as a result of operations at VAFB annually. VAFB also produces space operator graduates through USAF Space Training undergraduate courses (City of Lompoc, 2019a).

## 3.8.3.5 Environmental Justice

The Environmental Protection Agency's Environmental Justice Screening and Mapping Tool was used to initially screen for areas with minority and low-income populations, potential environmental quality issues, and environmental and demographic indicators. Minority environmental justice populations occur in the city of Lompoc.

## 3.8.3.6 Human Health and Safety

Firefly and/or its contractor(s) would be responsible for industrial hygiene and ground safety during SLC-2W modifications and launch operations. Industrial hygiene responsibilities include monitoring and exposure to workplace chemicals, radiation, physical hazards, hearing and respiratory protection, medical monitoring of workers subject to chemical exposures, and oversight of all hazardous or potentially hazardous operations. Ground safety responsibilities include protection from hazardous situations and hazardous materials. The potential exists for persons participating in the construction and grading activities to become exposed to hazardous materials and hazardous waste (see Section 3.10). In addition to those hazards, other physical hazards (e.g., confined spaces, uneven terrain, holes, and ditches) and biological hazards (e.g., rattlesnakes, ticks, black widow spiders, and poison oak) occur at the project site.

The 30 SW Launch Safety Office (Safety Office) has the responsibility to ensure the safety of launch support personnel and the general public from all launch operations as defined in Air Force Space Command Instruction 91-217 (Space Safety and Mishap Prevention Program). The Safety Office, as well as the FAA, would assess proposed launch profiles to ensure public safety criteria are met. The evaluation would assess hazards associated with debris, toxics, and blast distant focusing overpressure for a normal launch failure. All launch areas, including high-risk offshore areas and airspace, would be controlled and monitored to ensure public safety during launch operations. In addition, launch day meteorological conditions would be accounted for to ensure compliance with acceptable risk criteria.

All launch programs at VAFB are required to establish debris impact corridors as a part of their program's safety review, in case of a launch anomaly that requires flight termination. These debris impact corridors would not include environmental justice population areas or areas that would be hazardous to children's health and safety. When any launch, including a commercial launch, is scheduled to take place from VAFB, the Safety Office notifies the 2nd Range Operations Squadron (2 ROPS) of the associated hazard areas. Firefly would complete a debris analysis prior to launch. The 30 SW/SEL and the FAA would review and approve these analyses prior to authorizing any activities. Impact debris corridors would be established off the Santa Barbara County coast between Point Sal and Point Conception to meet security requirements and reduce hazards to persons and property during launch-related activities. Specific debris impact areas would be determined for each launch, based on its specific trajectory. Once notified of hazard areas by the 30 SW/SEL, the 2 ROPS notifies the FAA so that appropriate airspace restrictions are in place during launches. The U.S. Coast Guard issues a Local Notice to Mariners (LNM) prior to launch activities. LNMs are broadcast via radio and posted in harbors along the coast, as well as being published in the weekly U.S. Coast Guard Long Beach Broadcast to Mariners.

Offshore oil rigs located west of 120 degrees 15 minutes longitude also have evacuation or shelter-inplace procedures in place for use during launch operations. The 2 ROPS notifies the Bureau of Ocean Energy Management to notify oil rig personnel of launch operations. Surf Beach, Ocean Beach, and Jalama Beach County Parks also fall within some debris impact corridors, necessitating their closures during launch operations.

A Union Pacific railroad line runs through VAFB. Alpha would fly over part of the rail line. As such, railroad schedules and close coordination between train engineers and VAFB personnel ensure that trains are never overflown, to reduce potential risk to people and property.

Site security requirements, including those for security lighting and intrusion detection, are part of the requirements integral to launch program safety. 30th Space Wing Instruction (30 SWI) 31-101, Air Force Instruction (AFI) 31-101, and Department of Defense (DoD) Manual 5220.22-M detail these security requirements. Unified Facilities Criteria 4-010-01 was issued in January 2007 under the authority of DoD Instruction 2000.16, Antiterrorism Standards. This guidance requires DoD components to adopt and adhere to common definitions, criteria, and minimum construction standards for building to mitigate vulnerabilities and terrorist threats. Modifications to SLC-2W would be required to meet these construction standards.

## 3.8.4 ENVIRONMENTAL CONSEQUENCES

The FAA has not established significance thresholds for socioeconomics, environmental justice, or children's environmental health and safety risks. However, the FAA has identified factors to consider when assessing the significance of potential impacts. For socioeconomics, the factors to consider are whether the action would have the potential to:

- induce substantial economic growth in an area, either directly or indirectly (e.g., through establishing projects in an undeveloped area);
- disrupt or divide the physical arrangement of an established community;
- cause extensive relocation when sufficient replacement housing is unavailable;
- cause extensive relocation of community businesses that would cause severe economic hardship for affected communities;
- disrupt local traffic patterns and substantially reduce the levels of service of roads serving an airport and its surrounding communities; or
- produce a substantial change in the community tax base.

For environmental justice, the factors to consider are whether the Proposed Action would have the potential to lead to a disproportionately high and adverse impact on an environmental justice population (i.e., a low-income or minority population) due to significant impacts in other environmental impact categories or impacts on the physical or natural environment that affect an environmental justice population in a way that the FAA determines is unique to the environmental justice population and significant to that population.

For children's environmental health and safety risks, the factor to consider is whether the action would have the potential to lead to a disproportionate health and safety risk to children.

At peak operational activity, roughly 30 additional people would be working at SLC-2W. With the exception of approximately 10 people permanently moving to the VAFB area, many of these individuals would be associated with specific missions for short durations, and Firefly does not expect that they would move to the VAFB area. Rather, they would be housed in temporary housing such as local hotels, motels, local apartments, and short-stay facilities. Given the amount of available housing relative to the few people who would be relocating to the VAFB area on a temporary or long-term basis, the Proposed Action would not result in significant impacts related to population or housing.

Construction workers would be hired from the local labor pool. For the short duration of the construction, there would be a small economic benefit to the local area from increased employment. Firefly expects the majority of individuals used for launch support would come from outside the VAFB area. Since most of these personnel would be temporary, there would be no significant impact on local employment. Workers would likely generate revenues at local establishments, particularly restaurants, hotels, and recreational establishments. There might be a slight increase in revenues; however, any increase is not likely to be statistically noticeable. Therefore, the Proposed Action would not result in significant impacts related to socioeconomics.

Environmental justice populations do not occur in the area where construction or launch noise levels would be detectable above ambient noise levels. The Proposed Action would not result in any air emissions or water discharges that would adversely affect minority or low-income communities in a manner that would be greater than the comparison groups. The Proposed Action would not cause a disproportionate high and adverse impact on an environmental justice population. Therefore, the Proposed Action would not result in significant environmental justice impacts.

Firefly and the 30 SW would ensure compliance with OSHA regulations and other recognized standards during facility modifications and launch operations. Firefly would develop a health and safety plan and appoint a formally trained individual to act as safety officer. The appointed individual would be the point of contact on all problems involving job site safety. Therefore, human health and safety would not be adversely impacted by general construction related hazards. Similarly, public safety would be ensured during a launch through the establishment of appropriate hazard zones, as described above.

Neither adults nor children would be exposed to hazardous conditions because Firefly would establish debris impact corridors and coordinate the closure of areas within the hazard area in accordance with USAF and FAA regulations. Based on the above discussion of potential impacts and measures in place to protect public health and safety, there would be no known environmental health or safety risks that would disproportionately affect children. Therefore, the Proposed Action would not result in significant impacts related to children's environmental health and safety.

# SECTION 3.9 BIOLOGICAL RESOURCES (INCLUDING FISH, WILDLIFE, AND PLANTS)

# 3.9.1 DEFINITION OF RESOURCE AND REGULATORY SETTING

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

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

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

Under the Magnuson-Stevens Fishery Conservation and Management Act, the FAA must consult with NMFS if the action that may adversely affect essential fish habitat (EFH). As defined by the Act, EFH refers to waters and substrate necessary for fish to spawn, breed, feed, or grow to maturity.

The California Endangered Species Act protects plant and animal species at risk of extinction. A statelisted species, or any part or product of the plant or animal, may not be imported into the state, exported out of the state, "taken" (i.e., killed), possessed, purchased, or sold without proper authorization.

More information on biological resources, including the laws that protect them, can be found in the FAA Order 1050.1F Desk Reference (FAA, 2015).

## 3.9.2 STUDY AREA

The study area for biological resources is generally the same as the noise study area. This study area captures all areas where potential impacts to biological resources from facility modifications, launches, and the stage 1 and fairing splashdown areas might occur.

# 3.9.3 EXISTING CONDITIONS

Biological resources on VAFB are abundant and diverse compared to other areas of California because VAFB is within an ecological transition zone where the northern and southern ranges of many species overlap, and because the majority of the land within the base boundaries has remained undeveloped. Biological resources offshore are also diverse, including EFH and abundant marine mammal haulouts on San Miguel Island and other Channel Islands.

## 3.9.3.1 Terrestrial Resources

SLC-2W is located within a remnant dune and back dune area dominated by central dune scrub, central coastal scrub, iceplant, and disturbed/cleared and developed habitats (Wildscape, 2009). A variety of common wildlife species occur in this area and surrounding habitats, including many species of birds, amphibians, reptiles, and mammals.

Table 3-6 includes ESA-listed and state-listed species that occur or have the potential to occur within the study area. The FAA used the USFWS Information for Planning and Consultation (IPaC) system (USFWS, 2019) to generate ESA-listed species for Santa Barbara County, which includes the Northern Channel Islands. Potential occurrence of each protected species was determined based on past documentation of the species within the study area and on occurrence and suitability of habitat within the study area. Some protected species were intentionally not included because there would be no effect on them. For a full list of ESA-listed species and select migratory birds for Santa Barbara County, see the USFWS IPaC report in Appendix B. There is critical habitat for the western snowy plover (SNPL) within the study area on Santa Rosa Island. In addition, golden eagles (*Aquila chrysaetos*) and bald eagles (*Haliaeetus leucocephalus*) are occasionally observed within the study area and are protected under the Bald and Golden Eagle Protection Act.

Species	Status		Detential Occurrence
	Federal	State	Potential Occurrence
Invertebrates			
El Segundo Blue Butterfly	FE	-	Present
(Euphilotes battoides allyni)			
Amphibians			
California Red-legged Frog	ст		Potontial
(Rana draytonii)	ΓI	-	Fotential
Birds			
Belding's Savannah Sparrow			
(Passerculus sandwichensis	-	SE	Potential
alaudinus)			
California least tern	FE	SE	Breeding colony adjacent to SLC-2W
(Sternula antillarum browni)			at Purisima Point
Western snowy plover (Charadrius	FT	-	Breeding and wintering habitat
nivosus)			within the study area

Table 3-6: ESA-Listed and State-Listed Terrestrial Species with Potential to Occur Within the Study Area

Notes: FE = Federal Endangered Species; FT = Federal Threatened Species; SE = State Endangered Species.

# 3.9.3.1.1 El Segundo Blue Butterfly

The federally endangered El Segundo blue butterfly (ESBB) is typically active on VAFB from June to mid-August, although larvae may be present into September. ESBB are closely associated with their host plant, seacliff buckwheat (*Eriogonum parvifolium*). Adult ESBB lay their eggs on buckwheat flowerheads. ESBB larvae feed within the flowerheads until maturation. Upon maturation, larvae burrow into the soil and pupate below the host plant within the root and debris zone (Mattoni, 1992). Pupae remain in diapause until at least the following June, when they may emerge to breed. Critical habitat was proposed for ESBB in 1977 but has yet to be designated.

Seacliff buckwheat is found throughout central dune scrub, central coastal scrub, and disturbed habitats within and surrounding SLC-2W. Although there are only several ESBB localities recorded from within the SLC-2 fence line, over 760 ESBB localities have been documented within the maximum 1.34-mile dispersal distance between 2007 and 2018 (Figure 3-6; USAF, 2019b). SLC-2W has not received much survey effort due to restricted access to the site; however, ESBB are likely to occur throughout the facility where seacliff buckwheat is found.

## 3.9.3.1.2 California Red-Legged Frog

The federally threatened California red-legged frog (CRLF) has been recorded in the vicinity of SLC-2W (Figure 3-6). They have been documented traveling distances of over 1 mile during the wet season and spend considerable time in terrestrial riparian vegetation (USFWS, 2002). Regular CRLF surveys have occurred across VAFB and have shown that CRLF can potentially occur in virtually all known wetlands and bodies of water on VAFB. There are no wetland or riparian habitats within SLC-2W; however, there are four CRLF localities within approximately 1 mile of SLC-2W, which were documented in 2001 and 2017 (Figure 3-6). Of these, three localities were recorded at nearby vernal pools in 2001 (Christopher, 2004) and one live adult was adventitiously observed and photographed in a puddle on Spur Road in 2017 (later confirmed by ManTech SRS Technologies, Inc. biologist, A. Abela, pers. comm.). Thus, CRLF may occur within SLC-2W while dispersing, but constant presence is unlikely given the xeric conditions within and adjacent to the site.

Critical habitat for the CRLF was designated on March 17, 2010 (50 FR 12816-12959); however, it does not include VAFB, since it was excluded under ESA section 4(b)(2), for reasons including impacts on national security.

# 3.9.3.1.3 California Least Tern

The federally endangered California least tern (LETE) is found along the Pacific coast of California, from San Francisco southward to Baja California. The California populations are localized and increasingly fragmented due to habitat loss from coastal development. LETE are migratory and winter along the Pacific Coast of southern Mexico and the Gulf of California. They usually arrive at breeding grounds by the last week of April and return to wintering grounds in August. This species nests in colonies on relatively open beaches kept free of vegetation by natural scouring from tidal or wind action. Critical habitat for this species has not been designated.

Historically, LETE nested in colonies in several locations along the coastal strand of the north VAFB coastline. Since 1998, with the exception of two nests established south of San Antonio Creek in 2002, LETE have nested only at the primary colony site, in relatively undisturbed bluff top open dune habitat at Purisima Point approximately 0.3 miles east southeast of SLC-2W (Figure 3-6). LETE also forage in the lagoons formed at the mouths of the Santa Ynez River and San Antonio Creek and at other nearshore locations at VAFB. VAFB supports a very small percentage of California's breeding population of California least terns. However, as one of only three known breeding colonies between Monterey and Point Conception, the population on VAFB remains significant. Robinette et al. (2016) estimated that VAFB supports 25 pairs of breeding LETE.

## 3.9.3.1.4 Western Snowy Plover (Charadrius nivosus)

The Pacific coast population of the federally threatened SNPL occurs from southern Washington to Baja California, Mexico. VAFB has consistently supported one of the largest populations of breeding SNPL

along the U.S. West Coast (Robinette et al. 2016), as it provides important breeding and wintering habitat, which includes all sandy beaches and adjacent coastal dunes from the rocky headlands at the north end of Minuteman Beach to the south end of Surf Beach on South VAFB. Within the study area, SNPL occur at Purisima Point, Wall Beach, Surf Beach, Jalama Beach, and the Northern Channel Islands and regularly nest near SLC-2W (Figure 3-6). Designated critical habitat was revised in 2012 (77 FR 36727-36869) and includes Santa Rosa Island within the study area; however, VAFB is exempted under ESA section 4(b)(2).





#### 3.9.3.2 Aquatic Resources

There are no surface waters near SLC-2W where facility modifications are proposed. Construction activities would include application of common Best Management Practices (BMPs) (e.g., silt fencing) to avoid or minimize potential runoff. Therefore, facility modifications would not affect any aquatic biological resources (e.g., fish).

There are many marine species within the offshore portion of the study area, including several species of fish, sea turtles, seabirds, and marine mammals. All marine mammals are protected by the MMPA. Some of these marine mammals, as well as other marine species in the study area, are also protected by the ESA. Marine species, including protected species, have the potential to occur in the area where Alpha's expended first stage would fall into the open ocean, approximately 575 miles downrange on the approved launch trajectory. This splashdown area is offshore where densities of marine species decreases compared to coastal environments and upwelling areas. Given the low densities of protected marine species in the ocean, the likelihood of an individual protected species to be at the location of first stage splashdown during the brief moment of splashdown is highly unlikely. Therefore, these species are not carried forward for analyses.

The remote rocky shorelines and sandy beaches of VAFB and the Northern Channel Islands provide important haulout and breeding locations for a diverse array of pinnipeds (Figure 3-7). On VAFB, Pacific harbor seals (*Phoca vitulina richardsi*), California sea lions (*Zalophus californianus*), and Northern elephant seals (*Mirounga angustirostris*) regularly occupy the rock outcrops and protected coves near Minuteman Beach and at Purisima Point and between Point Arguello and the Boat House. Steller sea lions (*Eumetopias jubatus*) are also occasionally observed near Point Arguello. On the Northern Channel Islands, all of these species use many haulout locations, often in large numbers, along with northern fur seals (*Callorhinus ursinus*) and occasional occurrences of Guadalupe fur seals (*Arctocephalus townsendi*). The Guadalupe fur seal is listed as threatened under the ESA. Critical Habitat for the Guadalupe fur seal has not been designated.

The USAF has monitored the response of southern sea otters during launches at VAFB since 1998. The monitoring data indicate launch noise and overflights do not substantially affect the number or activities of southern sea otters in the nearshore marine environments of VAFB. Therefore, southern sea otters are not carried forward in the analysis.



Figure 3-7: Pinniped Haulouts Within the Study Area

## 3.9.4 ENVIRONMENTAL CONSEQUENCES

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

- A long-term or permanent loss of unlisted plant or wildlife species (i.e., extirpation of the species from a large project area, such as from a new commercial service airport)
- Adverse impacts on special status species or their habitats
- Substantial loss, reduction, degradation, disturbance, or fragmentation of native species' habitats or their populations
- Adverse impacts on a species' reproductive success rates, natural mortality rates, non-natural mortality (e.g., road kills and hunting), or ability to sustain the minimum population levels required for population maintenance

## 3.9.4.1 Terrestrial Resources

Botanical resources would not be affected because all facility modifications would occur in already developed or disturbed areas within the perimeter fence of SLC-2W. In addition, the 30 SW requires all construction activities to employ standard environmental protection measures (USAF, 2018a) that would ensure complete avoidance to any sensitive botanical resources.

Temporary impacts on wildlife species may occur within adjacent wildlife habitat due to an increase in noise, dust, and other construction-related disturbances during facility modifications. Animals in the area would likely move to adjacent suitable habitat if disturbed. Direct physical effects are not expected from facility modifications.

Temporary and infrequent impacts on wildlife species would occur as a result of launch noise. Some species would likely exhibit a startle response during Alpha takeoff. This area has been previously exposed to launch noise during the Delta II launch program at SLC-2W. None of the factors to consider for unlisted species would occur. Therefore, the Proposed Action would not result in significant impacts on unlisted species. The potential for significant impacts on the ESA-listed terrestrial species in the study area are discussed below.

# 3.9.4.1.1 El Segundo Blue Butterfly

All life stages of the ESBB could be affected by the removal of their host plant, seacliff buckwheat; however, all facility modifications would occur in already developed or disturbed areas within the perimeter fence of SLC-2W. In addition, the 30 SW requires all construction activities to employ the standard environmental protection measures cited above that would ensure any potential impacts to seacliff buckwheat and ESBB are avoided. The 30 SW conducted programmatic ESA consultation with the USFWS in 2015 for routine mission operations, including launches, and maintenance activities at VAFB. The USFWS issued a Programmatic Biological Opinion (PBO) (see Appendix B). The USFWS determined that the actions covered in the consultation would not jeopardize the continued existence of any federally listed species or destroy or adversely modify any critical habitat. After reviewing the description of Firefly's proposed Alpha launches, the USFWS determined Firefly's proposal is commensurate with prior activities at SLC-2W and that the 30 SW did not need to reinitiate ESA consultation for potential effects to the ESBB (see Appendix B). The 30 SW and Firefly must comply with all relevant terms and conditions in the PBO, including avoidance and minimization measures and

reporting requirements, during Alpha launches at SLC-2W. Therefore, the Proposed Action would not result in significant impacts on the ESBB.

## 3.9.4.1.2 California Red-Legged Frog

CRLF could be affected during facility modifications; however, since these activities would occur in already developed or disturbed areas, they are unlikely to be present. The USFWS determined Firefly's proposal is commensurate with prior activities at SLC-2W and that the 30 SW did not need to reinitiate ESA consultation for potential effects to the CRLF (see Appendix B). The 30 SW and Firefly must comply with all relevant terms and conditions in the PBO, including avoidance and minimization measures and reporting requirements, during Alpha launches at SLC-2W. Therefore, the Proposed Action would not result in significant impacts on the CRLF.

## 3.9.4.1.3 California Least Tern

Noise and visual disturbance during Alpha launches could cause LETE to flee nests, causing potential injury or mortality of adults, young, or nests. These potential impacts have been monitored by ManTech SRS Technologies and BioResources for the Delta II program five times. Pre- and post-launch monitoring of non-breeding LETE for the June 7, 2007, Delta II COSMO-1 launch, and monitoring of nesting LETE during the June 20, 2008, Delta II OSTM and June 10, 2011, Delta II AQUARIUS launches did not document any mortality of adults, young, or eggs, or any abnormal behavior (ManTech SRS Technologies, Inc., 2007b, 2008, 2011). The May and July 1997 Delta II launches, however, potentially caused the abandonment of up to five nests and the death of a chick due to exposure, although predation of adult LETE by owls may have been responsible for some of the losses observed (BioResources, 1997).

Engine noise at Purisima Point is expected to be approximately 120 dBA (Figure 3-8). This would be less than the engine noise produced by the Delta II vehicle, which was approximately 125 dBA at the same location (ENSR Consulting and Engineering, 1996). Consequently, behavioral disturbances as a result of engine noise and visual disruptions would be commensurate or less than prior activities at SLC-2W. The USFWS determined Firefly's proposal is commensurate with prior activities at SLC-2W and that the 30 SW did not need to reinitiate ESA consultation for potential effects to the LETE (see Appendix B). The 30 SW and Firefly must comply with all relevant terms and conditions in the PBO, including avoidance and minimization measures and reporting requirements, during Alpha launches at SLC-2W. Therefore, the Proposed Action would not result in significant impacts on the LETE.

# 3.9.4.1.4 Western Snowy Plover

Noise and visual disturbance during Alpha launches could cause SNPL to flee nests, causing potential injury or mortality of adults, young, or nests. SNPL monitoring during the breeding and non-breeding season for various launches on VAFB has routinely demonstrated that SNPL behavior is not adversely affected by launch noise or vibrations, and no incidents of injury or mortality to adults, young, or eggs have been documented (SRS Technologies, Inc., 2006a, 2006b, 2006c, 2006d; ManTech SRS Technologies, Inc., 2007a, 2008b, 2008c, 2011). The USFWS determined Firefly's proposal is commensurate with prior activities at SLC-2W and that the 30 SW did not need to reinitiate ESA consultation for potential effects to SNPL (see Appendix B). The 30 SW and Firefly must comply with all relevant terms and conditions in the PBO, including avoidance and minimization measures and reporting requirements, during Alpha launches at SLC-2W. Therefore, the Proposed Action would not result in significant impacts on SNPL.

Designated critical habitat on Santa Rosa Island would potentially receive sonic booms up to 2 psf during launches. 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.



Figure 3-8: Launch Noise Levels and Federally Listed Terrestrial Species Occurring in the Vicinity of Space Launch Complex 2

#### 3.9.4.2 Aquatic Resources

During an Alpha launch, engine noise levels would be approximately 111 to 120 dBA at the nearest pinniped haulout at Purisima Point (Figure 3-9). This is less than the engine noise generated by the Delta II launch vehicle, which was approximately 125 dBA at the same location (ENSR Consulting and Engineering, 1996). Sonic boom modeling of the planned trajectories predicts Alpha would produce a sonic boom up to 2.0 psf on the Northern Channel Islands (Figure 3-9). This is similar to sonic boom levels that have been measured on the Northern Channel Islands during prior Delta II launches, which have ranged from 0.4 to 1.34 psf (Marine Mammal Consulting Group and Science Applications International Corporation, 2012).

Both the predicted engine noise and sonic boom levels are commensurate with noise levels produced by the Delta II launch vehicle and thus likely to cause a similar level of impacts on 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. The USAF has monitored pinnipeds during launch-related sonic booms on the Northern Channel Islands during numerous launches over the past two decades and determined there are generally no substantial behavioral disruptions by sonic booms less than 1.0 psf (reviewed in Marine Mammal Consulting Group and Science Applications International Corporation, 2012). Even above 1.0 psf, only a portion of the animals present tend to react to sonic booms. Reactions between species are also different. For example, harbor seals and California sea lions tend to be more sensitive to disturbance than northern elephant seals. Guadalupe fur seals also tend to be less sensitive to disturbance than other pinniped species (Harris, pers. comm.). Monitoring of past sonic booms have shown that normal behavior and numbers of hauled out pinnipeds typically return to normal within 24 hours or less after a launch event. Any observations of injury or mortality of pinnipeds during monitoring have not been attributable to past launches.

Under the MMPA, NMFS issued a Final Rule for taking marine mammals incidental to USAF launches (NOAA Fisheries, 2019a), and a Letter of Authorization (LOA) (NOAA Fisheries, 2019b). The LOA allows launch programs to unintentionally take small numbers of marine mammals during launches. The 30 SW is required to comply with the conditions listed in the LOA and address NMFS concerns regarding marine mammals at VAFB and the Northern Channel Islands. Under the LOA, monitoring of marine mammals at VAFB and the Northern Channel sisted during launches, including the proposed Alpha launches. Given the authorizations in place and the required monitoring, the Proposed Action would not result in significant impacts on pinnipeds.



Figure 3-9: Estimated Launch Noise and Sonic Boom Levels in Relation to Pinniped Haulouts

## SECTION 3.10 HAZARDOUS MATERIALS, SOLID WASTE, AND POLLUTION PREVENTION

## 3.10.1 DEFINITION OF RESOURCE AND REGULATORY SETTING

The FAA has defined hazardous materials, solid waste, and pollution prevention as an impact category that includes an evaluation of the following:

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

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

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

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

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

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

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

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

EO 13834, *Efficient Federal Operations*, states that agencies "must comply with Federal as well as State, interstate, and local requirements for management and disposal of nonhazardous solid waste and hazardous waste. Agencies should pursue cost-effective waste prevention by first reducing overall waste generated, while also pursuing strategies that reduce disposal fees and minimize environmental impacts by diverting waste from treatment and disposal facilities, including landfill and incineration without energy recovery." According to the most recent Sustainability Report and Implementation plan released by the DoD in 2018, the DoD has set goals of diverting 50 percent of non-hazardous waste and 60 percent of construction and demolition waste for the 2018 and 2019 fiscal years (Department of Defense, 2018).

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

The State of California passed Senate Bill 1374, amending the Public Resources Code, Section 42912, which addresses the issue of construction and demolition debris, diversion requirements, and the development of a model ordinance to be implemented by local jurisdictions (e.g., Santa Barbara County).

More information on hazardous materials, solid waste, and pollution prevention can be found in the FAA Order 1050.1F Desk Reference (FAA, 2015).

## 3.10.2 STUDY AREA

The study area for hazardous materials, solid waste, and pollution prevention is VAFB.

## 3.10.3 EXISTING CONDITIONS

Operations at VAFB and associated properties require the use of hazardous materials by military personnel and on-base contractors in varying quantities throughout the base. There is one environmental restoration area at SLC-2W that contains hydrazine, freon, metals, RP-1, and trichloroethylene (TCE) due to discharges of neutralization waters from Delta/Thor missile launches from 1958 to 1984. Other contaminated sites near SLC-2W include SLC-2E, SLC-1E, SLC-1W, SLC-10E, SLC-10W, and SLC-10N, all containing hydrazine, freon, metals, RP-1, and TCE as a result of past missile launches. Although action is required at SLC-1E, all other sites are either open or closed.

Toxic hazard assessments would be required for the Alpha program to determine program-specific toxic material used for launches, payloads, ground support equipment, and at facilities. The 30 SW has detailed procedures in place to control use of toxic gases. The 30 SW maintains 30 SWI 91-106, Toxic Hazard Assessments, which defines control measures and procedures for conducting operations involving toxic fuels. The 30 SW runs atmospheric and dispersion computer models to predict toxic hazard corridors (THCs) for nominal and aborted launches, as well as for spills or releases of toxic materials from storage tanks or that occur during loading or unloading of propellants. 2 ROPS uses THCs to reduce the risk of exposure of launch personnel and the general public from toxic materials, including toxic gases. The 30 SW would run dispersion modeling for the Alpha program for nominal and abort scenarios prior to each launch. If the model predicts THCs over populated areas, the launch would be delayed until meteorological conditions allowed for launch to occur without this risk. However, due to the nature of Firefly, and the fuel types used, there are no anticipated THCs associated with Firefly.

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

## 3.10.4 ENVIRONMENTAL CONSEQUENCES

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

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

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

A site-specific spill plan would be developed and any spills would be quickly contained onsite consistent with existing procedures. At VAFB, hazardous materials are managed per federal and state regulations, contract specific requirements, and the VAFB Hazardous Materials Management Plan, 30 Space Wing Plan (30 SWP) 32-7086. With adherence to existing policies and procedures as outlined in the applicable federal, state, and local regulations, no impacts from hazardous materials are expected during facility modifications.

Standard procedures would be used to ensure that all equipment and holding tanks are maintained properly and free of leaks during operation, and that all necessary maintenance or repairs are carried out in pre-designated controlled, paved areas to minimize risks from accidental spillage or release. A Spill Prevention Control and Countermeasures Plan would be submitted to the 30 SW Asset Management Flight for approval. Hazardous waste would be handled and disposed of in strict adherence with the requirements of the procedures outlined in VAFB Hazardous Waste Management Plan, 30 SWP 32-7043, state, federal, DoD, and contract-specific requirements. These hazardous materials and wastes would be the same types as currently used and managed on VAFB during construction activities and launch operations (such as petroleum, oil, lubricant, LOX, RP-1, etc.). Proper disposal of hazardous waste would be accomplished through identification, characterization, sampling, and analysis of wastes generated. Chemical stockpile spill containment, if necessary, would be accomplished to minimize or preclude hazardous releases. General Requirements as listed in *Division 01 – General Requirements Section 01 57 20 Environmental Protection*, would be followed during all

construction activities (USAF, 2018a). Firefly is also developing a specific Hazardous Waste Management Plan for the Alpha at SLC-2W. Workers on site would be trained for Hazardous Waste Operations and Emergency, as appropriate. Per existing policies and procedures as outlined in the applicable federal, state, and local regulations, no impacts are expected from hazardous wastes generated during launch activities.

Facility modification and launch operations would create pollution in the air and water and would generate hazardous and solid waste. Debris from any activities would be segregated to facilitate subsequent pollution prevention options. Pollution prevention options would be exercised in the following order: reuse of materials, recycling of materials, and regulatory-compliant disposal.

Solid waste generated during facility modifications would include packaging from materials (cardboard and plastic), scrap rebar, wood, pipes, wiring, and miscellaneous waste generated by onsite construction workers. Contractors would be responsible for the disposal or recycling of all waste generated during the scope of the project. Solid waste would be minimized by strict compliance with VAFB's Integrated Solid Waste Management Plan. All materials that are disposed of off-base would be reported to the 30 SW Asset Management Flight Solid Waste Manager. Additionally, any materials recycled on-base by processes other than the base landfill would be reported to the 30 SW Asset Management Flight Solid Waste Manager at least quarterly, with copies of weight tickets and receipts provided.

Compliance with all applicable federal, state, and local laws and regulations, and applicable 30 SW plans and policies, would govern all actions associated with the Proposed Action, and would avoid or minimize potential impacts related to hazardous materials, solid waste, or pollution prevention. Therefore, significant impacts related to hazardous materials, solid waste, or pollution prevention are not expected.

# SECTION 3.11 WATER RESOURCES

## 3.11.1 DEFINITION OF RESOURCE AND REGULATORY SETTING

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

The major laws and EOs pertaining to water resources include the CWA; EO 11990, *Protection of Wetlands*; EO 11988, *Floodplain Management*; Safe Drinking Water Act; and Wild and Scenic Rivers Act. The CWA establishes the basic structure for regulating the discharge of pollutants into waters of the United States, including wetlands. EO 11990 require federal agencies to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative. Similarly, EO 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of 100-year floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative.

More information on water resources can be found in FAA Order 1050.1F Desk Reference (FAA, 2015).

## 3.11.2 STUDY AREA

The study area for water resources includes VAFB, with a focus on SLC-2W and adjacent areas where water resources might be affected by facility modifications and launches, as well as the Pacific Ocean.

## 3.11.3 EXISTING CONDITIONS

There are no waters of the United States, including wetlands, floodplains, or wild and scenic rivers within the study area. Therefore, the Proposed Action would not impact wetlands, floodplains, or wild and scenic rivers and these resources are not considered further.

## 3.11.3.1 Surface Water

The Santa Ynez River is considered the dividing line between North and South VAFB and is the major drainage for SLC-2W from north VAFB. There are also numerous unnamed minor drainage basins containing seasonal and ephemeral streams in the study area. Drainage from these basins is predominantly to the west, toward the Pacific Ocean. Surface water resources in the vicinity of SLC-2W is limited to the Pacific Ocean. Surface flow percolates into the groundwater to pass beneath road embankments and eventually enters the Pacific Ocean.

## 3.11.3.2 Ground Water

VAFB includes parts of two major groundwater basins and at least two sub-basins. Most of the northern third of VAFB is within the San Antonio Creek Basin, while most of the southern two-thirds of VAFB are within the Santa Ynez River Basin and associated Lompoc Terrace and Burton Mesa sub-basins. SLC-2W is located on the Santa Ynez River groundwater basin west of the Burton Mesa sub-basin. Groundwater at the site is unconfined and restricted to the unconsolidated material immediately above Sisquoc Formation bedrock. Groundwater is typically found approximately 50–140 ft. below ground surface. Predominant groundwater flow is toward the Pacific Ocean (USAF, 1988).

# 3.11.4 ENVIRONMENTAL CONSEQUENCES

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

Facility modifications and launch operations would include the use of hazardous materials and generation of wastewater that could result in an adverse impact on water resources if not properly controlled and managed. Proper management of materials and wastes during project activities would reduce or eliminate the potential for contaminated runoff. BMPs (e.g., silt fencing) would be implemented to properly manage materials and reduce or eliminate project-associated runoff to further reduce the potential for adverse effects, especially during the rainy season. Therefore, adverse impacts to surface waters from facility modifications and launch-related activities are not expected.

Surface waters near SLC-2W could be affected by the exhaust cloud that would form near the launch pad at lift-off as a result of the exhaust plume and evaporation and subsequent condensation of deluge and Ignition Pulse Suppression water. Because Alpha uses only LOX and RP-1 propellants, the exhaust cloud would consist of steam only and would not contain any hazardous materials. Therefore, adverse impacts to the quality of surface waters in the study area from the exhaust cloud are not expected.

A CWA Section 401 Water Quality Certification from the regional water quality control board and CWA Section 404 permit from the U.S. Army Corps of Engineers would not be required because no direct

impacts on water bodies or wetlands would occur. Also, facility modifications would not require coverage under the CWA National Pollutant Discharge Elimination System (NPDES) General Permit for Construction Activities (Construction General Permit) because the total disturbed area would be less than 1 acre. However, BMPs would be implemented to prevent contaminants from entering stormwater runoff. Exposed soils would be permanently stabilized to prevent erosion due to wind and rain.

Stormwater from the entire SLC-2W launch pad area drains into the retention basin. Stormwater would be analyzed before any discharge takes place to determine if residues from the launch pad have contaminated stormwater and treatment is required.

Operational activities associated with the Proposed Action would require coverage under a NPDES General Industrial Permit prior to any discharge to grade of stormwater. Firefly would apply for a permit from the local water board. The General Industrial Permit and related VAFB Storm Water Management Plan require BMPs to reduce and eliminate pollutants in stormwater and non-stormwater discharges associated with project activities. Compliance with BMPs would minimize potential adverse impacts on local water resources. Water containing prohibited chemical levels would be removed and hauled to an approved industrial wastewater treatment facility outside VAFB.

The Proposed Action would not adversely affect groundwater, including a sole source or other aquifer, and associated facility modifications would not require deep excavations and environmental protection measures would be implemented to prevent water quality impacts.

As discussed above, the first stage of the rocket is expendable; it would separate, fall to the ocean, and would not be recovered. Specifically, the first stage would splash down in the open ocean approximately 575 miles downrange on the approved launch trajectory. First stage debris, which is comprised of inert materials which are neither chemically or biologically reactive, is anticipated to sink relatively quickly. Accordingly, it would not affect water quality in the short term (while the debris is floating or descending through the water column) or in the long term (when the debris has settled into benthic habitats).

The Alpha propellant type is a mixture of a kerosene-based fuel (known as RP-1) and LOX. In the event of a launch failure, surface water quality in the ocean may be temporarily affected by the release of unconsumed RP-1. RP-1 is a Type 1 "Very Light Oil," which is characterized as being highly volatile and having low viscosity and low specific gravity. These features cause RP-1 to evaporate quickly when exposed to the air. It would be expected that the RP-1 would completely dissipate within 1–2 days after a spill in the water (National Oceanic and Atmospheric Administration, 2020). Following a spill of very light oil, cleanup is usually not necessary or possible, especially if it is a small quantity of oil as would be the case in the event of an unsuccessful launch. Most of the oil mass would evaporate within the first few minutes, while the rest would dissipate over the 1–2 days. Other factors causing increased agitation and dissipation, such as wave action, the oil would be volatized even more rapidly.

In summary, based on the above discussion, the Proposed Action would not result in significant impacts on water resources.

# CHAPTER 4 CUMULATIVE IMPACTS

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

Spatial and temporal boundaries were delineated to determine the area and projects the cumulative impacts analysis would address. The spatial boundary is VAFB, the city of Lompoc, and the Northern Channel Islands, which accounts for all potential cumulative impacts. The temporal boundary includes past actions that have occurred within the last three years, and reasonably foreseeable future actions include those that are planned to occur within the next five years. Past, present, and reasonably foreseeable actions at VAFB and the surrounding area include current and future aircraft operations at the airport, rocket launches, rocket engine testing, development in the local area related to activities at VAFB, and any other development that may occur as a result of economic growth in the area.

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

# SECTION 4.1 PAST ACTIONS

Past actions at VAFB, the city of Lompoc, and the Northern Channel Islands are primarily tied to commercial and military rocket launches (including first stage boost-back and landing), construction on VAFB's launch pads, regular military use of VAFB, and community development projects in Lompoc. Regular military use of VAFB includes aircraft takeoffs and landings as well as launches.

Actions recently completed at or around VAFB include the following:

- Refurbishment of SLC-4E and SLC-4W by SpaceX (USAF, 2016a)
- Commercial rocket launches (including landings) by SpaceX (USAF, 2016a)
- Boeing X-37B Spaceplane landing by USAF (USAF, 2018b)
- Voluntourism restoration project on San Nicolas Island (Kleist, 2018)
- Completion of a solar farm to provide 22.5 megawatts of power to VAFB (30th Space Wing Public Affairs, 2017)
- Completion of Building 7000 on VAFB to be LEED certified (30th Space Wing Public Affairs, 2017)
- Military and commercial rocket launches operated by the USAF
- Regular aircraft take-offs and landings at VAFB

# SECTION 4.2 PRESENT ACTIONS

Present actions at VAFB include military and commercial rocket launch programs and several residential developments in the adjacent city of Lompoc. Present actions at or around VAFB include the following:

- Construction of Mosaic Walk (13-unit residential project) in Lompoc (City of Lompoc, 2019b)
- Construction of Coastal Meadows (42-unit residential infill project) in Lompoc (City of Lompoc, 2019b)
- Construction of Burton Ranch in Lompoc (City of Lompoc, 2019b)
- Construction of River Terrace Residential Development in Lompoc (City of Lompoc, 2019b)
- Channel Islands Restoration will continue ecological restoration for endemic plants and animals (Channel Islands Restoration, 2019a, b)
- Construction of a pier on Santa Cruz Island (National Park Service, 2019)

- Crane construction on Anacapa island (National Park Service, 2019)
- Regular aircraft takeoffs and landings at VAFB

## SECTION 4.3 REASONABLY FORESEEABLE FUTURE ACTIONS

Reasonably foreseeable future actions at VAFB include continued launches of both commercial and military launch vehicles, regular military aircraft takeoffs and landings, and the development of residential and community real estate in Lompoc.

Reasonably foreseeable future actions at or around VAFB include the following:

- SpaceX Falcon 9 launches (including landings) at SLC-4E and SLC-4W (USAF, 2018)
- Construction of a 28,000 square foot health center in Lompoc (City of Lompoc, 2019b)
- Construction of Summit View Homes in Lompoc (City of Lompoc, 2019b)
- Construction of Strauss Wind Energy Project in Lompoc (Department of Planning and Development, Santa Barbara County, 2019)
- Regular aircraft take-offs and landings at VAFB

## SECTION 4.4 Environmental Consequences

The Proposed Action's impacts discussed in Chapter 3 were analyzed for their potential to result in cumulative impacts when added to other past, present, and reasonably foreseeable future actions. As discussed in Chapter 3, the Proposed Action would result in less than significant impacts related to air quality; climate; coastal resources; DOT Act, Section 4(f); noise and noise-compatible land use; socioeconomics, environmental justice, and children's environmental health and safety; biological resources; hazardous materials, solid waste, and pollution prevention; and water resources. The potential cumulative impacts on those environmental impact categories are described below.

## 4.4.1 AIR QUALITY

Past, present, and reasonably foreseeable future actions have and will result in air emissions in the study area. Construction of residential and commercial projects in and around VAFB, along with air and space craft operations, would result in increased emissions. All emissions would be temporary and not likely to result in an exceedance of air quality standards, including the NAAQS. Ecological restoration projects and renewable energy projects in and around VAFB would result in decreased air emissions.

The Proposed Action would result in temporary air emissions during facility modifications and Alpha launches. 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, because of the low amount of emissions and the temporary nature of the emissions. Therefore, the Proposed Action is not expected to result in significant cumulative impacts on air quality.

## 4.4.2 CLIMATE

Past, present, and reasonably foreseeable future actions have and would result in GHG emissions in the study area. Construction of residential and commercial projects in and around VAFB, along with air and space craft operations, would result in increased GHG emissions. All emissions would be temporary and not likely to result in an exceedance of air quality standards, including the NAAQS. Ecological restoration projects and renewable energy projects in and around VAFB would result in a larger regional carbon sink and decreased GHG emissions.

The Proposed Action would result in temporary air emissions during facility modifications and the Alpha launches. The facility modifications and launches would result in a maximum of 210.16 metric tons of

 $CO_2e$  over 5 years, which is less than the 10,000 metric ton threshold set by the SBCAPCD. This, when combined with other past, present, and reasonably foreseeable future actions, is not expected to result in exceedance of any GHG emissions standards, including the NAAQS, because of the low amount of emissions and the temporary nature of the emissions. Therefore, the Proposed Action would not result in significant cumulative impacts on climate.

## 4.4.3 COASTAL RESOURCES

Past, present, and reasonably foreseeable future actions that would have the potential to impact coastal resources include construction activities, rocket launches, renewable energy development, and restoration projects in the coastal zone. Impacts from these projects would result in both positive and negative impacts on coastal resources; however, all of them would be compliant with CZMA and CCA policies.

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

## 4.4.4 DEPARTMENT OF TRANSPORTATION, SECTION 4(f)

Past, present, and reasonably foreseeable future actions that would have the potential to impact DOT Section 4(f) properties include construction activities and rocket launches. Impacts from these projects would result in a change to the noise environment in properties that are within their individual study areas.

The Proposed Action and other concurrent projects in the study area do not include the conversion, closure (other than temporarily during launch activities), or creation of Section 4(f) properties. When combined with other past, present, and reasonably foreseeable future actions, the Proposed Action is not expected to result in significant cumulative impacts on Section 4(f) properties.

## 4.4.5 NOISE AND NOISE-COMPATIBLE LAND USE

Past, present, and reasonably foreseeable future actions that would have the potential to impact noise and noise-compatible land use include construction activities, rocket launches, renewable energy development, and restoration projects. There are about eight launches a year at VAFB (space and missile launch activities). Noise effects associated with each of these launches is relatively short (no more than five minutes).

Under the Proposed Action, noise levels that could increase the CNEL are limited to the immediate vicinity of the launch pad and are contained within the VAFB boundary. Construction activities at SLC-2 would result in temporary, intermittent impacts localized to the project site. Construction projects are typically temporary in duration, and the noise impact from the construction at SLC-2 would not be a significant contributor to the noise setting on VAFB. When combined with other past, present, and reasonably foreseeable future actions, the Proposed Action is not expected to result in significant cumulative noise impacts.

## 4.4.6 SOCIOECONOMICS, ENVIRONMENTAL JUSTICE, AND CHILDREN'S ENVIRONMENTAL HEALTH AND SAFETY

Past, present, and reasonably foreseeable future actions in the study area of the city of Lompoc and VAFB could result in impacts on socioeconomics. Implementation of the Proposed Action and other similar actions at VAFB would slightly increase the number of employees in the study area associated

with facility modifications and launch operations. However, construction contractors would be temporary. The development of the health center in Lompoc does have the potential to result in cumulative impacts on socioeconomics in the study area, as health center employees would become permanent members of the City of Lompoc and positively impact the socioeconomic resources in the study area. When combined with other past, present, and reasonably foreseeable future actions, the Proposed Action is not expected to result in significant cumulative impacts on socioeconomics.

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

When considered with other past, present, and future projects, the Proposed Action was found to have no cumulative impacts on environmental justice, as activities for the other projects and for the Proposed Action would occur within VAFB boundaries, and noise impacts were found not be significant; therefore, they would not disproportionately affect minority communities.

# 4.4.7 BIOLOGICAL RESOURCES

Past, present, and reasonably foreseeable future actions on VAFB that involve ground-disturbing activities and related noise impacts could have temporary and localized effects on biological resources. Cumulative adverse impacts could result if concurrent projects, along with the Proposed Action, cause disturbances to special-status species or their habitats. Since the construction required to modify SLC-2 for the Firefly Alpha program is limited to previously developed and disturbed areas, the potential for impacts is minimal. Additionally, Firefly Alpha launches are short and infrequent activities (up to 11 events per year) that are commensurate with the prior activities at SLC-2 and would not be expected to have residual effects past each operation.

Although the Proposed Action and other concurrent projects may disturb wildlife, the disturbance would be temporary and wildlife would continue to use habitat in the periphery of the projects. Compliance with the PBO and LOA would minimize impacts on special-status species. Therefore, implementation of Proposed Action in conjunction with other past, present, or reasonably foreseeable projects would not result in significant cumulative impacts on biological resources.

## 4.4.8 HAZARDOUS MATERIALS, SOLID WASTE, AND POLLUTION PREVENTION

Past, present, and reasonably foreseeable future actions discussed could result in impacts related to hazardous materials, solid waste, and pollution prevention. Currently VAFB is working to reduce waste and has been successful in meeting its diversion rate for construction and demolition materials. Other construction projects in and around VAFB will result in increased amounts of solid waste and possibly hazardous waste and pollution, however, given the temporary nature of construction the solid waste from them is not expected to be excessive. These past, present, and reasonably foreseeable future actions are expected to comply with all relevant federal, state, and local regulations related to hazardous materials and hazardous waste.
The Proposed Action would not increase the amount of hazardous materials and hazardous waste would not increase due to these materials already being present at VAFB. Hazardous materials and wastes resulting from the launches would be the same types as currently used and managed on VAFB during construction activities and launch operations (e.g., petroleum, oils, and lubricants; LOX; RP-1). There would be no hazardous materials resulting from launches; however, there could be small amounts produced during construction. Solid waste generated at VAFB would increase from facility modifications but are not expected to be significant. Activities associated with the Proposed Action would comply with all relevant federal, state, and local regulations related to hazardous materials and hazardous waste. When combined with other past, present, and reasonably foreseeable future actions, the Proposed Action is not expected to result in significant cumulative impacts to hazardous materials, solid waste, and pollution prevention.

#### 4.4.9 WATER RESOURCES

Past, present, and reasonably foreseeable future actions could result in cumulative impacts on water resources if concurrent projects were to inadequately address water resources at project locations. However, projects on VAFB, including the Proposed Action, are required to utilize site-specific BMPs to control runoff and conduct site restoration, as necessary, to minimize impacts on water quality. Impacts tend to be localized and temporary during construction activities. In addition, all VAFB cumulative projects, as shown in this chapter, would follow the conditions of the CWA Section 404 Permit and 401 Water Quality Certification, a Stormwater Pollution Prevention Plan prepared for the NPDES Construction General Permit, Post Construction Storm Water Standards, or Energy Independence and Security Act of 2007 Section 438, as applicable.

Under the Proposed Action, erosion and contamination caused by construction activities are not anticipated. Therefore, implementation of the Proposed Action, in conjunction with other past, present, or reasonably foreseeable projects, would not result in significant cumulative impacts on water resources.

#### 4.4.10 SUMMARY

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

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# Appendix B: Correspondence and Agreements

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## B.1 U.S. Fish and Wildlife Service Concurrence of "No Re-initiation"

# Request for Concurrence that Firefly does not require reinitiaiton

## YORK, DARRYL L GS-13 USAF AFSPC 30 CES/CEIEA <darryl.york@us.af.mil>

Thu 10/17/2019 10:18 AM

To:LaBonte, John P <John.LaBonte@ManTech.com>;

John:

Here's an email chain that includes all the back and forth correspondence from start to finish on this subject.

Darryl

From: YORK, DARRYL L GS-13 USAF AFSPC 30 CES/CEIEA Sent: Tuesday, April 16, 2019 4:20 PM To: CURRY-BUMPASS, TRACY L GS-12 USAF AFSPC 30 CES/CEIEA <tracy.curry-bumpass@us.af.mil> Cc: DEVENOGE, THOMAS P CIV USAF AFSPC 30 CES/CEIE <thomas.de\_venoge@us.af.mil> Subject: FW: [Non-DoD Source] Re: [EXTERNAL] FW: VAFB, Space Launch Complex 2

FWS agreed no reinitiation required at SLC-2.

From: Diel, Christopher <<u>christopher diel@fws.gov</u>> Sent: Tuesday, April 16, 2019 4:11 PM To: YORK, DARRYL L GS-13 USAF AFSPC 30 CES/CEIEA <<u>darryl.york@us.af.mil</u>>; EVANS, RHYS M CIV USAF AFSPC 30 CES/CEIEA <<u>rhys.evans@us.af.mil</u>>; Subject: Re: [Non-DoD Source] Re: [EXTERNAL] FW: VAFB, Space Launch Complex 2

Hi Darryl,

We were discussing too many projects at once on our side. UAS should be ULA in the last paragraph.

Thanks,

Chris

On Tue, Apr 16, 2019 at 3:24 PM Diel, Christopher <<u>christopher\_diel@fws.gov</u>> wrote:

Darryl,

Vandenberg Air Force Base proposes to lease Space Launch Complex 2 (SLC-2) to a new launch proponent. SLC-2 has been in operation since the mid-1960s, with 52 launches to date; the last launch at SLC-2 was the Delta II in September 2018, by United Launch Alliance (ULA). Vandenberg proposes to transfer SLC-2 from ULA to a new corporation, Firefly Aerospace. The first Firefly launch is proposed for late calendar year 2019.

The "Firefly Alpha" is a new type of rocket; at 29 meters in height (95 feet), it is considerably smaller than the Delta II, which is 39 meters (128 feet) in height. Firefly Alpha would use liquid oxygen (LOX) and RP-1 (rocket propellant) fuels. There would be no solid rocket fuels used, which had potential effects on beach layia, as analyzed in the PBO for Delta II launches.

The Firefly Alpha is expected to be quieter than the Delta II, with the engine noise predicted at 150 decibels at the launch pad at liftoff; whereas, the Delta II had an engine noise of 198 decibels at the launch pad at liftoff. Firefly Aerospace proposes to launch twice their first year, and up to 12 launches per year in years following.

Vandenberg Air Force Base believes that converting SLC-2 to launch a smaller, quieter rocket, and one that does not include solid fuels, would have significantly fewer impacts than the Delta II, and would not require reinitiation of PBO. In several years, Firefly Aerospace may propose to launch a larger vehicle from SLC-2, currently in development as the "Firefly Beta"; however, Vandenberg Air Force Base will coordinate with the Service on this at the appropriate time.

After reviewing the description of the proposed Firefly Alpha launches, the activities and effects analyzed for SLC-2 in the existing PBO, and the status of the species, we conclude that transfer from UAS to Firefly Alerospace and Firefly Alpha launches would not require reinitiation of the PBO. Please be aware that all relevant avoidance and minimization measures for launches at SLC-2, reasonable and prudent measures, terms and conditions, and reporting requirements remain in effect. If you have any questions or concerns, please feel free to contact me.

Sincerely,

Chris

On Mon, Apr 8, 2019 at 11:30 AM YORK, DARRYL L GS-13 USAF AFSPC 30 CES/CEIEA <a href="https://darryl.york@us.af.mil">darryl.york@us.af.mil</a> wrote:

Lena:

Hopefully the following information will answer your questions. Please let me know if you need further information.

- They will be starting at 2 launches their first year, following those 8 launches, with the hopes of 12 per year after that. The past EA's for SLC-2 Delta II program were 10. Any increase in tempo over what was analyzed before will have a supplemental EA and associated consultations, FireFly knows this.

- Engine noise and down range sonic boom from Alpha are expected to be lower than the current numbers associated with Delta II with core and solid rocket motors. Firefly has determined the predicted engine noise for the immediate area around SLC-2W at liftoff. Firefly is beginning to collect actual first stage (Reaver) engine noise data at their test site facility in TX. Firefly generated the far field noise OASPL contour plots, following the classic standard NASA SP-8072. See the attached "Alpha SLC-2W Predicted Engine Noise." Firefly analyzed the sonic boom created by Alpha using the computer program "PCBoom 6". This analysis produced results similar or below the current Delta II vehicle, as Alpha is a smaller vehicle with a similar shape. Thus, they are moving less air in a similar profile, creating a lower shock or sonic boom.

- They will be using the same fuel as the Delta program (RP-1/LOX).

Thx

Darryl

From: Chang, Lena <<u>lena\_chang@fws.gov</u>> Sent: Thursday, April 04, 2019 1:19 PM To: YORK, DARRYL L GS-13 USAF AFSPC 30 CES/CEIEA <<u>darryl.york@us.af.mil</u>> Cc: Diel, Christopher <<u>christopher diel@fws.gov</u>> Subject: Re: [Non-DoD Source] Re: [EXTERNAL] FW: VAFB, Space Launch Complex 2

Hi Darryl,

Our apologies on this; we had some internal discussion and questions for you just before the shutdown, but looking back now, I realized we never sent the questions!

Thank you for outlining the size and sound aspects of the proposed Firefly launches compared to the previous Delta launches. We did have an additional question about launch frequency. What is the proposed maximum launch frequency for Firefly launches, and are there any other aspects related to the proposed launches that will differ from the use of SLC-2 since 2015 (beyond the noted differences in rocket size/noise and fuel type)?

Thank you, Darryl.

Lena

Lena Chang | Senior Fish & Wildlife Biologist U.S. Fish & Wildlife Service | Ventura Fish & Wildlife Office 2493 Portola Road, Suite B | Ventura, California 93003 Direct: 805.677.3305 Main: 805.644.1766 | <u>lena chang@ftws.gov</u> <u>PreboolyVenum Pish & Wildle Office/US Pish & Wildle Service</u>

On Thu, Apr 4, 2019 at 11:54 AM YORK, DARRYL L GS-13 USAF AFSPC 30 CES/CEIEA <a href="https://darryl.york@us.af.mil">darryl.york@us.af.mil</a> wrote:

Chris/Lena:

I checked all my old emails and cannot find a response to this question Rhys asked on 12/04/2018. We need to confirm that this change in launch proponents at SLC-2 does not rise to the level of a reinitiation. We believe that it does not.

This transfer is a priority for the Wing and is moving quickly through Real Property process.

I know I've asked you for a lot lately but could you please confirm that you agree.

Thx

Darryl

From: Diel, Christopher <<u>christopher\_diel@fws.gov</u>> Sent: Friday, December 07, 2018 8:33 AM To: YORK, DARRYL L GS-13 USAF AFSPC 30 CES/CEIEA <<u>darryl.york@us.af.mil</u>> Subject: [Non-DoD Source] Re: [EXTERNAL] FW: VAFB, Space Launch Complex 2

Thanks, Darryl. I will follow up with Lena and we will get a response (or questions) to you soon.

Chris

On Fri, Dec 7, 2018 at 8:23 AM YORK, DARRYL L GS-13 USAF AFSPC 30 CES/CEIEA <<u>darryl.york@us.af.mil</u>> wrote: Chris:

Rhys forgot to copy you on this email. As we discussed with Lena at the INRMP meeting we don't believe this property transfer rises to the level of a reinitiation. We would like correspondence (email is fine) from your office acknowledging we notified you of this decision. Please let me know if you want to discuss further.

Thx

Darryl

-----Original Message-----From: EVANS, RHYS M CIV USAF AFSPC 30 CES/CEIEA <<u>rhys.evans@us.af.mil</u>> Sent: Tuesday, December 04, 2018 4:54 PM To: Chang, Lena <<u>lena\_chang@fws.gov</u>> Cc: YORK, DARRYL L GS-13 USAF AFSPC 30 CES/CEIEA <<u>darryl.york@us.af.mil</u>> Subject: VAFB, Space Launch Complex 2

Lena:

As we discussed last week, Vandenberg AFB is in the process of leasing Space Launch Complex 2 (SLC-2) to a new launch proponent. SLC-2 has been in operation since the mid-1960's (and operational under a different configuration since 1959). A total of 52 launches have occurred to date, the last launch being a Delta II in mid-September 2018, by United Launch Alliance (ULA). The site is being transferred from ULA a new corporation, Firefly Aerospace.

The first Firefly launch is expected probably late in calendar year 2019. The "Firefly Alpha" is a new type of rocket, though at 29 meters in height (95 feet), it is significantly smaller than the most commonly vehicle launched recently at SLC-2, the Delta II, which was 39 meters (128 feet) in height. Firefly Alpha will use liquid oxygen (LOX) and RP-1 (rocket propellant, basically a refined form of kerosene) as fuel, there will be no solid rocket fuels used (I mention this because solid rockets may result in acid deposition near the launch site; we had considered potential effects of solid rockets on beach layia, but that's not applicable for a launch using LOX and RP-1). We believe that converting the site to launch a smaller rocket, and one that does not include solid fuels (the Delta II did use solids for occasional launches, as boosters for heavier payloads), that effects of Firefly will be significantly less than the impacts from the Delta II. The significantly smaller rocket will be significantly quieter; therefore we believe that we do not need reinitiation of PBO. In several years, Firefly may plan to launch a larger vehicle from SLC-2, currently in development as the "Firefly Beta," however we'll discuss that with your office at the appropriate time.

Please let us know if you have any questions or concerns,

Thank you! rme

Rhys M. Evans Biological Scientist/Natural Resources Lead 30 CES/CEI Vandenberg Air Force Base, California <u>Rhys.evans@us.af.mil</u> 805-606-4198 (DSN 276-4198) --Christopher J. Diel Assistant Field Supervisor U.S. Fish & Wildlife Service, Ventura Field Office 2493 Portola Road, Suite B Ventura, CA 93003 805/677-3366

--Christopher J. Diel Assistant Field Supervisor U.S. Fish & Wildlife Service, Ventura Field Office 2493 Portola Road, Suite B Ventura, CA 93003 805/677-3366

Christopher J. Diel Assistant Field Supervisor U.S. Fish & Wildlife Service, Ventura Field Office 2493 Portola Road, Suite B Ventura, CA 93003 805/677-3366 B.2 Programmatic Biological Opinion on Routine Mission Operations and Maintenance Activities, Vandenberg Air Force Base, Santa Barbara County, California (8-8-13-F-49R)



IN REPLY REFER TO: 08EVEN-2013-F-0430 United States Department of the Interior

FISH AND WILDLIFE SERVICE Ventura Fish and Wildlife Office 2493 Portola Road, Suite B Ventura, California 93003



December 3, 2015

Beatrice L. Kephart 30 CES/CEI 1028 Iceland Avenue Vandenberg Air Force Base, California 93437

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

Dear Ms. Kephart:

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion based on our review of the U.S. Air Force's (Air Force) programmatic biological assessment and subsequent request to reinitiate consultation on routine mission operations and maintenance activities at Vandenberg Air Force Base (VAFB). We received your request for reinitiation, dated August 22, 2013, in our office on August 29, 2013. At issue are the effects of Air Force activities on the federally threatened California red-legged frog (*Rana aurora draytonii*), vernal pool fairy shrimp (*Branchinecta lynchi*), westem snowy plover (*Charadrius nivosus nivosus*), and southern sea otter (*Enhydra lutris nereis*); the federally endangered beach layia (*Layia carnosa*), Gambel's watercress (*Nasturtium gambelii*), Gaviota tarplant (*Deinandra increscens* ssp. villosa), Lompoc yerba santa (*Eriodictyon capitatum*), El Segundo blue butterfly (*Euphilotes battoides* ssp. allyni), tidewater goby (*Eucyclogobius newberryi*), unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*), California least tern (*Sterna antillarum browni*), and southwestern willow flycatcher (*Empidonax traillii extimus*). Your request and our response are in accordance with section 7 of the Endangered Species Act of 1973, as amended (Act)(16 U.S.C. 1531 et seq.).

Your reinitiation request included a description of anticipated effects on, what was at the time, the federally proposed endangered Vandenberg monkeyflower (*Diplacus vandenbergensis*) and requested a conference opinion. The Vandenberg monkeyflower has since been listed as endangered (79 FR 50844). Therefore, our analysis for this species is included in our biological opinion rather than as a conference opinion. Your request to reinitiate consultation also included the California brown pelican (*Pelecanus occidentalis*). The brown pelican has been delisted and is not discussed further in this biological opinion.

After reviewing the information provided by the Air Force and the status of the species for the Gambel's watercress, southwestern willow flycatcher, and the southern sea otter, we have

concluded that the proposed project activities are not likely to adversely affect these species. The bases for our determinations follow:

#### Gambel's Watercress

VAFB contains the only known extant population of the federally endangered Gambel's watercress. Approximately 100 individual plants were found along a deep, slow moving channel that runs along the south side of the Purisima Hills, which is part of the San Antonio Creek watershed and just north of the main entrance gate to VAFB (Keil and Holland 1998). This population occupies less than 1 acre. A historical population that was located at Barka Slough has been extirpated or has introgressed (i.e., hybridized) with the common watercress (*Nasturtium officinale*) (M. Elvin, Service biologist, pers. comm. 2008). Base-wide surveys for Gambel's watercress in suitable habitat were completed on VAFB in 1996 and the Air Force conducted surveys in 2008 and 2009.

The Air Force identified a primary buffer consisting of the area within 500 feet of the extant population of Gambel's watercress. A secondary buffer that encompasses the headwaters of the San Antonio Creek watershed beyond the primary buffer includes the area beyond already developed facility boundaries between the north cantonment area boundary and Firefighter Road. The closest existing infrastructure to the occupied habitat is a culvert and barbed wire fence located approximately 430 feet to the east. Both structures are within the primary buffer area.

While the Air Force would perform periodic maintenance of this culvert and fence, they would restrict all other activities within this primary buffer area. In addition, the Air Force proposes to avoid adversely affecting the Gambel's watercress and its habitat by implementing measures that include accessing the occupied area by foot only, conducting surveys for, and removal of, the common watercress if observed in occupied habitat, flagging individual Gambel's watercress plants to avoid, using only manual methods to remove invasive plant species, restricting heavy equipment used in invasive species control efforts to existing roads and trails, using backpack sprayers and extension hoses in upland areas, cleaning all equipment (including footwear) prior to entering occupied habitats, mixing chemicals in non-sensitive areas, and a Service-approved biologist familiar with Gambel's watercress will inform all project personnel of the occupied habitat location and the restrictions afforded to this area.

The Air Force would also implement a suite of measures within the secondary buffer area to minimize the potential impacts to the headwaters of the watershed, and within historical locations and areas that contain suitable habitat. The Air Force will minimize areas of disturbance to the maximum extent practicable, conduct maintenance and refueling of vehicles and equipment on existing roads and paved areas, restrict access for maintenance activities to existing roads, implement measures to minimize sedimentation, erosion, and the downstream deposition of project-related toxic compounds (i.e. cement), and coordinate project activities with 30 CES/CEI prior to conducting any project activities within this secondary buffer area. The Air Force will conduct surveys during the flowering and fruiting period (April through September) at least every 3 years contingent upon funding. Based on habitat and soil

characteristics, which may occur at various locations throughout the base, surveys will focus on areas with high potential for the occurrence of the species. Because the federally endangered Marsh Sandwort (*Arenaria paludicola*) is currently not known to occur on VAFB but it occurs in similar habitat, the Air Force proposed to survey for this species concurrently with Gambel's watercress during the base-wide survey efforts. The Air Force's botanist, or another botanist familiar with the Gambel's watercress and who are approved by the Service prior to conducting the surveys, would be the only biologists who could conduct the base-wide surveys.

The activities proposed by the Air Force would not affect Gambel's watercress because of the measures the Air Force would implement to avoid adverse effects to the extant population of the species. Thus, we are not discussing Gambel's watercress further in this biological opinion.

#### Southwestern Willow Flycatcher

A small population of the southwestern willow flycatchers, between one and five adults, consistently occurred on VAFB during the spring and summer months between 1995 and 2004. This population was distributed between two sites in willow riparian habitat along the Santa Ynez River, the Wildlife Natural Resources Area and near 13<sup>th</sup> Street. At the 13<sup>th</sup> Street site, two abandoned nests were found in 1995 and breeding was documented in 1998 (Farmer et al. 2003); however, this nesting site was destroyed by high water flows during the winter storms of 2000-2001. Southwestern willow flycatchers were documented from 1992 through 1994 near the Miguelito Wetland on the south bank of the Santa Ynez River east of the remnants of the 35<sup>th</sup> Street Bridge, with breeding confirmed in 1992 (Farmer et al. 2003). The northernmost nesting sites along the coastal California recovery unit were documented on the Santa Ynez River (Service 2002a); however, southwestern willow flycatchers have not been observed in this area in subsequent years.

Although there have been no confirmed sightings or observed breeding activity at VAFB since 2004, the Air Force proposes to implement measures to avoid and (or) minimize potential adverse effects to southwestern willow flycatchers if individuals are observed on base. A biologist familiar with southwestern willow flycatchers will conduct surveys in riparian habitats during the breeding season (May 15 through August 15) every third year contingent upon funding, and conduct pre-activity surveys if project activities are planned to occur in suitable habitat between May through August. If southwestern willow flycatchers are observed, project activities will be confined to already developed areas, or if the project requires new areas to be cleared only those areas outside of a 500-foot buffer from the nest would be disturbed. In addition, the Air Force will monitor the first two launches of any new or louder space vehicle or program from Space Launch Complex (SLC)-3 between May 15 and August 15 (surveys will be conducted before each launch, during the launch for daytime launches, if safety allows, and following each launch). The Air Force will also monitor at the Santa Ynez River during launches from SLC-4 if flycatchers are present. The Air Force will also direct all visitors to stay on established trails at the Wildlife Natural Resources Area, remove brown-headed cowbird eggs and chicks from parasitized nests, conduct maintenance of trails near historically occupied areas outside of the breeding season (unless nests are not present), and apply herbicides at least 100

feet from occupied habitat; only chemicals approved for use in aquatic habitats will be authorized.

Because the Air Force has not observed southwestern willow flycatchers on the base since 2004, breeding birds or migrants, and they propose to implement measures to avoid and (or) minimize potential effects of the project activities on individuals and suitable habitat, we determined that the project activities contained within this biological opinion are not likely to adversely affect southwestern willow flycatchers. Therefore, we are not discussing this species further in this biological opinion.

#### Southern Sea Otter

Southern sea otters currently inhabit shallow coastal waters in San Mateo, Santa Cruz, Monterey, San Luis Obispo, and Santa Barbara Counties. The range extends from around Half Moon Bay in the north to approximately Gaviota in the south. Sea otters inhabit the nearshore waters along VAFB. A small experimental population also occurs at San Nicolas Island in Ventura County; the result of translocation efforts conducted in 1987.

Following a period of decline between 1995 and 2000, the southern sea otter population appears to be moving toward recovery, with an average growth rate of approximately 5 percent per year over the 2001 to 2007 period (U.S. Geological Survey (USGS) 2007). Most of this increase has occurred at the south end of the range (south of Estero Bay), with a more sluggish rate of growth in the northern and central portions of the range where densities are highest, suggesting that sea otters may be approaching local carrying capacity in some areas (Tinker et al. 2006). The current population is estimated at approximately 2,800 individuals (USGS 2007).

The Air Force has attained monitoring data during their launch activities since 1998 that indicate launch noise and security overflights do not substantially affect the number or activities of this species in the nearshore marine environments of VAFB. The Air Force is controlling activities such as maintenance dredging and boat traffic within the harbor such that sea otters will not be affected. No other proposed project activities would affect sea otters. Therefore, we determined that the project activities contained within this biological opinion are not likely to adversely affect the sea otter, and we are not discussing this species further in this biological opinion. Likewise, activities conducted by the Air Force at the harbor are not expected to affect any other listed species and are not discussed further.

This biological opinion was prepared using information provided in your request for formal consultation, electronic and telephone communications between our staffs, and information in our files. A complete record of this consultation can be made available at the Ventura Fish and Wildlife Office.

#### CONSULTATION HISTORY

On September 22, 2011, we issued a programmatic biological opinion (PBO) to the Air Force for routine mission operations and maintenance activities at VAFB. Over forty projects have been covered under the PBO during the first 3 years of implementation. On August 22, 2013, the Air Force requested reinitiation of formal consultation to update species distributions, refine some specific covered activity descriptions, and to include the Vandenberg monkeyflower. The Air Force provided additional information via a letter dated February 24, 2014 and via email throughout the development of this biological opinion. We met with Air Force staff on March 13, and April 15, 2014, regarding the reinitiation measures.

## Superseded Existing Biological Opinions

Several existing section 7 consultations for projects similar to the project activities described in this programmatic biological opinion have been recently completed or are currently in effect. This programmatic biological opinion would supersede the existing consultations that contain similar actions to those that are analyzed within this document. The superseded biological opinions include: Titan Space Launch Program at SLC-4 (biological opinion number 1-8-96-F/C-29), Delta II/SLC-2 Space Launch Rate Increase (1-8-96-F-53R), Theater Missile Targets Program (1-8-98-F-24), Delta II/SLC-2 and Taurus LF-576-E Launch Programs (1-8-98-F-25R), Atlas Launch Program (1-8-99-F/C-79), Landfill Operations and Cell Closure (1-8-06-F-2), IRP Site 32 Cluster Project (1-8-06-F-26), Small Missile Launch Site LF-06 (1-8-06-F-17), Firebreaks and Access Roads (1-8-06-F-43), Military Munitions Response Program (MMRP) (1-8-07-F-54, 8-8-09-F-39R, 8-8-10-F-27R), Reinitiation of the Atlas Launch Program at SLC-3E (1-8-08-F-6R), Closure of Solid Waste Disposal Cell at the VAFB Landfill (1-8-06-F-2).

Some existing biological opinions will remain in place because the projects' actions are not similar or are larger in scope than the actions analyzed within this programmatic biological opinion. These include: Beach Management and Water Rescue Training (8-8-12-F-11R), San Antonio Creek Restoration (8-8-09-F-49R), Borrow Pits (8-8-10-F-5), Military Family Housing (1-8-06-F-7), Modification and Operation of SLC-4E (8-8-10-F-38), and the Expandable Evolved Launch Vehicle (EELV) Program and Firebreak and Landscape Maintenance at SLC-6 (1-8-99-F-27, 1-8-06-F-18, 1-8-07-F-1R).

## Qualifying Language

On September 11, 2008, we submitted comments to the Air Force regarding their use of qualifying language (e.g., "when practicable") in the avoidance and minimization measures. We stated that if such qualifying language is associated with the measures, we do not have an adequate level of certainty that the measures will be implemented and therefore we must analyze the effects of the proposed activities without the avoidance and minimization measures being implemented.

On January 15, 2010, the Air Force stated that the avoidance and minimization measures without the qualifying language implements spatial and temporal constraints that represent an unacceptable level of restriction to the Air Force's mission (T. Devenoge, Chief of Natural

Resources at VAFB, pers. comm. 2010). Consequently, the Air Force re-proposed to incorporate qualifying language into the avoidance and minimization measures in an effort to reduce the spatial and temporal constraints because the Air Force stated that it would be on a rare occasion when they could not implement the avoidance and minimization measures as part of a project's actions. In addition, as part of the pre-project notification requirement, the Air Force stated that it would inform us when implementing the measures would not be feasible as part of a project's actions, and they would implement the measures a vast majority of the time. Therefore, we agreed to analyze the effects of the actions as if the measures would be implemented, even if the qualifying language is incorporated; however, if the Air Force informs us in the pre-project notification that a measure is not feasible, thus not implemented, the Service will make a determination whether or not implementing a particular measure would result in effects to a federally listed species beyond our analysis. The following two scenarios would occur based on our determination:

- If the Service determines that there is no change to the effects analysis and the project is within the scope of this biological opinion, the project could go forth as planned.
- 2. If the Service determines that the project would result in a change to the effects analysis and (or) is not within the scope of this biological opinion, the subject project would not be covered by this biological opinion and the Air Force must either: (a) reinitiate this biological opinion, or (b) submit a request for a separate consultation pursuant to section 7 of the Act.

Federal regulations which implement section 7 of the Act require reinitiation of consultation when new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered (50 Code of Federal Regulations (CFR) 402.16). Taking of federally listed species that results from Federal agency actions not analyzed in a biological opinion, and not exempted by an associated incidental take statement, is prohibited pursuant to section 9 of the Act.

## BIOLOGICAL OPINION

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B.3 Section 106 Consultation for Cessation of NASA Ops at SLC-2 East and West and Initiation of Firefly Ops at SLC-2 West, Thor Launch Complexes Historic District, Vandenberg Air Force Base, Santa Barbara County, California



State of California • Natural Resources Agency

Gavin Newsom, Governor

Lisa Ann L. Mangat, Director

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

May 10, 2019

Reply in Reference To: USAF\_2019\_0424\_002

Richard Cote Deputy Base Civil Engineer 30<sup>th</sup> Civil Engineer Squadron Vandenberg Air Force Base 1172 Iceland Avenue Vandenberg AFB, CA 93437-6011

Re: Section 106 Consultation for Cessation of NASA Ops at SLC-2 East and West and Initiation of Firefly Ops at SLC-2 West, Thor Launch Complexes Historic District, Vandenberg Air Force Base, Santa Barbara County

Dear Mr. Cote:

The United States Air Force (USAF) is initiating consultation with the State Historic Preservation Officer (SHPO) regarding its effort to comply with Section 106 of the National Historic Preservation Act of 1966 (54 U.S.C. 306108), as amended, and its implementing regulation found at 36 CFR Part 800.

The USAF is proposing to terminate the National Aeronautics and Space Administration's (NASA) Title 51 License at Space Launch Complex-2 (SLC-2) and initiate a new license with Firefly Aerospace to operate at SLC-2. The USAF's proposed activities for the undertaking include:

- Installation of two, 12x12 roll-up doors and removal of equipment associated with NASA's Delta Launch program at Facility 1670 and installation of one 12x12 roll up door at Facility 1615;
- Modification of the SLC-2 West launch pad to accommodate the new launch program;
- Utility trenching;
- Installation of HVAC and mission support equipment in facilities 1615 and 1670; and
- Installation of equipment racks in facilities 1622 and 1693;

Constructed in 1963 as the Area 75 prelaunch checkout building, Facility 1670 was later modified to support the SLC-2 Delta program. Having evaluated Facility 1670 for National Register of Historic Places (NRHP) eligibility the USAF determined it does not meet NRHP eligibility requirements. Facility 1622, constructed in 1958 as the original SLC-2 West blockhouse, was formally been determined eligible for NRHP inclusion. Facility 1693, a component of the SLC-2 West pad was determined not eligible for NRHP inclusion through

May 10, 2019 Richard Cote Page 2

consensus as was Facility 1615, identified as a horizontal processing facility constructed after 1966. No prehistoric archaeological sites have been identified within the area of potential effects (APE).

Based on its historic property identification efforts and analysis of the proposed undertaking's effects on historic properties, the USAF is requesting the SHPO's concurrence that Facility 1670 does not meet NRHP eligibility requirements and with its finding of no adverse effect pursuant to 36 CFR Part 800.5(d)(1). After reviewing the information provided in support of this finding of effect, the SHPO has the following comments:

- Pursuant to 36 CFR Part 800.4(a)(1), the SHPO has no objection to the USAF's definition of the APE as the boundaries of the Thor Launch Complexes Historic District, SLC-2 and Facility 1670.
- The SHPO concurs that Facility 1670 does not meet NRHP eligibility requirements.
- 3) The SHPO concurs that a finding of no adverse effect is appropriate pursuant to 36 CFR Part 800.5(d)(1). Be advised that that under certain circumstances, such as an unanticipated discovery or a change in project description, the USAF may have future responsibilities for this undertaking under 36 CFR Part 800.

If there are any questions or concerns, contact Historian Ed Carroll at (916) 445-7006 or Ed.Carroll@parks.ca.gov.

Sincerely,

Julianne Polanco State Historic Preservation Officer

## B.4 Federal Aviation Administration Section 106 Consultation for Firefly Aerospace Alpha Launches at Vandenberg Air Force Base



Federal Aviation

Office of Commercial Space Transportation

800 Independence Ave., SW. Washington, DC 20591

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

#### SUBJECT: Section 106 Consultation for Firefly Aerospace Alpha Launches at Vandenberg Air Force Base

Dear Ms. Polanco,

As authorized by Chapter 509 of Title 51 of the U.S. Code, the Federal Aviation Administration (FAA) Office of Commercial Space Transportation licenses and regulates U.S. commercial space launch and reentry activity. The FAA is currently evaluating Firefly Aerospace's (Firefly) proposal to conduct launches of its Alpha launch vehicle at Space Launch Complex 2-West (SLC-2W) at Vandenberg Air Force Base (VAFB). Issuing licenses for commercial space launch operations is a federal action subject to compliance with the National Environmental Policy Act (NEPA) and is considered an undertaking subject to compliance with the National Historic Preservation Act (NHPA). The FAA is preparing an environmental assessment (EA) in compliance with NEPA. The U.S. Air Force (USAF; 30th Space Wing) is a cooperating agency in the preparation of the EA due to their jurisdiction by law. SLC-2W is located on VAFB property and the 30th Space Wing has ultimate responsibility for all operations that occur on VAFB property. This letter is intended to initiate Section 106 consultation and solicit your feedback.

#### Description of Undertaking

The FAA's undertaking is to issue a launch license to Firefly that would allow Firefly to launch Alpha rockets from SLC-2W at VAFB. Firefly is proposing to conduct 11 vertical launches per year over the next five years (2020–2024). Each launch would be preceded by a static fire engine test. Prior to conducting launches, Firefly would conduct facility modifications at SLC-2W to support Alpha launch operations. The FAA has no federal action related to the facility modifications. The USAF is responsible for authorizing the proposed facility modifications.

Alpha is a small, unmanned, light-lift, two-stage, liquid fueled launch vehicle. At 95 feet in length with a diameter of 6 feet, Alpha is much smaller than many other space launch vehicles launched from VAFB. Both the first and second stages use liquid oxygen and rocket propellant-1 (kerosene) as propellants. Alpha would fly a southern launch trajectory over south VAFB and the Pacific Ocean.

#### Area of Potential Effects, Identification of Historic Properties, and Finding of Effect

The USAF conducted Section 106 consultation with the State Historic Preservation Officer (SHPO) in 2019 for the same activities that would occur under the FAA's undertaking (see attached correspondence; consultation USAF\_2019\_0424\_002). The attached report titled *Identification of Historic Properties And Assessment of Effects, Cessation of NASA Operations at SLC-2 East and West and Initiation of Firefly Aerospace Operations at SLC-2 West, Vandenberg Air Force Base, Santa Barbara* 

*County, California* defines the area of potential effects (APE), identifies historic properties within the APE, and makes a finding of no adverse effect. The SHPO concurred with the USAF's definition of the APE and finding of no adverse effect.

The FAA concurs with the APE and finding of effect as discussed USAF's report, which includes Alpha launches at SLC-2W. Therefore, the FAA is requesting concurrence with a finding of no adverse effect for the undertaking of issuing Firefly a launch license for Alpha launches at SLC-2W. Given these activities have been previously reviewed by the SHPO, we would appreciate an expedited review and ask for your concurrence within ten business days. Thank you for your assistance in this matter. Please provide your response to Leslie Grey via e-mail at Leslie.Grey@faa.gov.

Sincerely,

Daniel Murray Manager, Space Transportation Development Division

Attachments: April 19, 2019 USAF Letter to SHPO April 2019 USAF Historic Properties Report May 10, 2019 SHPO Letter to USAF -

State of California • Natural Resources Agency

Gavin Newsom, Governor

Lisa Ann L. Mangat, Director

#### DEPARTMENT OF PARKS AND RECREATION OFFICE OF HISTORIC PRESERVATION

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

January 31, 2020

Reply in Reference To: FAA\_2020\_0121\_001

Daniel Murray Manager, Space Transportation Development Division FAA, Office of Commercial Space Transportation 800 Independence Ave., SW Washington, DC 20591

Re: Section 106 Consultation for Firefly Aerospace Alpha Launches, Vandenberg Air Force Base

Dear Mr. Murray:

The Federal Aviation Administration Office of Commercial Space Transportation (FAA) is consulting with the State Historic Preservation Officer (SHPO) in order to comply with Section 106 of the National Historic Preservation Act of 1966 (54 U.S.C. § 306108), as amended, and its implementing regulations at 36 CFR Part 800. The FAA is requesting concurrence with a finding of no adverse effect to historic properties.

The FAA plans to issue a launch license to Firefly Aerospace to launch rockets from Space Launch Complex 2-West (SLC-2W) at Vandenberg Air Force Base. Firefly Aerospace will conduct eleven vertical launches a year from 2020 to 2024. Facility modifications will be required prior to launches. The United States Air Force will be responsible for authorizing proposed modifications.

The FAA proposes to use prior Air Force Section 106 efforts to inform this undertaking, including the Area of Potential Effects (APE), identification efforts, and finding of effect the Air Force established in consultation with SHPO in 2019 for Firefly Aerospace operations at SLC-2W (refer to USAF\_2019\_0424\_002). The Air Force and SHPO agreed that SLC-2W was ineligible for listing on the National Register of Historic Places and that, while located within the National Register-eligible Thor Launch Complexes Historic District, launch operations conducted there would not adversely affect the historic district.

Having reviewed your submittal, SHPO concurs with the FAA's finding of effect. Please be reminded that changes in the scale or scope of the undertaking may necessitate further Section 106 consultation. January 31, 2020

If you have any questions or comments, contact State Historian Tristan Tozer at (916) 445-7027 or <u>Tristan.Tozer@parks.ca.qov</u>.

Sincerely,

Julianne Polanco State Historic Preservation Officer

#### B.5 Evacuation Agreement No. SPCVAN-103-0006; Supplemental Agreement No. 3

## EVACUATION AGREEMENT NO. SPCVAN-1-93-0006

## SUPPLEMENTAL AGREEMENT NO. 3

THIS SUPPLEMENTAL AGREEMENT entered into this 13<sup>th</sup> day of ("County") and Secretary of the Air Force ("Government" or "Air Force"). The Government and the County may be referred to jointly as the "Parties," and each separately may be referred to as a "Party."

#### RECITALS:

A. On 1 December 1992, the Parties entered into an evacuation agreement for the evacuation of County properties Jalama Beach Park, Ocean Beach Park and Point Sal Road in case of certain government operations for purposes of military necessity, security and public safety.

B. On 05 November 1997, the Parties agreed to extend the Agreement for one additional year through 01 December 1998 and to automatically renew the Agreement for a total additional term of five years from December 1, 1997 and added Surf Station Parking Lot to the Agreement.

C. On 13 May 2003, the Parties agreed to extend the agreement for five years though 30 November 2007.

#### AGREEMENT:

- 1. The Agreement is hereby modified in the following particulars, but no others:
  - a. Paragraph III. 13, page 5 of the Agreement is rescinded and replaced with paragraph 1.b, below, of this Supplement No. 3.
  - b. The term of the Agreement was extended for one additional year through 30 November 2008 and will automatically renew annually on 1 December 2008 and on each subsequent 1 December of the following three years for a total additional term of five years from 1 December 2007, unless otherwise amended or terminated pursuant to paragraph 1.b. of this Supplement Agreement No. 3. The Agreement may be modified, amended, revised, or discharged by either Party upon providing advanced written notice to the other Party. Such advanced notice must be provided at least 120 days in advance of the requested modification, amendment, revision, or discharge. Any notice under the terms of this Agreement shall be in writing, signed by a duly authorized representative of the party giving such notice. If notice is given to the County, it shall be addressed to the 1 of 4

County of Santa Barbara, General Services Department, Office of Real Estate Services, 1105 Santa Barbara Street, Santa Barbara, California 93101. If notice is given to the Government, it shall be addressed to the Installation Commander as follows: "30 SW/CC, Vandenberg AFB, California 93437" and a duplicate shall also be mailed and addressed to "30 CES/CECBR, 1172 Iceland Avenue, Bldg 11432, Vandenberg AFB, California, 93437.

2. All other terms and conditions of the Agreement shall be and remain the same, unless otherwise made void by operation of law.

3. This Supplemental Agreement shall be effective immediately.

2 of 4
Project:	Evacuation Agreement	
	SPCVAN-1-93-0006	
	Vandenberg Air Force Base, CA	
Tract No .:	Jalama, Ocean, Surf, Pt Sal Rd	
Folio:	003375	

IN WITNESS WHEREOF, Government and County have executed this Supplemental Agreement No. 3 to Evacuation Agreement SPCVAN-1-93-0006, by the respective authorized officers as set forth below to be effective as of the date executed by Government.

> "COUNTY" COUNTY OF SANTA BARBARA

By

Salud Carbajal, Chair, Board of Supervisors County of Santa Barbara

Date:

APPROVED AS TO FORM ROBERT W.GEIS, CPA AUDITOR-CONTROLLER

By: -L

APPROVED:

3 m

Ray Aromatorio, ARM, AIC Risk Program Administrator

APPROVED Scott McGolpin

Director of Public Works

3 of 4

ATTEST MICHAEL F. BROWN CLERK OF THE BOARD

By:

Deputy

APPROVED AS TO FORM: DENNIS MARSHALL COUNTY COUNSEL

By:

APPROVED:

Ronn Carlentine, Real Property Manager

APPROVED:

Daniel Hernandez

Parks Director

IN WITNESS WHEREOF, I have set my hand by authority of the Secretary of the Air Force as of the day and year first written above.

DEPARTMENT OF THE AIR FORCE

By: 🗘

DAVID J. BUCK Colonel, USAF Commander, 30th Space Wing

4 of 4

#### SUPPLEMENTAL AGREEMENT NO. 3 to EVACUATION AGREEMENT NO. DACA-09-3-98-0009 Between THE STATE OF CALIFORNIA and THE UNITED STATES OF AMERICA

#### WITNESSETH:

WHEREAS, The State of California granted to United States of America an evacuation agreement commencing 01 April 1998 and ending 31 March 2003 for an evacuation agreement between the parties for the evacuation of Tract 432 in order to provide for the safety of persons on land in the proximity of Vandenberg Air Force Base in connection with launch operation activities, and

WHEREAS, Supplemental Agreement No. 1 executed on 21 April 2003 to extend the term for a period of years ending 31 March 2009, and

WHEREAS, Supplemental Agreement No. 2 executed on 01 April 2009 to extend the term for a period of years ending 31 March 2014, and

WHEREAS, The parties would like to now extend the agreement for an additional one year with four one year periods.

NOW, THEREFORE, in consideration of these premises, the parties hereto do mutually agree that the evacuation agreement be extended and modified in the following particulars:

1. That the evacuation agreement be extended one year from 01 April 2014 through 31 March 2015 and each option, subject to the availability of funds, shall automatically renew annually on each subsequent 01 April of the following four years for a total additional term of five years to 31 March 2019

All other terms and conditions of the aforesaid evacuation agreement are hereby ratified and, except as modified by this Supplemental Agreement, shall remain in full force and effect.

#### SUPPLEMENTAL AGREEMENT NO. 3

to

#### EVACUATION AGREEMENT NO. DACA-09-3-98-0009

IN WITNESS WHEREOF, I have hereunto set my hand by authority of the State of California this \_\_\_\_\_\_ day of \_\_August\_\_\_\_, 2017.

STATE OF CALIFORNIA

DANITA RODRIGUEZ, Superintendent Channel Coast District California State Parks California Department of Parks and Recreation 1933 Cliff Drive, Suite 27 Santa Barbara, CA 93109

#### SUPPLEMENTAL AGREEMENT NO. 3 to EVACUATION AGREEMENT NO. DACA-09-3-98-0009

THIS SUPPLEMENTAL AGREEMENT is also executed by The Government under the authority of the Secretary of the Air Force this <u>20</u> day of <u>Oct</u>, 2017.

UNITED STATES OF AMERICA

MICHAEL S. HOUGH, Colonel, USAF Commander, 30th Space Wing

# Appendix C: Noise Study Report

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C.1 Federal Aviation Administration Memorandum regarding Noise Methodology Approval Request for Firefly Launches at Vandenberg Air Force Base (VAFB)



# Federal Aviation Administration

# Memorandum

Date:	October 15, 2019
To:	Leslie Grey, Office of Commercial Space Transportation (AST)
From:	Donald Scata Jr., Manager, Noise Division, Office of Environment and Energy (AEE)
Subject:	Noise Methodology Approval Request for Firefly Launches at Vandenberg Air Force Base (VAFB)

Dear Ms. Grey,

The Office of Environment and Energy (AEE) has reviewed the proposed non-standard noise modeling methodology to be used in the Environmental Assessment of the proposed vertical launch operations of the Firefly Alpha vehicle from Vandenberg Air Force Base in California (VAFB).

As the FAA does not currently have an approved propulsion noise model for launch vehicles, in accordance with FAA Order 1050.1F, all non-standard noise analysis in support of the noise impact analysis for the National Environmental Policy Act (NEPA) must be approved by AEE. This letter serves as AEE's response to the method proposed by Firefly for launch of the Alpha launch vehicle from Space Launch Complex 2W (SLC-2W) at VAFB. Firefly is proposing to use the Launch Vehicle Acoustic Simulation Model (RUMBLE), as described in their technical memorandum dated September 17, 2019.

The proposed methodology appears to be adequate for modeling propulsion for launch vehicles. Therefore, AEE concurs with the methodology proposed for this project. Please understand that this approval is limited to this particular Environmental Assessment and vehicle. Any additional projects using this or other launch noise methodologies or variations of launch vehicle will require separate approval.

Sincerely,

Donald Scata Jr. Manager, AEE-100/Noise Division

Digitally signed by DONALD S SCATA Date: 2019.10.15 14:43:32 -04'00'

# C.2 Noise Study Report

# Blue Ridge Research and Consulting, LLC

# **Technical Report**

# Noise Study for Firefly's Vandenberg Orbital Launch Site Environmental Assessment

October 17, 2019

Prepared for:

Brad Obrocto Director of Launch Operations Firefly Aerospace, Inc. Brad.Obrocto@Firefly.com

**Prepared by:** Michael James, M.S. Matt Calton, M.S.

Contract Number: MSA SOW – 19 Aug 2019

BRRC Report Number: BRRC 19-11 Blue Ridge Research and Consulting, LLC 29 N Market St, Suite 700 Asheville, NC 28801 (p)828-252-2209 (f) 831-603-8321 BlueRidgeResearch.com







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# **Acronyms and Abbreviations**

The following acronyms and abbreviations are used in the report:

BRRC	Blue Ridge Research and Consulting, LLC	
CNEL	Community Noise Equivalent Level	
dB	Decibel	
dBA	A-weighted Decibel Level	
dBC	C-weighted Decibel Level	
DI	Directivity Indices	
DNL	Day-Night Average Sound Level	
DoD	Department of Defense	
DSM-1	Distributed Source Method 1	
FAA	Federal Aviation Administration	
ft	Foot/Feet	
Hz	Hertz	
lbf	Pound Force	
lbs	Pound Mass	
L <sub>A,max</sub>	Maximum A-weighted OASPL in Decibels	
L <sub>max</sub>	Maximum Unweighted OASPL in Decibels	
NIHL	Noise-Induced Hearing Loss	
NIOSH	National Institute for Occupational Safety and Health	
OASPL	Overall Sound Pressure Level in Decibels	
OSHA	Occupational Safety and Health Administration	
EA	Environmental Assessment	
Ра	Pascal	
psf	Pounds per Square Foot	
Rumble	The Launch Vehicle Acoustic Simulation Model	
S.L.	Sea Level	
VAFB	Vandenberg Air Force Base	



# **1** Introduction

This report documents the noise study performed as part of Firefly's efforts on the Environmental Assessment (EA) for proposed operations at Vandenberg Air Force Base (VAFB). Firefly plans to conduct static test and vertical launch operations for the Alpha launch vehicle depicted in Figure 1. Both the static fire and launch events will occur at Firefly's VAFB SLC-2W facility. The potential impacts from propulsion noise are evaluated on a single-event and cumulative basis in relation to human annoyance, hearing conservation, and structural damage.

This noise study describes the environmental noise associated with the proposed Firefly operations. Section 2 describes the proposed Firefly operations; Section 3 summarizes the basics of sound and describes the noise metrics and impact criteria discussed throughout this report; Section 4 describes the general methodology of the propulsion noise modeling; and Section 5 presents the propulsion noise modeling results. A summary is provided in Section 6 to document the notable findings of this noise study.



Figure 1. Rendering of Firefly's Alpha launch vehicle (credit: Firefly)

# 2 Firefly Operations

Firefly plans to conduct Alpha operations for up to 11 pre-launch static fire engine tests and 11 vertical launches per year. The annual operations are presented in Table 1 in terms of acoustic time of day. The Alpha static fire and launch events will occur at Firefly's VAFB SLC-2W pad (34.7556°N, -120.6223°W). Pre-launch static engine tests of all four engines will last five seconds. Although Alpha launch operations will be unique to the vehicle configuration, mission, and environmental conditions, a representative launch azimuth of 179° was simulated using a nominal trajectory provided by Firefly. An overview of the facility and nominal trajectory is shown in Figure 2.



Total

11

11

2

0



#### Figure 2. Overview of launch facility and nominal trajectory

Table 2 presents Alpha modeling input parameters used to estimate noise emissions from the proposed Firefly operations. Although the vehicles' sea level (S.L.) thrust is provided in Table 2, the model uses a time-varying thrust profile based on the trajectory. The maximum modeled vehicle thrust reaches approximately 165,500 lbf during the first stage launch of the Alpha. All operational modeling parameters and trajectories were provided by Firefly personnel.

Table 1. Proposed Firefly Alpha operations				
			Annual Ope	erations
Vehicle	Event	Daytime 0700 – 1900	Evening 1900 – 2200	Nighttime 2200-0700

#### Table 2. Firefly Alpha modeling parameters

Launch

Alpha

**Pre-Launch Static Fire** 

Vehicle	Modeling Parameters	Values
Alpha	Manufacturer	Firefly Aerospace, Inc.
	Name	Alpha
	Length	95 ft
	Diameter	6 ft
	Gross Vehicle Weight	119,019 lbs
	Engines	Firefly Reaver (Qty. 4)
		35,613 lbf S.L. Thrust/Engine
	Vehicle's S.L. Thrust	142,452 lbf

7

8

2

3



# **3** Acoustics Overview

An overview of sound-related terms, metrics, and effects, which are pertinent to this study, is provided to assist the reader in understanding the terminology used in this noise study.

### 3.1 Fundamentals of Sound

Any unwanted sound that interferes with normal activities or the natural environment is defined as noise. Three principal physical characteristics are involved in the measurement and human perception of sound: intensity, frequency, and duration [1].

- Intensity is a measure of a sound's acoustic energy and is related to sound pressure. The greater the sound pressure, the more energy is carried by the sound and the louder the perception of that sound.
- Frequency determines how the pitch of the sound is perceived. Low-frequency sounds are characterized as rumbles or roars, while high-frequency sounds are typified by sirens or screeches.
- > **Duration** is the length of time the sound can be detected.

#### 3.1.1 Intensity

The loudest sounds that can be comfortably detected by the human ear have intensities a trillion times higher than those of sounds barely audible. Because of this vast range, using a linear scale to represent the intensity of sound can become cumbersome. As a result, a logarithmic unit known as the decibel (abbreviated dB) is used to represent sound levels. A sound level of 0 dB approximates the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level around 60 dB. Sound levels above 120 dB begin to be felt inside the human ear as discomfort. Sound levels between 130 and 140 dB are experienced as pain [2].

Because of the logarithmic nature of the decibel unit, sound levels cannot be simply added or subtracted and are somewhat cumbersome to handle mathematically. However, some useful rules help when dealing with sound levels. First, if a sound's intensity is doubled, the sound level increases by 3 dB, regardless of the initial sound level. For example:

Second, the total sound level produced by two sounds with different levels is usually only slightly more than the higher of the two. For example:

$$50.0 \, \text{dB} + 60.0 \, \text{dB} = 60.4 \, \text{dB}.$$

On average, a person perceives a change in sound level of about 10 dB as a doubling (or halving) of a sound's loudness. This relation holds true for both loud and quiet sounds. A decrease in sound level of 10 dB represents a 90% decrease in sound intensity but only a 50% decrease in perceived loudness because the human ear does not respond linearly [1]. In the community, "it is unlikely that the average listener would be able to correctly identify at a better than chance level the louder of two otherwise similar events which differed in maximum sound level by < 3 dB" [3].



#### 3.1.2 Frequency

Sound frequency is measured in terms of cycles per second or hertz (Hz). Human hearing ranges in frequency from 20 Hz to 20,000 Hz, although perception of these frequencies is not equivalent across this range. Human hearing is most sensitive to frequencies in the 1,000 to 4,000 Hz range. Most sounds are not simple pure tones, but contain a mix, or spectrum, of many frequencies. Sounds with different spectra are perceived differently by humans even if the sound levels are the same. Weighting curves have been developed to correspond to the sensitivity and perception of different types of sound.

A-weighting and C-weighting are the two most common weightings. These two curves, shown in Figure 3, are adequate to quantify most environmental noises. A-weighting puts emphasis on the 1,000 to 4,000 Hz range to match the reduced sensitivity of human hearing for moderate sound levels. For this reason, the A-weighted decibel level (dBA) is commonly used to assess community sound. Note, "unweighted" sound levels refer to levels in which no weighting curve has been applied to the spectra. Unweighted levels are appropriate for use in examining the potential for noise impacts on structures.



Figure 3. Frequency adjustments for A-weighting and C-weighting [4]

#### 3.1.3 Duration

Sound sources can contain a wide range of frequency (pitch) content as well as variations in extent from short durations to continuous, such as back-up alarms and ventilation systems, respectively. Some sound sources (air conditioners, generators, lawn mowers) are continuous with levels that are constant for a given duration; others (vehicles passing by) are the maximum sound during an event, and some (urban day and nighttime) are averages over extended periods [5].



#### 3.1.4 Common Sounds

Common sources of noise and their associated levels are provided for comparison to the noise levels from the proposed action. A chart of A-weighted sound levels from everyday sounds [6] is shown in Figure 4. Per the US Environmental Protection Agency, "Ambient noise in urban areas typically varies from 60 to 70 dB but can be as high as 80 dB in the center of a large city. Quiet suburban neighborhoods experience ambient noise levels around 45-50 dB" [7].



Figure 4. Typical A-weighted sound levels of common sounds [8]

#### **3.2 Noise Metrics**

A variety of acoustical metrics have been developed to describe sound events and to identify any potential impacts to receptors within the environment. These metrics are based on the nature of the event and who or what is affected by the sound. A brief description of the noise metrics used in this noise study are provided below.



#### Maximum Sound Level (L<sub>max</sub>)

The highest unweighted sound level measured during a single event, in which the sound changes with time, is called the Maximum Sound Level (abbreviated as L<sub>max</sub>). The highest A-weighted sound level measured during a single event is called the Maximum A-weighted Sound Level (abbreviated as L<sub>A,max</sub>). Although it provides some measure of the event, L<sub>max</sub> (or L<sub>A,max</sub>) does not fully describe the sound because it does not account for how long the sound is heard.

#### Day-Night Average Sound Level (DNL) and Community Noise Equivalent Level (CNEL)

Day-Night Average Sound Level is a cumulative metric that accounts for all noise events in a 24-hour period. To account for our increased sensitivity to noise at night, DNL applies an additional 10 dB adjustment to events during the acoustical nighttime period, defined as 10:00 PM to 7:00 AM. DNL represents the average sound level exposure for annual average daily events. Legislation in the state of California uses the Community Noise Equivalent Level (CNEL), a variant of the DNL. In addition to the 10 dB (i.e. 10 times weighting) adjustment during the acoustical nighttime period, the CNEL includes a ~4.8 dB adjustment (i.e. 3 times weighting) to events during the acoustical evening period (7:00 PM to 10:00 PM) to account for decreased community noise during this period. DNL and CNEL do not represent a level heard at any given time but represent long term exposure to noise.

#### **3.3 Noise Effects**

Noise criteria have been developed to protect the public health and welfare of the surrounding communities. The impacts of launch vehicle noise are evaluated on a cumulative basis in terms of human annoyance. In addition, the launch vehicle noise impacts are evaluated on a single-event basis in relation to hearing conservation and potential structural damage. Although FAA Order 1050.1F does not have guidance on hearing conservation or structural damage criteria, it recognizes the use of supplemental noise analysis to describe the noise impact and assist the public's understanding of the potential noise impact.

#### 3.3.1 Human Annoyance

A significant noise impact would occur if the "action would increase noise by DNL 1.5 dB[A] or more for a noise sensitive area that is exposed to noise at or above the DNL 65 dB[A] noise exposure level, or that will be exposed at or above this level due to the increase, when compared to the No Action Alternative for the same timeframe" [9].

DNL is based on long-term cumulative noise exposure and has been found to correlate well with longterm community annoyance for regularly occurring events including aircraft, rail, and road noise [10, 11]. Noise studies used in the development of the DNL metric did not include rocket noise, which are historically irregularly occurring events. Thus, it is acknowledged that the suitability of DNL for infrequent rocket noise events is uncertain. Additionally, it has been noted that the DNL "threshold does not adequately address the effects of noise on visitors to areas within a national park or national wildlife refuge where other noise is very low and a quiet setting is a generally recognized purpose and attribute" [9]. However, DNL is the most widely accepted metric to estimate the potential changes in long-term community annoyance.



Within the state of California, the potential for community impacts with regards to human annoyance are assessed using A-weighted CNEL for launch vehicle noise. The threshold levels for DNL (i.e. 65 dBA) are the same for A-weighted CNEL.

#### 3.3.2 Hearing Conservation

U.S. government agencies have provided guidelines on permissible noise exposure limits. These documented guidelines are in place to protect human hearing from long-term continuous daily exposures to high noise levels and aid in the prevention of noise-induced hearing loss (NIHL). A number of federal agencies have set exposure limits on non-impulsive noise levels, including the Occupational Safety and Health Administration (OSHA) [12], National Institute for Occupational Safety and Health (NIOSH) [13], and the Department of Defense (DoD) Occupational Hearing Conservation Program [14]. The most conservative of these upper noise level limits has been set by OSHA at 115 dBA. At 115 dBA, the allowable exposure duration is 15 minutes for OSHA and 28 seconds for NIOSH and DoD. L<sub>A,max</sub> contours are used to identify potential locations where hearing protection should be considered for rocket operations.

#### 3.3.3 Structural Damage

Typically, the most sensitive components of a structure to launch vehicle noise are windows, and infrequently, the plastered walls and ceilings. The potential for damage to a structure is unique interaction among the incident sound, the condition of the structure, and the material of each element and its respective boundary conditions. A report from the National Research Council on the "Guidelines for Preparing Environmental Impact Statements on Noise" [15] states that one may conservatively consider all sound lasting more than one second with levels exceeding 130 dB (unweighted) as potentially damaging to structures.

A NASA technical memo examined the relationship between structural damage claims and overall sound pressure level and concluded "the probability of structural damage [was] proportional to the intensity of the low frequency sound" [16]. This relationship estimated that one damage claim in 100 households exposed is expected at an average continuous sound level of 120 dB (unweighted), and one in 1,000 households at 111 dB (unweighted). The study was based on community responses to 45 ground tests of the first and second stages of the Saturn V rocket system conducted in Southern Mississippi over a period of five years. The sound levels used to develop the criteria were modeled mean sound levels.

It is important to highlight the difference between the static ground tests on which the rate of structural damage claims is based and the dynamic events modeled in this noise study. During ground tests, the engine/motor remains in one position, which results in a longer-duration exposure to continuous levels as opposed to the transient noise occurring from the moving vehicle during a launch event. Regardless of this difference, Guest and Slone's [16] damage claim criteria represents the best available dataset regarding the potential for structural damage resulting from rocket noise. Thus, L<sub>max</sub> values of 120 dB (unweighted) and 111 dB (unweighted) are used in this report as conservative thresholds for potential risk of structural damage claims.



# 4 Noise Modeling

An overview of the propulsion noise modeling methodologies used in this noise study are presented in the following section.

#### 4.1 Propulsion Noise Modeling

Launch vehicle propulsion systems, such as solid rocket motors and liquid-propellant rocket engines, generate high-amplitude broadband noise. Most of the noise is created by the rocket plume interacting with the atmosphere and the combustion noise of the propellants. Although rocket noise radiates in all directions, it is highly directive, meaning that a significant portion of the source's acoustic power is concentrated in specific directions.

The Launch Vehicle Acoustic Simulation Model (RUMBLE), developed by Blue Ridge Research and Consulting, LLC (BRRC), is the noise model used to predict the noise associated with the proposed operations. The core components of the model are visualized in Figure 5 and are described in the following subsections.



Figure 5. Conceptual overview of rocket noise prediction model methodology

#### 4.1.1 Source

The rocket noise source definition considers the acoustic power of the rocket, forward flight effects, directivity, and the Doppler effect.

#### Acoustic Power

Eldred's Distributed Source Method 1 (DSM-1) [17] is utilized for the source characterization. The DSM-1 model determines the launch vehicle's total sound power based on its total thrust, exhaust velocity, and the engine/motor's acoustic efficiency. BRRC's recent validation of the DSM-1 model showed very good agreement between full-scale rocket noise measurements and the empirical source curves [18]. The

#### Noise Study for Firefly's Vandenberg Orbital Launch Site Environmental Assessment – *Technical Report* – October 2019



acoustic efficiency of the rocket engine/motor specifies the percentage of the mechanical power converted into acoustic power. The acoustic efficiency of the rocket engine/motor was modeled using Guest's variable acoustic efficiency [19]. Typical acoustic efficiency values range from 0.2% to 1.0% [17]. In the far-field, distributed sound sources are modeled as a single compact source located at the nozzle exit with an equivalent total sound power. Therefore, launch vehicle propulsion systems with multiple tightly clustered equivalent engines can be modeled as a single engine with an effective exit diameter and total thrust [17].

#### Forward Flight Effect

A rocket in forward flight radiates less noise than the same rocket in a static environment. A standard method to quantify this effect reduces overall sound levels as a function of the relative velocity between the jet plume and the outside airflow [20, 21, 22, 23]. This outside airflow travels in the same direction as the rocket exhaust. At the onset of a launch, the rocket exhaust travels at far greater speeds than the ambient airflow. Conversely, for a vertical landing, the rocket exhaust and ambient airflow travel in opposing directions, yielding an increased relative velocity differential. As the differential between the forward flight velocity and exhaust velocity decreases, jet plume mixing is reduced, which reduces the corresponding noise emission. Notably, the maximum sound levels are normally generated before the vehicle reaches the speed of sound. Thus, the modeled noise reduction is capped at a forward flight velocity of Mach 1.

#### **Directivity**

Rocket noise is highly directive, meaning the acoustic power is concentrated in specific directions, and the observed sound pressure will depend on the angle from the source to the receiver. NASA's Constellation Program has made significant improvements in determining launch vehicle directivity of the reusable solid rocket motor (RSRM) [24]. The RSRM directivity indices (DI) incorporate a larger range of frequencies and angles then previously available data. Subsequently, improvements were made to the formulation of the RSRM DI [25] accounting for the spatial extent and downstream origin of the rocket noise source. These updated DI are used for this analysis.

#### **Doppler Effect**

The Doppler effect is the change in frequency of an emitted wave from a source moving relative to a receiver. The frequency at the receiver is related to the frequency generated by the moving sound source and by the speed of the source relative to the receiver. The received frequency is higher (compared to the emitted frequency) if the source is moving towards the receiver, it is identical at the instant of passing by, and it is lower if the source is moving away from the receiver. During a rocket launch, an observer on the ground will hear a downward shift in the frequency of the sound as the distance from the source of the waves is moving toward the observer, each successive wave crest is emitted from a position closer to the observer than the previous wave. Therefore, each wave takes slightly less time to reach the observer than the previous wave, and the time between the arrivals of successive wave crests at the observer is reduced, causing an increase in the frequency. While they are traveling, the distance between successive wave fronts is reduced such that the waves "bunch together." Conversely, if the source of waves is moving away

#### Noise Study for Firefly's Vandenberg Orbital Launch Site Environmental Assessment – *Technical Report* – October 2019



from the observer, then each wave is emitted from a position farther from the observer than the previous wave; the arrival time between successive waves is increased, reducing the frequency. Likewise, the distance between successive wave fronts increases, so the waves "spread out." Figure 6 illustrates this spreading effect for an observer in a series of images, where a) the source is stationary, b) the source is moving less than the speed of sound, c) the source is moving at the speed of sound, and d) the source is moving faster than the speed of sound. As the frequency is shifted lower, the A-weighting filtering on the spectrum results in a decreased A-weighted sound level. For unweighted overall sound levels, the Doppler effect does not change the levels since all frequencies are accounted for equally.



Figure 6. Effect of expanding wavefronts (decrease in frequency) that an observer would notice for higher relative speeds of the rocket relative to the observer for: a) stationary source b) source velocity < speed of sound c) source velocity = speed of sound d) source velocity > speed of sound

#### 4.1.2 Propagation

The sound propagation from the source to receiver considers the ray path, atmospheric absorption, and ground interference.

#### **Ray Path**

The model assumes straight line propagation between the source and receiver to determine propagation effects. For straight rays, sound levels decrease as the sound wave propagates away from a source uniformly in all directions. The launch vehicle noise model components are calculated based on the specific geometry between source (launch vehicle trajectory point) to receiver (grid point). The position of the launch vehicle, described by the trajectory, is provided in latitude and longitude, defined relative to a reference system (e.g. World Geodetic System 1984) that approximates the Earth's surface by an ellipsoid. The receiver grid is also described in geodetic latitude and longitude, referenced to the same reference system as the trajectory data, ensuring greater accuracy than traditional flat earth models.



#### Atmospheric Absorption

Atmospheric absorption is a measure of the sound attenuation from the excitation of vibration modes of air molecules. Atmospheric absorption is a function of temperature, pressure, and relative humidity of the air. The propulsion noise model utilizes an atmospheric profile, which describes the variation of temperature, pressure, and relative humidity with respect to the altitude. Standard atmospheric data sources [26, 27, 28] were used in conjunction with site-specific atmospheric data [29] to create a composite atmospheric profile for altitudes up to 66 miles. The atmospheric absorption is calculated using formulas found in ANSI Standard S1.26-1995 (R2004). The result is a sound-attenuation coefficient, which is a function of frequency, atmospheric conditions, and distance from the source. The amount of absorption depends on the parameters of the atmospheric layer and the distance that the sound travels through the layer. The total sound attenuation is the sum of the absorption experienced from each atmospheric layer.

Nonlinear propagation effects can result in distortions of high-amplitude sound waves [30] as they travel through the medium. These nonlinear effects are counter to the effect of atmospheric absorption [31, 32]. However, recent research shows that nonlinear propagation effects change the perception of the received sound [33, 34], but the standard acoustical metrics are not strongly influenced by nonlinear effects [35, 36]. The overall effects of nonlinear propagation on high-amplitude sound signatures and their perception is an ongoing area of research, and it is not currently included in the propagation model.

#### **Ground Interference**

The calculated results of the sound propagation using DSM-1 provide a free-field sound level (i.e. no reflecting surface) at the receiver. However, sound propagation near the ground is most accurately modeled as the combination of a direct wave (source to receiver) and a reflected wave (source to ground to receiver) as shown in Figure 5. The ground will reflect sound energy back toward the receiver and interfere both constructively and destructively with the direct wave. Additionally, the ground may attenuate the sound energy, causing the reflected wave to propagate a smaller portion of energy to the receiver. RUMBLE accounts for the attenuation of sound by the ground [37, 38] when estimating the received noise. The model assumes a five-foot receiver height and a homogeneous grass ground surface. However, it should be noted that noise levels may be 3 dB louder over water surfaces compared to the predicted levels over the homogeneous grass ground surfaces assumed in the modeling. To account for the random fluctuations of wind and temperature on the direct and reflected wave, the effect of atmospheric turbulence is also included [37, 39].

#### 4.1.3 Receiver

The received noise is estimated by combining the source and propagation components. The basic received noise is modeled as overall and spectral level time histories. This approach enables a range of noise metrics relevant to environmental noise analysis to be calculated and prepared as output.



### **5** Results

The following sections present the results of the environmental propulsion noise impacts associated with the proposed Firefly operations. Note, noise levels over water may be higher because of the acoustical hardness of the water surface. Single event and cumulative launch vehicle noise results are presented in Section 5.1 and Section 5.2, respectively.

#### 5.1 Single Event Noise

Individual launch site and static operations are evaluated using maximum A-weighted and unweighted sound levels for propulsion noise. The composite noise contour maps are provided representing the maximum sound levels over the representative launch azimuth proposed.

#### Maximum A-weighted Sound Level (L<sub>A,max</sub>)

The modeled L<sub>A,max</sub> contours associated with the launch and static fire operations at Firefly's VAFB SLC-2W facility are presented in Figure 7 and Figure 8. An upper limit noise level of 115 dBA is used as a guideline to protect human hearing from long-term continuous daily exposures to high noise levels and to aid in the prevention of NIHL. The 115 dBA contours associated with the launch and static fire events are entirely within the boundaries of VAFB. Thus, the potential for impacts to people in the community with regards to hearing conservation is negligible.

<u>Launch Operations</u> - The Alpha launch event generates modeled levels at or above an  $L_{A,max}$  of 115 dBA within 0.3 miles of the launch site. The 115 dBA contours for the Alpha launch events are shown in Figure 7.

<u>Static Fire Operations</u> - The Alpha static fire event noise contours are more directive than the launch event noise contours because the plume is redirected in-line with the deflector heading. A receptor located along the peak directivity angle may experience an  $L_{A,max}$  of 115 dBA at approximately 0.2 miles away from the during a static fire event. The 115 dBA contours for the Alpha static fire events are shown in Figure 8. Note, the levels produced by static fire events will remain constant over the duration of the event, whereas the levels produced by launch events will decrease as the rocket moves further away from the receptor.

#### Maximum Unweighted Sound Level (Lmax)

The modeled L<sub>max</sub> contours associated with the Alpha launch and static fire operations from Firefly's VAFB SLC-2W facility are presented in Figure 9 and Figure 10. For reference, the potential for structural damage claims is approximately one damage claim per 100 households exposed at 120 dB and one in 1,000 households at 111 dB [16]. The entire land area encompassed by the 111 dB noise contours resulting from the Alpha launch or static fire events lies within the VAFB boundaries.

<u>Launch Operations</u> - For the Alpha launch event, the modeled 120 dB and 111 dB L<sub>max</sub> contours are limited to radii of 0.6 miles and 1.6 miles from the launch site, respectively, as shown in Figure 9.

<u>Static Fire Operations</u> - For the Alpha static fire, a receptor located along the peak directivity angle may experience  $L_{max}$  values of 120 dB and 111 dB at approximately 0.6 miles and 1.5 miles from the launch site, respectively, as shown in Figure 10.

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Figure 7. L<sub>A,max</sub> contours for an Alpha launch from Firefly's VAFB SLC-2W



Figure 8. L<sub>A,max</sub> contours for an Alpha static fire at Firefly's VAFB SLC-2W

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Figure 9. L<sub>max</sub> contours for an Alpha launch from Firefly's VAFB SLC-2W



Figure 10.  $L_{\text{max}}$  contours for an Alpha static fire at Firefly's VAFB SLC-2W



#### 5.2 Cumulative Noise

Within the state of California, the potential for long-term community annoyance is assessed using A-weighted CNEL for launch vehicle noise. A significant noise impact would occur if the "action would increase noise by [CNEL] 1.5 dB[A] or more for a noise sensitive area that is exposed to noise at or above the [CNEL] 65 dB[A] noise exposure level, or that will be exposed at or above this level due to the increase, when compared to the No Action Alternative for the same timeframe" [9]. Figure 11 presents the A-weighted CNEL contours resulting from launch and static fire propulsion noise at Firefly's Vandenberg SLC-2W facility. The CNEL 65 dBA contour, shown in Figure 11, extends approximately 0.4 miles from the launch site and contains land area entirely within the VAFB boundary.

As CNEL contours representing the No Action Alternative at VAFB are unavailable, an alternative technique is used to identify the potential for significant noise impacts. The CNEL 60 dBA contour is used to conservatively identify the potential for significant noise impacts, as 60 dBA is the smallest level that could "increase noise by [CNEL] 1.5 dB[A] or more for a noise sensitive area that is exposed to noise at or above the [CNEL] 65 dB[A] noise exposure level" [9]. The CNEL 60 dBA contour, shown in Figure 11, extends approximately 0.7 miles from the launch site and contains land area entirely within the VAFB boundary.



Figure 11. CNEL contours for launch and static fire operations for both Alpha vehicles at Firefly's VAFB SLC-2W



### **6** Summary

This report documents the noise study performed as part of the EA for Firefly's VAFB SLC-2W facility. Firefly plans to conduct Alpha operations for up to 11 pre-launch static fire engine tests and 11 vertical launches per year. The potential impacts from propulsion noise are evaluated on a single-event and cumulative basis in relation to human annoyance, hearing conservation, and structural damage.

The potential long-term community annoyance to the proposed Alpha launch and static operations was estimated using the CNEL. The CNEL 65 and 60 dBA contours extend approximately 0.4 and 0.7 miles from the launch pad, respectively. This area does not encompass land outside of the boundaries of VAFB, and thus no residences are impacted. As defined by FAA Order 1050.1F, VAFB Alpha launch and static operations would not result in a significant noise impact.

The single event launch vehicle noise results are related to hearing conservation and structural damage claims. An upper limit noise level of L<sub>A,max</sub> 115 dBA is used as a guideline to protect human hearing from long-term continuous daily exposures to high noise levels and to aid in the prevention of NIHL. The 115 dBA contours associated with the launch and static fire events are entirely within the boundaries of VAFB. The potential for structural damage claims is approximately one damage claim per 100 households exposed at 120 dB and one in 1,000 households at 111 dB [16]. The entire land area encompassed by the 111 dB noise contours resulting from the Alpha launch or static fire events lies within VAFB boundaries.

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