# Final
# Supplemental Environmental Assessment
# to the
# November 2007 Environmental Assessment for the
# Operation and Launch of the Falcon 1 and Falcon 9
# Space Vehicles

**at**
**Cape Canaveral Air Force Station**
**Florida**

**Prepared For**

**Space Exploration Technologies Corporation**
**El Segundo, California**
**and**
**45th Space Wing**
**Patrick Air Force Base, Florida**

**August, 2013**

## EXECUTIVE SUMMARY

Space Exploration Technologies Corporation (SpaceX) has prepared this Final Supplemental Environmental Assessment (SEA) in concert with the United States Air Force (USAF) to evaluate the potential environmental impacts resulting from SpaceX operating and launching the Falcon 9 Block 2 vehicle, also referred to as Falcon 9 Version 1.1 (v1.1), from Launch Complex (LC) 40 at Cape Canaveral Air Force Station (CCAFS), Florida. The SEA is needed because the Falcon 9 v1.1 is larger than, and produces a greater total thrust than the Falcon 9 Block 1. The USAF is the Lead Agency. The Federal Aviation Administration (FAA) Office of Commercial Space Transportation will be a cooperating agency due to their launch licensing authority, and the National Aeronautics Space Administration (NASA) will be a cooperating agency because of their space vehicle expertise and their possible future use of the Falcon 9 v1.1 vehicle.

In November 2007, the Air Force published the *Environmental Assessment for the Operation and Launch of the Falcon 1 and Falcon 9 Space Vehicles at Cape Canaveral Air Force Station, Florida* (2007 EA) and in December 2007 issued a Finding of No Significant Impact (FONSI). The 2007 EA analyzed the Air Force leasing land and facilities to SpaceX, as well as the required construction modification of the LC-40 facility, and the operation and launch for both Falcon 1 and Falcon 9 (Block 1) vehicles. The 2007 EA and associated FONSI addressed the first version of the Falcon 9 vehicle; this SEA only addresses the newer version, which is called Falcon 9 Block 2, hereafter referred to as Falcon 9 v1.1. This SEA tiers off of the 2007 EA and focuses on the potential environmental impacts from operating and launching the proposed Falcon 9 v1.1 vehicle. SpaceX currently holds a license with the Air Force to use LC -40 and to operate and launch the Falcon 1 and Falcon 9 Block 1 from LC-40. SpaceX had been issued four FAA launch licenses to operate and launch the Falcon 9 Block 1 from LC-40. All four of these licenses have expired. SpaceX also has been issued two FAA reentry licenses for the Dragon Reentry Capsule to reenter in the Pacific Ocean. One reentry license remains active.

### PURPOSE AND NEED

The purpose and need for the Proposed Action have not changed from the 2007 EA. The ***purpose*** of the Proposed Action for SpaceX to operate and launch the Falcon 9 v1.1 from the LC-40 launch site at CCAFS in Brevard County, Florida is to continue fulfilling the United States' desired goal that space transportation costs must be significantly reduced in order to make continued exploration, development, and use of space more affordable. The Space Transportation section of the National Space Transportation Policy of 1994 addressed the commercial launch sector, stating, "assuring reliable and affordable access to space through U.S. space transportation capabilities is fundamental to achieving National Space Policy goals."

The ***need*** for the Proposed Action was established in the 2007 EA in that SpaceX was selected by NASA to demonstrate delivery and return of cargo to the International Space Station (ISS). SpaceX has successfully demonstrated that ability and now needs a larger version of the Falcon 9 to satisfy the NASA requirements in a more efficient and effective manner, and therefore continue to support the U.S. goal of encouraging activities by the private sector in order to strengthen and expand U.S. space transportation infrastructure. Additionally, the proposed action is needed to provide greater transport capability in its mission to resupply the ISS and would provide a possible launch vehicle for NASA and the National Oceanic and Atmospheric Administration (NOAA) scientific payloads.

## PROPOSED ACTION

The Proposed Action, which is the Preferred Alternative, is for SpaceX to operate and launch the Falcon 9 v1.1 and a variety of payloads, including the Dragon Capsule, from the established LC-40 launch site at CCAFS, from where it has been launching the Falcon 9 Block 1 version since 2010.

## ALTERNATIVE ACTIONS CONSIDERED BUT REMOVED FROM FURTHER CONSIDERATION

The original 2007 EA analyzed two alternative locations for the operation and launch of the Falcon 1 and Falcon 9 Block 1 vehicles. One alternative considered placement of the Falcon program at LC-36A or 36B, located east of ICBM road and south of LC-11 at CCAFS. A second alternative considered LC-47 located immediately east of Phillips Parkway road and approximately equal distance between LC- 40 to the north and LC- 37 to the south. LC-40 was ultimately chosen for the Falcon program since it presented the least environmental impact as discussed in the 2007 EA. For those reasons, those alternatives were not considered as alternatives to LC-40 for this SEA, therefore they were not further analyzed.

## NO ACTION ALTERNATIVE

Under the No Action Alternative, SpaceX would not be able to launch the Falcon 9 v1.1 from LC-40 at CCAFS. Thus, the SpaceX mission to assist NASA's resupply of the ISS would be limited, and the National Space Transportation Policy of 1994 stated goal of "assuring reliable and affordable access to space through U.S. space transportation capabilities" would also be limited.

## SUMMARY OF POTENTIAL ENVIRONMENTAL EFFECTS

The original 2007 EA assessed the following 14 resource areas which were considered to provide a context for understanding and assessing potential environmental effects of the Proposed Action and alternatives: land use/visual resources, noise, biological resources, cultural resources, air quality, orbital debris, hazardous materials/hazardous waste, water resources, geology and soils, transportation, utilities, health and safety, socioeconomics, and environmental justice. While this SEA addresses the same resources areas, since the Proposed Action is limited to the Falcon 9 v1.1 launch vehicle, only those areas specifically affected by the newer version were assessed. Additionally, a new resource area, Section 4(f) Properties, as defined in FAA Order 1050.1E, Change 1, *Environmental Impacts: Policies and Procedures*, was added. The environmental consequences associated with the Proposed Action and the No Action Alternative were analyzed for the appropriate Region of Influence (ROI) for each resource area and found to have no or minimal impact to the environment. The following table presents a summary of the resources considered and the potential impacts on those resources. The descriptions only discuss operations, since there are no construction related tasks within this proposed action.

| TABLE E-1: Summary of Potential Environmental Impacts from the Proposed Action and the No Action Alternative | |
|---|---|
| **Resource Area** | **Potential Environmental Impact from Proposed Action** |
| Land Use / Visual Resources | There would be no significant impacts to coastal resources. There would be no significant impacts to land use compatibility since CCAFS and LC-40 use includes launching space vehicles. Visible impact would only include the normally seen and short-lived vehicle contrails for each launch event. |
| Noise | There would be no significant impacts in noise levels in communities adjacent to CCAFS property due to normal daily operations. Short-term increases in the noise levels received in the community from the proposed launch of the Falcon 9 v1.1are also not anticipated to be significant. Long-term noise levels for the proposed launch activities for the Falcon 9 v1.1 are not expected to surpass the significance thresholds for impacts. Sonic booms generated by these launch events would impact the ocean surface beyond 30 miles off the coast and would not be audible on land; therefore, sonic booms would not produce any significant impacts in the surrounding areas. |
| Biological Resources | There would be no significant impacts on wildlife or vegetation (including federal and state-listed wildlife species) by daily operations. While protected species such as the Gofer tortoise and scrub-jay exist at CCAFS, they are not present at LC-40 and Falcon 9 v1.1 launches are not expected to create any significant impacts. SpaceX currently has a Light Management Plan which has been implemented for LC-40 operations which is designed to reduce or eliminate night-time impact to the sea turtle nesting/hatchling process. |
| Cultural Resources | Since there are no identified cultural or historical resources identified in or immediately around LC-40, there would be no impact on this resource area. |
| Air Quality | The operational impacts from the Proposed Action on air quality would not be significant. CCAFS and Brevard County are in an “Attainment” area and the operational emissions for the proposed Falcon 9 v1.1 vehicle launch represent an extremely small percentage of the Brevard County regional emissions and would not cause an exceedance of any NAAQS or Greenhouse gases (GHG). |
| Orbital Debris | There would be no significant impact to orbital debris by launching the Falcon 9 v1.1 vehicle. |
| Hazardous Materials / Waste | Operations supporting the Falcon 9 v1.1 vehicle would continue to use products containing hazardous materials, including paints, solvents, oils, lubricants, acids, batteries, surface coating, and cleaning compounds. Hazardous materials such as propellants, chemicals, and other hazardous material payload components would be transported to the facilities in accordance with DOT regulations. However, continued implementation of existing material and waste management and handling procedures during the operation of the Falcon 9 v1.1 vehicle would limit the potential for impacts. Therefore, there would be no significant impacts to the environment. |
| Water Resources | Operations supporting the launch of the Falcon 9 v1.1 would not result in additional impacts to surface water, groundwater resources, groundwater quality, wetlands, or floodplains. Continued implementation of the existing Spill Prevention, Control, and Countermeasures (SPCC) plan would reduce the potential for adverse impacts to water resources. |
| Geology and Soils | Daily operations and launches would not affect existing geology and soils, therefore there would be no significant impacts to this resource area. |
| Transportation | While there would be slightly more vehicle traffic during launch preparations, there would be no significant impacts on CCAFS traffic. |
| Utilities | There would be no significant impacts or need for additional electrical power needed for the Falcon 9 v1.1. Minor increased need for base-supplied deluge water of 30% or less for each launch is well within design standards for the existing systems therefore there would be no significant impacts to water supply. |
| Health and safety | The operation and launch of the Falcon 9 v1.1 does not add any new material or fuel sources to operations at LC-40. The only change is additional fuel volume usage of RP-1. |

| | |
|---|---|
| | All current and standard health and safety local, state, and federal procedures will continue to be in use during operation and launch, therefore this is no impact on health and safety. |
| Socioeconomics | Operations supporting the Falcon 9 v1.1 would cause no significant impacts on the area's socioeconomics. There may be a slight positive impact on area economics since SpaceX has been able to add new jobs. |
| Environmental Justice | Since the Falcon 9 v1.1 would operate from the existing facilities at CCAFS, there would be no significant impacts to area Environmental Justice issues. |
| 4(f) Properties | No designated 4(f) properties, including public parks, recreation areas, or wildlife refuges, exist within the boundaries of CCAFS. While several public parks, recreation areas, and wildlife refuges are located outside of CCAFS, including the Merritt Island National Wildlife Refuge and the Cape Canaveral National Seashore, operations of the Falcon 9 v1.1 vehicle would not result in a use of a Section 4(f) property. |

**CUMULATIVE IMPACTS**

Cumulative impacts are defined by the Council on Environmental Quality (CEQ) in 40 CFR §1508.7 as impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. The CEQ regulations further require that NEPA environmental analyses address connected, cumulative, and similar actions in the same document (40 CFR 1508.25). The cumulative impact analysis for this SEA focuses on the incremental interaction the Proposed Action may have with other past, present, and reasonably foreseeable future actions, and evaluates cumulative impacts potentially resulting from these interactions. These past, present, and reasonably foreseeable future actions at CCAFS and at Kennedy Space Center (KSC), focus on operating and launching other space vehicles, and their cumulative impacts. Implementation of the Proposed Action would likely not cause any significant cumulative impacts to resource areas.

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AADT | Average Annual Daily Traffic |
| ACHP | Advisory Council on Historic Preservation |
| ACM | Asbestos Containing Material |
| AE | Adverse Effect |
| AF | Air Force |
| AFB | Air Force Base |
| AFI | Air Force Instruction |
| AFSPC | Air Force Space Command |
| AFMAN | Air Force Manual |
| AFTOX | Air Force Toxic Chemical Dispersion Model |
| AIRFA | American Indian Religious Freedom Act |
| Al2O3 | Aluminum Oxide |
| ALTRV | Altitude Reservation |
| AMU | Applied Meteorology Unit |
| ANSI | American National Standards Institute |
| ARPA | Archaeological Resources Protection Act |
| ASME | American Society of Mechanical Engineers |
| AST | Aboveground Storage Tanks |
| ASTG | Aerospace Test Group |
| Avg | Average |
| AWSPL | A-Weighted (dBA) Sound Pressure Levels |
| BEBR | Bureau of Economic and Business Research |
| bls | below land surface |
| BMP | Best Management Practices |
| BSI | Boeing Services International |
| C | degrees Celsius |
| CAA | Clean Air Act |
| CCAFB | Cape Canaveral Air Force Base |
| CCAFS | Cape Canaveral Air Force Station |
| CCAS | Cape Canaveral Air Station |
| CCEMP | Consolidated Comprehensive Emergency Management Plan |
| CDNL | C-Weighted Day-Night Average Sound Level |
| CE | Commercially Exploited |
| CEQ | Council of Environmental Quality |
| CERCLA | Comprehension Environmental Response Compensation and Liability Act |
| CERL | Construction Engineering Research Laboratories |
| CFR | Code of Federal Regulations |
| ch. | Chapter |
| CMD | Corrective Measures Design |
| CMI | Corrective Measures Implementation |
| CMS | Corrective Measures Studies |
| CO | Carbon Monoxide |
| COPC | Contaminants of Potential Concern |
| CRM | Cultural Resources Manager |
| CRMP | Cultural Resources Management Plan |
| CS | Confirmation Sampling |
| CSEL | C-Weighted Sound Exposure Level |
| CSLA | Commercial Space Launch Act |
| CUP | Consumptive Use Permit |
| CWA | Clean Water Act |
| CZMA | Coastal Zone Management Act |
| CZMP | Coastal Zone Management Program |
| dB | Decibel |
| dBA | A-Weighted Decibel |
| DCE | Dichloroethene |
| DCG | Disaster Control Group |
| DERP | Defense Environmental Restoration Program |
| DNL | Day-Night Average Sound Level |
| DoD | Department of Defense |
| DOT | Department of Transportation |
| DPF | Defense Processing Facility |
| DSCS | Defense Secure Communication Satellite |
| EA | Environmental Assessment |
| EDC | Economic Development Commission of Florida's Space Coast |

| | |
|---|---|
| EELV | Evolved Expendable Launch Vehicle |
| EEZ | Exclusive Economic Zone |
| EFH | Essential Fish Habitat |
| EIAP | Environmental Impact Analysis Process |
| EIS | Environmental Impact Statement |
| EO | Executive Order |
| EPCs | Envelope Payload Characteristics |
| EPCRA | Emergency Planning and Community Right-to-Know Act |
| ER | Eastern Range |
| ERA | Ecological Risk Assessment |
| ERAP | Environmental Risk Assessment Program |
| ERP | Environmental Resource Permits |
| *ES* | *Envelope Spacecraft* |
| *ES* | *Engineering-Science, Inc.* |
| ESA | Endangered Species Act |
| ESB | Engineering Support Building |
| ESC | Environmental Support Contractor |
| ET | Earth Tech |
| EWR | Eastern and Western Range Safety Policies and Processes |
| FAA | Federal Aviation Administration |
| FAAQS | Florida Ambient Air Quality Standards |
| FAC | Florida Administrative Code |
| FCMA | Florida Coastal Management Act |
| FCMP | Florida Coastal Management Program |
| FDCA | Florida Department of Community Affairs |
| FDEP | Florida Department of Environmental Protection |
| FDOT | Florida Department of Transportation |
| FEIS | Final Environmental Impact Statement |
| FETSA | Florida Endangered and Threatened Species Act |
| FFWCC | Florida Fish and Wildlife Conservation Commission |
| FMOs | Fishery Management Officials |
| FNAI | Florida Natural Areas Inventory |
| FONSI | Finding of No Significant Impact |
| FOT | Follow-On Test |
| FSTR | Full Spectrum Threat Response |
| ft | feet |
| ft2 | square feet |
| FWCC | Fish and Wildlife Conservation Commission |
| GDSS | General Dynamics Space Systems |
| GPS | Global Positioning System |
| HABS | Historic American Building Survey |
| HAER | Historic American Engineering Record |
| HAP | Hazardous Air Pollutants |
| HAPCs | Habitat Areas of particular Concern |
| HAZMAT | Hazardous Material |
| HCl | Hydrogen Chloride |
| HHRA | Human Health Risk Assessment |
| HMTA | Hazardous Materials Transportation Act |
| HQ AFSPC/SG | Headquarters Air Force Space Command Surgeon's Office |
| HVAC | Heating Ventilation and Air-Conditioning |
| ICBM | Intercontinental Ballistic Missile |
| IIP | Instantaneous surface Impact Point |
| IM | Interim Measure |
| IMS | Incident Management System |
| INF | Intermediate Nuclear Forces |
| INRMP | Integrated Natural Resources Management Plan |
| IPA | Isopropyl Alcohol |
| IRP | Installation Restoration Program |
| ISS | International Space Station |
| ITE | Institute of Transportation Engineers |
| JPC | Joint Propellants Contractor |
| KSC | Kennedy Space Center |
| kVA | Kilo-Volt Amperes |
| LBP | lead-based paint |
| LC | Launch Complex |
| LDCG | Launch Disaster Control Group |
| LEO | Low-Earth Orbit |
| LOS | level of service |
| LOX | Liquid Oxygen |
| LT | Long Term |
| LTM | Long Term Monitoring |
| LUCIP | Land Use Control Implementation Plan |
| LVC | Launch Vehicle Contractors |
| MACT | Maximum Available Control Technology |

| | |
|---|---|
| max | Maximum |
| MBTA | Migratory Bird Treaty Act |
| MCL | Maximum Contaminant Level |
| MEK | Methyl Ethyl Ketone |
| MGD | Million Gallons per Day |
| µg/m 3 | Micrograms per Cubic Meter |
| MHz | Mega-Hertz |
| mm | Millimeters |
| MMH | Monomethylhydrazine |
| MMPA | Marine Mammal Protection Act |
| MNA | Monitored Natural Attenuation |
| MOA | Memorandum of Agreement |
| MPO | Metropolitan Planning Organization |
| MPPF | Multi-Payload Processing Facility |
| MR | Mitigation Required |
| MSFCMA | Magnusson-Steven Fishery Conservation and Management Act |
| MSL | Mean Sea Level |
| MST | Mobile Service Tower |
| MW | Mega-watt |
| MWH | Mega-watt Hours |
| N/A | Not Applicable |
| NAAQS | National Ambient Air Quality Standards |
| NAGPRA | Native American Graves Protection and Repatriation Act |
| NASA | National Aeronautic and Space Administration |
| NATO | North Atlantic Treaty Organization |
| NDE | Non-Destructive Engine |
| NE | No Effect |
| NEPA | National Environmental Policy Act |
| NESHAP | National Emission Standards for Hazardous Air Pollutant |
| NFRAP | No-Further Remedial Action Planned |
| NHPA | National Histor ic Preservation Act |
| NMFS | National Marine Fisheries Service |
| NO2 | Nitrogen Dioxide |
| NOAA | National Oceanic and Atmospheric Administration |
| NOI | Notice of Intent |
| NOx | Nitrogen Oxides |
| NPDES | National Pollutant Discharge Elimination System |
| NPL | National Priorities List |
| NRHP | National Register of Historic Places |
| NSA | New South Associates |
| NTO | Nitrogen tetroxide |
| NWS | National Weather Service |
| NWSO | National Weather Service Office |
| O3 | Ozone |
| OCST | Office of Commercial Space Transportation |
| ODS | Ozone Depleting Substances |
| OFW | Outstanding Florida Water |
| OPLAN | Operations Plan |
| OSHA | Occupational Safety and Health Act |
| OASPL | Overall Sound Pressure Level |
| OWS | Oil-Water Separator |
| PAE | Potentially Adverse Effect |
| PAFB | Patrick Air Force Base |
| PAH | Poly-nuclear aromatic hydrocarbons |
| Pb | lead |
| PCB | Poly-chlorinated biphenyl |
| PE | Positive Effect |
| PES | Parsons Engineering Science |
| PFDP | Preliminary Flight Data Package |
| PHSF | Payload Hazardous Servicing Facility |
| PHV | Peak-hour volume |
| PM10 | Particulate matter equal to or less than 10 microns in diameter |
| PM2.5 | Particulate matter equal to or less than 2.5 microns in diameter |
| POL | Petroleum Products, Oils, Lubricants |
| PPF | Payload Processing Facility |
| ppm | parts per million |
| PPMP | Pollution Prevention Management Action Plan |
| PPPG | Pollution Prevention Program Guide |
| PPWG | Pollution Prevention Working Group |
| PSD | Prevention of Significant Deterioration |
| PTE | Potential to Emit |
| R&D | Research and Development |
| RCRA | Resource Conservation Recovery Act |
| REEDM | Rocket Exhaust Effluent Dispersion Model |
| RFI RCRA | Facility Investigation |
| RHU | Radioisotope Heater Units |
| RMP | Risk Management Plan |
| ROI | Regions of Influence |

| | |
|---|---|
| RP-1 | Rocket Propellant 1 (standard kerosene rocket fuel MIL-P-25576) |
| RPM | Remedial Project Manager |
| RTG | Radioisotope Thermoelectric Generator |
| SAEF-2 | Spacecraft Assembly and Encapsulation Facility Number 2 |
| SAFMC | South Atlantic Fishery Management Council |
| SAO | Senior Acquisition Officer |
| SAP | Satellite Accumulation Points |
| SARA | Superfund Amendments and Reauthorization Act |
| SCTL | Soil Cleanup Target Level |
| Secs. | Sections |
| SEL | Sound Exposure Level |
| SHPO | State Historic Preservation Officer |
| SIP | State Implementation Plan |
| SJRWMD | St. Johns River Water Management District |
| SLC | Space Launch Complex |
| SMAB | Solid Motor Assembly Building |
| SMARF | Solid Motor Assembly and Readiness Facility |
| SMG | Spaceflight Meteorology Group |
| SO2 | Sulfur Dioxide |
| SPEGL | Short-Term Emergency Guidance Levels |
| SPIF | Spacecraft Processing and Integration Facility |
| SPL | Sound Pressure Level |
| SR | State Route |
| SRM | Solid Rocket Motor |
| SSC | Species of Special Concern |
| ST | Short Term |
| SW | Space Wing |
| SWI | Space Wing Instruction |
| SWMU | Solid Waste Management Unit |
| SWPPP | Storm Water Pollution Prevention Plan |
| T&E | Threatened and Endangered |
| TCE | Trichloroethylene |
| THC | Toxic Hazard Corridor |
| TNT | Trinitrotoluene |
| TPH | Total Petroleum Hydrocarbons |
| TPY | Tons per Year |
| TSCA | Toxic Substance Control Act |
| TSD | Treatment, Storage, or Disposal |
| TSDF | Treatment, Storage, or Disposal Facility |
| TSP | Total Suspended Particulate |
| U | Unknown Effect |
| UDMH | Unsymmetrical Dimethyl Hydrazine |
| UFC | Unified Facilities Criteria |
| U.S. | United States |
| US | U.S. Highway |
| USACE | U.S. Army Corps of Engineers |
| USAF | United States Air Force |
| U.S.C. | United States Code |
| USEPA | U.S. Environmental Protection Agency |
| USFWS | U.S. Fish and Wildlife Service |
| UT | Umbilical Tower |
| UV | Ultraviolet |
| VAFB | Vandenberg Air Force Base |
| V/C | Volume-to-Capacity |
| VC | Vinyl Chloride |
| VOC | Volatile Organic Compounds |
| VPF | Vertical Processing Facility |
| v1.1 | Version 1.1 (Falcon 9) |
| WWTP | Wastewater Treatment Plant |

## 1.0 PURPOSE AND NEED FOR THE PROPOSED ACTION

### 1.1 INTRODUCTION

Space Exploration Technologies Corp. (SpaceX) in concert with the United States Air Force (USAF) has prepared this Final Supplemental Environmental Assessment (SEA) to evaluate the potential environmental impacts resulting from operating and launching the Falcon 9 Block 2, also referred to as Falcon 9 Version 1.1 (v 1.1) vehicle, from Launch Complex (LC) 40 at Cape Canaveral Air Force Station (CCAFS), Florida. In November 2007 the USAF published the *Environmental Assessment for the Operation and Launch of the Falcon 1 and Falcon 9 Space Vehicles at Cape Canaveral Air Force Station, Florida* (2007 EA) and in December 2007 issued a Finding of No Significant Impact (FONSI). SpaceX is currently licensed by the USAF to operate and launch the Falcon 1 and Falcon 9 Block 1 from LC-40.

The 2007 EA analyzed the potential environmental impacts of operating the Falcon 1 and Falcon 9 (Block 1) launch vehicles, payloads, and Dragon capsule at LC- 40. The 2007 EA also analyzed the USAF leasing land and facilities to SpaceX, as well as cooperating agency actions - for the Federal Aviation Administration (FAA) Office of Commercial Space Transportation to issue launch licenses or reentry licenses, and the National Aeronautics and Space Administration (NASA) as a potential customer for SpaceX launch services. The 2007 EA did not assess the potential environmental impacts of operating and launching the Falcon 9 Block 2, hereafter referred to as Falcon 9 v1.1 vehicle. A SEA is required since the Falcon 9 v1.1 vehicle is larger than the Falcon 9 Block 1 and produces a larger amount of total thrust. This SEA tiers off of the 2007 EA, and focuses on the potential environmental impacts from operating and launching the proposed Falcon 9 v1.1 vehicle.

SpaceX currently holds a license with the USAF to operate and launch the Falcon 1 and Falcon 9 Block 1 from LC-40. SpaceX has been issued four FAA launch licenses to operate and launch the Falcon 9 Block 1 from LC- 40. All four of those launch licenses have expired. SpaceX also has been issued two FAA reentry licenses for the Dragon Reentry Capsule to reenter in the Pacific Ocean. One FAA reentry license remains active. NASA would continue to be a customer for SpaceX launch services.

This SEA has been prepared in accordance with the requirements of the National Environmental Policy Act (NEPA) of 1969 (42 United States Code [U.S.C.] §4321 et seq.), the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations [CFR] Parts 1500-1508), Air Force Environmental Impact Analysis Process (EIAP) (32 CFR Part 989), Department of Defense (DoD) Directive 6050, and FAA Order 1050.1E, Change 1, *Environmental Impacts: Policies and Procedures*. As SpaceX would continue to use LC-40 launch facilities at CCAFS for the Falcon 9 v1.1 vehicle, the USAF is again the lead agency in supervising preparation of the SEA. The FAA and NASA are cooperating agencies in reviewing the preparation of the SEA. SpaceX intends to apply for a launch license from the FAA to conduct launches of the Falcon 9 v1.1 vehicle with commercial payloads from CCAFS. SpaceX also intends to renew their existing reentry license from the FAA for the reentry of the Dragon Reentry Capsule and payload.

The Commercial Space Launch Act of 1984 (Public Law 98-575), as codified at 49 U.S.C. Subtitle IX, Ch. 701, Commercial Space Launch Activities, 49 U.S.C. Secs. 70101-70119 (1994) (the Act), declares that the development of commercial launch vehicles and associated services is in the national economic interest of the United States. To

ensure that launch services provided by private enterprises are consistent with national security and foreign policy interest of the United States and do not jeopardize public safety, and safety of property, the Act authorizes the Department of Transportation (DOT) to license and regulate United States commercial launch activities. Within the Department, the Secretary of Transportation's authority under Commercial Space Launch Activities has been delegated to the FAA's Office of Commercial Space Transportation.

In addition to the SEA, applicants for an FAA launch license must complete a policy review and approval, safety review and approval, payload review and determination, and a financial responsibility determination. All of these reviews, including the SEA, must be completed prior to receiving a launch or reentry license. All FAA safety analyses would be conducted separately and would be included in the terms and conditions of the license.

NASA provides special expertise with respect to potential environmental impacts from space launches and the operation of a launch site. NASA also has special expertise and interest in the operation of reusable suborbital rockets through its programs, such as its Flight Opportunities Program, which are intended to help foster the development of the commercial reusable suborbital transportation industry. In 2006, NASA awarded SpaceX a Commercial Orbital Transportation Services (COTS) contract to design and demonstrate a launch system to resupply cargo to the International Space Station (ISS). Besides NASA contracts, SpaceX has signed contracts with private sector companies, foreign government agencies, and the U.S. military for its launch services at its collective launch locations. The Falcon 9 Block 1 vehicle has successfully launched from CCAFS LC 40 under an FAA license 5 times (3 launch specific licenses and 1 multi-mission (2 launches) license). The maiden flight took place on June 4, 2010, and most recently launched on March 1, 2013. CCAFS is SpaceX's launch site for NASA flights, including all flights to the ISS. The Falcon 1 has not been launched at LC 40.

## 1.2 LOCATION AND BACKGROUND

CCAFS occupies approximately 15,800 acres (25 square miles) of land on Florida's Canaveral Peninsula (Figure 1-1). The Canaveral Peninsula is on the east coast of Brevard County Florida, approximately 155 miles south of Jacksonville, 210 miles north of Miami, and 60 miles east of Orlando. It is 4.5 miles wide at its widest point (Figure 1-2). CCAFS has 81 miles of paved roads connecting various launch support facilities with the centralized Industrial Area. The northern boundary of CCAFS adjoins the Kennedy Space Center (KSC) boundary on the barrier island. The Banana River separates CCAFS from KSC to the west. The Port of Canaveral adjoins CCAFS to the south. CCAFS's eastern boundary is the Atlantic Ocean. The base is accessible primarily from U.S. Highway 528, which is to the south, and from KSC, which is to the west and north. A total of 33 LCs have been constructed and used at CCAFS.

The USAF 45th Space Wing (45 SW) is currently the host wing, under Space Command, and conducts east coast military, civilian, and commercial launch operations. Operation and launch of the Falcon 9 v1.1 vehicle would occur at LC- 40 (Figure 1-2), which is located at the northern end of CCAFS, approximately 3,000 feet (ft) west of the Atlantic Ocean and 0.75 mile east of the Banana River. The LC- 40 site was constructed in 1964 for the USAF Titan IIIC Missile Program; the Titan IV launch vehicle was the largest vehicle launched from LC- 40.

Since the USAF completed the 2007 EA, supporting Environmental Baseline Surveys (EBS), and subsequent Environmental Impact Analysis Processes (EIAP) reviews, SpaceX has modified the launch pad and built a combined vehicle assembly and payload processing facility within the existing LC-40 previously disturbed area. The total area of the new hangar, processing facility, and annex is approximately 54,000 square feet (sf), which is smaller than the 157,000 sf that was analyzed in the 2007 EA. SpaceX also added tanks for highly refined kerosene, also known as rocket propellant-1 or refined petroleum-1 (RP-1), tanks for liquid oxygen (LOX), and other supporting facilities for the Falcon 9 launch vehicles, meant to support both the Falcon 9 (Block 1) and the Falcon 9 v1.1.

## 1.3 PURPOSE AND NEED FOR ACTION

The purpose and need for the Proposed Action have not changed from the 2007 EA. SpaceX continues to be contracted by NASA to support commercial and NASA customers desiring launch capabilities to easterly and ISS inclinations to, among other tasks, resupply the ISS since the Shuttle has been retired, and launch other commercial satellites. SpaceX entered a 5-year lease agreement in June of 2008 with the USAF to use LC- 40 for the construction and operation of a rocket launch program. The ***purpose*** of this Proposed Action is to fulfill SpaceX's original intent, as accepted by the USAF and NASA; to operate and launch the Falcon 9 v1.1 from the LC- 40 launch site at CCAFS in Brevard County, Florida, continuing to fulfill the United States' expectation that space transportation costs are reduced in order to make continued exploration, development, and use of space more affordable. The Space Transportation section of the National Space Transportation Policy of 1994 addressed the commercial launch sector, stating that "assuring reliable and affordable access to space through U.S. space transportation capabilities is fundamental to achieving National Space Policy goals."

The ***need*** for the Proposed Action was established in the 2007 EA in that SpaceX was selected by NASA to demonstrate delivery and return of cargo to the ISS. SpaceX has successfully demonstrated that ability and now needs a larger version of the Falcon 9 to satisfy NASA requirements in a more efficient and effective manner, and therefore continue to support the U.S. goal of encouraging activities by the private sector to strengthen and expand U.S. space transportation infrastructure. The Proposed Action would provide greater transport capability in its mission to support the ISS, and provide a possible launch vehicle for NASA and NOAA scientific payloads and commercial satellite operators. The program is expected to continue, and the USAF needs to meet its mission by extending the real property lease for continued use by SpaceX.

## 1.4 SCOPE OF THE SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT

### 1.4.1 Future Use of This Document

Future projects planned by SpaceX associated with operations at CCAFS will be reviewed and evaluated to determine if they fall within the scope of the original EA or this SEA. New space vehicles or re-entry/recovery operations planned would also require review of the original EA and this SEA. If an additional Supplemental EA or another EA is required, the USAF would need to develop a new Finding of No Significant Impact (FONSI) or an EIS prior to making a Federal decision. Actions found to result in significant impacts to the environment that could not be mitigated to a level of insignificance would need to be addressed in an EIS.

As with the original EA, NASA and the FAA will also rely on this analysis to support their environmental review for a SpaceX launch license application for the Falcon 9 v1.1 vehicle at LC- 40. If, after reviewing the SEA, the FAA determines the Proposed Action would not individually or cumulatively result in significant impacts on the human environment, the FAA would issue its own FONSI to support issuing a launch license to SpaceX. The FAA will draw its own conclusions from the analysis presented in this SEA and assume responsibility for its environmental decision and any related mitigation measures. In order for the FAA to use this analysis to support its determination, the SEA must meet the requirements of FAA Order 1050.1E, Change 1, *Environmental Impacts: Policies and Procedures*, which contains the FAA's policies and procedures for compliance with NEPA. NASA will individually draw their own conclusions from the analysis presented in this SEA and assume responsibility for its environmental decision and any related mitigation measures.

### 1.4.2 Structure of this SEA

This SEA presents the analysis and description of potential environmental impacts that could result from the Proposed Action and the No Action Alternative. As appropriate, the affected environment and environmental consequences of the Proposed Action and the No Action Alternative are discussed in context with resource area descriptions. This SEA incorporates the 2007 EA by reference to minimize redundancies, and notes minor changes to account for the simplified Proposed Action.

Section 2.0 of this EA describes the Proposed Action and the No Action Alternative. Since this supplemental EA only addresses a modified version of the Falcon 9, no other alternatives are being considered.

Section 3.0 provides a brief review of the affected environment for land use/visual resources, noise, biological resources, cultural resources, air quality, orbital debris, hazardous materials/hazardous waste, water resources, geology and soils, transportation, utilities, health and safety, socioeconomics, environmental justice, and Section 4(f) properties. Section 4(f) properties were added to be consistent with FAA Order 1050.1E, Change 1. The information included in this section describes existing conditions, which provides background for understanding the context of the action. Section 3.0 also provides justification for elimination of resource areas that would not be impacted by the Proposed Action.

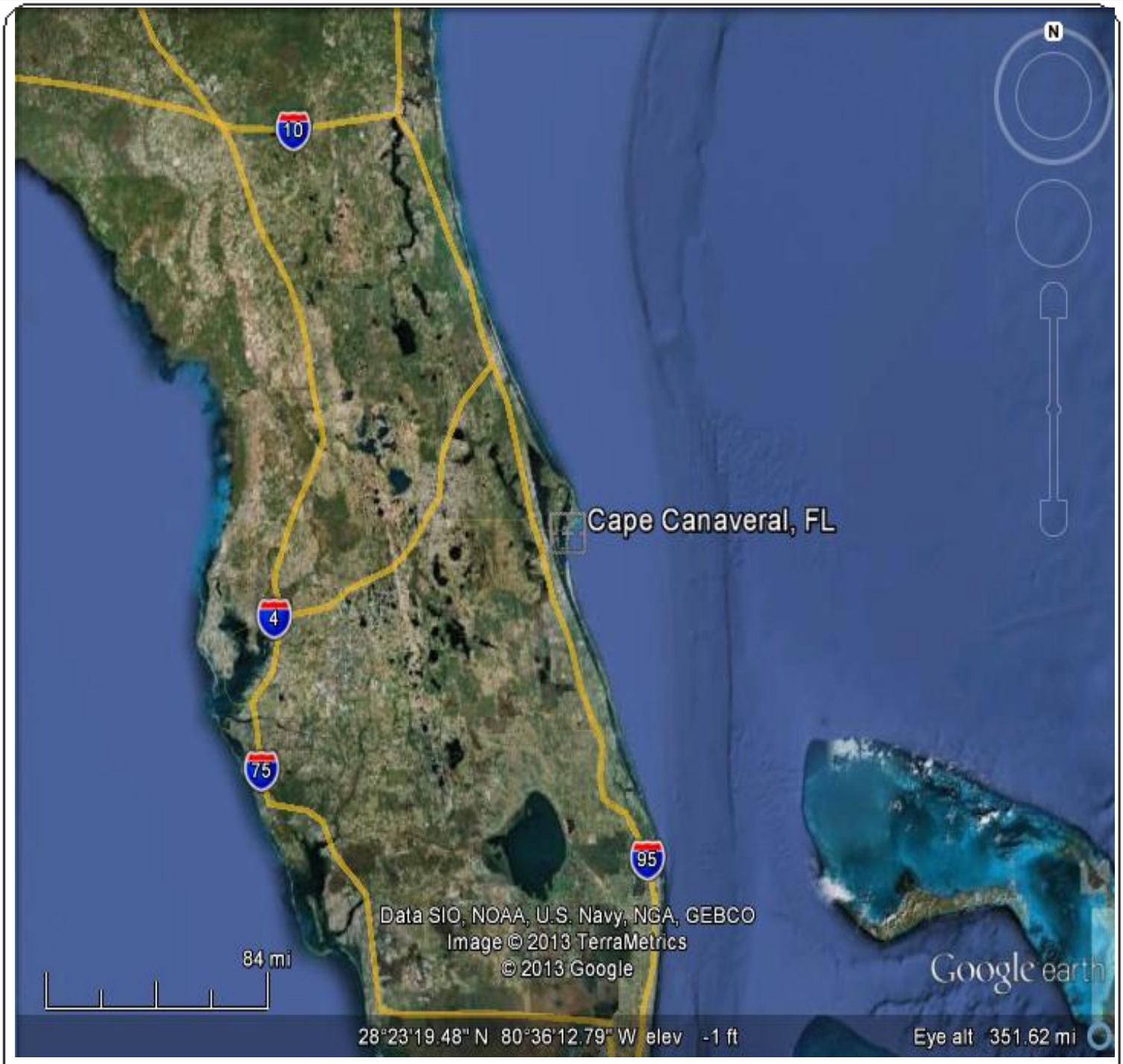
Section 4.0 addresses the potential direct and indirect effects of the Proposed Action and the No Action Alternative on the resource areas discussed in Section 3.0. Any proposed or required mitigation measures are also discussed in Section 4.0.

Section 5.0 describes cumulative impacts on resource areas from similar current and future actions.

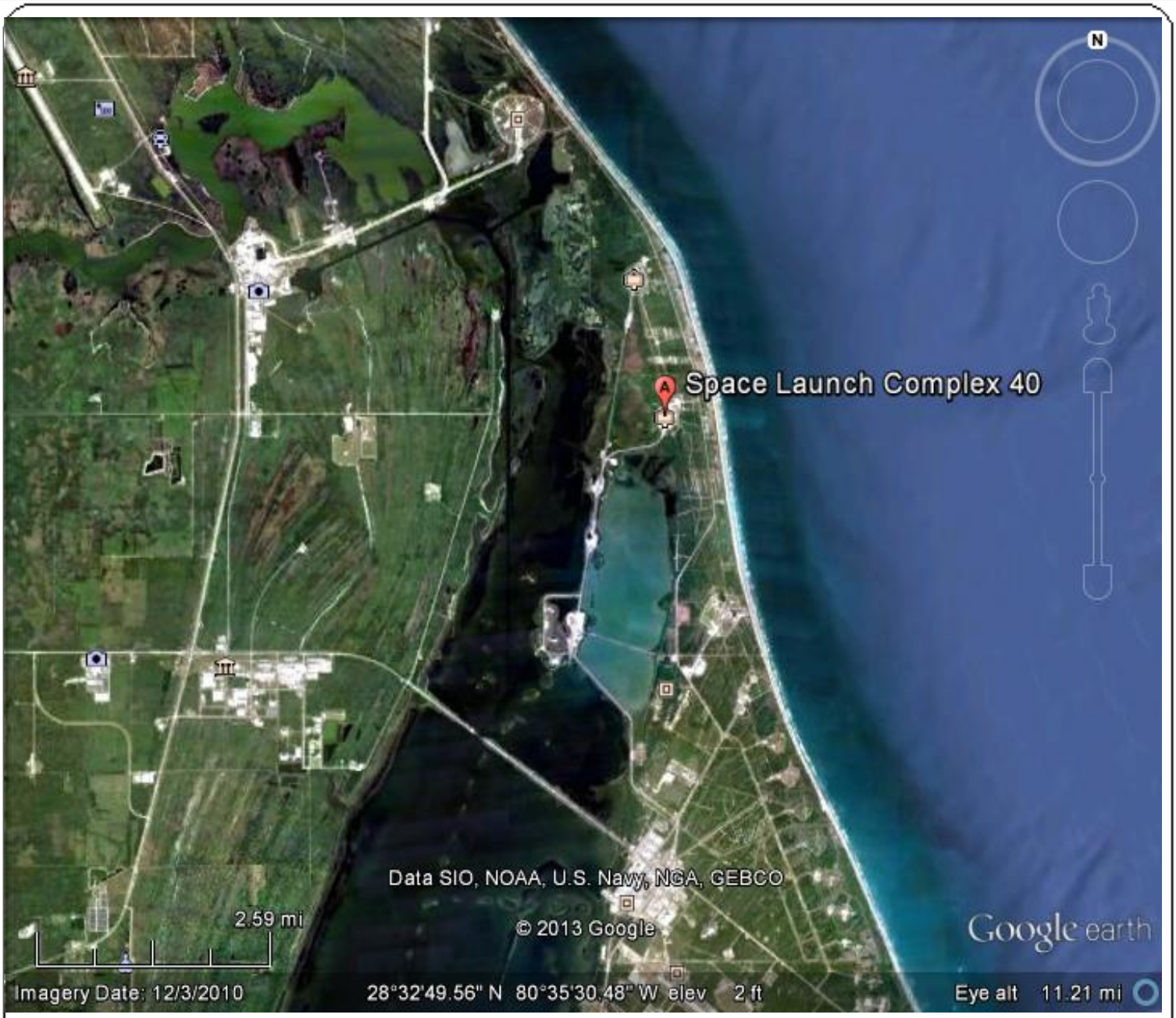
Section 6.0 presents a list of applicable environmental requirements relating to the Proposed Action. Letters (email) noting the cooperation between the FAA, NASA and the USAF in the preparation of this SEA is provided in Appendix A and is consistent with the 2007 EA. Appendix A also contains the Clearinghouse determination letter. A recent Falcon vehicle noise study is included in Appendix B, and data supporting past and future launch vehicle data is included in Appendix C.

## 1.5 REGULATORY REQUIREMENTS AND COORDINATION

The Florida State Clearinghouse reviews EAs for projects planned at CCAFS pursuant to Gubernatorial Executive Order 95-359; the Coastal Zone Management Act; 16 U.S.C. SS 1451-1464 as amended; and NEPA, 42 U.S.C. §4321, §§4331–4335, and §§4341–4347. The State of Florida Clearinghouse sends copies of the draft EA to applicable regulatory agencies for review and submits any comments to be addressed in the final EA. Therefore, this SEA was submitted for Clearinghouse review. Federal and local government agencies that were consulted for the 2007 EA were also informally consulted with by the USAF 45 SW. SpaceX is also required to follow, and has been following, regulatory coordination, approval, and permits with other agencies other than the USAF and FAA, as stated in the original 2007 EA.




| Figure # | | DRAWING TITLE | |
|---|---|---|---|
| 1-1 | G.E.A.R. Gator Engineering & Aquifer Restoration, Inc. 1173 Spring Centre South Blvd., Suite C Altamonte Springs, FL 32714-1976 Ph: 407-682-3009 • Fx: 407-682-3490 | SITE LOCATION: Cape Canaveral AFS<br>Brevard County, Florida | Drawn by: JM<br>Date: 3/14/13<br>Not to Scale |




| Figure # | | DRAWING TITLE | |
|---|---|---|---|
| 1-2 | G.E.A.R. Gator Engineering & Aquifer Restoration, Inc. 1173 Spring Centre South Blvd., Suite C Altamonte Springs, FL 32714-1976 Ph: 407-682-3009 • Fx: 407-682-3490 | LC 40 SITE LOCATION<br>CCAFS, Brevard County, Florida | Drawn by:JM<br>Date:3-17-13<br>Not to Scale |

## 2.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

### 2.1 Proposed Action Introduction and Background

Current activities at LC-40 remain consistent with those analyzed in the 2007 EA and are incorporated by reference. In summary, the 2007 EA analyzed the potential environmental impacts of operating SpaceX Falcon 1 and Falcon 9 Block 1 vehicles to provide commercial space operations from LC-40. That action included launching two space launch vehicles (the Falcon 1 and the Falcon 9 Block 1), utilizing the former Solid Motor and Refit Facility (SMARF) building as a vehicle support facility, constructing a new hangar facility with supporting systems, and the Dragon capsule re-entry from space and recovery. The goal was to conduct 8 to 12 launches per year for both the Falcon 1 and Falcon 9, beginning with up to six launches for each vehicle in 2008 and extending for five years. All flights were expected to have payloads which would include satellites, ISS cargo, or experimental payloads. In addition to standard payloads, the Falcon 9 vehicle would also carry a capsule (Dragon) as a payload that was developed to deliver cargo to the ISS under contract with NASA. Shortly after the 2007 EA was developed, SpaceX eliminated foreseeable utilization of the SMARF and instead constructed an approximately 38,000 sf launch vehicle hangar on the south side of the site, which was analyzed in the original EA. In 2011 and 2012, SpaceX also constructed an approximate 16,000 sf hangar annex and support facilities, including one additional LOX tank, which was addressed at the time with Air Force EIAP program (FORM 813s dated June 2011 and February 2012). Launch pad and facility modifications also were accomplished, which were supported by these earlier documents.

The Falcon Launch Vehicle Program has been designed for minimal vehicle assembly or processing on the launch pad, with most of the vehicle checkout and preparation occurring at the newly constructed hangar and annex just south of the LC-40 launch pad but within site boundaries (cited as the Vehicle Checkout Hangar, or just the Hangar, in the 2007 EA). As supported by the 2007 EA, payloads have been processed at the new hangar facility or an existing Payload Processing Facility, and the Falcon 9 Block 1 has been fueled on the pad on the day of the launch. The goal is to launch within a few days to several weeks of payload arrival at the launch site. See Figure 2-1 for LC-40 facility lay-out.

As a result of the decision to implement the Evolved Expendable Launch Vehicle Program at Vandenberg Air Force Base and at CCAFS, the Air Force had decided to deactivate LC-40 and place it in a “pre-demolition” state by the 45 SW (see *Environmental Assessment for the Deactivation and Turnover of Titan Space Launch Vehicle* Capability, September 2005). Over the past five years, SpaceX has conducted refurbishment and upgrades of the existing support buildings and pad to bring LC-40 back into operation as a launch facility for the Falcon Launch Vehicle Program. Since 2007, SpaceX has successfully launched the Falcon 9 (Block 1) under an FAA license from LC-40 five times (see Table 2-1 below). The most recent launch was March 1, 2013, which included carrying the Dragon capsule as payload. This launch was SpaceX’s second mission under the Commercial Resupply Services (CRS) contract with NASA.

| Table 2.1 Falcon 9 (Block 1) Launch History at LC-40, CCAFS | | | |
|---|---|---|---|
| **Flight Number** | **Vehicle** | **Flight Name/Reason** | **Date** |
| 1 | Falcon 9 | Inaugural Flight (test) | June 4, 2010 |
| 2 | Falcon 9 with Dragon capsule | NASA COTS Demo-1 | December 8, 2010 |
| 3 | Falcon 9 with Dragon capsule | NASA COTS Demo-2/3 | May 22, 2012 |
| 4 | Falcon 9 with Dragon capsule | NASA ISS Resupply Flt 1 | October 7, 2012 |
| 5 | Falcon 9 with Dragon capsule | NASA ISS Resupply Flt 2 | March 1, 2013 |

## 2.2 DESCRIPTION OF PROPOSED ACTION

### 2.2.1 Falcon 9 Version 1.1 Launch Vehicle

This SEA expands on the proposed action and analysis provided in the 2007 EA to include the assessment of the operation and launch of the Falcon 9 v1.1 at LC-40, CCAFS, Brevard County, Florida, and this proposed action does not include construction. As such, the description of the Proposed Action focuses on the Falcon 9 v1.1 and its comparison to the first version of the Falcon 9 Block 1 vehicle. While the Falcon 1 has not been launched at LC-40, and is currently not envisioned to be launched there in the future, it may be referred to in this SEA for comparison.


The Falcon 9 v1.1 is essentially the same vehicle design as the Falcon 9 Block 1 except it is taller, heavier, and has added thrust due primarily to a newer model of the Merlin engine. The Falcon 9 v1.1 is a medium-lift class launch vehicle with a gross lift-off weight of approximately 1,100,000 pounds (lbs) with an approximate length of 224 ft. The Falcon 9 v1.1 uses liquid oxygen (LOX) and highly refined kerosene, also known as rocket propellant-1 or refined petroleum-1 (RP-1), as propellants to carry payloads into orbit. See Table 2-2 below for a comparison of the Falcon 9 Block 1 and the Falcon 9 v1.1 vehicles.

**First and Second Stages**

The first stage of the Falcon 9 v1.1 is approximately 12 ft wide by 150 ft tall and includes nine Merlin 1D engines. The Merlin 1D engine produces 146,000 lbs of thrust and contains a pump-fed gas generator cycle, turbine exhaust roll control, and hydraulic thrust-vector control. The first stage consists of aluminum LOX and RP-1 tanks that hold approximately 62,000 gallons (gal) of LOX and 38,000 gal of RP-1. The second stage is approximately 12 ft wide by 41 ft tall, not including the fairing and payload, and uses one Merlin vacuum engine. The fairing (the top portion of the vehicle where the payload is encapsulated) would be 17 ft by 35 ft; a smaller version may also be used. The second stage consists of approximately 15,000 gal of LOX and 9,000 gal of RP-1 in tanks with a common bulk head. The Falcon 9 v1.1 vehicle uses helium gas stored in high pressure composite over-wrapped cylinders to pressurize the propellant tanks for both first and second stages. The helium flow is controlled through solenoid valves. Both stages include radio frequency (RF) transmitters.

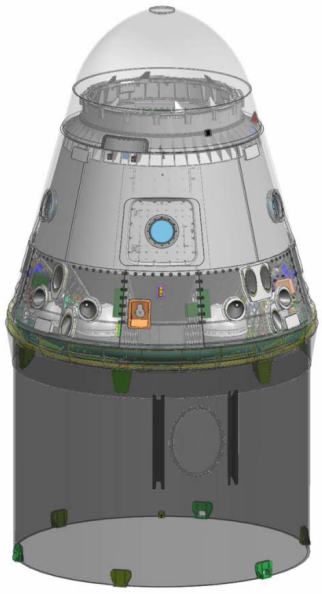
All Falcon 9 v1.1 launches would be expected to have payloads as part of the second stage, including satellites or experimental payloads. Most payloads would be commercial; however, some could be NASA or DoD payloads. SpaceX anticipates that primary commercial payload processing would occur at the hangar and hangar annex at LC-40, or an existing processing facility at CCAFS.

**TABLE 2-2 Launch Vehicle Comparison Matrix**

| Specification | Falcon 9 (Block 1)[a] | Falcon 9 (Block 2) v1.1 [b] | Change (percent) |
|---|---|---|---|
| Over-all length | 178 ft | 226 ft | 48 ft (27%) |
| 1st stage length | 100 ft | 150 ft | 50 ft (50%) |
| 2nd stage length | 41 ft plus fairing of 37ft | 41 ft (plus fairing 17x35 ft) | No or minor change |
| Width | 12 ft | 12 ft | No or minor change |
| Weight | 693,000 lbs | 1,100,000 lbs | + 407K lbs (59%) |
| Engines | Merlin 1C | Merlin 1D | New version |
| Engine Thrust (single) | 90,000 lbs-f | 147, 000 lbs-f | 57K lbs-f (63%) |
| Nominal burn time | 170 sec | 180 sec | 10 sec (6%) |
| Flight Termination system | Engine shut-off and Linear Shape Charges | | No or minor change |
| Thrust at lift-off | 1.01 M lbs-f (4,400 KN) | 1.32 M lbs-f (5,800KN) | .31 M-lbs f (31%) |
| First Stage Fuel | | | |
| RP-1 | 24,840 gal [c] | 38, 500 gal | 13,660 gal (55%) |
| LOX | 38,672 gal [c] | 64, 0000 gal | 25,328 gal (65%) |
| Second Stage Fuel | | | |
| RP-1 | 4,600 gal [c] | 9, 000 gal | 4,400 gal (96%) |
| LOX | 7,300 gal [c] | 15, 000 gal | 7,700 gal (105%) |
| Payload veh. Propellant | | | |
| Dragon: (combined propellant)<br><br>Future Payload: | 4,885 lbs | 4,885 lbs, note: flying with approx. 2,850 lbs<br>6,300 lbs | No Change<br><br>1,415 (29%) |

[a] Air Force/USAF 2007
[b] SpaceX Falcon 9 v1.1 Specifications
[c] Conversion factors: 1gal RP-1 = 6.82 lbs 1gal LOX = 9.527 lbs
ft = foot; m = meter; lbs = pounds; lbs-f = pounds-force; sec = second; gal = gallon; L = liter

In addition to standard payloads, the Falcon 9 v1.1 vehicle may carry a capsule, such as the Dragon Capsule (as shown below), which has been developed to deliver cargo and experiments to the ISS and Low Earth Orbit (LEO). The Dragon has successfully resupplied the ISS twice at the time of this document. The Dragon capsule's dry weight could range from 8,000 to 15,000 lbs depending on its cargo and configuration. Dry weight is the weight of the payload without the associated propellant weight. For missions where Dragon is the payload, Dragon would re-enter Earth's atmosphere at a pre-planned trajectory and would be tracked to a soft-landing in the Pacific Ocean (approximately 200 miles off the Southern California coast). Dragon has an electronic locator beacon and would be located and recovered by a pre-positioned salvage vessel. Recovery would occur within 24 hours of re-entry. The recovered Dragon would be returned to SpaceX facilities in Hawthorne, California; Vandenberg Air Force Base, California; or McGregor, Texas.



Most payloads would include some additional propellants on board, either for orbit maintenance or orbital insertion burns. Payload propellants may include hypergolic fuels such as unsymmetrical dimethyl hydrazine (UDMH), monomethylhydrazine (MMH), and nitrogen tetroxide (NTO), as well as pressurized gasses including helium and nitrogen, and some solid propellants. Hypergolic describes a propellant that ignites on contact with an oxidizer. Quantities for the Dragon would vary but could total up to 4,885 lbs for combined weight of MMH and NTO for the Falcon 9 v1.1. A future satellites propellant weight may total up to 6,300 lbs. The potential total for propellant load is less than the NASA Routine Payload combined weight of 7,055 lbs (NASA 2011). Total payload weights (dry weight plus propellant weights) could be up to 17,850 lbs for the Falcon 9 v1.1. Prior to use, propellants would be stored in sealed containers at the control center area. Payloads would be fueled in either the Payload Processing Facility or the Integration and Processing Hangar, and any residual propellants would be returned to the storage facility. A small amount of ordnance, such as small explosive bolts and on-board batteries, would typically also be used. Any hazardous materials would be handled in accordance with Federal, Air Force, State, and local laws and regulations. SpaceX has an established emergency response team and spills would be contained and cleaned up per the procedures identified in the SpaceX Hazardous Materials Emergency Response Plan (HMERP).

Ground transportation support during a launch campaign (preparation for and the actual launch event) would be minimal. This support would consist of four delivery trucks for delivery of the first stage, second stage, interstage, and payload. In addition, fuel (RP1) and LOX trucks would make weekly deliveries.

**Gas, Fuel, Oil, and Solvent Storage**

The following discussion is essentially the same as described in the 2007 EA for the Falcon 9 Block 1, with the exception of quantities. Helium would be used as a pressurant for the main tanks during flight. It would also be used as a purge during fueling operations and at engine start. Helium would be obtained from commercial sources via a pipeline and would be stored in above ground storage tanks within the vertical launch area fence line at LC-40. LOX and RP-1 would be stored in dedicated propellant storage areas within the vertical launch area. The Falcon 9 v1.1 (first and second stage combined) requires approximately 77,000 gal of LOX and 47,000 gal of RP-1. Storage would be required for the quantities used by the Falcon 9 v1.1, including approximately 200,000 gal of LOX and 60,000 gal of RP-1, which includes additional amounts for losses and quick launch turn-around. Losses involve LOX lost when it boils off in storage or as lines and tanks are chilled. RP-1 would be lost if there is an aborted launch attempt because of engine and system line flushes. The storage locations for all Falcon program liquid propellants would be afforded the appropriate level of separation and protection.

Since much of the required systems are already in operation, tanks and containment systems have been cleaned, tested, and certified; tanks are tested to the U.S Department of Transportation (DOT), American Society of Mechanical Engineers (ASME) Section VIII Pressure Vessel Code requirements, or American Petroleum Institute storage tank requirements, as applicable. Permanent lines have been installed to connect both the LOX and the RP-1 storage areas to the launch pad. These piping systems have been designed, installed, and tested in accordance with ASME B31 Piping Code requirements.

First and second stage fueling of LOX and RP-1 is done with quick disconnect fittings typically used in the aerospace industry. Gaseous nitrogen is used on the system for cleanliness purges and liquid nitrogen is used for cooling purges on an as-needed basis. Gaseous nitrogen is created from liquid nitrogen delivered to the site by pipeline.

In addition, approximately 100 gal of isopropyl alcohol would be on site per launch for additional cleaning operations, though only 20 gal would be required for various cleaning operations during launch preparation. Solvent flushes would be performed during operation of the launch vehicle programs. Small volumes (less than 300 gal) of heavy gear oil, hydraulic oil, and cutting oil (less than 5 gal), and a limited supply of various solvents and adhesives, would be stored in the shop area in the Hangar or at the pad for general use in the maintenance of ground equipment. An oxygen/acetylene torch with its associated gases (carbon dioxide [$CO_2$] and argon) may also be used on a limited basis. Welding equipment would be maintained on site for occasional use. SpaceX has also established an appropriate waste management process at the LC-40 facility.

### 2.2.2 Flight Termination System

The Falcon 9 v1.1 vehicle is currently equipped with a destructive termination system essentially the same as that of the Falcon 1 and Falcon 9 Block 1 v. The destructive termination system includes two linear shaped charges that are intended to rupture the vehicle tanks when commanded to destruct, thus dispersing propellants and breaking up the vehicle to minimize the impact to ground assets. In this event, the debris would impact in a wider area but in smaller pieces. A purely thrust termination capability is also present. The termination method selected by Range Safety would be based on the required trajectory and the payload. In the future, the Falcon 9 v1.1 vehicle would be equipped with a destructive flight termination system. The thrust termination system would be activated by a command from the Range Safety Officer which would disable power to the vehicle engines. Once power is removed, there are up to six different valves that would close and immediately shut off the first stage engine. Four valves would close on the second stage, again shutting down the stage's engine. Thus, upon activation of the thrust termination system in the future, the Falcon 9 v1.1 vehicle would fall to the ocean intact and may breakup upon impact, depending on the circumstances and time in the flight of the termination.

### 2.2.3 Launch Trajectory

The Falcon 9 v1.1 trajectories would be specific to each particular mission and essentially the same as that of the Falcon 1 and Falcon 9 (Block 1) vehicles, as discussed in the 2007 EA.

### 2.2.4 Frequency of Launches

The 2007 EA indicated that up to six launches of the Falcon 1 would be conducted per year beginning in 2008, and up to six launches for Falcon 9 Block 1 per year beginning in 2008. In the past three and one half years, there have been five launches of the Falcon 9 Block 1. The current Proposed Action is to eventually launch the Falcon 9 v1.1 between 8 to 12 times per year, which is the same frequency as projected in the 2007 EA. The Falcon 9v1.1 program may extend up to ten years. All flights are expected to have payloads. For comparison, the Titan program (Titan III through Titan IV vehicles) successfully executed 55 launches from LC-40 and 27 launches from LC 41 between 1965 and 2005.

### 2.2.5 Payloads

Falcon 9 v1.1 payloads, including the Dragon capsule, are expected to be essentially the same as for the Falcon 9 Block 1, as discussed in the 2007 EA, with the possible exception of weight. Total weight could be up to 17,850 lbs and would usually include some additional propellants on board, either for orbit maintenance or orbital insertion burns. These propellants, for payloads of both vehicles, may include hypergolic fuels such as UDMH, MMH, and NTO, and pressurized gasses including helium and nitrogen, and some solid propellants. Quantities for the Dragon would vary but could be up to a total of 4,885 lbs for combined weight of the two components. Future satellites may carry up to 6,300 lbs of propellant. In addition, a small amount of ordnance, such as small explosive bolts and on-board batteries are typical. Propellants would be stored prior to use in a certified facility near the facility where the loading will occur. Residual propellants would be returned to the storage facilities. All hazardous materials would be handled in accordance with Federal and 45 SW guidance.

Parameters for "spacecraft" containing payloads, including the Dragon capsule and possible future NASA payloads, fit within the parameters previously analyzed in the NASA *Routine Payload Final Environmental Assessment* published in June of 2002 and updated in NASA's *Final Environmental Assessment for Launch of Routine Payloads on Expendable Launch Vehicles, November 2011.* This Routine Payload EA discusses the concept of an Envelope Spacecraft (ES) which came from the need to provide a benchmark describing a bounding case for quantities and types of materials, emissions, and instrumentation. In addition, insofar as the pre-launch activities that are required to prepare routine payload spacecraft for launch are routine and not unusual, those activities were implicitly bounded by that ES as well. All spacecraft (referred to as NASA routine payloads [NRP]) examined in the Routine Payload EA meet rigorously defined criteria to ensure the spacecraft and their launch and operation would not present any new or substantial environmental or safety concerns. NRP spacecraft mission operations must comply with all requirements of NASA Policy Directive NPR 8715.6 (NASA Procedural Requirement for Limiting Orbital Debris) and NASA Standard (NASA-STD) 8719.14 (Process for Limiting Orbital Debris), which specify techniques to mitigate the generation of orbital debris from spacecraft, including end-of-mission spacecraft disposal. Because the potential environmental impacts of NRP were analyzed in the Routine Payload EA, which is still an accurate and valid assessment, this SEA does not analyze impacts but incorporates the NRP document by reference.

### 2.2.6 Launch Site Operations

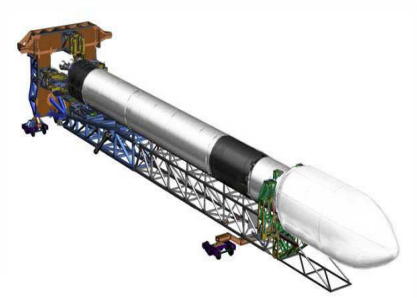
The 2007 EA has fully supported successful SpaceX site operations associated with five Falcon 9 Block 1 launches at LC-40. Those same operational procedures would be used to support the Falcon 9 v1.1 launch preparations. Current and future operations, including Hazardous Material (HAZMAT) Emergency Planning and Response, fueling operations, material storage, Environmental Emergency Plans, spill plans, maintenance and testing, and launch preparation, would continue to follow existing CCAFS guidance and regulations.

Since the 2007 EA, the number of full-time SpaceX employees/contractors present on-site at LC-40 has increased to approximately 50. During a launch campaign, an additional 50 local or transient workers would be working at LC-40 and/or control center area. On a per-mission basis, launch campaigns (preparation for and launch) are expected to last from two to eight weeks. During launch campaigns, the additional workers could work extended hours; however, only two days prior to launch would full-time SpaceX employees/contractors and the local or transient workers need to be on-site for up to 24 hours per day. Staffing on-site would return to normal levels (approximately 50 full-time SpaceX employees/contractors) within a day or two after the actual launch.

### 2.2.7 Primary Support for Launch Vehicles and Payloads

The Falcon 9 v1.1 and payload support is essentially the same as that the Falcon 9 Block 1, as discussed in the 2007 EA, with minor changes. SpaceX accomplishes payload preparation at their hangar annex facility at LC-40, or an offsite processing facility such as ASTROTECH.

The launch platform concrete pad and flame bucket was modified to accept the Falcon 9 launch vehicles during the past five years under the 2007 EA and subsequent Air Force Form 813 reviews. The vehicle system transporter/erector, very similar to the current one shown to the right, would continue to serves as a service tower for vehicle umbilical support while vertical, although the erector is sized larger to support the taller and heavier Falcon 9 v1.1. Just before launch, the transporter/erector strongback would be retracted at least 15 degrees from the vehicle. The transporter/erector would be painted initially and again between launches with a non-toxic paint to prevent corrosion.



**Falcon 9 on Transporter-Erector**

The 2007 EA assessed space for LOX and RP-1 aboveground storage tanks (ASTs) to support Falcon program launch operations. During the past five years, SpaceX installed one large spherical 110,000 gal LOX tank and one smaller pill-shaped 28,000 gal tank. Two 28,000 gal RP-1 ASTs were installed, a third 14,000 gal AST is also planned to be installed as part of previous site plans. A specific safety plan was developed for the Falcon 1 and Falcon 9 Launch Vehicle Programs. These safety plans ensure launch operations are in compliance with applicable regulations, as specified in numerous compliance documents, and by various organizations, including the Air Force and Space Wing Range Safety requirements, State, Federal, and DoD Standards for Ammunition and Explosives. On-going work between the Air Force and SpaceX has also incorporated the Falcon 9 v1.1 vehicle into those safety plans.

SpaceX has refurbished the existing deluge water system at LC-40 primarily for noise and vibration suppression. Since the thrust energies of the Falcon 1, the Falcon 9 (Block 1), and the Falcon 9 v1.1 first stage engines are less than those used on the Titan IV launch vehicle, which was launched at LC-40, the deluge water system continues to be adequate. The system normally discharges approximately 100,000 to 150,000 gal per test/launch activity. It was originally designed to discharge up to 300,000 gal per launch. See Table 2-3 below for a comparison of launch vehicles. During a Falcon 9 (Block 1) launch activity, the deluge system would discharge approximately nine times the volume of water or about 90,000 gal; during a Falcon 9 v1.1 launch, up to 130,000 gal may be discharged. During launch, all water not vaporized and expelled would be contained in the retention basin, analyzed, pumped out, and disposed of on-base at an approved industrial wastewater facility (see Section 3.8, Water Resources). The ground cloud formed by the steam would not contain any hazardous materials.

| Table 2-3 Comparison of Falcon 9 Block 1 and Falcon 9 v1.1 Vehicle General Characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Parameter** | **Falcon 1** | **Falcon 9** | **Falcon 9 V1.1** | **Atlas IIAS** | **Atlas V*** | **Delta IV** | **Titan IV** |
| **Length (ft)** | 68 | 178 | 228 | 156 | 194 | 230 | 183 |
| **Width (ft)** | 5.5 | 12 | 12 | 10 | 12.5 | 16.4 | 14 |
| **Stages** | 2 | 2 | 2 | 2 | 2 + 1 SRM | 2 | 2 + 2 SRM † |
| **First Stage Propellant** | LOX/RP-1 | LOX/RP-1 | LOX/RP-1 | LOX/RP-1 | LOX/RP-1 | LOX/LH2 | Liquid and solid* |
| **Weight (lbs)** | 60,000 | 693,000 | 1,100,000 | 413,500 | 774,000 | 1,630,000 | 2,070,000 |
| **Thrust at Lift-Off (lbs-F)** | 102,000 | 1,010,000 | 1,320,000 | 797,000 | 850,000 2.25[1] Mlbs | 650,000 1.75[2] Mlbs | >2,500,000 |

Notes: SRM = solid rocket motor; $LH_2$ = liquid hydrogen; KN = kilonewtons; Klbf = kilopounds-force; ft = feet; lbs = pounds; LOX = liquid oxygen; RP-1 = rocket propellant-1 * Indicates these characteristics are for the Atlas V 411 configuration, such as flown for the Atlas V NROL-28 launch. † Indicates Titan IV first stage contains a core rocket engine using hypergolic propellants and two solid rocket motors using 88% Hydroxyl Terminated Polybutadiene fuels. †† Indicates thrust level was from Titan IVB-12 launch.
*The Atlas, Delta, and Titan vehicles are not part of the SpaceX Falcon launch vehicle program, are shown for comparison, and would not be launched from the existing SpaceX SLC-40 Launch Site.
1: 2.25M lbs-f thrust includes 1 main liquid core and nominal 5 solid rocket strap-on motors
2: 1.75M lbs-f thust includes 1 main liquid core and nominal 4 solid rocket strap-on motors (EELV FSEIS March 2000)

### 2.2.8 Recovery Efforts

**First Stage**

Similar to the Falcon 9 Block1, the Falcon 9 v1.1 first stage would drop by parachute approximately 500 nautical miles downrange into the Atlantic Ocean, east of and well beyond the east coast of Florida, and would be recovered by a salvage ship that, during a launch, would be stationed in a Range Safety-designated safety zone near the anticipated area of impact. Recovery operations would be the same as described in the 2007 EA.

**Second Stage**

The second stage would enter orbit with the payload. Like the Falcon 9 (Block 1), the Falcon 9 v1.1 second stage is designed to be recoverable. In this event, the stage would re-enter the atmosphere upon a pre-programmed trajectory to impact in a predetermined position in the Pacific Ocean approximately 200 nautical miles off the coast of southern California (where the past Falcon 9 (Block1) flights have landed), or the Atlantic Ocean, currently planned off the east coast of Florida.

**Dragon Capsule Re-entry and Recovery**

The 2007 EA assessed the Dragon capsule re-entry and recovery. After completion of its mission to deliver cargo to the ISS, the Dragon would re-enter the atmosphere on a pre-planned trajectory and land in the Pacific Ocean. Two previous Dragon flights have re-entered and landed in that area. The trajectory of the Dragon is expected to remain the same, with a landing approximately 200 miles west of the southern California coast line.

**Debris Analysis**

As part of the safety review process, a Falcon 9 (Block 1) debris model was completed and included as Appendix C to the 2007 EA. The debris analysis was developed to be compliant with AFSPCMAN 91-710 and presents

estimated debris lists for Flight Termination System activation, explosions, and aerodynamic breakup modes. Also, well in advance of any planned mission (launch), SpaceX has, and would continue to, develop a Preliminary Flight Data Package (PFDP) which takes into consideration a trajectory which avoids over-flights of known structures such as oil rigs, and establishes potential debris corridors for the vehicle. An analysis of the Falcon 9 v1.1 is expected to indicate similar results. The reliability of both Falcon 9 vehicles is expected to be above 95 percent (less than five percent chance of breakup). The Falcon 9 vehicles are designed to be highly reliable because they minimize staging events and have an "engine out" capability, allowing the vehicles to continue with one failed engine in flight.

### 2.2.9 Wildlife Monitoring and Impact Avoidance

As stated in the 2007 EA, monitoring noise levels and wildlife responses to launches would be conducted for the Falcon Launch Vehicle Program at LC-40 to ensure the program would not adversely affect sensitive species. Noise monitoring results are provided in Section 3.2.3.1. To protect sea turtles from being disorientated, a light management plan has been developed and complies with the existing 45 SW exterior lighting management instruction.

## 2.3 ALTERNATIVES CONSIDERED BUT REMOVED FROM FURTHER CONSIDERATION

The original 2007 EA analyzed two alternative locations for the operation and launch of the Falcon 1 and Falcon 9 Block 1 vehicles. One alternative considered placement of the Falcon program at LC-36A or 36B, located east of ICBM road and south of LC-11 at CCAFS. A second alternative considered LC-47 located immediately east of Phillips Parkway road and approximately equal distance between LC- 40 to the north and LC- 37 to the south. LC-40 was ultimately chosen for the Falcon program since it presented the least environmental impact as discussed in the 2007 EA. Further, locating the Falcon 9 v1.1 vehicle at LC-40 eliminates all potential impacts at each of the other two locations. For those reasons, those alternatives were not considered as alternatives to LC-40 for this SEA, therefore they were not further analyzed.

## 2.4 NO ACTION ALTERNATIVE

Under the No Action Alternative, SpaceX would not launch the Falcon 9 v1.1. Since the Falcon 9 Block 1 is no longer in production, it would also not be launched at CCAFS to meet the National Space Transportation Policy's goal of providing low-cost and reliable access to space. The Commercial Space Launch Act's goal to encourage the use of underutilized government infrastructure and resources to promote commercial investment and use of space would not be realized at LC-40 under the No Action Alternative. Also, SpaceX would not be able to efficiently continue to support NASA's continued resupply operation of the ISS with heavier payloads from CCAFS.


| Figure # | | DRAWING TITLE | |
|---|---|---|---|
| 2-1 | G.E.A.R. Gator Engineering & Aquifer Restoration, Inc. 1173 Spring Centre South Blvd., Suite C Altamonte Springs, FL 32714-1976 Ph: 407-682-3009 • Fx: 407-682-3490 | LC 40 Facility Layout<br>CCAFS, Florida<br>NOTE: Approx Photo date April 2011 | Drawn by: JM<br>Date: 3-16-13<br>Not to scale |

## 3.0 AFFECTED ENVIRONMENT

In compliance with NEPA and CEQ regulations, this section describes the existing environment at CCAFS and the Proposed Action location. Each sub-section summarizes the affected environment for the resource areas analyzed in detail in this SEA. This information serves as a baseline from which to identify and evaluate environmental changes resulting from activities associated with the proposed launching of the Falcon 9 v1.1 at LC-40. The environmental documentation from the 2007 EA, and the U.S. Air Force's (USAF) associated EIAP process documents are incorporate by reference into each of these summaries. For each resource area, a region of influence (ROI) was established. The ROI is an area within which a federal action, program or activity may cause an impact. Generally the ROI will be CCAFS and LC-40. Although updates to the affected environment are noted, no substantive changes or alterations have occurred in the resource areas or the region of influence since the completion of the 2007 EA, therefore, those documents are considered valid discussions of the affected environment for this Proposed Action.

## 3.1 LAND USE ZONING / VISUAL RESOURCES

Brevard County and the City of Cape Canaveral are the local planning authorities for incorporated and unincorporated areas near CCAFS. Port Canaveral is used by NASA, the U.S. Navy, the USAF, and the U.S. Coast Guard to support launch and shipping activities. Neither Brevard County nor the City of Cape Canaveral has land use or zoning authority over CCAFS land because it is federally owned. The general plans of Brevard County and City of Cape Canaveral designate compatible land uses and zoning around CCAFS. CCAFS designates its own land use and zoning regulations.

CCAFS encompasses an area of 15,800 acres, representing approximately two percent of the total land area of Brevard County. Land uses at CCAFS include launch operations, launch and range support, airfield, port operations, station support area and open space, but does not include farm land. The launch operations land use category is present along the Atlantic Ocean shoreline and includes both inactive and active launch sites and support facilities. Open space is dispersed throughout the station. There are no public beaches located on CCAFS.

The area surrounding LC-40 is generally flat with scrub oak and palmetto type plants. The area that comprises LC-40 is already extensively developed and has been designated by CCAFS for use as a launch complex LC-40 is a designated Solid Waste Management Unit (SWMU). A Land Use Control Implementation Plan (LUCIP) was implemented as a result of a remedial action conducted at LC-40. The property is prohibited from residential or other non-industrial development without prior written notification to Florida Department of Environmental Protection (FDEP) and United States Environmental Protection Agency (USEPA) concerning potential land use changes. This LUCIP will remain in effect until changes to applicable Federal and State risk-based clean-up standards occur. (USAF 2005a)

Kennedy Space Center (KSC), which is north and west of CCAFS, includes predominantly industrial uses associated with NASA launch programs and open space associated with the Merritt Island National Wildlife Refuge. Uses of the river and ocean water areas surrounding CCAFS include commercial fishing, marine recreation and marine transportation. The Cape Canaveral National Seashore is located directly north of CCAFS and is operated by the National Park Service.

Federal activity in, or affecting, a coastal zone requires preparation of a Coastal Zone Consistency Determination, in accordance with the federal Coastal Zone Management Act (CZMA) of 1972, as amended (P.L. 92-583), and implemented by the National Oceanic and Atmospheric Administration (NOAA). Responsibility for administering the Coastal Zone Management Program (CZMP) has been delegated to states that have developed state-specific guidelines and requirements. In Brevard County, the Florida Coastal Management Program (FCMP), formed by the Florida Coastal Management Act (FCMA), applies to activities occurring in or affecting the coastal zone. The entire State of Florida is defined as being part of a coastal zone (NOAA, 2004); therefore, the Proposed Action is subject to the requirements of the Federal Coastal Zone Management Act. The FDEP is the state's lead coastal management agency. The USAF is responsible for making the final coastal zone consistency determinations for its activities within the state, and the FDEP along with FCMP member agencies will review the coastal zone consistency determination.

## 3.2 NOISE

Noise is usually defined as unwanted sound. High-amplitude noise can be unwanted because of potential structural damage. The ROI for this resource includes the area around LC-40 and the CCAFS land area. CCAFS is a relatively isolated facility, which reduces the potential for noise impacts on adjacent communities. The closest residential communities to LC-40 are the City of Merritt Island, located approximately seven miles to the west southwest and the City of Cape Canaveral, located approximately seven miles to the south. Ambient noise levels in these communities are normally low, with higher noise levels occurring in the communities' industrial areas, and lower noise levels (normally about 45 to 55 A-weighted sound level (dBA)) in the residential areas and along the beaches. Infrequent aircraft fly-overs and rocket launches from CCAFS and KSC currently increase noise levels for short periods of time. Existing noise sources at CCAFS include aircraft noise associated with aircraft landing facilities and current rocket launch operations at CCAFS and KSC. Other noise sources resulting from industrial operations are present in the vicinity of LC-40, but these sources are considered minor in comparison to launch noise, which includes both engine noise and sonic booms produced as launch vehicles reach supersonic speeds.

### 3.2.1 General Description

The decibel (dB) is the accepted standard unit for the measurement of sound. It is a logarithmic unit that accounts for the large variations in amplitude. Sound levels that have been adjusted to correspond to the frequency sensitivity of the human ear are referred to as A-weighted (dBA) sound pressure levels (AWSPL). If structural damage is a concern, then the overall sound pressure level (OASPL) is used. This quantity has no frequency weighting and therefore includes low frequencies that are not audible but can affect structures from vibration-related impacts. The largest portion of the total acoustic energy produced by a launch vehicle is usually contained in the low-frequency end of the spectrum (1 to 100 Hz). Launch vehicles also generate sonic booms. A sonic boom, the shock wave resulting from the displacement of air in supersonic flight, differs from other sounds in that it is impulsive and very brief (up to several seconds for launch vehicles). Since a sonic boom is not generated until the vehicle reaches supersonic speeds, the launch site itself does not experience a sonic boom. The entire boom footprint is some distance downrange of the launch site (USAF, 1998). Descriptors are used to assess and correlate the various effects of noise on humans, including land use compatibility, sleep and speech interference, annoyance, hearing loss, and startle effects. Although derived for humans, these descriptors can also be used to qualitatively assess the

effects of noise on wildlife. These descriptors are the A-weighted sound level. An A-weighted sound level is the momentary magnitude of sound weighted to approximate the human ear's frequency sensitivity. A-weighted sound levels are typically measured between 20 hertz and 20 kilohertz. The long-term equivalent A-weighted sound level (Leq) is an A-weighted sound level that is "equivalent" to an actual time-varying sound level. Table 3-1 shows the A-weighted sounds levels of commonly encountered sounds. C-weighting measures sound levels in dB, with no adjustment to the noise level over most of the audible frequency range except for a slight de-emphasis of the signal below 100 hertz and above 3,000 hertz. C-weighting is used as a descriptor of low-frequency noise sources, such as blast noise and sonic booms.

**TABLE 3-1: A-Weighted Sound Levels of Common Sounds**

| Common Sounds | Sound Level Range (dB) | Region of Comfort |
|---|---|---|
| Threshold of Hearing | 0-10 | JUST AUDIBLE |
| Recording Studio | 10-20 | |
| Bedroom at Night | 20-30 | |
| Quiet Urban Nighttime | 30-40 | QUIET |
| Quiet Urban Daytime | 40-50 | |
| Air Conditioner at 100 Feet | 50-60 | |
| Automobile at 100 Feet Vacuum Cleaner at 10 Feet | 60-70 | MODERATE |
| Heavy Truck at 50 Feet | 70-80 | |
| Garbage Disposal | 80-90 | |
| | 90-100 | VERY LOUD |
| Textile Mill Discotheque | 100-110 | |
| Oxygen Torch | 110-120 | UNCOMFORTABLE |
| | 120-130 | |

* Source: EELV FEIS April, 1998

### 3.2.2 Ambient Noise Levels

Noise levels around facilities at CCAFS and KSC approximate those of any urban industrial area, reaching levels of 60 to 80 dBA. Additional on-site sources of noise are the aircraft landing facilities at the CCAFS Skid Strip and the KSC Shuttle Landing Facility. Other less frequent but more intense sources of noise in the region are launches from CCAFS and KSC. The relative isolation of the CCAFS and KSC facilities reduces the potential for noise to affect adjacent communities. The closest residential areas to CCAFS are to the west southwest and to the south in the cities of Merritt Island and Cape Canaveral respectively. Each are approximately seven miles from the LC-40 launch pad.

### 3.2.3 Operations-Related Noise

Operation-related noise refers to noise generated from activities such as actual launches and also temporary noise during construction or refurbishment activities, and ongoing noise generated from worker traffic to and from the

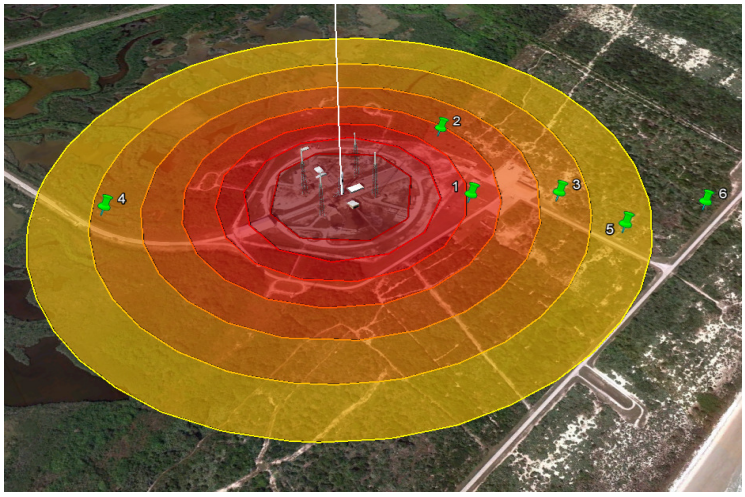
selected site. Vehicle launch engine noise produced is directly related to total vehicle lift-off thrust; the more thrust, the more noise. Historically, the highest recorded noise levels were those produced by the launches of the Space Shuttle, which in the launch vicinity could have exceed 160 dBA. Prior to the end of the shuttle program in 2011, Space Shuttle launch noise at Port Canaveral would have been expected to be typical of noise level at an industrial facility, reaching levels of 60 to 80 dBA (USAF, 1998). Peak overpressures exist from large vehicles such as the Titan IVB approach 49 kg /m2 (10 lb/ft2) in focal zones (USAF, 1998). However, regarding current and past launch programs on CCAFS, neither the Atlas, the Titan nor the Delta launches have been documented to cause any animal mortality or significant impact to wildlife habitat on CCAFS. Space vehicles currently launched at CCAFS are the Delta IV and the Atlas V, usually with a liquid center core and additional solid rocket motors attached. Operations related noise from the actual launches can be summarized as discussed below. Three distinct noise events are associated with launch and ascent of a launch vehicle: on-pad engine noise, in-flight engine noise, and sonic booms.

#### 3.2.3.1 Engine Noise

The launch is the major source of operational noise; all other noise sources in the launch area are considered minor compared to launch noise. The operation of launch vehicle engines produces significant sound levels. Generally, four types of noise occur during a launch: (1) combustion noise from the launch vehicle chambers, (2) jet noise generated by the interaction of the exhaust jet and the atmosphere, (3) combustion noise from post-burning of combustion products, and (4) sonic booms. The initial loud, low frequency noise heard in the immediate vicinity of the launch pad is a result of the first three types of noise combined. Sonic boom patterns are oriented according to the launch azimuth along the trajectory path and occur a considerable distance away from the launch pad out over the Atlantic Ocean. SpaceX measured noise levels for their May 22, 2012 Falcon 9 (Block 1) launch at LC-40. Table 3-2 below and the associated figure present that data. The launch time was 3:44 in the afternoon.

**TABLE 3-2 Falcon 9 (Block 1) Acoustic Data**

| Location | Distance from vehicle (feet) | Acoustics (OASPL) |
|---|---|---|
| 1 | 800 | 145 db |
| 2 | 975 | 136 db |
| 3 | 1450 | 132 db |
| 4 | 1600 | 130 db |
| 5 | 1900 | 129 db |
| 6 | 2500 | 126 db |



For comparison sake, Table 3-3 below presents the sound levels for the Delta II vehicle measured at CCAFS. Comparing these results generally show that Falcon 9 (Block 1) noise levels are approximately very similar to the Delta II, which was most recently launched in September 2011.

**Table 3-3: Measured Delta II Sound Levels, July 1992**

| Distance from Pad (feet) | Predicted Maximum OASPL | Noise Levels (dB) Measured Maximum OASPL | Measured Maximum AWSPL | Measured A-weighted SEL |
|---|---|---|---|---|
| 1,500 | 135.4 | 130.6 | 120.2 | 127.5 |
| 2,000 | 132.9 | 130.4 | 117.7 | 125.5 |
| 3,000 | 129.4 | 125.8 | 115.1 | 123.0 |

*Source: EELV FEIS April, 1998

**On-Pad Noise**

On-pad engine noise occurs when engines are firing but the vehicle is still on the pad. The engine exhaust is usually turned horizontally by deflectors or an exhaust tunnel. Noise is highly directional, with maximum levels in lobes that are about 45 degrees from the main direction of the deflected exhaust. Noise levels at the vehicle and within the launch complex are high. Since the sound source is at or near ground level, propagation from the launch vehicle to off-site locations is along the ground, with significant attenuation over distance. On-pad noise levels are typically much lower than in-flight noise levels because sound propagates in close proximity to the ground and undergoes significant attenuation when the vehicle is on or near the pad. Model simulated noise levels produced by the Falcon 9 v1.1 and Falcon Heavy vehicles are discussed in APPENDIX B.

**In-Flight Noise**

In-flight noise occurs when the vehicle is in the air, clear of the launch pad, and the engine exhaust plume is in line with the vehicle. In the early part of the flight, when the vehicle's motion is primarily vertical, noise contours are circular, particularly for the higher levels near the center. The outer contours tend to be somewhat distorted. They can be stretched out in the launch direction or broadened across the launch direction, depending on specific details of the launch. As the contours are approximately circular, it is often adequate to summarize noise by giving the sound levels at a few distances from the launch site. On-pad noise contours are much smaller than in-flight contours. The in-flight sound source is also well above the ground and therefore there is less attenuation of the sound as it propagates to large distances.

The major source of in-flight noise is from mixing of the exhaust flow with the atmosphere, combustion noise in the combustion chamber, shock waves and turbulence in the exhaust flow, and occasional combustion noise from the post-burning of fuel-rich combustion products in the atmosphere. The emitted acoustic power from a rocket engine and the frequency spectrum of the noise can be calculated from the number of engines, their size and thrust, and their flow characteristics. Normally, the largest portion of the total acoustic energy is contained in the low-frequency end of the spectrum (1 to 100 hertz).

**3.2.3.2 Sonic Booms**

Another characteristic of typical launch vehicles is that they reach supersonic (faster than the speed of sound)

speeds and will generate sonic booms. A sonic boom; the shock wave resulting from the displacement of air in supersonic flight, differs from other sounds in that it is impulsive and very brief (less than a second for aircraft and up to several seconds for launch vehicles). Because a sonic boom is not generated until the vehicle reaches supersonic speeds some time after launch, the launch site itself does not experience a sonic boom. The crescent shape of the typical sound contours from launch vehicles reflects this "after launch" nature of sonic booms. The portions of the footprint to either side of the trajectory represent the overpressures caused as the shock wave expands radially from the line of travel of the launch vehicle. The focal zone "super boom" region is very narrow (typically < 100 yards wide) and is also down track east of the coast. Sonic booms are not experienced on or near the launch pad or coastal shoreline. Past space vehicle launches, and current vehicles launched, which include the Delta IV, the Atlas V and the Falcon 9 have and would produce sonic booms down-track and off shore approximately 30 to 40 miles and are very short in duration.

## 3.3 BIOLOGICAL RESOURCES

This section describes the existing vegetation, both native and naturalized and special status animal species in the area immediately surrounding LC-40, and within the CCAFS perimeter. This resource area has had little to no change since the original EA was developed in 2007, there for a more complete description can be found on the 2007 EA. Vegetation communities include both upland and wetland habitats. Special status species include threatened and endangered (T&E) species, and species of special concern (SSC) that occur or could potentially occur at CCAFS, and could be affected by construction activities and the effects of launch operations. Sensitive and protected biological resources include plant and animal species listed as threatened or endangered by the USFWS and the FWCC. The Proposed Action does not include construction activities.

### 3.3.1 Native Vegetation Communities

At least ten high-quality natural communities of vegetation exist on CCAFS, despite the communities being fragmented by mission-related construction and clearing activities. Parallel to the coastline, CCAFS has a series of ridges and swales that support these communities. These communities include the oak scrub, rosemary scrub, maritime hammock, coastal strand, coastal dunes, grasslands, seagrasses, and three wetland communities (hydric hammock, interdunal swales, and estuarine tidal swamps and marshes). Vegetation on CCAFS, including LC-40 consists mainly of the indigenous Florida coastal scrub (including oak and rosemary scrub) and xeric and maritime hammocks. These scrub habitats also contain the Brazilian pepper, a non-native invasive plant, which invades these communities along disturbed areas, and then becomes established as it out competes native species. There are no federally listed plants at CCAFS. Eight species of state listed plants have been documented to be present on CCAFS; however, during a biological survey conducted on August 3, 2007, none of those eight species were found within the boundaries of LC-40. In the succeeding years since the 2007 EA, these species have remained absent from within the boundaries of LC-40.

### 3.3.2 Threatened and Endangered and Species of Special Concern

There are a variety of State and federally protected species potentially present in the vicinity of LC-40 (see Table 3-4 below). On September 22, 2011 the Federal Register announced the determination of the National Marine Fisheries

Service (NMFS) and the US Fish and Wildlife Service (USFWS) that the Loggerhead sea turtle (*Caretta caretta*) is composed of nine distinct population segments (DPSs) that constitute ‘‘species’’ that may be listed as threatened or endangered under the Endangered Species Act (ESA). In this final rule, they listed four DPSs as threatened and five as endangered under the ESA. They also proposed to designate critical habitat for the two loggerhead sea turtle DPSs occurring within the United States in a future rulemaking (50 CFR Parts 223 and 224 Endangered and Threatened Species; Proposed Listing of Nine Distinct Population Segments of Loggerhead Sea Turtles as Endangered or Threatened). The closest DPS location to CCAFS for the endangered Loggerhead sea turtle is the Northeast Atlantic Ocean DPS which is north of the equator, south of 60° N. Latitude, and east of 40° W. Longitude, so is essentially outside the ROI.

CCAFS contains habitat utilized by a large number of federal and state- listed species. Listed species that are known to be present or near (within 100 feet of the perimeter fence) LC-40 boundaries are presented in Table 3-4. For a list of Federal and state regulatory requirements which address vegetation and wildlife that may be present on CCAFS, and a more detailed description of protected species present at CCAFS, see the 2007 EA. Additionally, the USAF 45th Space Wings current revision of their Integrated Natural Resource Management Plan (INRMP) dated October 2008 contains descriptions of plants and animals occurring at CCAFS.

**TABLE 3-4: Protected Species Flora/Fauna Found in the Vicinity of LC-40**

| Common Name | Scientific Name | Status | |
|---|---|---|---|
| | | Federal | State |
| **Plants** | | | |
| Beach star | *Remirea maritime* | | E |
| Coastal vervain | *Verbena maritime* | | E |
| Curtiss’ milkweed | *Asclepias curtissii* | | E |
| Giant Leather Fern | *Acrostichum danaeifolium* | | CE |
| Golden polypody | *Phlebodium aurea* | | T |
| Hand fern | *Ophioglossum palmatum* | | E |
| Nodding pinweed | *Lechea cernua* | | T |
| Satin leaf | *Chrysophyllum olivaeforme* | | E |
| Inkberry | *Scaevola plumier* | | T |
| Nakedwood, Simpson’s Stopper | *Mycianthes fragrans* | | T |
| Sand dune spurge | *Chamaesyce cumulicola* | | E |
| Satin leaf | *Chrysophyllum olivaeforme* | | E |
| Sea lavender | *Tournefortia gnaphalodes* | | E |
| Shell mound prickly-pear cactus | *Opuntia stricta* | | T |
| **Birds** | | | |
| American oystercatcher | *Haematopus palliatus* | T (S/A) | SSC |
| Arctic Peregrine Falcon | *Falco peregrinus tundrius* | | E |
| Bald Eagle | *Haliaeetus leucocephalus* | T | T |
| Florida Scrub-Jay | *Aphelocoma coerulescens* | T | T |
| Least Tern | *Sterna antillarum* | | T |
| Piping Plover | *Charadrius melodus* | T | T |

| TABLE 3-4: Protected Species Flora/Fauna Found in the Vicinity of LC-40 | | | |
|---|---|---|---|
| **Common Name** | **Scientific Name** | **Status** | |
| | | **Federal** | **State** |
| Roseate spoonbill | *Ajaia ajaja* | | SSC |
| Roseate tern | *Sterna dougallii dougallii* | T | T |
| Snowy egret | *Egretta thula* | | SSC |
| Southeastern American Kestrel | *Falco sparverius paulus* | | T |
| Tricolored heron | *Egretta tricolor* | | SSC |
| White ibis | *Eudocimu albus* | | SSC |
| Wood Stork | *Mycteria Americana* | E | E |
| **Reptiles and Amphibians** | | | |
| Atlantic Green Turtle | *Chelonia mydas* | E | E |
| Atlantic Hawksbill Sea Turtle | *Eretmochelys imbricata imbratica* | E | E |
| Atlantic Loggerhead Turtle | *Caretta caretta* | T/E | T |
| American Alligator | *Alligator mississippiensis* | T (S/A) | SSC |
| Eastern Indigo Snake | *Drymarchon corais couperi* | T | T |
| Florida Gopher Frog | *Rana capito* | | SSC |
| Florida Pine snake | *Pituophis melanoleucus mugitus* | | SSC |
| Gopher Tortoise | *Gopherus polyphemus* | | T |
| Hawksbill sea turtle | Eretmochelys imbricate imbricata | E | E |
| Kemp's Ridley Sea Turtle | *Lepidochelys kempi* | E | E |
| Leatherback SeaTurtle | *Dermochelys coriacea* | E | E |
| Loggerhead sea turtle | *Caretta caretta* | T | T |
| | | | |
| **Mammals (Whales listed for completeness even though they are not near LC-40)** | | | |
| Florida Manatee | *Trichechus manatus* | E | E |
| Southeastern Beach Mouse | *Peromyscus polionotus niveiventris* | T | T |
| Finback whale | *Balaenoptera physalus* | E | E |
| Humpback whale | *Megaptera novaeangliae* | E | E |
| Northern right whale | *Eubalaena glacialis* | E | E |
| Sei whale | *Balaenoptera borealis* | E | E |
| Sperm whale | *Physeter catodon* | E | E |

CE – Commercially Exploited
S/A – Similar in Appearance
E – Endangered
T – Threatened
SSC – Species of Special Concern

**Source:** NASA 2010 KSC Environmental Resource Document March 2010

**NOTE:** Bald eagles were removed from the endangered species list in June 2007 because their populations recovered sufficiently. However, the protections under the Bald and Golden Eagle Act (Eagle Act) continue to apply. Please see the eagle information on our national website at http://www.fws.gov/migratorybirds/baldeagle.htm for information regarding new requirements.

There is no designated critical habitat under Section 4 of the Endangered Species Act at LC-40. A biological survey conducted August 3, 2007 revealed that suitable gopher tortoise habitat exists within 100 feet of LC-40, including one colony immediately north of the security fence with over 20 active burrows. In addition, the biological survey also

revealed that suitable habitat for the scrub jays exists within 100 feet of LC-40. Other species which may be listed on Brevard County's website may not be found in the vicinity of LC-40. See the 2007 EA for a more detailed description of protected species present at CCAFS.

## 3.4 CULTURAL RESOURCES

Cultural resources include prehistoric and historic sites, structures, districts, artifacts or any other physical evidence of human activity considered important to a culture, subculture or community for scientific, traditional, religious or any other reasons. In 1949, the Cape Canaveral Long-Range Proving Ground was formally established under the direction of the USAF. There is no scientific or physical evidence for paleontological resources at CCAFS. Additionally, there are no known archaeological sites located either within the complex boundary or near LC-40 (USAF 2007).

Historic building and structure surveys at CCAFS include those conducted by the National Park Service (1980); Resource Analysts, Inc. of Bloomington, Indiana (Barton et al. 1983); and the USACE Construction Engineering Research Laboratories (CERL) (McCarthy et al. 1994; Turner et al. 1994). LC- 40 was designed to support Titan IIIC space missions, which began with the first successful launch on 18 June 1965. In the 1970s, Titan IIICs launched from LC-40 placed mostly military satellites into very high, geosynchronous equatorial orbits. The last Titan IIIC lifted off SLC-40 in March 1982, followed by the first Titan 34D on 30 October 1982. Refurbishment to upgrade SLC-40 from a Titan 34D configuration to a Titan IV configuration began in July of 1990. On 15 October 1997, a Titan IVB/Centaur launched from SLC-40 lofted the Cassini orbiter and its attached Huygens probe into space for their journey to Saturn. Nonetheless, LC-40 is not considered a historic complex and there are no historic properties located in the immediate vicinity.

## 3.5 AIR QUALITY

This section describes air quality resources at CCAFS for the atmosphere at altitudes below 914 m (3000 ft), which contains the atmospheric boundary layer for CCAFS. Atmospheric monitoring for chemicals at CCAFS is within the atmospheric boundary layer where people live and work. CCAFS is located in Brevard County and is classified as attainment with National Ambient Air Quality Standards (NAAQS) and Florida Ambient Air Quality Standards (FAAQS). These regulations are contained in CFR Part 51 and F.A.C. 51 and F.A.C. 62. Since publication of the 2007 EA, the applicable ambient air quality standards have changed. Table 3-5 below presents updated data for Florida and National ambient air quality standards. CCAFS is considered a major source of air pollution for regulated criteria pollutants, and is now classified as a minor source of regulated HAPs under the current Title V Operating Permit. No conformity determination is required as the facility is located within NAAQS attainment area for all regulated criteria pollutants. To meet the requirements of Section 112(r) of the CAA and 40 CFR Part 68, CCAFS prepared a Risk Management Plan (RMP).This plan was required because CCAFS stored reportable quantities of RMP listed chemicals. The chemical holdings for which RMPs had been prepared were hydrogen at LCs 17, 36, and 40, and hydrazine and Aerozine-50 at LC-40. Hydrogen was removed from the RMP during a revision due to the fuel exemption provision of the RMP regulations (40 CFR Part 68); therefore hydrazine and Aerozine-50 at LC-40 were the only chemicals addressed in the RMP. The RMP was associated with the Titan program at LC-40. The RMP was discontinued when the Titan program ended and the

chemical holdings were removed from site. CCAFS no longer has a RMP.

Air quality at CCAFS is regulated federally under Title 40 CFR 50 NAAQS, Title 40 CFR 51 (Implementation Plans), Title 40 CFR 61 and 63 (National Emission Standards for Hazardous Air Pollutants [NESHAPs]), and Title 40 CFR 70 (Operating Permits).

FAAQS are not significantly different from the NAAQS. Specific regulations that may be applicable to launch complex activation activities include Rule 62-204.240, F.A.C. ( [FAAQS]), Rule 62-210, F.A.C. (Stationary Source General Requirements) establishes general requirements for stationary sources of air pollutant emissions and provides criteria for determining the need to obtain an air construction or air operation permit., Rule 62-212, F.A.C. (Stationary Source Preconstruction Permitting), Rule 62-213, F.A.C. (Operating Permits), and Rule 62-242, F.A.C. (Mobile Sources). CCAFS and KSC are classified as major sources because emissions are above major source thresholds. KSC and CCAFS have Title V permits. A summary of both Federal and State of Florida regulatory framework and other air related information is available in Appendix D of the original EA in 2007.

**Table 3-5: Florida and National Ambient Air Quality Standards**

| Regulated Pollutant | Averaging Time | Florida Standards (µg/m$^3$) | National Primary Standards | National Secondary Standards |
|---|---|---|---|---|
| CO | 8 Hours<br>1 Hour | 10,000<br>40,000 | 9 ppm<br>35 ppm | - |
| Lead (Pb) | Rolling 3 month average | 1.5 | 0.15 µg/m$^3$ (1) | 0.15 µg/m$^3$ (1) |
| $NO_2$ | Annual arithmetic mean | 100 | 53 ppb (2) | 53 ppb (2) |
| | 1 Hour | - | 100ppb | - |
| $O^3$ | 8 Hour | - | 0.075 ppm (3) | 0.075 ppm (3) |
| | 1 Hour | 235 | - | - |
| $PM_{10}$ | Annual<br>24 Hours | 50<br>150 | 150 µg/m$^3$ | 150 µg/m$^3$ |
| PM2.5 | Annual<br>24 Hours | -<br>- | 35 µg/m$^3$ | 35 µg/m$^3$ |
| $SO_2$ | Annual<br>24 Hours<br>3 Hours<br>1 Hour | 60<br>260<br>1,300<br>- | -<br>-<br>-<br>75 ppb (4) | -<br>-<br>0.5 ppm<br>- |

**Notes:**
(1) Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.
(2) The official level of the annual NO2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.
(3) Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations

under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.
(4) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.
**Sources:** USEPA Air Criteria as of Oct 2011 and 40 CFR 50 and Rule 62-204.240, F.A.C.

Also, since publication of the 2007 EA, ambient air quality measurement data for the region have become available for 2008. Table 3-6 includes data from 2006, 2007, and 2009. The updated table below shows that ground-level concentrations of criteria pollutants in the region around LC-40 continue to be within the NAAQS and Florida standards.

**Table 3-6: Measured Ambient Air Concentrations of Criteria Pollutants in the Region**

| Pollutant | Averaging Time | Nearest Monitoring Station | Maximum Measured Concentration (ppm, except PM in µg/m$^3$) | | |
|---|---|---|---|---|---|
| | | | 2006 | 2007 | 2008 |
| **$O_3$** | 1 Hour | Cocoa Beach | 0.081 (4$^{th}$ max)[a] | 0.077(4$^{th}$ max) | 0.071(4$^{th}$ max) |
| | 8 Hours | Cocoa Beach | 0.074(4$^{th}$ max) | 0.067(4$^{th}$ max) | 0.069(4$^{th}$ max) |
| **CO** | | Winter Park | 1.7 | 1.0 | 1.0 |
| | 1 Hour | Winter Park | 2.5 | 1.6 | 1.1 |
| **$NO_2$** | 8 Hours | Winter Park | 0.009 | 0.007 | 0.006 |
| | 1 Hour | Winter Park | 0.053 | 0.058 | 0.043 |
| **$SO_2$** | Annual | Winter Park<br>Cocoa Beach | 0.001 | 0.001 | 0.001 |
| | 24 Hours | Winter Park<br>Cocoa Beach | 0.004 | 0.006 | 0.004 |
| | 3 Hours | Winter Park<br>Cocoa Beach | 0.010 | 0.029 | 0.013 |
| **$PM_{10}$** | Annual | Cocoa Beach | 14 | 16 | 17 |
| | 24 Hours | Cocoa Beach | 27 | 74 | 58 |
| **$PM_{2.5}$** | Annual | Melbourne | 9.0 | 7.3 | 8.03 |
| | 24 Hours[b] | Melbourne | 36 | 24 | 21.3 |
| **Lead** | Quarterly | No lead monitors are located within 100 miles of LC-40 | - | - | - |

**a** The ozone standard is attained when the expected number of days per calander year with maximum hourly average concentrations above the standards, average over three consecutive years, is equal to or less than one. By this statistic, the standard is met when the fourth-highest average concentration in each or the three years is less that the value of the standard.
b The 24-hour PM2.5 standard is attained when the standard value is not exceeded on more than an average of one day per year over a three year period. By this statistic, the 24-hour PM2.5 standard was attained in 2006-2008 despite maximum concentrations that exceeds the value or the standard (35 ug/m$^3$) in 2006.
Source: EPA, 2009a

Presented below in Table 3-7 is a summary of both the 2010 and 2011 CCAFS Air Emissions Inventory Report (most recent) actual and potential annual emissions estimates for all NAAQS and FAAQS regulated criteria pollutants and total HAPs (included in the current Title V Air Operating Permit). CCAFS is still listed as a

"synthetic minor" source for HAPs but remains a Title V "major" source of criteria pollutants (Pius Sanabani email 5/6/2013).

| Table 3-7: Summary of CCAFS Criteria Pollutant & HAPs Emissions (Tons per Year-TPY) for 2010 and 2011 | | | | |
|---|---|---|---|---|
| **Pollutant** | **2010 Actual (TPY)** | **2010 Potential (TPY)** | **2011 Actual (TPY)** | **2011 Potential (TPY)** |
| PM | 893.611 | 959.475 | 364.923 | 430.230 |
| PM10 | 405.212 | 424.035 | 167.561 | 185.920 |
| NOx | 59.354 | 118.136 | 65.525 | 150.877 |
| SO2 | 3.663 | 7.364 | 4.160 | 7.266 |
| CO | 14.104 | 31.851 | 15.018 | 84.561 |
| VOC | 11.268 | 77.592 | 10.816 | 77.168 |
| HAPs | 1.384 | 1.960 | 0.945 | 1.372 |

Since the 2007 EA there has been changes in Greenhouse gas (GHG) regulations. GHG are gas emissions that trap heat in the atmosphere. These emissions occur from natural processes and human activities. Some scientific evidence indicates a trend of increasing global temperature over the past century which may be due to an increase in GHG emissions from human activities. The climate change that may be associated with this global warming may produce negative economic and social consequences across the globe. In February 2010, the CEQ issued NEPA guidance for considering the effects of climate change and GHG emissions. Specifically, if a proposed action would be reasonably anticipated to cause direct emissions of 25,000 metric tons or more of CO2-equivalent GHG emissions on an annual basis, agencies should consider this an indicator that a quantitative and qualitative assessment may be meaningful to decision makers and the public. For long-term actions that have annual direct emissions of less than 25,000 metric tons of CO2-equivalent, CEQ encourages Federal agencies to consider whether the action's long-term emissions should receive similar analysis. CEQ does not propose this as an indicator of a threshold of significant effects, but rather as an indicator of a minimum level of GHG emissions that may warrant some description in the appropriate NEPA analysis for agency actions involving direct emissions of GHGs. (CEQ Memorandum 18 February 2010). Table 3-8 below shows the most recent summary of GHG for CCAFS. The Air Force is currently working on assembling data for 2012. Note that the threshold for reporting GHG is 25,000 $MtCO_2$ per year (40 CFR 98).

| **TABLE 3-8 Summary of Greenhouse Gases Emissions for CCAFS (Years 2010 and 2011)** | | | |
|---|---|---|---|
| GHG | GHG Emissions for 2010 | | |
| | Ton (Short) | Ton (Metric) | $MtCO_2e$ |
| $CO_2$ | 2,998.578 | 2,720.23 | 2,720.283 |
| $N_2O$ | 0.065 | 0.059 | 18.280 |
| $CH_4$ | 209.487 | 190.045 | 3,990.912 |
| TOTAL REPORTABLE GHG* for 2010 | | | **6,729.475** |
| GHG | GHG Emissions for 2011 | | |
| $CO_2$ | 3,160.034 | 2,866.735 | 2,866.735 |
| $N_2O$ | 0.052 | 0.047 | 14.624 |
| $CH_4$ | 122.215 | 110.872 | 2,328.303 |
| TOTAL REPORTABLE GHG* for 2011 | | | **5,209.662** |

## 3.6 ORBITAL DEBRIS

Orbital debris continues to be a concern as a potential collision hazard to spacecraft including the Dragon Capsule, an essentially remains the same as discussed in the 2007 EA. Large pieces of debris are of concern with respect to re-entry and eventual Earth impact. Space debris can be classified as either natural or man-made objects. It is estimated that there are more than 10,000 objects greater than 10 cm (4 inches) in size in orbit, tens of millions between 0.1 and 10 cm (0.039 and 4 inches) in size in orbit, and trillions less than 0.1 cm (0.039 inch) in size in orbit (OSTP, 1995). The effects of launch-vehicle-generated orbital debris impacts on other spacecraft including the Dragon Capsule depend on the altitude, orbit, velocity, angle of impact, and mass of the debris. See the 2007 EA for a more detailed description of orbital debris.

## 3.7 HAZARDOUS MATERIALS/HAZARDOUS WASTE

Numerous types of hazardous materials are used to support the missions and general maintenance operations at CCAFS and at LC-40 such as petroleum products, oils, lubricants, volatile organic compounds, corrosives, refrigerants, adhesives, sealants, epoxies, and propellants (USAF, 2000). Management of hazardous materials, excluding hazardous fuels, is the responsibility of each individual or organization, in this case SpaceX. Resource Conservation and Recovery Act (RCRA) requirements will be accomplished by the directives listed in the respective permits issued to KSC/CCAFS (OPLAN 10-2 Vol II, OPLAN 19-14 and KHB 8800.6). There are no sites at CCAFS listed or under consideration for listing on the National Priorities List (EPA, 2013). There are no underground storage tanks at LC-40.

In the event of a spill of hazardous materials, the Air Force would provide initial emergency spill response; however, the remainder of emergency/corrective actions would be the responsibility of SpaceX. SpaceX is responsible for preparing its own Emergency Response Plan for the Falcon Launch Vehicle Program in accordance with the CCAFS Hazardous Materials Emergency Response Plan. The CCAFS Hazardous Materials Emergency Response Plan ensures that adequate and appropriate guidance, policies, and protocols regarding hazardous material incidents and associated emergency response are available to and followed by all installation personnel and commercial entities.

Hazardous waste management, at CCAFS is regulated under RCRA (40 CFR 260-280) and Rule 62-730, SpaceX is responsible for the management and disposal of hazardous wastes. SpaceX manages all hazardous waste generated from its operations in accordance with all local, state, and federal regulations and maintains their own hazardous waste satellite accumulation points (SAP) and 90-day hazardous waste accumulation areas, in accordance with applicable RCRA regulations. SpaceX has developed its own Hazardous Waste Management Plan for the Falcon Launch Vehicle Program in accordance with the 45th Space Wing Hazardous Waste Management Plan, to document how SpaceX would control hazardous wastes for the program. In addition, all hazardous waste must be handled and disposed per the requirements established by the Federal regulations and the FDEP. SpaceX is responsible for the collection and transport of hazardous wastes (including propellant waste) from the SAPs to a 90-day hazardous accumulation area, then to an offsite permitted treatment, storage, and disposal facility (TSDF). There should not be propellant waste unless there would be a spill, or leak, during RP-1 loading for the Falcon 9 v1.1vehicle.

SpaceX is responsible for ensuring that the management and disposal of all hazardous wastes is conducted in accordance with all applicable federal, state, and local regulations, and is responsible for the coordination of all environmental emergency response actions at the leased premises. SpaceX has also developed its own Spill Prevention Control and Countermeasure (SPCC) plan for petroleum related storage tanks and systems.

**Installation Restoration Program**

The Installation Restoration Program (IRP) is an Air Force program that identifies, characterizes, and remediates past environmental contamination on Air Force installations. Under the IRP Program, LC-40 was designated in the late 1990s as Solid Waste Management Unit (SWMU) 46. There has been no change in the IRP status at LC-40 since the 2007 EA.

## 3.8 WATER RESOURCES

Water resources include groundwater and surface water, and their physical, chemical, and biological characteristics. CCAFS is within the Florida Middle East Coast Basin and situated on a barrier island that separates the Banana River from the Atlantic Ocean. This basin contains three major bodies of water: the Banana River to the immediate west, Mosquito Lagoon to the north, and the Indian River to the west, separated from the Banana River by Merritt Island. Several water bodies in the Middle East Coast Basin have been designated as Outstanding Florida Waters in Chapter 62-3 of the Florida Administrative Code, including most of Mosquito Lagoon and the Banana River, Indian River Aquatic Preserve, Banana River State Aquatic Preserve, Pelican Island National Wildlife Refuge, and Canaveral National Seashore. These water bodies are afforded the highest level of protection, and any compromise of ambient water is prohibited. In addition, in 1990 the Indian River Lagoon system has been determined to be an Estuary of National Significance under the National Estuary Program. The Banana River has been designated a Class III surface water, as described by the CWA. Class III standards are intended to maintain a level of water quality suitable for recreation and the production of fish and wildlife communities. There are no wild and scenic rivers located on or near CCAFS.

**Surface Water**

LC-40 and the roadway connecting to the SMARF are completely surrounded by low-lying marshlands and sloughs. Wetlands that are associated with the Banana River are located 1,000 ft to the west and the Atlantic Ocean is approximately 1,300 ft to the east. On site, surface water drains by overland flow to four man-made, low-lying percolation areas and drainage swales. The on-site swales consist primarily of mowed and maintained grass. Surface water recharges the groundwater system through infiltration when water collects in the low-lying areas of the site. There are no permanent surface water bodies within the fenced area of the site. FEMA mapping indicates LC-40 lies outside the 100-year floodplain (USAF 2007).

**Ground Water**

The surficial and the Floridan aquifer systems underlie CCAFS. The surficial aquifer system, which comprises of generally sand and marl, is under unconfined conditions and is approximately 70 ft thick. The surficial aquifer is recharged by infiltration of precipitation through the thin vadose zone. Groundwater in the surficial aquifer at CCAFS

generally flows to the west, except along the extreme eastern coast of the peninsula. The surficial aquifer at LC-40 consists of clastic sediments that contain groundwater primarily under unconfined conditions. Groundwater occurs at depths ranging from about 3.2 to 18.0 ft below land surface (bls). Shallow groundwater movement across the site is west and south under a hydraulic gradient that ranges from 0.001 to 0.003 ft/ft.

## 3.9 GEOLOGY AND SOILS

The geology topography and soils underlying CCAFS and specifically LC-40 are unchanged and remain as described in the 2007 EA. Generally the surficial sands immediately underlying the surface are marine deposits that typically extend to depths of approximately 10 to 30 ft below the surface. The Caloosahatchee Marl underlies the surficial sands and consists of sandy shell marl that extends to a depth of 70 ft below the surface. The Hawthorn Formation, which consists of sandy limestone and clays, underlies the Caloosahatchee Marl and is the regional confining unit for the Floridan aquifer.

The CCAFS topography consists of a series of relic dune ridges formed by wind and wave action, indicating that gradual beach deposits occurred throughout time. The higher naturally occurring elevations occur along the eastern portion of CCAFS, with a gentle slope to lower elevations toward the marshlands along the Banana River. The soils are exceptionally dry, even though the water table is often near the surface during rainy periods. Soils at LC-40 are primarily of the Palm Beach and Canaveral soils, but are excessively drained. The subsoil extends to a depth of 40 to 60 inches. Other soil classifications found at LC-40 area are Urban Land and Coastal beaches. The majority of the complex is considered a developed area.

## 3.10 TRANSPORTATION

### Regional Access

The CCAFS area can be accessed from Daytona Beach and other locations via U.S. Highway (US) 1 or Interstate 95; Orlando lies approximately 50 miles to the west on State Route (SR) 528; and Miami is approximately 187 miles to the south on US 1 or Interstate 95.

### Local Access

The majority of the employees and other related support services providers for CCAFS reside within the unincorporated areas of Brevard County and in the cities of Cape Canaveral, Cocoa, Cocoa Beach, and Rockledge, which are all within 14 miles of the station. The key roads providing access to CCAFS from the local communities include SR A1A, SR 520, SR 528, SR 401, SR 3, and SR 405. The NASA Causeway (SR 405), Beach Road, and SR 528 connect CCAFS with KSC, the inner barrier islands and the mainland. Southern access into CCAFS occurs through Gate 1. Gate 1 is accessed by SR 401 via SR A1A, SR 520, and SR 528. Western access onto CCAFS is provided by SR 3 and SR 405. From the north, CCAFS can be accessed through Gate 4 and Gate 6 at KSC. Conditions for key roads on/near CCAFS were presented in Table 3.10-2. of the 2007 EA. However since the Shuttle Program was terminated in 2011, the general work force that would be using these road ways has significantly declined.

The major on-site roadway on CCAFS is Samuel C. Phillips Parkway, a 4-lane divided highway that accommodates most of the north-south traffic: LC-40 main access is from Phillips Parkway. Titan Road from

the south also provides access to the SMARF and LC-40. During the past five years, rail access between the SMARF and LC-40 has been removed.

## 3.11 UTILITIES

**Water**

Water for CCAFS is acquired from the City of Cocoa's municipal potable water distribution system under a long-term agreement which has a 37 million gallon per day (MGD) capacity. Water is utilized at CCAFS for both potable and non-potable purposes. Launch pad use of non-potable water includes noise abatement, cooling and shock wave attenuation associated with the deluge system. Pump house number 7 supplies non-potable deluge water to LC-40 and LC-41. The design capacity of supply water to LC- 40 is up to 800,000 gallons per launch for deluge purposes. The pump house is able to supply 40,000 gallons per minute.

**Electrical Power**

Florida Power and Light provide power and lighting transmission systems for both CCAFS and KSC. Together, CCAFS and KSC have a total capacity of 216,000 kilovolt-amperes (kVA). The USAF owns the distribution system. Transmission lines enter the installation at three locations; capacity of the three substations is 55 megawatts (MW), and they are capable of providing 1,320 MWH/day.

## 3.12 HEALTH AND SAFETY

The areas in and around CCAFS that could be affected by payload processing, transport, and launch are the subject of health and safety concerns. Range safety organizations review, approve, monitor, and impose safety holds, when necessary, on all pre-launch and launch operations in accordance with AFSPC 91-710. The objective of the range safety program is to ensure that the general public, launch area personnel, foreign land masses, and launch area resources are provided an acceptable level of safety, and that all aspects of pre-launch and launch operations adhere to public laws. SpaceX has been compliant with all facility safety procedures. Range safety procedures are also in place. Impact debris corridors for the Falcon 9 v1.1 vehicle would be established similar to those established for the Falcon 9 Block 1 vehicle as part of the program's safety review using the results of the Falcon 9 Block 1 debris analysis. Debris data developed for the Falcon 9 Block 1 was in compliance with AFSPCMAN 91-710 also satisfies FAA requirements. Impact debris corridors would be established off the Brevard County, Florida coast to meet security requirements and reduce the hazard to persons and property during a launch-related activity. Impact debris corridors are established through the designation of debris impact areas for each specific launch.

The 45 SW has prepared detailed procedures to be used to control toxic gas hazards. Atmospheric dispersion computer models are run to predict toxic hazard corridors (THCs) for both nominal and aborted launches, as well as spills or releases of toxic materials from storage tanks or that occur during loading or unloading of tanks. Range Safety uses the THCs to reduce the risk of exposure of CCAFS and KSC personnel and the general public to toxic materials, including toxic gases.

Explosive safety quantity-distance criteria are used to establish safe distances from launch complexes and

associated support facilities to non-related facilities and roadways. DoD and USAF Explosive Safety Standards establish these regulations. The criteria utilize the trinitrotoluene, also called TNT, explosive equivalent of propellant, to determine safe distances from space launch operations or processing and holding areas. SLC-40 was originally sited to meet these criteria under the Titan IV program. Per AFSPCMAN 91-710, all facilities including launch complexes, used to store, handle, or process ordnance items or propellants shall be properly sited and approved in accordance with DoD quantity distance criteria and explosives safety standards as specified in DoD 6055.9-STD and implemented in AFMAN 91-201.

## 3.13 SOCIOECONOMICS

CCAFS is located in eastern Brevard County, Florida which has an estimated population of about 543,376 according to the 2010 census (Brevard 2013 US 2010 census). The median household income for 2011 in Brevard County was $50,068, and the unemployment rate was approximately 11.4 percent. Space Florida's report titled *Brevard Workforce-Aerospace Work Force Outlook Report Phase III,* dated January 2010, estimated that over 9,000 workers may be affected by the loss of the Shuttle Program. However as reported by the Florida Department of Economic Development at www.Floridatoday.com on April 19, 2013 is now approximately 7.4 percent. In general, the economic influence of the aerospace industry has declined somewhat with the termination of the Shuttle program. Commercial space launch companies such as SpaceX, other firms, and Space Florida's efforts have had a positive impact on the economics of Brevard County.

## 3.14 ENVIRONMENTAL JUSTICE

Environmental justice is defined by the U.S. EPA as "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." Executive Order 12898, "General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," requires all federal agencies to adopt strategies to address environmental justice concerns within the context of agency operations. Section 989.33 of AFI 32-7061, *Environmental Impact Analysis Process* requires that a project proponent comply with EO 12898 to ensure that these types of impacts are considered in EAs and other environmental documents.

The 2010 Census of Population and Housing reports numbers of minority residents are as follows: Minority populations included in the census are identified as Black or African American, American Indian and Alaskan Native, Asian, Native Hawaiian/Other Pacific Islander, Hispanic, or Other. Based upon the US Census Bureau 2011 quickFacts information, Brevard County had a population of 543,376 persons. Of this total, 8.4 percent were Hispanic, 10.5 percent were Black, and 77.3 percent were considered White but not Hispanic, and approximately 3.8 percent were other races. Orange County had a population of 1,145,956 people, of this total 27.5 percent were Hispanic, 21.7 percent were Black, 45.8 percent were considered White but not Hispanic, and 5 percent were other races (Brevard 2013).

## 3.15 SECTION 4(f) PROPERTIES

The Federal statute that governs impacts in this Resource Area is commonly known as the DDOT Act, Section 4(f) provisions. Section 4(f) of the DOT Act, which is codified and renumbered as Section 303(c) of 49 U.S.C., provides

that the Secretary of Transportation will not approve any program or project that requires the use of any publicly owned land from a public park, recreation area, or wildlife and waterfowl refuge of national, State, or local significance or land from an historic site of national, State, or local significance as determined by the officials having jurisdiction thereof, unless there is no feasible and prudent alternative to the use of such land and such program, and the project includes all possible planning to minimize harm resulting from the use. This order continues to be refer to as Section 4(f) matters or properties. No designated 4(f) properties, including public parks, recreation areas, or wildlife refuges, exist within the boundaries of CCAFS. There are however several public parks, recreation areas, in addition to the Merritt Island Wildlife Refuge and the Cape Canaveral National Seashore, which are adjacent to Kennedy Space Center and CCAFS. The nearest public park, Jetty Park, is located about 7 miles south of LC-40 in the City of Cape Canaveral. Other public parks within an appoximate15 mile radius of the launch site included: Kelly Park, Kars Park, Kings Park, and Manatee Cove Park. Additionally, the St. John's National Wildlife Refuse and Tosohatchee State Game Preserve are located west of the launch site. The Merritt Island Wildlife Refuge overlaps the northwestern portion of the KSC. The Cape Canaveral National Seashore is adjacent to the Merritt Island Wildlife Refuge.

## 4.0 ENVIRONMENTAL CONSEQUENCES

The environmental consequences analysis in this section focuses on the potential environmental impacts of the operation activities associated with, and the launch of the Falcon 9 v1.1 vehicle. The analysis incorporates the potential environmental consequences analyzed in the 2007 EA. The analysis in this SEA identifies any additional impacts or changes beyond those analyzed in the 2007 EA. Changes to the natural and human environment that could result from the Proposed Action are evaluated relative to the existing environmental conditions as described in Section 3.0. Three levels of impact may be identified:

- No Impact- No impact is predicted,
- No Significant Impact- An impact is predicted, but the impact does not meet the intensity/context significance criteria for the specified resource, and
- Significant Impact- An impact is predicted that meets the intensity/context significance criteria for the specified resource.

Under NEPA (42 U.S.C. 4321 *et seq.),* significant impacts are those that have potential to significantly affect the quality of the human environment. Human environment is a comprehensive phrase that includes the natural and physical environments and the relationship of people to those environments (40 CFR Section 1508.14). CEQ Regulations specify that in determining the significance of effects, consideration must be given to both "*context*" and "*intensity*" (40 CFR Part 1508.27):

***Context*** refers to the significance of an effect to society as a whole (human and national), to an affected region, to affected interests, or to just the locality. In other words, the context measures how far the effect would be "felt."

***Intensity*** refers to the magnitude or severity of the effect, whether it is beneficial or adverse. Intensity refers to the "punch strength" of the effect within the context involved. The intensity of an action refers to the severity of the impacts, both regionally and locally, and may be determined by:

- Unique characteristics in the area (i.e., wetlands, parklands, ecologically critical areas, cultural resources, and other similar factors);
- Overall beneficial project effect versus individual adverse effect(s);
- Public health and safety;
- Degree of controversy;
- Degree of unique or unknown risks;
- Precedent-setting effects for future actions;
- Cumulatively significant effects;
- Cultural or historic resources;
- Special-status species or habitats; and/or
- Compliance with federal, state, or local environmental laws.

The level at which an impact is considered significant varies for each environmental resource. Based on the criteria discussed above, a resource-specific definition of what constitutes a significant impact was prepared for each of the 15 resource areas analyzed in this chapter. This provides the SEA reviewer with a basis for determining if a specific program activity would result in a significant impact to a specific resource area.

## 4.1 LAND USE ZONING / VISUAL RESOURCES

An impact may be considered significant if the project results in nonconformance with approved land use plans, conversion of prime agricultural land to other uses, a decrease in the land's productivity, or a conflict with existing uses or values of the project area or other properties.

**Proposed Action**

The Proposed Action would occur primarily at LC-40, which is designated for space launch activities. Operations for launching the Falcon 9 v1.1 vehicle would be consistent with both the Base General Plan and the Air Force mission at CCAFS and current LC-40 operations. The Proposed Action would not convert prime agricultural land to other uses; result in a decrease in the land's productivity; or conflict with existing uses or values of the project area or other base properties. Therefore, the Proposed Action would generate no significant impacts on on-base land use. Activities at LC-40 would be in conformance with its designated use (for space launch activities). ,The Falcon 9 v1.1 launch erector and umbilical tower, at approximately 170 feet, would be present only during testing or a launch, and would have a smaller height and profile, with less visual presence/impact than that of prior LC-40 activities for the Titan IV vehicle. While the SpaceX facilities and Falcon 9 v1.1 would not be visible by the public except possibly from the ocean, Falcon 9 v1.1 lunches and associated exhaust contrail would be visible in the sky. However the contrail visual impact would be similar to all other vehicle launches and would dissipate quickly as wind and air currents affect the trail. Therefore, the Proposed Action would not generate significant impacts on visual resources within the flight range of the Falcon 9 v1.1 vehicle.

Issuance of a federal license or permit for an activity in or affecting a coastal zone must be consistent with the Coastal Zone Management Act, which is managed by the Florida Department of Community Affairs. The Coastal Zone Management Act (CZMA) of 1972 requires Federal agency activities with reasonably foreseeable effects on coastal zones to be consistent with state programs that are approved under Federal coastal management programs. The state agency that implements or coordinates a state's federally approved coastal management program is responsible for Federal consistency reviews. Operation and launch activities for the Falcon 9 v1.1 vehicle at LC-40 would take place in the State-designated coastal zone similar to other vehicle launches; there are also no construction activities. Therefore, no impacts to natural shoreline processes and coastal resources would be expected. The Florida Department of Environmental Protection (FDEP) Clearinghouse staff reviewed the document and determined that the Proposed Action is consistent with the Florida Coastal Management Program (FCMP). FDEP concurrence would be based on compliance with FCMP authorities, which includes Federal and State monitoring of the activity to ensure its continued conformance, and adequate resolution of any issues that arise during subsequent regulatory reviews. The FDEP's final concurrence letter of the project's consistency with the FCMP is included in Appendix A.

Potential noise impacts on humans in the coastal zone are discussed in Section 4.2, Noise, and potential noise impacts on wildlife in the coastal zone are discussed in Section 4.3, Biological Resources.

**No-Action Alternative**

Under the No-Action Alternative, the Falcon 9 v1.1 vehicle would not be implemented or launched; therefore no impacts to land use or the Coastal Zone would occur.

## 4.2 NOISE

Noise impact criteria are based on land use compatibility guidelines and on factors related to the duration and magnitude of noise level changes. Annoyance effects are the primary consideration for most noise impact assessments on humans. Noise impacts on wildlife are discussed in Section 4.3, Biological Resources. Since the reaction to noise level changes involves both physiological and psychological factors, the magnitude of a noise level change can be as important as the resulting overall noise level. A readily noticeable increase in noise levels would often be considered a significant effect by the local residents, even if the overall noise level was still within land use compatibility guidelines. On the other hand, noise level increases that are unnoticed by most people are not considered a significant change, even if the overall noise level is somewhat above land use compatibility guidelines. Finally, certain noise levels (e.g., from sonic booms) have the potential to break glass or damage structures. A high risk or high potential to break glass or damage structures caused by high noise levels generated from the proposed project would be considered a significant impact. Also, in accordance with FAA Order 1050.1E, a significant noise impact would occur if the Proposed Action would cause noise sensitive areas to experience an increase in noise of DNL 1.5 dBA or more at or above DNL 65 dBA noise exposure when compared to the No Action Alternative during the same time frame.

**Proposed Action**

Under the Proposed Action, operational noise would be intermittent. Noise generated during program operations is discussed in terms of launch noise and sonic boom impacts. Regulations state that exposure to impulsive or impact noise should not exceed a 140 dB peak sound pressure level. Table 4-1 below provides overall sound pressure levels (OASPL) versus distance for the Falcon 9 Block 1 and Falcon Heavy vehicles. Levels do not include attenuation due to atmospheric absorption, nor noise suppression from the water deluge system. Recent ground acoustic levels modeling completed for the Falcon 9 Block 1 and Falcon Heavy indicate that sound pressure levels fall below 100 dBA at 5.3 miles from the launch site for the Falcon 9 Block 1. (SpaceX 2010). Table 4-1, Modeled Engine Noise for the Falcon vehicles below, presents unweighted and A-weighted noise levels for those Falcon vehicles. Recent measured noise levels of the Falcon 9 (Block 1) discussed in Section 3, during a launch in 2012 showed that the OASPL noise level decreased to 126 dB at a distance of 2,500 ft from the vehicle.

Noise levels at the launch site are directly correlated to the thrust of the space launch vehicle at lift-off. Thrust levels for the Falcon 9 and the Falcon Heavy are approximately 1.0 and 2.5 million pounds force (Mlbf) respectively, while the Falcon 9 v1.1 thrust of 1.3 Mlbf is thirty percent more than the Falcon 9 Block 1 and approximately one half of the Falcon Heavy vehicle's thrust. The Titan IV thrust level was more than 2.5 Mlbf. Acoustic overpressures from the Titan IV launch at a distance between 100 and 200 ft from the launch vehicle were predicted to be equivalent to approximately 172 to 160 dB respectively (USAF 1988). Modeled noise levels at 125 ft for the Falcon 9 Block1 and

Falcon 9 Heavy vehicles are predicted to be less than this, at 156.1 and 160.9 dB, respectively (SpaceX 2010); the Falcon 9 v1.1 noise level would be approximately 158 dB.

Table **Error! No text of specified style in document.**-1: Modeled engine noise levels for the Falcon 9 Block 1 and Falcon 9 Heavy launch vehicles**.**

| Distance (ft) | Falcon 9 Block 1 | | Falcon 9 Heavy | |
|---|---|---|---|---|
| | Unweighted OASPL (dB)[1] ± 4.9 dB | A-weighted OASPL (dB)[1] ± 4.9 dB | Unweighted OASPL (dB)[1] ± 4.9 dB | A-weighted OASPL (dB)[1] ± 4.9 dB |
| 125 | 156.1 | 149.0 | 160.9 | 149.6 |
| 500 | 146.7 | 135.6 | 151.5 | 141.9 |
| 1,000 (0.2 mile) | 139.2 | 129.3 | 144.0 | 134.5 |
| 1.500 | 134.9 | 125.6 | 139.7 | 130.2 |
| 2,000 | 132.0 | 123.1 | 136.8 | 127.3 |
| 2,500 (0.5 mile) | 129.8 | 121.1 | 134.5 | 125.0 |
| 3,000 | 128.0 | 119.5 | 132.7 | 123.2 |
| 3,500 | 126.5 | 118.1 | 131.2 | 121.7 |
| 4,000 | 125.2 | 116.9 | 130.0 | 120.4 |
| 4,500 | 124.1 | 115.9 | 128.8 | 119.3 |
| 5,000 | 123.1 | 115.0 | 127.9 | 118.3 |
| 5,500 (1.0 mile) | 122.2 | 114.2 | 127.0 | 117.4 |
| 6,000 | 121.4 | 113.4 | 126.2 | 116.6 |
| 6,500 | 120.6 | 112.7 | 125.4 | 115.9 |
| 7,000 | 120.0 | 112.0 | 124.7 | 115.2 |
| 7,500 | 119.3 | 111.4 | 124.1 | 114.6 |
| 8,000 (1.5 miles) | 118.7 | 110.9 | 123.5 | 114.0 |
| 8,500 | 118.2 | 110.4 | 123.0 | 113.4 |
| 9,000 | 117.7 | 109.9 | 122.4 | 112.9 |
| 9,500 | 117.2 | 109.4 | 121.9 | 112.4 |
| 10,000 (1.9 miles) | 116.7 | 108.9 | 121.5 | 111.9 |

Notes:
1. OASPL in dB (ref 20 micropascals). Thrust assumed to be 846,971 lbs for Falcon 9 Block 1 and 2,540,913 for the Falcon 9 Heavy.

The A-weighted OASPL noise level for the Falcon 9 Block 1 and the Falcon Heavy at 9,500 ft is predicted to be 109.4 and 112.4 dBA, respectively (SpaceX 2010). Noise from a Falcon 9 v1.1, launch would be anticipated to be slightly more than Falcon 9 Block 1, but less than that from the Heavy or the Titan IV launch based on the noise modeling and thrust factors. At 1.8 miles (approximately 9,500 ft) from the pad, noise from a Titan IV launch was predicted to be 119 dBA (USAF 1988).

APPENDIX B contains a noise study entitled *Far-Field Launch Noise During Falcon 9 v1.1 and Falcon Heavy Liftoff From Texas Launch Site.* The study was accomplished by Blueridge Research and Consulting, LLC and dated October 2012. That study addressed both engine noise and sonic booms for the Falcon 9 v1.1 and concluded that when considering the "A-weighted" OASPL noise contours presented in reference to the 115 dBA OSHA guidelines, the 115 dBA contour line would encompass the area of concern and any location outside of the contour should experience levels less than 115 dBA. The results of the study concludes that levels may exceed the 115 dBA guideline up to a distance of approximately 1.2 miles from the pad for the Falcon 9 v1.1, but would be less than 100 dBA at the 7 mile point.

The study also assessed the structural impact resulting from the launch noise; the unweighted levels of 111 dB and 119 dB are highlighted as a general guideline for assessing potential risk to structural damage claims based on an outside study. The study concluded that one damage claim in 1,000 households exposed is expected at an average level of 111 dB, and one in 100 households at an average level of 119 dB. The area on land exposed to levels of 119 dB or greater is included within 3.4 miles for the Falcon 9 v1.1 and exposed to levels of 111 dB up to 9.1 miles. There are no homes within a 7 mile radius, and these levels are less than launch events from the Titan IV. Based on the existing baseline noise levels at CCAFS from current launches and the modeled launch noise for the Falcon 9 v1.1, it is anticipated that noise levels under the Proposed Action would not exceed the FAA's noise significance threshold; that is, the Proposed Action would not result in an increase in noise of DNL 1.5 dBA or more at or above DNL 65 dBA noise exposure for the closest noise sensitive areas, which are the residential areas of Cape Canaveral.

In addition to modeling the launch noise, the ground overpressure due to sonic booms was modeled to give a complete view of the noise impact generated by a launch event. Results of the sonic boom analysis in the referenced study show that the surface intercept of the sonic boom would be observed more than 40-miles off the coast. Since sonic boom pressure waves and resultant impact noise levels occur down track and since all launch trajectories are over the ocean, sonic noise would occur away from the eastern coastline of Florida, and would not occur on or near land. Therefore, impacts on humans due to launch pad engine noise, flight noise or sonic boom noise would be less than significant under the Proposed Action.

**No-Action Alternative**

Under the No-Action Alternative, the Falcon 9 v1.1 vehicle would not be implemented or launched; therefore; no impacts from noise would occur.

## 4.3 BIOLOGICAL RESOURCES

An impact to biological resources may be considered significant if the Federal action would impact a threatened or endangered species, substantially diminish habitat for a plant or animal species, substantially diminish a regionally or locally important plant or animal species, interfere substantially with wildlife movement or reproductive behavior, and/or result in a substantial infusion of exotic plant or animal species. Any action that may affect Federally-listed species or their critical habitats requires consultation with the USFWS under Section 7 of the ESA of 1973 (as amended). Also, the Marine Mammal Protection Act of 1972 prohibits the taking of marine mammals, including harassing them, and may require consultation with the NMFS. The NMFS is also responsible for evaluating potential impacts to Essential Fish Habitat (EFH) and enforcing the provisions of the 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (50 CFR 600.905 et seq.).

**Proposed Action**

The Proposed Action would not be expected to significantly impact biological resources around LC-40. The biological resources data and analyses in the 2007 EA remains substantially valid. The Proposed Action would not be expected to have a significant impact on terrestrial vegetation and wildlife, marine species, or protected species. Launch activities for the Falcon 9 v1.1 vehicle could have some small impacts near the launch pad associated primarily with

fire and heat. NASA has mapped the effects on local vegetation of 14 Delta, 20 Atlas, and 8 Titan launches from CCAFS (SCHMALZER, 1998). Vegetation scorching has been limited to small areas (less than a hectare (2.5 acres)) within 150 m (492 ft) of the launch pad for Atlas and Titan launches. Acid and particulate deposition for Delta launches has extended less than 1 km (0.6 mi) from the launch pad and affected relatively small areas (up to 46 hectares (114 acres)). Continuous acid deposition has not exceeded 1 km (0.6 mi) from the launch pad for Titan launches. However, isolated acid deposition has occurred up to 9.3 km (5.8 mi) from the launch pad under certain meteorological conditions. Particulate deposition from Titan launches has occurred over larger areas (2,366 hectares or 5847 acres) and up to 14.6 km (9.1 mi) from the launch pad. No discernable vegetation or other environmental damage appears to be caused by this particulate deposition (USAF 1998). The Falcon 9 v1.1 vehicle utilizes liquid fuels (LOX and RP1) and there is comparatively less or very little expected acid or particulate deposition. Therefore, the Falcon 9v1.1 would affect a much smaller area to a much lesser extent. No animal mortality has been observed at CCAFS that could be attributed to Delta, Atlas, or Titan launches (SCHMALZER, 1998). Similar results would be expected for the Falcon 9 v1.1 vehicle launches.

**Falcon Spacecraft Affect on Marine Life**

During a nominal launch, the Falcon 9 v1.1 vehicle and spacecraft would be carried over the Cape Canaveral coastal waters and on into orbit without impacts of any kind on the marine life or habitat. Only in the event of an early launch abort or failure where the spacecraft and launch vehicle debris would fall into this area would there be a potential impact. Launch vehicle debris from a liquid propellant vehicle is considered a negligible hazard because virtually all hazardous materials are consumed in the destruct action or dispersed in the air, and only structural debris remains could strike the water. Even in a destruct action, the Dragon spacecraft or launch vehicle may survive to impact the water essentially intact, presenting some potential for habitat impact. This potential arises from the fact that some Falcon Program spacecraft may carry hypergolic propellants, which are toxic to marine organisms. However, since the Dragon capsule is the same as that discussed in the 2007 EA; conclusions indicating impact to marine life would be minor would apply to this action. Debris from launch failures has a small potential to adversely affect managed fish species and their habitats in the vicinity of the project area. However, after consultation with the NMFS for other launches, the USAF found "no greater than minimal adverse effects" to essential fish habitat under NMFS regulations (USAF, 2000b).

**Falcon Launch Affect on Species**

Florida scrub jays, gopher tortoises and southeastern beach mice and sea turtle nesting occur in the vicinity of LC 40. A small potential exists that individuals of these species would be directly impacted by launch operations. Previous environmental analyses in the 2007 EA concluded that impacts to these species are expected to be minimal. The behavior of scrub jays observed after Delta, Atlas, and Titan launches has been normal, indicating no noise-related effects (SCHMALZER, 1998). Since noise and energy levels for the Falcon 9v1.1 are less than the Titan IV, behaviors of those animals are also expected to be normal following launches. Sonic booms created by launches from CCAFS launch complexes occur over the open Atlantic Ocean. The effect of sonic booms on open ocean species by EELV type vehicles such as the Delta IV and Atlas V is not expected to have an impact beyond a startle-type response (USAF 2000a). As mentioned, the Falcon 9 v1.1 noise and energy levels are less than some EELV vehicles such as the Atlas. Sonic booms are infrequent, and marine species in the ocean's surface waters are present in low densities (although seasonal

migration, generally in the winter, would include periodic groups of migrating whales that follow the coastline). The sonic boom footprint lies beyond 30 miles from CCAFS. Based upon this information, and previous informal consultation with the NMFS, the USAF has determined that the Proposed Action would have no effect on species protected by the ESA.

**Facility Lighting**

Sea turtles can be negatively affected by artificial facility lighting, especially during beach nesting and turtle hatching time periods since they may move towards the light source instead of back to the ocean. Artificial lights tend to disorientate sea turtles. While the Proposed Action would not modify current facility lighting, SpaceX also maintains a light management plan that has been approved by CCAFS and would continue its implementation to ensure sea turtles are not affected.

**No-Action Alternative**

Under the No-Action Alternative, the Falcon 9 v1.1 vehicle would not be implemented or launched; therefore no impacts on biological resources would occur.

## 4.4 CULTURAL RESOURCES

Impacts on cultural resources would be considered significant if they resulted in the disturbance or loss of value or data that qualify a site for listing in the National Register of Historic Places (NRHP); if there was substantial disturbance or loss of data from newly discovered properties or features prior to their recordation, evaluation, and possible treatment; or if the project substantially changed the natural environment or access to it such that the practice of traditional cultural or religious activities was restricted.

**Proposed Action**

LC-40 is not considered a historic complex and there are no historic properties or known archeological sites located in the immediate vicinity. Therefore no impact to historic or archeological resources would occur as a result of Falcon 9 v1.1 operations at LC-40.

**No-Action Alternative**

Under the No-Action Alternative, the Falcon 9 v1.1 vehicle would not be implemented or launched; therefore no impacts to cultural resources would occur.

## 4.5 AIR QUALITY

This section describes the potential effects to air quality resulting from either implementation of the Proposed Action, or the No-Action Alternative. The Proposed Action would have a significant impact on regional air quality if the worst-case scenario emission estimate exceeded current federal and state air quality standards within Brevard County. This exceedance would occur if calculated long and short-term impacts from the direct and indirect emission sources were significant when compared with the federal and state standards for CCAFS and

Brevard County, and both lower and upper atmospheres.

**Proposed Action**

The following analysis compares the Falcon launch vehicles to previously analyzed vehicles and spacecraft as part of NASA's routine payload final EA (June 2002 and updated in 2011). In that document all candidate launch vehicles considered for launch of routine payload spacecraft at CCAFS were reviewed through the environmental impact analysis process and determined to have no substantial impact on ambient air quality. In addition, range safety regulations at CCAFS prohibit launches when air dispersion models predict a toxic hazard to the public. Consequently, the public in and around the launch sites is unlikely to be exposed to concentrations of any launch vehicle emissions that exceed the allowable public exposure limits adopted by the range safety organizations.

**Air Quality Impacts from Launch Vehicles**

The analysis used for the Falcon 9 v1.1 is essentially the same as for that of the Falcon 9 Block 1, therefore this section is a summary and the full analysis can be found in the original EA (USAF 2007). This section will however mention changes. Air dispersion models are used at CCAFS to predict toxic hazard corridors for nominal launches, catastrophic launch failures, and spills of liquid propellants. Among the models used are the Rocket Exhaust Effluent Dispersion Model (REEDM), the Launch Area Toxic Risk Assessment Model (LATRA), and the Ocean Breeze/Dry Gulch (OB/DG) model. As documented in previous EAs and EISs performed for the launch vehicles at CCAFS, these emissions would not substantially impact ambient air quality or endanger public health. The potential for an accidental release of liquid propellants would be minimized by adherence to applicable USAF and NASA safety procedures. (EELV FEIS 1998). Spills would be managed in according to a spill response plan already in place at CCAFS

**Nominal Launches**

Comparison launch vehicles for the Falcon 1 and Falcon 9 launch vehicles include the Athena, the Atlas family, the Delta family, Pegasus, Taurus, and Titan II. The liquid engines and solid rocket motors (SRMs) on these vehicles produce air emissions during liftoff and flight. The primary emission products from the Falcon liquid engines which use RP-1 (kerosene) and liquid oxygen (LOX) are carbon dioxide, carbon monoxide, water vapor, oxides of nitrogen, and carbon particulates. Most carbon monoxide emitted by liquid engines is oxidized to carbon dioxide during afterburning in the exhaust plume. Table 4.5-1 shows actual emissions from the Falcon vehicles during tests conducted by SpaceX (SPACEX 2007b).

**T a b l e 4 - 2 Merlin Engine Exhaust Species**

| M1C Mass Fractions | | | Exhaust Mass | | Entrained Air Mass | | Air/Exhaust Mixed Plume Emission | | |
|---|---|---|---|---|---|---|---|---|---|
| | Chamber | Exit | Flow | | Flow | | Mass Flow (40 V/Vo) | | Mass % |
| CO | 44.55% | 37.84% | 1226.1 | lbm/sec | 0 | lbm/sec | 9.717 | lbm/sec | 0.0027% |
| CO2 | 24.05% | 34.59% | 1120.6 | lbm/sec | 0 | lbm/sec | 3032.1 | lbm/sec | 0.84% |
| H | 0.14% | 0.00% | 0 | lbm/sec | 0 | lbm/sec | 0 | lbm/sec | 0.00% |
| HCO | 0.00% | 0.00% | 0 | lbm/sec | 0 | lbm/sec | 0 | lbm/sec | 0.00% |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HO2 | 0.01% | 0.00% | 0 | lbm/sec | 0 | lbm/sec | 0 | lbm/sec | 0.00% |
| H2 | 1.01% | 1.24% | 40 | lbm/sec | 0 | lbm/sec | 0 | lbm/sec | 0.00% |
| H2O | 25.40% | 26.33% | 853 | lbm/sec | 0 | lbm/sec | 1213.4 | lbm/sec | 0.34% |
| H2O2 | 0.00% | 0.00% | 0 | lbm/sec | 0 | lbm/sec | 0 | lbm/sec | 0.00% |
| O | 0.48% | 0.00% | 0 | lbm/sec | 0 | lbm/sec | 0 | lbm/sec | 0.00% |
| OH | 3.29% | 0.00% | 0.2 | lbm/sec | 0 | lbm/sec | 0 | lbm/sec | 0.00% |
| O2 | 1.07% | 0.00% | 0 | lbm/sec | 74747.8 | lbm/sec | 73732.4 | lbm/sec | 20.49% |
| N2 | 0.00% | 0.00% | 0 | lbm/sec | 278582.8 | lbm/sec | 278582.8 | lbm/sec | 77.41% |
| Ar | 0.00% | 0.00% | 0 | lbm/sec | 3318.2 | lbm/sec | 3318.2 | lbm/sec | 0.92% |
| **Total** | **100.00%** | **100.00%** | **3240** | **Lbm/sec** | **356649** | **lbm/sec** | **359889** | **lbm/sec** | **100.00%** |
| | | | | **Total air + exhaust:** | **359889** | **lbm/sec** | | | |

**Notes:** **F9 Flow Rate (9 x M1C) = 3240 lb/sec**

**Entrained Air (at 40 V/Vo) = 356792 lb/sec**

Table 4-3 below lists the quantity of criteria pollutants and HCl that would be emitted into the lowest 915 m (3,000 ft) of atmosphere during each launch of five comparison launch vehicles. The criteria pollutants include volatile organic compounds (VOC), nitrogen oxides (NOX), carbon monoxide (CO), sulfur dioxide (SO2), and particulate matter less than 10 microns in diameter (PM10).

Emission of aluminum oxide from the SRMs is included in the PM10 column. These five vehicles represent the largest emission sources from various combinations of liquid engines and SRMs on comparison vehicles. Specifically, they represent: a) LH2/LOX engines (Delta IV-H), b) RP1/LOX engines (Atlas V Heavy), c) A-50/NTO engines (Titan II), d) LH2/LOX engines with SRMs (Delta IV M+ (5,4), and e) RP1/LOX engines with SRMs (Atlas V 551/552).

**Table 4-3: Air Emissions (tons) Per Launch of comparison Vehicles into Lowest 3,000 Feet of Atmosphere**

| Vehicle | VOC | Nox | CO | SO2 | PM10 | HCl |
|---|---|---|---|---|---|---|
| **Delta IV Heavy** | 0 | 1.6 | 0 | 0 | 0 | 0 |
| **Atlas V Heavy** | 0 | 1.2 | 0 | 0 | 0 | 0 |
| **Titan II** | 0 | 0.04 | 0.06 | 0 | 0 | 0 |
| **Delta IV Medium+** | 0 | 0.71 | 0.0054 | 0 | 10 | 5.1 |
| **Atlas V 551/552** | 0 | 1.1 | 0.01 | 0 | 15 | 7.8 |

Sources: USAF, 2000a & USAF, 1987

In addition to scheduled launches, on rare occasions, a launch could fail. Such a failure would result in deflagration, in which the fuel from all stages is explosively burned. Deflagrations result in a very hot, extremely buoyant ground cloud that rises fast in particular atmospheric conditions and that is typically dispersed over a wide area in the first 10,000 feet. (NASA Routine Payload Final EA 2002 and as updated 2011).

Appendix I of the original EA documents the mean hazard distance predictions for release of the routine payload's maximum liquid propellant loads, which consist of 1000 kg (2200 lb) of hydrazine, 1000 kg (2200 lb) of MMH, and 1200 kg (2640 lb) of NTO. The U. S. Air Force Toxic Chemical Dispersion Model (AFTOX) Version 4.0 (Kunkel, 1991) was used to predict the mean hazard distances resulting from the spillage of each of the three liquid propellants. AFTOX is a simple Gaussian puff/plume dispersion model that assumes a uniform windfield. AFTOX was used to predict mean distances to selected downwind concentrations of each toxic vapor. The selected concentrations used for this analysis were the Short-Term Emergency Guidance Levels (SPEGLs) for hydrazine (0.12 ppm 1-hour average), MMH (0.26 ppm 1-hour average), and nitrogen dioxide (1.0 ppm 1- hour average). AFTOX runs were conducted for daytime and nighttime conditions at two different wind speeds (2 and 10 m/s (7 and 32 feet per second)). These meteorological conditions were selected to illustrate possible hazard distances. Other meteorological conditions would produce different hazard distances but would not change the conclusion that the concentrations fall below hazardous levels within a relatively short distance of the release. Appendix I provides some AFTOX output relevant to this SEA. Other acceptable modeling such as REEDM, LATRA, or OB/DG would be used by CCAFS with SpaceX input to verify parameters stated by AFTOX results.

Spillage of the entire payload propellant load, while unlikely, could occur during payload processing, payload transportation, payload mating to the launch vehicle, or during the actual launch operation. A launch accident could result in payload ground impact resulting in propellant tank rupture and spillage. The cases modeled by AFTOX are worst case since they assume that the spills are unconfined and evaporate to completion without dilution or other mitigating action.

**Launch Vehicle Emissions**

The Clean Air Act does not list rocket engine combustion emissions as ozone depleting substances (ODSs), and therefore rocket engine combustion emissions are not subject to limitations on production or use. While not regulated, rocket engine combustion is known to produce gases and particles that reduce stratospheric ozone concentrations locally and globally (WMO, 1991). Launch emissions are considered mobile source emissions and are not required to obtain air permits.

The propulsion systems utilized by the Falcon 9 vehicles emit a variety of gases and particles directly into the stratosphere including H2O, [NOx, HOx], and soot (carbon). A large fraction of these emissions are chemically inert and do not affect ozone levels directly. Other emissions, such as H2O, are not highly reactive, but they do have an impact on ozone globally since they participate in chemical reactions that help determine the concentrations of ozone destroying gases known as radicals. A small fraction of rocket engine emissions are the highly reactive radical compounds that attack and deplete ozone in the plume wake immediately following launch. Particulate emissions, such as carbon (soot), may also be reactive in the sense that the surfaces of individual particles enable important reactions that would not proceed otherwise.

Potential air emissions from the proposed launches would include activities related to liquid fuel loading (LOX and RP-1) and projected numbers of maximum launches. Air Permits are not required for emissions from the actual

launches, as these are mobile sources and are temporary in nature, and therefore not considered to be "significant" or major emissions, neither for criteria nor HAPs pollutants.

All of the types of emissions described for this proposed program are exempt from air permitting requirements at CCAFS pursuant to FAC Rule 62-210.300(3)(a), Categorical Exemptions, although these type emissions are required to be estimated and would be included in the next Title V Air Emissions Inventory Update for the CCAFS facility-wide emissions estimations. These types of categorically excluded emissions units or activities are considered to produce "insignificant" emissions pursuant to FAC Rule 62-213.430(6). The liquid fuel loading operations on CCAFS are included as categorically excluded from air permitting and are considered to be insignificant sources of air pollution by the FDEP.

Emissions from the SpaceX Merlin engines have been previously characterized as comprising CO2, CO, water vapor, nitrogen oxide (NOx), and carbon particulates in the original EA 2007. (USAF 2007). The Falcon 9 v1.1 vehicle is driven by the Merlin 1-D engine. Most CO emitted by the liquid fuel engines is oxidized to CO2 during afterburning in the exhaust plume. Thus, CO2, a GHG, is the primary emission from the actual launch vehicle. Other pollutants could be emitted during launch operations, including CO that is not oxidized to CO2. Only a small proportion of the emissions associated with each launch would have the potential to affect ambient air quality, which is defined as the area below the mixing height, and which is typically defined as 3,000 ft AGL. The launch of the Falcon 9 v1.1 would be expected to reach the mixing height within a few seconds. The amount of CO released per launch of a Falcon vehicle has been identified in the 2007 EA . To estimate the amount of CO that would be released below the mixing height, an estimate of 20 percent of total emissions was used. Further, it was assumed that none of the CO was oxidized to CO2. Based on this assumption, ten launches of the Falcon 9 v1.1 vehicle would produce zero tons of VOCs, $NO_2$, $SO_2$, $PM_{10}$ and $PM_{2.5}$ products. It would produce 1,714.3 tons per year of CO. This amount is not enough to result in an exceedance of the NAAQS for CO and represents less than .02 percent of Brevard Counties CO emissions for 2008 (USEPA Air Emission sources) . Small quantities of the other pollutants, such as NOx, would primarily occur above 3,000 ft and would disperse quickly after launch and therefore were not quantified for the analysis and are essentially zero. Brevard County and CCAFS is in attainment, and therefore the General Conformity Rule does not apply. In conclusion, the operational impacts from the Proposed Action on air quality would not be significant.

Since the original EA was written in 2007, GHG are required to be addressed. Annual GHG emissions associated with the Proposed Action operations are compared to U.S. 2010 GHG emissions (EPA 2012d) and the 2011 global CO2 emissions in Table 4-4 below. The estimated CO2 emissions from probable annual operations of the Falcon 9 v1.1 at CCAFS are less than a millionth of 1 percent of the total GHG emissions generated by the U.S. in 2010 and less than a millionth of 1 percent of the total CO2 emissions generated worldwide (European Commission–Joint Research Centre 2012). Emissions of GHGs from the Proposed Action alone would not cause any appreciable global warming that may lead to climate changes. However, these emissions would increase the atmosphere's concentration of GHGs. At present, no methodology exists that would enable estimating the specific impacts (if any) that this increment of warming would produce locally or globally. Locally, while launching the Falcon 9 v1.1 vehicle would increase yearly levels of GHG at CCAFS, the combined totals would still be less than forty percent of the mandatory reporting limit of 25,000 MtCO2e.

| Table 4-4 Estimated Carbon Dioxide (CO2) Emissions from Falcon v1.1 Operations | |
|---|---|
| **Annual Emissions Source** | **Metric Tons CO2e per Year** |
| Global Total CO2 Emissions | 3,400 x $10^7$ |
| U.S. 2010 Total GHG Emissions | 6,821.8x $10^6$ |
| 2011 CCAF GHG Emissions (Total ) | 5,209 |
| 10 Falcon 9 v1.1 launches | 3,871 |
| Falcon 9 v1.1 GHG Percent of Global GHG<br>Percent of US GHG<br>Percent of CCAFS GHG | .000000113<br>.000000567<br>74% |

The Falcon Launch Vehicle Program is designed for minimal vehicle assembly or processing on the launch pad, with most of the vehicle assembly taking place at proposed SpaceX facilities at CCAFS. Since the atmospheric emissions associated with launch programs is expected to be brief and sporadic, the long-term cumulative air quality impacts in the lower atmosphere would not be expected to be significant. Short-term cumulative air quality impacts would not occur because launches for the various programs would not be conducted at the same time. The relatively small emissions associated with ground support operations would have little incremental and cumulative impact in an area that presently meets air quality standards. The proposed action at LC-40 would not be expected to have a significant impact on air quality or climate change.

**No-Action Alternative**

Under the No-Action Alternative, the Falcon 9 v1.1 vehicle would not be launched; therefore, no impacts to air quality or climate change would occur.

## 4.6 ORBITAL DEBRIS

### 4.6.1 Falcon Orbital and Reentry Debris

This section describes the potential effects of orbital debris from either implementation of the Proposed Action, or the No-Action Alternative. Orbital debris, as a result of U.S. and foreign space activities, may reenter the Earth's atmosphere. NASA's policy is to employ design and operations practices that limit the generation of orbital debris, consistent with mission requirements and cost-effectiveness. NASA Safety Standard (NSS) 1740.14 "Guidelines and Assessment Procedures for Limiting Orbital Debris" requires that each program or project conduct a formal assessment for the potential to generate orbital debris. General methods to accomplish this policy include:

- Depleting on-board energy sources after completion of mission,
- Limiting orbit lifetime after mission completion to 25 years or maneuvering to a disposal orbit,
- Limiting the generation of debris associated with normal space operations,

- Limiting the consequences of impact with existing orbital debris or meteoroids,
- Limiting the risk from space system components surviving reentry as a result of post-mission disposal, and
- Limiting the size of debris that survives reentry.

**Proposed Action**

The Falcon 9 v1.1 would continue with "routine payloads", including the Dragon capsule and would comply with all requirements of NPD 8710.3, "Policy for Limiting Orbital Debris Generation" and NSS 1740.14. The Falcon v1.1 launch operations, flight profile and trajectory would be the same as the Falcon 9 Block 1 and discussion of orbital debris would be as discussed in the 2007 EA. Based on the preceding discussion, the launch of Falcon 9 v1.1 vehicle and space craft, and their potential addition to, or affects from orbital debris is not expected to have a significant impact on the environment.

**No-Action Alternative**

Under the No-Action Alternative, the Falcon 9 v1.1 vehicle would not be implemented or launched; therefore, no impacts to orbital debris would occur.

## 4.7 HAZARDOUS MATERIALS/HAZARDOUS WASTE

A project may result in a significant impact to hazardous materials/hazardous waste if it increases the potential for exposure to hazardous materials/waste or increases the likelihood of a hazardous materials release to the environment. Impacts on hazardous materials and waste management would also be considered significant if they resulted in noncompliance with applicable regulatory guidelines or increased the amounts generated beyond available waste management capacities.

**Proposed Action**

The Proposed Action would not be expected to significantly impact hazardous materials, solid waste, and pollution prevention around LC-40. The hazardous materials, solid waste, and pollution prevention data and analyses in the 2007 EA remain substantially valid. All hazardous materials would continue to be handled and disposed of per the requirements established by OSHA (Hazardous Materials) and per the Hazardous Materials Contingency Plan developed for the Falcon Launch Vehicle Program. SpaceX has implement proper handling procedures for payloads containing hypergolic fuels. Since all applicable federal, state, county, and USAF rules and regulations would continue to be followed for the proper storage, handling, and usage of hazardous materials under the Falcon Launch Vehicle Program, less than significant impacts on hazardous materials management should occur under the Proposed Action. Changes in quantities of fuel would be addressed by revising required procedures appropriately.

The approximate quantities of materials that would be used during processing of a routine payload spacecraft would remain the same as for the Falcon 9 Block 1. Facilities at LC- 40 have been permitted to process hypergolic propellants and would continue operating under those permit requirements for any hypergolic

propellants and waste products.

**Spacecraft (Dragon Capsule) Processing Hazardous Waste Production**

The hazardous materials used to process routine payload spacecraft could potentially generate hazardous waste. SpaceX would use the same material for the Falcon 9 v1.1 and payloads and would continue operating in accordance with existing requirements. No Class I ODSs would be used in the payload processing facilities.

**No-Action Alternative**

Under the No-Action Alternative, the Falcon 9 v1.1 vehicle would not be implemented or launched; therefore, no impacts on hazardous materials or hazardous waste management would occur.

## 4.8 WATER RESOURCES

A project may have a significant impact on water resources if it substantially affects any significant water body, such as an ocean, stream, lake, or bay; causes substantial flooding or exposes people to reasonably foreseeable hydrologic hazards such as flooding; substantially affects surface or groundwater quality or quantity; or exceeds the existing potable water or wastewater system capacities for CCAFS.

This section describes the potential effects to surface water and groundwater, including hydrology and water quality, as well as wetlands, and Floodplain affects resulting from either implementation of the Proposed Action, or the No-Action Alternative.

**Proposed Action**

The Proposed Action would not be expected to significantly impact water resources around LC-40 or CCAFS. Water resource discussions and information in the 2007 EA remain substantially valid. Wetlands do not occur within the boundary of LC-40, but do occur approximately 300 feet from the boundary. The FEMA listed100 year floodplains are more than 100 feet beyond LC-40 fence lines. Launch of the Falcon 9 v1.1 vehicle would not affect wetlands, nor would they be affected by flooding. Under the proposed action, launch deluge wastewater generated by both testing and launch operations of the Falcon 9 v1.1 would be contained in the deluge (impermeable concrete) basin, tested, and removed and hauled to an approved off-base disposal facility, similar to what has occurred during Falcon 9 Block 1 launches. SpaceX currently requests (and receives authorization) from CCAS for wastewater disposal directly to the CCAFS treatment system Therefore, no impacts on surface water quality would occur from industrial wastewater from the deluge water system.

Operation of the Proposed Action has the potential to cause inadvertent discharge of industrial wastewater (deluge water) into jurisdictional waters of the United States in the event of an overflow of the deluge water system deluge basin, due to their proximity to the retention basin. However, with the deluge basin capacity of approximately 400,000 gallons, it is highly unlikely that the maximum discharge of deluge wastewater would be

inadvertently discharged from the basin. Therefore, less than significant impacts on jurisdictional waters of the United States are expected under operation of the Proposed Action.

The intermittent drainage from SLC-40 could be affected by the exhaust cloud that would form near the launch pad at liftoff as a result of the exhaust plume and evaporation and subsequent condensation of deluge water. As the Falcon 9 v1.1vehicle use only LOX and RP-1 propellants, the exhaust cloud would consist of steam only and would not consist of any significant amounts of hazardous materials. As the volume of water condensing from the exhaust cloud is expected to be minimal and temporary, the exhaust cloud would generate less than significant impacts on surface water quality at LC-40.

Upon impact with the ocean of the first stage, approximately 5-gallons of residual RP-1 would be expelled into the ocean and would dissipate within hours. Due to the small volume of this release into the open ocean, impacts on water quality in the ocean would be less than significant.

Just as there were no expected impacts to water resources from spacecraft processing for the Falcon 9 Block 1 and its payloads, there also are no expected impacts from operation of the Falcon 9 v1.1. All materials and procedures would remain essentially the same.

The typical operation of the facility proposed for use for routine payload processing would require an average of approximately 500 liters (110 gallons) per day of water for potable use and for payload processing activities (ASTROTECH, 1993). This water would be supplied by the existing water distribution systems at CCAFS and would have a negligible impact on system capacity or surface and groundwater resources. Wastewater would continue to be processed through the existing wastewater handling and treatment systems at CCAFS, and would have a negligible impact on system capacity or surface and groundwater resources. The proposed action fits within the current scope of water discharge permit definitions. Local and regional water resources would not be affected since there would be no substantial increase in use of surface or groundwater supplies.

**No-Action Alternative**

Under the No-Action Alternative, the Falcon 9 v1.1 vehicle would not be implemented or launched; therefore, no impacts to hydrology or water quality would occur.

## 4.9 GEOLOGY AND SOILS

A project may result in a significant geologic impact if it increases the likelihood of, or results in exposure to, foundation instability, land subsidence, or other severe geologic hazards. It may also be considered a significant geologic impact if it results in the loss of the use of soil for agriculture or habitat, loss of aesthetic value from a unique landform, loss of mineral resources, or causes severe erosion or sedimentation.

**Proposed Action**

The proposed action would not be expected to impact geology and soils and the analyses in the 2007 EA remains substantially valid. No unique geologic features of exceptional interest or mineral resources occur in the

project area, and there is no construction within this Proposed Action; therefore, no impact would occur to these resources. Since there has been recorded site contamination and a removal action, any soil that may be disturbed should remain onsite or properly disposed of. Operation of the Proposed Action would not affect geology or soils at or near LC-40. Therefore, no impacts on these resources would occur under operation of the Proposed Action.

**No-Action Alternative**

Under the No-Action Alternative, the Falcon 9 v1.1 vehicle would not be implemented or launched; therefore, no impacts on geology and soils would occur.

## 4.10 TRANSPORTATION

This section discusses the projected traffic conditions along roadways which may be affected by SpaceX's Falcon 9 v1.1 vehicle program. A project would have a significant impact on transportation if it caused an exceedance of the capacity of roadways or impact structural sections of roadways.

**Proposed Action**

The Proposed Action would not be expected to significantly impact transportation and the analyses in the 2007 EA remains substantially valid. The first stage of the Falcon 9 v1.1 is approximately 50 ft longer than the Falcon 9 Block 1 with a total length of approximately 150 ft. The added length will require a special trailer rig with a back axle and wheel base that has the ability to maneuver, very similar to the operations of a fire ladder- truck. This allows the vehicle to better negotiate turns. Initial assembly of each of the first and second stages of the Falcon vehicle would occur at the SpaceX facility in Hawthorne, California. Following assembly, the stages would be transported separately to CCAFS via the US highway system. Payloads would be shipped via major arterials depending upon their origin. Shipment of these components to CCAFS would occur no more than 12 times a year; therefore, they would have a less than significant impact on traffic in the region. Hazardous materials and hazardous wastes transferred for the Falcon 9 v1.1 are in the same categories as the Falcon 9 Block 1 and as those normally encountered in public transportation; their shipment over public highways and roads would be in compliance with Department of Transportation regulations. Worker trips have approximately doubled since 2007 since SpaceX has doubled the original expected work force. During routine operations between launches, vehicle trips per launch would be expected to be the same as for Falcon 9 Block 1 and less than existed for a Titan IV launch. Therefore, operation of the Proposed Action would generate less than significant impacts on transportation.

Over all launch viewing traffic per year has declined significantly since the Shuttle program was terminated in 2011. Traffic volume increases for a Falcon 9 Block 1 launch was less than that of a Shuttle launch and traffic for the launch of a Falcon 9 v1.1 is expected to be the same as Falcon 9. Therefore impact from increased visitor or public observers would cause less than a significant impact on CCAFS and local traffic patterns.

**No-Action Alternative**

Under the No-Action Alternative, the Falcon 9 v1.1 vehicle project would not be implemented or launched; therefore, no impacts on transportation would occur.

## 4.11 UTILTIES

This section describes the potential effects to the water supply system, the solid waste management aspect, and the electrical supply system by implementing the proposed action or the No-Action Alternative. The action may have a significant impact on these resources if it substantially affects capacity of the systems to maintain existing services.

**Proposed Action**

### Water Supply

Current potable and non-potable water supply to LC 40 was designed to support a Titan IV launch vehicle program. Pumphouse number 7 (Facility #29150) supplies LC 40 and LC 41 with water for the deluge system. As such, the water supply to SLC 40 (Table 4-5 below) can easily handle the Falcon 9 v1.1 vehicle launch requirements which may reach 130,000 gallons per launch. Since only one launch vehicle would be in preparation for a launch at any given point, Falcon program reliance on the water supply would be relatively small and there would be no significant impact expected.

**Table 4-5 Pump Station #7 Capacity**

| PARAMETER | CAPACITY / AMOUNT |
|---|---|
| Water Storage Tank | 1,250,000 gallons |
| Diesel fuel tank for pumps | 10,000 gallons |
| Deluge Pumps | 6 |
| Pump capacity | 7500 Gallons per minute |
| Total pump capacity | 45,000 Gallons per minute |
| LC40 Design Usage (Titan IV launch)<br>Falcon 9 Block 1) required need<br>Falcon 9 v1.1 required need | 700K-800K per launch<br>100K per launch<br>130K per launch |
| Water Line Pressure | 210 psi |

### Solid Waste Management

Impacts on solid waste would be considered significant if they resulted in noncompliance with applicable regulatory guidelines or increased the amounts generated beyond available waste management capacities. Operation of the EELV Program was anticipated to generate approximately 0.3 ton of solid waste per day (U.S. Air Force 1998a). Operation of the Proposed Action is expected to generate less solid waste than the EELV Program. The Falcon 9 v1.1 vehicle launch operations is not expected to increase solid waste, therefore the Proposed Action, would generate less than significant impacts on solid waste.

### Electrical Power

The electrical power capabilities for operation at SLC 40 and the SMARF were designed to support the Titan IV launch program. The Falcon 9 v1.1 launch program electrical power needs are less than that of the Titan Program. Therefore there would not be a significant impact on available electrical power capabilities for the Proposed Action.

**No-Action Alternative**

Under the No-Action Alternative, the Falcon 9 v1.1 vehicle would not be operated or launched; therefore, no impacts to water supply, solid waste management, or electrical use would occur.

## 4.12 HEALTH AND SAFETY

An impact would be considered significant if it created a potential public health hazard, or involved the use, production, or disposal of materials that pose a hazard to people, animals, or plant populations in the affected area.

**Proposed Action**

As described in the 2007 EA and Section 3.12, CCAFS range safety regulations ensure that the general public, launch area personnel, and foreign land masses are provided an acceptable level of safety, and that all aspects of pre-launch and launch operations adhere to public laws. Range safety organizations review, approve, monitor, and impose safety holds, when necessary, on all pre-launch and launch operations. The operation and launch of the Falcon 9 v1.1 does not involve any change to current operations and does not introduce different or new hazardous materials or operations. Additionally, as part of the FAA license application review process, the FAA would conduct a safety review of operations.

All payload processing and launch facilities used to store, handle, or process ordnance items or propellants must have an Explosive Quantity-Distance Site Plan. All payload and launch programs that use toxic materials must have a Toxic Release Contingency Plan (TRCP) for facilities that use the materials. A Toxic Hazard Assessment (THA) must also be prepared for each facility that uses toxic propellants. The THA identifies the safety areas to be controlled during the storage, handling, and transfer of the toxic propellants.

Hazardous materials such as propellant, ordnance, chemicals, and booster/payload components are transported in accordance with DOT regulations for interstate shipment of hazardous substances (Title 49 CFR 100- 199). Hazardous materials such as liquid rocket propellant are transported in specially designed containers to reduce the potential of a mishap should an accident occur. As discussed in Section 2, the only change to propellants has been quantities of RP1 and LOX that is used. First stage fuel total load increased by approximately 60%, and second stage fuel total load increased by about 100%. However the new values are less on-pad fuel than the Titan IV vehicle had used for those launches.

Processing of routine payload spacecraft would involve the handling of toxic and hazardous propellants including hydrazine, MMH, and NTO. Hydrazine and MMH are strong irritants and may damage eyes and cause respiratory tract damage. Exposure to high vapor concentrations can cause convulsions and possibly death. Repeated exposures to lower concentrations may cause toxic damage to liver and kidneys as well as anemia. The U. S. EPA classifies hydrazine and MMH as probable human carcinogens. Both are flammable and could spontaneously ignite when exposed to an oxidizer. NTO is a corrosive oxidizing agent. Contact with the skin and eyes can result in severe burns. Inhalation of vapors can damage the respiratory system. NTO would ignite when combined with fuels and may promote ignition of other combustible

materials. Fires involving NTO burn vigorously and produce toxic fumes. While the Falcon 9 v1.1 payload fuel stays the same (or less) for the Dragon capsule, a future satellite payload may contain approximately 1,500 gallons more of hypergolic fuels. This does not change current payload processing, health or safety.

Health and safety impacts to personnel involved in the propellant loading operations in the payload processing facilities would be minimized by adherence to U. S. Occupational Safety and Health Administration (OSHA) and U. S. Air Force Occupational Safety and Health (AFOSH) regulations. These regulations require use of appropriate protective clothing and breathing protection. Toxic vapor detectors are used in the facilities to monitor for leaks and unsafe atmospheres.

Spills, fires, and explosions would be possible outcomes from accidents during payload processing. A violent fire or an explosion could produce severe injuries or even death. A catastrophic accident of this type during payload processing would be extremely unlikely. Most propellant spills would be contained within the processing facility with no health impacts to personnel. The most likely consequences of a severe accident during processing would be some level of damage to the spacecraft and the immediate liquid propellant transfer area. Facility design would limit damage to the spacecraft and the transfer area.

Injuries would not be anticipated if facility personnel follow emergency procedures. If human error (e.g., not following procedures, not wearing protective clothing, or not donning breathing equipment) occurs at the time of the accident, exposure of personnel to toxic propellant vapors may result. This would give some level of short-term adverse health impact and an incremental increase in the chance of the exposed individual developing cancer.

Extremely small quantities of toxic propellant vapors would be emitted from payload processing facilities during propellant loading operations. These small emissions would not impact the health of the public or on-site personnel. The THA for the facility would provide additional protection by identifying the safety areas to be cleared of unprotected personnel during propellant operations.

**Launch Vehicle Impacts**

The Range Safety organizations at CCAFS use models to predict launch hazards to the public and on-site personnel prior to every launch. These models calculate the risk of injury resulting from toxic gases, debris, and blast overpressure both from nominal launches and launch failures. Launches are postponed if predicted risk of injury exceeds acceptable limits. The allowable collective public risk limit in use at CCAFS is extremely low (30 x 10-6). The Proposed Action involves launch vehicles that have previously been approved for launch of spacecraft from CCAFS. This action would not increase launch rates nor utilize launch systems beyond the scope of approved programs at CCAFS. Therefore the operation and launch of the Falcon 9 v1.1 would not result in a substantial increase in potential impacts to health and safety.

**No-Action Alternative**

Under the No-Action Alternative, the Falcon 9 v1.1 vehicle would not be operated or launched; therefore, no health and safety impacts would occur.

## 4.13 SOCIOECONOMICS

Socioeconomic impacts would be considered significant if they substantially altered the location and distribution of the local population, caused the population to exceed historic growth rates, decreased jobs so as to substantially raise the regional unemployment rates or reduce income generation, substantially affected the local housing market and vacancy rates, or resulted in the need for new social services and support facilities.

**Proposed Action**

SpaceX's local normal operations employ approximately 50 fulltime employees and 50 contract employees at LC-40 and other spaces at CCAF. During Falcon 9 v1.1 launch workup periods, an additional approximately 50 people would be at CCAFS to support the launch over an average of a two week period. The addition of these workers at CCAFS does not represent a significant increase in the population or growth rate of the region which was 543,376 people recorded during the 2010 census. While the proposed action would not significantly affect the local housing market, the addition of added economic activity would result in a small but positive impact to the local economy, especially since 2011 when the Shuttle Program was terminated and potentially thousands of local workers lost their jobs. Therefore, the Proposed Action would generate no negative socioeconomic impacts on the region and would generate a small positive impact.

**No-Action Alternative**

Under the No-Action Alternative, the Falcon 9 v1.1 vehicle would not be operated or launched and there may be a small negative impact on socioeconomics.

## 4.14 ENVIRONMENTAL JUSTICE

A significant impact to environmental justice would occur if:

- There was a significant adverse impact to the natural or physical environment or to health that affected a minority or low -income population or children;
- There was a significant adverse environmental impact on minority or low-income populations or children that appreciably exceeded those on the general population or other comparison group;
- The risk or rate of environmental hazard exposure by a minority or low-income population was significant and exceeded those by the general population or other comparison group; or
- A health or environmental effect occurred in a minority or low-income population affected by cumulative or multiple adverse exposures from environmental hazards.

**Proposed Action**

The operation and launch of the Falcon 9 v1.1 would occur within the boundaries of CCAFS and over the Atlantic Ocean similar to current operations of existing launch vehicles. Since there are no minority or low income groups that are in that area, environmental impacts generated by the proposed action would be less than significant and would not affect minority or low-income populations. Therefore, operation and launch of the Falcon 9 v1.1 vehicle would not cause any environmental justice impacts.

**No-Action Alternative**

Under the No-Action Alternative, the Falcon 9 v1.1 vehicle would not be launched; therefore, no environmental justice impacts would occur.

## 4.15 SECTION 4(f) PROPERTIES

Section 4(f) impacts would be considered significant if the action occurred on or caused any required use of publicly owned land such as a public park, recreation area, or wildlife and waterfowl refuge of national, State, of local significance or land from an historic site of national, State, or land of local significance as determined by the officials having jurisdiction thereof for a significant period of time and/or caused harm to that public land.

**Proposed Action**

There are no Section 4(f) properties located within the boundaries of CCAFS. Therefore, there would be no physical use of a Section 4(f) property via permanent use of land, and there would be no temporary occupancy of a Section 4(f) property. When there is no physical use and no temporary occupancy, but there is the possibility of constructive use, the FAA must determine if the impacts would substantially impair[1] the 4(f) property. Section 4(f) properties located within approximately a 15 miles radius of LC-40 include Merritt Island National Wildlife Refuge, Cape Canaveral National Seashore, Jetty Park, Kelly Park, Kars Park, Kings Park, and Manatee Cove Park. Additionally, the St. John's National Wildlife Refuse and Tosohatchee State Game Preserve are located west of the launch site. Due to their proximity to LC-40, these properties would experience noise from proposed Falcon 9 v1.1 launches. Noise levels at these 4(f) properties would increase temporarily during launches. The increased noise level would only last a few minutes and would occur at most twelve times a year under the Proposed Action.

For decades, the 4(f) properties have been experiencing increased noise levels during launches taking place at CCAFS and adjacent KSC. Some of the launch vehicles (e.g., Space Shuttle and Titan IV) that have launched from CCAFS and KSC produced more thrust and thus louder noise than would occur under the Proposed Action. Due to the long history of these 4(f) properties experiencing noise from launches at CCAFS and KSC, and because there would only be a maximum of twelve launches per year, the FAA has determined the Proposed Action would not substantially diminish the protected activities, features, or attributes of any of the Section 4(f) properties identified, and thus would not result in substantial impairment of the properties. Therefore, the Proposed Action would not be considered a constructive use of these Section 4(f) properties and would not invoke Section 4(f) of the DOT Act.

**No-Action Alternative**

Under the No-Action Alternative, the Falcon 9 v1.1 vehicle would not be launched; therefore, no Section 4(f) property impacts would occur.

## 5.0 CUMULATIVE IMPACTS

According to 40 CFR § 1508.7, cumulative impacts are defined as "…the incremental impact of the actions 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." Cumulative impacts include impacts from the vehicles that would be launched at CCAFS, KSC, or Space Florida acquired facilities and other past, present, and reasonably foreseeable future activities that could affect the resources impacted by the Proposed Action. Due to the nature of the Proposed Action and its location on the coast within CCAFS, only launch-related actions occurring at CCAFS would meaningfully interact in time and space with the Proposed Action such that potential cumulative impacts could result.

### 5.1 REASONABLY FORESEEABLE FUTURE ACTIONS

The past, present and reasonably foreseeable actions at CCAFS, KSC are listed in Appendix C, and are assumed to still be accurate and applicable to the Cumulative Impacts analysis in this SEA. Using data as described in Appendix C, the launch rate since 2010 is shown below in Table 5-1

**TABLE 5-1 Past Vehicle Launches at KSC and CCAFS**

| Year | Launch Vehicles (number of Launches) | | | | TOTAL |
|---|---|---|---|---|---|
| | Shuttle | Delta IV | Atlas V | Falcon 9 (Block 1) | |
| 2010 | 3 | 3 | 3 | 2 | 11 |
| 2011 | 3 | 3* | 4 | 0 | 10 |
| 2012 | - | 3 | 5 | 2 | 10 |
| 2013 (thru May) | - | 1 | 2 | 1 | 4 |
| Total Launches | 6 | 10 | 14 | 5 | 35 |

NOTE: *One Delta Launch in 2011 was a Delta II 7000

Also based on data presented in Appendix C, the forecast for CCAFS and KSC launches during the next several years are shown below in Table 5-2

**TABLE 5 -2 Future planned Vehicle Launches at KSC and CCAFS**

| Year | Launch Vehicles (number of Launches) | | | | TOTAL |
|---|---|---|---|---|---|
| | Shuttle | Delta IV | Atlas V | Falcon 9 (Block 1) | |
| 2013 | - | 2 | 3 | 4 | 9 |
| 2014 | - | | | 9 | 9 |
| 2015 | - | | | 9 2* | 11 |
| 2016 | - | | | 1 | 1 |
| Total Launches | - | 2 | 3 | 25 | 30 |

NOTE: *Two Falcon Vehicle Launches in 2015 proposed to be Falcon Heavy

SpaceX also plans to conduct a Pad Abort Test of the Crew Dragon Spacecraft from LC-40. The intent of the test is to integrate a launch abort propulsion system into Dragon to support the pad abort. The test article would consist of a Dragon capsule sitting on top of a trunk structure and stand in the center of the launch pad. The pad abort test would be initiated by commanding the SuperDraco engine system startup sequence, firing all eight engines. Once operation of all engines is confirmed, the capsule would separate from the Dragon trunk by firing three redundant frangible nuts

that connect the capsule to the trunk test stand structure. Dragon would then follow a propulsive trajectory away from LC-40 toward the ocean. After the burn is completed, three main parachutes would be deployed and Dragon would descend back to earth. Once the capsule is in the water, a recovery boat would approach Dragon and collect the capsule and deployed parachutes. Onboard the recovery boat, the propulsion system would be safed. Dragon would be transferred to a truck and immediately transported to a SpaceX processing facility in Texas for decontamination and further engineering evaluation.

As reflected in Table 5-2, SpaceX also intends to launch their Falcon Heavy Rocket from CCAFS. The Falcon Heavy, the world's most powerful rocket, represents SpaceX's entry into the heavy lift launch vehicle category. The vehicle would provide SpaceX with the ability to carry satellites or interplanetary spacecraft weighing over 53 metric tons to Low Earth Orbit (LEO). Two flights of the Falcon Heavy are planned for 2015.

It should also be noted that recently, Space Florida published their desire to develop a conceptual launch complex referred to as the Shiloh site. The site is located on KSC property and on the boarders of Brevard and Volusia Counties. Since that particular site is in concept only, and a potential launch schedule has not yet been established, this analysis does not consider that a reasonably foreseeable action.

## 5.2 CUMULATIVE IMPACT ANALYSIS ON RESOURCE AREAS

The actions listed in Table 5.1 and 5.2 (excluding SpaceX Falcon 9 v1.1. launches), as well as the projects described above, considered in conjunction with the Proposed Action, formed the basis for the cumulative impacts analysis. This section therefore analyzes the incremental interaction that the Proposed Action may have with the actions described in the previous section and evaluates the potential cumulative impacts resulting from these interactions. With the exception of land use, air quality and noise, the ROI for each resource area discussed below is limited to CCAFS and KSC. The ROIs for land use, air quality and noise extend beyond CCAFS and are consistent with the ROIs presented in 2007 EA. As described in the previous chapter, no direct impacts were identified for cultural resources, water resources, orbital debris, geology and soils, transportation, health and safety, environmental justice, and 4(f) properties. When considered with other past, present, and foreseeable future actions, the proposed action would therefore not contribute to any cumulative impacts associated with these resource categories and are therefore not considered further in this analysis.

### Land Use/Visual Resources

The proposed action would not result in any significant impacts to land use compatibility since CCAFS and LC-40 current use includes launching space vehicles. Furthermore, the Proposed Action would not generate significant impacts on visual resources within the flight range of the Falcon 9 v1.1 vehicle other than short-lived visible vehicle contrails.

The past, present, and reasonably foreseeable future actions with the potential to affect land use and visual resources are presented in the previous section. None of the actions have, or would, convert prime agricultural land to other uses. These actions are also consistent with existing land use within the ROI as well as with the Base General Plan and the Air Force mission at CCAFS. The visual presence of the infrastructure associated with these activities is well established and is considered part of the local landscape.

As a result, the overall cumulative effect of other past, present, and reasonably foreseeable future actions on land use and visual resources is considered negligible and less than significant. When considered with other past, present, and foreseeable future actions, it is not anticipated that the Proposed Action would contribute a noticeable incremental impact to the overall negligible and less than significant effect on land use and visual resources.

**Noise**

Short-term increases in the noise levels received in the community from the proposed launch of the Falcon 9 v1.1 are also not anticipated to be significant. Long-term noise levels for the proposed launch activities for the Falcon 9 v1.1 are not expected to surpass the significance thresholds for impacts. Sonic booms generated by these launch events would impact the ocean surface beyond 30 miles off the coast and would not be audible on land; therefore, sonic booms would not produce any significant impacts in the surrounding areas.

The past, present, and reasonably foreseeable future actions with the potential to affect noise are presented in the previous section. As reflected in the tables, launch frequencies are anticipated to remain fairly constant when comparing past and future launch manifests and incorporating the Proposed Action. All past and future launches have or will result in short-term and temporary increases in noise levels. It should also be noted that each launch would or has occurred separately, avoiding combining noise related impacts from more than one launch at a time.

As a result, the overall cumulative effect of other past, present, and reasonably foreseeable future actions from noise is considered minor and less than significant. When considered with other past, present, and foreseeable future actions, it is not anticipated that the Proposed Action would contribute a noticeable incremental impact to the overall minor and less than significant impact from noise.

**Biological Resources**

The Proposed Action would not be expected to have a significant impact on terrestrial vegetation and wildlife, marine species, or protected species. Launch activities for the Falcon 9 v1.1 vehicle could have some small impacts near the launch pad associated primarily with fire and heat. The Falcon 9 v1.1 vehicle utilizes liquid fuels (LOX and RP1) so there is negligible level of acid or particulate deposition anticipated. There would be no significant impacts on wildlife or vegetation (including state-listed wildlife species) by daily operations. An anomaly on the launch pad such as an explosion could however injure or kill wildlife found adjacent to the launch pad or within debris impact areas. Potential fires started from the anomaly could result in a temporary loss of habitat and mortality of less mobile species (USAF 1998). An improbable mishap downrange would occur over the open ocean and would not likely jeopardize any wildlife, given the relatively low density of species within the surface waters of these open ocean areas (USAF, 1998). Debris from launch failures has a small potential to adversely affect managed fish species and their habitats in the vicinity of the project area.

The past, present, and reasonably foreseeable future actions with the potential to affect biological resources are presented in the previous section. As discussed in the 2007 EA, NASA has mapped the effects on local vegetation from 14 Delta, 20 Atlas, and 8 Titan launches from CCAFS (SCHMALZER, 1998). The study found that vegetation scorching has been limited to small areas (less than a hectare (2.5 acres)) within 150 m (492 ft) of the launch pad for Atlas and Titan launches and that acid and particulate deposition for Delta launches has extended less than 1 km (0.6 mi) from the launch pad and affected relatively small areas (up to 46 hectares (114 acres). The study further found that continuous acid deposition has not exceeded 1 km (0.6 mi) from the launch pad for Titan launches.

However, isolated acid deposition has occurred up to 9.3 km (5.8 mi) from the launch pad under certain meteorological conditions. Particulate deposition from Titan launches has occurred over larger areas (2,366 hectares or 5847 acres) and up to 14.6 km (9.1 mi) from the launch pad but that no discernible vegetation or other environmental damage appears to have been caused by this particulate deposition (USAF 1998). In addition, no animal mortality has been observed at CCAFS that could be attributed to Delta, Atlas, or Titan launches (SCHMALZER, 1998). It can further be assumed that individual environmental due diligence was undertaken or is being undertaken for the past and future activities with any required mitigation for impacts to biological resources being implemented. Ocean mammals would also not be expected to be affected by sonic booms beyond a "startle" response.

As a result, the overall cumulative effect of other past, present, and reasonably foreseeable future actions on biological resources are considered minor and less than significant. When considered with other past, present, and foreseeable future actions, it is not anticipated that the Proposed Action would contribute a noticeable incremental impact to the overall minor and less than significant effect on biological resources.

**Air Quality**

CCAFS and Brevard County are in an "Attainment" area and the operational emissions for the proposed Falcon 9 v1.1 vehicle launch represent an extremely small percentage of the Brevard County regional emissions and would not cause an exceedance of any NAAQS or Greenhouse gases (GHG).

The past, present, and reasonably foreseeable future actions with the potential to affect air quality are presented in the previous section. As discussed in the 2007 EA, NASA's routine payload final EA (June 2002) analyzed all of the candidate launch vehicles considered for the launch of routine payload at CCAFS and determined them to have no substantial impact on ambient air quality. It should also be noted that each launch would or has occurred separately, avoiding simultaneously combining impacts associated with exhaust plumes from more than one vehicle at a time. In addition, there are a number of Executive Orders such as EO 13514 Federal Leadership in Environmental, Energy, and Economic Performance that provide emission reduction expectations for federal agencies. The public in and around the launch sites is also unlikely to be exposed to concentrations of any launch vehicle emissions that exceed the allowable public exposure limits adopted by the range safety organizations.

As a result, the overall cumulative effect of other past, present, and reasonably foreseeable future actions on air quality is considered minor and less than significant. When considered with other past, present, and foreseeable future actions, it is not anticipated that the Proposed Action would contribute a noticeable incremental impact on air quality.

**Hazardous Materials/Hazardous Waste**

Operations supporting the Falcon 9 v1.1 vehicle would use products containing hazardous materials, including paints, solvents, oils, lubricants, acids, batteries, surface coating, cleaning compounds, propellants, chemicals, and other hazardous material payload components. However, continued implementation of existing handling and management procedures for hazardous materials, hazardous wastes, and solid wastes generated during the operation of the Falcon 9 v1.1 vehicle would limit the potential for impacts.

The past, present, and reasonably foreseeable future actions with the potential to affect hazardous materials and hazardous waste are presented in the previous section. Numerous types of hazardous materials are used to support the missions and general maintenance operations at CCAFS and KSC. Management of hazardous materials is the responsibility of each individual or organization and is regulated under RCRA (40 CFR 260-280) and Rule 62-730. In addition, there are a number of Executive Orders, particularly EO 13423 Strengthening Federal Environment, Energy, and Transportation, and EO 12088, Federal Compliance with Pollution Control Standards that provide waste reduction expectations for federal agencies.

As a result, the overall cumulative effect of other past, present, and reasonably foreseeable future actions from hazardous materials and waste are considered minor and less than significant. When considered with other past, present, and foreseeable future actions, it is not anticipated that the Proposed Action would contribute a noticeable incremental impact from hazardous materials and waste.

**Utilities**

There would be no need for additional electrical power for the Proposed Action and therefore no direct impacts. There is however a need to increase base-supplied deluge water for each launch by 30% or less. This analysis of utilities therefore only considers water supply. The proposed action requires approximately 130,000 gallons per launch. The system was originally designed to accommodate up to 800,000 gallons. Since only one launch vehicle would be in preparation of actual launch at any given point, the Proposed Action's requirement on the water supply would be minor and therefore not result in any significant impacts on water supply.

The past, present, and reasonably foreseeable future actions with the potential to affect utilities are presented in the previous section. These programs all require a water supply in order to successfully function. Water for CCAFS is acquired from the City of Cocoa's municipal potable water distribution system under a long-term agreement which has a 37 million gallon per day (MGD) capacity. The City's contract is with the U.S. Government and includes KSC, CCAFS and Patrick Air Force Base. A total of 6.5 MGD is allocated for all three facilities. Historically, total consumption of water from the city for all three facilities has averaged 3.7 MGD. In addition, there are a number of Executive Orders such as EO 13423 Strengthening Federal Environment, Energy, and Transportation that provide water conservation expectations for federal agencies, making an increase in federally related water demand unlikely.

As a result, the overall cumulative effect of other past, present, and reasonably foreseeable future actions on utilities (ie. water supply) are considered negligible and less than significant in the context of supply. When considered with other past, present, and foreseeable future actions, it is not anticipated that the Proposed Action would contribute a noticeable incremental impact on utilities (water supply).

**Socioeconomics**

The Proposed Action would not significantly affect the local housing market, the addition of added economic activity would result in a minor but positive impact to the local economy. The Proposed Action would generate no negative socioeconomic impacts on the region and would generate a small positive impact, especially since 2011 when the Shuttle Program was terminated resulting in a reduction of employment opportunities within the ROI.

The past, present, and reasonably foreseeable future actions with the potential to affect socioeconomics are presented in the previous section. The Spaceport (KSC and CCAFS) is Brevard County's major employer. The presence of these employers causes a chain of economic reactions throughout the local region and nearby counties. These actions have, or will have a positive influence on socioeconomics, through contributions to the local economy.

As a result, the overall cumulative effect of other past, present, and reasonably foreseeable future actions on socioeconomics is considered beneficial and less than significant. When considered with other past, present, and foreseeable future actions, it is anticipated that the Proposed Action would contribute a noticeable incremental beneficial minor and less than significant impact on socioeconomics.

## 6.0 APPLICABLE ENVIRONMENTAL REQUIREMENTS

This section provides a description of representative federal, state, local, and Air Force regulations with which SpaceX must comply during operation of the proposed action.

## 6.1 FEDERAL REGULATIONS

**Federal Regulations Regarding Environmental Quality**

The National Environmental Policy Act (42 U.S.C. 4321-4347 as amended) requires federal agencies to analyze the potential environmental impacts of major federal actions and alternatives and to use these analyses as a decision making tool on whether and how to proceed with the Proposed Action or Alternatives.

**Federal Regulations Regarding Biological Resources**

Public Law 93-205 requires military installations to protect and conserve federally listed, endangered, and threatened plants and wildlife.

The Endangered Species Act of 1973 declares the intention of the Congress to conserve threatened and endangered species and the ecosystems on which those species depend. The Act requires that federal agencies, in consultation with the U.S. Fish and Wildlife Service and NOAA Fisheries, use their authorities in furtherance of its purposes by carrying out programs for the conservation of endangered or threatened species. Section 7 of the Endangered Species Act (16 U.S.C. 1536) contains provisions that require federal agencies to consult with the Secretary of Interior and to take necessary actions to ensure that actions authorized, funded, or carried out by them do not jeopardize the continued existence of endangered species and threatened species. Federal agencies must ensure that actions taken will not result in the destruction or modification of the habitat of endangered species.

Marine Mammal Protection Act (16 U.S.C. 1361 et seq.), Section 101(a)(5)(A) directs the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of marine mammals by United States citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and regulations are issued. Permission may be granted for periods of 5 years or less if the NMFS finds that the taking will have a negligible impact on the species or stock(s); will not have an unmitigatable adverse impact on the availability of the species or stock(s) for subsistence uses; and the permissible methods of taking and requirements pertaining to the monitoring and reporting of such taking are set forth.

The Florida Endangered and Threatened Species Act (FETSA) establishes the conservation and wise management of T&E species as State policy. Agencies are required to consider impacts to T&E species when planning and implementing projects, as mandated by the Florida Fish and Wildlife Conservation Commission (FFWCC).

The Magnuson-Stevens Fishery Conservation and Management Act (Sustainable Fisheries Act) identifies EFH and threats to EFH. This Act requires consultation with NMFS to ameliorate any threats to EFH from non-fishing activities.

The Marine Mammal Protection Act prohibits the harassing or killing of any marine mammal. Harassment is any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the

wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering. The Act requires the observation of distance requirements from marine mammals as imposed by the NFMS.

**Federal Regulations Regarding Cultural Resources**

The National Historic Preservation Act of 1966 (Public Law 89-665), as amended; Executive Order 11593 of 1971 (36 CFR 154); the American Indian Religious Freedom Act of 1978 (Public Law 95-341); the Archaeological Resource Protection Act of 1979 (Public Law 96-95); the Native American Graves Protection and Repatriation Act of 1990 (Public Law 101-601); and the Air Force Instruction for cultural resource management of 1994 (AFI 32-7065).

On a day-to-day basis, cultural resource management CCAFS is guided primarily by the National Historic Preservation Act and its implementing regulations, 36 CFR 800.

The Archaeological Resource Protection Act was passed in 1979 to protect archaeological resources and sites on public lands, and requires a permit for any excavation or removal of archaeological resources from public lands.

The Native American Graves Protection and Repatriation Act and its implementing regulations, 43 CFR 10, provides ownership or control of Native American human remains and selected cultural items excavated or discovered on federal lands with designated Native American tribes, organizations, or groups. If human remains or selected cultural items are discovered on federal lands, the appropriate Native American group must be notified. AFI 32-7065 provides detailed guidance for compliance with relevant extant authorities.

**Federal Regulations Regarding Air Quality**

The proposed action is federally regulated by the following Titles (listed and discussed below):

Title 40 CFR 50: NAAQS;

Title 40 CFR 51: Requirements for Preparation, Adoption, and Submittal of Implementation Plans;

Title 40 CFR 61: NESHAP;

Title 50 CFR 63: NESHAP for Source Categories;

Title 40 CFR 70: State Operating Permit Program; and

Title 49 CFR Parts 100-199: Hazardous Materials Regulation.

Title 40 CFR 50 (NAAQS): The Clean Air Act required the U.S. EPA to establish ambient ceilings for certain criteria pollutants. Subsequently, the U.S. EPA promulgated regulations that set NAAQS. Two classes of standards were established: primary and secondary. Primary standards prescribe the maximum permissible concentration in the ambient air required to protect public health. Secondary standards specify levels of air quality required to protect public welfare, including materials, soils, vegetation, and wildlife, from any known or anticipated adverse effects.

The criteria pollutants for which the NAAQS have been established include carbon monoxide, nitrogen dioxide, ozone, $PM_{10}$, $PM_{2.5}$, and sulfur dioxide.

The U.S. EPA classifies air quality within each Air Quality Control Region with regard to its attainment of federal primary and secondary NAAQS. According to U.S. EPA guidelines, an area with air quality better than the NAAQS for a specific pollutant is designated as in attainment for that pollutant. Any area not meeting ambient air quality standards is classified as nonattainment. When there is a lack of data for the U.S. EPA to define an area, the area is designated as unclassified and treated as an attainment area until proven otherwise.

Title 40 CFR 51 Subpart W (General Conformity): General conformity rule applies to federal actions that are not covered by transportation conformity rule, with several listed exceptions. Other than the listed exemptions and presumptions of conformity, general conformity applies to actions in which projected emissions exceed applicable conformity de minimis thresholds. However, if the emissions from a federal action do not equal or exceed de minimis thresholds but do represent 10 percent or more of a nonattainment or maintenance area's total emissions of any criteria pollutant, the action is considered "regionally significant" and the requirements of conformity determination apply.

Title 40 CFR 61(NESHAP): The NESHAP regulates stationary sources with a prescribed standard under Title 40 CFR 61. Such stationary sources may be required to obtain an operating permit issued by an authorized Air Pollution Control agency or by U.S. EPA in accordance with Title V of the Clean Air Act. The NESHAP identifies and list a variety of hazardous air pollutants that are regulated.

The only sections of NESHAP standards that may apply to the proposed project is Title 50 CFR 63 Subpart GG for manufacturers of commercial, civil, or military aerospace vehicles or components and that are major sources of hazardous air emissions. Such emissions would result from cleaning operations, surface coating with primers and topcoats, paint removal, and waste storage.

Hazardous wastes that are subject to RCRA requirements would be exempt from the subpart. Those wastes would include specialty coatings, adhesives, primers, and sealant materials at aerospace facilities. Other exemptions would include hazardous air pollutants or VOC contents less than 0.1 percent for carcinogens or 1.0 percent for non-carcinogens and low volume coatings.

Title 40 CFR 70 (State Operating Permit Programs): In accordance with Title V of the Clean Air Act large facilities that are capable of producing large amounts of air pollution are required to obtain an operating permit. Permits are issued by the District. Typical activities that require the Clean Air Act Title V permit include any major source (source that emits more than 100 tons per year of criteria pollutant in a nonattainment area for that pollutant or is otherwise defined in Tide I as a major source); affected sources as defined in Title IV; sources subject to Section 111 regarding New Source Performance Standards; sources of air toxics regulated under Section 112 of the Clean Air Act; sources required to have new source or modification permits under Parts C or D of Title I of the Clean Air Act; and any other source such as Hazardous Waste pollutants designated by U.S. EPA regulations.

Part 70 Federal Operating Permits are issued to specific emission sources. Sources requiring permits are determined

based on the source's potential to emit certain threshold levels of pollution given their equipment and processes. Facilities requiring Part 70 Federal Operating Permits include sources with the potential to emit the following:

- Regulated air pollutant or HAP amounts equal to or greater than:
  - 100 tons/year of any regulated air pollutant;
  - 10 tons/year of any individual HAP or 25 tons/year of a combination of HAPs; or
  - Lesser quantity thresholds for any HAP established by the U.S. EPA rulemaking.
  - Any stationary source defined by the U.S. EPA as major for the District under Title I, Part D (Plans for Nonattainment Areas) of the Clean Air Act and its implementing regulations including:
  - For ozone nonattainment areas, sources with the potential to emit 100 tons per year or more of volatile organic compounds or oxides of nitrogen in areas classified as "marginal" or "moderate," 50 tons per year or more in areas classified as "serious," 25 tons per year or more in areas classified as "severe," and 10 tons per year or more in areas classified as "extreme";
    - Acid rain sources included under the provisions of Title IV of the Clean Air Act and its implementing regulations.
    - Any source required to have a pre-construction review permit pursuant to the requirements of the New Source Review/Prevention of Significant Deterioration program under Tide I, Parts C and D of the Clean Air Act and its implementing regulations;
    - Any solid waste incineration unit required to obtain a Part 70 permit pursuant to Section 129(e) of the Clean Air Act and its implementing regulations; and
    - Any stationary source in a source category required to obtain a Part 70 permit pursuant to regulations promulgated by the U.S. EPA Administrator.

Title 49 CFR Parts 100-199: Liquid propellant for the Falcon launch vehicle must be shipped and handled in accordance with Title 49 CFR Parts 100-199. The liquid propellants would be shipped directly from the manufacturing location to the launch site.

**Federal Regulations Regarding Hazardous Waste/Hazardous Materials**

The CERCLA of 1980 responds to the immediate cleanup of hazardous waste contamination from accidental spills or from waste disposal sites that may result in long-term environmental damage.

The RCRA of 1974 (42 U.S.C. 6901 et seq.) was designed to control the handling and disposal of hazardous substances by responsible parties. Hazardous waste, as defined by RCRA, is a "waste that may cause or significantly contribute to serious illness or death, or that poses a substantial threat to human health or the environment when improperly disposed." The treatment, storage, and disposal of solid waste (both hazardous and nonhazardous) is regulated under the Solid Waste Disposal Act as amended by RCRA and the Hazardous and Solid Waste Amendments of 1984.

The SARA of 1986, Title III: Emergency Planning and Community Right-to-Know Act establishes standards for community right-to-know programs, and requires the reporting of releases of certain toxic chemicals. Local planning committees, comprising government, news media, industry, environmental, organizations, and medical representatives, receive right-to-know information from facilities. Facilities with Standard Industrial Classification codes between 20 and 39 that manufacture, process, or otherwise use listed toxic chemicals, must report a release

of these toxic chemicals to the environment, in greater than reportable quantities, on a Form R.
Under 49 CFR Section 170 are Department of Transportation requirements for the shipment of hazardous materials. This section specifies the proper container type, shipping name, and labeling requirements for the transportation of hazardous materials.

The Toxic Substances Control Act of 1976 regulates chemical substances and mixtures that present an unreasonable risk of injury to health, or the environment, and acts with respect to chemical substances and mixtures which are imminent hazards.

**Federal Regulations Regarding Water Resources**
The Clean Water Act (33 U.S.C. 1251 et seq.) prohibits the discharge of pollutants from a point source into navigable waters of the United States, except in compliance with a NPDES (40 CFR Part 122) permit. The navigable waters of the United States are considered to encompass any body of water whose use, degradation, or destruction will affect interstate or foreign commerce.

Section 402 of the Clean Water Act requires that the U.S. EPA establish regulations for issuing permits for storm water discharges associated with industrial activity. A NPDES permit is required if activities involve the disturbance of 1 to 5 acres of land. A Notice of Intent must be submitted to the SJRWMD by SpaceX and a storm water pollution prevention plan must be developed.

Section 404 establishes a program to regulate the discharge of dredged and fill materials into waters of the United States, including wetlands. Activities in waters of the United States that are regulated under this program include fills for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports), and conversion of wetlands to uplands for farming and forestry. U.S. EPA and the Corps of Engineers jointly administer the program. In addition, the U.S. Fish and Wildlife Service, NOAA Fisheries, and state resource agencies have important advisory roles.

**Federal Regulations Regarding Environmental Justice and Coastal Zone Management**
Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations) requires that all federal agencies develop environmental justice strategies and make environmental justice a part of their mission by identifying and addressing, as appropriate, any disproportionate and adverse human health or environmental effects of their activities on minority or low income populations.

The Coastal Zone Management Act (CZMA) of 1972 (16 USC 2452-24645) (Florida Department of Community Affairs (FDCA)) plays a significant role in water quality management. Under the CZMA, a Federal action that may affect the coastal zone must be carried out in a manner that is consistent with state coastal zone management programs.

**State of Florida Construction related Regulations**

While this proposed action does not include construction, for consistency, any modifications to impervious surfaces (additions, deletions, replacements) would required coordination with 45$^{th}$ SW as well as the St Johns River Water

Management District (SJRWMD) and the US Army Corps of Engineers (USACE). Additionally, projects creating 4,000 square feet or more of paved surface for vehicles will require an Environmental Resources Permit (ERP) (Part IV Chapter 373 Florida Statutes). Projects creating 9,000 square feet or more of total impervious surface (the sum of building and parking area) would also require an Environmental Resources Permit. Coverage under an EPA Construction General Permit must be sought by the operator of a construction activity that:

- Will disturb one acre or greater, or
- Will disturb less than five acres but is part of a larger common plan of development or sale whose total land disturbing activities total five acres or greater (or is designated by the NPDES permitting authority), and;
- Will discharge storm water runoff from the construction site into a municipal separate storm water sewer system (MS4) or waters of the United States.

If the above criteria apply, a Notice of Intent for Storm Water Discharges Associated with construction activity under a NPDES General Permit must be submitted to FDEP (Chapter 62-25 Florida Administrative Code) and to 45 CES/CEIE offices. When all construction activities have been completed a Notice of Termination would be submitted to FDEP. Since the CCAFS is an "industrial area", any proposed modifications to stormwater related flow at LC-40 would require coordination with the SJRWMD.

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# APPENDIX A

## John Kaiser

**Subject:** FW: SpaceX Falcon 9 EA supplemental discussion

John,

Thank you for reaching out to us. Please let me know if you would like to schedule a time to chat.

Daniel Czelusniak
Commercial Space Transportation, AST-100
Federal Aviation Administration
(202)267-5924

From: Stacey Zee/AWA/FAA
AST-100, Space Transportation Development Div
To: "John Kaiser" <john@gearengineer.com>
Cc: Daniel Czelusniak/AWA/FAA@FAA, Ed Springer/AWA/FAA@FAA
Date: 03/08/2013 09:09 PM
Subject: Re: SpaceX Falcon 9 EA supplemental discussion

---

John -

Nice to hear from you. I do remember you from the 2007 work. My co-worker, Dan Czelusniak,is the lead for this project. I've copied Dan and Ed Springer (the SpaceX project manager for launches from the Cape) on the email.

If you like - we can set up a call for next week to discuss the project.

Looking forward to working with your team again.

Stacey M. Zee
Commercial Space Transportation, AST-100
Federal Aviation Administration
800 Independence Ave, SW, Suite 325
Washington, DC 20591
(202)267-9305

From: "John Kaiser" <john@gearengineer.com>
To: Stacey Zee/AWA/FAA@FAA
Date: 03/08/2013 02:10 PM
Subject: SpaceX Falcon 9 EA supplemental discussion

---

Good afternoon Stacey.

It has been a number of years since we spoke/emailed and I hope you are well. I also understand that you may have “moved up” a

level or two; congratulations!

Back in 2007 we had communicated while I was involved in developing the SpaceX Falcon 9 EA for the Air Force at CCAFS. Matt Thompson at SpaceX mentioned you were still at the FAA.
I am with GEAR now, but we continue to support certain SpaceX environmental related needs as requested. You may have heard about SpaceX plans to develop a modification to the original Falcon 9…it is labeled the "Block 2" or Version 1.1. SpaceX has recently reached out and asked that we develop an amendment or supplemental to the original EA that would address this new modification.

We have been in contact with the Air Force who plan to remain the "lead agency", and this is our first email to the FAA to start the path toward a "coordinated" approach. We will be doing the same with NASA, similar to how the original EA progressed.

So my first question is will you or someone else be the main POC for this document. We do not expect the Falcon 1.1 mod to generate much if any impact beyond that of the original EA, but so far all parties involved feel that the changes do need to be analyzed per NEPA.

Thank you so much and
Best regards

*John P. Kaiser, PMP*
**Project Manager**
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**Please consider the environment before printing this e-mail.**

## John Kaiser

**Subject:** FW: SpaceX Falcon 9 V1.1 supplemental EA

---

**From:** Montgomery, Lizabeth R. {Beth}(GSFC-2500) [mailto:lizabeth.r.montgomery@nasa.gov]
**Sent:** Wednesday, March 13, 2013 10:11 AM
**To:** John Kaiser
**Subject:** RE: SpaceX Falcon 9 V1.1 supplemental EA

We want to be a "Cooperating Agency" too.

---

**From:** John Kaiser [mailto:john@gearengineer.com]
**Sent:** Wednesday, March 13, 2013 10:08 AM
**To:** Montgomery, Lizabeth R. {Beth}(GSFC-2500)
**Cc:** 'Kary Policht'; 'Matthew Thompson'; 'HAWKINS, DALE K GS-12 USAF AFSPC 45 CES/CEAO'; 'LONG, EVA M GS-11 USAF AFSPC 45 CES/CEAO'; Daniel.Czelusniak@faa.gov; Stacey.Zee@faa.gov; neeld@GEARengineer.com
**Subject:** SpaceX Falcon 9 V1.1 supplemental EA

Good morning Beth,

Thanks for taking my call this morning. As I explained, Air Force is planning to again be the Lead Agency for this supplemental EA since they were the Lead for the original and since the action is still at CCAFS. Dale Hawkins and Eva Long from 45th Space Wing there will be running that.

Also as we discussed, we suggest that as before the FAA be a "Cooperating Agency" for this document. This morning you did mention that NASA will be doing a concurrent FONSI based on the supplemental EA. Following SpaceX internal reviews of the document, we would plan to send electronic drafts to Air Force, NASA, and FAA for initial review. As we get into the DOPAA we plan to begin reviews there rather than waiting for the complete document. The FAA is on board with this approach also.

Thank you again, we look forward to working with you.

*John P. Kaiser, PMP*
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**John Kaiser**

**From:** Milligan, Lauren [Lauren.Milligan@dep.state.fl.us]
**Sent:** Tuesday, June 18, 2013 11:15 AM
**To:** 'John Kaiser'
**Subject:** RE: SpaceX Environmental Assessment for CCAFS Upgrade to Falcon 9 Version 1.1 - State Clearance Letter

Mr. John P. Kaiser, PMP, Project Manager
Gator Engineering & Aquifer Restoration, Inc.
1173 Spring Centre South Boulevard, Suite C
Altamonte Springs, FL 32714-1976

RE: Department of the Air Force – Draft Supplemental Environmental Assessment for the Operation and Launch of the Falcon 1 and Falcon 9 Space Vehicles at Cape Canaveral Air Force Station, SpaceX Upgrade to Falcon 9 Version 1.1 – Brevard County, Florida.
SAI # FL201306186623C (Reference Previous SAI # FL200709273782C)

Dear John:

Florida State Clearinghouse staff has reviewed the proposed project under the following authorities: Presidential Executive Order 12372; Section 403.061(42), *Florida Statutes*; the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended; and the National Environmental Policy Act, 42 U.S.C. §§ 4321-4347, as amended.

Based on the information contained in the submittal and negligible project impacts, the state has determined that the proposed federal action is consistent with the Florida Coastal Management Program.

If you have any questions regarding this message or the state intergovernmental review process, please don't hesitate to contact me at (850) 245-2170 or Lauren.Milligan@dep.state.fl.us. Thank you.

Yours sincerely,

*Lauren P. Milligan*

Lauren P. Milligan, Environmental Manager
Florida State Clearinghouse
Florida Department of Environmental Protection
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**From:** John Kaiser [mailto:john@gearengineer.com]
**Sent:** Thursday, June 13, 2013 4:36 PM
**To:** Milligan, Lauren
**Subject:** RE: Two SpaceX upcoming Environmental Assessments for Clearinghouse

**Subject:** FW: Request Concurrence on Not Likely to Adversely Affect Determination for SpaceX Vehicle

-----Original Message-----
From: Teresa Calleson [mailto:teresa_calleson@fws.gov]
Sent: Thursday, September 26, 2013 12:14 PM
To: CHAMBERS, ANGY L GS-12 USAF AFSPC 45 CES/CEIE
Subject: RE: Request Concurrence on Not Likely to Adversely Affect Determination for SpaceX Vehicle

Angy,

Pursuant to your August 28, 2013 request for concurrence with the revised SpaceX Operations at the Cape Canaveral Air Force Station, the U.S. Fish and Wildlife Service has reviewed the attached document and other information that you have provided describing the operational changes at SpaceX Complex
40 and associated changes to the Light Management Plan. As we understand the operational changes, no additional construction outside the launch pad is proposed. Since the new Space X launch vehicles are of similar size as compared to previous operations, the Service does not anticipate any effects to listed species as a result of the change. As such, the Service provides its concurrence with the "may affect, not likely to adversely affect"
determination made in the Environmental Assessment.

As an update, the correspondence approving the Revised Light Management Plan for the complex should be signed today. I will send the electronic version of the signed letter, as soon as it is available. The Service appreciates your efforts on the lighting issues at SpaceX CX40, the revisions to the Light Management Plan for the complex, and your overall efforts to protect marine turtles and hatchlings! Thank you for your cooperation! Please do not hesitate to contact Service staff at the North Florida Ecological Services Field Office, should there be any future issues that need to be addressed. Thanks!

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# APPENDIX B

Blue Ridge Research and Consulting, LLC

**Final (Revised Oct 2012)**

# Far-Field Launch Noise During Falcon 9 and Falcon Heavy Liftoff from Texas Launch Site

***October 2012***

**Prepared for:**
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Jaclyn Johnson
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Annapolis, MD 21401

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**Contract Number:**
9877-27417

**BRRC Report Number:**
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# 1 Introduction

This noise analysis supports the Environmental Impact Statement (EIS) for the Federal Aviation Administration (FAA) Office of Commercial Space Transportation (AST) Proposed Action to issue launch licenses and/or experimental permits to Space Exploration Technologies Corp. (SpaceX) that would allow SpaceX to conduct launches of the Falcon 9 and Falcon Heavy orbital vertical launch vehicles and a variety of reusable suborbital launch vehicles from a launch site on privately owned property in Cameron County, Texas (Figure 1). The Falcon 9 is a medium-lift class launch vehicle, which is designed to provide cargo and crew to the International Space Station and other low Earth orbit (LEO) destinations. The Falcon Heavy is a heavy-lift class launch vehicle, designed to place satellites/payloads into LEO and Geostationary Transfer Orbit [1]. SpaceX has proposed to conduct up to twelve total launches per year between the Falcon 9 and Falcon heavy (up to two per year). The majority of launches would occur between the hours of 7:00 a.m. and 7:00 p.m. However, there could be up to one nighttime launch per year. All launches, including pre-flight activities, would be conducted under the control of SpaceX, FAA/AST, and the Launch Operations Area with Houston Air Route Traffic Control Center.


**Figure 1. Proposed launch site location in Cameron County, Texas**

In support of the EIS, advanced acoustic models were used to generate noise contours for assessing the noise levels and exposures in the area surrounding the proposed launch site. The acoustic models consider many aspects of the launch vehicle including its engine characteristics, ascent trajectory, and

the vehicle dimensions. Both vehicles are shown in Figure 2[1], and they use the SpaceX Merlin 1D liquid-propellant rocket engine, shown in the far right image of Figure 2. The first stage of the Falcon 9 utilizes one nine-engine core while the Falcon Heavy utilizes three nine-engine cores. Both vehicles use liquid oxygen (LOX) and highly refined kerosene, also known as rocket propellant-1 or refined petroleum-1 (RP-1), as propellants to carry payloads into orbit.

This noise study describes the environmental noise associated with the proposed Falcon 9 and Falcon Heavy operations. Section 2 summarizes the noise metrics discussed throughout this report. Section 3 describes the general methodology of the launch noise model and sonic boom noise model. The modeling results are presented in Section 4 and Section 5 summarizes the notable findings of this noise study.

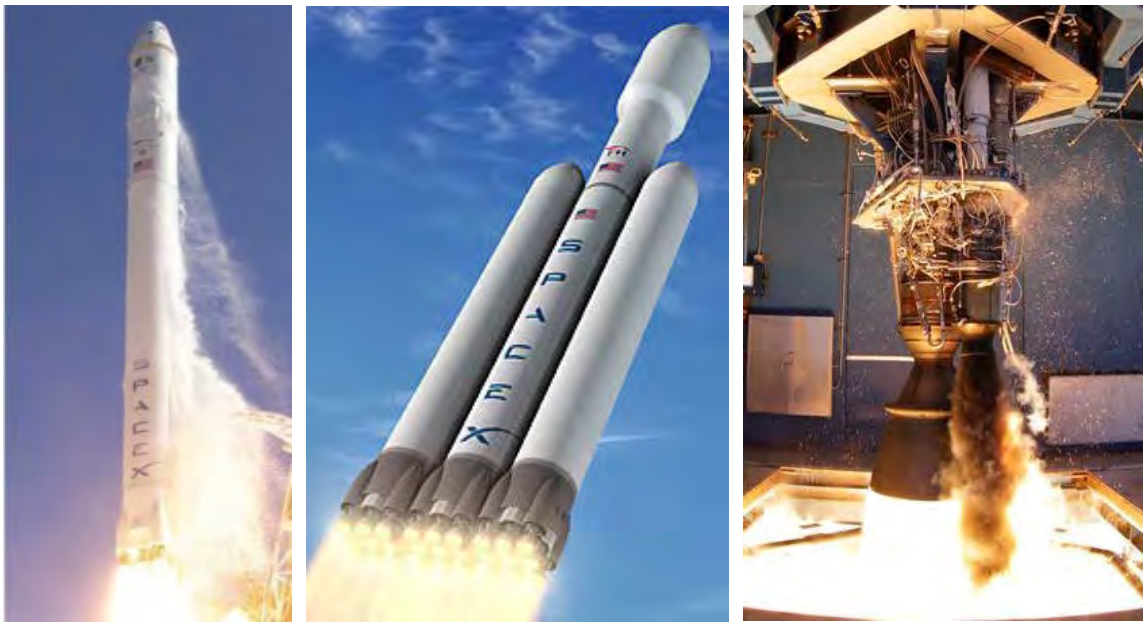

**Figure 2. Falcon 9 (left), Falcon Heavy (center), SpaceX Merlin 1D Engine (right)**

[1] Images courtesy of SpaceX (www.spacex.com)

# 2 Noise Metrics and Criteria

## 2.1 Noise Metrics

Any unwanted sound that interferes with normal activities or the natural environment can be defined as noise. Noise sources can be continuous (constant) or transient (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 transient noise events.

The decibel (dB) is a ratio that compares the sound pressure of the sound source of interest (e.g. the rocket launch) to a reference pressure (the quietest sound we can hear, 20 µPa (micropascal)). Standard weighting filters help to shape the levels in reference to how they are perceived. An "A-weighting" filter approximates the frequency response of human hearing, adjusting low and high frequencies to match the sensitivity of human hearing. For this reason, the A-weighted decibel level (dBA) is commonly used to assess community noise. However, if the structural response is of importance to the analysis, a "Flat-weighted" (unweighted) level is more appropriate.

The impact of noise can be described with the use of noise metrics, which depend on the nature of the event and who or what is affected by the sound. Individual time-varying noise events have two main characteristics: a sound level that changes throughout the event and a period of time during which the event is heard. The overall sound pressure level (OASPL) provides a measure of the sound level at any given time, while the maximum OASPL ($L_{max}$) indicates the maximum OASPL achieved over the duration of the event. Sound Exposure Level (SEL) represents both the magnitude of a sound and its duration. SEL provides a measure of the cumulative noise exposure of the entire acoustic event, but it does not directly represent the sound level heard at any given time. Mathematically, it represents the sound level of a constant sound that would, in one second, generate the same acoustic energy as the actual time-varying acoustic event. For sound generated by rocket launches, which last more than one second, the SEL is greater than the $L_{max}$ because an individual launch can take minutes and the $L_{max}$ occurs instantaneously.

The Day-Night Average Sound Level (DNL) is a cumulative noise metric that accounts for the SEL of all noise events in a 24-hour period. Typically DNL values are expressed as the level over a 24-hour annual average day. In order to account for increased human sensitivity to noise at night, a 10 dB penalty is applied to nighttime events (occurring between the hours of 10:00 p.m. and 7:00 a.m.). Noise contour maps of these metrics are comprised of lines of equal noise level or exposure, and they serve as visual aids for assessing the impact of noise on a community.

## 2.2 Noise Criteria

Noise criteria have been developed in order to protect the public health and welfare of the surrounding community. The following noise criteria address human annoyance, hearing conservation, and structural damage.

### 2.2.1 Human Annoyance

FAA order 1050.1E, Change 1 [2], guidance on noise indicates that a significant noise impact would occur if analysis shows that the Proposed Action will cause noise sensitive areas to experience an increase in noise of DNL 1.5 dB or more at or above DNL 65 dBA noise exposure when compared to the no action alternative during the same time frame. DNL has been found to correlate well with adverse community impacts for regularly occurring events including aircraft, rail, and road noise [3, 4]. DNL is based on long-term consistent noise exposures. However, the Proposed Action is for up to twelve total launches per year. Thus, it is acknowledged that the suitability of DNL for infrequent noise events is uncertain with respect to current research and dose response studies. The DNL contours are provided to estimate the potential annoyance in compliance with FAA requirements.

### 2.2.2 Hearing Conservation

Multiple federal government agencies have provided guidelines on permissible noise exposure limits. These documented guidelines are in place to protect one's hearing from long-term continuous daily exposures to high noise levels and aid in the prevention of noise-induced hearing loss (NIHL). The National Institute for Occupational Safety and Health (NIOSH) has standardized employee noise exposure requirements based on level and duration allowed during an 8-hour workday [5]. NIOSH recommendations are designed such that over a 40-year lifetime exposure, the excess risk of developing occupational NIHL is 8%. NIOSH established a recommended exposure limit (REL) for noise at 85 dBA with a 3 dB exchange rate, which means as the level increases by 3 dB the duration is reduced by a factor of two. The Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for noise starts at 90 dBA for an 8-hour period [6]. However, the OSHA exchange rate is 5 dB.

For the entire American public at all times rather than the American worker during his workday, the U. S. Environmental Protection Agency (EPA) has recommended an exposure limit of 70 dBA for 24 hours which provides a margin of safety [7]. EPA recommendations are designed such that over a 40-year lifetime exposure, the excess risk of developing occupational NIHL is 4% [7]. For exchange rates the EPA recommends two separate rates for continuous and short exposure periods (less than 15 minute), 3 dB and 6 dB, respectively. In terms of upper limits on the noise levels, NIOSH set the maximum exposure at 140 dBA, and OSHA set it at 115 dBA. The EPA does not state a maximum level for non-impulsive noise. Therefore, a maximum noise level of 115 dBA will be used to identify potential locations where hearing protection should be considered for a rocket launch. This level is conservative for NIHL since rocket launches will occur at a rate of once a month. At this level the different guidelines provide a range of exposure times from 15 minutes (OSHA) to 28 seconds (NIOSH and EPA).

The Department of Defense occupational Hearing Conservation Program states that the maximum allowable exposure to steady-state noise is 130 dBA [8]. Thus, in the event the sound levels were greater

than the predicted values there would be 15 dBA margin of safety before a threat of hearing damage for a short-term continuous level of 130 dBA.

### 2.2.3 Structural Damage

Generally, the most sensitive components of a structure to launch noise are windows, and infrequently, the plastered walls and ceilings. A NASA technical memo written by Guest and Sloan [9] found a relationship between structural damage claims and overall sound pressure level from rocket firings. The study was based on community responses to the 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. Guest and Sloan [9] determined that "the probability of structural damage [was] proportional to the intensity of the low frequency sound." The study concluded that one damage claim in 1,000 households exposed is expected at an average continuous level of 111 dB, and one in 100 households at 119 dB. The sound levels used to develop the criteria were mean modeled sound levels. It is important to highlight the difference between the static ground tests in which the probability of structural damage is based on and the launch events of concern for this noise analysis. The ground tests occurred for durations much greater than the exposure duration expected for the proposed launch events. Additionally, during ground tests, the engine remains in one position which results in longer exposure duration to continuous levels as opposed to the transient noise occurring from the moving vehicle during a launch event. However, the relationship between damage claims and level documented by Guest and Sloan [9] is the best available noise criteria regarding structural damage resulting from rocket noise. The distances at which the cited levels occur are presented in this noise analysis to provide a general guideline for assessing potential risk to structural damage claims. In addition, a report from the Office of Naval Research on the "Guidelines for Preparing Environmental Impact Statements on Noise" [10] states that one may conservatively consider all sound lasting more than one second with levels exceeding 130 dB (unweighted) as potentially damaging to structures. However, this report is not specific to the low-frequency noise generated by large rockets.

# 3 Acoustic Modeling Methodology

## 3.1 Launch Noise

The majority of the noise generated by a rocket launch is created by the rocket plume, or jet exhaust, interacting with the atmosphere along the entire plume, and combustion noise of the propellants. Launch noise occurs in the region surrounding the launch pad and radiates in all directions. However, it is highly directive meaning that a significant portion of the source's acoustic power is concentrated in a specific direction. Additionally, the level of noise received depends on the distance from the source. Noise decreases as the distance from the source increases, for example, there is a 6 dB decrease in OASPL per doubling of distance when described by spherical spreading.

In addition to the launch noise, a launch vehicle can create sonic booms as a result of the shock waves created from supersonic flight, when the vehicle travels faster than the speed of sound. The perception of a sonic boom depends on the distance from the vehicle to the observer as well as the physical characteristics of the vehicle and the atmospheric conditions. The noise is perceived as a deep double boom, with most of its energy concentrated in the low frequency range. Although sonic booms generally last less than one second, their potential for impact is considerable.

## 3.2 Far-Field Launch Noise Modeling

The acoustic model developed to predict far-field noise from launch vehicles is based on Eldred's Distributed Source Method 1 (DSM-1) reported in NASA SP-8072 [11]. The noise level observed depends on the vehicle specific sound power and the location of the observer in reference to the vehicle's noise source. Sound power is a measure of the acoustic energy per unit of time. The DSM-1 model determines the launch vehicle's total sound power based on its total thrust and exhaust-velocity. Both vehicles utilize SpaceX Merlin 1D Engines, each of which have a diameter of 33.8 in (0.85 m) and produce a thrust of 147,000 lbf ($6.5 \times 10^5$ N). Both vehicles use the same rocket propellant, which produces an exhaust exit velocity of approximately 9,500 ft/s (2,900 m/s). Only the first stage of the vehicle's launch is considered in this analysis, during which time the total thrust and exhaust velocity are assumed constant.

For launch vehicles with multiple tightly clustered equivalent engines, such as the Falcon 9, the engines can be modeled as a single engine with an effective exit diameter and total thrust [11]. For the Falcon 9, this equates to an effective diameter of 101.4 in (2.6 m) and a total thrust of 1,320,000 lbf ($5.8 \times 10^6$ N). The three nine-engine cores of the Falcon Heavy are handled differently, by multiplying the observed pressure for one nine-engine core by a scale factor of three, equivalent to a 4.7 dB addition. Table 1 displays the total thrust of the Falcon 9 and Falcon Heavy launch vehicles.

**Table 1. Total thrust of the Falcon 9 and Falcon Heavy launch vehicles**

| Parameter | Falcon 9 | Falcon Heavy |
|---|---|---|
| Number of Engines | 9 | 27<br>(9 x 3 cores) |
| Total Thrust | 1,320,000 lbf<br>($5.8 \times 10^6$ N) | 3,800,000 lbf<br>($17.0 \times 10^6$ N) |

The modeled noise source comprises a range of frequencies, each of which contains a portion of the total sound power. The portion of sound power contained in each frequency band is not equal and the distribution depends on the ratio of the nozzle exit diameter to exhaust exit velocity [11]. The modeled noise source is actually represented by a set of noise sources distributed along the vehicle exhaust plume, hence the name "Distributed Source Method." The defining feature of the DSM-1 is that each noise source corresponds to a unique frequency. The location of each source influences the distance and angle to the observer. However, for far-field observer locations, the variation in distance and angle from each source to the observer is minimal. Therefore, the set of distributed sources can be modeled as a compact source located at the nozzle exit with an equivalent total sound power and range of frequencies.

The sound pressure level observed is a function of the sound power generated by the engine and the location of the observer in reference to the noise source. The observed sound pressure level decreases as the distance from the source increases. The noise source radiates sound in all directions, however, it is highly directive meaning the acoustic power is concentrated in a specific direction and the sound pressure observed will depend on the angle from the noise source to the observer location. Section 3.2.2 describes the source directivity in more detail. The distance and angles are calculated based on the provided trajectory paths (Figure 3) courtesy of SpaceX, which include the ground location and altitude with respect to time.

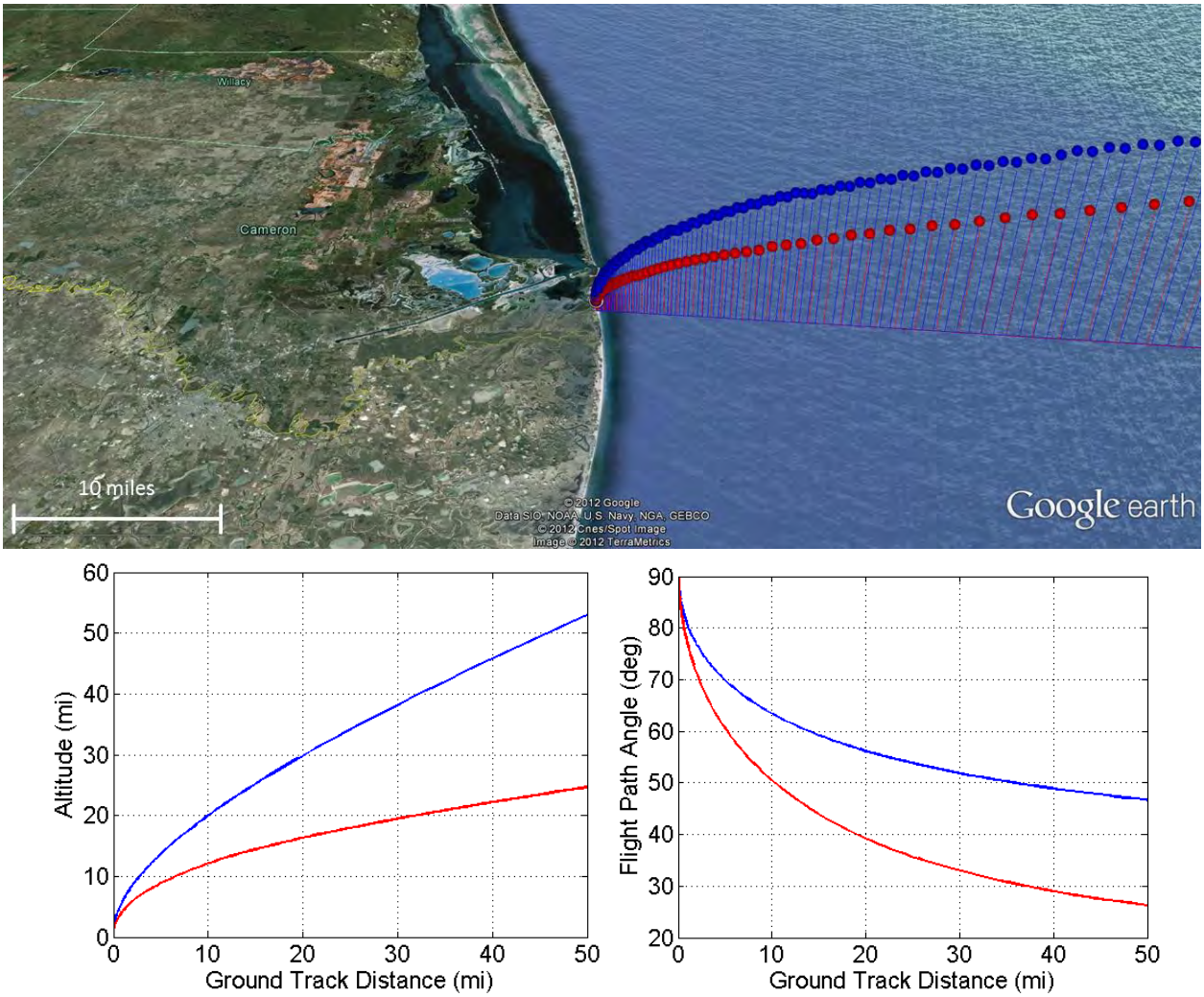


**Figure 3. Trajectory (top), altitude profile (bottom left), and flight path angle (bottom right) of Falcon 9 (blue) and Falcon Heavy (red)**

### 3.2.1 Acoustic Efficiency

The acoustic efficiency, defined as the ratio of the sound power to the exhaust mechanical power, determines the percentage of energy in the exhaust that is converted to acoustic energy. The launch vehicle's total sound power depends on the acoustic efficiency of the engine. The acoustic efficiencies of rocket engines generally range from 0.2% to 1.0%, with 1.0% considered a conservative upper bound and 0.5% the most probable [11]. The acoustic efficiency of the rocket engine was modeled using the best available methods. Guest's [12] variable acoustic efficiency model predicted an acoustic efficiency based on the total mechanical power of the engine. The predicted result, used in this study, is an acoustic efficiency of 0.4% for the SpaceX Merlin 1D Engine.

### 3.2.2 Source Directivity

Directivity is the measure of the focusing of the noise source's sound power and its value depends on the frequency and the angle to the observer. Eldred's report [11] includes a set of directivity indices based on the best available data at the time. NASA's Project Constellation Program has made significant

improvements in determining launch vehicle directivity, which resulted from measurements taken of the static firings of the reusable solid rocket motor (RSRM) of NASA Ares I – Crew Launch [13]. The RSRM directivity indices incorporate a larger range of frequencies and angles then previously available data. These updated directivity indices were used for this analysis.

### 3.2.3 Doppler Effect

Doppler effect is defined as the change in frequency of a wave for an observer moving relative to its source. It is commonly heard when a vehicle sounding a siren or horn approaches, passes, and recedes from an observer. The perceived frequency is related to the actual frequency by the speed of the source and receiver and the speed of the waves in the medium. The received frequency is higher (compared to the emitted frequency) during the approach, it is identical at the instant of passing by, and it is lower during the recession. The relative changes in frequency can be explained as follows. When 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. Therefore the time between the arrival of successive wave crests at the observer is reduced, causing an increase in the frequency. While they are travelling, the distance between successive wave fronts is reduced; so the waves "bunch together". Conversely, if the source of waves is moving away from the observer each wave is emitted from a position farther from the observer than the previous wave, so the arrival time between successive waves is increased, reducing the frequency. The distance between successive wave fronts is increased, so the waves "spread out". This spreading effect is illustrated in Figure 4 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. During a rocket launch an observer on the ground will hear a downward shift in the frequency of the sound as the rocket increases its speed relative to the observer. In this case, the difference in observed frequency to emitted frequency increases as the distance from the source to receiver increases. As the frequency is shifted lower the A-Weighting filtering on the spectrum results in a decreased A-weighted sound level. Note there would be no change in the unweighted sound levels.

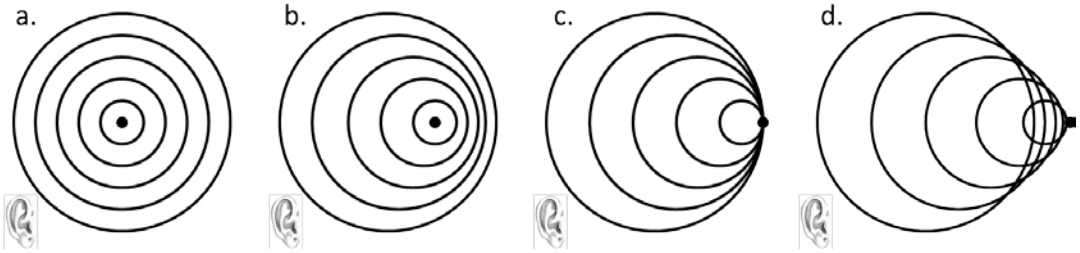


**Figure 4. Effect of expanding wavefronts (decrease in frequency) that an observer would notice for higher relative speeds of the rocket relative to the observer for: a) stationary source b) source velocity < speed of sound c) source velocity = speed of sound d) source velocity > speed of sound**

### 3.2.4 Ground Interference

Sound propagation using NASA SP-8072 [11] results in the prediction of a free-field sound level 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) shown in Figure 5. The ground will reflect sound energy back toward the receiver. Depending on the frequency of the wave and the geometry, this reflected wave may interfere with the direct wave causing constructive or destructive interference. Additionally, the ground may absorb a portion of the sound energy causing the reflected wave to propagate a smaller portion of energy to the receiver. The acoustic model accounts for the attenuation of sound by the ground [14, 15] by including the effect of the ground on a receiver when estimating the received noise. A receiver height of 5 feet is assumed along with a homogeneous semi-hard ground surface. It should be noted that noise levels directly above a water surface may see an increase of up to 3 dB because of the acoustical hardness of the water surface.

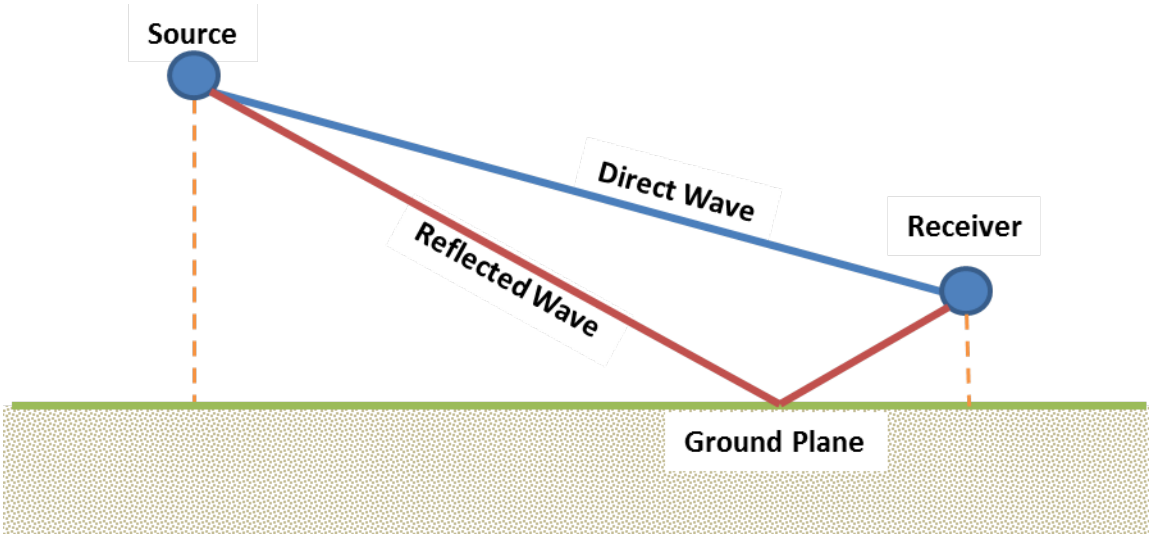


**Figure 5. Sound propagation near the ground is modeled as the combination of a direct wave (blue) and a reflected wave (red) from the source to the receiver.**

### 3.2.5 Atmospheric Absorption and Nonlinear Effects

Atmospheric absorption is a measure of the sound attenuation due to the temperature, pressure and relative humidity of the air. The attenuation of sound due to atmospheric absorption generally increases with frequency. However, due to the distortion of high-pressure sound waves as they travel through the medium, nonlinear propagation effects may counteract the effect of atmospheric absorption at certain distances.

The results of a study conducted by McInerny and Ölçmen [16] showed that rocket noise can be viewed as a distribution of nonlinear effects due to weak shocks and small-scale random noise. McInerny and Ölçmen also note that as the propagation distance increases, the importance of the shocks decreases and the noise is subjected to the linear effects of atmospheric absorption. However, McInerny and Ölçmen [16] state that even 9.3 miles (15 km) from the source, “the Titan IV sound-pressure data

retained vestiges of weak shock behavior." Additionally, in a study documented by Gee et al. [17], measurements of high-power jet aircraft appeared to have greater high-frequency energy than predicted by linear theory, indicating evidence of nonlinear propagation effects. Furthermore, nonlinear predicted spectra, which neglected atmospheric variability, showed better agreement with measured spectra than linear predictions with atmospheric absorption. Considering the results of these studies, the nonlinear effects are assumed to counteract the effects of atmospheric absorption within the region of study and therefore, both of these behaviors are neglected in the acoustic model.

## 3.3 Sonic Boom Noise Modeling

The single-event prediction model, PCBOOM4 [18, 19], provided by the Air Force Center for Engineering and Environment (AFCEE) is used to predict the sonic boom footprint. PCBOOM4 calculates the magnitude and location of sonic boom overpressures on the ground due to supersonic flight. Several inputs are required to calculate the sonic boom impact, including the aircraft model, the trajectory path, the atmospheric conditions and the ground surface height. Predicted sonic boom footprints are in the form of constant pressure contours.

# 4 Results

The following sections present the results of the acoustic models described in Section 3, with the purpose of supporting the EIS for FAA's Proposed Action to issue launch licenses and/or experimental permits to SpaceX to conduct operations of its Falcon 9 and Falcon Heavy orbital vertical launch vehicles from a launch site in Cameron County, Texas. The modeled launch noise impact is represented by four acoustic metrics, A-weighted OASPL ($L_{A,max}$), unweighted OASPL ($L_{max}$), SEL, and DNL, and presented in the form of noise contour maps. The launch noise model utilizes a flight trajectory profile provided by SpaceX (Figure 3), in which only the first stage is considered. The modeled noise does not include the effect of atmospheric absorption or nonlinear propagation effects as described in Section 3.2.5.

In addition to the noise contour maps, special consideration is given to the noise levels observed at the nearest house location. The time history of the OASPL is presented to assess the launch noise levels in reference to the noise criteria described in Section 2.2. Lastly, the results of the sonic boom model are presented to provide a complete assessment of the noise impact.

## 4.1 Maximum A-weighted OASPL Contour Maps

The OASPL provides a measure of the level at any given time. The $L_{A,max}$ represents the maximum A-weighted OASPL observed over a duration of an event. The noise levels resulting from the launch of the Falcon 9 launch vehicle are shown in the six-mile-radial and twenty-mile-radial contour maps in Figure 6 and Figure 7, respectively. The Falcon Heavy launch $L_{A,max}$ contour maps are shown in Figure 8 and Figure 9. The contour maps are centered on the launch site and the contour lines are labeled with their respective levels in 5 dBA increments. As a reference location, the site of the nearest house is marked with a black diamond. The asymmetric extension of the contours directly below the flight path is a consequence of the vehicle's trajectory, specifically the flight path angle and its altitude, which is more prevalent for the Falcon Heavy as its trajectory lies closer to the ground in comparison to the Falcon 9.

The maximum $L_{A,max}$ at any given distance from the launch pad is shown Table 2 for the Falcon 9 and Falcon Heavy.. The level presented for a given distance encompasses all headings, resulting in the collapse of the contour data to a line. It should be noted that distances less than 2,000 ft are approaching the near-field range where a more rigorous study would be required to account for a non-compact source, the deflection of the plume off the pad and the pad structure, the effect of the deluge system, and near-field propagation, among other effects. Hearing protection to reduce levels below 115 dBA is recommended at distances up to 1.2 and 2.1 miles for the Falcon 9 and Falcon Heavy, respectively.

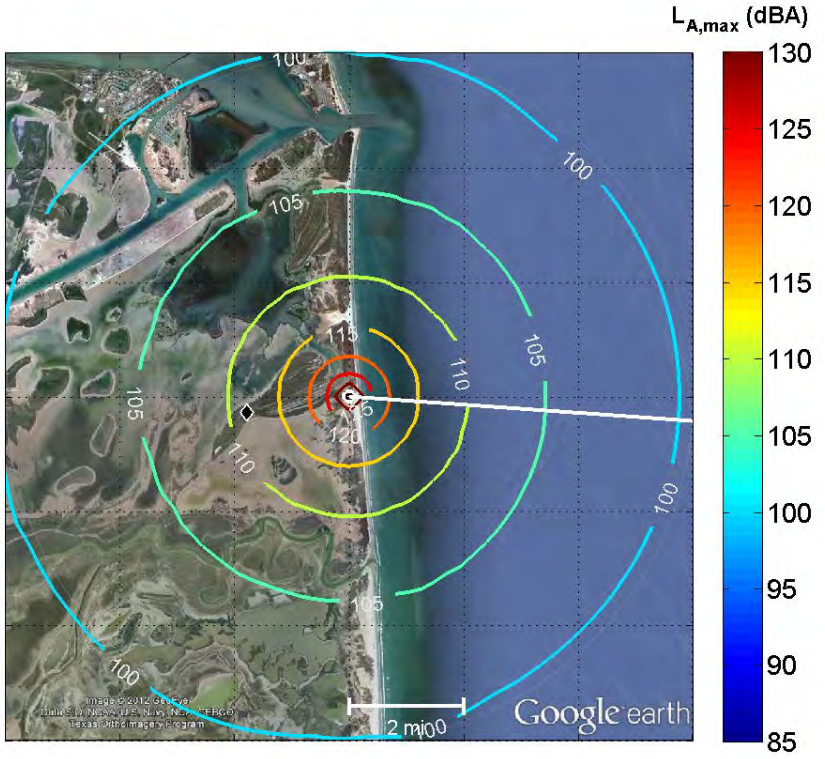


**Figure 6. Falcon 9 $L_{A,max}$ within 6-mile radius from launch site**

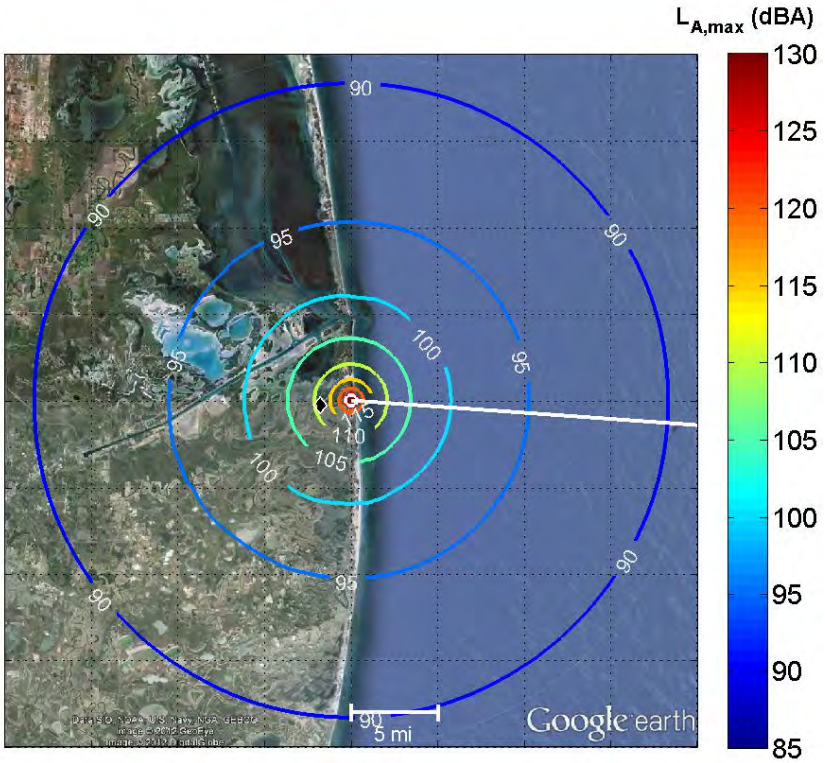


**Figure 7. Falcon 9 $L_{A,max}$ within 20-mile radius from launch site**

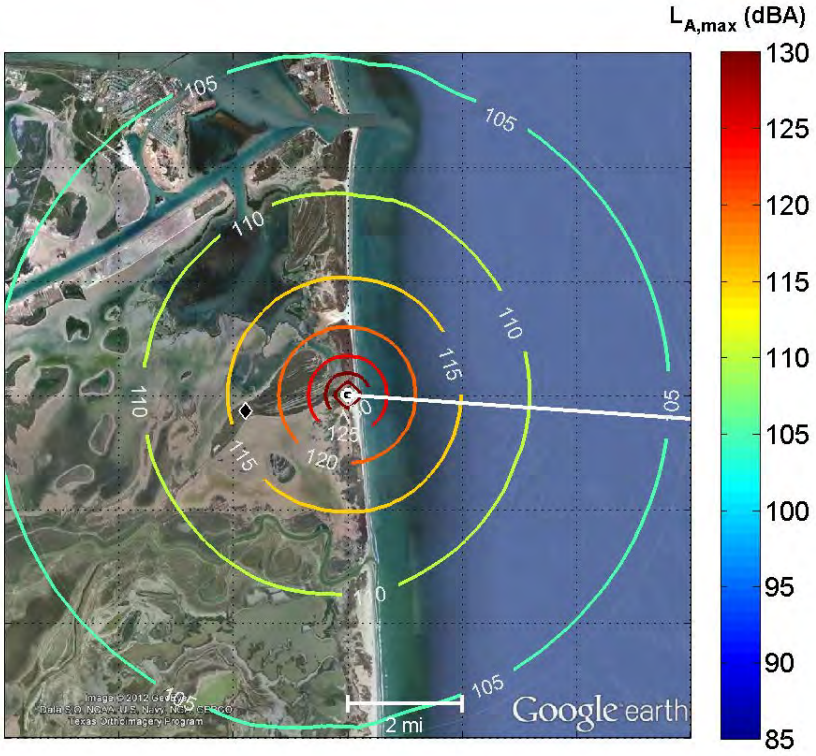


**Figure 8. Falcon Heavy $L_{A,max}$ within 6-mile radius from launch site**

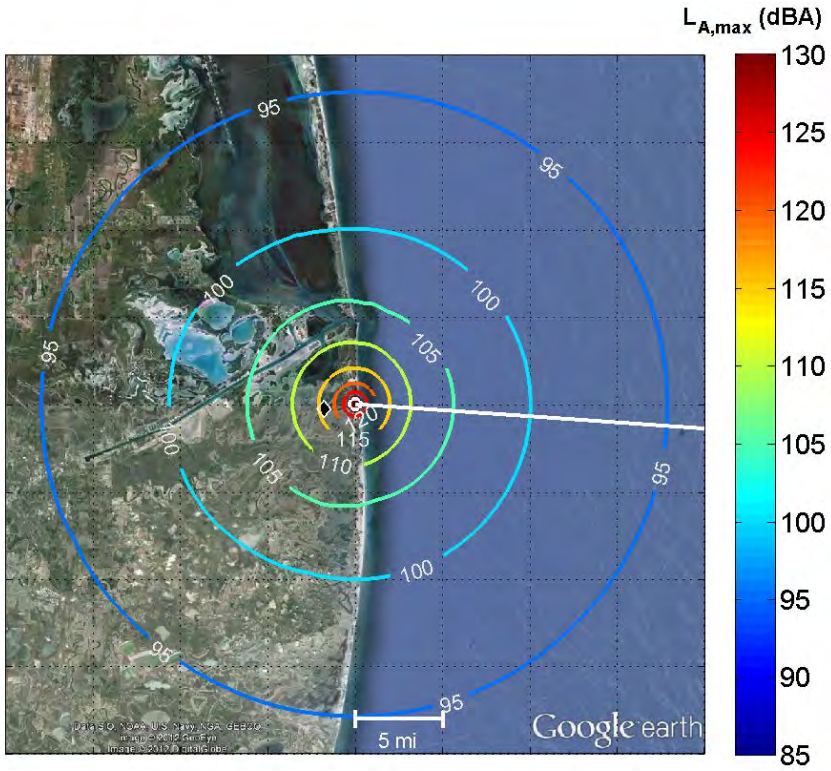


**Figure 9. Falcon Heavy $L_{A,max}$ within 20-mile radius from launch site**

**Table 2. Maximum predicted $L_{A,max}$ versus distance**

| Maximum Predicted $L_{A,max}$ (dBA) | | |
|---|---|---|
| Distance (mi) | Falcon 9 | Falcon Heavy |
| 0.2 | 130 | 135 |
| 0.3 | 128 | 133 |
| 0.4 | 125 | 130 |
| 0.5 | 123 | 128 |
| 0.6 | 122 | 126 |
| 0.7 | 120 | 125 |
| 0.8 | 119 | 123 |
| 0.9 | 118 | 123 |
| 1.0 | 117 | 122 |
| 1.5 | 113 | 118 |
| 2 | 111 | 115 |
| 3 | 107 | 112 |
| 4 | 104 | 109 |
| 5 | 102 | 107 |
| 6 | 100 | 105 |
| 7 | 99 | 104 |
| 8 | 98 | 103 |
| 9 | 96 | 101 |
| 10 | 95 | 100 |
| 12 | 94 | 99 |
| 15 | 92 | 97 |
| 17 | 91 | 95 |
| 20 | 89 | 94 |

## 4.2 Maximum Unweighted OASPL Contour Maps

A NASA technical memo written by Guest and Sloan [9] found a relationship between structural damage claims and overall sound pressure level from rocket firings, where "the probability of structural damage [was] proportional to the intensity of the low frequency sound." The study concluded that one damage claim in 1,000 households exposed is expected at an average level of 111 dB, and one in 100 households at an average level of 119 dB. These specific levels are provided as a general guideline to assess the potential risk for structural damage when reviewing the $L_{max}$ contour maps. The noise levels resulting from the launch of the Falcon 9 launch vehicle are shown in the six-mile-radial and twenty-mile-radial contour maps in Figure 10 and Figure 11, respectively. The Falcon Heavy launch $L_{max}$ contour maps are shown in Figure 12 and Figure 13. The contour maps are centered on the launch site and the contour lines are labeled with their respective levels in 5 dB increments. As a reference location, the site of the nearest house is marked with a black diamond. The asymmetric extension of the contours directly below the flight path, shown in Figure 13, is a consequence of the vehicle's trajectory, specifically the flight path angle and its altitude, which is more prevalent for the Falcon Heavy as its trajectory lies closer to the ground in comparison to the Falcon 9.

The maximum $L_{max}$ at any given distance from the launch pad is shown in Table 3 for the Falcon 9 and Falcon Heavy. The level presented for a given distance encompasses all headings, resulting in the collapse of the contour data to a line. The relationship between damage claims and level documented by Guest and Sloan is the best available noise criteria regarding structural damage resulting from rocket noise. The distances at which the cited levels occur are presented in this noise analysis to provide a general guideline for assessing potential risk to structural damage claims. The area on land exposed to levels of 119 dB or greater is included within 3.4 and 6.4 miles from the launch site for the Falcon 9 and Falcon Heavy, respectively. The area on land exposed to levels of 111 dB or greater is included within 9.1 and 17.3 miles from the launch site for the Falcon 9 and Falcon Heavy, respectively.

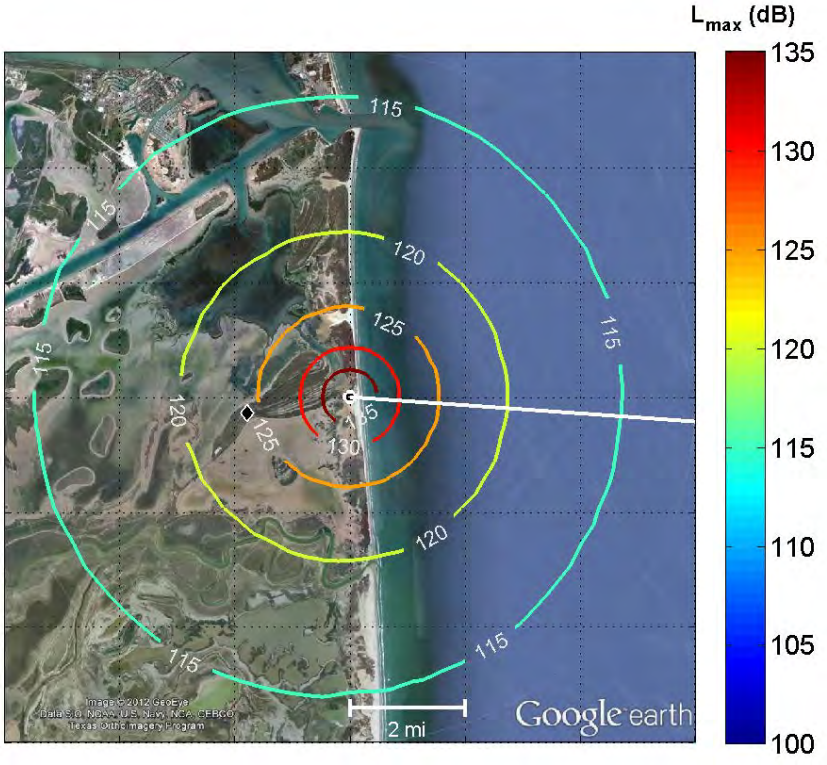


**Figure 10. Falcon 9 $L_{max}$ within 6-mile radius from launch site**

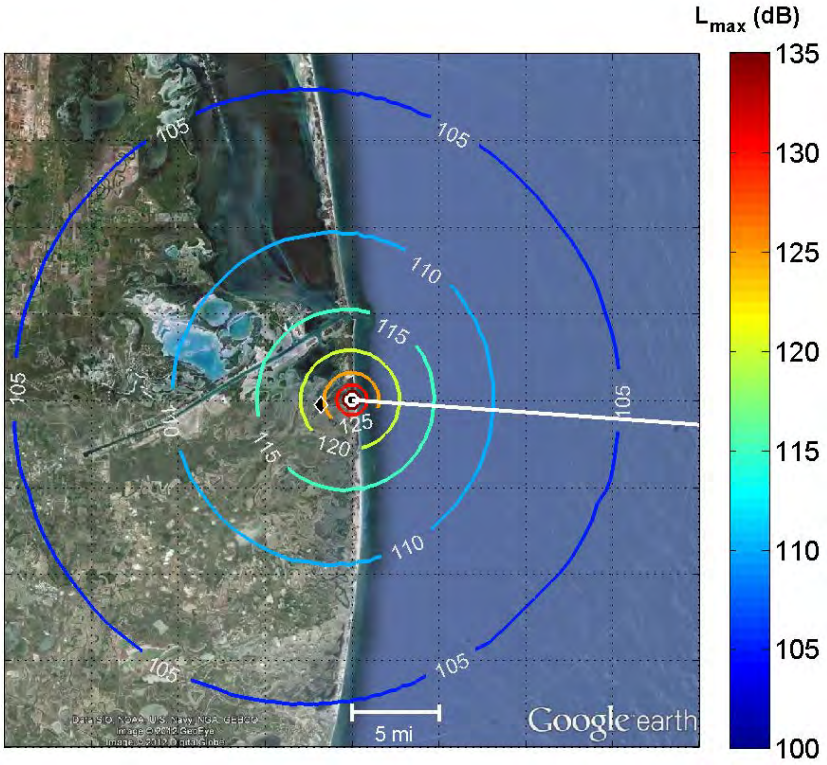


**Figure 11. Falcon 9 $L_{max}$ within 20-mile radius from launch site**

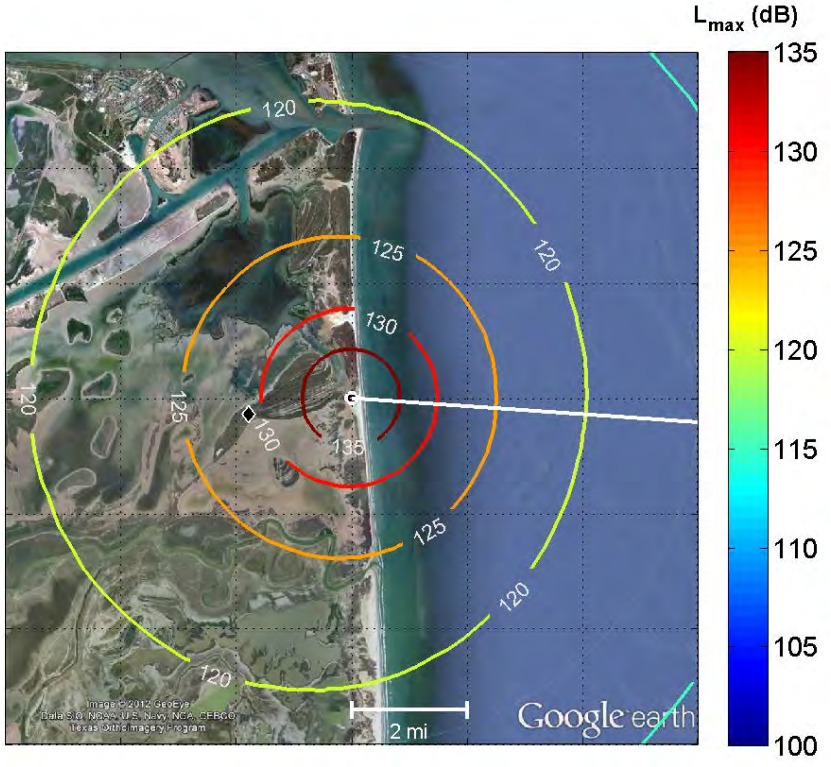


**Figure 12. Falcon Heavy $L_{max}$ within 6-mile radius from launch site**

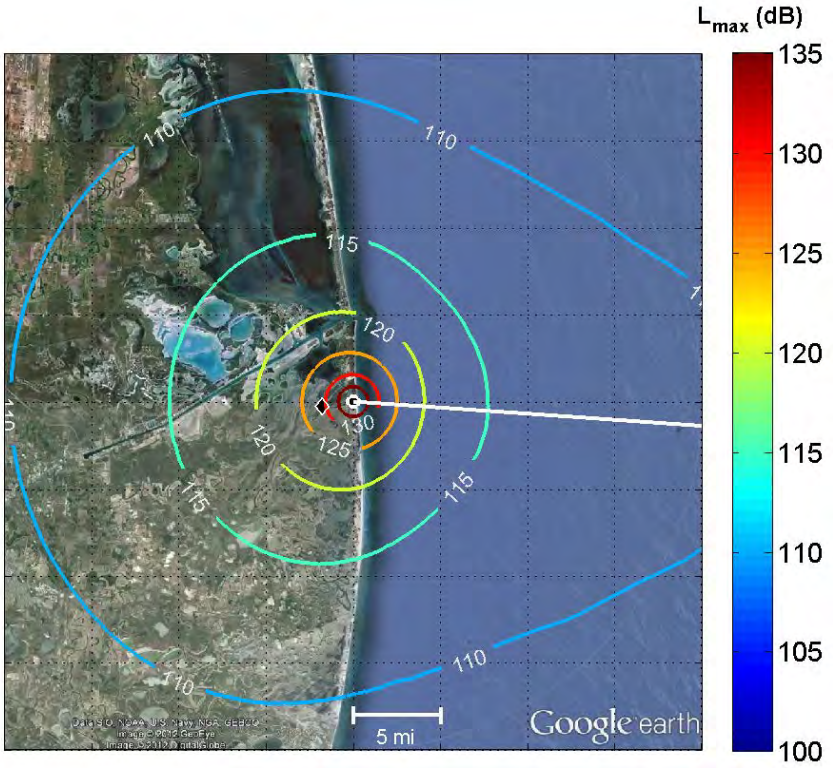


**Figure 13. Falcon Heavy $L_{max}$ within 20-mile radius from launch site**

**Table 3. Maximum predicted $L_{max}$ versus distance**

| Maximum Predicted $L_{max}$ (dB) | | |
|---|---|---|
| Distance (mi) | Falcon 9 | Falcon Heavy |
| 0.2 | 141 | 146 |
| 0.3 | 139 | 144 |
| 0.4 | 137 | 142 |
| 0.5 | 135 | 140 |
| 0.6 | 133 | 138 |
| 0.7 | 132 | 137 |
| 0.8 | 130 | 135 |
| 0.9 | 130 | 135 |
| 1.0 | 129 | 134 |
| 1.5 | 126 | 130 |
| 2 | 123 | 128 |
| 3 | 120 | 125 |
| 4 | 117 | 122 |
| 5 | 116 | 121 |
| 6 | 114 | 119 |
| 7 | 113 | 118 |
| 8 | 112 | 117 |
| 9 | 111 | 116 |
| 10 | 110 | 115 |
| 12 | 109 | 114 |
| 15 | 107 | 112 |
| 17 | 106 | 111 |
| 20 | 105 | 111 |

## 4.3 A-weighted SEL Contour Maps

SEL represents both the magnitude of a sound and its duration. SEL provides a measure of the net exposure of the entire acoustic event, but it does not directly represent the sound level heard at any given time. The modeled A-weighted SEL resulting from the launch of the Falcon 9 launch vehicle are shown in the six-mile-radial and twenty-mile-radial contour maps in Figure 14 and Figure 15, respectively. The Falcon Heavy launch SEL contour maps are shown in Figure 16 and Figure 17. The contour maps are centered on the launch site and the contour lines are labeled with their respective levels in 5 dBA increments. As a reference location, the site of the nearest house is marked with a black diamond. The asymmetric extension of the contours directly below the flight path is a consequence of the vehicle's trajectory, specifically the flight path angle and its altitude, which is more prevalent for the Falcon Heavy as its trajectory lies closer to the ground in comparison to the Falcon 9. The receptor locations along the flight path are exposed to larger sound levels for a longer duration as they experience the noise from the vehicle approaching their position directly overhead in addition to the vehicle moving farther away.

The maximum SEL at any given distance from the launch pad is shown in Table 4 for the Falcon 9 and Falcon Heavy. The level presented for a given distance encompasses all headings, resulting in the collapse of the contour data to a line.

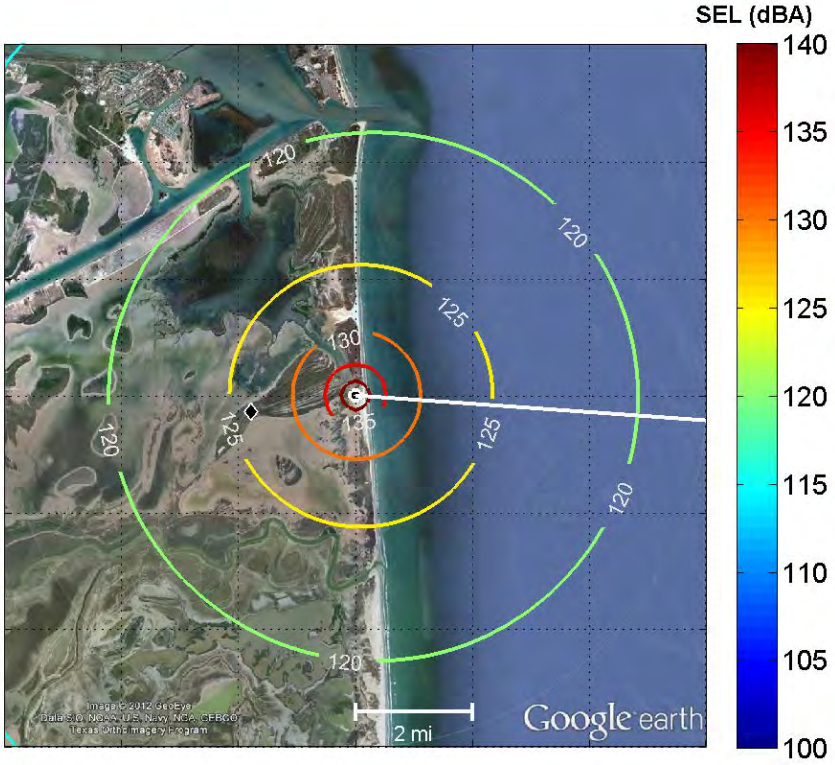


**Figure 14. Falcon 9 SEL within 6-mile radius from launch site**

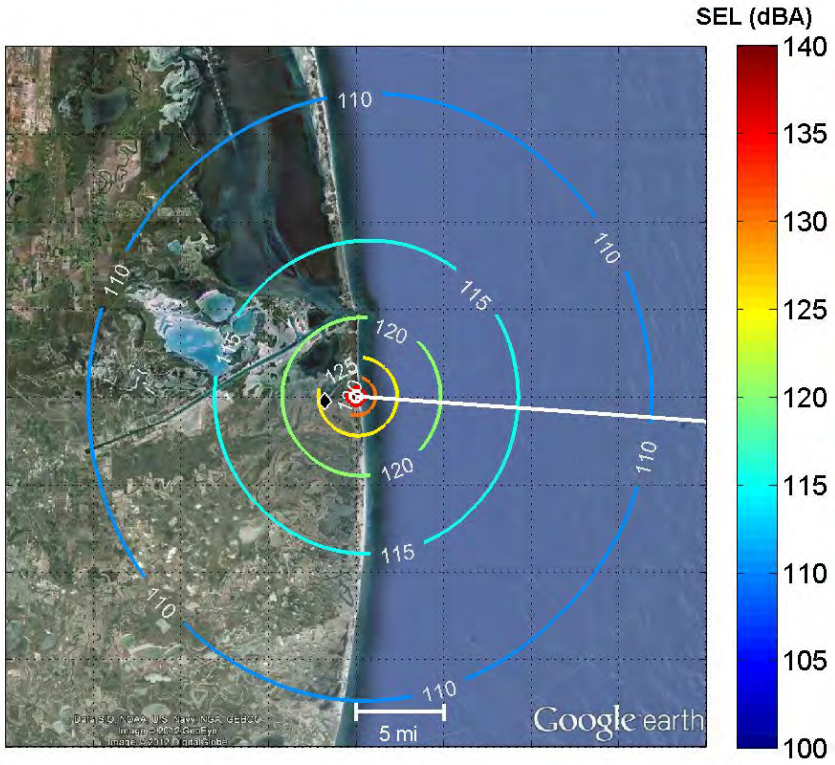


**Figure 15. Falcon 9 SEL within 20-mile radius from launch site**

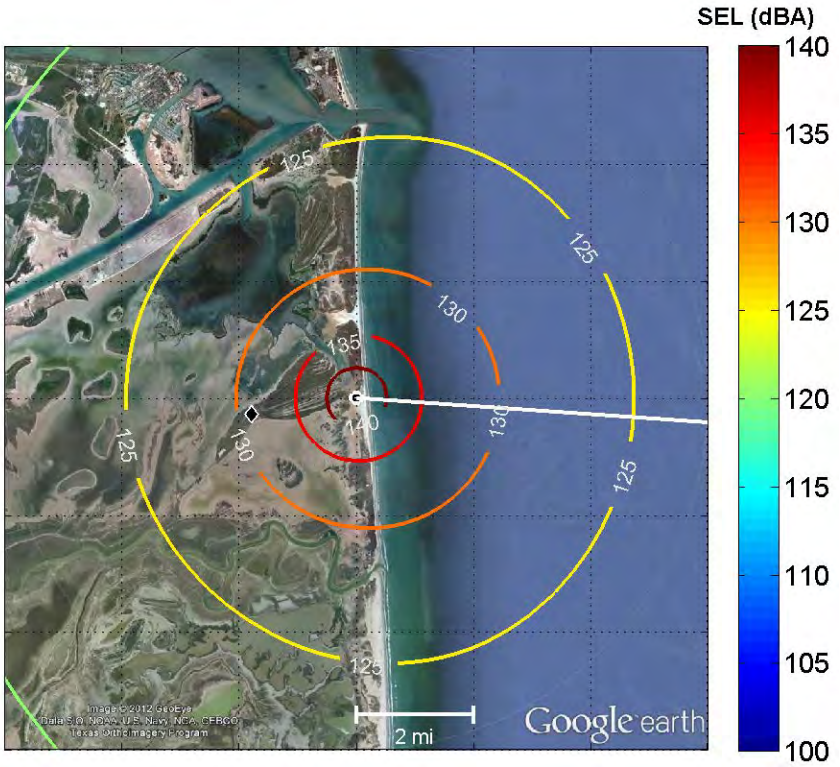


**Figure 16. Falcon Heavy SEL within 6-mile radius from launch site**

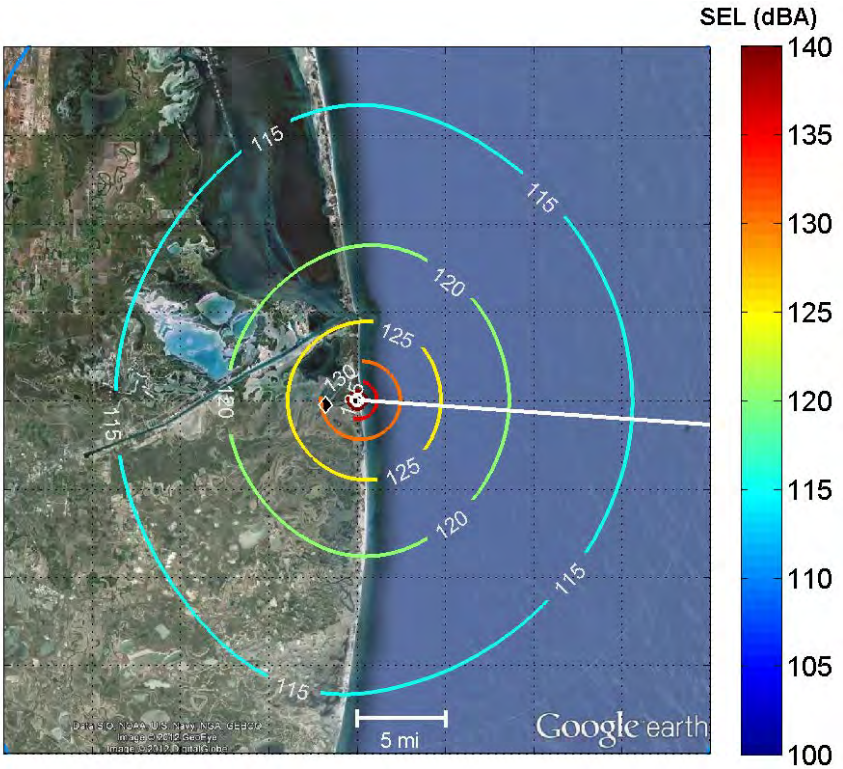


**Figure 17. Falcon Heavy SEL within 20-mile radius from launch site**

**Table 4. Maximum predicted SEL versus distance**

| Maximum Predicted SEL (dBA) | | |
|---|---|---|
| Distance (mi) | Falcon 9 | Falcon Heavy |
| 0.2 | 141 | 145 |
| 0.3 | 139 | 144 |
| 0.4 | 137 | 142 |
| 0.5 | 135 | 140 |
| 0.6 | 134 | 139 |
| 0.7 | 133 | 138 |
| 0.8 | 132 | 137 |
| 0.9 | 131 | 136 |
| 1.0 | 131 | 136 |
| 1.5 | 128 | 133 |
| 2 | 126 | 131 |
| 3 | 123 | 129 |
| 4 | 121 | 126 |
| 5 | 120 | 125 |
| 6 | 118 | 123 |
| 7 | 117 | 122 |
| 8 | 116 | 121 |
| 9 | 115 | 120 |
| 10 | 114 | 119 |
| 12 | 113 | 118 |
| 15 | 111 | 116 |
| 17 | 110 | 115 |
| 20 | 109 | 113 |

## 4.4 DNL Contour Map

Daily average sound levels are typically used for the evaluation of community annoyance. DNL is a composite metric that accounts for the SEL of all noise events in a 24-hour period. Typically DNL levels are expressed as the level over a 24-hour annual average day. In order to account for increased human sensitivity to noise at night, a 10 dB penalty is applied to nighttime events (occurring between the hours of 10:00 p.m. and 7:00 a.m.). Therefore, the DNL is dependent on the number of annual daytime and nighttime events. The Proposed Action includes up to twelve total launches per year which equates to 0.033 average daily events.

The Proposed Action includes up to one nighttime launch per year. Three scenarios are outlined in Table 5 and their respective 65 dBA noise contours are shown in Figure 18. Scenario A includes ten Falcon 9 and two Falcon Heavy daytime launch events. Scenario B includes one nighttime event for a Falcon 9 and Scenario C includes one nighttime event for a Falcon Heavy. Each scenario shows a significant increase in the DNL relative to current conditions as defined by FAA order 1050.1E, Change 1 [2] as the current background noise levels are estimated at approximately 45 dBA [20]. The area inside the DNL 65 dBA contour levels extend to distances of 1.5, 2.0, and 2.8 miles, for Scenario A, B, and C, respectively. The number of households within the DNL 65 dBA is estimated using Google Earth as 0, 13, and 39, for Scenario's A, B, and C, respectively. However, the Proposed Action is for up to twelve total launches per year. Thus, it is acknowledged that the suitability of DNL for infrequent noise events is uncertain with respect to current research and dose response studies. The DNL 65 dBA noise contours are provided in this section to comply with FAA requirements.

**Table 5. Annual operations scenarios used to compute DNL noise contours**

| Scenario | Falcon 9 Annual Operations | | Falcon Heavy Annual Operations | | Total Operations |
|---|---|---|---|---|---|
| | Daytime | Nighttime | Daytime | Nighttime | |
| A | 10 | 0 | 2 | 0 | **12** |
| B | 9 | 1 | 2 | 0 | **12** |
| C | 10 | 0 | 1 | 1 | **12** |

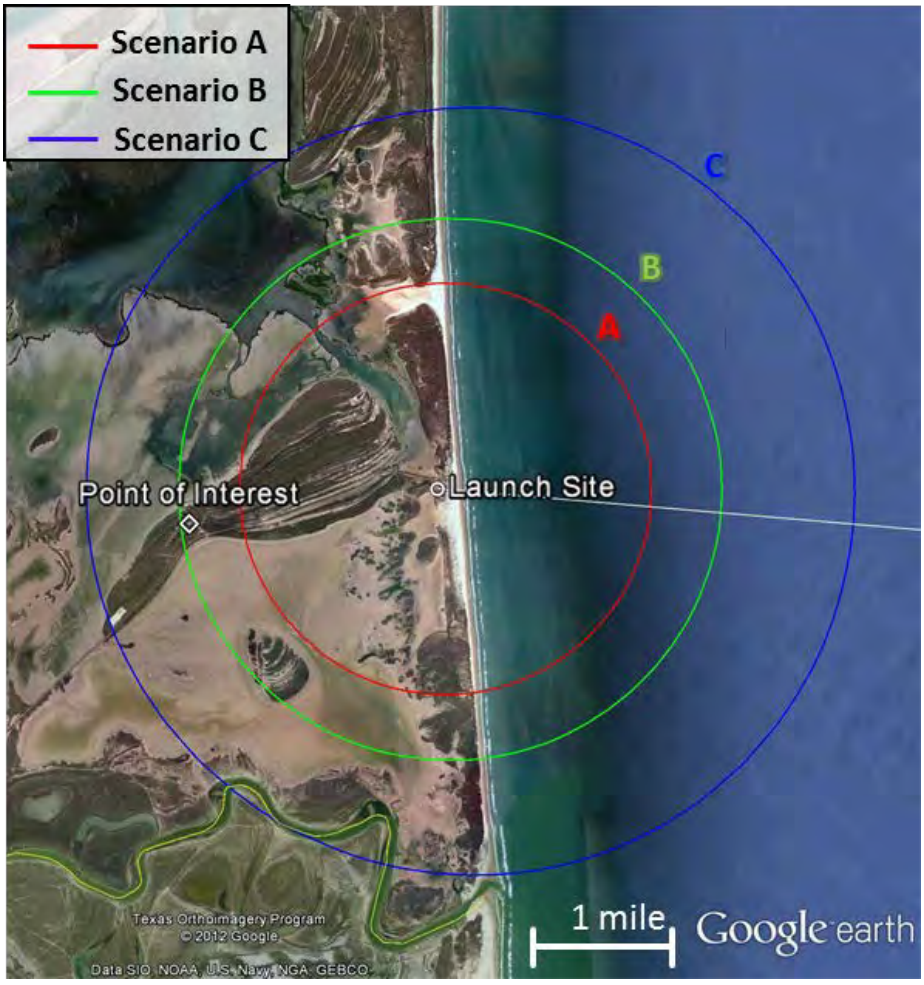


**Figure 18. DNL 65 dBA noise contours for the three annual operations scenarios**

## 4.5 Sonic Boom Noise Contours

The Falcon 9 and Falcon Heavy sonic boom footprints due to supersonic flight are presented in Figure 19 and Figure 20, respectively. The sonic boom overpressure is measured in pounds per square foot (psf) and the contours may not close due to the finite time steps of the trajectory profile. The trajectory is plotted in white for reference. The sonic booms modeled intercept the ground well off the coast of the study area in the Gulf of Mexico.

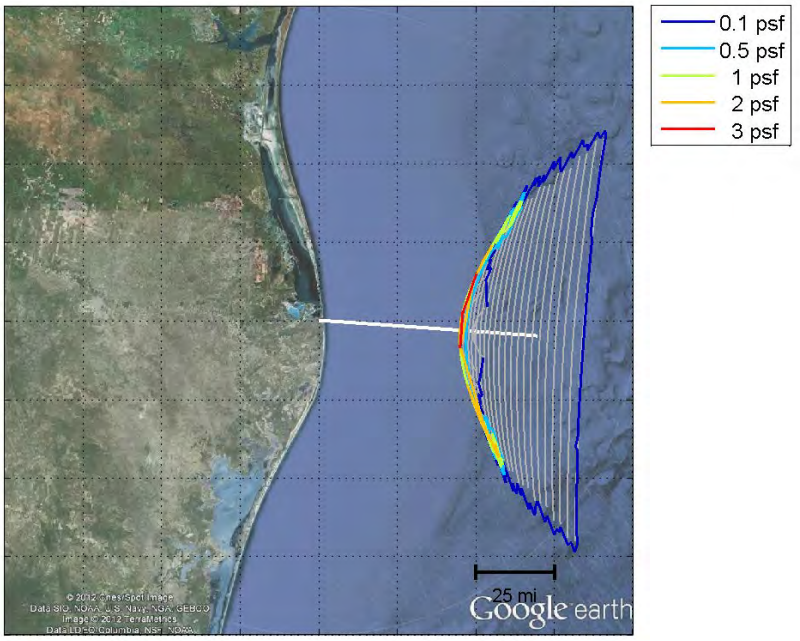


**Figure 19. Falcon 9 sonic boom footprint within a 100-mile radius from launch site**

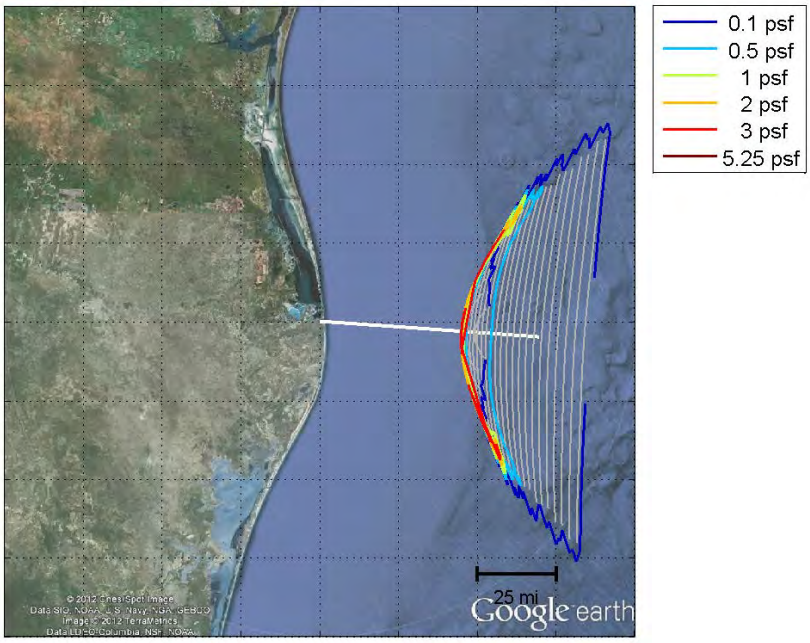


**Figure 20. Falcon Heavy sonic boom footprint within a 100-mile radius from launch site**

## 4.6 OASPL at Nearest House Location

The nearest house location was modeled as a specific point of interest to determine the sound levels due to a single launch event of the Falcon 9 and Falcon Heavy. The nearest house, shown in Figure 21, is located approximately 1.8 miles from the proposed launch site at a latitude and longitude of, 25.99279167° N and 97.18148611° W [21]. Assessment methods include a presentation of the "A-weighted" OASPL with respect to time at the nearest house location in addition to the noise contours.


**Figure 21. Location of nearest house in reference to the proposed launch site**

The model predicted maximum OASPL of 111 dBA and 116 dBA for the Falcon 9 and Falcon Heavy, respectively, as shown in Table 6. The OASPL time history observed at this location for the Falcon 9 and Falcon Heavy, are shown in Figure 22 and Figure 23, respectively. Near the end of the first stage, the OASPL appears to decrease at a slower rate, which is due to the nature of the trajectory. Although the vehicle is moving farther away, its orientation to the ground is shifting so that more acoustic energy is directed towards the house based on the angle from the source to receiver. In addition, as the launch vehicle moves away from the house, the time required for a doubling of distance, equating to a level decrease of 6 dB, increases, resulting in a reduced slope.

Occupants at this location should consider the use of hearing protection during a launch event based on the 115 dBA OSHA standard. For the structure, the probability of a noise induced structural vibration damage claim will be greater than one in 100 for a launch event.

**Table 6. $L_{max}$ at nearest house location**

| OASPL at Nearest House Location | Unweighted OASPL (dB) | A-weighted OASPL (dBA) |
|---|---|---|
| Falcon 9 | 124 | 111 |
| Falcon Heavy | 129 | 116 |

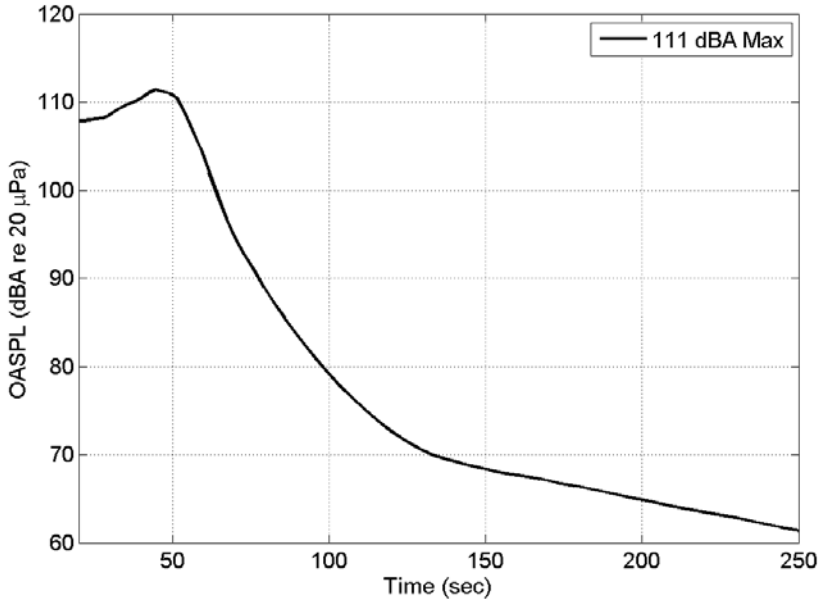


**Figure 22. Falcon 9 OASPL time history at nearest house location**

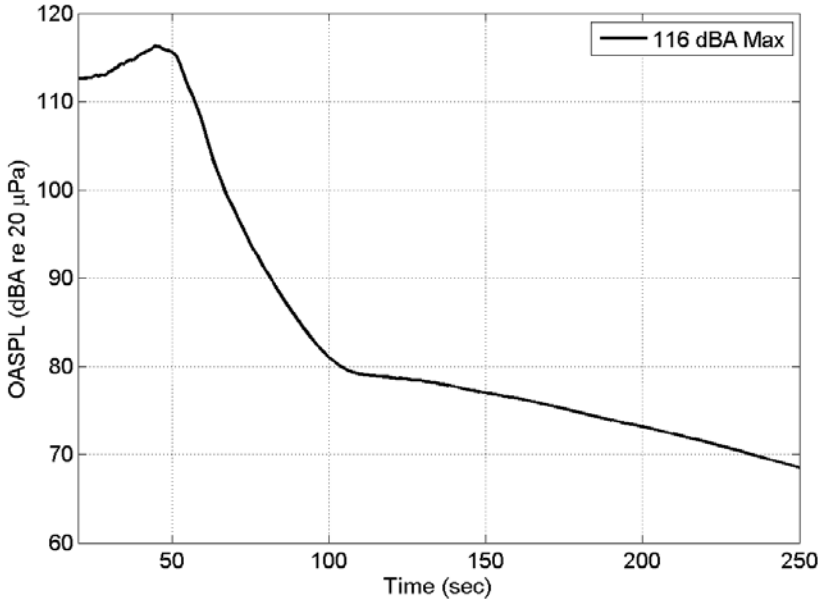


**Figure 23. Falcon Heavy OASPL time history at nearest house location**

# 5 Summary

This noise analysis supports the EIS for the FAA/AST Proposed Action to issue launch licenses and/or experimental permits to SpaceX that would allow SpaceX to conduct launches of the Falcon 9 and Falcon Heavy orbital vertical launch vehicles and a variety of reusable suborbital launch vehicles from a launch site on privately owned property in Cameron County, Texas. The launch noise impact assessment utilizes noise contour maps generated with an advanced acoustic model and should be viewed in reference to the noise criteria presented in Section 2.2.

To assess the noise impact on humans, "A-weighted" OASPL noise contours are presented in reference to the 115 dBA OSHA guidelines. The noise level is greatest nearest to the launch site and decreases as the distance from the launch site increases. Therefore, when considering the 115 dBA guideline, the 115 dBA contour line will encompass the area of concern and any location outside of the contour should experience levels less than 115 dBA. The results of this study conclude that levels may exceed the 115 dBA guideline within distances of approximately 1.2 and 2.1 miles for the Falcon 9 and Falcon Heavy, respectively. However, the public is notified in advance of launch dates, and while some observers may, under appropriate atmospheric conditions, find the noise from a launch to be an annoyance, the noise is maintained for short durations, is of low frequency, attenuates rapidly, and occurs infrequently.

Special consideration was given to the nearest house, located approximately 1.8 miles from the launch site, where the model predicted a $L_{A,max}$ of 111 dBA and 116 dBA for the Falcon 9 and Falcon Heavy. Although, the 115 dBA guideline may be a conservative limit when considering the relatively short-term increase to this level, it is recommended that persons should wear sufficient hearing protection during a launch.

To assess the potential for increases in community annoyance DNL 65 dBA contours are provided for three scenarios. Each scenario shows a significant increase in the DNL relative to current conditions as defined by FAA order 1050.1E, Change 1 [2] as the current background noise levels are estimated at approximately 45 dBA [20]. The area inside the DNL 65 dBA contour levels extend to distances of 1.5, 2.0, and 2.8 miles, for Scenario A, B, and C, respectively, as defined in Section 4.4. The number of households within the DNL 65 dBA is estimated using Google Earth as 0, 13, and 39, for Scenario's A, B, and C, respectively. However, the Proposed Action is for up to twelve total launches per year. Thus, it is acknowledged that the suitability of DNL for infrequent noise events is uncertain with respect to current research and dose response studies. The DNL contours are provided to estimate the potential annoyance in compliance with FAA requirements.

To assess the structural impact resulting from the launch noise, the unweighted levels of 111 dB and 119 dB are highlighted as a general guideline for assessing potential risk to structural damage claims based on the study by Guest and Sloan [9]. The study concluded that one damage claim in 1,000 households exposed is expected at an average level of 111 dB, and one in 100 households at an average level of 119 dB. The area on land exposed to levels of 119 dB or greater is included within 3.4

and 6.4 miles from the launch site for the Falcon 9 and Falcon Heavy, respectively. The area on land exposed to levels of 111 dB or greater is included within 9.1 and 17.3 miles from the launch site for the Falcon 9 and Falcon Heavy, respectively. The unweighted levels at the nearest house during a Falcon 9 or Falcon Heavy launch suggest that the probability of a noise induced structural vibration damage claim will be greater than one in a 100.

In addition to modeling the launch noise, the ground overpressure due to sonic booms was modeled to give a complete view of the noise impact generated by a launch event. Results of the sonic boom analysis clearly show that the ground intercept of the sonic boom is observed more than 40-miles off the coast in the Gulf of Mexico.

# 6 Works Cited

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[4] L. Finegold, C. Harris and H. v. Gierke, "Community Annoyance and Sleep Disturbance: Updated Criteria for Assessing the Impacts of General Transportation Noise on People"," *Noise Control Engineering Journal,* vol. 42, pp. 25-30, January - February 1994.

[5] National Institute for Occupational Safety and Health (NIOSH), "Criteria for a Recommended Standard-Occupational Exposure to Noise – Revised Criteria 1998," DHHS (NIOSH) Pub. No. 98-126, 1998.

[6] Occupational Safety & Health Administration (OSHA), "Occupational Saftey and Health Standards," 1910.95 App A.

[7] The U. S. Environmental Protection Agency (EPA), "Information on levels of environmental noise requisite to protect public health and welfare with an adequate margin of safety," 55/9-74-004, 1974.

[8] Department of Defense, "Instruction: Hearing Conservation Program (HCP)," DoDI 6055.12, 2010.

# APPENDIX C

## Past and Future Launch Vehicle Actions

# RECENT PAST US SPACE LAUNCHES

| | | | | |
|---|---|---|---|---|
| 02/08/10 | Endeavour | Launch Pad 39A | STS-130 | (S) One-Hundred-Thirtieth Space Shuttle Mission |
| 02/11/10 | Atlas V | Launch Pad 41 | SDO | (S) Solar Dynamics Observatory |
| 03/04/10 | Delta IV | Launch Pad 37B | GOES-P | (S) Geostationary Operational Environmental Satellite |
| 04/05/10 | Discovery | Launch Pad 39A | STS-131 | (S) One-Hundred-Thirty-First Space Shuttle Mission |
| 04/22/10 | Atlas V | Launch Pad 41 | X-37B OTV-1 | (S) Air Force Orbital Test Vehicle |
| 05/14/10 | Atlantis | Launch Pad 39A | STS-132 | (S) One-Hundred-Thirty-Second Space Shuttle Mission |
| 05/27/10 | Delta IV | Launch Pad 37B | NAVSTAR IIF-01 | (S) Global Positioning System Satellite |
| 06/04/10 | Falcon 9 | Launch Pad 40 | Vehicle Test | (S) Carried Unpowered Dragon Space Capsule Mock-Up |
| 06/08/10 | Trident II | Maryland | Vehicle Test | (T) Performance Data Is Not Available |
| 06/08/10 | Trident II | Maryland | Vehicle Test | (T) Performance Data Is Not Available |
| 06/09/10 | Trident II | Maryland | Vehicle Test | (T) Performance Data Is Not Available |
| 06/09/10 | Trident II | Maryland | Vehicle Test | (T) Performance Data Is Not Available |
| 08/14/10 | Atlas V | Launch Pad 41 | AEHF-1 | (S) Advanced Extremely High Frequency Military Com Satellite |
| 11/21/10 | Delta IV | Launch Pad 37B | NROL-32 | (S) National Reconnaissance Office Classified Payload |
| 12/08/10 | Falcon 9 | Launch Pad 40 | COTS-1 | (S) Commercial Orbital Transportation Services |
| 02/24/11 | Discovery | Launch Pad 39A | STS-133 | (S) One-Hundred-Thirty-Third Space Shuttle Mission |
| 03/05/11 | Atlas V | Launch Pad 41 | X-37B OTV-2 | (S) Air Force Orbital Test Vehicle |
| 03/11/11 | Delta IV | Launch Pad 37B | NROL-27 | (S) National Reconnaissance Office Classified Payload |
| 05/07/11 | Atlas V | Launch Pad 41 | SBIRS GEO-1 | (S) Space Based Infrared System Geostationary Military Payload |
| 05/16/11 | Endeavour | Launch Pad 39A | STS-134 | (S) One-Hundred-Thirty-Fourth Space Shuttle Mission |
| 07/08/11 | Atlantis | Launch Pad 39A | STS-135 | (S) One-Hundred-Thirty-Fifth And Final Space Shuttle Mission |
| 07/16/11 | Delta IV | Launch Pad 37B | NAVSTAR IIF-02 | (S) Global Positioning System Satellite |
| 08/05/11 | Atlas V | Launch Pad 41 | JUNO | (S) Probe To Orbit The Planet Jupiter |
| 09/10/11 | Delta II 7000 | Launch Pad 17B | GRAIL | (S) Gravity Recovery And Interior Laboratory Twin Lunar Orbiters |
| 11/26/11 | Atlas V | Launch Pad 41 | MSL | (S) Mars Science Laboratory With Curiosity Rover |
| 01/19/12 | Delta IV | Launch Pad 37B | WGS-4 | (S) Wideband Global Satcom Military Satellite |
| 02/22/12 | Trident II | Tennessee | Vehicle Test | (T) Performance Data Is Not Available |
| 02/24/12 | Atlas V | Launch Pad 41 | MUOS-1 | (S) Mobile User Objective System Navy Communications Satellite |
| 04/14/12 | Trident II | Maryland | Vehicle Test | (T) Performance Data Is Not Available |
| 04/14/12 | Trident II | Maryland | Vehicle Test | (T) Performance Data Is Not Available |
| 04/16/12 | Trident II | Maryland | Vehicle Test | (T) Performance Data Is Not Available |
| 04/16/12 | Trident II | Maryland | Vehicle Test | (T) Performance Data Is Not Available |
| 05/04/12 | Atlas V | Launch Pad 41 | AEHF-2 | (S) Advanced Extremely High Frequency Military Com Satellite |
| 05/22/12 | Falcon 9 | Launch Pad 40 | COTS-2 COTS-3 | (S) Commercial Orbital Transportation Services |
| 06/20/12 | Atlas V | Launch Pad 41 | NROL-38 | (S) National Reconnaissance Office Classified Payload |
| 06/29/12 | Delta IV | Launch Pad 37B | NROL-15 | (S) National Reconnaissance Office Classified Payload |
| 08/30/12 | Atlas V | Launch Pad 41 | RBSP-A/RBSP-B | (S) Twin Radiation Belt Storm Probes |
| 10/04/12 | Delta IV | Launch Pad 37B | NAVSTAR IIF-03 | (S) Global Positioning System Satellite |
| 10/07/12 | Falcon 9 | Launch Pad 40 | CRS-1 | (S) Commercial Resupply Services To International Space Station |
| 10/23/12 | Trident II | Vigilant | Vehicle Test | (T) Performance Data Is Not Available |
| 12/11/12 | Atlas V | Launch Pad 41 | X-37B OTV-3 | (S) Air Force Orbital Test Vehicle |
| 01/30/13 | Atlas V | Launch Pad 41 | TDRS-K | (S) Tracking And Data Relay Satellite |
| 03/01/13 | Falcon 9 | Launch Pad 40 | CRS-2 | (S) Commercial Resupply Services To International Space Station |
| 03/19/13 | Atlas V | Launch Pad 41 | SBIRS GEO-2 | (S) Space Based Infrared System Geostationary Military Payload |

**NOTE: A Delta IV vehicle was launched from CCAFS LC 37 on May 24, 2013**

**SOURCE: [www.Spaceline.org](http://www.Spaceline.org) (Clifford J. Lethbridge and Spaceline, Inc. May 2013**

# Kennedy Space Center & Cape Canaveral Launch Schedule

**July 19, 2013 • Atlas 5 • MUOS**
**Launch Site: SLC-41, Cape Canaveral Air Force Station, Florida**
The United Launch Alliance will launch an Atlas 5 rocket for the Navy. This mobile user objective satellite (**MUOS)** built by Lockheed Martin will be the second for the military branch and will provide more ground communications for the military.

**July, 2013 • Falcoln 9 • SES 8**
**Launch Site: SLC-40, Cape Canaveral Air Force Station, Florida**
SpaceX will launch a Falcon 9 rocket carrying the SES 8 communications satellite.

**July 2013 • Delta 4 • WGS 6**
**Launch Site: SLC-37B, Cape Canaveral Air Force Station, Florida**
United Launch Alliance will launch a Delta 4 rocket with the fifth Wideband Global SATCOM spacecraft built by Boeing.

**August 2013 • Falcoln 9 • Tahicom 6**
**Launch Site: SLC-40, Cape Canaveral Air Force Station, Florida**
This SpaceX rocket launch will carry the Thaicom 6 satellite into orbit.

## September 13, 2013 • Atlas 5 • AEHF
**Launch Site: SLC-41, Cape Canaveral Air Force Station, Florida**
Held over from a November 2012 launch, this United Launch Alliance rocket will take an Advanced Extremely High Frequency satellite into orbit.

## September 2013 • Falcoln 9 • Orbcomm OG2
**Launch Site: SLC-40, Cape Canaveral Air Force Station, Florida**
This SpaceX rocket launch will carry the eight second-generation Orbcomm OG2 satellite into orbit.

## October 2013 • Delta 4 • GPS 2F-5
**Launch Site: SLC-37B, Cape Canaveral Air Force Station, Florida**
This United Launch Alliance rocket will carry a U.S. Air Force navigation satellite for the Global Positioning System.

## November 11, 2013 • Falcoln 9•SpaceX CRS 3
**Launch Site: SLC-40, Cape Canaveral Air Force Station, Florida**
SpaceX's Falcon 9 rocket will launch the Dragon C3 for its fifth operational cargo delivery mission to the International Space Station. The flight is being conducted under the Commercial Resupply Services contract with NASA.

**November 18, 2013 • Atlas 5 • MAVEN**
**Launch Time: 1:47 pm- 3:47 pm**
**Launch Site: SLC-41, Cape Canaveral Air Force Station, Florida**
The United Launch Alliance will launch an Atlas 5 rocket that will carry the Mars Atmosphere and Volatile Evolution.

**NOTE: All Launch times are To Be Determined**

**SOURCE: www.spacecoastlaunches.com updated 5/14/2013**

| Customer | Vehicle Arrival at Launch Site | Vehicle | Launch Site |
|---|---|---|---|
| SES (Europe) | 2013 | Falcon 9 | Cape Canaveral |
| Thaicom (Thailand) | 2013 | Falcon 9 | Cape Canaveral |
| ORBCOMM - Multiple Flights | 2013-2014 | Multiple | Cape Canaveral |
| NASA Resupply to ISS – Flight 3 | 2013 | F9/Dragon | Cape Canaveral |
| NASA Resupply to ISS – Flight 4 | 2013 | F9/Dragon | Cape Canaveral |
| AsiaSat | 2014 | Falcon 9 | Cape Canaveral |
| AsiaSat | 2014 | Falcon 9 | Cape Canaveral |
| NASA Resupply to ISS – Flight 5 | 2014 | F9/Dragon | Cape Canaveral |
| NASA Resupply to ISS – Flight 6 | 2014 | F9/Dragon | Cape Canaveral |
| NASA Resupply to ISS – Flight 7 | 2014 | F9/Dragon | Cape Canaveral |
| Space Systems/Loral | 2014 | Falcon 9 | Cape Canaveral |
| DSCOVR (US Air Force) | 2014 | Falcon 9 | Cape Canaveral |
| DragonLab Mission 1 | 2014 | F9/Dragon | Cape Canaveral |
| Asia Broadcast Satellite/Satmex | 2014 | Falcon 9 | Cape Canaveral |
| NASA Resupply to ISS – Flight 8 | 2015 | F9/Dragon | Cape Canaveral |
| NASA Resupply to ISS – Flight 9 | 2015 | F9/Dragon | Cape Canaveral |
| NASA Resupply to ISS – Flight 10 | 2015 | F9/Dragon | Cape Canaveral |
| Bigelow Aerospace | 2015 | Falcon 9 | Cape Canaveral |
| DragonLab Mission 2 | 2015 | F9/Dragon | Cape Canaveral |
| SES (Europe) | 2015 | Falcon 9 | Cape Canaveral |
| NASA Resupply to ISS – Flight 11 | 2015 | F9/Dragon | Cape Canaveral |
| NASA Resupply to ISS – Flight 12 | 2015 | F9/Dragon | Cape Canaveral |
| STP-2 (US Air Force) | 2015 | Falcon Heavy | Cape Canaveral |
| Asia Broadcast Satellite/Satmex | 2015 | Falcon 9 | Cape Canaveral |
| Intelsat | 2015 | Falcon Heavy | Cape Canaveral |
| Iridium – Flight 5 | 2016 | Falcon 9 | Cape Canaveral |

**Source: www.spacex.com/launch_manifest (as of May 2013)**