Final Environmental Assessment for Suborbital Processing, Launch, and Recovery Operations

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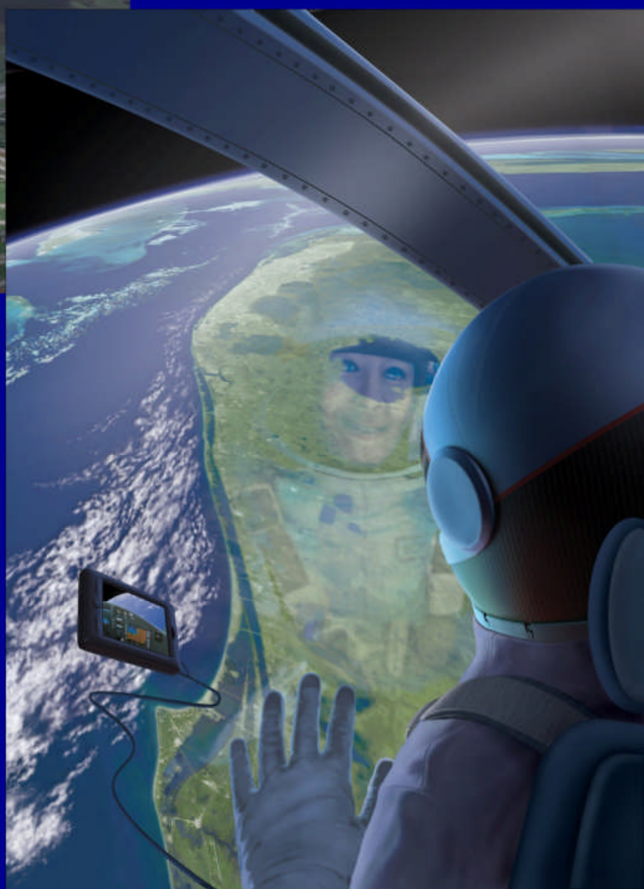

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FINAL ENVIRONMENTAL ASSESSMENT

FOR SUBORBITAL PROCESSING, LAUNCH, AND RECOVERY OPERATIONS

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Abstract

This Environmental Assessment addresses the potential impacts associated with the Proposed Action, including the No Action Alternative, evaluated for the development and ground operations of suborbital processing, launch and recovery operations at Kennedy Space Center (KSC); and increased flight operations at the Shuttle Landing Facility (SLF) including testing and evaluation of experimental spacecraft. The Proposed Action includes construction of new facilities at south-field and mid-field SLF sites, allowing increased operations. Expanded SLF operations would include commercial spaceflight program and mission support aviation, aviation test operations, airborne research and technology development, parabolic flight missions, experimental spacecraft evaluation, and demonstration of supersonic passenger flight vehicles. Horizontal take-off and landing (HTOL) of suborbital vehicles at the SLF and vertical take-off and landing (VTOL) of suborbital vehicles were also evaluated as part of the Proposed Action. Three alternative sites are proposed for VTOL of suborbital vehicles. The No Action Alternative assumes no expanded uses of the SLF beyond the level addressed in the 2007 Environmental Assessment, including HTOL activities, and no VTOL activities at KSC. The environmental impacts from construction and operations associated with the Proposed Action were classified as none, minimal, minor, or moderate. There would be impacts with construction and operations under the Proposed Action; these impacts were classified as moderate, minor, minimal, or none. Mitigation would be required for loss of habitats. There would be no impacts from the No Action Alternative, with the exception of a minor effect on socioeconomics.

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EXECUTIVE SUMMARY

This Environmental Assessment has been prepared in compliance with the National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S.C. §§ 4321-4370d) and according to the Procedures of Implementation of NEPA for the National Aeronautics and Space Administration (NASA) [Title 14, Code of Federal Regulations, part 1216 subparts 1216.1 and 1216.3].

Purpose and Need

As established by the Office of the President and directed from Congress, it is NASA's mission to expand commercial uses of space and the space industry. This directive is detailed in the NASA Authorization Act of 2010 and the Space Act of 1958, as amended. The Proposed Action is consistent with both of these policy directives.

Under the Proposed Action, NASA would permit the establishment and operation of commercial venture capabilities at Kennedy Space Center (KSC), under its jurisdiction for activities supporting both government and commercial civil space activities as described in this document. This would be accomplished through the execution of long-term land use leases and Space Act Agreements. The use and management of this property is described in KSC-1649 Rev. A, the Interagency Agreement between NASA and USFWS. Under the agreement, the primary purpose for the land is NASA's utilization of it in partial fulfillment of its mission, with the secondary purpose being management by the United States Fish and Wildlife Service (USFWS) as a national wildlife refuge. The purpose of this EA is to document potential environmental impacts from the construction of the HTOL site, VTOL sites and increased uses of the SLF and associated ground operations.

The purpose of NASA's Proposed Action is to expand its spaceport capabilities to include the processing, launch, and recovery of horizontally and vertically launched suborbital rocket powered vehicles to 1) enable improved access to KSC's space launch and test operation capabilities by commercial and other non-NASA users; 2) advance NASA's mission by fostering a commercial space launch and services industry, and 3) improve the return on taxpayer investment of KSC Spaceport facilities through expanded use and improved utilization.

The Proposed Action is needed to facilitate and foster the operation of a new breed of suborbital launch vehicles to meet the demand for lower-cost access to space. In doing so, the Proposed Action helps assure that the substantial federal investment in KSC, and particularly the SLF with its related support facilities, will continue to provide benefits to both the government and the private sector after the retirement of the Space Shuttle Program in 2011. Additionally, the use of KSC lands for the development and operation of suborbital launch vehicles that launch and land vertically will enhance the use of the upper atmosphere for both commercial and government users.

Proposed Action and Alternatives

One Proposed Action and one No Action alternative were analyzed. The Proposed Action includes 1) increased flight operations at the Shuttle Landing Facility (SLF), 2) horizontal take-off (launch) and landing (HTOL) of suborbital rocket powered vehicles from the SLF, and 3) development of a site to process, launch, and land Vertical Take-off and Landing (VTOL) vehicles conducting suborbital flights.

Increased flight operations at the SLF would involve construction of new facilities at the south-field and mid-field sites and increased flight operations at the SLF in the following broad categories: commercial spaceflight program and mission support aviation, aviation test operations including unpiloted aerial vehicles (UAV), airborne research and technology development and demonstration, parabolic flight missions, testing and evaluation of experimental spacecraft, ground based research and training, and development and demonstration of future supersonic passenger flight vehicles. To take full advantage of the capabilities of the SLF, new construction would occur at both the south-field and mid-field sites.

The HTOL of suborbital rocket powered vehicles is proposed to occur at a single location, the SLF. The HTOL site would support medium thrust rockets. The HTOL vehicles would take off horizontally using rocket powered engines of no greater than 26,689 Newtons (N) (6,000 pounds-force [lbs-f]) of thrust, and would use a steep ascent trajectory. Multiple users with their own vehicles could be utilizing the site for these operations.

The VTOL site would support reusable vehicles in the small to medium classes with thrusts of up to 13,345 N (3,000 lb-f). Such vehicles could fly up to 105km (65 mi) in altitude, return to launch site, and land in a powered mode. Their rocket engines would be processed and the vehicle would either be prepared for another flight or removed from the launch area. The site improvements for this proposed facility would include a launch and landing concrete pad, two surface systems regolith test beds, parking areas for trucks, fuel tankers, trailers and cars, power hook-ups, LOX loading area, LOX dewar/tanker truck parking, and a GHe loading/unloading area. The VTOL is anticipated to be a multi-user facility supporting the integration and launch of two or more vehicle systems using a single launch pad. It is anticipated that the combined average annual launch rate would exceed 100 launches per year. The VTOL site location would be selected from one of three alternatives.

Under the No Action Alternative, NASA would not expand uses of the SLF beyond the level and activities addressed in the 2007 Environmental Assessment. These include NASA use for the Space Shuttle, agency mission support requirements, and currently approved commercial uses. The uses of the SLF and the associated construction and/or modification of facilities would not occur. After the Space Shuttle Program ended in 2011, activity level and operations at the SLF greatly decreased. Many facilities, including those addressed in this EA, will either be maintained at a reduced level, maintained in long-term storage mode, or disassembled. The No Action Alternative would also exclude VTOL operations at KSC, and HTOL activities at the SLF.

Environmental Consequences

KSC encompasses nearly 56,451 hectares (ha) [139,490 acres (ac.)] on the east coast of central Florida. Approximately 3,035 ha (7,500 ac.) of KSC are actively used to support space mission operations, with the remaining lands being managed by the U.S. Fish and Wildlife Service as wildlife habitat. Resources identified that could be impacted by the Proposed Action include transportation, utilities, air quality, wildlife, threatened and endangered species, cultural resources, geology and soils, noise, surface and groundwater quality, socioeconomics, and land use. Four classifications of environmental impacts were pre-determined, and the resources were evaluated in terms of these classifications: none (no impacts expected); minimal (impacts would not be expected, or are too small to cause any discernable degradation to the environment); minor (impacts would be measurable, but not substantial, because the impacted system is capable of absorbing the change, or mitigation measures compensate for potential degradation); or major (impacts could individually or cumulatively be substantial).

Minor impacts from construction under the Proposed Action were in the categories of geology and soils, wildlife, land use, noise, threatened and endangered species, and socioeconomics. Additionally, construction at the different sites would also be expected to minimally impact transportation, facilities and infrastructure, land use, utilities and services, air, climate change, noise, hydrology and water quality, threatened and endangered species, hazardous materials and waste, geology and soils, biological resources wildlife, and biological resources land cover; these effects would be localized and temporary. Mitigation requirements for the loss of impacted habitats would be planned during the permitting process.

Impacts to KSC resources under increased flight operations at the SLF are expected to be limited to the south-field and mid-field sites. Construction impacts would be minimal to all resources except facilities and infrastructure, noise, and socioeconomics, where effects are predicted to be minor. Impacts of the new operations planned for the SLF would have minor effects on facilities and infrastructure, threatened and endangered species, socioeconomics, and noise, while all other resources would be minimally affected or not affected at all.

HTOL of suborbital rocket powered vehicles from the SLF would have greater impacts to KSC resources than increasing flight operations at the SLF. Under this part of the action, there would be construction of a new launch/landing area. Construction impacts would be moderate to land use, facilities and infrastructure, hydrology and water quality, land cover, and threatened and endangered species. Impacts to noise, geology and soils, and socioeconomics would be minor, while the effects on other resources would not be affected or would be minimally affected. Operational impacts would be moderate for land use, facilities and infrastructure, hydrology and water quality, and threatened and endangered species. Impacts to noise, geology and soils, and socioeconomics would be minor, while effects on the other resources would not be affected or would be minimally affected.

Development of a site to process, launch, and land VTOL vehicles conducting suborbital flights would have greater impacts to KSC resources than increased flight operations at the SLF, but less impact than HTOL of suborbital rocket powered vehicles from the SLF. Under this part of the action, construction would be limited to the selected VTOL site. Construction impacts would be moderate to land cover and threatened and endangered species only. Construction impacts would be minor to facilities and infrastructure and noise, while effects on other resources would be none or minimal. Operational impacts would be minor for facilities and infrastructure, noise, threatened and endangered species, and socioeconomics, while effects on the remaining resources would be none or minimal. Under the No Action alternative, there would be a minor impact to socioeconomics.

Neither the Proposed Action nor the No Action Alternative would be expected to produce any consequences related to Environmental Justice as all activities are located away from population centers. The expanded uses would not be expected to affect the surrounding communities any differently than the current programs at KSC.

Table of Contents

LISTS OF ILLUSTRATIONS

FIGURES

TABLES

ACRONYMS

Ac	Acre
ACI	Archaeological Consultants Inc.
AFB	Air Force Base
Al	Aluminum
AFI	Air Force Instruction
ALS	Approach Lighting Systems
AO	Airfield Operations
ARFF	Airfield Rescue and Fire Facility
AST	Commercial Space Transportation
B	Billion
BMP	Best Management Practice
C	Celsius
Ca	Calcium
CAA	Clean Air Act
CASI	Climate Adaptation Science Investigation
CCAFS	Cape Canaveral Air Force Station
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act

CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
Cl	Chloride
CMS	Corrective Measures Study
CO	Carbon Monoxide
CO2	Carbon Dioxide
CNS	Canaveral National Seashore
CST	Commercial Space Transportation
CPUE	Catch Per Unit Effort
CVLC	Commercial Vertical Launch Complex
Cy	Cubic Yard
CZMA	Coastal Zone Management Act
dB	Decibel
dBA	A-weighted Decibel
DBA	Deluge Basin Area
DO	Dissolved Oxygen
DoD	Department of Defense
DOI	Department of Interior
DTP	Domestic Treatment Plant

EA	Environmental Assessment
ECS	Environmental Control System
EDB	Ethylene Dibromide
EHF	Environmental Health Facility
EI	Enabled Industries
EIS	Environmental Impact Statement
EO	Executive Order
ELV	Expendable Launch Vehicle
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right to Know Act
ERD	Environmental Resources Document
ERP	Environmental Resource Permit
ESV	Ecological Screening Values
ETR	Eastern Test Range
F	Fahrenheit
FAA	Federal Aviation Administration
FAC	Florida Administrative Code
FCMP	Florida Coastal Management Program
FDEP	Florida Department of Environmental Protection

Fe	Iron
FEMA	Federal Emergency Management Agency
FEMP	Federal Energy Management Program
FDOT	Florida Department of Transportation
FMSF	Florida Master Site File
FPL	Florida Power and Light
FRTA	Fire Rescue Training Area
Ft	Feet
FTA	Fire Training Area
FWS	Fish and Wildlife Service
GCM	Global Climate Models
GCTL	Groundwater Cleanup Target Level
GHe	Gaseous Helium
GN2	Gaseous Nitrogen
HABS	Historic American Buildings Survey
HAER	Historic American Engineering Record
HBF	Hydrocarbon Burn Facility
HMTA	Hazardous Materials Transportation Act
HOF	Hypergol Oxidizer Facility

HQ	Headquarters
HTOL	Horizontal Take-off and Landing
in	Inch
INM	Integrated Noise Model
IHA	InoMedic Health Applications, LLC
IPCC	International Panel on Climate Change
IRL	Indian River Lagoon
IRP	Installation Restoration Program
ISS	International Space Station
ISP	Specific Impulse
K	Potassium
KDP	KSC Documented Procedure
Km	Kilometers
KNPR	Kennedy NASA Procedural Requirements
kV	Kilovolts
KSC	Kennedy Space Center
LACB	Landing Aids Control Building
lb-f	Pounds-force
lbs	pounds

LC	Launch Complex
LH2	Liquid Hydrogen
LIDAR	Light Intensification Detection and Ranging
LOX	Liquid Oxygen
LPS	Lightning Protection System
LS	Launch Support
LUC	Land Use Controls
LVM	Launch Vehicle Manufacturing
m	Meter
MCL	Maximum Contaminant Levels
MDD	Mate/Demate Device
Mg	Magnesium
MGD	Million gallons per day
mi	Miles
mil	Million
Mn	Manganese
MINWR	Merritt Island National Wildlife Refuge
MSBLS	Microwave Scanning Beam Landing System
mt	Metric tons

MMBtu	Million British thermal units
N	Newton
Na	Sodium
NASA	National Aeronautics and Space Administration
NASCAR	National Association for Stock Car Auto Racing
NCDC	National Climatic Data Center
NE	Northeast
NEPA	National Environmental Policy Act
NFA	No Further Action
NOAA	National Oceanic and Atmosphere Administration
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRHP	National Register of Historic Places
NW	Northwest
ODS	Ozone Depleting Substances
OFW	Outstanding Florida Waters
OSHA	Occupational Safety and Health Administration
PAFB	Patrick Air Force Base
PAH	Polynuclear Aromatic Hydrocarbons

PAMS	Permanent Air Monitoring System
PAPI	Precision Approach Path Indicator
PCBs	Polychlorinated Biphenyls
PM	Particulate Matter
PM10	Particles of 10 micrometers or less
Ppm	Parts per million
Ppt	Parts per thousand
PRL	Potential Release Location
PRO	Petroleum Range Organics
Psf	Pounds per square foot
PTCR	Pad Terminal Connection Room
QD	Quantity Distance
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RLV	Reusable Launch Vehicle
RMP	Risk Management Plan
RP-1	Rocket Propellant 1
SHPO	State Historic Preservation Officer
SI	Services Industry

SJRWMD	St. Johns River Water Management District
SLF	Shuttle Landing Facility
SPCC	Spill Prevention, Control and Countermeasures
SPL	Sound Pressure Level
SSC	Species of Special Concern
SSPF	Space Shuttle Processing Facility
SR	State Road
STP	Sewage Treatment Plant
STS	Space Transportation System
SVOC	Semi Volatile Organic Compound
SWCTL	Surface Water Cleanup Target Levels
SWMU	Solid Waste Management Unit
TACN	Tactical Air Navigation Site
TACAN	Tactical Air Command and Navigation System
TCE	Trichloroethylene
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TRPH	Total Recoverable Petroleum Hydrocarbons
TSCA	Toxic Substances Control Act

TV	Television
UAV	Unpiloted Aerial Vehicle
US	United States
USAF	United States Air Force
USC	United States Code
USDA	United States Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
VAB	Vehicle Assembly Building
VAFB	Vandenberg Air Force Base
VOA	Volatile Organic Analyzer
VOCs	Volatile Organic Compounds
VTOL	Vertical Take-off and Landing
WHMP	Wildlife Hazard Management Plan

1.0 INTRODUCTION, PURPOSE AND NEED

Federal agencies proposing actions on federal properties are required to consider environmental consequences resulting from their actions. This is based on several regulatory mandates including the National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S.C. 4321, et seq.), the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR parts 1500-1508), and National Aeronautics and Space Administration (NASA) policy and procedures (14 CFR part 1216 subpart 1216.3). As NASA is considering a plan to develop commercial venture capabilities at John F. Kennedy Space Center (KSC), this Environmental Assessment (EA) is necessary to support NASA's compliance with NEPA, 40 CFR 1500-1508, and related federal and state environmental regulations. In support of NASA's overall mission, the proposed plan includes the operations of suborbital rocket-powered vehicles and expanded uses of the Shuttle Landing Facility (SLF) for horizontal take-off and landing (HTOL), similar to conventional aircraft, as well as Vertical take-off and landing (VTOL). The plan also includes the development of an additional site on KSC to support vertical take-off and landing (VTOL) with rocket-powered vehicles.

1.1 Background

NASA was created in 1958 to lead the nation's civilian space exploration and aeronautical technology development activities. It subsequently established a Launch Operations Center in Florida on Merritt Island during the 1960s. Today, it continues to operate KSC as the nation's primary federal spaceport for civil access to space. NASA operated the Space Shuttle Program, which retired in 2011; and KSC was responsible for ground processing, launch, and landing activities for the Space Shuttle. NASA is furthermore engaged in developing new capabilities to implement future space programs and supports the development of the commercial space industry. KSC has already supported commercial activities such as Space Exploration Park, Starfighter Aerospace, race car engine testing, and Zero-G Corporation flights. Some of the proposed activities and initiatives will require construction of facilities on KSC lands, be they leased or otherwise permitted for use by commercial or other outside entities.

When NASA initiated the Space Shuttle Program in the 1970s, it assessed the environmental consequences of Space Shuttle-related activities at KSC (NASA 1978). An Environmental Impact Statement was produced that included, among other things, construction and operation of the SLF, shuttle orbiter landings, and associated mission training and support aviation. In 2007, the SLF was reassessed to include a variety of non-shuttle related uses, documented in "*Final Environmental Assessment for Expanded Use of the Shuttle Landing Facility*." This analysis did not cover the use of rocket-powered vehicles for horizontal or vertical launches, or the related facility needs. The proposed addition of these vehicles on KSC is a federal action subject to review, as required by NEPA. NASA is the lead federal agency in cooperation with the Federal Aviation Administration (FAA), the U.S. Fish and Wildlife Service (FWS) and the National Park Service (NPS) for this EA.

As NASA anticipated continued requirements for the SLF well beyond the end of the Space Shuttle Program, it plans to expand utilization of this unique asset. Expanded utilization would mean improved efficiency of the SLF's operation and increased opportunity for the private sector, including the opportunity to participate and support U.S. space exploration and development. Expansion would include the use of horizontally-launching rocket-powered spacecraft from the SLF. NASA is also considering the use of other areas of KSC for vertical launch and landing of suborbital spacecraft. Both of these types of spacecraft and their respective operations are new to KSC.

In the 2007 EA for expanded uses of the SLF, NASA's Proposed Action included construction of support infrastructure that would enable a variety of new applications to occur on a regular basis. NASA would enter into the appropriate agreements enabling the SLF to accommodate: 1) landings of commercially operated suborbital vehicles and "fly back" booster stages that are launched vertically from other sites; 2) horizontal launch of both suborbital and orbital vehicles from carrier aircraft, and the return of carrier aircraft and suborbital vehicles to the SLF; 3) horizontal launch and landing of single element suborbital vehicles (without rocket engines); and 4) expanded categories of aviation and non-aviation uses. The SLF infrastructure would be upgraded to accommodate these new uses.

The Proposed Action in this EA includes: increasing over current levels the number of occurrences of existing SLF operations, the use of rocket-powered horizontal launch vehicles at the SLF (as well as landing those vehicles), and development of other areas of KSC for the launch and landing/recovery of vertical rocket-powered suborbital vehicles. The proposed locations for these potential activities are shown in Figure 1-1.

1.2 Federal Agency Involvement

Four federal agencies are directly involved in this Proposed Action: NASA, FWS, NPS, and the FAA. The FAA is the licensing and permitting agency for proposed commercial launch activities. The FWS and NPS have management responsibilities on KSC properties. Although it is not a cooperating agency on this EA, the U.S. Air Force (USAF) 45^{th} Space Wing is involved as it coordinates use of the restricted air space over KSC and Cape Canaveral Air Force Station (CCAFS) and manages launches conducted at the Eastern Test Range (ETR).

1.2.1 Role of NASA

As the landowner, NASA KSC is responsible for operating and maintaining the SLF to support Agency space and aviation requirements. It is also responsible for managing other areas on KSC for space-related development and operations. KSC furthermore provides oversight for current non-NASA space and technology development related uses, and would be responsible for establishing and coordinating appropriate use agreements and operating procedures for those activities outlined in the Proposed Action. Non-government aviation and commercial space access activities at the SLF and elsewhere on KSC are required to be in compliance with all applicable FAA regulations.

1.2.2 Role of FAA

The FAA establishes regulations and requirements for airfield facilities and operations used by commercial aviation and space access activities, including those commercial operators who use the SLF. The FAA Office of Commercial Space Transportation (AST) has served as a cooperating agency in the preparation of this EA because of its role in licensing and permitting the operation of commercial launch vehicles, as well as licensing the operation of commercial launch sites. The FAA/AST's mission is to ensure protection of the public, property, and the national security and foreign policy interests of the U.S. during commercial launch or reentry activities, and to encourage, facilitate, and promote U.S. commercial space transportation. The FAA is also responsible for regulating civil aviation activities operating in the U.S. In coordination with NASA and the USAF, the FAA would oversee airspace management of the spaceflight and aviation uses evaluated in this EA.

The FAA would issue experimental permits or launch/reentry licenses, as appropriate, for commercial space transportation operators utilizing the SLF and other areas of KSC. In addition, should NASA subsequently enter into any agreement with a non-federal entity to operate the SLF or other site on KSC for commercial use, the FAA would issue a Launch Site Operator License and regulate the activities of the non-federal spaceport operator in addition to regulating the operation of the SLF and other launch and landing sites on KSC as a non-federal or joint-use airfield supporting civil aviation. The FAA is a cooperating agency in the development of this EA.

1.2.3 Role of FWS and NPS

FWS and NPS are U.S. Department of Interior agencies having management responsibilities for land potentially affected by the activities evaluated in this EA. NASA coordinates all land uses and activities that may have impacts on these agencies' responsibilities and missions. Through official agreement with NASA, FWS manages the acreage of KSC not specifically used for space or related operations as part of the Merritt Island National Wildlife Refuge per the

Interagency Agreement between NASA and FWS, document KCA-1649 Rev. A. NPS manages the Canaveral National Seashore (CNS) per their agreement with NASA (KCA-4307[1]) for use of the property at KSC, which is partially located within the northern portion of the Center. Both the FWS and NPS are cooperating agencies in the preparation of this EA.

1.2.4 Role of USAF

The USAF 45th Space Wing, headquartered at Patrick Air Force Base, Florida, is responsible for managing the KSC and CCAFS restricted airspace on behalf of both federal users by agreement with NASA. NASA and USAF coordinate airspace use and requirements with the FAA. Commercial space launch activities at the Eastern Test Range are managed in accordance with agreements between NASA, the USAF, and the FAA.

1.3 Site Operator and Spaceflight/Aviation Operator Involvement

KSC currently operates the SLF through its support contractors and has continued this relationship through the retirement of the Space Shuttle Program in 2011. The SLF is a FAA Part 139 compliant airport facility (Code of Federal Regulations Title 14 Part 139) and operates as an integral part of a federal spaceport. It already accommodates limited non-governmental use. After the FAA discontinued certifying federally operated airfields for Part 139 compliance, NASA upheld SLF facilities compliance with Part 139. Since 2011, NASA has entered into interagency agreements with entities such as Space Florida, the Titusville-Cocoa Airport Authority, Boeing, and SpaceX; and may continue to do so with similarly structured organizations for service in space launch and/or aviation operations conducted at the SLF and other designated areas of KSC. Any Site Operator other than NASA which facilitates space launch and landing activities on KSC would have to apply for and be granted a Launch Site Operator License from the FAA. Commercial space vehicle operators must also obtain the appropriate license or experimental permit from the FAA. The FAA's application process involves several review steps, including an environmental review per NEPA. The analyses from this EA would be used to support the FAA's license and permit determinations, as appropriate.

Commercial Spaceflight Operators must obtain the appropriate license from the FAA's Office of Commercial Space Transportation. Any non-federal Aviation Operators must hold the appropriate FAA licenses and certifications to operate.

1.4 Purpose and Need

1.4.1 Purpose

As established by the Office of the President and directed from Congress, it is NASA's mission to expand commercial uses of space and the space industry. This directive is detailed in the NASA Authorization Act of 2010 and the Space Act of 1958, as amended.

The purpose of NASA's Proposed Action to expand its spaceport capabilities to include the processing, launch, and recovery of horizontally and vertically launched suborbital rocket powered vehicles is to 1) enable improved access to KSC's space launch and test operation capabilities by commercial and other non-NASA users; 2) advance NASA's mission by fostering a commercial space launch and services industry, and 3) improve the return on taxpayer investment of KSC Spaceport facilities through expanded and improved utilization.

1.4.2 Need

The Proposed Action is needed to facilitate and foster the operation of a new breed of suborbital launch vehicles to meet the demand for lower-cost access to space. In doing so, the Proposed Action helps assure that the substantial federal investment in KSC, and particularly the SLF with its related support facilities, will continue to provide benefits to both the government and the private sector after the retirement of the Space Shuttle Program in 2011. Additionally, the use of KSC lands for the development and operation of suborbital launch vehicles that launch and land vertically will enhance the use of the upper atmosphere for both commercial and government users.

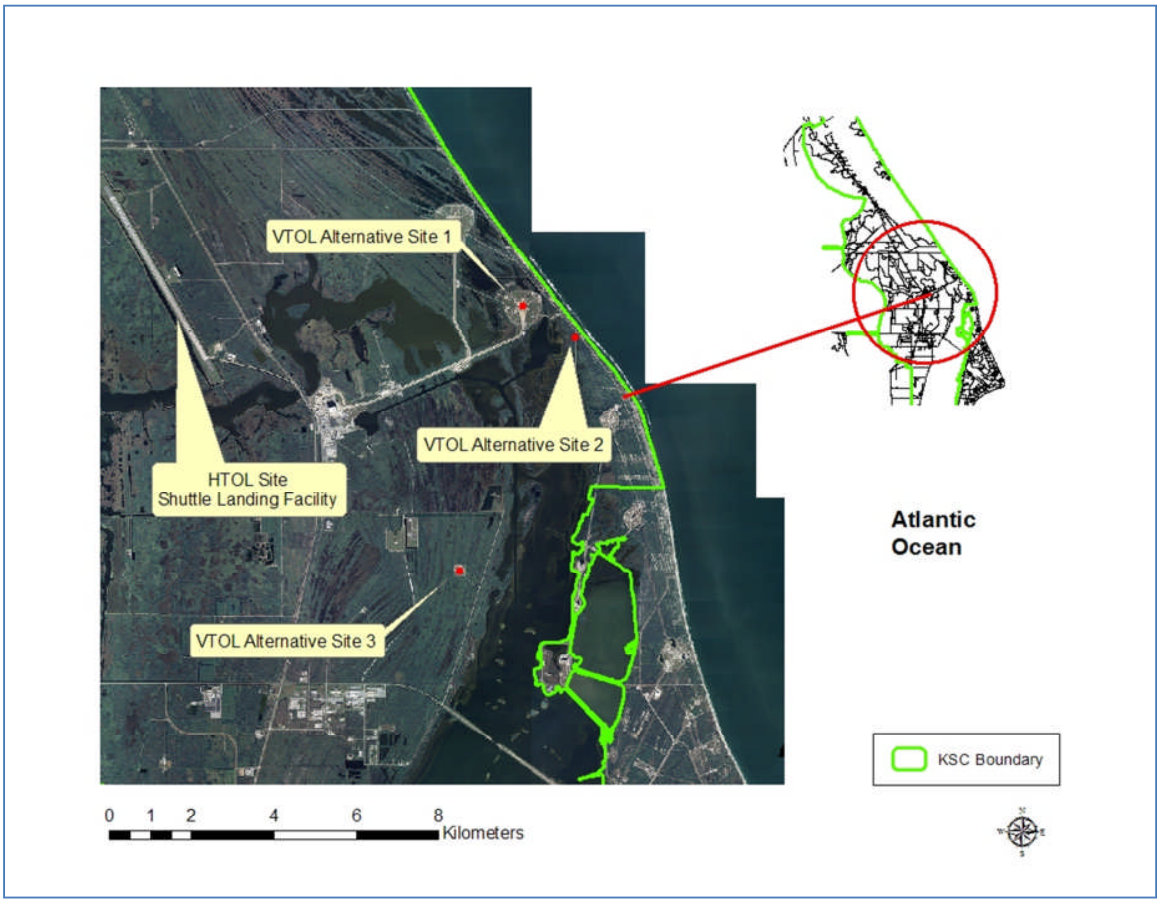

Figure 1-1. General location of the SLF and alternate Vertical Launch Sites on Kennedy Space Center, Florida. HTOL = horizontal take-off and landing; VTOL = vertical take-off and landing.

2.0 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

NASA proposes to permit the use of the Shuttle Landing Facility (SLF) and other sites on KSC for new suborbital processing, launch, and recovery activities, as well as testing and evaluation of experimental spacecraft. The Proposed Action is expected to broaden the KSC user base to include commercial and other non-NASA entities.

This action involves an increase in flight operations at the SLF and the addition of new suborbital rocket engines for horizontal take-off and landing (HTOL). Three locations are being evaluated as VTOL sites. The VTOL site would also support small lunar and Martian regolith test beds. The Proposed Action involves the development and operation of several facilities by non-NASA tenants under a land-use agreement.

2.1 Proposed Action

The Proposed Action includes 1) increased flight operations at the SLF, 2) HTOL of suborbital rocket powered vehicles from the SLF, and 3) development of a site to process, launch, and land VTOL vehicles conducting suborbital flights. The VTOL site location would be selected from one of three alternatives as described below.

2.1.1 Existing Facilities and Current Uses

The following sections discuss the current uses of the existing facilities at KSC.

2.1.1.1 Shuttle Landing Facility

The SLF, as described in the earlier SLF EA (NASA 2007), was designed and constructed in the 1970s to serve as the primary landing and recovery site for the Space Shuttle orbiter. In order to support the Space Shuttle's horizontal landings, the SLF is 4,572 m (15,000 ft) long and 91.4 m (300 ft) wide. It has 305 m (1,000 ft) of paved overruns at each end and the paving thickness is 38.1 cm (15 in) at the center. See Figure 2-1, a photo rendering of existing conditions at the SLF (NASA 2007). The potential environmental impacts of building and operating the SLF were identified and analyzed in the original Space Shuttle Program Environmental Impact Statement (NASA 1979). It was anticipated that approximately 25 shuttle orbiter landings would occur each year. Over the 29-year operational history of the Space Shuttle program, the actual number of orbiter landings has been considerably lower, averaging four or five per year. The environmental impacts of expanding the SLF were identified and analyzed previously (NASA 2007).

Figure 2-1. Graphic rendering of existing conditions at the SLF (NASA 2007).

The SLF was required by NASA for support of the Space Shuttle Program through the retirement of the system in late 2011. NASA also requires the use of the SLF for a variety of agency aircraft operations related to general mission management, and institutional security and property management activities. The annual projected flight operations from continued NASA usage and other existing uses is not anticipated to exceed 6,000 operations annually, as shown in Table 2-1 and had been anticipated to decline after 2011. Total flight operations from new categories of uses as analyzed in the previous SLF EA (NASA 2007), when combined with existing uses, are still well below previous peak years (Table 2-1). This assessment addresses the impacts of additional operations, as shown in Table 2-2, of the types of vehicles assessed in the previous EA (NASA 2007).

In addition to the runway, the SLF has other valuable tangible resources. These include the Convoy Equipment Shelter, a support office complex, flight operations and flight crew support facilities at the Landing Aids Control Building (LACB), a control tower constructed in 2004 at the mid-field site, and the Airfield Rescue and Fire Facility (ARFF) completed in 2007 at the south-field site. There is also the 4,645 m^2 (50,000 $ft.^2$) environmentally controlled Reusable Launch Vehicle (RLV) Facility, a hangar constructed in 1999 to support reusable launch vehicles and/or aircraft employed in orbital launch operations. It currently houses the Starfighters and NASA Flight Operations helicopter fleet. The NASA helicopter fleet moved to the SLF from Patrick Air Force Base in 2010. As of 2010, a FWS helicopter is also being housed at this facility.

The SLF activities predominantly included return of the Space Shuttle from lower Earth orbit missions, via ferry flights from alternate landing sites; shuttle training aircraft operations that allow astronaut flight crews to practice repetitive simulated approaches and landings to the SLF in a variety of conditions; T-38 aircraft training and mission support flights; NASA mission management flights to and from KSC; and mission support including environmental surveys, security flights, medical flights, weather observation, chase vehicle flights, and payload delivery operations for Space Shuttle missions. The commercial Starfighter Flight Operations program originally trained and screened pilots for future orbital and suborbital activities and now includes science mission support. Their five F104 aircraft stationed at the SLF was increased to eight by the end of 2011, with 100 sorties anticipated per year. The numbers of all flight operations that have occurred at the SLF between 1998 through 2011 are shown in Table 2-1. The SLF also supports "straight line" testing of high speed automobiles approximately 4 weeks per year on a non-interference basis.

The SLF is used to a lesser extent by the Department of Defense (DoD), for non-shuttle related aircraft operations. This includes delivery of large payloads to be processed in commercial facilities and launched aboard commercially operated expendable launch vehicles (ELV) from CCAFS.

Table 2-1. The number of flight operations (take-offs and landings) that occurred at the SLF between 1998 and 2011 [(NASA 2007) and (Ron Feile, pers. comm., May 2012)].

Year	Number of Flight Operations
1998	14,645
1999	16,602
2000	18,743
2001	14,283
2002	6.535
2003	3,572
2004	3,264
2005	3,529

Year	Number of Flight Operations
2006	3,533
2007	4,826
2008	4,167
2009	5,521
2010	4,753
2011	3634

Table 2-2. Anticipated frequency of flight operations at the SLF.

CATEGORIES OF EXISTING NASA AND NASA-RELATED USES	2012	2013	2014	2015
SPACE SHUTTLE PROGRAM OPERATIONS				
Unpowered End-of-mission Landings by Orbiter	0	0	0	0
Shuttle Carrier Aircraft Ferry Flights of Orbiter Vehicle	6	0	0	0
Astronaut Flight Crew Training & Mission Preparation (T-38 fleet)	0	0	0	0
Shuttle Training Aircraft Operations (modified Gulfstream)	0	0	0	0
NASA PROGRAM & MISSION SUPPORT AVIATION				
Mission Management Aircraft (Grumman Gulfstream fleet)	20	20	20	20
NASA Helicopter Support Flights	500	500	500	500
Heavy Payload Cargo Flights (e.g. Guppy/Beluga/Boeing 747/C5)*	40	50	60	60
Light Payload Cargo Flights (e.g. Citation/Gulfstream/Lear)	6	6	6	6
Astronaut Flight Crew Training, Mission Prep, and Mission Support (T-38 fleet)	200	200	200	200
DoD USE: SPACE OPERATIONS & SUPPORT				
Various Aircraft Types (e.g. C-5, helicopter, jet aircraft)	200	75	75	75

TENANT FLGHT OPERATIONS				
Starfighters	100	150	200	200
Others (E-Green Technologies, Zero-G, X-37, etc.)	50	100	150	200
Unmanned Aerial Systems	25	100	150	200
HORIZONTAL LAUNCH AND LANDING				
User 1	25	300	900	1250
User 2	0	25	300	900
User 3	0	0	25	300
TOTAL	1172	1526	2586	3921
* Includes payloads delivered to SLF for NASA, USAF, and existing commercial launch operators at CCAFS				

2.1.1.2 Launch Complex 39A

LC39A is being prepared for commercial users. An EA is currently underway assessing LC39 for the future use by multiple commercial users. Pads 39A and 39B were developed in the 1960s and modified in 1987. These were developed initially for NASA's Apollo lunar program using the Saturn V rockets. Both pads were later modified for the Space Shuttle and were slated for use in NASA's Constellation Program, which was cancelled in 2010. Modifications for the Constellation Program were underway at Pad B prior to that program's cancellation, and the pad was used for the first test flight of the Ares 1-X rocket. There have been 2 to 4 Space Shuttle launches per year from Pad A in recent years, significantly less than the 40 launches per year projected and assessed in the Space Transportation System (STS) Programmatic EIS (NASA 1978). Peak launch rates were nine in 1985 and eight in 1982.

2.1.1.3 Fire Training Area

The Fire Training Area (FTA) consists of approximately 8.6 ha (21.2 ac). It has been an active fire training facility for KSC fire-fighting personnel since 1966. It is located along Static Test Road approximately 3.2 km (2 mi) north of NASA Parkway E and 549 m (1,800 ft) west of the Banana River. Facilities currently at the site include a classroom building, GN2 Control Building, a Fire and Rescue Drill Tower, shed with solar panels, and a Technical Rescue Training Course which includes a shuttle access mockup. Recent additions installed for training purposes include various tanks, a tractor trailer, a single tube-bank vessel, and a tanker.

2.1.2 Increased Flight Operations at the Shuttle Landing Facility

Under the Proposed Action, increased flight operations at the SLF would include new aviation and non-aviation activities anticipated to occur at least through 2020. The Proposed Action would increase SLF operations in the following broad categories: commercial spaceflight program and mission support aviation, aviation test operations including unpiloted aerial vehicles (UAV), airborne research and technology development and demonstration, parabolic flight missions, experimental spacecraft testing (e.g. Project Morpheus), ground-based research and training, and development and demonstration of future supersonic passenger flight vehicles. To take full advantage of the capabilities of the SLF, new construction would occur at both the south-field and mid-field sites. These new construction actions were evaluated in the previous SLF EA (NASA 2007).

Land-altering activities for construction of a hazard field adjacent to the SLF would be required for hazard avoidance testing of the Morpheus spacecraft. Morpheus is a lunar lander prototype vehicle designed for a terrestrial vertical test bed. The Johnson Space Center (JSC) has selected the SLF as the preferred site for performing its lunar lander prototype flight tests. Twelve flights are to be performed in a 10-week period, testing twice per week with a two week down time in between test campaigns.

2.1.3 Horizontal Takeoff and Landing of Suborbital Vehicles

The Proposed Action includes the horizontal take-off (launch) and landing (HTOL) of suborbital rocket-powered vehicles, which is proposed to occur at a single location, the SLF. The new horizontal technologies (i.e., propulsion systems and propellants) are being developed to provide affordable access to space. In addition to the new horizontal technologies, the commercial space launch industry is continuing to develop new reentry technologies using both powered and unpowered landings. The FAA evaluated this type of action within a conceptual framework (not at one specific geographic location) in the Final Programmatic Environmental Impact Statement for Horizontal Launch and Reentry of Reentry Vehicles (FAA, 2005).

These HTOL vehicles would take off from the SLF using rocket powered engines of no greater than 26,689 Newtons (N) (6,000 pounds-force [lb-f]) of thrust, fly up to 105 kilometers (km) (65 miles [mi]) altitude and return to the SLF in either a powered or un-powered mode. Vehicles assessed in this EA include the type of horizontally launched suborbital vehicles that take-off under their own power using rocket propulsion ignited on the runway (FAA, 2005).

Multiple users with their own vehicles could be utilizing the site for these operations. The assumption for this analysis is that operations would be conducted with three different operators throughout the year and typically on normal business days (i.e. Monday through Friday) during daylight hours. There may be occasional operations during the night and/or on weekends (current estimates of 5% each). There are 10 flights anticipated in 2012 with one operator. As the program grows to two operations per operator per day, estimates are for full use by 2020 with approximately 1,566 operations per year.

Each HTOL operator would have a maximum of 30 staff on-site at full use. The estimated progression of staffing is: Year 2012 = 10 people, Year 2015 = 60 people, Year 2017 = 90 people. The HTOL program would require construction of facilities as previously evaluated in the SLF expansion EA (NASA 2007).

Proposed HTOL Flight Vehicles

For the purposes of this EA, medium thrust rockets 13,345 N (3,000 lb-f) are used as representative vehicles for the HTOL program at KSC. The wingspan of a representative vehicle would be approximately 6.7 to 9.0 m (22 to 30 ft) and the length of the vehicle would be approximately 5.8 to 12.2 m (19 to 40 ft). The weight of the vehicle when fully fueled and ready for takeoff would be between 1,150 and 7,500 kg (2,600 and 16,500 lbs). Various concept vehicles for HTOL were described in the Final Programmatic Environmental Impact Statement for Horizontal Launch and Reentry of Reentry Vehicles (FAA, 2005) with an example shown in Figure 2-2.

Figure 2-2. The horizontal launch concept vehicle (courtesy FAA 2005).

The rocket engines would be ignited and the vehicle would take off horizontally and would use a steep ascent trajectory until its fuel supply is exhausted. Once the engines are turned off or propellant is exhausted, the vehicle would fly on a parabolic trajectory for four (4) to 240 seconds, and coast to apogee. Suborbital flight missions performed from KSC are expected to achieve an apogee (the highest point in the trajectory) of about 105 km (65 mi.) above mean sea level or more, and provide approximately five minutes of microgravity time. After reaching apogee, the vehicle would glide to a pullout and energy management area between ten (10) and 160 km (six and 100 mi) downrange of the SLF. It may be necessary to fly several circular patterns within the energy management area to expend excess energy before gliding back to the SLF.

The vehicle would make an unpowered or powered horizontal landing on the runway. In the event of an emergency landing, the pilot would attempt to reach a designated abort site. These abort sites will be dependent on the vehicles and their flight paths.

Fuels and Chemical Volumes

Various chemicals are required for horizontal launch vehicle integration and launch activities. These include, but are not limited to: propellants, fuels, drying agents, and oxygen displacers. Types and quantities of these chemical commodities and propellants required for the HTOL rockets are listed in Table 2-3, but could include others later defined. The volumes provided in Table 2-3 cover the upper limit considered for an HTOL vehicle.

Table 2-3. Potential launch site fueling components utilized for HTOL launch activities.

Specification	Chemical	Quantity for one Launch (liters/gallons)
Fuel-b	Kerosene	1200/317
Fuel-c	Rocket Propellant-1 [RP-1]	1200/317
Oxidizer	Liquid Oxygen (LOX)	2100/555
Oxidizer	Ethanol, methane capable	1200/317

Table 2-4. Fueling components storage requirements for HTOL launch activities.

Chemical Storage	**Storage Quantity for 1 Launch (liters/gallons)**
Kerosene	18,000/4,755
Rocket Propellant-1 [RP-1]	18,000/4,755
Liquid Oxygen (LOX)	31,500/8,325
Ethanol, methane capable	18,000/4,755

2.1.4 Vertical Take-off and Landing of Suborbital Vehicles

The Proposed Action also includes development of a site to process, launch, and land vertical take-off and landing (VTOL) vehicles conducting suborbital flights. Potential locations for the VTOL are outlined in Sections 2.1.4.2; 2.1.4.3; and 2.1.4.4. It is assumed that processing will also occur off-site as needed by the various entities. Operations would include various vertically launched rockets with thrusts up to 13,345 N (3,000 lb-f). Such vehicles could fly up to 105 km (65 mi) in altitude, return to the launch site, and land in a powered mode. Their rocket engines would potentially fire throughout the entire flight operation. Following landing, vehicles would be processed and the vehicle would either be prepared for another flight or removed from the launch area.

The site improvements for this proposed facility would be contained within approximately 0.8 ha (2 ac) of land. The site would contain a launch and landing pad of no larger than 15.2 m x 15.2 m (50 ft x 50 ft) constructed of concrete or some other heat resistant material. Co-located at the VTOL site would be two surface systems regolith test beds (a layer of loose dust, soil, and broken rock covering compacted stone beneath a geotextile fabric), needed to support future lunar and Martian explorations. The lunar and Martian test beds would each be approximately 4.6 m^2 (50 ft^2) with similar properties as described below:

- 0.9 m (3 ft) depth of lunar/Martian regolith simulant encased in a permanent concrete walled structure;
- a 0.3 m (1 ft) deep layer of compacted Florida Department of Transportation (FDOT) 57 stone under the regolith separated by nonwoven geotextile fabric to facilitate drainage within the regolith;
- a drain system at the base of the regolith to route drainage to a perimeter outlet;
- a 2.4 m (8 ft) wide closeable access-way to facilitate regolith filling;
- embedded tarp anchors along the perimeter;
- a tarp to protect the regolith when not in use;
- a shared wall between the two test beds.

The remaining site development would consist of parking areas for trucks, lightning protection towers, fuel tankers, trailers and cars, power hook-up, and areas for additional support equipment. Specifically there would be a LOX loading area, LOX dewar/tanker truck parking (used during LOX loading/unloading), and a GHe loading/unloading area, to be located within the 15.2 m (50 ft) clear zone. The communication interface would be wireless and a wired Ethernet would be used for ground-based measurement equipment. Power interfaces would be intermittent and not hard wired to a vehicle at launch. The proposed VTOL layout plan is shown in Figure 2-3.

Figure 2-3. A conceptual diagram of the proposed VTOL site with launch pad and two surface test pads.

The VTOL is anticipated to be a multi-user facility supporting the integration and launch of two or more vehicle systems using a single launch pad. Approximately ten launch operators would be expected to support each launch operation and up to three entities would be using the facility each year. Existing launch vehicles, vehicles currently under development, and vehicles developed in the future would potentially use the VTOL site.

It is anticipated that the combined average annual launch rate for each of the three users of the VTOL would exceed 100 launches per year, for a total estimate of 300 per year during its nominal operational life of 30 years. Operations would be conducted throughout the year, typically on normal business days (i.e., Monday through Friday) during daylight hours. There could be occasional operations during the night and/or on weekends (current estimates of 5% each). The gradual increase of operations personnel working at the site is estimated to be Year 2012 = 10 people, Year 2015 = 20 people, and Year 2017 = 30 people. The typical types of launch vehicles, and the propellants and gases required to support them are described in more detail below.

2.1.4.1 Proposed VTOL Flight Vehicles

The VTOL site would support reusable vehicles in the small to medium vehicle classes with thrusts of up to 13,345 N (3,000 lb-f). Several developers have rockets that could be accommodated by the VTOL site.

Each suborbital rocket would consist of a payload, avionics system, oxidizer tank, and fuel tank. Payloads would vary and are undefined at this time. Ground equipment would be needed to support the launch and landing of the suborbital rockets.

An example of pre-flight activities for a launch might include the use of a tanker truck of isopropyl alcohol and one tanker truck of LOX for transport of these materials to the launch site. Storage of these materials would occur at another location on or off KSC. The suborbital rockets would be assembled in another location and then transported to the launch pad. The suborbital rocket would be removed from the transporter and positioned at the launch pad using dollies, a forklift, and/or crane. The rocket would be inspected for loosened electrical or mechanical connections or other damage. Flight control diagnostics and health checks would be run to ensure proper operation of electrical systems and moving parts.

Propellants for the suborbital rocket would be loaded at the launch pad. Following transfer, the loading equipment would be removed from the area. Standard safety precautions would be followed, such as clearing the area of unnecessary personnel and ignition (including spark) sources. In the event of a spill, propellant-loading operations would be halted until the spill was properly cleaned up and had no reasonable chance of creating an explosion or combustion hazard during further operations.

Once cleared for flight, the operations would involve igniting the engines and controlling the vehicle from a remote location on KSC. The flights may last for up to 30 minutes which include ascent to apogee, a time of microgravity operations at apogee and a descent.

The reusable suborbital rockets would be designed to make powered, vertical landings. The rocket would touch down and flight control systems unnecessary to vehicle recovery would be shut down. For example, in a rocket using LOX as an oxidizer, the LOX would be flash boiled and vented and the LOX system purged. Next, the isopropyl alcohol system would be drained into a suitable container and its systems purged. Finally, the remaining pressurants would be vented to the atmosphere prior to moving the rocket to its transport vehicle.

Fuels and Chemical Storage

Various chemicals are required for launch vehicle integration and launch activities. These include, but are not limited to, propellants, fuels, drying agents, and oxygen-displacers. Types and quantities of these chemical commodities and propellants required for example VTOL vehicles are shown in

Table 2-5. Currently viable candidate rockets use LOX, ethanol, and isopropyl alcohol. They do not use solid boosters, ordnance, or hypergols. Future VTOL rockets are expected to utilize existing and improved forms of rocket liquid propellants.

Based on several candidate vehicles, the specifications and volumes of chemicals estimated for the upper limit rocket class considered for VTOL are provided in Table 2-5 (RS&H 2010).

Table 2-5. VTOL Rocket Criteria.

Max ISP	250 s
Throttle	3500 lb-f to 250 lb-f
Max Altitude	490,000 ft with engine shutdown
Delta Velocity	9900 ft/s (approx)
Fuel	Isopropyl Alcohol, 325 lbs
Oxidizer	Liquid Oxygen (LOX), 456 lbs

The minimum size of the proposed complex and the relative positions and distances between the various facilities within the site were established using Quantity Distance (QD) criteria for propellants during a preliminary concept study for candidate Class G vehicles (RS&H 2010). QD is the minimum acceptable distance between explosive materials and facilities, roads, and other assets. VTOL operations would require minimum construction of facilities which are covered in this EA.

Administrative and Logistics Facilities

Mobile units or trailers would likely be used for logistics and administrative purposes during launch preparations. Primary administrative sites would be offsite from the launch pad area.

Lightning Protection System

A lightning protection system (LPS) would be required to safeguard the VTOL launch vehicle and personnel from the dangers associated with lightning. The LPS projected for use in this system would be constructed of one or more highway light standards approximately 30.5 m (100 ft) tall.

There are three alternative sites for VTOL. The general locations are shown in Figure 1-1 and the sites are further described in Chapter 3 of this EA. Alternative 1 is Launch Complex (LC) 39A, Alternative 2 is located between LC39A and LC41, and Alternative 3 is at the FTA on Static Test Road in central KSC. The difference in the alternatives for VTOL is simply the location. Boundaries and design would all be similar with possible orientation changes that would best suit the environmental setting of each site.

2.1.4.2 VTOL - Alternative 1

Alternative 1 (see Figure 2-4) would utilize the existing LC39A which had served as the launch pad for the Space Shuttle program. For an overall location map, see Figure 1-1.

Figure 2-4. Graphic rendering of VTOL Alternative Site 1.

2.1.4.3 VTOL - Alternative 2

Alternative 2 (see Figure 2-5) is located south of LC39A and north of LC41 along the KSC coastline. It straddles a section of coastal scrub and low-lying areas between Phillips Parkway and a railroad track just east of the Banana River. The western half of the site extends into impoundments T-25-A and T-25-B. Radar Wind Profiler, Site D (J8-2227) is located on the eastern edge. The area is presently undeveloped. While the site has evidence of human-induced disturbance, it is in a natural state, supporting vegetative communities and wildlife species which are described in this document.

Figure 2-5. Graphic rendering of VTOL Alternative Site 2.

2.1.4.4 VTOL - Alternative 3

Alternative 3 (see Figure 2-6) would utilize the established Fire Training Area. It is located along Static Test Road approximately 3.2 km (2 mi) north of NASA Parkway East and 0.5 km (1,800 ft) west of the Banana River.

Figure 2-6. Graphic rendering of VTOL Alternative Site 3 at the Fire Training Area.

2.2 No Action Alternative

The No Action alternative would exclude development for and operation of HTOL vehicles at the SLF. Under the No Action alternative, the VTOL site would not be developed and no operation of VTOL vehicles would occur on KSC.

2.3 Alternatives Considered But Not Carried Forward

The SLF was considered as an alternative location for VTOL operations but was eliminated due to the distance from the ocean and the fact that flights would bring vehicles over inhabited areas.

Locations for VTOL outside the boundaries of KSC property were not considered because such locations fail to meet the need for the Proposed Action, which is to assure that the substantial federal investment in KSC continues to provide benefits to both the government and the private sector after the retirement of the Space Shuttle Program in 2011 and the use of KSC lands for the development and operation of suborbital launch vehicles. Consequently, alternative locations at Cape Canaveral Air Force Station were eliminated from further consideration, as NASA is looking to optimize reuse of KSC property.

2.4 Impacts and Resources Not Analyzed in Detail

This draft EA does not analyze potential impacts to the following environmental resource areas in detail, for the reasons explained below:

Wild and Scenic Rivers – There are no wild and scenic rivers as designated by the Wild and Scenic Rivers Act located within or near the proposed construction or operating area. The nearest wild and scenic river, the Wekiva River, is approximately 53 miles west of KSC.

Farmlands – There are no prime or unique farmlands as defined by the Farmland Protection Policy Act located at KSC.

3.0 Affected Environment

Chapter 3 provides a description of the environment that would be affected by the Proposed Action, as required by the CEQ regulations for implementing NEPA (40 CFR § 1500-1508). The description focuses on those features of the environment that potentially would be affected by the proposed increase in flight operations at the SLF, the use of rocket powered horizontal and vertical launch vehicles at the SLF, and the development of a site to process, launch, and land VTOL vehicles conducting suborbital flights. The resource sections of this Chapter describe the general conditions at KSC, followed by localized descriptions for each site as the details are pertinent and available.

3.1 Land Use

This section describes general land use within the specific sites, and the nearby surrounding area. Land use can be defined as the human use of land resources for various purposes including economic production, natural resources protection, or institutional uses. Land uses are frequently regulated by mission objectives, program/project plans, policies, ordinances, and regulations that determine the types of uses that are allowable, or protect specially designated or environmentally sensitive uses. The HTOL, SLF and all of the VTOL site alternatives are located on KSC and are bound by NASA's land use regulations (Figure 3-1).

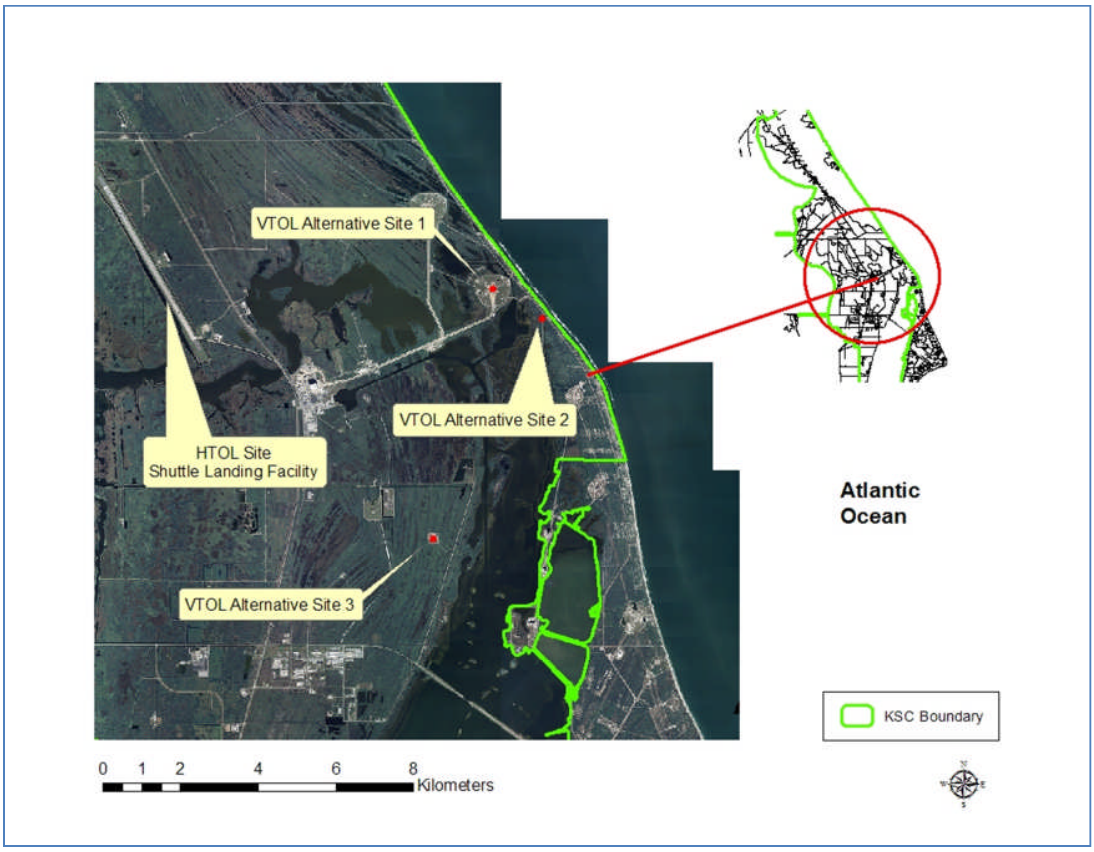

Figure 3-1. Proposed HTOL and VTOL site locations on Kennedy Space Center, FL.

Land and open water resources of KSC comprise 57,400 ha (142,000 ac) in Brevard and Volusia Counties, and are located along the east coast of central Florida at 28^{o} 38'N, 80^{o} 42'W (NASA 2010). The majority of the KSC land areas are located on the northern part of Merritt Island, which forms a barrier island complex adjacent to Cape Canaveral (NASA 1979). Undeveloped areas, including uplands, wetlands, mosquito control impoundments, and open water areas, comprise approximately 95% of the total KSC area (NASA 2010). Nearly 40% of KSC consists of open water areas of the Indian River lagoon system including portions of the Indian River, Banana River, Mosquito Lagoon, and all of Banana Creek (NASA 2010).

KSC was established under NASA jurisdiction for the purpose of implementing the Nation's space program (National Space Act, 1959). NASA maintains operational control over approximately 1,787 ha (4,415 ac) of KSC (NASA 2010). This area comprises the operational areas, which is dedicated to NASA ground processing, launch and landing activities and includes facility sites, roads, lawns, and maintained right-of-ways. Undeveloped areas are dedicated to safety zones around existing facilities or are reserved for planned and future expansions.

The overall land use and management objectives of NASA and KSC are to maintain the nation's space mission operations while supporting alternative land uses that are in the nation's best interest. NASA considered impacts under Section 4(f) of the DOT Act, which has been recodified and renumbered as 49 U.S.C. Section 303(c). It is the policy of the United States Government that special effort should be made to preserve the natural beauty of the countryside and public park and recreation lands, wildlife and waterfowl refuges, and historic sites. Land use is carefully planned and managed to provide required support for missions while maximizing protection of the environment. Land planning and management responsibilities for areas not directly utilized for NASA operations have been delegated to the USFWS at MINWR and the NPS at CNS. See Section 3.12 for a discussion of historic properties.

The designation of MINWR and CNS, in 1963 and 1975, respectively, on the 54,723 ha (135,225 ac) outside of NASA's operational control reflects this "best interest" objective. Both MINWR and CNS effectively provide a buffer zone between NASA operations and the surrounding communities. The NPS administers a 2,693 ha (6,655 ac) area of the CNS, while the USFWS administers the remaining 52,030 ha (128,570 ac) of the CNS and MINWR. The USFWS and NPS exercise management control over agricultural, recreational, and environmental programs within their respective jurisdictions at KSC, subject to operational requirements defined by NASA, such as temporary closures for launch and landing-related activities (NASA 2010). NASA remains the landowner and retains the authority to remove lands or construct facilities within MINWR or CNS as needed to support the space program.

3.1.1 Surrounding Land Use

Major municipalities in the immediate vicinity of KSC include the City of Titusville and Merritt Island. Titusville is located on the western shore of the Indian River, on the mainland more than 11 kilometers (7 mi) from the SLF and approximately 19 km (12 mi) from the alternative VTOL site locations. The unincorporated community of Merritt Island is south of KSC and the northern limit is approximately 11 to 14 km (7 to 8.5 mi) from all proposed sites and land use is primarily agriculture and residential. Brevard County has zoned the State Road (SR) 3 corridor as agriculture, rural, residential, and industrial. Agricultural areas are dominated by citrus groves and industry in this area is limited to a liquid nitrogen gas manufacturing plant adjacent to KSC property on the west side of SR 3. This plant is a strategic facility for KSC, and nitrogen is piped directly to KSC where it is used for purging equipment.

3.1.2 Coastal Zone Management

Activities at KSC are not subject to the Coastal Zone Management Act (CZMA) of 1972. However, NASA and other federal agencies are required to review their activities with regard to direct effects to the coastal zone. The Florida Department of Environmental Protection (FDEP) is responsible for executing the state-wide coastal management program. The Florida Coastal Management Program oversees activities occurring in or affecting the coastal zone and is based on a network of agencies implementing 24 statutes protecting the state's coastal resources. By definition, the entire state of Florida is within the coastal zone; however, for planning purposes, a "no development" zone has been established. NASA is responsible for making the final coastal zone consistency determinations for their activities within the state.

3.2 Facilities and Infrastructure

There are approximately 813 facilities located on KSC including space vehicle and testing facilities, chemical storage buildings, launch complexes, processing areas, runway, laboratories, and offices. Equipment and personnel in these facilities provide a variety of functions in support of the KSC mission including the following:

- Assemble, integrate, and validate launch vehicle elements along with associated payloads. Conduct launch, recovery, and landing operations
- Design, develop, construct, operate, and maintain each launch and landing facility and the associated support facilities
- Maintain ground support equipment required to process launch vehicle systems and their associated payloads
- Partner with DoD launch activities and provide logistics support to Cape Canaveral Air Force Station (CCAFS), Patrick Air Force Base (PAFB), Vandenberg Air Force Base (VAFB), and various contingency and secondary landing sites around the world
- Research and develop new technologies to support space launch and ground processing activities
- Provide Government oversight and approval authority for commercial expendable vehicle launch operations.

3.2.1 SLF

The Shuttle Landing Facility was constructed and ready for flights in 1976. It was specifically designed for Space Shuttle orbiter landings. The paved runway is 4,572 m (15,000 ft) long with a 1000 ft (304.8 m) overrun on each end. The concrete portion of the runway is 300 ft (91.4 m) wide with 50 ft (15.2 m) asphalt shoulders on each side. On the northeast corner of the parking apron is the Mate/Demate Device (MDD). Adjacent to the MDD is the Landing Aids Control Building (LACB) which houses personnel operating the SLF on a daily basis. South of the midfield, east of the runway, are the control tower, orbiter recovery convoy staging area, and a viewing area for the press and guests. Just south of the LACB is Fire Station #2 and the Tow way used for transporting the orbiter to processing facilities in the LC39 area. Along the Tow way are the Convoy Vehicle Enclosure, Flight Vehicle Support Building, and the Reusable Launch Vehicle (RLV) Hangar (owned by Space Florida), which houses the Starfighter aircraft, NASA helicopters, and MINWR helicopter.

3.2.2 VTOL - Alternative 1

LC 39A is currently inactive. The area was undeveloped prior to the mid-1960s when construction for the Apollo Program began. Retrofitted in 1975 to support Space Shuttle launches, Pad A encompasses 66,211 sf inside the perimeter fence. It is the southernmost of the two shuttle launch sites situated along the eastern boundary of KSC. A concrete ramp, inclined at a 5% grade, leads from the end of the river rock crawlerway just inside the launch complex perimeter to the pad. The pad surface is raised 42 ft (12.8 m) above ground level and consists of the flame trench, a high pressure gas storage enclosure, Pad Terminal Connection Room (PTCR) and the Environmental Control System (ECS) Room. The pad can be illuminated at night by five clusters of Xenon high-intensity searchlights located around the pad perimeter. Low pressure sodium light fixtures are used on the perimeter fence and remain on during dusk to dawn to assist security personnel in performing routine security checks. The pad has approximately 390 lights with the majority being high pressure sodium and the remainder being either incandescent or fluorescent.

3.2.3 VTOL - Alternative 2

The majority of this area is currently undeveloped. Radar Wind Profiler Site D (J8-2227) was installed in the eastern portion of the site in 1994 and is used to collect wind data. Electrical Load Break Switch 310 and Electrical Substation 1161 are also located in this area. Cameral Pad #12 (J8-2228) was built in 1965 east of Phillips Parkway across from this proposed site and is used for staging optical tracking devices during launches at Complexes 39A, 39B, 40, and 41. It consists of a mounded camera pad area with a 50 ft x 20 ft concrete pad and an adjacent asphalt by-pass roadway. There are no potable water or sewer connections associated with the camera pad. Just north of the camera pad is Field Mill Site #13 (J8-2226), a meteorological instrument used to measure the strength of a static electric field.

3.2.4 VTOL - Alternative 3

The Fire Training Area includes the GN2 Control Building and Equipment Building for a former meteorological station, a Classroom Building, the Fire and Rescue Drill Tower, a former Small Arms Shooting Range consisting of soil berms, and a Technical Rescue Training Course. The classroom facility is used primarily to teach safety and rescue classes to NASA and contractor personnel. The Fire and Rescue Drill Tower was historically used for as a burn building for fire training. It is no longer structurally sound however the exterior ladder is used for a fall protection course. The GN2 Control Building is currently used as a storage and testing facility.

3.3 Transportation

KSC is serviced by over 340 km (211 mi.) of roadways, with 263 km (163 mi.) of paved roads and 77 km (48 mi.) of unpaved roads. NASA Causeway is the primary entrance and exit for cargo, tourists, and personnel. The four-lane road originates on the mainland in Titusville as SR 405 and crosses the Indian River Lagoon (IRL) onto KSC. After passing through the Industrial Area, the road reduces to two lanes of traffic, crosses over the Banana River, and enters CCAFS. The major north-south artery for KSC is Kennedy Parkway (SR 3). It can be accessed from the north where it intersects with US 1 south of Oak Hill, and from Titusville via State Road (SR) 406/402. The southernmost entrance and exit for KSC is SR 3 on north Merritt Island. The SLF and associated facilities are accessed via SR 3 to Astronaut Road on the west (see Figure 3-2).

LC39A may be accessed from SR3 and Saturn Causeway or via Phillips Parkway and Pad By-Pass Road (see Figure 3-3). VTOL Alternative 2 is adjacent to Phillips Parkway (alternatively called Beach Road, see Figure 3-4). Access to the Fire Training Area is via NASA Parkway East, north to Static Test Road and west to Fire Training Road (see Figure 3-3).

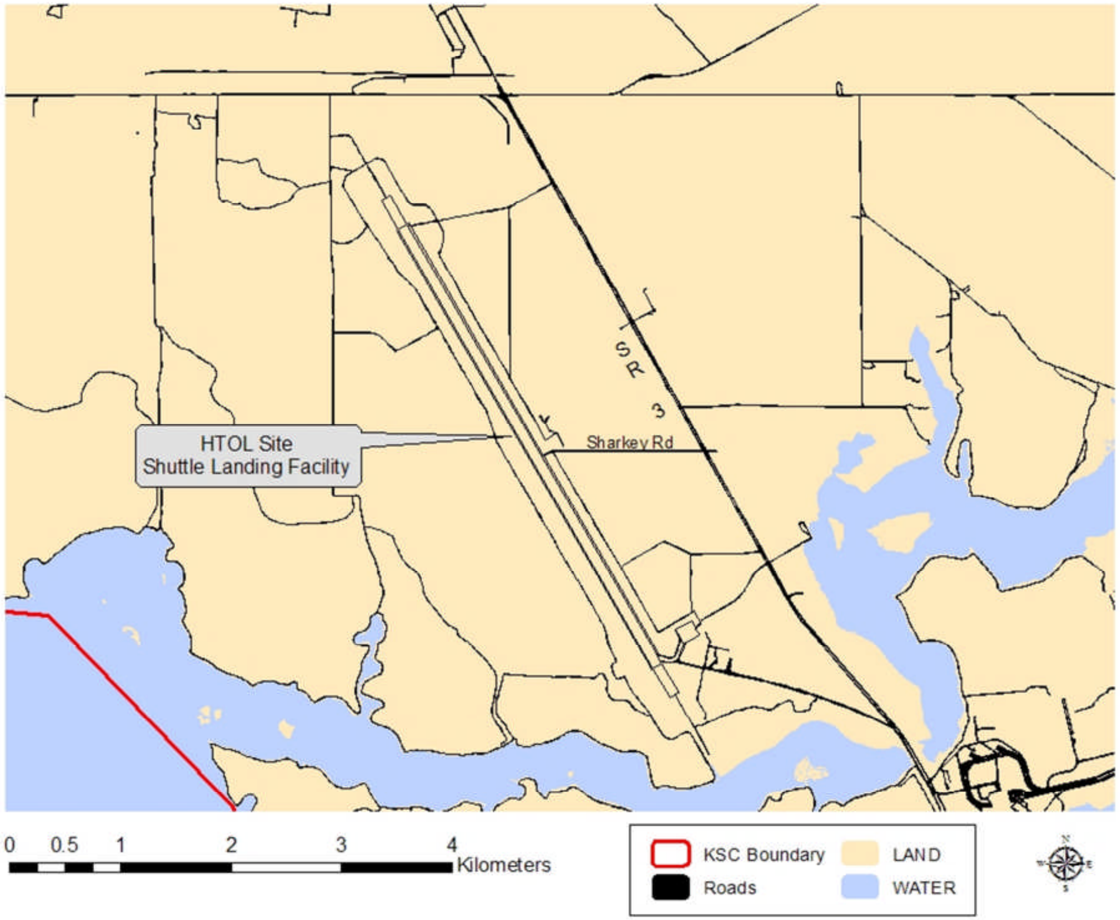

Figure 3-2. HTOL Site at the SLF.

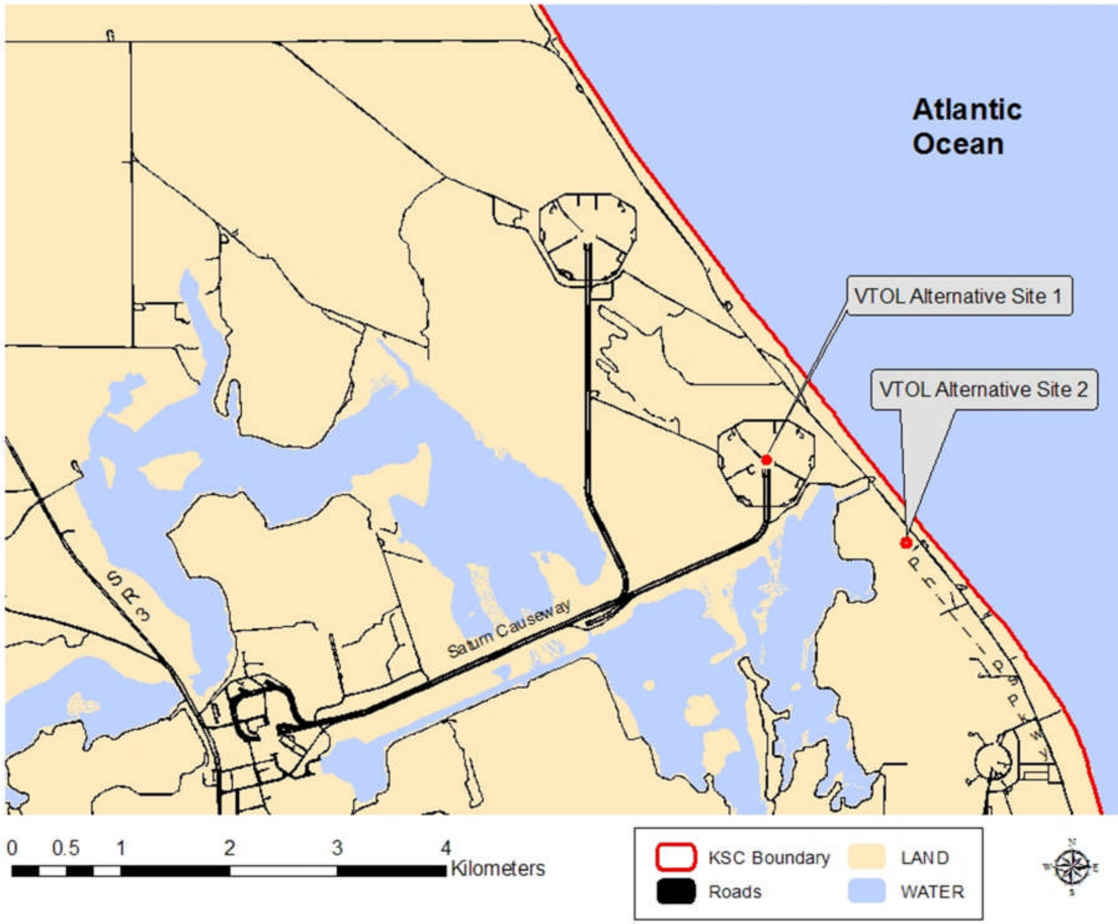

Figure 3-3. VTOL Alternative Site 1 and 2.

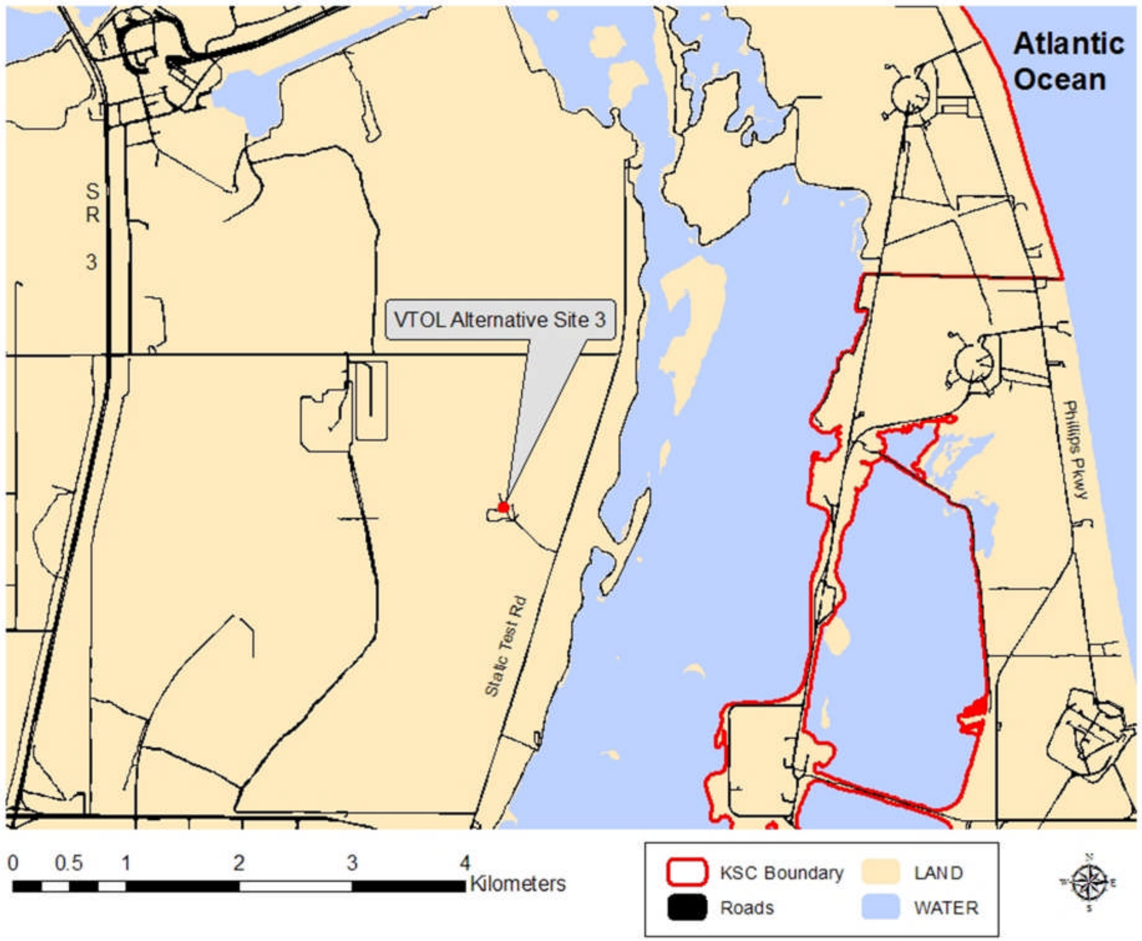

Figure 3-4. VTOL Alternative Site 3.

3.4 Utilities

3.4.1 Water Supply and Treatment

KSC's potable water is supplied by the City of Cocoa, which obtains its water from artesian wells located west of the St. Johns River in Orange County. Water enters KSC along SR 3 from a 60 centimeters (cm) [24 inch (in)] water main and extends north along SR 3 to the Vehicle Assembly Building (VAB) Area. The average demand for water is 4.5 million liters (l)/day [1.2 million gallons (gal)/day]. Various storage systems and secondary pump systems across KSC supply water needs for fire suppression launch activities, and potable water (NASA 2010).

Approximately 80% of the sanitary sewer service at KSC is provided by two collection/transmission systems, one located in the Industrial Area and one in the VAB Area. These systems collect and transport raw wastewater to the Regional Plant located on CCAFS. There are also a number of septic tank systems throughout KSC that typically support small offices or temporary facilities (NASA 2010).

3.4.2 Stormwater Collection

Impervious areas constructed after 1992 are subject to the rules of St. John's River Water Management District (SJRWMD) to provide for the treatment of pollutants and the attenuation of potential flooding impacts. As facilities are constructed or improved, stormwater systems must be built or upgraded to be consistent with the requirements of SJRWMD rule 40C-4, F.A.C. On KSC, roadways are drained to a swale system which removes potential floodwater from the road surfaces. There are over 100 surface water management systems controlling stormwater runoff at KSC. Regional systems serve the Industrial Area, VAB Area, South VAB Area, and the SLF.

3.4.2.1 SLF

Drainage from the shuttle landing strip is facilitated by a 24 in (61 cm) slope from the center line to the edge. Wet retention areas surround the runway, tow way, and associated facilities. The SLF stormwater permit for this area is covered under Permit #40-009-16630-3 entitled "Replace Fire Station No 2, LC 39 Area".

3.4.2.2 VTOL - Alternative 1

The deluge basin area in northern section of LC39A is graded to divert surface runoff from the pad and flame trench to two open concrete holding tanks. During launch, water flows to these holding tanks, located northwest and northeast of the flame trench. Water from launch is treated by adjusting the pH level and is tested prior to discharge to a permitted percolation pond and spray field. During non-launch times diversion gates are opened to divert stormwater to concrete conveyances which directs the water offsite. There are numerous grassed swales around the pad which discharge through culverts to a swale that runs along the perimeter access road. The access road swale discharge to receiving waters located around periphery of LC39A, including marsh areas, impounded wetlands, Pintail Creek and Broadaxe Creek.

3.4.2.3 VTOL - Alternative 2

This area is undeveloped and contains no stormwater discharge or treatment systems.

3.4.2.4 VTOL - Alternative 3

There is a dry retention pond located just north of the Fire and Rescue Drill Tower. A drainage ditch south of the tower and north of the classroom building extends from east of the berm to the undisturbed area east of the site. A swale runs along the south side of Fire Training Road and discharges to a roadside swale along Phillips Parkway.

3.4.3 Electricity and Natural Gas

The electric power distribution system at KSC is a combination of a Florida Power and Light Company (FPL) transmission system and two NASA-owned distribution systems. FPL transmits 115 kilovolts (kV) to KSC, which are distributed to two major substations. The C-5 substation serves the LC39 Area, providing 13.8 kV, and the Orsino substation serves the Industrial Area, providing 13.2 kV, for a total of 25% of the electricity currently allocated to KSC. An FPL solar site located in the Industrial Area has been providing approximately 1 megawatt of power directly to KSC since late 2009. In 2008, electricity consumption on KSC was 274,929 megawatt-hours and electricity provided approximately 74% of KSC's total energy use (NASA 2010).

In 1994, KSC began converting some facilities, equipment, and vehicles to natural gas. A 40 km (25 mi.) pipeline was constructed by City Gas Company of Florida, which distributes the gas within KSC. In 2008, 331,010 dekatherms of natural gas were used, accounting for approximately 26% of KSC's total energy use (NASA 2010).

3.4.4 Communications

The KSC Communications System provides a variety of services including: 1) conventional telephone services; 2) transmission of voice data and video; 3) voice data and video services; and 4) operation and maintenance of KSC's cable plant. There are three major distribution and switching stations located in the Industrial Area (First Switch) and in the VAB Area (Second and Third Switches). These three stations provide service for over 18,500 telephones on KSC.

3.4.5 Solid Waste

General solid refuse at KSC is collected by a private contractor and disposed of off-site at the Brevard County Landfill, a 78 ha (192 ac) Class I landfill located near the City of Cocoa. In 2009, the landfill received 1,400 tons of waste per day, of which less than 1% came from CCAFS and KSC (Brevard County Landfill administration, personal communications April 2009). The Brevard County Landfill has a 10- to 12-year life expectancy. KSC has an unlined Class III Landfill with permit restrictions which can only accept construction and demolition debris. The life expectancy of the KSC Class III Landfill is 13 – 49 years (R. Brown, Pers. comm.).

3.5 Hazardous Materials and Waste

3.5.1 Hazardous Materials Management

A hazardous material is defined in the Hazardous Materials Transportation Act (HMTA) as a substance or material in a quantity and form which may pose an unreasonable risk to health and safety or property when transported in commerce. Hazardous materials are identified and regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Occupational Safety and Health Act, (OSHA) the Toxic Substance Control Act (TSCA), and the Emergency Planning and Community Right-to-Know Act (EPCRA). Numerous types of hazardous materials are used to support the various missions and general maintenance operations at KSC. These materials range from common building paints to industrial solvents and hazardous fuels. Categories of hazardous materials used in support of past Space Shuttle activities include petroleum products, oils, lubricants, volatile organic compounds (VOC), corrosives, refrigerants, adhesives, sealants, epoxies, and propellants. Management of hazardous materials is the responsibility of each individual or organization.

The KSC Spill Prevention, Control, and Countermeasure (SPCC) Plan (KSC-PLN-1919) outlines the criteria established by KSC to prevent, respond to, control, and report spills of oil. Various types and quantities of oil are stored, transported, and handled to support the operations of KSC. The primary objective of the SPCC Plan is to serve as a guide for KSC personnel that are responsible for the prevention, response, control, and reporting of all oil spills. The KSC SPCC Plan describes both the facility-wide and site-specific (KSC-PLN-1920) approaches for preventing and addressing spills.

3.5.2 Hazardous Waste Management

Hazardous waste is defined in the Resource Conservation and Recovery Act (RCRA) as any solid, liquid, contained gaseous, or semi-solid waste, or any combination of wastes that could or do pose a substantial hazard to human health or the environment. Waste may be classified as hazardous because of its toxicity, reactivity, ignitability, or corrosivity. In addition, certain types of waste are "listed" or identified as hazardous in 40 CFR 263. All hazardous wastes generated on KSC must be managed, controlled and disposed of per the KSC Waste Management requirements outlined in KNPR 8500.1, KSC Environmental Requirements.

In this section, the presence of known or suspected contaminants on or near the three alternative sites is discussed. NASA KSC has a program to evaluate sites where contamination is present under RCRA and its Hazardous and Solid Waste Amendments. KSC's Remediation Program was initiated in response to an agreement with FDEP in the late 1980s regarding KSC's oldest contamination remediation sites or Solid Waste Management Units (SWMU),Wilson Corners and Ransom Road Landfill. Since then, KSC has been working with the EPA and FDEP to identify potential release sites and implement corrective action at those sites as warranted. EPA's SWMU Assessment initially identified 16 sites for investigation under the corrective action program. Additional sites were also identified by KSC as the program was implemented. In addition to corrective action sites, the remediation group also manages petroleum contamination sites. To date, KSC has identified and/or investigated approximately 200 sites located on KSC.

SWMUs and Potential Release Locations (PRL) are generally concentrated in operational areas such as the VAB, LC39, Industrial Area, and facilities on CCAFS currently or formerly operated by NASA (NASA 2009b). The most prevalent soil contaminants are petroleum hydrocarbons, RCRA metals, and polychlorinated biphenyls (PCB), and the most prevalent groundwater contaminants are chlorinated solvents and associated degradation products (NASA 2009b). A general outline of the surrounding SWMU and PRL sites are listed in Figures 3-5 to 3-8 below.

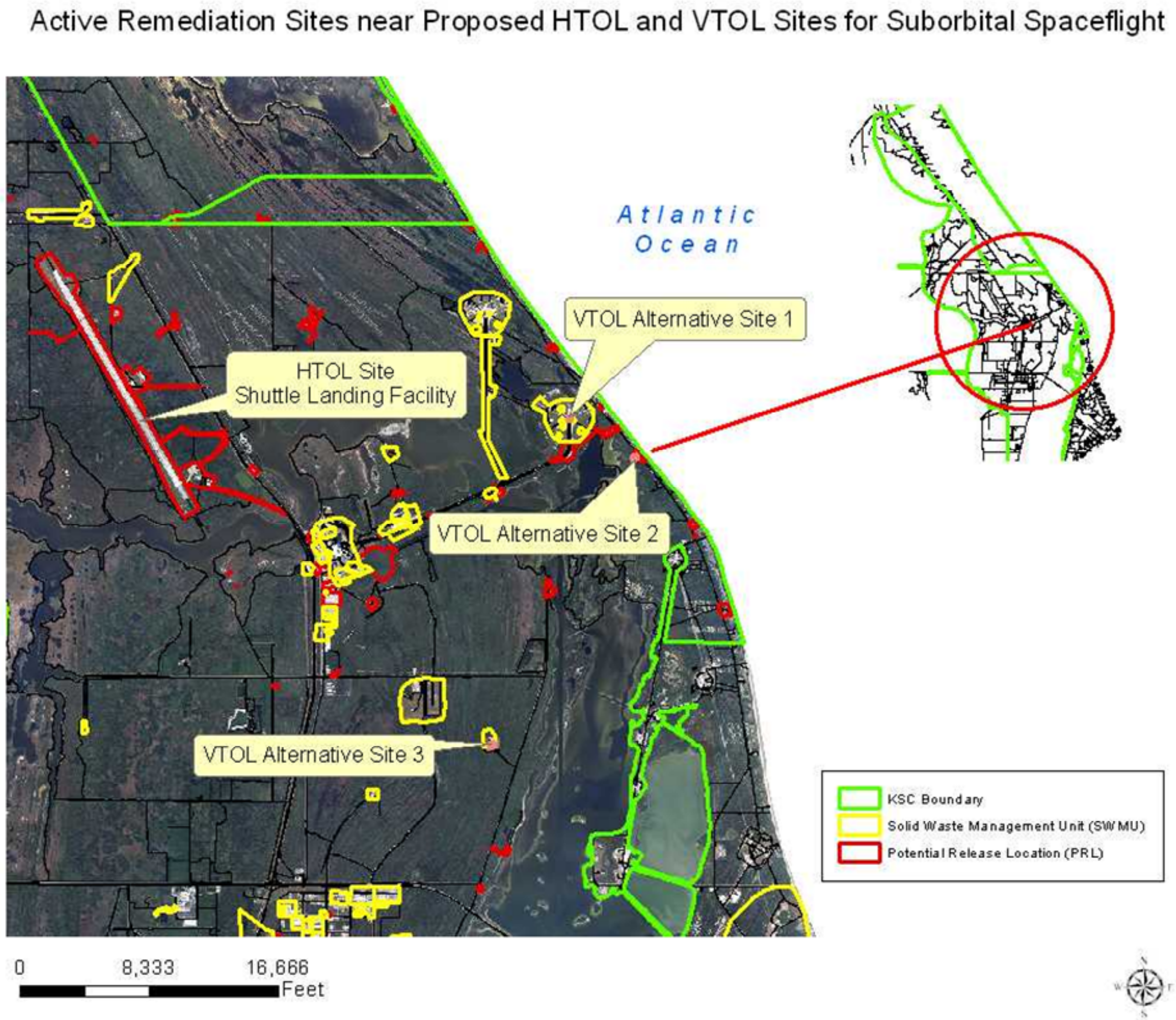

Figure 3-5. Active Remediation Sites near Proposed HTOL and VTOL Sites.

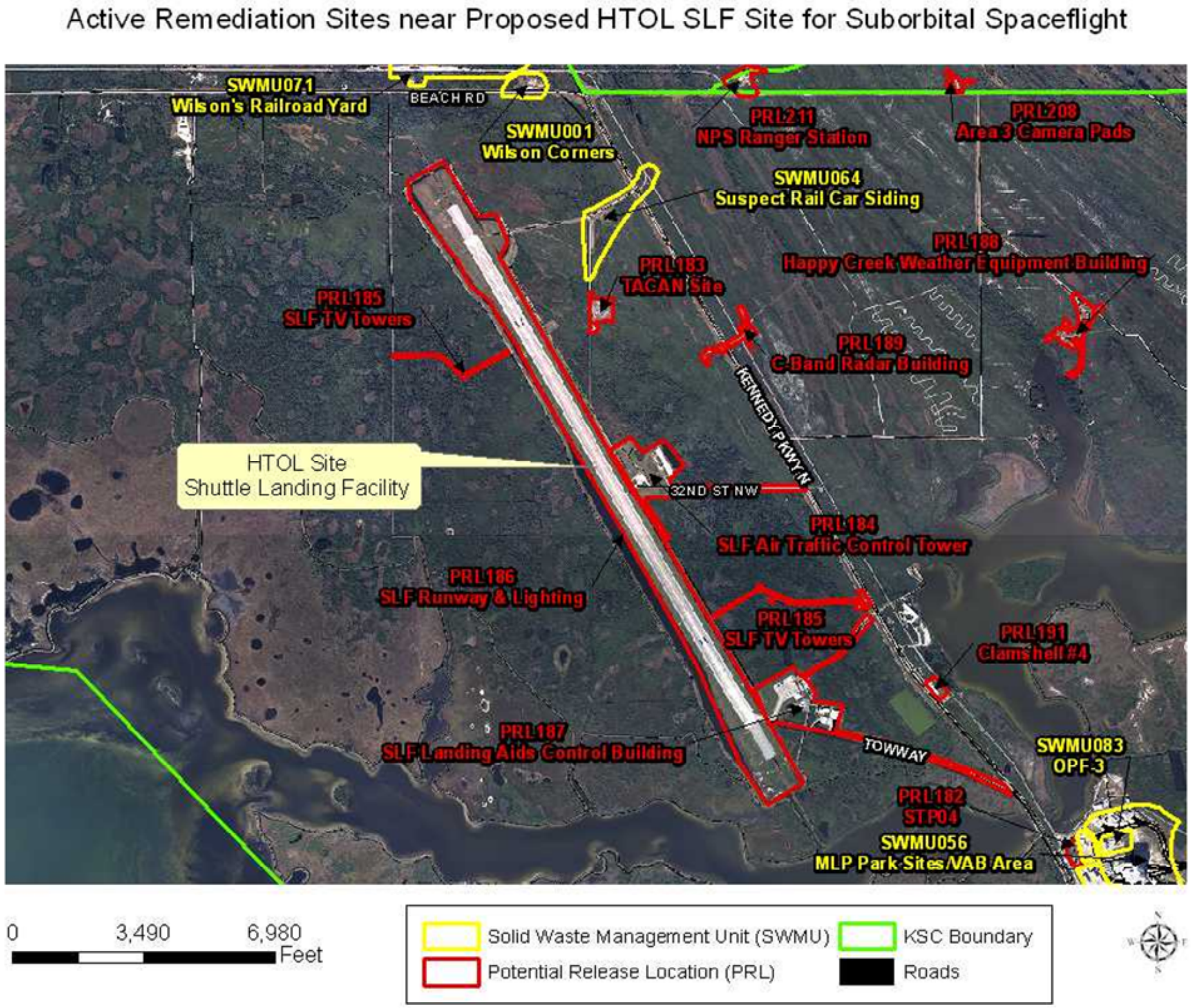

Figure 3-6. Active Remediation Sites near Proposed HTOL SLF Site.

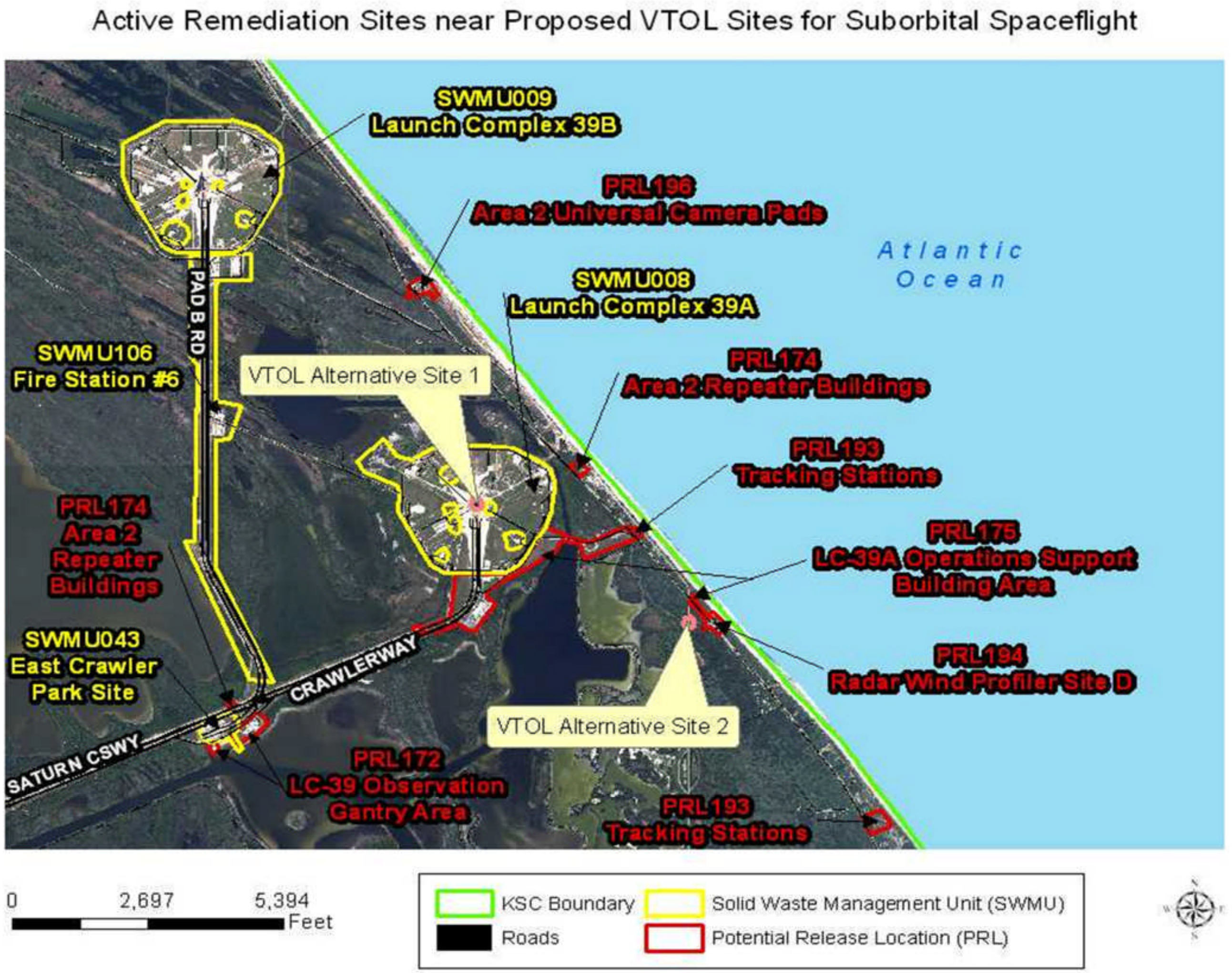

Figure 3-7. Active Remediation Sites near Proposed VTOL Sites 1 and 2.

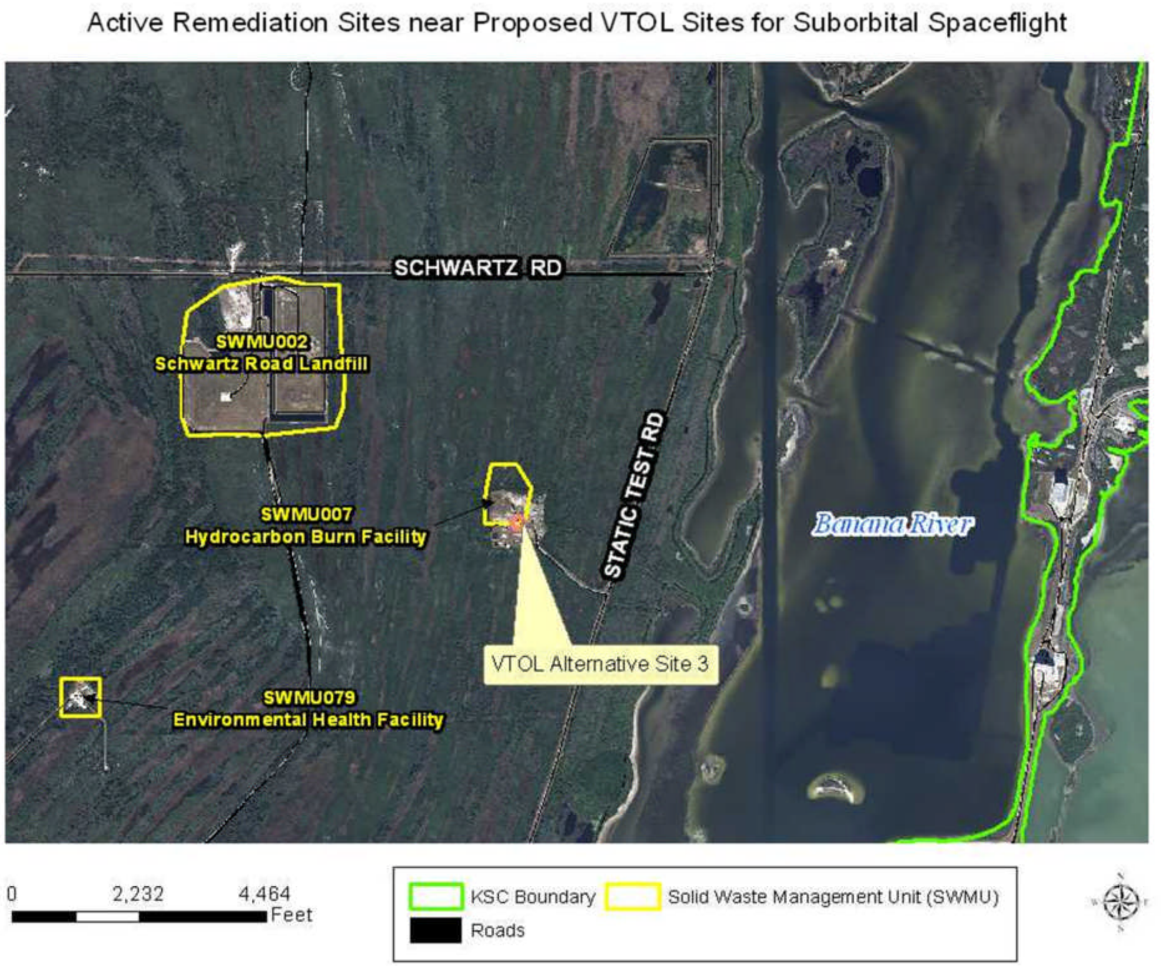

Figure 3-8. Active Remediation Sites near Proposed VTOL 3 Site.

3.5.2.1 SLF

Seven PRLs have been identified at the SLF and are described in the following paragraphs.

A SWMU assessment was conducted at the Mid-Field Park Site (PRL 62) in 1995 to determine the presence or absence of contamination. This assessment included groundwater and soil sampling. Samples were analyzed for Volatile Organic Compounds (VOCs), Semi-Volatile Organic Compounds (SVOCs), and metals. Soil sample results were below target levels in the Florida Soil Cleanup Goals. Groundwater had slight exceedances for aluminum, iron, manganese, benzene, and naphthalene and a monitoring well was installed for confirmatory sampling. A sample collected in January 1997 was analyzed for metals, VOCs, SVOCs, and total cyanide which were all below analytical method detection limits. Based on these results a recommendation of NFA was made for this site.

The SLF South PRL 95 is located at the southernmost portion of the shuttle runway near the Aircraft Ground Equipment Shed. Small spills occurred at this site during transfers of fuel from a tank trailer to a tank truck. Soil and groundwater sampling was conducted in 1999. A recommendation was made to remove 21 cubic yards of soil contaminated with petroleum range organics (PRO), VOCs and polynuclear aromatic hydrocarbons (PAHs). In June 2000, contaminated soil was excavated and removed from the site and the area was backfilled with clean fill (HSW Report 2000). No PRO, VOCs, SVOCs, lead, or ethylene dibromide (EDB) were detected in the groundwater. A No Further Action (NFA) status was proposed for this site.

The Tactical Air Navigation Site (TACN/PRL 183), consists of the TACAN antenna, J5-0440, and the Ascent Wind Profiler, J5-0341. A SWMU assessment was conducted in 2009 and locations of concern include active transformers, a backup generator, the TACAN antenna tower location, a former heavy equipment storage area, and the Ascent Wind Profiler antenna field herbicide application area. Potential contaminants are metals, hydrocarbons, PCBs, and SVOCs. Confirmatory sampling is planned.

The Air Traffic Control Tower site (PRL 184) is located north of Sharkey Road, east of the SLF. Locations of concern at this site included the former TACAN towers locations, past and present electrical equipment locations, former air traffic control tower site, a historic generator spill, and site groundwater. Potential contaminants are Polychlorinated Biphenyls (PCBs), metals, and hydrocarbons. Confirmatory sampling is planned for this PRL.

SLF TV Towers (PRL 185) consists of two areas, TV Tower 1 on the east side and TV Tower 2 on the west side of the SLF, respectively. A SWMU assessment was conducted in 2009 and locations of concern are active electrical transformers. Potential contaminants include PCBs and hydrocarbons. Confirmatory sampling is planned.

The SLF Runway and Lighting area (PRL 186) is a former camera pad constructed in 1966 and removed in 1974 during construction of the SLF. Facilities included in the SWMU assessment, conducted in 2010, included the shuttle runway (UK-0027), four Microwave Scanning Beam Landing System (MSBLS) Shelters and Monitors, the Approach Lighting System (ALS) Substations, Precision Approach Path Indicator (PAPI) Lights North and South, and associated facilities and areas and locations of concern are past and present electrical equipment locations, portable generators, and dry wells. Potential contaminants are metals, hydrocarbons, VOCs, SVOCs, and PCBs. Confirmatory sampling is planned.

Four locations of concern were identified in the LACB area (PRL 187) during a SWMU Assessment conducted from October 2009 through December 2010, which included past and present electrical equipment locations, the MDD refurbishment area, and site groundwater. Potential contaminants are metals, hydrocarbons, Volatile Organic Compounds (VOCs), Semi-Volatile Organic Compounds (SVOCs), and PCBs. Confirmatory sampling is planned.

3.5.2.2 VTOL - Alternative 1

LC39A has been designated as SWMU 008. There are nine operational support areas that may have impacted environmental media which include the Compressed Air Building (J8-1659), Environmental Control System (J8-1768), Heating, Ventilation, and Air Conditioning Building (J8-1707), Hypergol Fuel Facility (J8-1906), Hypergol Oxidizer Facility (J8-1862), Deluge Basin Area (DBA, two holding tanks), Sewage Treatment Facility (STP #5), Domestic Treatment Plant (DTP) #1 associated with the liquid oxygen (LOX) Operation Support Building A-1 (J8-1503), and DTP #2 associated with the liquid hydrogen (LH2) Operation Support Building A-2 (J8-1614).

RCRA Facility Investigation (RFI) activities were performed at LC39A from early 1998 through mid-2000. In the DBA portion of the site, groundwater impacts due to VOCs were observed. In the HOF area, PAHs, pentachlorophenol, and 2,4, and 6-trichlorophenol were detected above maximum contaminant levels and groundwater cleanup target levels (MCLs/GCTLs) in two monitoring wells. Surface water inside and outside of the perimeter fence contained PAHs and metals above Surface Water Cleanup Target Levels (SWCTLs) and some pesticides were also detected outside the fence line. An interim measure was conducted in 2000 which removed soils contaminated with PCBs and PAHs.

Supplemental RFI activities were performed from mid-2000 through early 2003 to further evaluate extent of contamination and assist with further evaluation of potential ecological risks to the environment. These investigations focused on the Liquid Oxygen (LOX) Area, the DBA, the Hypergol Oxidizer Facility (HOF) area and the surface water and sediment outside of the perimeter fence. Groundwater at LC39A is classified as GIII (for remediation purposes) and will not be used as a future source of drinking water. Groundwater from the pad area discharges to surrounding surface waters which are classified as Outstanding Florida Waters (OFW) and, therefore, must not receive discharges of contaminants above background levels. A corrective measures study (CMS) Work Plan has been developed to address groundwater contamination at LC39A. Metals are present in the swale sediments and a CMS was recommended to evaluate means for controlling potential off-site migration of these contaminants. There are several contaminants in site soils that pose an unacceptable risk to future potential residents. Restrictions are in place for any site work to prevent soils from leaving the area from which they were excavated. An interim measure was completed in 2009 for TCE contaminated soils in the area west of the LOX tank. This activity included excavation and disposal of 500 cubic yards (cy) of contaminated soil. A groundwater plume has been identified in the northwest portion of the pad and is under investigation.

The 21st Century Program has a project that was funded last year that is re-assessing the LC 39A area. They are collecting groundwater and soil samples from within the fence area at LC 39A. The collections of samples began in January of 2012. This project will provide an updated baseline of the groundwater and soil contaminants at LC 39A once complete.

3.5.2.3 VTOL - Alternative 2

This site is located within less than a mile of LC39A and LC41, both of which have SWMUs associated with them. See above description of SWMU 008 at LC39A.

Installation Restoration Program (IRP) Site DP-24 (SWMU C047) is present at LC41. Hydrazine, diesel fuel, halogenated solvents, paints, thinners, trace metals, and waste oils may have been disposed of at the site. In October 1996, a RFI was conducted at this site and an estimated 150,000 tons of PCB-contaminated soil were identified at LC41 (USAF 1998). Approximately 25% of the contaminated soil was identified as containing PCB concentrations exceeding the regulated level of 50 parts per million (ppm). In 1999, PCB-contaminated soils that could pose a risk to industrial workers were removed from the site. Remaining soils inside the fence line at the facility contained residual levels of PCB that could pose a risk if the site became a residential area. The RFI report that was issued in January 2000 recommended the land use controls (LUC) be implemented to ensure that the site does not become a residential setting. A Statement of Basis summarizing the soil LUC remedy decision has been finalized and approved (USAF 2005a).

3.5.2.4 VTOL - Alternative 3

There are three identified remediation sites at the FTA. The Hypergol FTA (SWMU 006) was investigated and given a NFA designation by EPA in March 1990.

The Hydrocarbon Burn Facility (HBF) site (SWMU 007) encompasses approximately 5.3 ha (13 ac). Previous activities at the HBF resulted in the accumulation of Light Non-Aqueous Phase Liquids on the surface of the groundwater in various locations (HBF PSS 2010). This site is under the corrective measures implementation phase and is currently undergoing semi-annual groundwater monitoring (HBF GWMR 2010).

The Fire Rescue Training Area (FRTA) (PRL 144), is approximately 3.6 ha (9 ac) in size. An environmental investigation of the site identified six locations of concern and three of the areas were associated with transformers. Other locations investigated included a wooden shed, a drill tower, and a former shooting range. Soils were analyzed for PCBs, PAHs, total recoverable petroleum hydrocarbons (TRPH), SVOCs, and/or VOCs. Soil chemical concentrations were less than FDEP Soil Cleanup Target Levels (SCTLs), Ecological Screening Values (ESVs), or KSC background concentrations.

The shooting range soils were found to have antimony and lead at concentrations greater than FDEP SCTLs, ESVs, and KSC background concentrations. During September and October of 2009, an interim measure was conducted in which 576 tons of contaminated soil were excavated and disposed of offsite (FRTA CSR 2010). A NFA designation was recommended for soil and groundwater at each of the locations of concern within the FRTA.

3.6 Atmospheric Environment

3.6.1 Climate

The climate at KSC is characterized as maritime-tropical with humid summers and mild winters. The area experiences moderate seasonal and daily temperature variations.

Average annual temperature is 22° centigrade (C) [71° Fahrenheit (F)] with a minimum monthly average of 13° C (60° F) in January and a maximum of 28° C (81° F) in July. During the summer, the average daily humidity range is 70 to 90% and the winter is drier with humidity ranges of 55 to 65% (Mailander 1990).

Prevailing winds during the winter are steered by the jet stream aloft and are typically from the north and west. As the jet stream retreats northward during the spring, the prevailing winds shift and come from the south. During the summer and early fall, as the land-sea temperature difference increases and the Bermuda high-pressure region strengthens, the winds originate predominantly from the south and east.

The central Florida region has the highest number of thunderstorms in the U.S. during the summer months (May – September), and over 70% of the annual 122 cm (48 in.) of rain occurs in the summer. During thunderstorms, wind gusts of more than 97 kilometers/hour (60 mi./hr.) and rainfall of over 2.5 cm (1.0 in.) often occur in a one-hour period, and there are numerous cloud-to-ground lightning strikes. Hurricane season extends from August through November. The most active hurricane season in KSC's history was 2004, when damages to facilities exceeded $100M. Additionally, many habitats, such as marshes, shoreline, and dunes were affected, at least temporarily, due to the storm surge and beach erosion (NASA 2004b).

3.6.2 Climate Change

Greenhouse gases, thermal emissions, and solar irradiance are the key factors interacting together to maintain temperatures on Earth within the tolerance limits for life to exist. Changes in greenhouse gas concentrations in the atmosphere have been identified as the primary drivers of past climate change on Earth (EPA 2009a). Human land use changes, burning of fossil fuels for energy use, and other activities are contributing to increases in greenhouse gases in the atmosphere. The potential impacts of increasing concentrations of atmospheric carbon dioxide (CO_2) (and other climate altering materials such as methane, aerosols, and black carbon particulates) on the Earth's climate have been well documented by the International Panel on Climate Change (IPCC 2007) and are the dominant reason for societal interest in the carbon cycle. They include warmer temperatures, rising sea levels, changes in rainfall patterns, and a host of other associated and, often interrelated effects. However, the consequences of the buildup of CO_2 in the atmosphere extend beyond climate change alone. "CO_2 fertilization" of plants (Caspersen et al. 2000, Schimel et al. 2000, Houghton 2002) and ocean acidification are foremost among these direct, non-climatic effects. The uptake of CO_2 by the world's oceans as a result of human activity over the last century has made them more acidic (Orr et al. 2005). This acidification will compromise the growth and survival of corals, plankton, and other marine organisms that build their skeletons and shells from calcium carbonate, and could dramatically alter the composition of ocean ecosystems, possibly eliminating coral reefs by 2100 (Orr et al. 2005).

Emissions of CO_2 at KSC are primarily associated with commuting vehicle traffic, ground support operations, and launch events; however a comprehensive carbon budget for each activity is not available. A baseline annual estimate for the last 30 years of the shuttle program was calculated with the following assumptions:

- an average workforce of 15,000 employees with 13,000 vehicles (NASA 2010), averaging 20 miles per gallon, and driving an average of 60 miles a day, 240 days a year
- Center power consumption of 1,400,000 million British thermal units (MMBtu) from a combination of electrical purchases, natural gas, fuel oil, diesel and gasoline
- four (4) Space Shuttle launches per year utilizing two (2) SRBs per launch.

Commuting contributes approximately 83,200 metric tons (mt) of CO_2, Center energy use contributes 60,600 mt, and the four shuttle launches contribute 156 mt (Dreschel and Hall 1990) for an estimate of 144,000 mt of CO_2 per year for each year of the 30 year Shuttle Program. With retirement of the Space Shuttle and the reduction in the work force and ground support operations, annual CO_2 emissions are currently estimated at approximately 99,000 mt. This assumes a reduction to 7,000 vehicles, Center energy use of 1,200,000 MMBtu, and no Space Shuttle launches (Energy Program 2010).

In 2010 the NASA Headquarters Office of Strategic Infrastructure and the NASA Earth Sciences Office established the Climate Science Adaptation Investigation (CASI) team to develop downscaled climate change forecast for the different NASA centers to address potential impacts and adaptation strategies to ensure sustainability of valuable NASA infrastructure. Members of the CASI team have developed regional and local climate projections for KSC using 16 different global climate models (GCMs) and statistical methods to link the model values to empirical long term data from the City of Titusville covering the period between 1900 and 2010. The Titusville data for temperature and rainfall are presented in Figures 3-9a and 3-9b. Temperature has been trending upward for the period of record. Rainfall has displayed no upward or downward trend in intensity or volume.

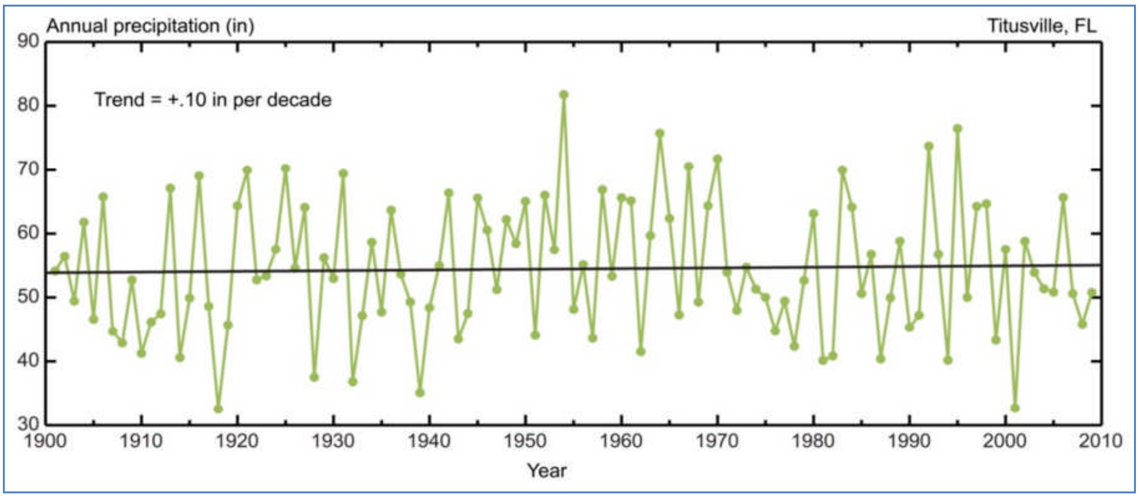

Figure 3-9a. Long-term rainfall data for Titusville, Florida showing no increasing or decreasing trend.

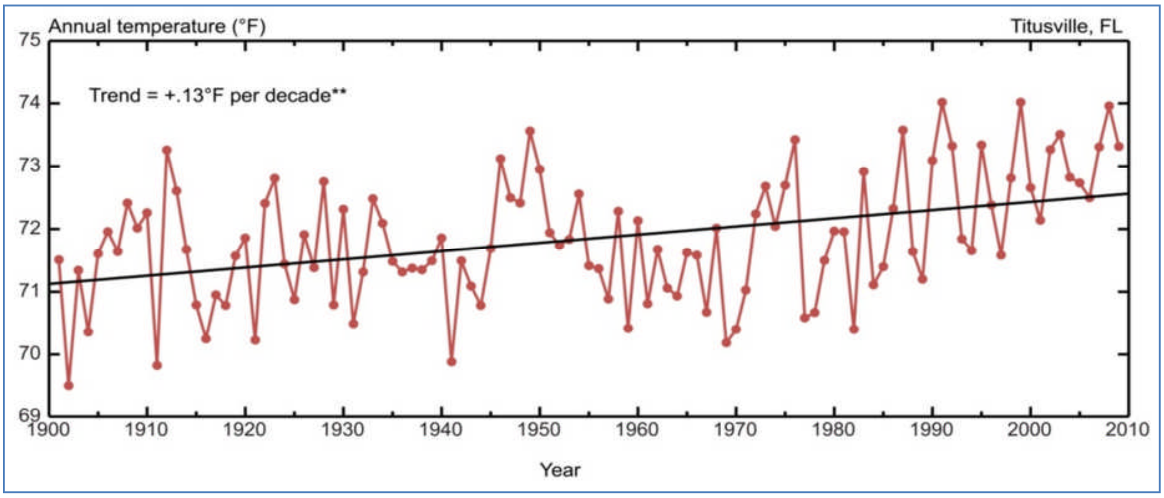

Figure 3-9b. Long term temperature data from Titusville, Florida showing the increasing trend.

Results of the regional CASI GCM based forecast for future climate conditions in the project area are summarized in Tables 3-1 to 3-3.

Average air temperature for the 30-year climate baseline period is 72 degrees. Climate forecasts for the region suggest average temperatures will increase by as much as 6 degrees during the later part of the century. Rainfall projections indicate little change in the total annual amount of 135 cm (53 in). Projections for the occurrence of days above and below temperatures that impact the outdoor workforce are shown in Table 3-2. Current estimates suggest there will be a dramatic increase in the numbers of days above

32°C (90°F) when compared to the annual baseline average. This will greatly influence the potential for heat stress and will require additional management action. The number of cold days is expected to decrease slightly. Projections of the occurrence of extreme events are summarized in Table 3-3. As the amount of energy in the atmosphere increases, the probability of extreme events like downpours and extreme winds increases. Heat stress conditions are very likely. The intensity of rainfall events will likely increase and the possibility of extreme winds (hurricanes) are more likely to trend upward.

Table 3-1. Estimated climate conditions for air temperature and rainfall for the KSC[1].

	Baseline 1971 – 2000	2020s	2050s	2080s
Air temperature Central range[2]	72 °F	+ 1 to 2 °F	+ 2.5 to 3.5 °F	+ 3 to 6 °F
Precipitation Central range	53.0 in	-5 to +5 %	-5 to +5 %	-5 to +5 %

[1] Based on 16 GCMs and 3 emissions scenarios the baseline for temperature and precipitation is a 30-year period 1968 and 2007, with the best available observed daily weather data in Titusville. Data from National Climatic Data Center (NCDC) temperature data and precipitation data are from Titusville.

[2] Central range equal middle 67% of values from model-based probabilities; temperature ranges are rounded to the nearest half-degree, and precipitation to the nearest 5%.

Table 3-2. Estimated changes in the numbers of days of extreme hot or cold temperatures for KSC (Adapting Now to a Changing Climate, NP-2010-11-687-HQ, NASA).

Daily Temperature	**Baseline**	**2020s**	**2050s**	**2080s**
Days at or above 95 ^{o}F	12	21 to 28	31 to 57	42 to 101
Days at or above 90 ^{o}F	82	99 to 114	118 to 142	125 to 173
Days at or below 40 ^{o}F	20	13 to 15	10 to 14	7 to 11
Days at or below 32 ^{o}F	4	2 to 3	2	1 to 2

Table 3-3. Projected likelihood of extreme events through the later part of the 21st Century, based on global climate simulations, published literature, and expert judgment (Adapting Now to a Changing Climate, NP-2010-11-687-HQ, NASA).

Event	**Trend**	**Likelihood**
Heat Stress	up	Very Likely (>90%)
Downpours	up	Likely (>66%)
Intense Storms	up	More likely than not (.50%)
Extreme Winds	up	More likely than not (.50%)

3.6.3 Air Quality

The ambient air quality at KSC is predominantly influenced by daily operations such as vehicle traffic, utilities fuel combustion, and standard refurbishment and maintenance operations. Other operations occurring infrequently throughout the year, including launches and prescribed fires, also play a role in the quality of air at KSC as episodic events. Air quality has been influenced to some extent by emissions sources outside of KSC, as noted with long term monitoring, this has occurred primarily with regional oil-fired power plants located within 18.5 km (10 mi.) of KSC. Both plants are currently offline and one new generation plant is being built (FPL).

Air quality is monitored by a Permanent Air Monitoring System (PAMS) station located north of the Industrial Area. The PAMS station continuously monitors concentrations of sulfur dioxide, nitrogen dioxide, carbon monoxide, and ozone, as well as meteorological data. KSC is currently located within an area classified as attainment with respect to the National Ambient Air Quality Standards established by the EPA and FDEP for all criteria pollutants (NASA 2010). Air quality at KSC is considered good, primarily because of the distance of the facility from major sources of pollution. There are no class I or nonattainment areas for NAAQs within approximately 60 miles from KSC.

Automobile emissions are one of the most influential factors contributing to air quality fluctuations routinely occurring on KSC. Mobile sources and the control of their emissions are regulated under the Clean Air Act (CAA). A summary of air source emissions standards for KSC is provided in the Tables 3-4 to 3-6.

Table 3-4. State and Federal Ambient Air Quality Standards

Pollutant	Average Time	State of Florida Standard	Federal Primary Standard	Federal Secondary Standard
Carbon Monoxide	8 hour*	9 ppm (10 mg/m3)	9 ppm (10 mg/m3)	
	1 hour*	35 ppm (40 mg/m3)	35 ppm (40 mg/m3)	
Lead	Quarterly Arithmetic Mean	0.15 µg/m3	0.15µg/ m3	(same as primary)
Nitrogen Dioxide	Annual Arithmetic Mean	0.05 ppm (100 µg/m3)	0.053 ppm (100 µg/m3)(2)	(same as primary)
Ozone	1 hour+	0.12 ppm (235 µg/m3)	0.075 ppm(3)	(same as primary)
Sulfur Dioxide	Annual Arithmetic Mean	0.02 ppm (60 µg/m3)	0.03 ppm (80 µg/m3)	
	24 hour*	0.1 ppm (260 µg/m3)	0.14 ppm (365 µg/m3)	
	3 hour*	1300 µg/m3 (0.5 ppm)		1300 µg/m3 (0.50 ppm)
Inhalable Particulates (PM-10)	Annual Arithmetic Mean	50 µg/m3	50 µg/m3	(same as primary)
	24 hour*	150 µg/m3	150 µg/m3	(same as primary)

Pollutant	**Average Time**	**State of Florida Standard**	**Federal Primary Standard**	**Federal Secondary Standard**
Particulates (PM-2.5)	Annual Arithmetic Mean		15 µg/m3 **	(same as primary)
	24 hour		65 µg/m3 **	(same as primary)
(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.				
Source: Florida Department of Environmental Regulation (FDER) and Environmental Protection Agency (EPA) 2011.				

Table 3-5. KSC Air Quality Data

KSC Air Quality Data Summary PAMS A, 2010

Parameters	Federal and State Standards	January	February	March	April	May	June
Ozone	Primary	52.2	53.1	60.7	60.3	47.3	**127.6**
(ppb)	120 (1-HR)1	(100.0%)	(100.0%)	(99.3%)	(94.6%)	(100.0%)	(76.7%)
Sulfur Dioxide	Primary	1.8	0.8	1.5	2.6	3.8	2.7
	140 (24-H)2,3						
(ppb)	Secondary	4.8	3.6	2.1	36.7	5.2	3.4
	500 (3-HR)2	(82.7%)	(85.1%)	(96.2%)	(94.6%)	(98.1%)	(80.4%)
Nitrogen Dioxide	50 (1-HR)1	8.8	2.6	8.1	12.5	9.30	0
	Primary	0.848	0.669	0.569	0.928	0.801	0
(ppb)	50 (Ann. Avg.)3	(60.5%)	(100.0%)	(99.6%)	(81.3%)	(11.1%)	(0%)

Parameters	Federal and State Standards	July	August	September	October	November	December
Carbon Monoxide	Primary35 (1-HR)1	**38.5**	0.700	0.3	.100	.175	0.342
(ppm)	Secondary	**11.75**	0.700	0.4	.150	0.113	0.068
	9 (8-HR)2	(100.0%)	(100.0%)	(99.3%)	(99.7%)	(98.8%)	(92.8%)
Ozone	Primary	131.4	20.1	26.9	36.2	41.0	41.2
(ppb)	120 (1-HR)1	(76.3%)	(88.4%)	(100.0%)	(97.6%)	(99.0%)	(94.2%)
	Primary	2.2	2.4	1.0	1.7	3.6	0.7
Sulfur Dioxide	140 (24-H)2,3						
(ppb)	Secondary	3.2	3.5	3.1	4.2	4.3	3.6
	500 (3-HR)2	(90.5%)	(66.7%)	(98.8%)	(99.3%)	(97.2%)	(62.9%)

Parameters	Federal and State Standards	July	August	September	October	November	December
Nitrogen Dioxide	50 (1-HR)1	0	14.4	4.4	6.0	7.6	14.3
	Primary	0.803	0.818	0.818	0.67	0.73	1.09
(ppb)	50 (Ann. Avg.)3	(0%)	(35.2%)	(100.0%)	(100.0%)	(100.0%)	(94.2%)
Carbon Monoxide	Primary	1.1	0.4	0.433	0.617	0.675	1.4
	35 (1-HR)1						
(ppm)	Secondary	0.724	0.150	0.241	0.341	0.397	1.338
	9 (8-HR)2	(99.7%)	(88.2%)	(100.0%)	(100.0%)	(100.0%)	(42.2%)

Table 3-6. KSC Air Quality Data Summary PAMS A: Ten Year Mean (1997-2007)

Parameters	Federal3 and State Standards	Min.	Max.	Mean	Std. Dev.	Percent Valid
Ozone	Primary					
(ppb)	75 (1-HR)1	23.0	34.9	29.1	3.7	90.8
Sulfur Dioxide	Primary					
	140 (24-H)2,3	4.0	15.9	9.1	4.0	
(ppb)	Secondary					95.6
	500 (3-HR)2	6.2	36.1	13.3	8.0	
Nitrogen Dioxide	50 (1-HR)1	0.2	6.1	1.5	1.9	64.9
	Primary					
(ppb)	50 (Ann. Avg.)3	0.268	0.760	0.549	0.217	77.9 w/o
						Nov.- Dec.

Parameters	Federal3 and State Standards	Min.	Max.	Mean	Std. Dev.	Percent Valid
Carbon Monoxide	Primary					
	35 (1-HR)1	0.2	17.3	2.7	5.2	
(ppm)	Secondary					95.7
	9 (8-HR)2	0.125	3.638	1.061	1.490	

KEY: 1 - Maximum hourly average concentration (not to be exceeded more than once per year) 2 - Maximum time-period average concentration (not to be exceeded more than once per year) 3 - Federal and State standard values are identical except for SO2; State Primary (24-hour) is 100 PPB. 21 days are required to yield a valid month

No exceedance level set for NO2 to date. 50 PPB is considered significantly high.

( ) Indicates percent of valid data Capture

--- Indicates instrument down-time

There were no exceedances of either the primary or secondary air quality standards for O_3, NO_2, or SO_2 for the first quarter of 2010. The CO for 1-hour value of 38.5 slightly exceeded the Primary Standard of 35.0 ppm and the 8-hour value of 11.75 exceeded the Secondary Standard of 9.0 ppm during January. These exceedances of CO were most likely caused by controlled burning on KSC (J. Drese, Pers. Com.). There was an exceedance of both the Primary and Secondary Standards for O_3 during June, the second quarter. These O_3 exceedances were due to transport of an air parcel in front of a fast moving storm (IHA 2010). There were no other exceedances of either primary or secondary standards for O_3, NO_2, or SO_2, or CO for the remaining two quarters of 2010.

During the past 10 years, carbon monoxide has been indicated at increased concentrations typically in February, March, September, and highest in May. Carbon Monoxide concentrations have indicated a downward trend, with the higher 10 year average for 1 hour values due most likely due to the controlled and natural fires occurring during the dry months (personal communication, J. Drese, January 2012). Nitrogen Dioxide has also indicated a downward trend, and the 2011 mean is higher than the 1996 mean (below the limits). Most recently, Sulfur Dioxide was indicated at higher values for the 24 hr value than the previous 10 year mean for the months of November and December 2011. Increased concentrations have typically been indicated during the April to May timeframe (personal communication, John Drese, January 2012).

Total inhalable 10-micron particulates (PM-10) were monitored historically (1983-1989, 1992-1999) at the PAMS and two other sites on KSC. During those times, there was only one exceedance in PM-10; this occurred during the ground clearing for the International Space Station (ISS) (Drese 2006). KSC is not currently monitoring PM 2.5 or PM 10. One ozone and particle monitoring station operated by the Florida Air Quality System (FLAQS) is located approximately 45 miles south of KSC at 401 Florida Avenue, Melbourne, FL (Latitude: 28° 3' 13" Longitude: -80° 37' 43"). Monitoring began for ozone on 3/1/2000, and particle pollution on 10/25/2007. Historical information for 2007 – 2011 indicates the highest daily average occurred on June 15th 2010, at 27.1 µg/m3, which is well below the daily State and Federal Ambient Air Quality Standards.

3.7 Noise

Noise is an undesirable sound that may interfere with communication or if of sufficient intensity over time, results in decreased hearing acuity. In the natural world, noise can be defined as any sound that occurs above a tolerance level of a species in question, and alters its normal behavioral patterns. Given certain intensities, frequencies, and duration, noise can change the behavior of humans and wildlife. Noise is usually associated with human activity although some natural sounds may be considered noise. Noise is measured in decibels (dB) and an A-weighted sound pressure level (dBA) is commonly applied. Noise at KSC was described in detail in the SLF Expansion EA (NASA 2007) and typical sound levels are summarized below in Table 3-7.

KSC is a large controlled access area and the noise environment is isolated to the activities within this area where launch vehicle and spacecraft processing and launch represent a primary mission. Aircraft and launches at both KSC and CCAFS do present sound levels that extend beyond the respective boundaries. Located on Merritt Island KSC is bounded by the Atlantic Ocean and Cape Canaveral Air Force Station to the east and the Indian River on the west. From the SLF the nearest city is Titusville (~6 mi.), just across the Indian River. Open space lies to the north. Land just to the south of KSC is largely undeveloped and low density housing (~9 mi from SLF). The beach cities of Cape Canaveral and Cocoa Beach are also to the southeast and immediately south of Port Canaveral (~15 mi from SLF). The sound produced by current rocket launches is noticed in all these areas and these perimeter locations are commonly visited by the public for “close-up” witnessing of launches.

Noise generated at KSC originates from several different sources: 1) traffic, 2) industrial operations, 3) construction, 4) aircraft, and 5) launches. Traffic noise at KSC is generated by employees traveling to and from their workplace and the local movement of a mix of trucks and passenger vehicles. Road surfaces are mostly asphalt with a maximum speed limit of 55 miles per hour (mph) on the major roadways and commonly 35 mph or less on local roads. Typical noise from passenger vehicles are 72 -74 dBA at 55 mph at a distance of 50 ft (15.24 m). At the same distance medium trucks (e.g., vans, delivery trucks, buses, with exhaust located under the vehicle) can result in a sound level of 80 to 82 dBA at 55 mph at 50 ft (15.24 m). Heavy trucks (e.g., semi-trucks, with exhaust located 6 to 8 ft (1.8 to 2.4 m) above the roadway can produce 84 to 86 dBA at 55 mph at 50 ft. (15.24 m). Overall noise from these sources is dependent on many factors including traffic volume, speed, vehicle type, roadway geometry, and local structures. Most of the vehicular activity is during the daylight hours commonly between 0630 and 1630. Both second and third work shifts are present, yet the population and traffic is greatly reduced. Rail operations are extremely infrequent, low speed, and limited to local movement of flight vehicle elements.

Table 3-7. Examples of typical sound levels.

Common Sounds	**Sound Level** *(dBA)*
Threshold of hearing	0 - 10
Quiet rural nighttime	20
Quiet suburban nighttime	20 - 25

Common Sounds	**Sound Level** *(dBA)*
Quiet urban nighttime	40
Business office	50
Heavy traffic at 90 m (300 ft)	60
Gas lawn mower at 30 m (100 ft)	70
Noisy urban daytime	80
Gas lawn mower at 0.9 m (3 ft)	95
Inside subway train	100
Jet flyover at 300 m (1,000 ft)	110

Construction noise is largely limited to the site, yet noise can carry to surrounding areas. Some typical values for noise levels from construction and associated vehicles were shown in the SLF EA (NASA 2007) with examples summarized below in Table 3-8.

Table 3-8. Examples of construction noise sources.

Source	**Sound Level** *(max. dBA)*	**Estimated Sound Level at 120 m (400 ft)** (est. dBA)
Dump truck	108	70
Concrete mixer	105	67
Dozer	107	69 - 84
Loader	104	5 - 68
Generator	96	58
Crane	104	55 - 70

Noise from aircraft at and near KSC is associated with operations at the SLF with runways 15 and 33 and the nearby Skid Strip at CCAFS runways 12 and 30.

KSC experiences launch-related noise from Launch Complex's 41 (Atlas V), Complex 40 (SpaceX), and Complex 37 (Delta IV). The Space Shuttle has been NASA's reusable, heavy lift vehicle since 1981 with launches reaching as many as nine in one year in 1985 from Launch Complex 39. At the pad launch noise could reach 160 dBA with sound diminishing with distance. Noise from the February 2008 Space Shuttle launch (STS-122) was measured by the KSC Environmental Health office with a logging noise dosimeter at a fall-back position (approximately 2. 8 mi, or 14,700 ft (4,500 m)). Pre- and post-launch event data indicated sound levels ≤70 dBA at fall-back. At launch time there was short term increase to a peak of 99 dBA with a gradual decrease to ambient conditions. The entire cycle (as seen in Figure 3-10) was less than one minute. In considering the magnitude and short duration of the noise, personnel exposures do not reach the OSHA permissible exposure limit (PEL) of 90 dBA 8-hr TWA, or even the action level (85 dBA 8-hr TWA) for hearing conservation program concerns. Nor do they present sound pressure levels that exceed the 115 dBA upper limit for unprotected personnel. NASA has a significantly more protective exposure limit than OSHA, and noise exposure from the short duration launch noise is similarly well below hearing conservation concerns when that policy is applied.

Figure 3-10 shows sound pressure level (SPL) at fall-back (2.8 mi from LC-39A). Sound levels (dBA and dBC shown) are 1-second averages. The criterion level of a potential noise hazard is 85 dBA and was exceeded for 28 seconds. The much higher C-weighed SPLs reflect the strong low frequency sound component of the overall spectrum.

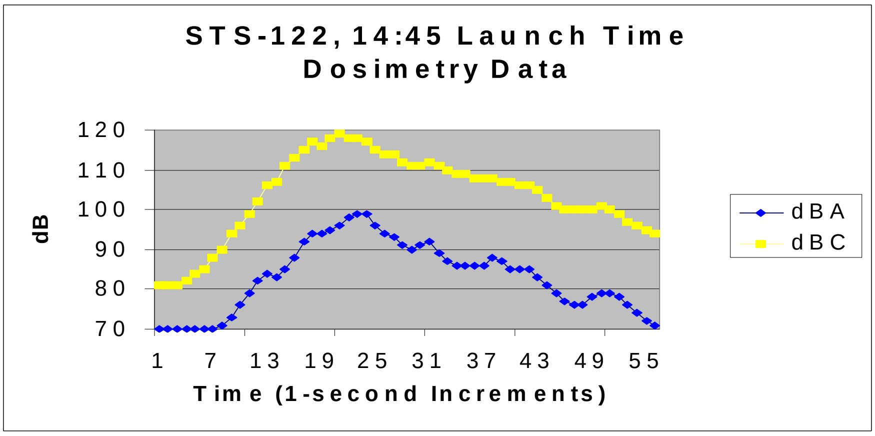

Figure 3-10. SPL at fall-back (2.8 mi from LC39A) shown in 1-second averages in dBA and dBC.

3.7.1 SLF

SLF flight operations include conventional fixed wing aircraft and helicopters. There has been air show activity as well with flights by military pilots and fighters. Noise from this activity is dependent on aircraft type and flight characteristics. Additionally, the effects of the noise are dependent on the hours of operation. Few operations take place in the evening (i.e., 22:00 to 07:00 hrs) when humans are more sensitive to noise. Flight activity is commonly cargo delivery (e.g., flight hardware and support equipment), limited commercial test flights (e.g., F-104), official business travel (e.g., Gulfstream), astronaut flight training and activity preceding launch day, and helicopter flights. Flight operations have changed through the recent years from 18,743 operations per year in 2000 to as few as 3,264 in 2004. Since 2004, flights have increased to 5,521 in 2009, and then decreased in 2010 to 4,753 (see Table 2-4). Flight operations expressed in terms of operations per day equate to 2.1 operations per day in 2000 to 0.4 in 2004, and 0.5 operations per day in 2010.

Baseline noise studies have not been performed for SLF aircraft activity; however some example aircraft approach and departure noise contours have been generated by Integrated Noise Model (INM) (NASA 2007, Expanded Use of SLF). Examples of those results are shown below for a 747 departure and approach, see Figures 3-11 and Figure 3-12, respectively.

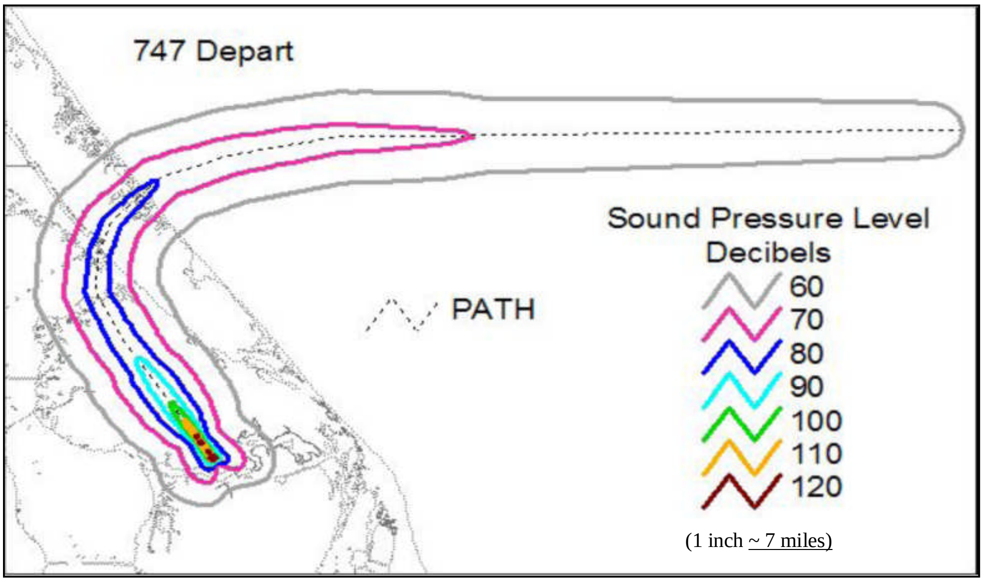

Figure 3-11. Boeing 747 sound level contours (dBA, LAMAX) for an SLF departure.

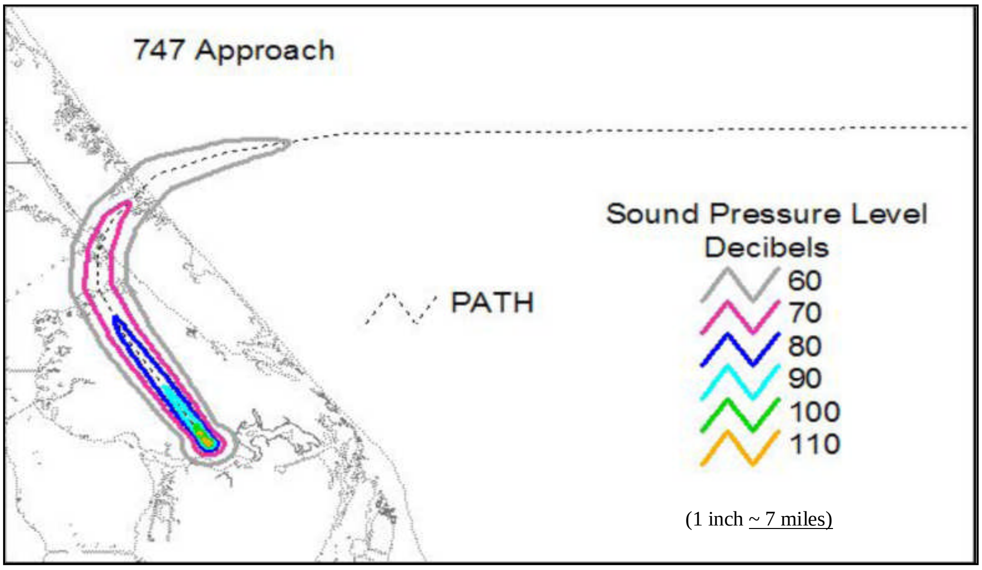

Figure 3-12. Boeing 747 sound level contours (dBA, LAMAX) for an SLF approach.

Sonic booms can be created by aircraft and rocket activity when they exceed the speed of sound. The duration is brief, measuring in milliseconds. The closer the source is to the receiver, the greater the intensity; thus in general, the greater the altitude the less the intensity on land. The occurrence and local experience is not common. Test flights to include supersonic flights of commercial endeavors have taken place from the SLF. In 2007 flight operations of F-104s were monitored for noise at several KSC locations. Supersonic tests flights in 2007 by F-104 aircraft were assessed to determine experienced noise levels at several locations. Logged sound pressure level data, including peak values, did not indicate levels above normal background during times of sonic activity. Similarly, observers positioned at selected monitoring stations did not detect sonic boom activity during those tests.

In addition to the typical or routine noise sources at KSC, another noise source has been experienced at the SLF. That source is the commercial use by NASCAR racecar organizations for straight line testing of their vehicles. The initial occurrence of this application heard in 2007 when noise levels were monitored during a two day racecar event. In no case were racecar sound levels identified with logged 10-second data at each monitoring station. A SLF midfield dosimeter was used to provide a time signature for each run. Although elevated events were recorded at each monitoring station, manned stations identified all peaks to be associated with other actions such as airboats, buses, trucks, passenger vehicles, and wildlife; and none correlated with the racecar run pattern. Some runs were audible at one location (e.g., Blackpoint Road.), yet detection within the full spectrum data was not possible. In those cases, the sound levels remained low (e.g., 38 – 43 dBA). By comparison, roadway traffic activity noise resulted in 41 to 52 dBA at the same location. An example of a single series of racecar runs and the racecar signature is provided below in Figure 3-13.

Figure 3-13 illustrates the racecar signature compared to a remote site with rare traffic, Happy Creek sound level results (10-second data). The racecar run's signature is defined with the SLF midfield curve. Happy Creek monitoring station is shown at the lowest detection level throughout the series of runs. Short-term increases in Happy Creek sound levels were associated with traffic and wildlife.

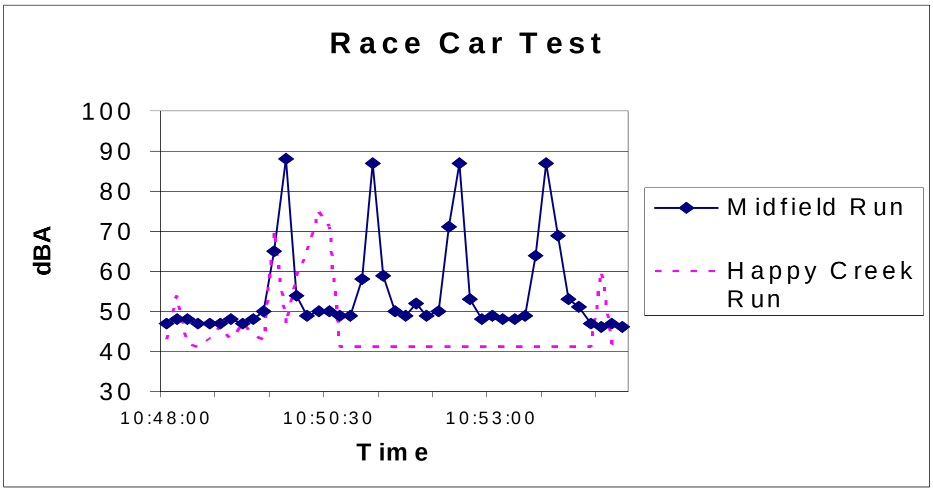

Figure 3-13. Race car signature compared to Happy Creek sound level results (10-second data).

3.7.2 VTOL - Alternative 1

This alternative site (LC-39A) was used during the Apollo program for Saturn V launches and currently for the Space Shuttle program. The noise environment there is influenced by local traffic, launch systems maintenance, shuttle launch preparation work, and launches from nearby launch complexes over a background noise of nearby coastline and natural areas. When not influenced by work activities, the area is anticipated to have sound levels in the range of 34 to 51 dBA, as found at Playalinda Road located north of LC39A. This was determined from an earlier assessment taken during racecar activities at the SLF. Light traffic can result in short term increases to above 70 dBA. An example of the noise produced by a Space Shuttle launch (i.e., 160 dBA) and its effects almost three miles (15,840 ft) to the west (maximum 99 dBA, with influence of less than one minute) was described above. Conversion of the site for suborbital vehicle flights to 13,345 N (3,000 lbs-f) of thrust would result in a much reduced noise footprint at launch and landing activities as compared to a Space Shuttle launch.

3.7.3 VTOL - Alternative 2

The site is near LC39A [approximately 1.2 km (0.75 mi)] and LC41 [approximately 1.6 km (1 mi)]. Launches from these nearby pads can result in sound levels that could exceed 130 dBA for a short duration following a similar pattern or curve shape (reference Figure 3-10). Other launch pads are more distant but do result in short-term elevated sound levels. The current environment is also influence by noise levels from traffic along Phillips Parkway; background noise with traffic and in the absence of traffic and nearby work activities is expected to be similar to that described for Alternate 1.

3.7.4 VTOL - Alternative 3

The site is west of the Banana River and approximately 3.2 km (2 mi) from any processing facilities such as the Solid Rocket Booster Assembly and Refurbishment Area, and approximately 2.4 km (1.5 mi) from the Environmental Health Facility (EHF). The environment is influenced by launch noises similar to other areas at KSC due to lightly traveled Schwartz Road and the training activities that take place on this site. Sound levels are expected to be similar to other areas fairly remote areas measured (34–51 dBA) when there is no traffic or training area activity.

3.8 Geology and Soils

Data regarding the geology and soils of KSC were well described in "Geology, Geohydrology and Soils of Kennedy Space Center: A Review" (Schmalzer and Hinkle 1990). Descriptions for these resources are found in the SLF EA (NASA 2007) and the KSC ERD (NASA 2010) as well.

3.8.1 Geology

Sediments underlying KSC have accumulated in alternating periods of deposition and erosion since the Eocene. Surface sediments are of Pleistocene and Recent ages. Fluctuating sea levels with the alternating glacial interglacial cycles have shaped the formation of the barrier islands. Merritt Island is an older landscape whose formation may have begun as much as 240,000 years ago, although most of the surface sediments are not that old. Cape Canaveral probably dates from <7,000 years before present, as does the barrier strip separating Mosquito Lagoon from the Atlantic Ocean. Deep aquifers beneath KSC are recharged inland but are highly mineralized in the coastal region and interact little with surface vegetation. The Surficial aquifer is recharged by local rainfall and sand ridges in the center of Merritt Island are important to its recharge. Discharge is from evapotranspiration, seepage to canals and ditches and, seepage into interior wetland swales, impoundments, lagoons, and the ocean. This aquifer exists in dynamic equilibrium with rainfall and with the fresh-saline water interface. Freshwater wetlands depend on the integrity of this aquifer, and it provides freshwater discharge to the lagoons and impoundments.

3.8.2 Soils

The soils of KSC are mapped in the soil surveys for Brevard County (Huckle et al. 1974) and Volusia County (Baldwin et al. 1980). Fifty-eight soil series and land types are represented, even though Merritt Island is a relatively young landscape and one formed from coastal plain deposits. The primary source of parent material for KSC soils is sands of mixed terrestrial and biogenic origin. Soils on the barrier island section east of Banana River and Mosquito Lagoon are younger than those of Merritt Island and, therefore, have had less time to weather. Well-drained soil series (e.g., Palm Beach and Cape Canaveral) in these areas still retain shell fragments in the upper layers, while those inland on Merritt Island (e.g., Paola and Pomello) do not. The presence of shell fragments influences soil nutrient levels, particularly calcium and magnesium, and pH. The eastern and western sections of Merritt Island also differ in age. The eastern section of Merritt Island inland to about SR 3 has a ridge swale topography, presumably retained from its formation as a barrier island; west of SR 3, the island is flatter, without obvious ridges and swales, probably due to the greater age of this topography. Differences in age and parent material account for some soil differences, but on landscapes of Merritt Island with similar age, topography has a dramatic effect on soil formation. Relatively small elevation changes cause dramatic differences in the position of the water table that, in turn, affect leaching, accumulation of organic matter, and formation of soil horizons. In addition, proximity to the lagoon systems influences soil salinity (NASA ERD 2010).

3.8.2.1 SLF

The soils series list for the SLF vicinity is based on the U.S. Department of Agriculture, Natural Resources Conservation Service database (Feb. 2010) and the distribution is depicted in Figure 3-14. There are approximately 11 types as described in the figure legend. The primary site of the activities is obviously developed as the concrete runway with drainage ditches on all sides.

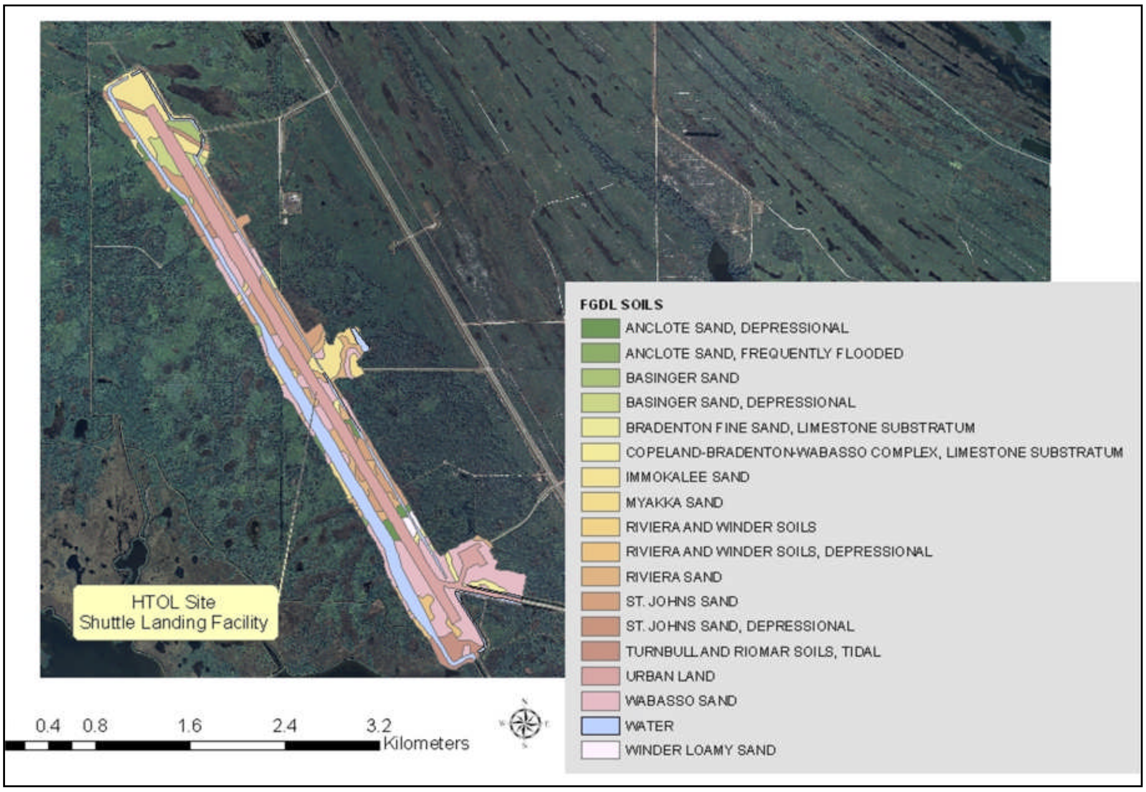

Figure 3- 14. The soils distribution for the SLF area.

3.8.2.2. VTOL - Alternative 1

Soils at LC39A are highly disturbed since the site has been an industrial facility launching rockets over the last 50 years. Evaluation of the 10 acre area of influence for Alternative 1 using the USGS soils maps indicates the entire area is classified as urban land. The site has received many feet of fill and concrete and been disturbed by launch operations and maintenance. Surface soils within the LC39A fence were sampled by Schmalzer et al. 1993 as part of the long-term monitoring for the Space Shuttle program. The pH in the soil is highly buffered and remains alkaline even after 10 years of processing Space Shuttle launches and the associated HCL deposition that occurred with each launch.

3.8.2.3 VTOL - Alternative 2

The soils at this site are relatively undisturbed and are, therefore, described in Figure 3-15. Both Palm Beach and Pompano Sands, which comprise most of the site, are often found on dune-like ridges generally parallel to the coast. They formed in regolith, a marine deposit of thick beds of sand and shell fragments. Native vegetation typically associated with Palm Beach sands includes cabbage palm (*Sabal palmetto*), running oak (*Quercus pumila*), saw palmetto (*Serenoa repens*), common seagrape (*Coccoloba uvifera*), sea oats (*Uniola paniculata*), bays (*Laurus* spp.), and oaks (*Quercus* spp.), while palmetto, widely spaced cypress (*Taxodium* spp.), gum (*Liquidambar* spp.), and slash pine (*Pinus elliottii*), and native grasses are usually found on Pompano soils. Along the western edge of the site is a relatively small area of "tidal" soils made up of Riomar and Turnbull series. Riomar series consists of very poorly drained, moderately deep, very slowly permeable soils that formed in loamy or clayey tidal deposits and occur on nearly level mangrove islands and swamps. The Turnbull series consists of very deep, poorly drained, slowly permeable soils near sea level and are flooded periodically by tidal overwash. They formed in clayey and sandy estuarine deposits. Native vegetation often found on this soil consists of needle grass rush (*Juncus roemerianus*), smooth cordgrass (*Spartina alterniflora*), bushy sea-oxeye (*Borrichia frutescens*), marsh hay cordgrass (*S. patens*), glasswort (*Salicornia* spp.), bigleaf sump weed (*Iva frutescens*), and seashore salt grass (*Distichlis spicata*). On Riomar soils, plant communities usually include red (*Rhizophora mangle*), black (*Avicennia germinans*) and white (*Laguncularia racemosa*) mangroves, with some areas of sea rocket (*Cakile edentula*) perennial glasswort (*S. perennis*), seashore salt grass, and seashore paspalum (*Paspalum vaginatum*) (USDA 2008).

During 1998 and 1999, a baseline study was conducted on KSC to document the background chemical composition of the soils, groundwater, surface water and sediments (Schmalzer et al. 2000). Soil samples from 200 soil sampling locations, within 10 soil classifications throughout KSC, were analyzed for organochlorine pesticides, aroclors, chlorinated herbicides, PAH, total metals, pH, cation exchange capacity, bulk density, resistivity, and soil texture.

This site is largely undisturbed, with the exception of the mosquito control impoundment to the west. In addition, there are at least two metal pylons approximately 10 m (30 ft) tall positioned on concrete slabs; their past function had not been determined at the time of this writing. It is unlikely that the area was historically utilized for agriculture, as the dominant soil types are not suited for that land use (USAF 1998).

As part of the 1999 baseline study, two sediment samples were analyzed from this proposed site (Schmalzer et al. 2000). Organochlorine pesticide, aroclor, and chlorinated herbicide levels were below lab reporting limits. For PAH, 2 – Methylnaphthalene, acenaphthylene, benzo(a)pyrene, naphthalene, and phenanthrene had concentrations that were higher than the detect ability limits. PAH can have biotic origins, although most naphthalene's are of human origin and are generally petroleum byproducts or coal-tar derivatives. Concentrations of metals in the soil samples were at low levels, except arsenic, which was slightly higher than the detect ability limit (Schmalzer et al. 2000).

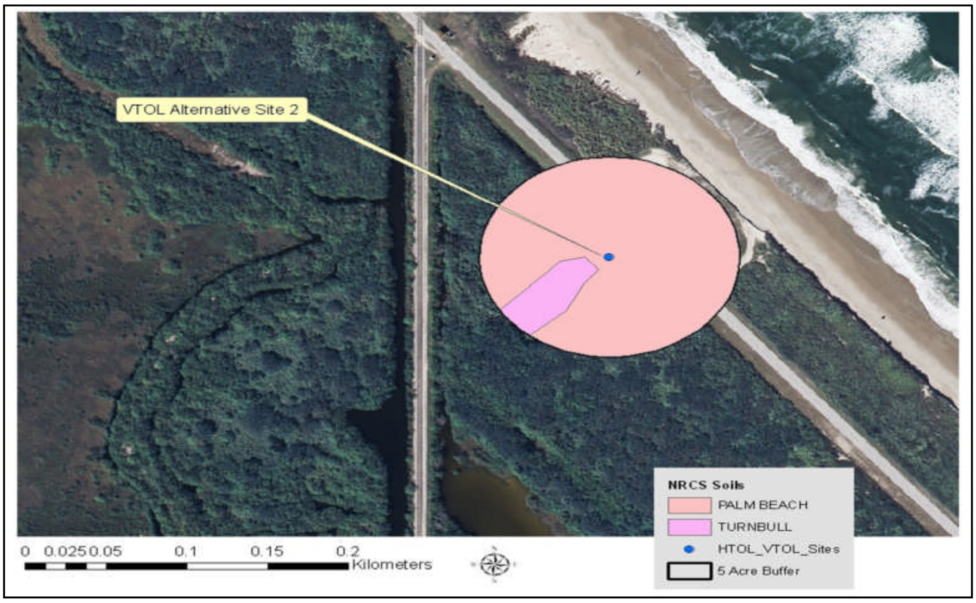

Figure 3-15. The soils distribution at the VTOL Site 2.

3.8.2.4. VTOL - Alternative 3

The Fire Training Area surface soils are highly disturbed by several decades of activities in this area. Evaluation of the USGS (2010) data for soil distribution simply results in the single category; urban land.

3.9 Hydrology and Water Quality

3.9.1 Surface Water

The surface waters in and surrounding KSC are shallow estuarine lagoons and include portions of the Indian River, the Banana River, Mosquito Lagoon, and Banana Creek. The area of Mosquito Lagoon within the KSC boundary and the northernmost portion of the IRL, north of the Jay Jay Railway spur crossing (north of SR 406), are designated by the State as Class II, Shellfish Propagation and Harvesting. All other surface waters at KSC have been designated as Class III, Recreation and Fish and Wildlife Propagation. All surface waters within MINWR are designated as Outstanding Florida Waters as required by Florida Statutes for waters within National Wildlife Refuges.

Surface water quality at KSC is generally good, with the best water quality being found adjacent to undeveloped areas of the IRL, such as Mosquito Lagoon, and the northernmost portions of the Indian River and Banana River (NASA 2010).

Several monitoring programs are used to document the surface water quality of waters surrounding KSC. NASA, the USFWS, and Brevard County maintain water quality monitoring stations at surface water sites within and around KSC. The data collected are used for long-term trend analysis to support land use planning and resource management. Surface water quality has been monitored at 11 sites within the boundary of KSC since 1984, with quarterly monitoring until 2000, and then biannually to present. The purpose of this monitoring program is to maintain a baseline ecological database of basic surface water quality parameters. Parameters collected include nutrients, phenols, grease and oil, color, total suspended solids, total dissolved solids, chlorophyll, turbidity, and metals. Most of the basic surface water parameters such as salinity, dissolved oxygen (DO), pH, temperature, and conductivity follow seasonal and diurnal patterns typical of the IRL. Compared to all the water quality parameters tested, only zinc has been consistently above baseline levels (D. Scheidt, Dynamac, personal communications, 28 Sep 2008). Zinc is a major component in anticorrosion surfaces on launch structures. As such, the values near the launch sites are slightly elevated during routine long-term monitoring, but based on detailed launch sampling studies, levels show sharp increases immediately after launch activities. The zinc adsorbs onto particulates after the launch, which then settle to the bottom and bring zinc levels in the water column back to prelaunch levels.

Fresh surface waters within KSC are primarily derived from the surficial groundwater which is recharged by rainfall. Shallow groundwater supports numerous freshwater wetlands on KSC. Groundwater discharge to surrounding estuarine systems helps maintain lagoon salinity levels. Groundwater underflow is a major factor in establishing the equilibrium of the fresh-saltwater interface in the surficial aquifer system (Edward E. Clark 1987) prohibiting salt water from intruding into surface waters.

Discharge from the surficial aquifer is from evapotranspiration, and seepage into canals, interior wetlands, swales, impoundments, the Indian River Lagoon, and the Atlantic Ocean. During most of the year, shallow groundwater discharges to swales and canals (Schmalzer and Hinkle 1990). Many of the larger canals are excavated below the groundwater table and, as a result, always contain water.

Most of the coastal dune systems on KSC lack naturally occurring freshwater bodies. Many estuarine wetlands on KSC have been impounded for mosquito control and isolated from the estuary since the late 1950’s and 1960’s. The water quality of these impoundments varies depending on the amount of exchange that exists between them and the lagoon via culverts. Dissolved oxygen may periodically become too low to sustain most aquatic life. Likewise, salinities may fluctuate substantially during the course of a year depending on the amount of rainfall.

3.9.2 Floodplain

Executive Order (EO) 11988 directs agencies to consider alternatives to avoid adverse effects and incompatible development in floodplains. The proposed alternative sites are located across three different Federal Emergency Management Agency (FEMA) flood zone categories including AE, X, and X5 (Figures 3-16 to 3-19). Zone AE involves areas inundated by 100-year flooding with base flood elevations determined. Zone X lands are outside of the 100 and 500-year floodplains. And finally, Zone X5 is an area inundated by the 500-year flooding or 100-year flooding with mean depths less than 0.3 m (1 ft), or drainage areas of less than 13 km^2 (5 mi^2).

The SLF is located in flood zone categories AE and X with a small portion on the north end in category X5. LC39A is in flood zone X. VTOL Alternative 2 includes flood zones AE and X5 in roughly equal parts. Most of the FTA is in category X with small areas to the east and south in category X5.

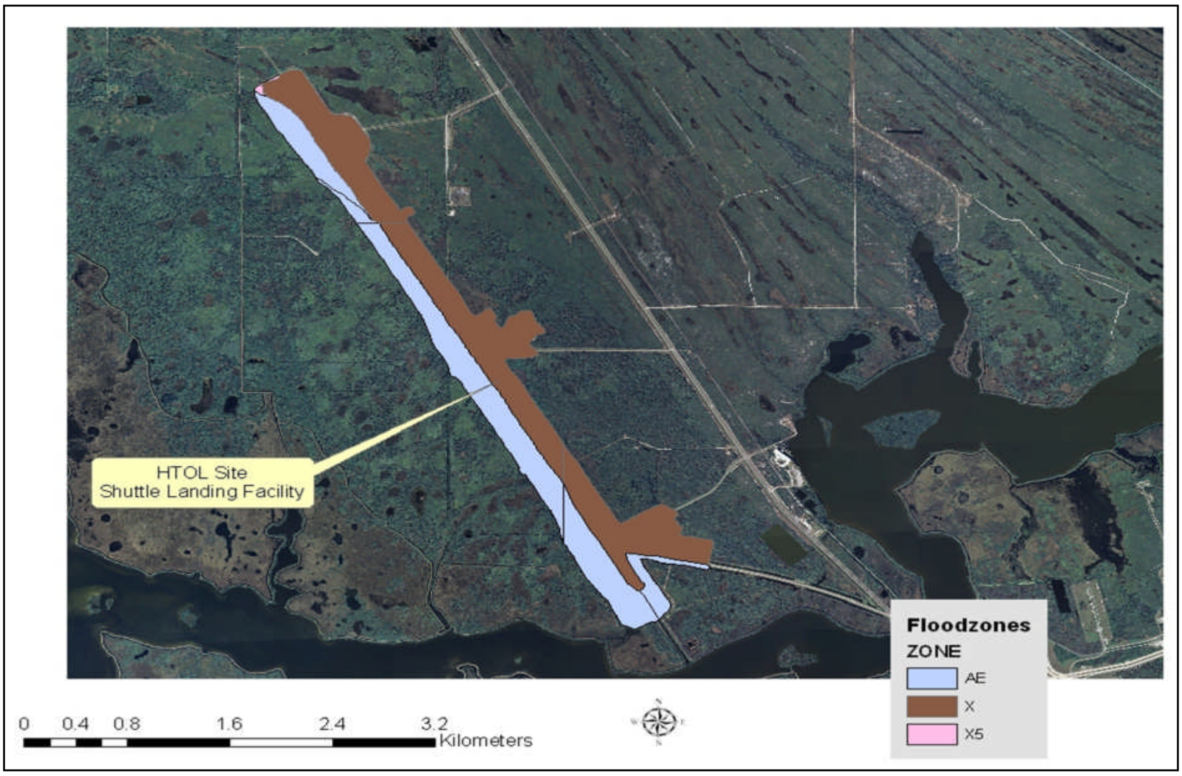

Figure 3-16. FEMA flood zones for the SLF.

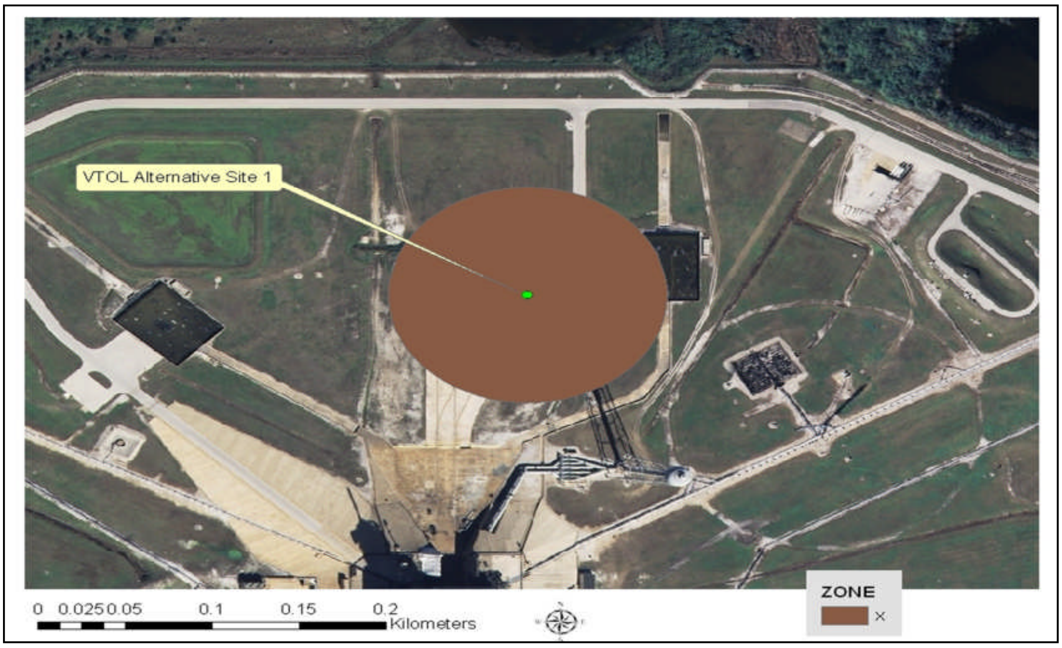

Figure 3-17. FEMA flood zones within the 2 ha (5 ac) at VTOL Site 1 (LC39A).

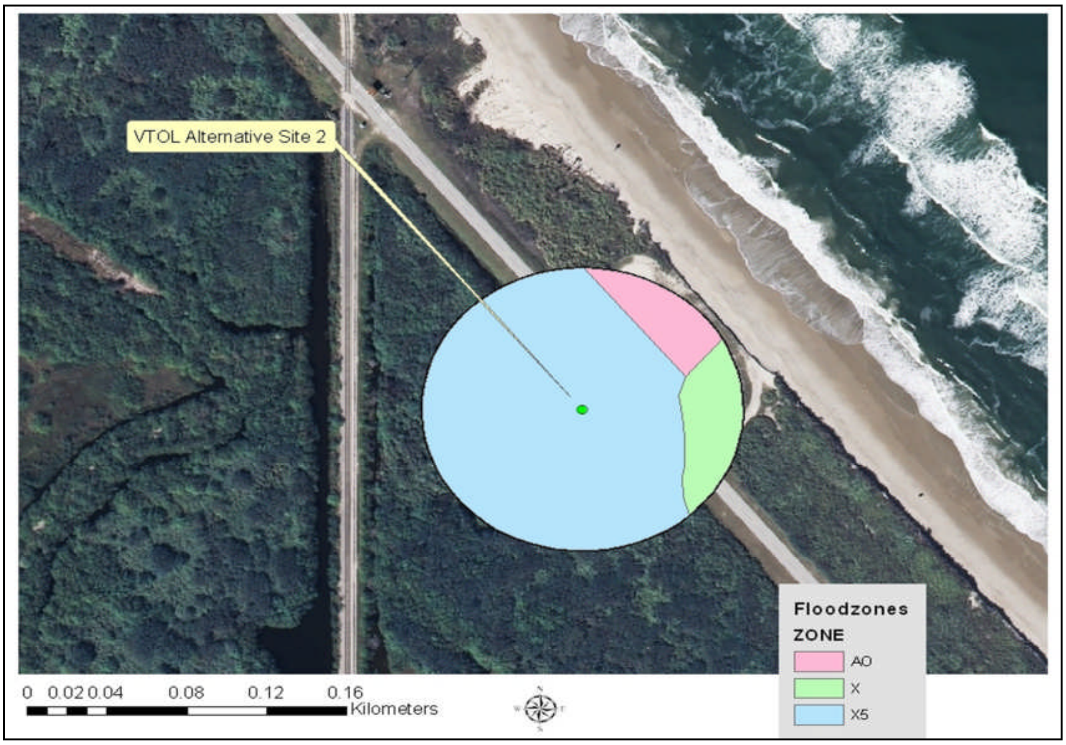

Figure 3-18. FEMA flood zone map for 2 ha (5 ac) surrounding the VTOL Site 2.

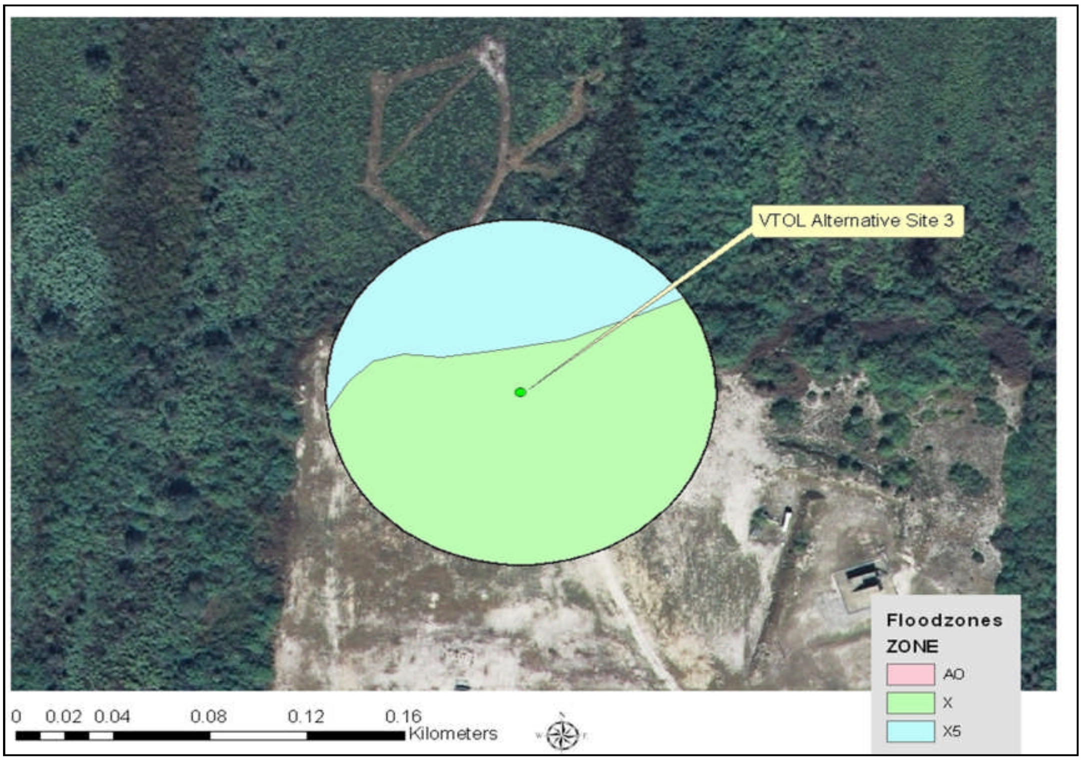

Figure 3-19. FEMA flood zones for 2 ha (5 ac) of the VTOL Site 3.

3.9.3 Coastal Erosion and Sea Level Rise

The SLF and three VTOL sites are all located in the vicinity of the lagoon and coast. The SLF is within 0.8 km (0.5 mi) of Banana Creek and within 4.8 km (3 mi) of the Indian River. VTOL Alternatives 1 and 2 are located 0.8 km (0.5 mi) or less from the beach and VTOL Alternative 3 is within 1.6 km (1 mi) of the Banana River. The following section summarizes current and future beach erosion scenarios. In addition, current and projected sea level rise is discussed.

3.9.3.1 Erosion (Recent Dune Loss)

The causes of erosion are varied and include both natural processes (wind, waves, currents, storm surge, etc.) and anthropogenic activities (sand mining, construction of inlets, etc.). In many cases, several of these factors work together. In Florida, of the 1,328 km (825 mi) of coastline, at least 629 km (391 mi) of beaches are critically eroded (FDEP 2008). Beaches are declared "critically eroded" if they pose a threat to homes and other buildings, wildlife habitat, or important cultural resources.

Much of the 116 km (72 mi) coastline of Brevard County is eroding. With the exception of Cape Canaveral, Brevard County beaches are part of a long, narrow barrier island. The beaches are backed by a 3 m (10 ft) dune that runs along much of the island. Erosion rates in Brevard County have accelerated since the late 1960s. From 1875 to 1993, erosion rates averaged approximately 0.4 m/yr (1.2 ft/yr), while between 1969 and 1993, erosion rates increased to an average of 4.6 m/yr (15.2 ft/yr) (Bush al. 2004). Since 1972, over 24 beach sand re-nourishment projects have been undertaken countywide to mitigate these beach losses, utilizing over 11 million m^3 (14 million yd^3) of sand (K. Bodge, Olsen Associates, Inc., personal communication, 21 Oct 2008). At Cape Canaveral, the average tidal range is 1 m (3.5 ft), with a spring tide range of 1.2 m (4.1 ft). During major hurricanes, water levels can peak 2.7 to 3.3 m (9 to 11 ft) above mean low water.

Several sections of KSC's coastline have been gradually eroding during the past few decades, including areas in the vicinity of LC-39. Other beaches, primarily south of the Cape on CCAFS, are in a depositional or dune-building phase. Following several years of high erosion beginning in 2004, NASA requested USGS to conduct a study to determine the current and potential future status of its protective dune system. A "KSC Coastal Vulnerability Study" was initiated in early 2008 (USGS 2008). It utilized Light Detection and Ranging topography data, as well as tidal, wave, and storm-surge information to construct a dune erosion and over wash model for the coastline along KSC and CCAFS. Preliminary results reveal that erosion and deposition along Cape shores are determined by two processes. First, there is a long-term (on the order of a 100 years and more) southward shifting of the Cape, due primarily to the direction of the prevailing, north-to-south long shore current along this region of Florida's Atlantic coast (Bush et al. 2004). Overlaid on this large-scale process are more localized and episodic events involving the interaction of large waves, high tides, and storm-surge. Collectively, these three factors constitute wave run-up or the height that water can reach up to or over a dune and potentially cause erosion. Initial USGS findings show that several areas north of the Cape are experiencing moderate to severe erosion [1-2 m/yr (3-6 ft/yr) inland migration of dune face; see Figure 3-20].

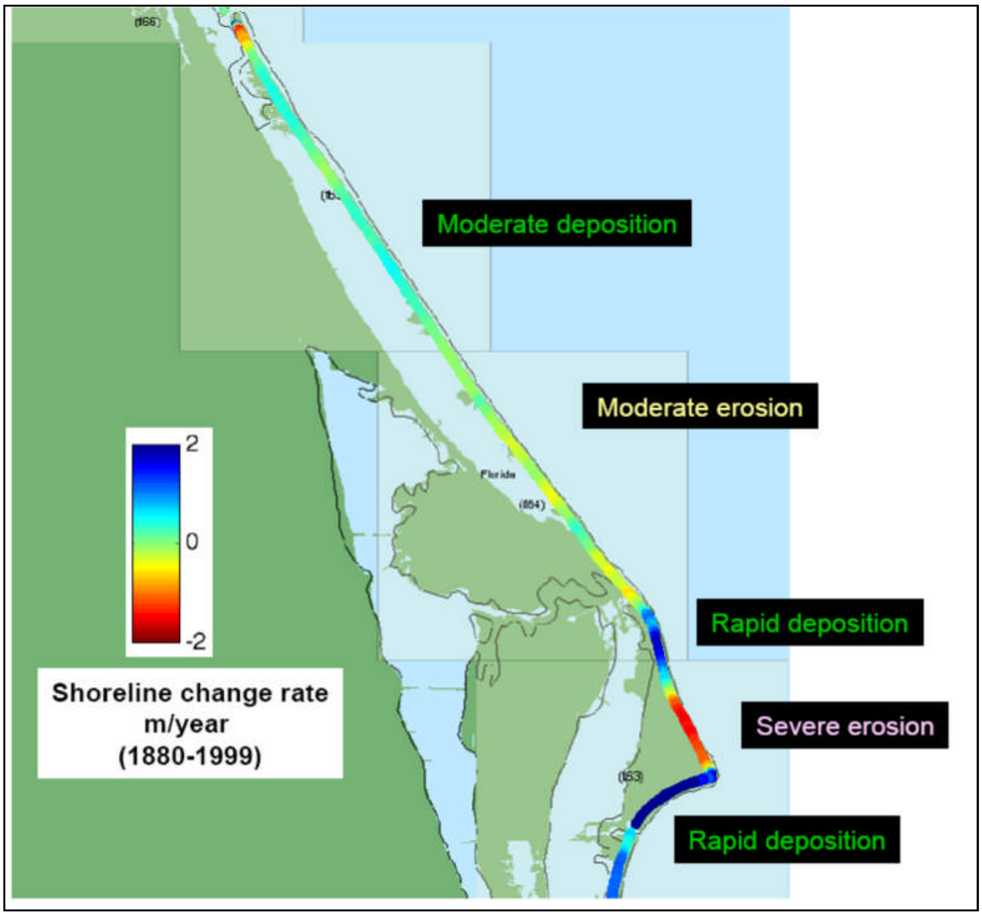

Figure 3-20. Shoreline erosion and deposition rates along KSC and CCAFS (USGS 2008).

In addition, the study developed coastal vulnerability models based on 1999 and 2006 dune height data. These models show that the chances for extreme erosion events (dune overwash) increased substantially between 1999 and 2006. Generally, along eroding coastlines, dunes tend to migrate landward if unobstructed by human infrastructure (Bush et al. 2004). The same process appears to be occurring at several locations along KSC's beaches. Figure 3-21 shows the predicted dune locations at a rapidly eroding KSC site (located several kilometers north of VTOL Alternative 2) for three time intervals, with the coastline retreat of more than 25 m (82 ft) during the next 14 years.

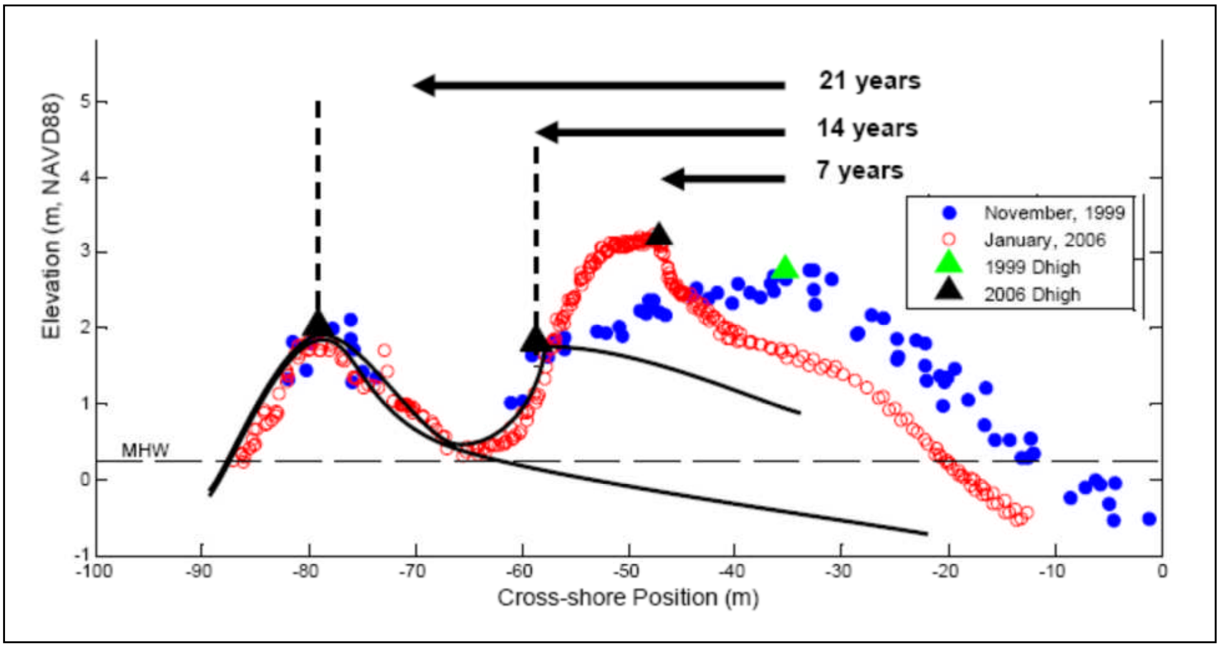

Figure 3-21. Predicted dune locations at a rapidly eroding location on KSC (USGS 2008).

3.9.3.2 Sea level rise

At the coast, "mean sea level" is defined as the height of the sea with respect to a local land benchmark, averaged over a period of time long enough to eliminate the effects of wave and tidal fluctuations. Changes in mean sea level as measured by coastal tide gauges are called "relative sea level changes," because they can come about either by movement of the land on which the tide gauge is situated or by changes in the height of the adjacent sea surface. A eustatic sea level change is that which is caused by an alteration to the volume of water in the world ocean.

According to the International Panel on Climate Change (IPCC) (IPCC 2007), global mean sea level continues to rise due to thermal expansion of the oceans in addition to the loss of mass from glaciers, ice caps and the Greenland and Antarctic Ice Sheets (Church et al. 2001, Bindoff et al. 2007). There is high confidence that the rate of sea level rise has increased between the mid-19th and the mid-20th centuries (Bindoff et al. 2007). For the 20th century, the average rate was 1.7 ± 0.5 mm/yr (0.07 ± 0.2 in/yr), consistent with the 2001 IPCC estimate of 1 to 2 mm/yr (0.04 to 0.08 in/yr) (Church et al. 2001). However, satellite observations available since the early 1990s provide more accurate sea level data with nearly global coverage. This decade-long satellite altimetry dataset shows that since 1993, sea level has been rising at a rate of around 3 mm/yr (0.12 in/yr). It is important to note that the change in sea level is highly non-uniform spatially, and in some regions, rates are up to several times the global mean rise, while in other regions sea level is falling.

Several recent studies are predicting higher rates of sea level rise than what has been reported in IPCC AR4 report. The projected increased rates of sea level rise have been attributed to a greater contribution of melting glaciers and increased ice-sheet flow. According to Meier et al. 2007, sea level is likely to rise at rates ranging between 2.2 and 5.1 mm/yr (0.09 – 0.20 in/yr), while another study estimates rates of 3.1 – 6.1 mm/yr (0.12 – 0.24 in/yr) (Carlson et al. 2008).

In the region of Cape Canaveral and KSC mean sea level is considered to be -0.26 m (0.8 ft) NAVD88 while mean water level of the Indian River Lagoon in the vicinity is estimated at -0.21 m (0.7 ft) NAVD88 based on analyses of data from historic and current NOAA tide gauges in the region and discussions with staff at the St. Johns River Water Management District (Ron Brockmeyer, pers. com.) Monthly water levels in the IRL and Atlantic Ocean fluctuate annually on a cyclic basis with maximum heights generally in October, falling rapidly as the ocean cools and contracts through the winter with minimal elevations in February and March. This cycle is shown in Figure 3-15 for the USGS tide station at Haulover Canal.

Projected sea level rise scenarios for KSC have been provided by the NASA Climate Adaptation Science Investigation team (see Table 3-9). These projections are based on results of the analysis of 16 global climate models and include the more current information on rapid ice melt. At KSC the rise in sea level will produce a similar rise in lagoon level as a result of their connection through inlets and groundwater. An analysis of the potential for land inundation by rising lagoon and sea level is summarized graphically in Figure 3-23. This analysis is based on land surface elevations derived from the 2007 LIDAR mission conducted by the Florida Division of Emergency Management. The analysis shows which areas of KSC land will have the same or lower elevation than the lagoon and be subject to flooding during the fall high water period. The analyses do not take into account a rising surficial aquifer or storm conditions.

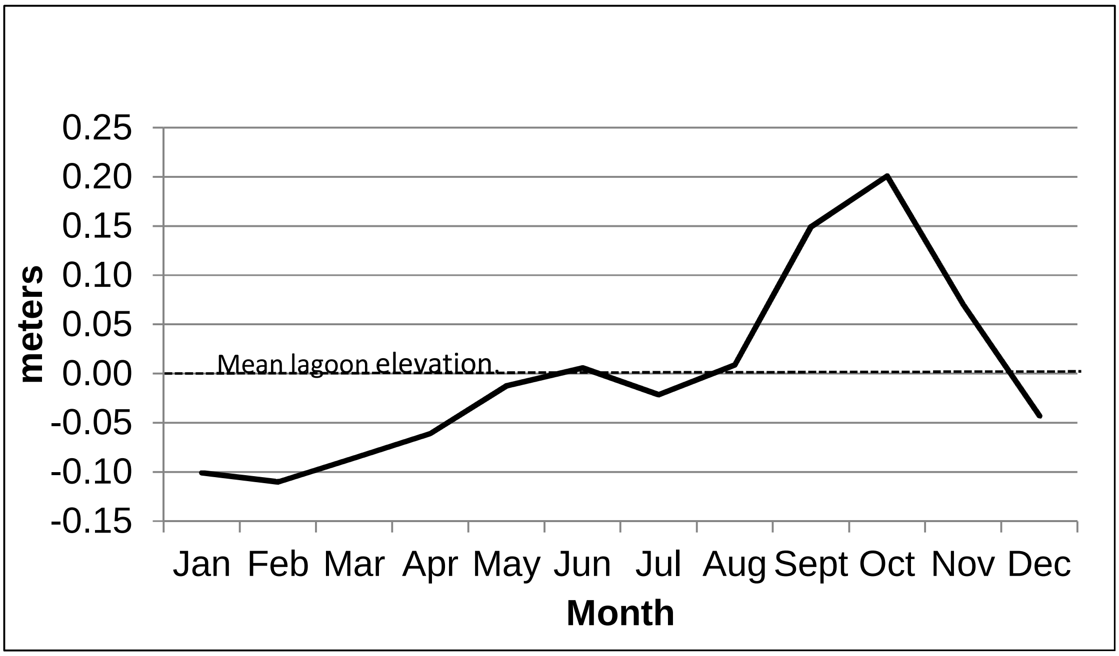

Figure 3-22. Annual average cycle of water level in the Indian River Lagoon measured at the USGS water level recording station in Haulover Canal between the Indian River Lagoon and Mosquito Lagoon.

Table 3-9. Projected sea level rise in the vicinity of KSC through the late part of the 21st Century.

	2020s	**2050s**	**2080s**
Sea level rise[1] **Central rise**	+ 2 to 3 in	+ 5 to 8 in	+ 9 to 15 in
Rapid ice-melt[2] **Sea level rise**	~ 6 to 8 in	~ 21 to 24 in	~ 43 to 49 in

[1] The model-based sea level rise projections may represent the range of possible outcomes less completely than the temperature and precipitation projections.

[2] "Rapid ice-melt scenario" is based on acceleration of recent rates of ice melt in the Greenland and West Antarctic Ice sheets and paleoclimate studies.

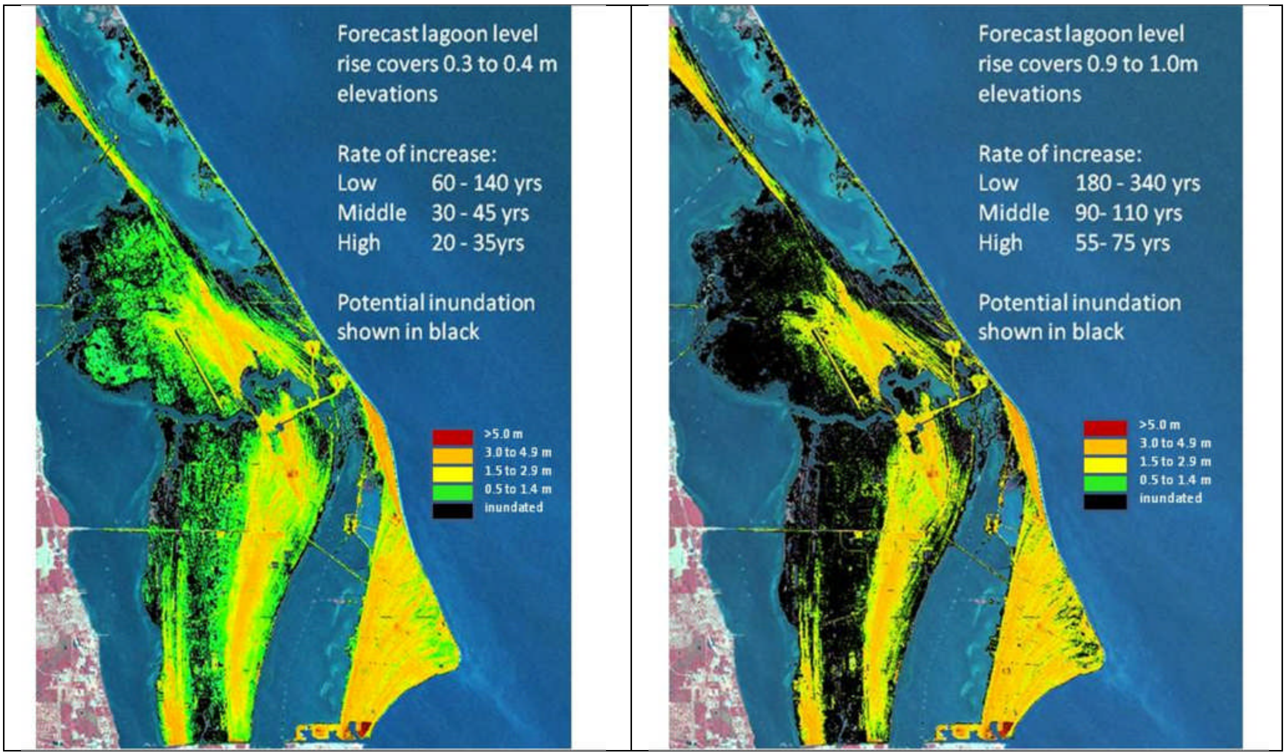

Figure 3-23. Potential land surface inundation rates under three different sea level rise scenarios.
Low = rise at current rates
Middle = central rise based on global climate model projections
High = rapid ice melt scenario

3.9.4 Groundwater Sources

The State of Florida has created four categories used to rate the quality of groundwater in a particular area. The criteria for these categories are based on the degree of protection that should be afforded to that groundwater source, with Class G-I being the most stringent and Class G-IV being the least. The groundwater at KSC is classified as Class G-II, which means that it is a potential potable water source and generally has a total dissolved solids content of less than 10,000 milligrams/liter (parts per million). The groundwater at the LC39 pads has been classified as Class G-III, because of their proximity to the ocean. Any future long-term pumping would allow salt water to encroach into the aquifer, rendering it non-potable (NASA 2003 – KSC-TA-6166). The subsurface of KSC is comprised of the surficial aquifer, the intermediate aquifer, and the Floridian aquifer. Recharge to the surficial aquifer system is primarily due to the infiltration of precipitation. However, the quality of water in the aquifer beneath KSC is influenced by the intrusion of saline and brackish surface waters from the Atlantic Ocean and the IRL. This is evident by the high mineral content, principally chlorides, that has been measured in groundwater samples collected during various KSC surveys.

KSC is surrounded by brackish to saline surface water and nearly all of their groundwater originates as precipitation that infiltrates through soil into flow systems in the underlying geohydrologic units. Of the approximately 140 cm (55 in) of precipitation occurring annually, approximately 75% returns to the atmosphere through evapotranspiration. The remainder is accounted for by runoff, base flow, and recharge of the surficial aquifer.

3.9.5 Groundwater Quality

The quality of water in an aquifer is dependent upon the characteristics of the underlying rocks, the proximity of the aquifer to highly mineralized waters, the presence of residual saline waters, and the presence of chemical constituents in the aquifer and overlying soils.

3.9.5.1 Surficial Aquifer Systems

Unconsolidated, surficial aquifers are subject to contamination from point sources and from general land use. Contaminants may include trace elements, pesticides, herbicides, and other organics (Burkart and Kolpin 1993, Kolpin et al. 1995, 1998; Barbash et al. 1999). Urban and agricultural land uses have affected some Florida aquifers (Rutledge 1987, Barbash and Resek 1996). Point source contamination to the KSC surficial aquifer has occurred at certain facilities (Edward E. Clark 1985, 1987).

Baseline conditions of the surficial aquifer have been studied in some detail (Schmalzer et al. 2000, Schmalzer and Hensley 2001). In the 2001 study, six sample sites were located in each subsystem of the surficial aquifer, for a total of 24 sites. The sampling protocol required installing a shallow well 4.6 m (15 ft) deep at each site. Intermediate wells [10.7 m (32.1 ft)] were installed at four sites per subsystem (16 total). Deep wells [15.2 m (49.9 ft)] were installed at three sites per subsystem (12 total). Fifty-one wells were installed at varying depths. Groundwater samples were collected using standard procedures. Groundwater samples were analyzed for organochlorine pesticides, aroclors, chlorinated herbicides, PAH, total metals, DO, turbidity, pH, specific conductivity, temperature, total dissolved solids (TDS), and total organic carbon (TOC).

The baseline data suggest that widespread contamination of the surficial aquifer on KSC has not occurred (Schmalzer and Hensley 2001). No organochlorine pesticides, aroclors, or chlorinated herbicides were found above laboratory detection limits. Although pesticide residues or degradation products and chlorinated herbicides occurred in some soils, those concentrations were low and migration into the aquifer either has not occurred or has not been widespread. Some PAHs were found in the shallow wells. PAHs occur in a variety of KSC soils at relatively low concentrations, which is not surprising since PAHs have both natural and anthropogenic sources (e.g., Douben 2003).

Most trace metals were in low concentrations in KSC groundwater, if they occurred above detection levels. These findings are consistent with the low concentrations of most trace metals in KSC soils and the primarily quartz composition of the terrigenous deposits comprising the surficial sediments of Merritt Island (Brown et al. 1962, Milliman 1972, Field and Duane 1974). Aluminum (Al), iron (Fe), and manganese (Mn) occurred above detection limits more frequently than other trace metals. Al and Fe are abundant components in the Earth's crust and are present in KSC soils. Intense leaching, particularly in acid scrub and flatwoods soils, mobilizes Al and Fe (Paton et al. 1995). Iron is a typical constituent of groundwater in the surficial aquifer in Florida (Miller 1997). Mn is one of the most abundant trace elements (Kabata-Pendias and Pendias 1984); it is present in KSC soils but the concentrations are relatively low. Solution and precipitation of Fe and Mn are affected by pH and oxidation-reduction conditions.

The chemical parameters varying most with subaquifer and depth were calcium (Ca), chloride (Cl), magnesium (Mg), potassium (K), and sodium (Na), as well as, conductivity and TDS that are related to these cations and anions. The trends were generally consistent among these; the shallow wells in the Dune-Swale subaquifer had the lowest values. Concentrations increased with depth within a subaquifer. At a given depth, concentrations in the Dune-Swale and West Plain subaquifers were lower than in the Dune and Marsh subaquifers. These trends reflect increased mineralization with depth and differences between the freshwater Dune-Swale and West Plain subaquifers and the more saline Dune and Marsh systems. The Dune and Marsh subaquifers interact with saline water of the Atlantic Ocean and Indian River Lagoon system, respectively (Edward E. Clark 1987).

3.9.5.2 Intermediate Aquifer System

The groundwater quality in the intermediate aquifer system varies from moderately brackish to brackish due to its recharge by upward leakage from the highly mineralized and artesian Floridan aquifer system, and in some cases from lateral intrusion from the Atlantic Ocean. Groundwater in the semi-artesian Sand and Shell aquifer is brackish. Groundwater in the Shallow Rock aquifer is brackish with some sites receiving seawater intrusion. The limited data that exists for the relatively thin Hawthorn Limestone Aquifer indicate that the aquifer is moderately brackish (Edward E. Clark 1987).

3.9.5.3 Floridan Aquifer System

The Floridan aquifer system at KSC contains highly mineralized water with high concentrations of chlorides due to the fact that seawater was trapped in the aquifer when it formed. The high concentrations of chlorides can also be explained to a lesser degree by induced lateral intrusion (due to inland pumping) and a lack of flushing due to a low proximity to freshwater recharge areas (Edward E. Clark 1987).

3.10 Biological Resources

This section provides a general overview of the biological resources on KSC, as well as site-specific information on the terrestrial, wetland, and aquatic resources, and threatened and endangered species occurring at each of the alternative sites. Information sources for this section included general literature searches, but were largely derived from results of biological studies previously conducted at KSC. Information was also gathered from interviews with local experts, KSC Earth Systems Modeling and Data Management Laboratory databases, GIS database searches, and field analyses designed to address specific data needs. For the VTOL alternative sites, a 2 ha (5 ac) area was described and evaluated for impacts.

The KSC operational area and its surroundings (CNS, MINWR, and CCAFS) provide for the greatest wildlife diversity among federal properties in the continental U.S. (Breininger et al. 1994a). This high biodiversity is attributable, in part, to the location of KSC within a biogeographical transition zone composed of faunal and floral assemblages derived from both temperate Carolinian and tropical/subtropical Caribbean biotic provinces (Ehrhart 1976, Sweet et al. 1979, Greller 1980, Stout 1979, DeFreese 1991). In addition, KSC's location within the Merritt Island/Cape Canaveral/Turnbull ecosystem and IRL watershed, proximity to the coast, and abundance of migratory birds further contribute to the regional species diversity found here. This ecosystem, in conjunction with the nearby St. Johns River Basin ecosystem, provide for important biological corridors between temperate Carolinian and tropical/subtropical Caribbean provinces (Breininger et al. 1994a).

Vegetation maps for KSC show scrub and pine flatwoods as the dominant upland communities (Provancha et al. 1986). Fresh and salt marshes occur adjacent to the estuary and in low areas interspersed among scrub and pine flatwoods (Schmalzer and Hinkle 1985). Scrub and pine flatwoods on KSC support the largest population of Florida scrub-jays along the Atlantic coast (Cox 1987, Breininger et al. 1994a, Breininger et al. 1996, Breininger et al. 2001). In addition to scrub-jays, these community types support an exceptionally large number of listed wildlife species as permanent residents (Breininger et al. 1994a). The Indian River Lagoon system surrounding KSC makes up the dominant aquatic community. The Mosquito Lagoon supports the largest contiguous areas of submerged aquatic vegetation within the IRL system. These areas consist predominantly of sea grass beds which provide forage for manatees and juvenile green sea turtles. The beaches along KSC are important nesting areas for several sea turtle species and shorebirds, while nearby dunes and coastal scrub provide habitat for the largest remaining population of Southeastern beach mice.

Breininger (1985) prepared a comprehensive assessment of the status of endangered and potentially endangered wildlife (amphibians, reptiles, birds, and mammals) on KSC, including the relative occurrence by habitat and a bibliography of wildlife habitat associations applicable to KSC. This document, updated in 1994 (Breininger et al. 1994a), evaluated the biology and regional ecology of

119 resident or migratory wildlife species that were threatened, endangered, or declining, and potentially occurred on KSC. Threats to biological diversity on KSC were also reviewed, noting the small population sizes, population isolation, ecosystem and habitat fragmentation, road mortality, and other edge effects may put biological diversity at greater risk than traditional impacts caused by habitat loss and contamination resulting from construction.

3.10.1 Land Cover

Florida's geological history has largely been determined by sea level changes that directly influenced soil formation and topography, and resulted in the plant communities present today. Fluctuating sea levels that corresponded to glacial and inter-glacial periods have created a series of alternating dune ridges and depressions. This "ridge and swale" topography is now a series of adjacent bands of uplands and wetlands running in a generally north/south direction across the island. The dominant uplands communities are scrub and pine flatwoods (Provancha et al. 1986). Long, narrow freshwater marshes are interspersed among the bands of uplands. Forests occur on higher areas among marshes and lower areas among scrub and pine flatwoods (Breininger et al. 1994a). Adjacent to the estuary that surrounds much of KSC are salt marshes, various wetland shrub communities, and mangrove swamps. The land cover classes for each alternative site and their respective sizes are listed in Table 3-10.

Table 3-10. Land cover classes for each alternative site and their respective sizes.

Land Cover Types	**Area Covered ha (ac)**		
	VTOL Site 1	VTOL Site 2	VTOL Site 3
Coastal Strand		1.0 (2.4)	
Ditch	< 0.1 (0.1)		
Infrastructure - Primary	0.6 (1.4)	0.2 (0.5)	0.1 (0.2)
Infrastructure - Secondary		< 0.1	< 0.1
Oak Scrub		0.3 (0.7)	< 0.1 (0.1)
Ruderal - Herbaceous	1.4 (3.4)	0.6 (1.4)	1.5 (3.7)
Hardwood Hammock			0.3 (0.8)
Wetland - Freshwater			< 0.1 (0.1)
Totals:	**2.0 (4.9)**	**2.1 (5.0)**	**2.0 (4.9)**

*Note: acreages rounded to the nearest 0.1.

3.10.1.1 SLF

The land cover within the SLF boundary consists primarily of concrete, mowed grass, and ditches (see Figure 3-24). Any other vegetative cover types that would be disturbed for suborbital projects were previously assessed in the SLF expansion EA (NASA 2007). There is one isolated patch of hardwood hammock near the southeast end of the runway.

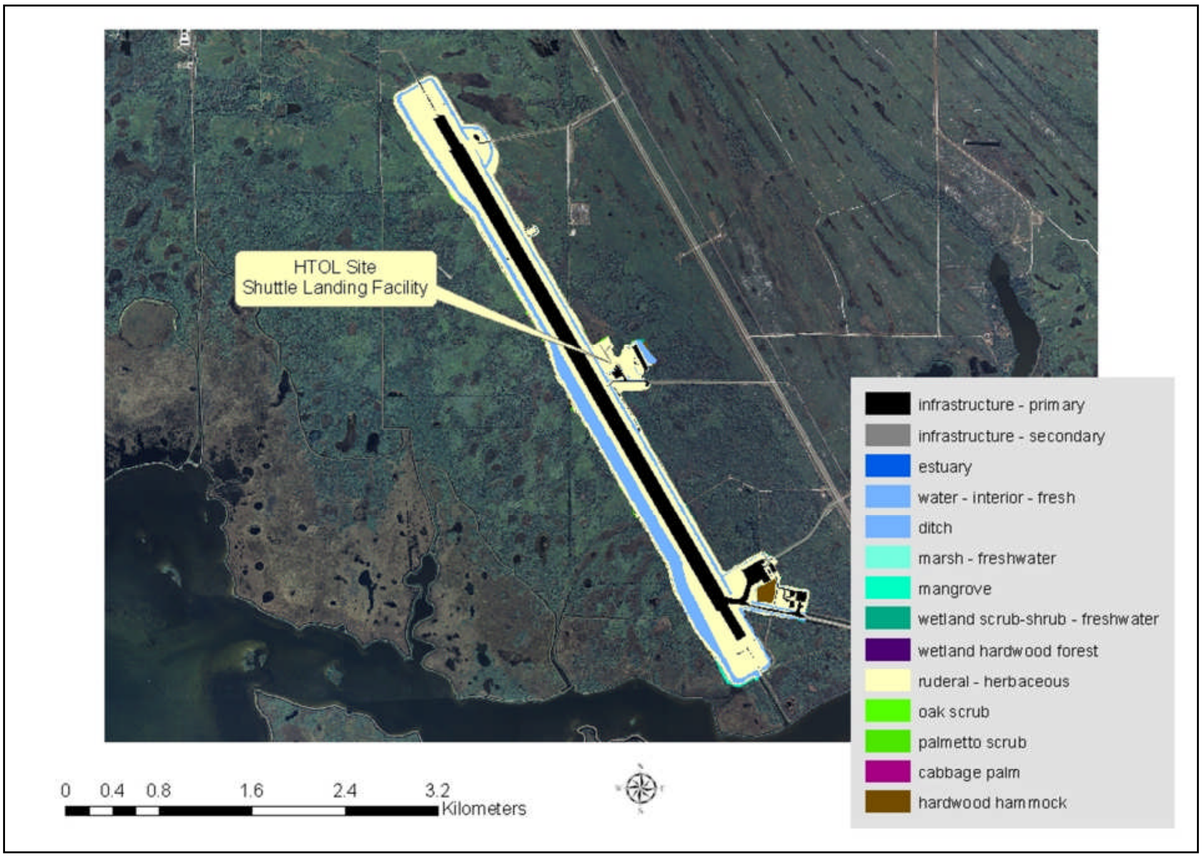

Figure 3-24. Habitat types within the perimeter of the SLF.

3.10.1.2 VTOL - Alternative 1

This site lies within the perimeter of LC39A (Figure 3-25). The two main cover types are infrastructure and ruderal (Table 3-25), and there is a ditch running north to south on the east side.

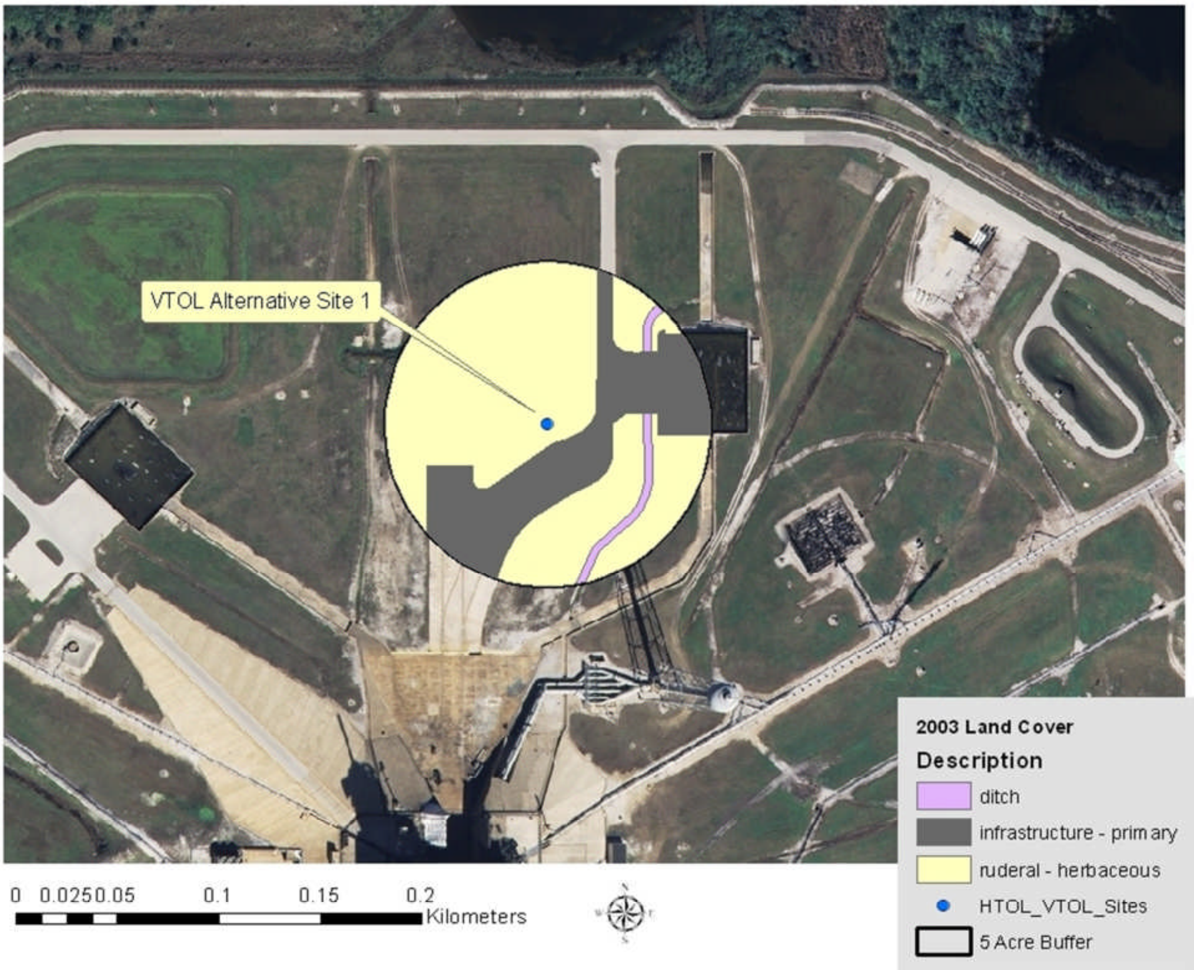

Figure 3-25. Habitat types within a 2 ha (5 ac) circle around proposed VTOL Site 1 (LC39A).

3.10.1.3 VTOL - Alternative 2

This site lies on a strip of land between the Atlantic Ocean and an impounded marsh on the Northern Banana River (Figure 3-26), south of LC39A and north of LC 41. The dominant land cover is coastal strand (48%), followed by ruderal herbaceous (28%), with the other types making up the remaining 24% (Table 3-7). The oak scrub (14%) and coastal strand areas are of high quality, and the site contains relatively few exotic plants, although Brazilian peppers (*Schinus terebinthifolius*) have invaded some of the hydric areas along the western portion.

Figure 3-26. Habitat types within a 2 ha (5 ac) circle around the proposed VTOL Site 2.

3.10.1.4 VTOL - Alternative 3

This site is primarily covered with herbaceous weeds (68%) that are infrequently mowed (Table 3-27). Three types of natural vegetation are present within the site in small amounts: oak scrub, hardwood hammock, and freshwater wetland totaling 0.5 ha (1.2 ac) (Figure 3-27).

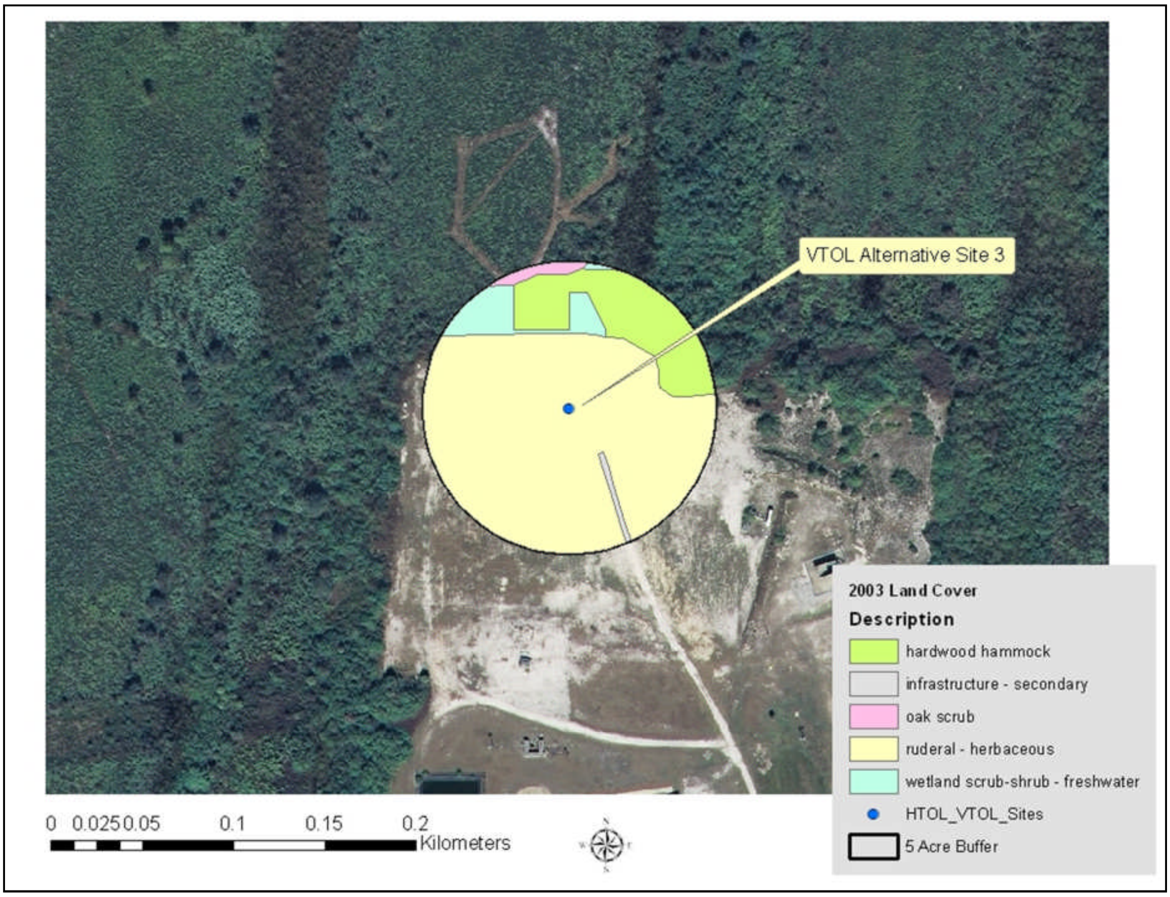

Figure 3-27. Habitat types within a 2 ha (5 ac) circle around the proposed VTOL Site 3.

3.10.2 Wildlife

3.10.2.1 Invertebrates and Fish

The IRL was designated as an "estuary of national significance" in 1990 by the EPA. The IRL supports over 400 species of fishes (Gilmore 1977, Snelson 1983), 260 species of mollusks, and 479 species of shrimps and crabs (Woodward-Clyde 1994). Commercially important species include game fish (e.g., snook, *Centropomus undecimalis*, seatrout, *Cynoscion nebulosus*, and tarpon, *Megalops atlanticus*) and crabs. In addition, several areas of the IRL are important shellfish harvesting areas. Lagoon habitats serve as nursery grounds for virtually all fish resident within the lagoon, as well as many offshore species. Studies of terrestrial invertebrates have been limited to research aimed at controlling salt marsh mosquitoes, *Ochlerotatus taeniorrhynchus* and *Ochlerotatus sollicitans* (Platts et al. 1943, Clements and Rogers 1964). A detailed biological survey of terrestrial invertebrates has not been performed on KSC. No fish would be expected to occur within the habitats present at Sites 2 and 3.

3.10.2.1.1 SLF

The ditches at the SLF are quite large and many of the common "ditch species" are present, such as rainwater killifish, mosquitofish, sailfin mollies, sheepshead minnow, killifish (*Fundulus* spp.*)*, and the goldspotted killifish (*Floridichthys carpio*). There is connection to the estuary during periods of high water, which allows access to the ditches by estuarine fish. There are high densities of sportfish including red drum (*Sciaenops ocellatus*), black drum (*Pogonias cromis*), spotted seatrout (*Cynoscion nebulosus*), tarpon (*Megalops atlanticus*), and common snook (*Centropomus undecimalis*). Other estuarine species documented include ladyfish (*Elops* spp.), white and black mullet (*Mugil* spp.), and hardhead catfish (*Ariopsis felis*). Typically, the salinity is low (5-15 ppt, depending on rainfall) and many freshwater fish persist in these ditches as well. Common freshwater species include Florida gar (*Lepisosteus platyrhinchus*), largemouth bass (*Micropterus salmoides*), shad (*Dorosoma* spp.), and sunfish (*Lepomis* spp.). The SLF ditches are the only location on KSC where non-native blue tilapia (*Oreocromis aureus*) has been documented (Eric Reyier and Doug Scheidt, personal communication, March 2011).

3.10.1.2.2 VTOL - Alternative 1

The ditches at this site could potentially support a number of small species of fish, including mosquitofish (*Gambusia affinis*), sailfin molly (*Poecilia latipinna*), rainwater killifish (*Lucania parva*) and sheepshead minnow (*Cyprinodon variegatus*). These are important food sources for many of the birds that are present on KSC.

3.10.2.2 Herpetofauna

Fifty species of reptiles and 19 species of amphibians have been documented as occurring on KSC (Seigel et al. 2002; R. Seigel pers. comm.; Appendix A Table 1). Six of these species are federally protected as Threatened (T) or Endangered (E) and will be further discussed in Section 3.10.4, including three species of sea turtles that nest along the coastline during the summer months, and use the surrounding lagoons as developmental habitat for juveniles.

In addition to the six federally listed species, there are three state listed species that are protected by the State of Florida. These include the Florida gopher frog (*Rana capito aesopus*), the gopher tortoise (*Gopherus polyphemus*), and the pine snake (*Pituophis melanoleucus mugitis*). The Florida gopher frog and Florida pine snake are uncommon on KSC and little is known about their numbers or distribution. Conversely, the gopher tortoise is common, wide-spread, and well studied on KSC. The gopher tortoise inhabits the uplands where it excavates burrows for shelter from weather, climate, predators and fire. Many other vertebrate and invertebrate species also use the tortoise burrows, and for this reason, the tortoise is considered a keystone species. Because gopher tortoises prefer the uplands habitats that are typically used for development, and are often found in previously disturbed areas, conflicts with operations occasionally arise. In these situations, the KSC Gopher

Tortoise Guideline is to 1) avoid disturbing gopher tortoises or their burrows whenever possible by working with project managers to reconfigure projects; 2) to remove tortoises from harm's way when temporary impacts cannot be avoided so they can remain or be returned to their original home range once the project is completed; or 3) to relocate away from the project site if the impacts are widespread and permanent.

3.10.2.2.1 SLF

Only the ditch habitat would be expected to support populations of amphibians and reptiles. Large alligators are quite common in these ditches. Due to the water being slightly to moderately saline, it is not likely that frogs or other amphibians would breed in the ditches, and freshwater turtles would not be common either.

3.10.2.2.2 VTOL - Alternative 1

Because the majority of land cover inside the LC39A perimeter is concrete and mowed grass and the entire perimeter is fenced, very few reptiles would be expected to occur. There are a small number of gopher tortoises that occupy some of the berms around the pad surface and other facilities. Alligators have been documented in the larger ditches and have occasionally been pulled from the deluge water pit after launches. They likely enter the perimeter from the surrounding salt marshes and impoundments through the small drainage flows that cross under the perimeter fence.

3.10.2.2.3 VTOL - Alternative 2

Some gopher tortoises occur at this site, but the density is low and most burrows are present along sandy paths and at the edge of mowed grass on the eastern end of the site. The habitat becomes less suitable heading west toward the impoundments. This proposed site could potentially support a more robust tortoise population, because it has not been burned since 1983 (Duncan et al. 2009). In order for the habitat to be more suitable, the over-story and mid-story would need to be considerably reduced to allow for light to penetrate the scrub floor. This would promote the growth of herbs and grasses that tortoises need for food and open up space for burrows.

3.10.2.2.4 VTOL - Alternative 3

As is the case with Alternative 1, the land cover at this site is highly disturbed and does not support a robust population of amphibians and reptiles. There are a few gopher tortoises on-site concentrated in the berm in the northeast corner that was historically used for target practice by KSC Security. There is a large [737 ha (1820 ac)] contiguous patch of scrub habitat surrounding this site that is actively managed by the FWS. A sizeable population of gopher tortoises has been documented there, and the area could potentially have populations of several species of frogs, other turtles, lizards, and snakes (see Appendix A).

3.10.2.3 Birds

KSC provides habitats for 330 bird species (USGS 2007); nearly 90 species nest on KSC, many of which are year-round residents (Breininger et al. 1994a). There are over 100 species that reside in the area during the winter. The remaining species regularly use KSC lands and waters for brief periods of time, usually during migration. KSC lies within the Atlantic flyway, a major migratory bird corridor that extends from the Arctic coast of Alaska to the mainland of South America. Millions of songbirds, seabirds, birds of prey, and waterfowl follow the Atlantic flyway every fall and spring.

Two species of birds that occur on KSC are federally protected and discussed further in Section 3.10.4. In addition, there are 12 species that are protected by the State of Florida (see Table 3-8). Six of these belong to a group of birds commonly called waders (Order Ciconiiformes). Wading birds are typically associated with wetlands and aquatic habitats and include species of storks, egrets, herons, ibises, and spoonbills. The wading bird population on KSC is very large, and it is estimated that between 5,000 and 15,000 birds are present at any given time, depending on the season (Smith and Breininger 1995). The largest numbers occur during the spring and the fewest birds are present in the winter.

Monthly aerial surveys of wading bird habitats have been conducted since 1987, and surveys of nesting colonies are performed each spring (see Figure 3-28). Annual nesting totals ranging from 2,567 to 3,587.

Figure 3-28. Wading bird nesting colonies on KSC in proximity to the SLF and the alternative VTOL sites.

Two small wading bird colonies are in the vicinity of the site proposed under Alternative 1; one is 1.7 km (1.1 mi) northwest of the site and the other is 1.3 km (0.8 mi) south and is also 1.3 km (0.8 mi) west of the site proposed under Alternative 2. VTOL Alternative 3 is 1.3 km (0.8 mi) from a small colony on the western edge of the Banana River. The SLF has two colonies <3 km (1.9 mi) away. One is in Banana Creek west of SR 3 on the edge of an impoundment and the other is in Banana Creek east of SR 3; this colony is used every year and supports several thousand birds, particularly white ibis.

Until July 2007, the bald eagle (*Haliaeetus leucocephalus*) was federally listed as threatened. The population of this species was successfully recovered after serious declines caused by hunting, pesticide use, and habitat loss (Jenkins and Sherrod 2002). Bald eagles are currently listed as threatened under State law and remain protected under the federal Bald and Golden Eagle Protection Act as well as the Migratory Bird Treaty Act. KSC supports an annual average of 14 breeding pairs of the southern bald eagle; see Figure 3-29 for 2009/2010 nest sites. Production for the 2004 – 2011 seasons ranged between 8 and 18 fledglings. Eagles use mature live pines and pine snags within pine flatwoods. They also will occasionally build nests on man-made towers. KSC offers an ideal opportunity for bald eagle nesting due to the wide expanse of relatively undisturbed pine flatwoods, and the freshwater and estuarine wetland complex that provides a diversity of excellent foraging habitats (Hardesty and Collopy 1991).

None of the VTOL alternative sites are near documented bald eagle nests. There are three bald eagles nest on the east side of the SLF: The first is 1.4 km (0.9 mi) away, the second is 1.5 km (0.9 mi) away, and the third is 2.2 km (1.4 mi) away.

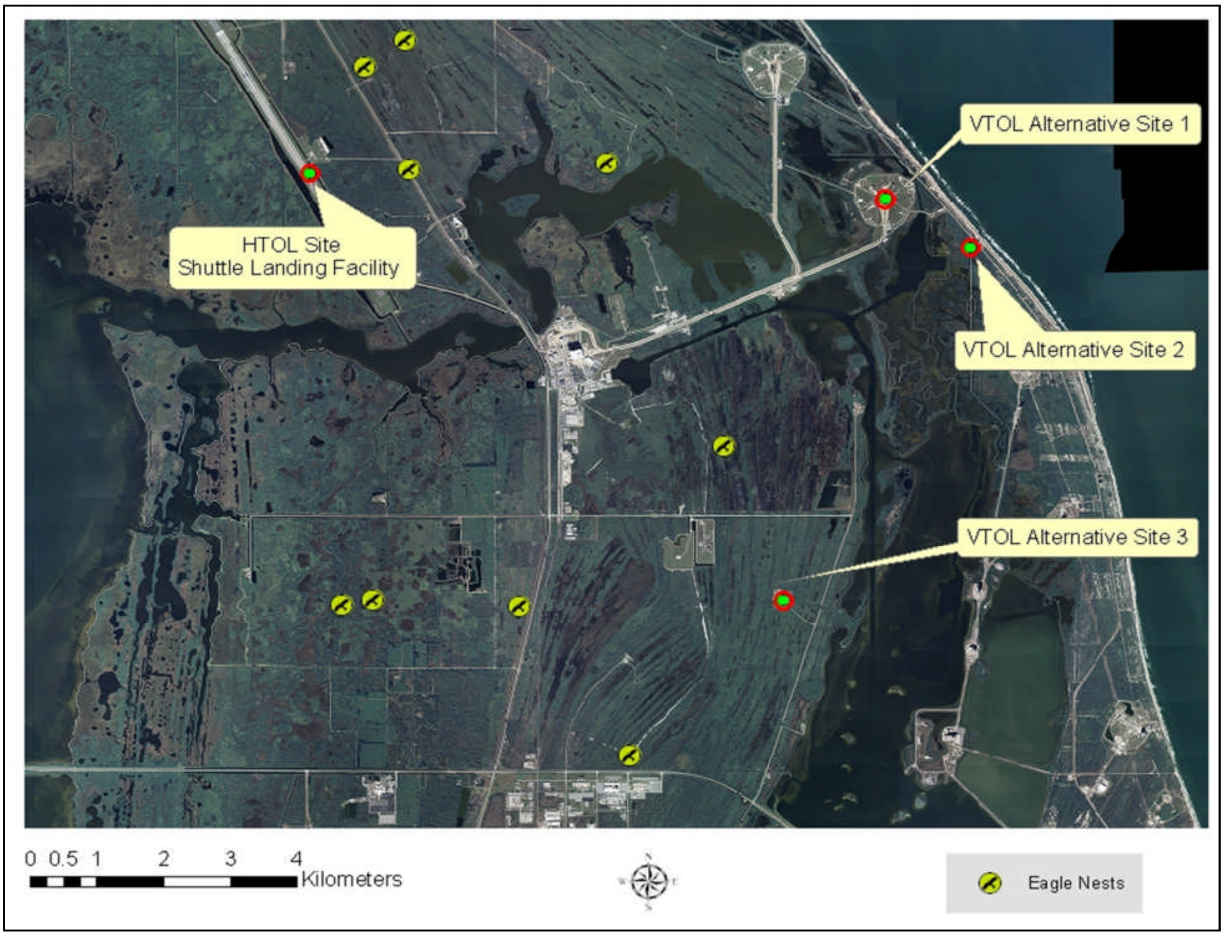

Figure 3-29. 2009/2010 Bald eagle nest sites in the vicinity of the SLF and the VTOL site alternatives.

Of the remaining five State-listed bird species, two are common year-round residents [eastern brown pelican (*Pelecanus occidentalis carolinensis*) and black skimmer (*Rynchops niger*)], the least tern

(*Sterna antillarum*) is common, but leaves in the winter, and the remaining two species occur in the winter [Arctic peregrine falcon (*Falco peregrinus tundrius*) and southeastern American kestrel (*Falco sparverius paulus*)].

3.10.2.4 Mammals

Thirty species of mammals inhabit KSC lands and waters (Ehrhart 1976). There are 13 species of whales that potentially could occur in the inshore and/or offshore waters of Florida. Four of these are federally listed as Endangered: the humpback whale (*Megaptera novaeangliae*), the sperm whale (*Physeter macrocephalus*), the Sei whale (*Balaenoptera borealis*), and the north Atlantic right whale (*Eubalaena glacialis*). The waters off of Florida are designated as critical habitat for the right whale because they are calving grounds. However, because the densities of these whales are so low in the vast open ocean areas, and the possibility of a mishap occurring that would jeopardize their populations is extremely unlikely (USAF FEIS. 1998), impacts to whale species are not analyzed further in this document. The Atlantic bottlenosed dolphin (Tursiops *truncatus*) is quite common throughout the Indian River Lagoon system. Typical terrestrial species include the opossum (*Didelphis virginiana*), hispid cotton rat (*Sigmodon hispidus*), raccoon (*Procyon lotor*), river otter (*Lutra canadensis*), and bobcat (*Lynx rufus*). Due to the regional loss of large carnivores such as the Florida panther (*Puma concolor coryi*) and red wolf (*Canis rufus*), the bobcat and otter now hold the position of top mammalian predators on KSC. In recent years, sightings of coyote (*Canis latrans*) have become more common; the impacts of adding this predator to the mix have not been determined, but it is known that they will depredate sea turtle nests and likely influence other prey populations as well.

A proliferation of mid-level predators such as the raccoon and opossum has resulted from an imbalance of predator/prey ratios. These species, as well as some of the more opportunistic species, such as the cotton rat and eastern cottontail rabbit (*Sylvilagus floridanus*), account for a large portion of the small mammal biomass, rather than habitat specific species such as the state-listed Florida mouse (Podomys Floridanus) and the federally protected southeastern beach mouse (Peromyscus polionotus niveiventris). The nine-banded armadillo (Dasypus novemcinctus), an invasive exotic species, is another animal whose numbers have risen due to a lack of natural predators.

At least three species of bats have been documented. They occasionally use facilities as roosts sites, and situations sometimes arise when bats come into direct contact with people. In those cases, the bats must be excluded from the site. Several bat houses have been erected on KSC to help mitigate the impacts of exclusions. A very large, reproductively active bat roost is located in the bridge on SR 405 where it crosses over SR 3, just inside the KSC security gate. Several thousand bats are thought to use this bridge year-round.

The feral hog (*Sus scrofa*), an invasive, exotic species, is very abundant on KSC and considered to be one of the most serious environmental problems. Feral hogs are extremely prolific and reproduce year-round. They are voracious feeders and eat a large variety of plants and animals. They are particularly destructive in wet areas and can cause damage that takes years to repair. The FWS has a hog removal program that takes many hogs each year, but will probably never be sufficient to remove all of the hogs.

Most of the mammals discussed in this section could use the SLF and VTOL site proposed under Alternative 3 for feeding, or while passing between less disturbed areas surrounding those sites. The fence around LC39A (VTOL Alternative 1) makes it much less accessible to mammals and they are uncommon within the pad perimeter. Because of the natural habitat that occurs at VTOL Alternative 2, the use of that site by a variety of mammals would be expected to be more, and many of the smaller mammal populations would be greater.

3.10.3 Threatened and Endangered Species

Eleven federally listed wildlife species have been documented on KSC, more than on any other National Wildlife Refuge in the continental U.S. (see Table 3-11). Seven of these are only incidentally present and do not make important contributions to the area's biota: hawksbill sea turtle (*Eretmochelys imbricata*), Kemp's ridley sea turtle (*Lepidochelys kempi*), Atlantic salt marsh snake (*Nerodia clarkii taeniata*), snail kite (*Rosthrhramus sociabilis*), Audubon's crested caracara (*Polyborus plancus audubonii*), piping plover (*Charadrius melodus*), and roseate tern (*Sterna dougallii*). The American alligator (*Alligator mississippiensis*) was once on the brink of extinction, but recovery efforts enabled populations throughout its range to rebound strongly. They are abundant on KSC and can sometimes cause problems related to traffic safety and encounters with people around and within facilities. However, because the alligator is similar in appearance to another listed species, the American crocodile (*Crocodylus acutus*), it remains on the federally protected list.

Table 3-11. Threatened and endangered wildlife species documented at KSC, Florida.

SCIENTIFIC NAME	COMMON NAME	PROTECTION	
Amphibians and Reptiles		**STATE**	**FEDERAL**
Lithobates capito aesopus	Florida gopher frog	SSC	
Alligator mississippiensis	American alligator		T(S/A)
Caretta caretta	Loggerhead		T
Chelonia mydas	Atlantic green turtle		E
Dermochelys coriacea	Leatherback sea turtle		E
Gopherus polyphemus	Gopher tortoise	T	C
Drymarchon couperi	Eastern indigo snake		T
Nerodia clarkii taeniata	Atlantic saltmarsh snake		T
Pituophis melanoleucus mugitus	Florida pine snake	SSC	
Birds			
Pelecanus occidentalis carolinensis	Eastern brown pelican	SSC	
Egretta thula	Snowy egret	SSC	
Egretta caerulea	Little blue heron	SSC	
Egretta tricolor	Tricolored heron	SSC	
Egretta rufescens	Reddish egret	SSC	
Eudocimus albus	White ibis	SSC	
Ajaia ajaja	Roseate spoonbill	SSC	
Mycteria americana	Wood stork		E
Haliaeetus leucocephalus	Bald eagle		P
Falco sparverius paulus	Southeastern American kestrel	T	
Charadrius melodus	Piping plover		T
Sterna antillarum	Least tern	T	
Rynchops niger	Black skimmer	SSC	
Aphelocoma coerulescens	Florida scrub-jay		T
Mammals			
Peromyscus polionotus niveiventris	Southeastern beach mouse		T
Podomys floridanus	Florida mouse	SSC	
Trichechus manatus	West Indian manatee		E
Key: SSC = species of special concern, T(S/A) = threatened due to similarity of appearance, T = threatened, E = endangered, C = candidate for federal listing, P = Bald and Golden Eagle Protection Act			

Eight federally listed species occur on KSC either commonly or occasionally: loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), leatherback sea turtle (*Dermochelys coriacea*), eastern indigo snake (*Drymarchon couperi*), wood stork (*Mycteria americana*), Florida scrub-jay (*Aphelocoma coerulescens*), southeastern beach mouse (*Peromyscus polionotus niveiventris*), and the West Indian manatee (*Trichechus manatus*).

Sea Turtles

Three different sea turtle species nest along KSC, CCAFS, and CNS beaches between March and September. These turtles include the loggerhead (threatened), green sea turtle (endangered), and leatherback sea turtle (endangered). Nesting sea turtle research has taken place on these beaches since the early 1970s, and long-term monitoring has been done for KSC's Life Science Services and Medical and Environmental Services contracts since 1984. The loggerhead accounts for over 95% of the nests on KSC, with an annual average of 1,300 (Popotnik and Epstein 2002). Green sea turtle nest numbers oscillate between 50 nests one year and 200 nests the next. Leatherback sea turtles nest infrequently on KSC, with only one or two nests recorded in a typical year. Management for these species differs among the agencies, but includes yearly monitoring of numbers of nests and false crawls, lighting surveys, dune restoration when appropriate, nest protection using flat, wire mesh screening, and in some cases predator removal. Primary nest predators include raccoons, feral hogs, and ghost crabs (*Ocypode quadrata*).

The IRL surrounding KSC provides developmental habitat for juvenile sea turtles (Mendonca and Ehrhart 1982), with the majority being found in Mosquito Lagoon. Species observed include the loggerhead, green sea turtle, and recently, a Kemps ridley (*Lepidochelys kempii*). Data collected over many years through 2006, have the following general findings: During the 1990s to present, green turtles occur at much higher frequencies than loggerheads, exactly opposite of results from the mid-1970s. Based on intermittent sampling using traditional tangle nets, the relative numbers of lagoonal turtles appear much lower in Mosquito Lagoon as compared to further south in the IRL. However, in January 2010, over 1,000 sea turtles were retrieved from the waters of Mosquito Lagoon, and another 1500 from the nearby Indian River, the Banana River. These unprecedented numbers were rescued, during a stranding event brought about by a prolonged period of extremely cold water temperatures. The majority of turtles were juvenile green sea turtles, which illustrates the importance of the KSC area as an important developmental habitat.

The incidence of the fibropapilloma virus in the KSC area is no different than other sections of the IRL. The animals using Mosquito Lagoon tend to reside there for at least several years prior to departure, based on capture and recapture data (Provancha et al. 2005). The Mosquito Lagoon provides vast seagrass beds for green turtles to forage and shellfish resources are available for loggerheads. This Mosquito Lagoon study area has been recommended as a long-term index study site by the State of Florida (Eaton et al. 2006).

Eastern Indigo Snake

Eastern indigo snakes became federally listed as threatened under the Endangered Species Act in 1978. They are thought to be common on KSC, although actual population numbers would be quite difficult to obtain. Eastern indigo snakes have very large home ranges and use a variety of habitat types that include uplands, wetlands, hammocks, and disturbed areas. Research on home range sizes, habitat use, and trapping methods using radio tagged indigos has been conducted on KSC beginning in the early 1990s (Breininger et al. 2004; Dyer 2004).

Florida Scrub-jay

The federally threatened Florida scrub-jay is found in Florida and nowhere else in the world. Habitats occupied by Florida scrub-jays are typically oak scrub, oak/palmetto, and coastal scrub, as well as ruderal and disturbed areas in coastal regions. In order for scrub-jays to persist and flourish, the characteristics of the habitat must fall within a narrow range that is ideally maintained by fire. Florida scrub-jays live year-round in fairly stable territories, mate for life, and the young stay in their natal territory with the family for several years.

KSC and CCAFS together support one of the largest remaining populations of Florida scrub-jays, with an estimate of 550 pairs (USFWS 2007). Scrub-jay habitat is intensively managed on KSC, primarily by controlled burning and mechanical treatment. KSC has a scrub habitat compensation plan that is used to determine mitigation rates when scrub is taken for development (Schmalzer et al. 1994). Mitigation takes place as restoration of degraded scrub habitat elsewhere on KSC. Scrub-jay and scrub habitat research began on KSC in the late 1970s, and over 40 articles have been published in scientific journals or as Master's theses.

Wood Stork

Wood storks are federally protected as endangered. Wood stork populations have declined sharply in Florida, from 60,000 pairs in the 1930s to 11,232 pairs in 2006. Monthly aerial wading bird surveys show that approximately 250 wood storks use KSC impoundments, ditches, and estuaries for feeding and roosting. Wood storks are present on KSC throughout the year, but there is an apparent influx of non-resident birds during the winter. Wood storks were first recorded nesting on KSC in 1972; in subsequent years, 300 – 400 pairs were documented, representing almost 10% of the Florida population. Freezes in the mid-1980s severely reduced the mangrove population, the wood stork's primary nesting substrate in this area, and the number of nests varied from zero to 122 through 1990. Wood stork nesting has not been documented on KSC since 1990, although the mangroves have recovered and support nesting by other species of wading birds (Smith and Breininger 1995).

Southeastern Beach Mouse

The federally threatened southeastern beach mouse is a subspecies of the old field mouse (*P. polionotus*). It inhabits the sand dunes and adjoining scrub along the Atlantic coastline. Extensive coastal development has resulted in the loss and fragmentation of coastal dunes habitat for all of the subspecies of beach mice in Florida. The historic range of the southeastern beach mouse once extended from Ponce Inlet to Miami Beach. Currently, it can only be found from the Apollo Beach to Port Canaveral, with isolated small populations at Archie Carr National Wildlife Refuge and Sebastian Inlet State Park. CNS/KSC/CCAFS coastal dune provides habitat and protection for the last remaining core populations of this subspecies. Population monitoring and habitat use evaluations have occurred sporadically since the early 1980s. In 2010, a three-year occupancy study was undertaken to determine the presence of beach mouse throughout the entire CNS, KSC, and CCAFS complex. It is intended for this occupancy study to also document the extent of beach mouse populations in atypical habitats further inland where they have been captured in recent years.

West Indian Manatee

The estuarine waters surrounding KSC serve as a year-round safe harbor and foraging areas for West Indian manatees. Monthly aerial surveys of manatees have been conducted over the Banana River since 1977. Manatees can be found at KSC during all months of the year except when winter cold fronts drop water temperatures below 19^{o}C (66^{o}F). KSC generally experiences a spring peak in manatees followed by a fairly consistent number of animals in summer, another increase each fall, and then a drop each winter. The north end of the Banana River, south to near KARS Park I, is protected from entry of motorized watercraft, either by KSC security restrictions or as a designated manatee sanctuary. In 2003, peak counts resulted in over 670 individuals observed on one survey. This represents approximately 20% of the total Florida population and 40% of the east coast population. It is assumed that the quiet KSC waters (within the sanctuary) combined with extensive seagrass beds (primarily *Halodule* and *Syringodium)* provide good habitat that manatees continue to use and teach their offspring to locate (Provancha and Hall 1991).

3.10.4 Alternative Sites

3.10.4.1 SLF

Three federally protected species, the eastern indigo snake, wood stork, and Florida scrub-jay, have been documented in the natural habitats surrounding the SLF. Impacts to these species from new construction and operations at the SLF were assessed in the SLF expansion EA (NASA 2007). Only the wood stork uses habitat within the SLF perimeter. It feeds in the ditches on the abundant fish resources.

3.10.4.2 VTOL - Alternative 1

None of the federally listed species are known to occur within the perimeter of LC39A.

3.10.4.3 VTOL - Alternative 2

The habitats on this site are largely undisturbed and have the potential to support six federally listed species.

Sea Turtles

The eastern boundary of this site lies approximately 250 m (805 ft) from the beach in an area that supports annual sea turtle nest densities of about 80/km (50/mi), based on data from the last decade (KSC Ecological Program database). Sea turtle disorientations, caused by artificial light reaching the beach, has been relatively high along this stretch in past years after hurricanes and storms in the mid-2000s eroded and modified the dune.

Indigo Snakes

Three of the six habitat types present on this site (oak scrub, coastal strand, and upland hardwood forest) constitute potential eastern indigo snake habitat. Indigos are less impacted by lack of fire management than other upland species and prefer a mix of habitat types. Indigos often use gopher tortoise burrows as refugia; the density of tortoises at this site is low, but they are present. Tortoise burrows are abundant in adjacent areas, and would be easily accessible to any indigo snake that might be occupying this site. It is very difficult to survey for eastern indigos, and at the present time, their presence can only be confirmed by direct observation or finding a shed skin. However, based on data collected from other areas on KSC, the habitat appears to be suitable.

Florida Scrub-jays

In 2009, two scrub-jay families were documented using habitat at this site. One family had two adults and three helpers; the other family had two adults and one helper (Geoff

Carter, pers. comm., May 2009). The best habitat is on the east end of the site, and the scrub becomes less suitable heading west toward the impoundments. This site could potentially support more scrub-jay territories if the habitat was optimal, but it is generally in poor shape for scrub-jays (D. Breininger, Dynamac, personal communications, 9 Jun 2008). This site has not burned at least since 1983 (Duncan et al. 2009). The scrub on the east end receives the benefits of salt pruning from the ocean, but the remaining scrub needs canopy and understory reduction to be more suitable for jays.

Southeastern Beach Mice

This site supports potential habitat for southeastern beach mice in the coastal strand and oak scrub. The site contains a permanent beach mouse transect which has been sampled for this species during two separate distribution studies (Provancha and Oddy 1992; Provancha et al. 2005b). The transect is approximately 200 m (600 ft) from the beach, situated in coastal strand with dominant vegetation including gopher apple, wax myrtle, and Chapman oak. During the 2003 - 2005 study, seven beach mice were captured at this transect, representing a catch per-unit effort (CPUE) of 0.06, below the average CPUE of 0.098 for all KSC transects (Provancha et al. 2005b). Overall, this site is densely vegetated and does not contain optimal habitat, but because it is located in close proximity to very favorable dune habitat, it may function as a population overflow area and as a refuge during tropical storms and hurricanes.

3.10.4.4 VTOL - Alternative 3

Eastern Indigo Snakes

The land cover at this site is highly disturbed, but there is a small population of gopher tortoises, and the area is surrounded on two sides by actively managed oak scrub. No indigos have been documented from this site, but based on habitat characteristics of areas known to be occupied by indigos, there is the potential that they could occur there.

Florida Scrub-jays

No scrub-jays would be expected to occupy the impact area at this site, but there is actively managed scrub habitat on two sides. This scrub is not part of the KSC Ecological Program’s long-term monitoring data set for scrub-jays, so it is not known if it is currently occupied. However, the potential exists that jays occur there, and if they do not presently, the scrub-jay population may expand there in the future due to improving habitat conditions.

3.10.5 Listed Plants

No federally listed plant species have been found to occur on KSC. KSC supports 33 plant species that are protected by the State of Florida, either as threatened, endangered, or commercially exploited (NASA 2002, Schmalzer and Foster 2005). Four of these could potentially occur at VTOL Site 2: *Chamaesyce cumulicola*, *Glandularia maritime*, *Lantana depressa* var. *floridana*, and *Opuntia stricta* (NASA ERD 2010).

3.11 Socioeconomics and Children's Environmental Health and Safety

KSC is Brevard County's largest revenue source and among its biggest employers. In Fiscal Year 2010, KSC and other NASA centers spent $1.8B in wages and purchases within Florida. Its monetary injection is found to have a total State-wide impact of $4.1B in total output (NASA 2010a).

In 2009, commercial space transportation and enabled industries (CST & EI) generated $208.3B in economic activity and launch vehicle manufacturing and its services industry (LVM & SI) generated $828M. The industry created $76B in induced economic activity in the form of housing, consumption and other purchases.

KSC's capability to attract, enter and leverage the commercial market is critical to its sustainability, and essential for regional economic recovery and long-term growth. KSC bears a proud legacy in space exploration and technological advancement in an ecologically sensitive and rare wildlife sanctuary. It is a symbol of national pride and a direct representation of human optimism. KSC was established as a launch operations center in 1962 and grew to become the nation's premier spaceport (J. Muncy, personal communication, February 4, 2011). In similar fashion, KSC can attract the private sector initially through launch missions and in time, engage its full scope of business.

Initial projections for KSC's LC39 to LC41 commercial use are 100 to the upwards of 250 flights annually. Estimates for the cost of each launch are $50K, and which allocates $4.5M for initial set-up and establishment at KSC in year one (C. Abell, personal communication, December 2010). Commercial presence at KSC introduces opportunities for tourism and community outreach in addition to the economic activity directly resulting from flight operations. Furthermore, commercial use of KSC's launch complex creates an opportunities for the private industry to experience KSC's vast resource, efficiency and workforce qualifications.

KSC's 2010 workforce population was 12,400 (C. Abell, personal communication, December 2010), down 19% since 2009 (NASA 2010a). In January 2011, the workforce was downsized and future reductions are anticipated. In significant contrast, the commercial space and launch manufacturing industry employed over one million employees in the workforce in 2009 (FAA 2009). Despite the current US financial crisis and increased unemployment, KSC is uniquely positioned to participate in private ventures.

In 2010 KSC's workforce population was 15,248, of which 14% were civil servants. Each space-related job was found to create an additional 1.26 jobs within Florida's labor market. KSC's 2010 presence was directly and indirectly responsible for nearly 33,000 jobs State-wide (NASA 2010a). The highest employment levels at KSC were recorded during the Apollo program. In 1968, KSC recorded a peak population of 25,895. Employment dropped precipitously to a historic low upon Apollo's mission fulfillment, to 8,441 in 1976. The Space Shuttle program injected a sharp rise in employment 1979 and by the year 2005, approximately 14,595 personnel were employed at KSC, of which civil service employees accounted for 12% of the workforce. As of September 2010, KSC population was 13,631.

The possibility for road closure during launches from VTOL Alternatives 1 and 2 exists, if either of those sites is chosen. Generally, road closure depends on the potential extent of falling debris, spread of toxic substances, and the projected distance of the supersonic overpressure shock wave associated with each launch. The specifics pertaining to road closures that are normally open to the public during normal operations, would be determined once the details concerning the vehicle types to be launched are ascertained.

Children's Environmental Health and Safety

Under EO 13045, Protection of Children From Environmental Health Risks and Safety Risks, dated April 21, 1997, federal agencies are encouraged to consider potential impacts of proposed actions on the safety or environmental health of children. The nearest location containing a moderate concentration of children is the KSC Child Development Center located at KSC, approximately 4 to 8 miles away from the site locations. This is a child care center and pre-school service available for children ages six weeks to five years old. There are no other schools, daycare facilities, playgrounds, or other places where children are concentrated within KSC. The No Action Alternative would not impact children. Under the Proposed Action, development at any of the sites would not negatively affect children.

3.12 Cultural Resources

The SLF area was classified as a Historic District of the Space Shuttle Program. It received Historic American Buildings Survey/Historic American Engineering Record (HABS HAER) study and documentation was completed in late 2010. The SLF is uniquely numbered by the National Park Service with the HAER number, FL-8-11-J. The SLF Area Historic District includes three properties: the runway, the Landing Aids Control Building (LACB), and the Mate-Demate Device (MDD). The boundary of the historic district is comprised of the footprints of the three properties. The SLF is the site where all five Space Shuttle orbiters originally arrived at KSC from their assembly plant in Palmdale, California. As described in Chapter 2, it served as the main Shuttle landing site, and as a return from landing site when weather or other issues necessitate the use of Edwards Air Force Base (AFB) in California for landing. The SLF is eligible for listing on the National Register of Historic Places in the context of the Space Shuttle program and is part of the SLF Historic District.

3.12.1 VTOL - Alternative 1

LC39A is listed on the National Register of Historic Places in the context of the Apollo program and eligible in the context of the Space Shuttle program and is part of the LC39A Historic District. The LC39A site was evaluated for it eligibility for historical status and ultimately documented in August 2010 as part of the National Park Service process for recording a historic property prior to reuse. The HABS HAER Level II documentation included written history, archival photographs and an index of photographs. The LC39A HAER number is FL-8-11-F. The site is capable of redevelopment since the official documentation is now complete.

3.12.2 VTOL - Alternative 2

As part of an earlier, unpublished, environmental assessment for the Commercial Vertical Launch Complex (CVLC) program, an archaeological survey was performed in 2008 at this site. It included ground surface reconnaissance and systematic and judgmental subsurface testing. Testing was conducted at 25 m (82 ft) intervals within the locations of previously recorded sites 8BR915 and 8BR916, at 50 m (164 ft) intervals in the moderate probability areas, and at 100 m (328 ft) intervals or judgmentally within a sample of the remaining low probability areas. A total of 56 shovel tests were excavated. As a result, no evidence of either previously recorded site was found, and no new archaeological sites were discovered. Both 8BR915 and 8BR916 are presumed destroyed. No historic resources, including buildings or structures, are located within this site. A description of the two previously recorded sites and updated Florida Master Site File (FMSF) forms are in the Archeological Consultants Inc. report (ACI 2008).

3.12.3 VTOL - Alternative 3

The Fire Training Area does not have any historic recognition or eligibility listed at this time. According to the KSC Historic Context and Historic Period Archaeological Site Location Predictive Model (revised May 2009); this site is not within but is near a zone that has high probability of archeological concern (B. Naylor, NASA, Personal Communication). Northeast of this area is 8BR00061 which is an unverifiable archaeological site listed in the Florida Master Site File as "non-cultural" and has not been evaluated by the Florida State Historic Preservation Officer.

3.13 Light Emissions and Visual Impacts

NASA considers the extent to which any lighting associated with an action would create an annoyance among people in the vicinity or interfere with their normal activities. Visual and aesthetic resources refer to natural or developed landscapes that provide information for an individual to develop their perceptions of the area. Areas such as coastlines, national parks, and recreation or wilderness areas are usually considered to have high visual sensitivity. Heavily industrialized urban areas tend to be the areas of the lowest visual sensitivity. The existing conditions at the KSC are characterized as having low visual sensitivity, because the site is currently an industrialized area that supports rocket launches. Notable visual structures include the lightning protection towers at LC 39A. Due to the flat topography and the height of the lightning towers (approximately 528 feet), the lightning protection towers can be seen several miles away. Existing light sources at KSC include nighttime security lighting at the launch complex and buildings. NASA has a guideline used to address the light impacts to threatened, endangered, and Species of Special Concern at KSC under KSC Light Management Plan.

4.0 ENVIRONMENTAL CONSEQUENCES

This chapter evaluates the potential impacts of the Proposed Action. This chapter is based on the best information available and addresses cumulative impacts on KSC and the nearby communities over a 20-year period. Mitigation recommendations are included for resources where impacts could potentially be major.

The only category expected to be impacted under the No Action Alternative would be socioeconomics. The No Action Alternative is not expected to impact Land Use; Facilities and Infrastructure; Transportation; Utilities; Hazardous Materials and Waste; Air Quality; Noise; Geology and Soils; Hydrology and Water Quality; Biological Resources; or Cultural Resources. Therefore, these resources are not discussed under the No Action Alternative.

Tables 4-1, 4-2, and 4-3 are Resource/Issue matrices that define the potential impact to each resource category for the Proposed Action. Impact classifications are defined as follows:

None – no impacts expected

Minimal – impacts are not expected to be measurable, or are too small to cause any discernable degradation to the environment

Minor – impacts would be measureable, but not substantial, because the impacted system is capable of absorbing the change

Moderate – impacts would be measureable, but could be reduced through appropriate mitigation

Major – impacts could individually or cumulatively be substantial

Beneficial – impacts are positive in nature

The assessment determined that the Proposed Action would not result in “Major” impacts. Six resource areas were listed as potentially experiencing “Moderate” impacts (Land Use, Facilities and Infrastructure, Noise, Hydrology, Land Cover, and Threatened and Endangered Species). The reasoning and supporting data or references behind each impact classification are given in the sections below.

Table 4-1. Anticipated impact levels on resources for the Increased Flight Operations at SLF and the No Action Alternative.

Resource/Issue	Proposed Action	No Action
Land Use	MINIMAL	NONE
Facilities and Infrastructure	MINIMAL	NONE
Transportation	MINIMAL	NONE
Utilities and Services	MINIMAL	NONE
Hazardous Materials and Waste	NONE	NONE
Air Quality	MINIMAL	NONE
Climate Change	MINIMAL	NONE
Noise	MINIMAL	NONE
Geology and Soils	MINOR	NONE
Hydrology and Water Quality	MINIMAL	NONE
Land Cover	NONE	NONE
Wildlife	MINOR	NONE
Threatened and Endangered Species	MINIMAL	NONE
Socioeconomics	MINIMAL (beneficial)	NONE
Cultural Resources	NONE	NONE

Table 4-2. Anticipated impact levels on resources for the HTOL of Suborbital Vehicles and the No Action Alternative.

Resource/Issue	Proposed Action	No Action
Land Use	MINOR	NONE
Facilities and Infrastructure	MINIMAL	NONE
Transportation	MINIMAL	NONE
Utilities and Services	MINIMAL	NONE
Hazardous Materials and Waste	MINIMAL	NONE
Air Quality	MINIMAL	NONE
Climate Change	MINIMAL	NONE
Noise	MINOR	NONE
Geology and Soils	MINIMAL	NONE
Hydrology and Water Quality	MINIMAL	NONE
Land Cover	NONE	NONE
Wildlife	MINOR	NONE
Threatened and Endangered Species	MINOR	NONE
Socioeconomics	MINOR (beneficial)	MINOR
Cultural Resources	NONE	NONE

Table 4-3. Anticipated impact levels on resources for the VTOL of Suborbital Vehicles (by alternative) and the No Action Alternative.

Resource/Issue		Alternative Site 1	Alternative Site 2	Alternative Site 3	No Action
Land Use	*	MINIMAL	MODERATE	MINIMAL	NONE
Facilities and Infrastructure	*	MINOR	MODERATE	MINOR	NONE
Transportation	*	MINIMAL	MINIMAL	MINIMAL	NONE
Utilities and Services	*	MINIMAL	MINIMAL	MINIMAL	NONE
Hazardous Materials and Waste	*	MINIMAL	MINIMAL	MINIMAL	NONE
Air Quality	*	MINIMAL	MINIMAL	MINIMAL	NONE
Climate Change	*	MINIMAL	MINIMAL	MINIMAL	NONE
Noise	*	MINOR	MINOR	MINOR	NONE
Geology and Soils	*	NONE	MINOR	NONE	NONE
Hydrology and Water Quality	*	MINIMAL	MODERATE	MINIMAL	NONE
Land Cover	C	MINIMAL	MODERATE	MODERATE	NONE
	O	MINIMAL	MINIMAL	MINIMAL	NONE
Wildlife	C	MINIMAL	MINIMAL	MINIMAL	NONE
	O	MINIMAL	MINIMAL	MINIMAL	NONE
Threatened and Endangered Species	C	MINIMAL	MODERATE	MODERATE	NONE
	O	MINOR	MODERATE	MINOR	NONE

Resource/Issue		Alternative Site 1	Alternative Site 2	Alternative Site 3	No Action
Socioeconomics	*	MINOR +	MINOR +	MINOR +	MINOR
Cultural Resources	*	NONE	NONE	NONE	NONE

C = impacts anticipated from construction phase
O = impacts anticipated from operational phase
*** = impacts anticipated from both construction and operational phases**
+ = anticipated beneficial impact).

4.1 Land Use

Impacts on land use are determined by comparing established land uses with the changes that would result from the Proposed Action. Potential issues relating to Coastal Zone Management are also considered. Since land use is not expected to be impacted differently between the construction and ground operations phases of the project, the discussion of the effects of these two stages has been combined in this section.

4.1.1 SLF

There would be minimal impacts to existing land use for increased activity at the SLF. Additional activities would be consistent with current industrial use of the SLF and associated facilities. Impacts would be due to additional commodities and increased quantities of these chemicals used and stored at the SLF for proposed expansion of activities.

4.1.2 HTOL

Impacts to land use at the SLF would be minor due to changes in land use classification, and establishment of zones to protect personnel and facilities from launch hazards. Quantity Distance (QD) arcs, transitional surfaces, and other safety setbacks and exposure limits are restrictions on the use of land adjacent to launch complexes. These restrictions would be added or revised with the addition of HTOL operations at the SLF. Land use categories describing operational and support activities at the SLF would include Airfield Operations (AO), which is the current designation, Launch, and Launch Support. MINWR would have to consider HTOL site operations in their prescribed fire planning and coordination activities to ensure that controlled burning and related activities would not impact operations at the launch site.

4.1.3 VTOL - Alternative 1

Under Alternative 1, development of the VTOL site would not cause a change in land use. LC39A is currently designated as a NASA operational area with the land use category being Launch – Launch Complex. MINWR would have to consider VTOL site operations in their prescribed fire planning and coordination activities to ensure that controlled burning and related issues would not impact operations at the launch site. Impacts to LC39A land use due to VTOL operations would be minimal.

4.1.4 VTOL - Alternative 2

This site is currently in an area managed by MINWR. However, this change in land use would be in accordance with the purposes for which KSC was established by NASA, and is authorized by Congress. On August 28, 1963, the USFWS entered into a cooperative agreement with NASA to establish the Merritt Island National Wildlife Refuge on KSC, NASA-owned land, where space operations have priority (NASA 1978, USFWS 2008). Under the agreement, the primary purpose of the land is for NASA to utilize it in partial fulfillment of its mission, with the secondary purpose of the area being management by USFWS. The use and management of this property is described in The Interagency Agreement between NASA and USFWS document KSC-1649 Rev. A.

Under Alternative 2, land management would be transferred back from MINWR to NASA. This would be followed by utilization of the property by NASA as a launch site. Use of the facility by multiple commercial entities would be accomplished on a reimbursable basis. Once removed from MINWR oversight, lands at the alternative sites would no longer be subject to controlled burning operations, one of the refuge's primary management tools. In addition, MINWR would have to consider VTOL site operations in their prescribed fire planning and coordination activities to ensure that controlled burning and related issues would not impact operations at the launch site. Development of this proposed site for VTOL would result in a land use classification change from Conservation to Launch and Launch Support. The change in land management oversight of this site and the resulting impact on fire management would be considered a moderate impact to land use.

4.1.5 VTOL - Alternative 3

Under Alternative 3, VTOL development would result in minimal changes in land use. The FTA is currently a NASA operational area. Implementation of VTOL operations would change the land use classification of this site from Spaceport Management to Launch and Launch Support (LS). Safety setbacks and exposure limits would restrict use of land adjacent to this site. MINWR would consider VTOL site operations in their prescribed fire planning and coordination activities to ensure that controlled burning and related issues would not impact operations at the launch complex.

4.1.6 Coastal Zone Management

The CZMA provides for management of our Nation's coastal uses and resources. The Act encourages coastal states to develop and implement comprehensive management programs that will balance the need for coastal resource protection with the need for economic growth and development in the coastal zone. Once a management program developed by the coastal state is approved by NOAA, the state is authorized to review certain federal activities affecting the land or water uses or natural resources of its coastal zone for consistency with its program. This authority is referred to as "federal consistency" and allows states to review various federal projects and those that are federally funded. The Florida Coastal Management Program (FCMP) was approved by NOAA in 1981 and is codified in Chapter 380, Part II, F.S. The State of Florida's coastal zone includes the entire state and its territorial seas. However, KSC is explicitly excluded from the FCMP, but still voluntarily complies with it. The SLF and the proposed alternative sites for VTOL of suborbital vehicles are not within the FCMP "no development zone." Implementation of the Proposed Action would be consistent with the FCMP.

4.1.7 Cumulative Impacts on Land Use

Cumulative impacts on SLF land use from increased activities and the addition of HTOL operations would be minimal. These impacts would be a result of increased quantities and types of commodities used and stored at the SLF, as well as additional land use category designations associated with HTOL. New QDs and safety setbacks may also be established as necessary, but these would be determined during the individual projects' licensing process with the FAA. Development of the VTOL site would be expected to have a moderate cumulative effect on land use under Alternative 2 due to the undisturbed/undeveloped nature of the area. Currently, the land is set aside primarily for conservation, being managed by MINWR for wildlife and habitat diversity. However, relatively few natural areas on KSC are being converted to operational use. Mitigation for impacts to these sites could be accomplished through habitat restoration in other degraded areas of KSC. For example, MINWR is restoring some former citrus groves to native habitats such as scrub oak and pine flatwoods (USFWS 2008). There would also be a minor impact on prescribed burn management activities which would require increased coordination between launch site operators and MINWR.

4.2 Facilities and Infrastructure

4.2.1 SLF

An increase in activities at the SLF would bring additional permanent employees and transient visitors as addressed previously in the EA for expanded use of the SLF (NASA 2007). No new facilities above those previously evaluated would be necessary to house personnel. Numbers of employees necessary to support the additional activities at the SLF would be small in comparison to those considered in the previous EA and the impact would be minimal.

4.2.2 HTOL

There would be an incremental increase of HTOL operations personnel up to 90 people by 2017. The HTOL program would require construction of facilities as previously evaluated in the SLF expansion EA (NASA 2007), including an expanded propellants, fuels, and ordnance storage, staging and support area. This would involve modification of existing developed areas of the SLF, resulting in minimal impact.

4.2.3 VTOL

Two of the alternative sites currently have sufficient infrastructure that could be utilized by VTOL. Extension and connection of utilities and construction of VTOL launch pad, lightning protection towers, ground operations facilities, concrete pads and driveways, and regolith test beds would be necessary. For further information regarding the facilities that would be needed for VTOL, see Chapter 2.0. Modification and construction of utilities and structures within the already developed areas of the Alternative 1 site (LC39A) and Alternative 3 site (FTA) would result in minor impacts.

Alternative 2

Under Alternative 2, the site does not currently have any buildings or sufficient infrastructure that could be utilized. Vegetation clearing, site grading, installation of water, wastewater, and electrical lines, and construction of ground operations facilities, launch structures, parking lots, and roads would be necessary. Chapter 2.0 provides further information on the facilities that would be needed for VTOL. The impact of this development would be moderate.

4.3 Transportation

4.3.1 SLF and HTOL

Construction – The construction activities at the SLF would be limited to modification of existing improved areas at the facility. Increased traffic due to construction would have minimal impacts to traffic routes within KSC. The majority of construction activity would occur during normal working hours and could cause some traffic delays but would not exceed the capacity of affected roads.

Operation - Increased operations at the SLF under the Proposed Action would be expected to produce only minimal impacts to roads on KSC as the number of vehicles would not increase substantially. The slight increases in traffic due to HTOL operations at the SLF would also be minimal. No data are collected as to the number of vehicles present on KSC on a daily basis, so for the purposes of this analysis, the assumption was made that the number of vehicles is equal to the number of employees on both sites, plus those vehicles needed for fueling and equipment delivery. Approximately 90 people are expected to support HTOL operations by 2017. The expected number of vehicles for transportation of personnel, equipment, and commodities would be fewer than 100. Therefore, on KSC, the impact from even the maximum increased number of vehicles would be minimal. Traffic delays would not be anticipated as the roadways have sufficient capacity to handle the increased loads. Current traffic levels are approximately half of the peak levels that were experienced during the 1960s on KSC when the majority of the existing roads were built (KSC in-house traffic data).

4.3.2 VTOL

Construction – Increased traffic due to construction workers and equipment would occur during development of all three VTOL alternative sites. Due to the existence of infrastructure at the sites under Alternatives 1 and 3, impacts to traffic and roadways would be minimal at these sites. Work under Alternative 2 would involve land clearing, hauling debris off site, and delivering fill materials, in addition to the construction workforce and equipment traffic. However, these impacts are expected to be short-term and easily absorbed by the existing roadways and traffic patterns, and should be minimal.

Operation – The pre- and post launch operations of VTOL under all 3 alternative sites would be expected to produce minimal traffic impacts. VTOL operations are anticipated to add fewer than 50 vehicles for transportation of personnel, equipment, and commodities. KSC roadways have sufficient capacity to handle the limited increase in traffic and therefore delays would not be expected. In the event that VTOL events were to become a public viewing opportunity, spectators would be transported to viewing areas via large buses which would not greatly increase traffic volumes.

4.3.3 Cumulative Impacts on Transportation

Cumulative effects of the development associated with the Proposed Action on transportation are expected to be minimal. The additional 150 vehicles per day associated with HTOL and VTOL operations comprise less than one percent of the total number of vehicles on KSC. Mitigation for the increased traffic could include mass transportation between the sites and other locations, carpooling and vanpooling programs, and employer support allowing options for telecommuting whenever feasible.

4.4 Utilities and Services

Construction and ground operation of the increased actions at SLF, HTOL and VTOL at any of the alternative sites are anticipated to have minimal impacts on the current domestic and industrial wastewater treatment, solid waste, electricity and natural gas, communications, and potable water resources on KSC.

All of these utilities are currently available in the general vicinity of each of the sites, except VTOL Alternative 2. Tie-ins could be established without significantly affecting the local areas. In some cases, utilities ducts would need to be established, but these would likely be routed along roadways and other easements that are already maintained for those purposes. When fully operational, all of the existing utilities and services at each of the alternative sites are expected to absorb the additional demands and waste.

4.4.1 SLF

The Proposed Action is expected to have minimal impacts to utilities. Employees supporting additional SLF activities would use the proposed office space evaluated in the previous EA for expanded use of the SLF (NASA 2007). The existing water, sewer, power, and communications lines in the area are sufficient to handle the anticipated increased needs. Therefore, the larger workforce would have a minimal impact on all utilities. The additional transient visitors/day anticipated under the Proposed Action would have minimal impacts on utilities. It is expected that they would use modified existing facilities at the south-field and mid-field sites, as well as the RLV Support Complex.

4.4.2 HTOL

HTOL operations would use the same utilities at the SLF as described in the above section. The addition of 90 people by the year 2017 would result in minimal impacts to these systems.

4.4.3 VTOL

The construction and operation of the VTOL facilities would require connections to wastewater, electrical, communication, and potable water utilities.

4.4.3.1 Alternative 1

Tie-ins from existing utility lines located at LC39A to the VTOL launch area would be necessary. A water main, communication and electrical duct banks, and sanitary sewer service are already available within the Pad 39A perimeter. A fiber optic communications line is available to the east along Phillips Parkway.

4.4.3.2 Alternative 2

A communications duct bank currently runs along the west side of Phillips Parkway, ending just south of this proposed site. There is also a fiber optic communications line on the east side of Phillips Parkway which extends north and south of this site. There are existing electrical and water lines along Phillips Parkway. Sewer lines would have to be run from LC39A, located 2.4 km (1.5 mi) north. Existing substations and wastewater treatment plants would have sufficient capacities for anticipated needs.

4.4.3.3 Alternative 3

Potable water and electrical lines exist at the FTA. A communications duct bank is located along Static Test Road. There is a septic tank and drain field located on site east of building L7-0940. The capacity of this system is small and would need to be upgraded for heavy use. Alternatively, the wastewater line could be constructed and tied into the existing pipe along NASA Causeway at the intersection with Static Test Road, approximately 2 miles south of the entrance to the FTA. A natural gas pipeline also runs along NASA Causeway.

4.4.4 Cumulative Impacts on Utilities and Services

The cumulative effects on utilities and services as a result of increased activities and HTOL at SLF, and VTOL site development and operations would be minimal. The electrical supply, communications, natural gas, and solid waste facilities are expected to be able to accommodate any associated increased demand. The future water supply could become more limited. In 2005, City of Cocoa projections called for average daily demand to increase to 138 million liters (36.40 million gallons) by 2023, representing an increase of 34%. In their projections, the city of Cocoa assumed that demand from all U.S. Government uses would remain constant (6.50 MGD maximum; USAF 2005a). Future SLF, HTOL, and VTOL operations and personnel could implement water conservation measures and evaluate alternative water sources in order to minimize impacts on this resource.

4.5 Hazardous Materials and Waste

4.5.1 Construction

The construction activities would use small quantities of hazardous materials, which would result in generation of small volumes of hazardous wastes. The hazardous materials that are expected to be used are common to construction activities and include diesel fuel and gasoline to power the construction equipment, hydraulic fluids, oils and lubricants, welding gases, paints, solvents, adhesives, and batteries. Appropriate hazardous material management techniques would be followed to minimize their use and waste disposal. The use, management, and disposal of hazardous materials for both the construction and operations phases are described in KNPR 8500.1, KSC Environmental Requirements. The construction contractors will make all reasonable and safe efforts to contain and control any spills or releases that may occur. All hazardous material releases to air, water, soil, and pavement at KSC must be reported per the requirements in KDP-KSC-P-3008, Hazardous Materials Emergency Response. With the proper procedures and safeguards in place, it is not expected that soil or groundwater contamination would be caused by development of VTOL sites.

Nonhazardous and hazardous waste generated during construction of the launch site would include construction debris, empty containers, spent solvents, waste oil, spill cleanup materials, and lead-acid batteries from construction equipment. Construction contractors would be responsible for safely removing these wastes from the site for recycling or disposal in accordance with applicable requirements. Vegetation and construction debris resulting from site preparation would be taken to the KSC landfill or burned on site. Combustible vegetative materials may be burned within the confines of KSC after obtaining a burn permit issued by KSC. Burning may be limited or prohibited during periods of dry weather, or when sensitive flight hardware is housed in the vicinity of the burn site. Burn permits must be scheduled a minimum of 48 hours in advance, and may be requested through the Duty Officer. The Florida Division of Forestry must also be notified when burning land clearing debris, and authorization must obtained the same day the burn is to take place or after 4:00 pm the previous day.

4.5.2 Operation

Hazardous materials used in support of launch operations would include fuel and propellants, as well as isopropyl alcohol and acetone for cleaning. Chemicals used for launch and stored at the site could include kerosene, RP-1, LOX, and ethanol. During the construction and ground operation of any of the alternative sites, hazardous materials and waste would be handled and disposed of in a manner consistent with the guidelines established by NASA as outlined in KNPR 8500.1, KSC Environmental Requirements. There would also be contingency plans for responding to and minimizing the effects of spills. With the proper procedures and safeguards in place, it is not expected that soil or groundwater contamination would be caused by operational activities at the SLF, HTOL, and VTOL sites.

4.5.3 Remediation Program

The Proposed Action, including construction and operation, should not have a significant impact on the NASA KSC Remediation Program's plans for managing SWMU and PRL sites (KSC SWMU/PRL maps 2010).

4.5.3.1 SLF and HTOL

Confirmation sampling work plans have been developed for PRL sites at the SLF (PRLs 183, 184, 185, 186, and 187). These work plans will not be implemented until 2012 at the earliest. Sampling could occur along with increased SLF activities and HTOL operations without interference.

4.5.3.2 VTOL - Alternative 1

At this proposed site (SWMU 008 – LC39A), restrictions preventing soil from being removed from the site, or requirements for management as hazardous waste according to KNPR 8500.1, would need to be adhered to during construction. During any activities in the vicinity of groundwater monitoring wells in various locations within LC39A, care would need to be taken to prevent damage to the wells.

4.5.3.3 VTOL - Alternative 2

This site was never used as operational area for NASA programs and is not known or expected to have significant levels of soil or groundwater contamination, and there would be no associated impacts from the development of VTOL. There is a possibility of spills and releases but these can be minimized with procedures, safeguards, and worker training.

4.5.3.4 VTOL - Alternative 3

At VTOL site under Alternative 3 (SWMU 007), the corrective measures implementation phase is ongoing as well as semi-annual groundwater monitoring. Activities associated with VTOL site preparation and operations would need to be coordinated with the Remediation Project Manager and care taken to avoid damage to monitoring wells.

4.5.4 Cumulative Impacts on Hazardous Materials and Waste

Although many hazardous materials and waste are known to accumulate in the environment, it is not expected that there would be any cumulative effects caused by environmental contamination as a result of the Proposed Action. Safeguards would be in place to minimize the release of toxic chemicals in the environment, and rapid response plans would ensure that accidental spills would be cleaned up quickly.

4.6 Air Quality

This section describes the environmental consequences of the Proposed Action on air quality within KSC, the nearby surrounding area, and each of the alternative VTOL sites. The impact discussions for the alternative VTOL sites are grouped together because the impacts would be similar regardless of which site is chosen.

Impacts to air quality would be due to activities associated with the construction activities, ground and launch operations, including spaceflight hardware processing, the occasional operation of generators, and ground vehicle emissions. These effects on air quality on a local and regional scale are expected to be minimal. However, tenants of the SLF, HTOL, or VTOL facilities would apply for their own Title V Operating Permit if they anticipated having any significant emission sources, operations, or processes from operations not funded by NASA. Tenants under NASA contracts or directly supporting NASA missions would be included in the KSC Title V Operating Permit.

4.6.1 SLF

Stationary emission sources, aircraft emissions, and ground vehicle emissions were evaluated in the EA for expanded use of the SLF (NASA 2007) and were determined to minimally impact air quality. Emissions from additional activities at the SLF compared to those evaluated in the previous EA (NASA 2007) are not expected to substantially increase impacts to ambient air quality.

4.6.2 HTOL

HTOL vehicles proposed for launch at KSC would potentially use RP-1, LOX, methanol, ethanol, and kerosene as propellants. The primary emission products are carbon dioxide (CO_2), carbon monoxide (CO), water vapor (H_2O), and small amounts of nitrogen oxides (NO_x) and particulate matter (PM). Emissions for Concept Y vehicles were estimated in support of the Oklahoma Spaceport EA (FAA 2006a). Based on these estimations and a review of additional EAs for activities involving rockets using similar propellants (FAA 2006b, FAA 2007, FAA 2010), the total potential emissions of any criteria pollutants under the Proposed Action would not be expected to cause exceedances of the National Ambient Air Quality Standards (NAAQS) or the Florida Ambient Air Quality Standards (FAAQS). Emissions would be of short duration and rapidly dispersed due to movement of the vehicle, wind action, and exhaust gas turbulence. Based on KSC data, the number of flight operations (take off and landings) at SLF has decreased since 2001 to approximately 4753. During that time, KSC remained in attainment for NAAQs. Approximately 1566 operations are projected by 2020, still well below the high of 18,743 in 2000. The emissions for HTOL operations would have a minimal impact on air quality.

4.6.3 VTOL

Impacts to air quality from construction would be minimal and of short duration. At each site and in the immediate vicinity, dust from the removal of vegetation and exposure of topsoil and exhaust from heavy machinery would temporarily decrease the local air quality. Air pollutants generated could include particulate matter (PM), particles of 10 micrometers or less (PM10), sulfur and nitrogen oxides, and others. These materials would quickly dissipate, and the air quality would return to the average ambient levels found at each location. In addition, the site under Alternative 2 is undeveloped and would require the clearing of vegetation and possible burning of cleared vegetation. The use of controlled burns to dispose of ground cover from land clearing activities is a common practice in Florida. Burning debris emits smoke and ash into the air, reducing air quality. Open burning is a regulated activity and requires authorization from the Florida Division of Forestry and a burn permit from the KSC Duty Office. Burning of vegetative debris on KSC requires strict adherence to specific procedures, restrictions, and criteria to be followed during the burning activities. On a regional scale, construction related air quality impacts are expected to be negligible.

Potential propellants for use by VTOL launch vehicles include LOX, isopropyl alcohol, hydrogen peroxide, ethanol and methanol. The emissions from these suborbital rockets include H_2O, CO_2, NO_2, O_2, and carbon. Based on emissions calculated from reusable suborbital rockets to be launched at the 2007 X Prize Cup (FAA 2007), air quality impacts would not be expected to exceed NAAQS or FAAQS. CO and carbon might appear in the rocket emissions but would readily burn in the ambient air. The resulting CO_2 would disperse in the atmosphere and have no impact on air quality. The VTOL rockets would not emit any hazardous air pollutants. Effects on ambient air quality at KSC would be minimal.

4.6.4 Additional Impacts of the Proposed Action

The following discussion is applicable to all proposed activities and alternative site locations. Permits (Chapters 62-4, 62-210, 62-212, F.A.C.) are required for all operations that have the potential to emit air pollutants to the atmosphere over the threshold quantities. Furthermore, CAA Section 112(r), places a general duty on the owners and operators of stationary sources producing, processing, handling, or storing any extremely hazardous substance, or any substance listed pursuant to Section 112(r) to: 1) identify hazards that may result from accidental releases; 2) design and maintain a safe facility; and 3) minimize the consequences of releases. Tenants would also be required to develop a Risk Management Plan (RMP), referred to in 40 CFR 68, "Chemical Accident Prevention Provisions". This section states that companies that manufacture, process, store, or handle regulated substances in amounts greater than threshold quantities were required to comply with these regulations by June 21, 1999. All decisions relating to this activity are based on the EPA List of Regulated Flammable Substances and List of Regulated Toxic Substances and their corresponding threshold quantities. In addition, facilities must be aware of the General Duty Clause of the CAA, which addresses all hazardous substances, regardless of the threshold amount. All processes at the HTOL and VTOL site locations that include hazardous chemicals, regardless of the quantity or applicability to the RMP List Rule, would be subject to the general duty clause of the RMP rule. EPA has delegated authority to the State of Florida Department of Community Affairs to administer the RMP regulations. Because of the nature of the proposed HTOL and VTOL site locations, the risk associated with manufacturing, processing, storing, or handling regulated substances would be considered minimal for air pollutant concentration emissions at any of the alternative sites.

Because the exact types and quantities of exhaust-generating devices for the Proposed Action are not known, this paragraph addresses reasonably foreseeable air quality impacts from boilers, hot water generators, and backup electric generators and non-toxic substances often associated with ground processing activities. The capacities for typical operations of the size proposed at the SLF, HTOL, and VTOL site locations are estimated to be small, have low fuel usage, and are not expected to produce emissions above potential to emit (PTE) threshold levels established as major sources of pollution[Chapter

62-213.300(2) F.A.C.]. For that reason, the emissions are estimated to have minimal air quality impacts. Tenants of the SLF, HTOL, and VTOL facilities would be required to meet all Federal, State, and local air quality requirements, and tenants would apply for their own Title V operating permits if they expected to have any regulated air pollution sources, operations, or processes for operations not funded by NASA.

The increase of emissions related to traffic associated with SLF, HTOL, and VTOL operations would be negligible. An estimated 150 additional vehicles would be in use each day from employees working at the SLF, HTOL, and VTOL site locations. A lower number of vehicles were determined not to have a substantial impact to air quality in a study conducted as part of the NEPA planning for the International Space Research Park (NASA 2004c). Therefore, the additional emissions generated from the increase in ground transportation vehicles would be considered minimal.

4.6.5 Cumulative Impacts on Air Quality

The most influential air quality fluctuations on a routine basis are created by the emissions from automobiles entering and departing KSC each day. None of the three actions listed in this EA, separately or combined, provide substantial cumulative impacts.

4.6.5.1 SLF

Under the Proposed Action, operation of the SLF site location would be associated with an increase in traffic, undetermined types and quantities of exhaust generating devises such as boilers, hot water generators, and back-up generators. Based on current regulations and best available predictions for the activities affiliated with the SLF site location, the increased traffic or increased generation of exhaust is not expected to have a substantial cumulative impact on air quality.

4.6.5.2 HTOL and VTOL

Air quality fluctuations on a routine basis will be created by the emissions from automobiles entering and departing KSC each day. Under the Proposed Action, HTOL and VTOL operations would be associated with an increase in traffic. Based on best available predictions of traffic affiliated with the Proposed Action, the increased traffic is not expected to have a substantial cumulative impact on air quality. Potential emissions resulting from HTOL and VTOL vehicle launches and landings would be small in comparison to launches of the Delta, Titan, Saturn V rockets, and the Space Shuttle. Therefore, HTOL and VTOL operations would have minimal cumulative impacts.

4.6.6 Avoidance and Minimization Measures

This section proposes potential mitigation measures or identifies regulatory authority required for each identified impact. The impacts presented are applicable for each of the proposed action sites.

Although construction activities are not expected to substantially impact the quality of the air within the local region, construction emissions could be minimized. Best Management Practices would be employed to mitigate for emissions due to construction activities which would include water spraying for dust control.

Open burning regulations are found in Chapter 62-256, F.A.C. The burn permit will stipulate if an air curtain incinerator is required to be used during controlled burns to dispose of ground cover and construction debris from land clearing activities. The FDEP and the Florida Department of Forestry are the primary agencies regulating open burning at KSC, and the burns are permitted by KSC through the Duty Office. If an air curtain incinerator is properly used as prescribed in F.A.C. 62-256, the air emissions would remain negligible and have minimal impacts.

The mitigation measures for the minimal air quality impacts associated with each of the three actions; SLF, HTOL, and VTOL are essentially the same.

During the operational phase, the increase in the number of vehicles that would be associated with the proposed development of the sites would not have a substantial negative impact on air quality at KSC, Brevard County, or the region. Since a decrease in air quality at KSC is not expected, and there are no plans to develop a regional mass transport system, NASA would encourage the use of the Brevard County sponsored commuter van pool systems and other public transportation systems, such as the Space Coast Area Transit. As part of the NASA educational outreach activities, NASA would provide educational information on the value of reducing traffic and improving air quality within KSC. These outreach activities could, for example, be part of the KSC Environmental Awareness Week.

4.6.7 Climate Change

During the construction phase of each of the alternative actions greenhouse gas emissions such as CO_2 would be released by fossil fuel powered machinery and vehicles. These emissions are considered minimal and unavoidable and in many cases represent only a shift in location of machinery and vehicle use and not an addition to total regional emissions.

The principal source of carbon emissions would be associated with loss of vegetation from construction of VTOL Alternative 2. Vegetation, alive or dead, is an important carbon stock, and ecosystems in the U.S. contain approximately 60,418 million metric tons (mil mt)/66,600 mil tons of carbon (Heath and Smith 2004). According to the U.S. Climate Change Science Program (CCSP), the size of the carbon sink in U.S. forests appears to be declining, based on inventory data from 1952 to 2007 (Birdsey et al. 2007). The carbon density (the amount of carbon stored per unit of land area) is highly variable, as it is directly correlated to the amount of biomass (including the organic component of soil) in an ecosystem or plant community. When land is cleared, carbon dioxide is released into the atmosphere through such processes as decomposition and burning. Although exact carbon densities for oak scrub, one of the dominant vegetative communities on VTOL Alternative 2, were not available for incorporation into this EA, the amount of carbon released into the atmosphere due to the development of VTOL site locations was extrapolated based on known values for other similar vegetative communities. Olson et al. (1985) estimated that the amount of carbon in live "semiarid woodland and low forest" ranged between 2 and 10 kg/m2 (0.4 – 2.0 lbs/ft2). If these values are assumed to be comparative to oak scrub, then the amount of carbon in live vegetation on a hectare of this community type would be between 4 and 20 mt (1.8 – 8.9 ton/ac). Based on these values, an average maximum amount of oak scrub-carbon released through the development of VTOL Alternative 2 would be 1,155 mt/ha (462 tons/ac). There would be an additional amount of carbon released by the other lesser vegetation communities found on the site.

Many ecosystems often function as carbon sinks, and in addition to the carbon stored in live vegetation, plant communities can contribute carbon to the soil. Consequently, each parcel of land that is cleared of vegetation results in the loss of a potential carbon sink. Oak scrub on KSC has been shown to have carbon assimilation rates between 1.07 and 4.67 mt/ha (0.48 – 2.08 tons/ac) per year (Powell et al. 2006). For the purposes of this analysis, it was assumed that the carbon uptake ability of this community type is uniform across the study area. In addition, the assumption was made that oak scrub on VTOL Alternative 2 has carbon assimilation rates of 4.67 mt/ha (2.08 tons/ac), the maximum found by Powell et al. (2006). In that case, the removal of oak scrub would cause a loss of uptake ability of approximately 10 mt (15 tons) in direct proportion to the amount of this vegetation type found on VTOL Alternative 2. The loss of vegetative communities other than oak scrub would also result in less land available for carbon sequestration.

Thus, the clearing of land for the development of VTOL Alternative 2 would have two impacts as it relates to climate change: carbon would be released by the removal of vegetation, and a carbon storage area would be lost. However, it is likely that these consequences could be minimized and offset by long-term reductions in fossil fuel use and other mitigation strategies.

Operational phase impacts include the release of greenhouse gases from energy use in support of ground operations and flight operations. Emissions associated with ground operations include employee vehicle emissions, emissions from heavy machinery, emissions from electric power generation, and intentional and unintentional venting or discharges of volatile components of aircraft and rocket fuels. Proposed increases in aircraft flight operations will also contribute largely to local emissions of greenhouse gases.

Of growing concern is the potential climate change impact of the emerging commercial space industry that the Proposed Action supports (Ross et.al. 2010). Rocket launches represent the only human produced source of black carbon "soot" emitted directly in the stratosphere above 20 km (12 mi). These black carbon soot particles can have a greater impact on climate forcing than rocket emissions of CO2. In modeling studies, utilizing the Whole Atmosphere Community Climate Model (WACCM), researchers have shown these soot particles may accumulate into a thin cloud at an altitude of about 40 km (24 mi) which remains relatively localized in latitude and altitude (Ross et.al 2010). The model suggests that if this layer reached high enough concentrations the earth's surface and atmospheric temperatures could be altered. The globally integrated effect of these changes is, as for carbon dioxide, to increase the amount of solar energy absorbed by the earth's atmosphere. Mitigation and or minimization of this potential impact are being addressed in the aerospace industry by advancing propulsion system designs and innovative fuel mixtures that burn more cleanly and reduce soot formation.

The amount of CO2 that would potentially be released by the Proposed Action as a result of associated energy is estimated to be less than 6,000 mt. With continued implementation of energy conservation programs at KSC and other measures that minimize the use of fossil fuels, it is expected that emissions from the additional workforce and increased flight activities will not make a substantial contribution to GHG emissions or climate change.

4.6.7.1 Cumulative Effects on Climate Change

The Proposed Action is designed to encourage the use of the significant national resources at KSC in support of the developing space industry. This new and growing industry will require the use of energy and has the potential to impact the cumulative regional contributions to climate change. However, these new contributions may be minimized and even offset by regional efforts to modernize energy production and energy conservation. The local aging oil fired power plants on the Indian River Lagoon adjacent to KSC have been taken off line and one is being converted to a more efficient natural gas fired system. At KSC, Florida Power and Light has constructed a 100 mega watt solar power generation facility. NASA has recently committed funds to develop a new industrial and office complex that will require green energy efficient LEED certified design for all new construction. Old and inefficient buildings are being taken out of service on both KSC and CCAFS to reduce energy use and costs of operations and maintenance in the post shuttle era reducing greenhouse gas contributions.

Other regional activities contributing to cumulative effects on climate include expansion of Port Canaveral and the cruise and commercial shipping activities. In 2010, the $100 million Seaport Canaveral state-of- the-art fuel tank terminal was opened to supply the state of Florida with jet fuel, gasoline, diesel, and fuel oil. This facility replaces old inefficient infrastructure reducing hydrocarbon vapor loss and spill potential. In November 2011, the new cruise ship Carnival Ecstasy began using Port Canaveral as a home base of operations. In 2011, more than 1.55 million people boarded multiday cruises from Port Canaveral. In 2012, the 4,000 passenger Disney Fantasy will begin using Port Canaveral adjacent to KSC and CCAFS.

From FY 1990 through FY 2005, NASA decreased its energy use by approximately 16%. In addition, future energy use is expected to continue to decline, as NASA HQ's Environmental Management Division assists field centers with the objective of improving energy efficiency and water conservation (NASA 2009b). Furthermore, the carbon output of the Proposed Action would be minimized through the implementation of various energy efficient strategies.

4.6.7.2 Mitigation

In this section, several strategies for reducing fossil fuel emissions and enhancing carbon sequestration are summarized.

Reducing Carbon Emissions through Energy Efficiencies:

Carbon emissions from transportation associated with the HTOL and VTOL site locations are expected to be less than what is emitted as a result of the energy used for facilities. However, there are a variety of ways in which carbon dioxide emissions from vehicles associated with the HTOL and VTOL site locations can be reduced. These fuel conservation measures include carpooling and the use of fuel-efficient/electric vehicles.

In the U.S., energy used in buildings and transportation are the primary sources of carbon dioxide (EPA 2009c), and the amount of carbon dioxide released by the HTOL and

VTOL site locations could be significantly reduced through the implementation of various structural designs, operational controls, and alternative energies. Facilities would be designed, where feasible, to minimize energy consumption. Increasing energy efficiencies associated with cooling and lighting would be a priority, while energy use reduction measures for specific, mission-related operations would be evaluated on a case-by-case basis. The Department of Energy's Federal Energy Management Program (FEMP) provides energy-saving information through its "High Performance Federal Buildings" database (FEMP 2009a). Additional information can be found at FEMP's "Sustainable Design and Operations" website (FEMP 2009b), "Whole Building Design Guide" by the National Institute of Building Sciences (2009), the U.S. Green Building Council (2009), and others. Incorporating alternative energies (e.g. solar power) into the design or modification of facilities would further help reduce its overall consumption of fossil fuels.

Terrestrial Carbon Sequestration:

As previously mentioned, vegetated lands can function as carbon sinks or sequestration areas. Carbon accumulation in forests and soils eventually reaches a saturation point, beyond which additional sequestration is no longer possible. This happens, for example, when trees reach maturity, or when the organic matter in soils builds back up to original levels before losses occurred. Representative carbon saturation periods for key forestry practices range between 90 to over 120 years (EPA 2009d). As an option, NASA might consider setting aside land for the purposes of offsetting the carbon emitted from the development, as outlined in the IPCC's Mitigation Report (Barker et al. 2007). In addition to its value as a carbon storage area, this land could also be selected for its function as mitigation habitat for wildlife species of concern.

4.7 Noise

This section describes the environmental consequences on noise from the Proposed Action as it relates to increased flight operations at the SLF, HTOL of suborbital vehicles, and VTOL of suborbital vehicles at the proposed alternative sites, and the nearby surrounding area.

Most public health impacts of noise were identified in the 1960s (Kryter 1985). In a relatively recent review of noise exposure and public health, Passchier-Vermeer and Passchier (2000) found that, world-wide, noise exposure remains on the increase, both in industrialized nations and in developing world regions. In addition, the review stated, "there is sufficient scientific evidence that noise exposure can induce hearing impairment, hypertension and ischemic heart disease, annoyance, sleep disturbance, and decreased school performance."

Congress enacted the Noise Control Act of 1972 to "…promote an environment for all Americans free from noise that jeopardizes their health and welfare..." (42 USC §4901 et. seq.). In 1978, the Quiet Communities Act (42 USC §4913) directed the Federal Government to develop and disseminate noise control information and educational materials to the public, conduct research into the effects of noise on humans, animals, wildlife, and property, and investigate the economic impact of noise on property and human activities. Both of these Acts resulted in the promulgation of regulations regarding the noise produced by transportation-related equipment such as locomotives, trucks, and construction equipment (40 CFR 201-211). However, Federal regulations governing low noise emission requirements for products exclude any rockets or equipment which are designed for research, experimental, or developmental work to be performed by NASA (40 CFR 203.1). The 1972 Noise Control Act defined acceptable levels of noise under various conditions that would protect public health and welfare. The noise guidelines published by EPA identify a day/night sound level (L_{dn} or DNL) of less than 55 dBA as adequate to protect outdoor activities against interference and annoyance due to noise.

Noise can interrupt activities and result in annoyance to those in close proximity to events such as a launch or flight. Common metrics for quantifying noise include A-weighted decibels (dBA), which simulates the frequency response of the human ear, and DNL, which is a 24-hour average of noise levels with a 10 dB penalty for noise occurring at night (10:00 pm to 7:00 am). The 10 dB adjustment accounts for increased human sensitivity to noise at night. The FAA identifies a significant threshold for noise. Noise-related impacts would be considered significant if analysis shows that the Proposed Action will cause a noise sensitive area to experience an increase in noise of DNL 1.5 dBA or more at or above the DNL 65 dBA noise exposure level when compared to existing conditions (FAA Order 1050.1E, Chg 1).

4.7.1 SLF

The impact from noise associated with SLF flight activity is related to the type of aircraft, number of flights, flight paths, spatial factors, and temporal characteristics. The ambient noise levels are increased from engine noise from startup through departure, and from approach to end of flight. Total flight operations have varied significantly through the years (Table 2-1) ranging from over 14,000 operations in each of the years from 1998 to through 2001 to less than 5,000 operations in all but one of the last 8 years. Projected flight operations (non-HTOL) increase slightly from 2012 (1,147 operations) through

2015 (1,471) (Table 2-2). The mix of aircraft will change but many are represented by past usage or similarity to previously used and existing aircraft. Many flights have flight paths and sonic maneuvers over the Atlantic Ocean, to the immediate east of the SLF. Based on general reduction in flight operation numbers and similarity with aircraft currently operating at the SLF, the overall noise impact is anticipated to be minimal. The flights are not expected to significantly increase the DNL in residential areas to the west (Titusville) and beyond the KSC gates to the south.

4.7.2 HTOL

The incorporation of HTOL activity at the SLF is projected (Table 2-2) to result in 25 operations in 2012 and increase to 2,450 per year by 2015. These operations are in addition to the ones described in paragraph 4.7.1 for the SLF and do not represent a replacement of other projected annual flight operations. When combined with the non-HTOL operations, the total operations by 2015 (3,921) remain lower than each of the preceding few years.

HTOL activity can impact the ambient noise levels from engine noise at launch and landing and sonic booms associated with launch and reentry. Concept vehicles were addressed in the Final Programmatic EIS for Horizontal Launch and Reentry of Reentry Vehicles (FAA, 2005). Horizontal launch of a medium thrust, steep ascent trajectory rocket with a gliding reentry and approach were estimated to generate 128 dBA at 33 feet during initial ignition, with full ignition 20,000 feet above ground. Energy loss at that distance and dissipation of the noise would result in no impact at ground level. Two other concept included jet takeoff from the SLF with either rocket ignition at a higher altitude or ignition of the towed rocket from a carrier jet (e.g. modified Boeing 747) at a higher altitude. The jet powered take off noise ranged from 110 to 120 dBA between 50 to 200 feet. Approach and departure noise contours for a Boeing 747 have been developed (Figs. 3-11 and 3-12) as example sound pressure levels associated with a representative flight path. Take off noise would not be expected to differ significantly from current aircraft noise, and the projected flights (operations) by 2015 are less than experienced use during the shuttle program (Tables 2-1 and 2-2). More noise related data will be needed to refine projected noise impacts as these concept vehicles are put into service.

Supersonic speeds will be reached and sonic booms will be associated with both launch and reentry. Once the reentry vehicle is in the lower atmosphere it would be at subsonic speeds. The overpressure produced by the concept vehicles was estimated to be less than 2 pounds per square foot (psf), well below the 7.25 psf impulse noise threshold criteria, and was not found to produce a significant impact (FAA 2005).

4.7.3 VTOL

The proposed activities for each alternative are the same; these include initial construction, pre-launch operations, launch and landing. The anticipated noise associated with each activity would be the same regardless of site. The impact of that noise on the site, nearby environment, and the spaceport, and nearest communities may differ. The noise impacts of each activity are addressed separately with the similarities and any differences among the three Alternatives identified.

4.7.3.1 Construction and Ground Operations

Noise Impacts to Humans

Ambient noise levels are expected to increase during construction and operational activities as a result of the development of the VTOL site for each alternative. Outdoor noise levels generated by construction vehicles and ground operation activities could occasionally be above the recommended levels for workers, but the effects would be mitigated per OSHA requirements (OSHA 2009). However, in the vicinity of the proposed alternative VTOL sites, noise levels generated from activities on each site are expected to have minimal impacts to people because these areas are sufficiently far from places frequented by personnel. Noise levels would not violate local noise ordinances, as sounds emitted from the sites would be attenuated to levels well below the threshold values once they reach workplaces within KSC and the communities surrounding KSC.

Noise Impacts to Wildlife

While numerous studies on noise pollution and its effects on people have been conducted for decades, research into the effects of noise on wildlife was initiated in the 1970s (Radle 1998). It continues today as an emerging science across a broad field of disciplines (Acoustic Ecology Institute 2009, Finegold et al. 2004). Most researchers agree that noise can affect an animal's physiology and behavior, and if it becomes a chronic stressor, noise can be injurious (Finegold et al. 2004, Radle 1998). However, it is also generally accepted that the effects of noise on most wildlife species are poorly understood (Larkin et al. 1996; Brown 2001). This is, in part, due to the relatively large degree of variation in the responses to noise between species and populations. Noise affects individual species or populations differently, depending on a host of intrinsic and extrinsic factors, including developmental and reproductive stages, sex, habitat types, and others (Busnel and Fletcher 1978). In addition, performing controlled experiments in the field is often difficult, and the majority of research related to the effects of noise on wildlife has been conducted on laboratory animals and the results extrapolated (Brown 2001). The potential effects of noise on wildlife are numerous, and include: acute or chronic physiological damage to the auditory system; increased energy expenditure; physical injury incurred during panicked responses; interference with normal activities, such as feeding; and impaired communication among individuals and groups (Brown 2001). The impacts of these effects might include habitat loss through avoidance, reduced reproductive success, and mortality. In a 2001 overview of research on the effects of noise on wildlife, Brown summarized that "thresholds are unknown, evidence for habituation is limited, long-term effects are generally unknown, and how observed behavioral and physiological response might be manifested ecologically and demographically are poorly understood and seldom addressed" (Brown 2001).

Noise generated during the construction phase at any of the three alternative sites would potentially have discernable, but temporary effects on wildlife occurring nearby. A degree of buffering of noise is afforded to wildlife by vegetation; attenuation rates of up to 10 dBA per 100 m (328 ft) have been demonstrated in vegetated areas (Price et al. 1988). Given that rate, noise would be expected to carry 300 - 400 m (984 - 1,312 ft) away from the construction sites. Beyond this distance, noise levels would be lower than what has been experimentally shown to have deleterious effects on animals (Brown 2001). Most wildlife occurring closer to noise sources would be free to move away or find shelter (e.g., burrows), and by timing construction activities during the non-breeding season of protected species (see Section 4.10.3), the impacts would be expected to be minimal.

Sources of noise (other than launch and landing, discussed in section 4.7.3.2) generated during the operational phase, will consist primarily of traffic and, occasional operation of generators and some heavy equipment. It is expected that the noise levels associated with these activities will have a minimal impact on the surrounding wildlife.

4.7.3.2 Noise Impacts from Launch and Landing

Under Alternative 1, the site is within the developed perimeter of the launch pad and sound levels can exceed 160 dBA at launch in the current use. The addition or change by incorporating a launch facility for a 13,345 N (3,000 lb-f) of thrust suborbital vehicle is anticipated to result in a minimal operational and launch/landing noise impact. Relatively small rockets, gross weight to 2,800 lbs, have produced sound levels of 83 dBA at approximately one-half mile (850m) away and 81 dBA at approximately a mile (1700 m) away (FAA, 2007). Although the frequency of launches from this site would be greater than the current schedule, the noise footprint of suborbital vehicles at launch and landing would decrease from the current use at KSC.

Under Alternative 2, the site, near two launch pads (LC39A and LC41), experiences short-term launch related noise that may exceed 130 dBA at the time of nearby launches. Launch and landing from this site could produce similar sound levels near the source with the noise levels decreasing with distance from the pad. Although the on-site noise levels may be similar to those currently experienced there, the frequency of these launches is anticipated to be greater and result in minor impacts at this site. Given the example launch vehicles, the adjacent launch complexes could experience sound levels less than 85 dBA at launch, which would cause very little impact at those locations.

Under Alternative 3, the site is more distant from current launch facilities and landing activities but is nearer to the main workforce facilities at KSC. The immediately adjacent land is used for training and occasional testing. Launch and landing noise can impact these activities directly or result in affecting their schedules. There would be minor impacts to the site from VTOL operations. The nearest workplace beyond the immediate area is the Environmental Health Facility approximately 2.4 km (1.5 mi) to the west. The KSC Industrial Area to the southwest and processing facilities to the northwest are approximately 3.2 km (2 mi) away. Impacts to these workplace locations would not be substantial.

Larger launch vehicles than considered in this document have been assessed for the determination of their impact on nearby communities. In each case (FAA, 2010 and FAA 2008) the estimated SPLs resulted in a DNL substantially lower than 65 DNL at locations equivalent to Titusville and City of Cape Canaveral. No significant noise impact is anticipated from launch and landing operations.

4.7.4 Cumulative Impacts of Noise

The cumulative impacts of the noise environment associated with the Proposed Action include construction and operations and can vary by specific site location.

4.7.4.1 SLF and HTOL

Air traffic is projected to be less than many historical years of activity at the SLF, thus noise events are lessened overall but would have some increase from the most recent historical lows. Flight paths of new aircraft activity are anticipated to be predominantly to and from the east rather than common activity experienced in the past destination and land based activity. The noise associated with the new aircraft activity is dependent upon many factors and there are few noise data to suggest great differences from the noise experienced from current jet activity and the overall impact is estimated to be minor. Additional studies here or performed on the new technology elsewhere and applied to this area would contribute greatly in defining those impacts. With the similarities in aircraft to past operations, the projected concept of the horizontal rocket launch vehicle, and the overall flight operations projected to not exceed recent history and be far less than many years, the nearest community (Titusville, approx. 7 mi) is not expected to experience a significant adverse noise impact.

4.7.4.2 VTOL

Noise associate with the construction, operations, and launch/landing activities associated with the VTOL are common to each site. Differences in overall impact are associated with the magnitude in changes in land use and proximity to non-direct launch workplaces. Minimal impacts to the current noise environment would be observed under Alternative 1 co-located at a current launch complex. The location of Alternative 2 is near the current launch complexes located just south of LC39A and north of LC41. The environmental noise associated with that site is expected to change but be minor with respect to the cumulative impact. The location of Alternate 3 is within a developed area, yet the current activity does not greatly influence the surrounding, undeveloped and natural noise environment. This location is not near current launch activities and is the closest site to non-direct launch workplaces. This proximity to high population workplaces will increase the overall impact unlike the other two sites. The cumulative impacts of the noise associated with Alternate 3 would be minor. The nearest communities are not expected to experience a significant adverse impact.

4.8 Geology and Soils

Development of the proposed SLF, HTOL, and VTOL at any of the three alternative sites would not significantly (directly or cumulatively) impact the local geology or soils of KSC.

4.8.1 SLF

No additional land clearing is expected for this action and therefore would not result in impacts to the soils or deposits. SPCC plans are in place for daily operations and maintenance as described in the Hazardous Waste section 4.5.

4.8.2 HTOL

No additional land clearing is expected for HTOL of suborbital vehicles at the SLF; thus, there would be no impacts to the soils or deposits. SPPC plans are in place for daily operations and maintenance as described in the Hazardous Waste section 4.5.

4.8.3 VTOL

Potential impacts to the surface and shallow soils for the VTOL action are discussed in this section. The impact focus is on Alternative 2, where the effect of construction on an undeveloped site could potentially impact the geology and soils, whereas the other alternative sites are already developed. Operations are not expected to impact the geology and soils for any of the VTOL sites.

4.8.3.1 Alternative 1

This site has been developed and utilized for over 50 years with large changes to the natural surface soils. No impacts to geology and soils are expected at this site from the VTOL construction or operation.

4.8.3.2 Alternative 2

Land clearing and site preparation activities would cause disturbance in the upper soil layers of this relatively undisturbed site and might result in changes in the subsurface flow of water from rainfall events. This issue is discussed further in Section 4.9. Construction activities related to VTOL at this site would impact the Palm Beach, and Pompano Sands that make up the majority of the soils on the site and are common along the coastal stand of KSC and the Florida Atlantic coast. Overall disturbance would be considered minor to soils and none to geology.

4.8.3.2 Alternative 3

This site has been developed and utilized for over three decades with filling and paving over the natural surface soils. No significant impacts to geology and soils are expected at this site from the VTOL construction or operation.

4.8.4 Cumulative Impacts on Soils

If the Proposed Action was implemented, the cumulative effects on the geology and soils, regardless of which operation and site was chosen, are expected to be minor. The soils that would be disturbed are relatively common locally and regionally.

4.9 Hydrology and Water Quality

Many construction activities can affect surface water quality by increasing run-off potential. Vegetation clearing, soil disturbance, and grading of the landscape can reduce the quality of the surface water. Exposed soils increase turbidity of water running off the land into surface waters or wetland systems, and compacted soils become less permeable, contributing to runoff. The lack of vegetation can cause nutrients, otherwise used by plants, to flow directly into surface water bodies. Infrastructure such as facilities, paved areas, and landscaped areas would alter, to some degree, the hydrological cycle and surface/groundwater quality. In addition, impervious surfaces reduce the area available for rainwater to percolate into the soil. This generally has two direct consequences when it rains: there is less water available for recharging the local surficial aquifer, and the amount of runoff that flows into low-lying area increases. Stormwater management systems would help mitigate many of the impacts associated with impervious surfaces. However, extreme rainfall events (such as those associated with tropical systems) would likely exceed the capacity of most stormwater systems, and some runoff would be transported off-site.

4.9.1 SLF and HTOL

Surface Water

Construction - The modification of facilities for storage of propellants and ordnance for increased activities at the SLF and the addition of HTOL operations would have minimal effects on surface water quality. A surface water management system would be built to treat increased runoff caused by any new impervious area. During actual construction activities, impacts to surface waters from erosion and sedimentation would be controlled by using Best Management Practices (BMPs).

Operation - The operation of the SLF for increased activities and HTOL operations would have minimal impacts on the surface water quality. The new stormwater management systems at the south-field and mid-field sites would be capable of treating all stormwater runoff for new construction evaluated in the SLF EA. The current SLF emergency spill plan for fuels is sufficient to address potential problems associated with expanded uses.

Groundwater

Construction - The groundwater quality at the south-field and mid-field sites is affected by runoff that percolates into the surficial aquifer from roadways and existing facilities. Construction for the Proposed Action could temporarily increase the amounts of sedimentation and pollutants that could migrate into the groundwater system. However, employing BMPs and the existence of the stormwater management system would reduce or eliminate this impact to groundwater quality.

Operation – Expanded uses of the SLF as described in the Proposed Action would have minimal impact to the groundwater quality. Impacts from surface water degradation would be absorbed by the surface water management system that would be constructed, preventing transfer of pollutants into the groundwater.

4.9.2 VTOL

For VTOL site development, a National Pollutant Discharge Elimination System (NPDES) Stormwater Construction Permit would be required by FDEP, and a Stormwater Pollution Prevention Plan (SWPPP) would have to be implemented. A stormwater management system would need to be designed and an ERP obtained from SJRWMD for any activity that meets the requirements listed in Rule 40C, F.A.C. Impacts to groundwater would be minimal to none with required treatment of runoff by a permitted stormwater management system prior to percolation into the ground.

The potential local impacts to hydrology and water quality from the construction and operation of a VTOL site are summarized in Table 4.4.

Table 4-4. General site-specific impacts to hydrology and water quality associated with construction and operations of roads and facilities, if a VTOL site was developed.

Activity	Impact
Vegetation Clearing	Alters local evapotranspiration processes, exposes soil to wind and rain erosion (turbidity), reduces storage, increases runoff potential, alters surficial aquifer recharge rates.
Soil Disturbance	Alters runoff, storage, and infiltration rates. Increases turbidity potential.
Grading	Alters runoff, storage, and infiltration rates. Increases turbidity potential.
Impervious Surfaces	Alters runoff, storage, and infiltration rates. Alters local evapotranspiration processes. Reduces local surficial aquifer recharge.
Landscaping	Alters local evapotranspiration processes, runoff, storage, and infiltration rates. Use of fertilizers and pesticides.
Irrigation	Alters local evapotranspiration processes, runoff, storage, and infiltration rates. Impacts to surficial aquifer.
Stormwater Conveyance	Alters local evapotranspiration processes, runoff, storage, and infiltration rates. Impacts to surficial aquifer
Retention Ponds	Alters local evapotranspiration processes runoff, storage, and infiltration rates. Impacts to surficial aquifer
Vehicle Use	Increased loading of pollutants associated with parking lots, roads, tires, fossil fuel combustion ($NO2$, CO, $CO2$, grease and oil, polycyclic hydrocarbons, metals)
Ground Processing	Accidental releases of a variety of chemicals could occur during the operational phase of VTOL and potentially affect surface and groundwater quality. Some of the chemicals likely used at the VTOL sites are listed in Section 2.2.3.2.

4.9.2.1 VTOL - Alternative 1

Currently, stormwater runoff is treated by existing swales within LC39A. With further development and addition of VTOL operations, management of runoff from new impervious surface might be required and could be accomplished by compensatory treatment outside the LC39A perimeter. There would be minimal impact to surface water at this site.

4.9.2.2 VTOL - Alternative 2

A stormwater management system must be designed and constructed to handle runoff from the proposed VTOL launch complex and additional impervious surface from support and staging areas. An Environmental Resource Permit (ERP) would be obtained from the SJRWMD. A small mosquito control impoundment (T-25-B, USFWS 2006) located to the west of this site could be impacted by water flowing off the site. This impoundment should have the capacity to handle excess water from this site during extreme rainfall events. Development of this site, which would involve land clearing and grading, and the addition of impervious surface and associated stormwater treatment, would have moderate impacts on the hydrology of the area.

4.9.2.3 VTOL - Alternative 3

Additional site development and impervious surface at this site would also require an ERP. There is not an existing permitted stormwater management system at the Fire Training Area. Since the site is previously disturbed, additional impervious surface and associated stormwater treatment would have minimal impact.

4.9.3 Cumulative Impacts on Hydrology and Water Quality

With the implementation of mitigating controls in the form of a stormwater management system, development of the VTOL site would have a moderate cumulative effect on hydrology and water quality. Regionally, vegetated lands are increasingly being covered by impermeable surfaces (buildings, roads, parking lots), which increases runoff and limits replenishment of groundwater. Impervious surfaces have long been implicated in the decline of watershed integrity in urban and urbanizing areas (Brattebo and Booth 2004). Although stormwater management has been implemented for construction efforts since the 1990s, these retention and detention ponds are generally not able to accommodate large amounts of water associated with heavy rainfall, resulting in some excess runoff flowing into canals, wetlands, and frequently, the IRL. However, because extreme rainfall events are rare, these quantities are generally small, and can be absorbed by the lagoon system. In addition, regional efforts to manage stormwater and control point-source pollution have been generally successful, with areas of the IRL having improved water quality and an increase in associated seagrass coverage since the early 1990's (St. Johns River and South Florida Water Management Districts, 2002).

The impact to the Dune (Barrier Island) subaquifer would be minimal if VTOL Alternative 2 was selected for development. The Dune subsystem has previously been impacted by the development of over 40 launch structures, numerous support facilities, parking lots, and roads associated with NASA and DoD activities since the 1950s. In addition, this aquifer subsystem already has relatively high concentrations of chloride, sodium, and other elements associated with sea water or lagoon water intrusion (Edward E. Clark 1987), and a decline in recharge rates will increase the chlorinity of the aquifer. Furthermore, this aquifer will likely become increasingly saline as the result of sea level rise associated with climate change (Bates et al. 2008, analyzed in Section 4.6.3). Impacts to the Dune-Swale subaquifer, underlying VTOL Alternative 2, would be minimal. This surficial aquifer subsystem is much larger than the Dune subsystem, and lies under land that is relatively undeveloped.

The cumulative effects on surface water quality in the IRL or Atlantic Ocean from the development of any of the VTOL sites would be minor. Even with stormwater management plans implemented, heavy rains would cause runoff at each site to end up in mosquito control impoundments located along the edges of the Banana River lagoon. Eventually, some stormwater could end up in the IRL although some of the sediment would have settled out, and the concentration of other pollutants would be somewhat reduced.

4.9.4 Mitigation

Surface water discharges from the selected site would be managed according to requirements of the SJRWMD conditions for issuance of Environmental Resource Permits. The SJRWMD Applicants Handbook for Management and Storage of Surface Waters Chapter 10.3 states: The post-development peak rate of discharge must not exceed the pre-development peak rate of discharge, and the peak discharge requirement shall be met for the 25-year frequency storm. In determining the peak rate of discharge, a 24-hour duration storm is to be used. In addition, the SJRWMD requires wet detention systems to be designed in a manner that meets applicable water quality standards in SJRWMD Rule 40C-42.026(4).

Water quality impacts to the Outstanding Florida Waters associated with the IRL and MINWR would be minimized by the design, operation, and maintenance of a stormwater management system that would meet or exceed all requirements of the SJRWMD.

Construction of VTOL facilities at any of the proposed alternative sites would be conducted following best engineering practices to minimize hydrologic and water quality impacts onsite and to surrounding areas of KSC. Stormwater management plans that included stormwater modeling would be developed with conceptual land use plans to determine site design at all four of the proposed sites. Stormwater analyses would be conducted to determine the amount of land necessary to provide adequate treatment and storage capacity, for both pre- and post-developed conditions. The resulting stormwater storage and treatment areas would help filter much of the suspended solids out of the water percolating into the ground. In addition, the biological and chemical processes that take place in stormwater detention/retention ponds would reduce the amount of contaminants found in runoff, and fewer pollutants would make their way into the water table.

4.10 Biological Resources

In this section, the impacts of the alternative actions at the SLF, HTOL and the three VTOL site alternatives on land cover and habitats, wildlife, and legally protected species are summarized.

4.10.1 Land Cover

4.10.1.2 SLF and HTOL

No impacts to land cover are anticipated at the SLF due to either increasing the number of flights or HTOL, other than those assessed in the previous EA (NASA 2007).

4.10.1.3 VTOL - Alternative 1

Impacts to land cover under Alternative 1 are expected to be none or minimal. Depending on the exact siting of the facility, there may or may not be a conversion of mowed grass (ruderal land cover type) to impervious surface. The maximum acreage of that conversion would be 1.4 ha (3.5 ac).

4.10.1.4 VTOL - Alternative 2

This site is currently undeveloped and would have to be altered through a combination of vegetation clearing, filling of low-lying areas, digging of ditches and stormwater retention ponds, and the addition of various impervious surfaces. The potential development of the dominant land cover type, coastal strand, would constitute a moderate impact for several reasons. This habitat type does not occur in great amounts on KSC, so the loss of acreage is more crucial than for land cover types that are common. In addition, the coastal strand area is of high quality, and supports a number of protected wildlife species (discussed in Section 4.10.2), including Florida scrub-jays. The natural land cover also functions to minimize light pollution on the beach (important for marine turtles), stabilize the dune system, and protect areas further inland from erosion and other sea level rise effects.

If this site was the chosen alternative, the development of scrub and coastal dune that are classified as Florida scrub-jay habitat would require mitigation. KSC has an established protocol for scrub-jay habitat restoration elsewhere on KSC. The rate of compensation would be determined during the Section 7 consultation with the USFWS.

4.10.1.5 VTOL - Alternative 3

The primary land cover type that would potentially be impacted by development under Alternative 3 is ruderal herbaceous (i.e., mowed grass). This would involve the conversion of pervious to impervious surface, and those consequences are discussed in Section 4.9. Development within the scrub or wetlands at the site would constitute loss of habitat that would require mitigation as determined by the regulatory agencies during the permitting process. Impacts would be classified as moderate.

4.10.1.6 Cumulative Impacts on Land Cover

Minimal cumulative land cover impacts would be expected if development were to occur at the SLF (for increased uses or HTOL). The same is true for VTOL Sites 1 and 3. These areas are already highly disturbed and the primary detrimental conversion of land cover types would be from pervious to impervious surface. These impacts would be addressed and mitigation plans designed during the stormwater permitting process.

Development of the VTOL site under Alternative 2 would contribute to moderate cumulative impacts caused by the loss and fragmentation of natural plant communities. Fragmentation often leads to encroachment on the native system by non-native and invasive species, changes in microclimate, increased difficulties managing habitats (particularly with prescribed fire), greater incidences of wildlife mortality on roads, and other factors that result in further degradation (Lindenmayer and Fischer 2006). Because Alternative 2 is in close proximity to the beach, loss of the vegetation would potentially allow more artificial light to be seen by nesting and hatchling marine turtles, causing increased disorientation (further discussed in Section 4.10.3.4). Loss of vegetation would also make the dune more susceptible to erosion brought about by storm surges and long-term sea level rise. Eventually, regrowth of native vegetation would reestablish light protection and stabilize the dune.

4.10.1.7 Mitigation Measures

The loss of vegetation along the dune would require mitigation for increased possibility of marine turtle disorientation from lights shining from the facility. KSC already has a facility lighting plan in place (NASA 2002) that would help reduce impacts. In addition, a screen of native vegetation could either be left in place at the dune/beach interface during development or could be planted post-development to shield lights from shining onto the beach. In the meantime, an artificial light barrier could be erected to shield the beach.

4.10.2 Impacts to Wildlife

Potential noise impacts to wildlife are discussed in Section 4.7.3.

4.10.2.1 SLF and HTOL

The primary impact expected to wildlife from increasing the number of flights by SLF clients and from developing HTOL would be greater potential for bird/aircraft collisions. This impact would likely be minor. The SLF has a Wildlife Hazard Management Plan (WHMP) that addresses bird strike issues and management methods (Bryan 2009). Key components of this plan to minimize the opportunity for bird strikes include runway inspections for birds and other wildlife (daily and before vulnerable missions), habitat management to discourage use of the area by wildlife, wildlife control measures (a variety of scare tactics), and a communications protocol between aircraft and air traffic control personnel in the event of collision danger.

4.10.2.2 VTOL - Alternative 1

Because the 65 ha (161 ac) area within the perimeter fence of LC39A is classified as impervious surface, existing facilities, or mowed grass, there would be minimal impact to wildlife from loss of habitat. Several bird species, including wading birds such as white ibis and cattle egret, feed in the grass. During the fall migration period, kestrels frequent the pad area to prey on smaller birds, rodents, and insects. There are 15 to 20 gopher tortoise burrows (estimated 7 to 10 tortoises) within the perimeter fence; most are located in the grass on the sides of elevated pads. Any tortoises that would be displaced by construction of the VTOL facility would be relocated to an appropriate area within the LC39A perimeter. Even if the entire 2 ha (5 ac) development impact area was taken from the ruderal land cover type, it would constitute just 3% of the total ruderal habitat available within the LC39A perimeter, and < 1% of the total ruderal habitat for KSC.

4.10.2.3 VTOL - Alternative 2

This area is mostly undisturbed, but loss of the natural habitat would constitute a minimal impact to non-listed wildlife. Most of the species expected to be found at this site are common on KSC, are not protected at the state or federal levels, and are not exclusively dependent on the habitats that are found at this site (Breininger et al. 1994). Impacts to protected species are discussed in Section 4.10.3. The area that would be developed is extremely small as compared to the amount of wildlife habitat that is available on KSC and none of the specific species' populations would be significantly harmed by the loss of a few individuals.

4.10.2.4 VTOL - Alternative 3

The situation under Alternative 3 is similar to Alternative 1 in that the majority of the area is highly disturbed and the primary land cover is mowed grass (ruderal herbaceous). There are gopher tortoise burrows in the berm in the northeast corner of the general area. If this precise location was chosen for the VTOL facility development, those tortoises would be relocated to the scrub habitat that is adjacent to the site. If the oak scrub, hardwood hammock, or freshwater wetlands habitat were developed, impacts to wildlife would be expected to be minimal because the areas are so small.

4.10.2.5 Potential Impacts to Birds from Lightning Protection System Towers

Regardless of which VTOL alternative (other than No Action) was chosen, the facility would be required to have lightning protection in the form of three 23 m (75 ft) tall towers. The towers would be free standing without guy wires, and because they would be less than 61 m (200 ft) tall, no FAA lighting would be required.

Towers have been shown to pose a collision risk to migrating birds that typically travel in large flocks at night (Weir 1973, USFWS 1979, American Bird Conservancy 2000). KSC is located along the Atlantic Flyway migration route and the coastline is used by birds as a guide as they travel between nesting and overwintering locations.

The only published study of bird collisions on KSC was conducted from 1970-1981 at the VAB (Taylor and Kershner 1986). More than 5,000 birds, representing 62 species, were collected around the VAB during inclement weather conditions (Taylor and Kershner 1986). Several kills occurred during spring migration (March – May), while the majority occurred during fall migration (September – October). The VAB is 160 m (525 ft) tall, 218 m (716 ft) long, and 158 m (518 ft) wide. The structure and surrounding area were typically well lit, potentially attracting migrating birds off their course and to the area.

Lights are known to confuse migrating birds, particularly when visibility is poor, which increases the likelihood of bird strikes (Manville 2005a).

In 2008-2009, a lightning protection system (LPS) was constructed at LC39B as part of the Constellation Program (NASA 2007). The system consists of three 184 m (605 ft) tall towers with a network of nine grounding cables extending between the towers and the ground. The towers are 24 m (80 ft.) apart, forming an equilateral triangle around the launch pad surface. Each tower is constructed of steel to a height of 161 m (528ft). The remaining 23 m (77 ft) is a fiberglass cone needed to insulate the steel tower from direct lightning strikes. Because of the height of the towers, FAA lighting is required. Three sets of flashing lights are on each tower, and the fiberglass cone is illuminated. Primary impacts to wildlife expected from the towers are disorientation of nesting and hatchling sea turtles from increased light pollution on the adjacent beach (discussed at length in NASA 2007), and increased possibility of bird strikes. As mitigation for the construction and operation of the lightning protection system, surveys for dead birds are conducted twice per year (five days per week for eight weeks during fall migration and 10 weeks during spring migration, per the USFWS Division of Migratory Bird Management). Results from the fall 2010 survey are shown in Table 4-5 (Weiss and Bolt 2010). Spring 2011 surveys are currently being conducted and in their eighth week (out of ten) with 11 birds found of eight different species.

Table 4-5. Species and numbers of birds observed during fall 2010 bird strike surveys at LC39B.

Species	Number of birds
Pied Bill Grebe	1
Snowy Egret	2
Cattle Egret	1
Unidentified Egret	3
White Ibis	1
Black Vulture	2

Green Winged Teal	1
Clapper Rail	1
Sora	1
Common Moorhen	6
Sanderling	1
Rock Dove	1
Yellow Billed Cuckoo	6
Blue-gray Gnatcatcher	1
Magnolia Warbler	2
Palm warbler	1
American Redstart	1
Boat-tailed Grackle	2
Total Number of Birds	34
Total Species Observed	**18**

Impacts from the LPS for the VTOL facility are expected to be comparable between the three site alternatives. Most bird kills occur at towers that are 305 m (1,000 ft) or greater; incidences of strikes are substantially increased when the towers have wires or are illuminated with non-flashing red lights (Manville 2000; Longcore, T., et al. 2008; Gehring J., et al. 2009). The VTOL towers will be no taller than 23 m (75 ft) which is one-eighth the height of the LC39B LPS towers, will not have guy wires or grounding wires, and will not need FAA-required lighting. Based on results from the LC39B bird strike surveys, we would anticipate fewer bird mortalities from the VTOL LPS and the impacts would be classified as minimal.

4.10.2.6 Cumulative Impacts to Wildlife

Cumulative impacts at the SLF from increased number of operations and HTOL would potentially come from bird/aircraft collisions over the long term. In the recent past, bird strikes at the SLF averaged four per year. The SLF has not had a bird strike incident since 2009, a year in which there were five strikes. Contributing factors to fewer strikes are slightly reduced flight activity, particularly reduced numbers of shuttle training approaches (higher speed, lower altitude passes), as crews and shuttle mission numbers have diminished. The WHMP (Bryan 2009), which includes installation of a propane gas cannon bird scare system, bird reporting requirements being disseminated to all arrivals and departures, greatly enhanced visibility of the entire surface area from the new air traffic control tower, and diligent attention to the bird threat condition since 2007, all contribute to generally safer conditions in the runway environment (T. Friers, R. Feile pers. comm. June 2011).

SLF air traffic totals were 5,521 in 2009; 4,753 in 2010; and 3634 in 2011. Significant flight reductions were expected immediately post-shuttle, and even with expanded uses at the SLF, it is anticipated that the number of missions will not reach or exceed what has been experienced in the past, and that the number of strikes should subsequently trend downward (T. Friers, R. Feile pers. comm. May 2012). Therefore, cumulative impacts on wildlife from increased operations at the SLF, including HTOL, are expected to be minimal.

Cumulative impacts for any of the VTOL site alternatives are anticipated to be minimal. There is a large undeveloped area of KSC that is being managed as conservation land; the habitat types that would be developed are a very small percentage of the total acreage of those habitats available. Non-listed wildlife species populations have abundant access to those areas, and the loss of habitat or individual animals to development would not constitute a significant threat to populations.

4.10.3 Threatened and Endangered Species

This section discusses the impacts to federally listed species resulting from the development of SLF, HTOL and VTOL and each of the alternative sites (Table 4-6).

Potential noise impacts to threatened and endangered species are mentioned briefly in some sections below, but are discussed in detail in Section 4.7.3.

4.10.3.1 SLF

Impacts to protected species from increasing the number of flights at the SLF fall into two categories: 1) collisions with aircraft, discussed in Section 4.10.2; and 2) responses to noise, discussed in Section 4.7.2. None of the federally protected bird species listed in Table 3-8 occur regularly in great numbers (Larson et al. 1997) or have been documented as being involved in strike incidents at the SLF. The bald eagle poses a potential strike risk as eagles fly great distances across the landscape, and each year KSC has 12-15 active nests between October and March. Two active nesting territories occur within 1.5 km (0.9 mi) of the SLF runway. However, eagles are rarely observed at the runway. Adherence to the WHMP should reduce potential impacts to minimal.

Data on the acute or long-term effects of noise on wildlife species in natural habitats are scarce. However, impacts to protected species from noise associated with increasing the number of routine aircraft operations are expected to be minimal. The nearest wading bird colony is 2.5 km (1.6 mi) from the SLF, and the closest eagles' nest is located 1.3 km (0.8 mi) away (Figure 3-1 and 3-2 respectively). No adverse effects on wildlife from current operations at the SLF have been documented.

4.10.3.2 HTOL

The primary impacts to protected wildlife expected from HTOL are related to noise. Noise characteristics of rocket engine takeoffs and landings are discussed in Section 4.7.2. Ground noise levels could reach 128 dBA within 10 m (33 ft) of the rocket on launch, and up to 120 dBA within 61 m (200 ft). Noise levels of powered landings would be less than or equal to those on takeoff. Research on the effects of noise on wildlife at KSC during the launch of the Space Shuttle has shown an initial startle response in birds and other wildlife which then quickly return to their normal activities, and there were no documented short-term adverse effects. More noise related data will be needed to refine projected noise impacts as the currently conceptual HTOL vehicles are put into service. Given the existing state of knowledge, the impacts are classified as minor.

4.10.3.3 VTOL - Alternative 1

This site lies within the perimeter of LC39A, and there are no habitats there that support any federally protected species. Occasionally, alligators wander from the adjacent estuary through the culvert system into the deluge water pit, but these animals are removed as soon as they are discovered and returned to the wild.

During VTOL operations, noise levels from launches are not expected to approach the levels of noise that have been experienced from launch operations in the past. However, the launches are scheduled to occur much more frequently (up to 300 per year). The types of rockets being planned for use by VTOL produce noise levels of 83 dBA at approximately 0.8 km (0.5 mi) away and 81 dBA approximately 1.6 km (1.0 mi) away (FAA 2007). There are not data to determine the long-term impacts of such noise levels on wildlife but the distance from the launch site and habitat outside the complex perimeter are expected to reduce the noise impacts to minor.

No light pollution impacts are expected to occur to marine turtles if Alternative 1 is selected. The location of the VTOL will be at least ½ km (0.3 mi) from the beach, there will be no LPS tower lights, all facility lighting will comply with the KSC Lighting Plan, and no launches are planned to occur at night.

4.10.3.4 VTOL - Alternative 2

This site is in undeveloped habitat that potentially supports five federally protected species: loggerhead and green sea turtles, eastern indigo snakes, Florida scrub-jays, and southeastern beach mice.

Some noise impacts would be expected from launches under Alternative 2 (noise characteristics are detailed in section 4.10.3.3 above). Wildlife occurring in the area surrounding the launch pad would be somewhat protected from excessive noise levels by vegetation. In addition, VTOL operations are slated to happen during daylight hours only. Beach mice and indigo snakes spend much of the daytime within burrows underground. Adult sea turtles would not be on the beach during the day, and nest hatching occurs at night. There could be potential impacts to Florida scrub-jays, but that has not been observed on KSC or CCAFS where many families occur and successfully reproduce immediately adjacent to active launch pads. Impacts from noise are expected to be minimal.

Sea Turtles

Loggerhead sea turtle nesting densities in the section of beach adjacent to this proposed site are just under 100 nests/km (62 nests/mi). Nesting females or hatchlings on the nearby beach could be negatively influenced by facility lighting at the VTOL, but not from launches as none are planned for nighttime hours. Adherence to the KSC Light Management Plan should reduce the moderate impacts to nesting and hatching loggerheads and green sea turtles to minor. If Alternative 2 was selected, specific mitigation and design requirements would be addressed during the facility design stage.

Indigo Snakes

The habitat appears to be suitable and could be incorporated within one or two (one male or one male plus one female) snakes' home ranges. If the entire area was lost for use by one or two indigo snakes, the impact to the KSC population would be minimal. However, if Alternative 2 was selected, a Section 7 consultation with the USFWS would be required.

Florida Scrub-jays

Coastal strand and scrub habitats make up 33% of this proposed site; both of these are potential scrub-jay habitat. The scrub habitat has not been actively managed, and as a consequence, only parts of two jay territories occur in the area. Impacts to the KSC scrub-jay population would be expected to be moderate. If Alternative 2 was selected, a Section 7 consultation with the USFWS would be required, and mitigation details would be established during that process.

Southeastern Beach Mice

This site is currently a densely vegetated coastal scrub community with limited openings and not considered optimal southeastern beach mouse habitat. However, it has potential for improvement and because it is located in close proximity to very favorable dune habitat, it may function as a population overflow area and as a refuge during tropical storms and hurricanes. Sampling on this site has resulted in the regular capture of beach mice but in relatively low numbers, with a 6% capture rate (CPUE 0.06, compared to the KSC transect average CPUE of 0.096, Provancha et al. 2005). Impacts from development at this site would be classified as moderate, and a Section 7 consultation with the USFWS would be required.

4.10.3.4.1 Mitigation

If Alternative 2 was selected, the development of scrub and coastal dune classified as Florida scrub-jay habitat would likely require mitigation. KSC has an established protocol for scrub-jay habitat restoration elsewhere on KSC. The rate of compensation would be determined during the Section 7 consultation with the USFWS. Restoration would be expected to improve habitat for indigo snakes, and possibly beach mice as well as scrub-jays.

The loss of vegetation along the dune would require mitigation for increased possibility of marine turtle disorientation from lights shining from the facility. KSC already has a facility lighting plan in place (NASA 2002) that would help reduce impacts. In addition, a screen of native vegetation could either be left in place at the dune/beach interface during development or could be planted post-development to shield lights from shining onto the beach.

4.10.3.5 VTOL - Alternative 3

A small amount of oak scrub, < 0.1 ha (0.1 ac) is within the potential impact area of the VTOL. Federally listed species that might occur in this scrub are the eastern indigo snake, Florida scrub-jay, and southeastern beach mouse. However, loss of this small amount of habitat would not jeopardize any of these species' populations on KSC, and the loss of scrub habitat would be mitigated through restoration of degraded scrub elsewhere on KSC; impacts would be classified as moderate. The area is adjacent to a large tract of high quality Florida scrub-jay habitat, and impacts from rocket launch and landing noise might be expected for the jays living there. The types of rockets planned for VTOL produce noise levels of 83 dBA at approximately 0.8 km (0.5 mi) away and 81 dBA approximately 1.6 km (1.0 mi) away (FAA 2007). There are no data to determine the long-term impacts of such noise levels on wildlife, but the distance between the launch site and habitat, and the attenuating effects of the vegetation are expected to reduce the noise impacts to minor.

4.10.3.6 Cumulative Impacts

Cumulative impacts to listed species from increased missions at the SLF are expected to be minimal from either bird strikes (see Section 4.10.2.6 for a discussion) or noise (see Section 4.7.3). The number of missions in the near term is expected to decrease dramatically at the close of the shuttle program, but if those numbers began to increase due to alternative uses (including HTOL), it would be many years, if ever, that they would reach levels that have been previously experienced at the SLF. The WHMP (Bryan 2009) has instituted several procedures and techniques that further reduce the probability of substantial numbers of listed species occurring at the SLF; therefore, long-term impacts are expected to be minor and no threatened or endangered species populations are expected to be jeopardized.

Cumulative impacts under Alternatives 1 and 3 are expected to be minimal. The numbers of listed species that occur within those areas are very low, and loss of the habitats at those sites would not contribute to the decline of any protected species populations. Cumulative impacts under Alternative 2 would be moderate, mostly due the loss of scrub habitat that would no longer be available to Florida scrub-jays. However, the acreage of scrub lost would be small and could be mitigated through restoration of degraded scrub habitat elsewhere on KSC.

Table 4-6. State and federal listed species with potential for impacts from SLF increased flights, HTOL, and VTOL development.

SCIENTIFIC NAME	COMMON NAME	STATUS OF PROTECTION		VTOL SITE 1	VTOL SITE 2	VTOL SITE 3	SLF/ HTOL
Amphibians and Reptiles		STATE	FEDERAL				
Alligator mississippiensis	American alligator	SSC	T(S/A)	X			X
Caretta caretta	Loggerhead	T	T		X		
Chelonia mydas	Atlantic green turtle	E	E		X		
Dermochelys coriacea	Leatherback sea turtle	E	E		X		
Gopherus polyphemus	Gopher tortoise	T			X		
Drymarchon corais couperi	Eastern indigo snake	T	T		X		
Birds							
Egretta thula	Snowy egret	SSC		X			X
Egretta caerulea	Little blue heron	SSC		X			X
Egretta tricolor	Tricolored heron	SSC		X			X
Eudocimus albus	White ibis	SSC		X			X
Ajaia ajaja	Roseate spoonbill	SSC					X

SCIENTIFIC NAME	COMMON NAME	STATUS OF PROTECTION		VTOL SITE 1	VTOL SITE 2	VTOL SITE 3	SLF/ HTOL
Amphibians and Reptiles		STATE	FEDERAL				
Falco peregrinus tundrius	Arctic peregrine falcon	E			X		
Falco sparverius paulus	Southeastern American kestrel	T		X	X		
Sterna antillarum	Least tern	T					X
Rynchops niger	Black skimmer	SSC					X
Aphelocoma coerulescens	Florida scrub-jay	T	T		X		
Mammals							
Peromyscus polionotus niveiventris	Southeastern beach mouse	T	T		X		

4.11 Socioeconomics and Impacts to Children's Environmental Health and Safety

This section identifies potential impacts on the population, housing, social conditions, employment, and regional economy that might result from construction and operation of the SLF, HTOL and VTOL. As similarly described in the SLF expansion EA (NASA 2007), each of these Actions would draw from the local workforce for the VTOL construction efforts. However, since 2007, KSC has experienced a large reduction in workforce and continued in a downward direction throughout 2011 without the infusion of new programs and projects. Construction for VTOL would be a relatively small effort but nonetheless, it would be a beneficial impact to the local economy. In addition, the operations associated with the Proposed Action would draw in a range of 10 to 90 workers, for a beneficial induced impact to the local economy. No appreciable difference exists between the VTOL alternative sites because they are all located within the KSC security zones.

Impact to Children's Environmental Health and Safety

Impacts to children's environmental health and safety are evaluated in terms of the potential for high and adverse environmental consequences resulting from the project to disproportionately affect children. The location where children are concentrated in the vicinity of the project areas is at the KSC Child Development Center, which is approximately 4 to 8 miles from the proposed site locations. As a result of the schools' vicinity to the proposed launch pad location, children attending these schools may be exposed to increased noise levels associated with the Proposed Action. As shown in tables 4-1 to 4-3, minor noise impacts are expected from the Proposed Action. Therefore, because noise emissions would be less than significant, the Proposed Action would not pose disproportionate high or adverse impacts to children's environmental health or safety.

4.11.1 No Action Alternative

Under the No Action Alternative, additional activities at the SLF, including HTOL operations would not occur. VTOL would not be developed. VTOL operations, launch pads, associated facilities, and supporting infrastructure would not be built. Therefore, additional workers for construction of VTOL facilities and support of SLF, HTOL, and VTOL activities would not be hired, resulting in no increases to local or regional economic activity. Local suppliers, and markets (including indirect) would not benefit from the No Action Alternative. In fact some markets will be negatively impacted, as they are already in decline, some of which are at a critical point in determining survivorship based on outcome of new economic opportunities from KSC.

Under the No Action Alternative, the potential beneficial impacts to socioeconomics as a result of the Proposed Action would not occur. The rate of growth could decline further from its current direction, at least in the foreseeable future. The social conditions (crime rates, education, etc.) might be impacted if the Proposed Action was not implemented.

4.12 Cultural Resources

Consultation with the Florida State Historic Preservation Office (SHPO) regarding the Proposed Action has taken place in accordance with the KSC Programmatic Agreement (KSC-4185). However, once the preferred site is selected, the Florida SHPO requests notification of the site details, along with the opportunity for additional comment at that time. A copy of the Florida State Clearinghouse letter and SHPO letter can be found in Appendix A.

4.12.1 SLF

As described in the SLF Expansion EA (NASA 2007), the minor construction efforts that might be needed for increasing operations at the SLF would not substantially impact any of the existing facilities at the SLF Historic District. Nor would this increased activity, following the phase out of the shuttle program, impact the basic look and aesthetics of the SLF. It would enhance the basic functionality that already exists.

The increased activities will be similar in nature to that of any airfield and those already described (NASA 2007). The increased activities at the SLF would not directly impact the integrity of the SLF Historic District or the individual properties within it, namely the Runway, the LACB, or the MDD.

4.12.2 HTOL

As per the description above for the SLF increased activities, the HTOL of suborbital rocket powered vehicles from the SLF would not negatively impact the existing facilities within the SLF Historic District.

4.12.3 VTOL

Discussions with the KSC Historic Preservation Officer and review of documentation completed for KSC indicate that development of the VTOL site at any of the three alternative locations should have no significant effect on any known archaeological sites or historic or contributing resources. HABS HAER documentation for LC 39A and the SLF were approved by the Florida State Historic Preservation Office in 2011. The NPS approval for submittal to the Library of Congress for the LC39a Historic District occurred in December 2011.

4.12.3.1 Alternative 1

The LC39A complex underwent HABS HAER Level II documentation as part of the transition and retirement process for the Shuttle Program with final reporting completed in August of 2010. Depending on the precise footprint of the site within the LC39A boundary, it is possible that the 2 acres of structural changes required for VTOL would be considered a moderate impact to the site. Such action would be enabled once the preferred site is selected and consultation and coordination with the Florida SHPO has taken place.

4.12.3.2 Alternative 2

This site was evaluated in 2008 during development of an EA for the CVLC concept program. No cultural or historical resources were found during site surveys and records searches (ACI 2008). Therefore, should Alternative 2 be selected, no cultural impacts would occur.

4.12.3.3 Alternative 3

No impacts to archeological resources are expected under Alternative 3. There is one small area near the FTA footprint that has been classified as having potential archaeological relevance. This is a very small portion of the northeastern corner of the site. The final VTOL development would avoid this section of the property thereby eliminating potential impacts to archaeological resources.

4.13 Light Emissions and Visual Impacts

Because the sites at KSC considered for the Proposed Action are located in industrialized areas, the visual sensitivity is low. Though the Prosed Action would require some construction and modifications, these additions would be consistent with existing infrastructure and would not represent a visually significant impact to the area. Construction under the Proposed Action would not substantially degrade the existing visual character or quality of the site and its surroundings. Therefore, the Proposed Action is not expected to have significant impacts related to light emissions and visual resources.

5.0 ENVIRONMENTAL JUSTICE

On February 11, 1994, the President of the U.S. signed Executive Order (EO) 12898, entitled, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." The general purposes of the EO are to: 1) focus the attention of Federal Agencies on the human health and environmental conditions in minority and low-income communities with the goal of achieving environmental justice; 2) foster non-discrimination in Federal programs that substantially affect human health or the environment; and 3) give minority and low income communities greater opportunities for public participation in, and access to, public information on matters relating to human health and the environment. The EO directs federal agencies, including NASA, to develop environmental justice strategies. Further, EO 12898 requires NASA, to the greatest extent practicable and permitted by law, to make the achievement of environmental justice part of NASA's mission. Disproportionately high adverse human health or environmental effects on minority or low-income populations must be identified and addressed. In response, NASA established an agency-wide strategy, which, in addition to the requirements set forth in the EO, seeks to: 1) minimize administrative burdens; 2) focus on public outreach and involvement; 3) encourage implementation plans tailored to the specific situation at each Space Center; 4) make each Center responsible for developing its own Environmental Justice Plan; and, 5) consider both normal operations and accidents. KSC has developed a plan to comply with the EO and NASA's agency-wide strategy.

In 2010, 20.8% of Brevard County's 543,376 populations was minority, according to the US Census Bureau. Black persons accounted for 10.1% of this minority population and those of Hispanic or Latino origin constituted 8.1% of the population. Florida's state average for the minority population in this same year was considerably higher, at 41.4%, due to the relatively larger concentration of Hispanics and Latinos in the central and southern Florida study areas.

In 2009, 11.6% of Brevard County's population reported incomes below the poverty threshold, with 17.5% of persons below the age of 18 living under the poverty level. Both figures are lower than Florida's 2009 state average of 15% and 21.5%, respectively. Between 1999 and 2009, Brevard County's population under the poverty threshold has increased almost 2%.

The Proposed Action would be expected to produce beneficial impacts related to Environmental Justice. The proposed activities would spawn community outreach programs relating to education in space exploration, thus improving opportunities in the minority population. The proposed activities have moderate economic benefits, including increased demand in the workforce, higher revenues and increased per capita income. While the population under the poverty threshold may not directly benefit through employment and income, it may indirectly benefit as regions economic heath is improved through the proposed activity.

The proposed activities would be implemented within the boundaries of KSC. The closest residential areas are 13 km (9.5 mi.) south on Merritt Island, and 12 km (7.6 mi.) west in Titusville; the distances of these areas from the activity sites preclude any direct impacts from construction. Operational impacts, specifically noise, are expected to be negligible in the residential areas based on data models and surveys. Economic impacts are not expected to adversely affect any particular group. Personnel could be drawn from the local workforce and provide economic benefits to the local area.

6.0 PREPARERS, CONTRIBUTORS, AND CONTACTS

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Appendix A

1. Table 1. Herpetological Species Documented as Occurring on Kennedy Space Center (Seigel et al. 2002; R. Seigel pers. comm.). The list does not include marine turtles.
2. Florida State Clearinghouse Letter
3. Florida SHPO Letter

Table 1. Herpetological Species Documented as Occurring on Kennedy Space Center (Seigel et al. 2002; R. Seigel pers. comm.). (The list does not include marine turtles)

Alligator mississippiensis (American alligator)
Apalone ferox (Florida softshell turtle)
Chelydra serpentina (snapping turtle)
Deirochelys reticularia (chicken turtle)
Gopherus polyphemus (gopher tortoise)
Kinosternon baurii (striped mud turtle)
Kinosternon subrubrum (common mud turtle)
Malaclemys terrapin (diamondback terrapin)
Pseudemys nelsoni (Florida redbelly turtle)
Pseudemys peninsularis (Florida cooter)
Sternotherus odoratus (common musk turtle)
Terrapene carolina (box turtle)
Anolis carolinensis (green anole)
Anolis sagrei (brown anole)
Cnemidophorus sexlineatus (racerunner)
Eumeces egregius (mole skink)
Eumeces inexpectatus (southeastern five-lined skink)
Hemidactylus garnotii (Indo-Pacific gecko)
Hemidactylus turcicus (Mediterranean gecko)

Table 1. (Continued) Herpetological Species

Ophisaurus attenuatus (slender glass lizard)
Ophisaurus compressus (island glass lizard)
Ophisaurus ventralis (eastern glass lizard)
Scincella lateralis (ground skink)
Agkistrodon piscivorus (cottonmouth)
Cemophora coccinea (scarlet snake)
Coluber constrictor (racer)
Crotalus adamanteus (diamondback rattlesnake)
Diadophis punctatus (ring-necked snake)
Drymarchon corais (indigo snake)
Elaphe guttata (corn snake)
Elaphe obsoleta (yellow rat snake)
Farancia abacura (mud snake)
Heterodon platirhinos (eastern hog-nosed snake)
Lampropeltis getula (common kingsnake)
Lampropeltis triangulum (scarlet kingsnake)

Mr. Donald J. Dankert, Biological Scientist
NASA Environmental Management Branch
Mail Code: TA-A4C
John F. Kennedy Space Center
Kennedy Space Center, FL 32899

RE: National Aeronautics and Space Administration – Draft Final Environmental Assessment for Suborbital Processing, Launch, and Recovery Operations at John F. Kennedy Space Center – Brevard County, Florida.
SAI # FL201206286285C

Dear Don:

Florida State Clearinghouse staff has reviewed the referenced Draft Final Environmental Assessment (EA) under the following authorities: Presidential Executive Order 12372; § 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.

As noted in the draft final EA, the proposed Vertical Take-off and Landing site construction activities will likely require the issuance of an environmental resource permit (ERP) from the St. Johns River Water Management District (SJRWMD) for onsite stormwater management. Further inquiries concerning the state's ERP permitting requirements should be directed to Ms. Susan Moor, Supervising Regulatory Scientist, in the SJRWMD's Palm Bay Service Center at (321) 676-6626 or smoor@sjrwmd.com. In addition, an NPDES permit may be required from the Department's NPDES Stormwater Program in Tallahassee – please contact Department staff at (850) 245-7522 for additional information.

Based on the information contained in the draft final EA and minimal project impacts, the state has determined that, at this stage, the proposed federal activities are consistent with the Florida Coastal Management Program (FCMP). The state's continued concurrence will be based on the activities' compliance with FCMP authorities, including federal and state monitoring of the activities to ensure their continued conformance, and the adequate resolution of any issues identified during subsequent regulatory reviews. The state's final concurrence of the project's consistency with the FCMP will be determined during the environmental permitting process, in accordance with Section 373.428, *Florida Statutes*.

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
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Please take a few minutes to share your comments on the service you received from the department by clicking on this link DEP Customer Survey.

FLORIDA DEPARTMENT *of* STATE

RICK SCOTT
Governor

KEN DETZNER
Secretary of State

Mr. Donald Dankert
Environmental Planning
Environmental Management Branch
Mail Code TA-A4C
Kennedy Space Center, FL 32899

July 31, 2012

RE: DHR Project File Number: 2012-3494
Draft Final Environmental Assessment for Suborbital Processing Launch and Recovery Operations
Kennedy Space Center, Brevard County

Dear Mr. Dankert:

This office reviewed the referenced project for possible impact to historic properties listed, or eligible for listing, on the *National Register of Historic Places*. The review was conducted in accordance with Section 106 of the *National Historic Preservation Act of 1966*, as amended, *36 CFR Part 800: Protection of Historic Properties* and the *National Environmental Policy Act of 1969*, as amended.

We have reviewed the sections of the referenced document that address cultural resources. We do not anticipate the undertaking adversely affecting historic properties. However, this office requests that when the preferred alternative is selected our office is notified and allowed to comment.

We look forward to working with you on a successful project. If you have any questions concerning our comments, please contact Scott Edwards, Historic Preservationist, by electronic mail *scott.edwards@dos.myflorida.com*, or at 850.245.6333 or 800.847.7278.

Sincerely,

Laura A. Kammerer

Laura A. Kammerer
Deputy State Historic Preservation Officer
For Review and Compliance

PC: Barbara A. Naylor, NASA