National Aeronautics and Space Administration

Environmental Assessment (DRAFT)

For Launch of NASA Routine Payloads

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DRAFT ENVIRONMENTAL ASSESSMENT FOR LAUNCH OF NASA ROUTINE PAYLOADS ON EXPENDABLE LAUNCH VEHICLES

TITLE PAGE

Lead Agency: National Aeronautics and Space Administration (NASA)

Cooperating Agencies: Federal Aviation Administration, Air Force Space and Missile System Center, National Oceanic and Atmospheric Administration, and U.S. Army Space and Missile Defense Command.

Proposed Action: NASA routine spacecraft as payloads on expendable launch vehicles from Cape Canaveral Air Force Station, Florida; Vandenberg Air Force Base, California; Ronald Reagan Ballistic Missile Defense Test Site at the U.S. Army Kwajalein Atoll in the Republic of the Marshall Islands; NASA Wallops Flight Facility, Virginia; and Kodiak Launch Complex, Alaska.

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Abstract: This Draft Environmental Assessment updates the *Final Environmental Assessment for Launch of NASA Routine Payloads on Expendable Launch Vehicles from Cape Canaveral Air Force Station, Florida and Vandenberg Air Force Base, California* (June 2002) and addresses NASA's proposed action to launch a variety of spacecraft missions. The spacecraft used in these missions are considered routine payloads; the same threshold quantities and characteristics describe them all, and they would present no new or substantial environmental impacts or hazards as compared to previously analyzed and documented impacts. These scientific and technology demonstration missions are needed for U.S. space and Earth exploration. All spacecraft (referred to as NASA routine payloads [NRP]) examined in this environmental assessment would meet rigorously defined criteria to ensure that the spacecraft and their launch and operation would not present any new or substantial environmental or safety concerns. The NRPs would launch from existing launch facilities (or those currently under construction) at Cape Canaveral Air Force Station, Florida; Vandenberg Air Force Base, California; the Ronald Reagan Ballistic Missile Defense Test Site at U.S. Army Kwajalein Atoll in the Republic of the Marshall Islands; NASA Wallops Flight Facility, Virginia; and Kodiak Launch Complex, Alaska. National Environmental Policy Act documentation exists that analyzes the potential environmental impacts at each of these launch sites for the evaluated launch vehicles.

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EXECUTIVE SUMMARY

ES.1 PROPOSED ACTION

This Environmental Assessment (EA) for Launch of NASA Routine Payloads on Expendable Launch Vehicles addresses the National Aeronautics and Space Administration's (NASA's) proposed action to launch a variety of spacecraft missions on launch vehicles. This document incorporates by reference the *Final Environmental Assessment for the Launch of NASA Routine Payloads on Expendable Launch Vehicles from Cape Canaveral Air Force Station, Florida and Vandenberg Air Force Base, California, June 2002 (2002 NRP EA)* and adds additional launch sites and launch vehicle families. The spacecraft used in these missions could be considered NRP spacecraft[1] as described by a set of threshold quantities and characteristics that would present no new or substantial environmental impacts or hazards. This EA also modifies some of the Envelope Payload Characteristics (EPCs) that were found to be unnecessarily low, as well as the rationale for why the potential impacts of these EPCs would not be substantial. These scientific and technology demonstration missions are needed for U.S. Space and Earth exploration to include real-time weather data gathering. All of the payloads provided NEPA compliance by this EA (referred to hereafter as NRP spacecraft) would meet rigorously defined criteria ensuring that the spacecraft and their operation would not present any new or significant environmental impacts as compared to previously analyzed and documented impacts.

The proposed action is comprised of preparing, launching and decommissioning missions designated as NRPs. The *2002 NRP EA* provided NEPA compliance for launches of NRP spacecraft from Cape Canaveral Air Force Station (CCAFS) and Vandenberg Air Force Base (VAFB), and payload processing at CCAFS, VAFB and Kennedy Space Center (KSC), aboard a certain set of approved expendable launch vehicles (ELVs). This EA includes the potential impacts of launching NRP spacecraft from additional launch sites: Ronald Reagan Ballistic Missile Defense Test Site at the United States Army Kwajalein Atoll (USAKA/RTS), Republic of the Marshall Islands (RMI), Wallops Flight Facility (WFF), Virginia, and Kodiak Launch Complex (KLC), Alaska on two additional launch vehicle families (Falcon and Minotaur), and the Taurus II addition to the Taurus family of launch vehicles that would launch from WFF and potentially from KLC in the future.

The Federal Aviation Administration (FAA) is a cooperating agency on this document because the FAA Office of Commercial Space Transportation issues launch operator licenses and experimental permits for commercial spacecraft activities at CCAFS, KLC, VAFB, USAKA/RTS, and WFF. The United States Air Force (USAF) Space and Missile System Center (SMC) is also a cooperating agency on this EA. In addition, the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Army Space and Missile Defense Command are also cooperating agencies on this EA.

As was the case in the *2002 NRP EA*, the design and operational characteristics and therefore, the environmental impacts of NRPs would be rigorously bounded. NRP spacecraft would utilize materials, launch vehicles, facilities, and operations that are normally and customarily used at

[1] For the purposes of this document, a payload is an item that a launch vehicle carries over and above what is necessary for the operation of the launch vehicle in flight. A payload can be a spacecraft, an instrument, etc.

CCAFS, KSC, VAFB, USAKA/RTS, WFF, and KLC. The NRP spacecraft would use these materials, launch vehicles, facilities, and operations only within the scope of activities already approved or permitted.

Under the proposed action, missions meeting the criteria for a NRP spacecraft would be launched from CCAFS, Florida; VAFB, California; USAKA/RTS, RMI; WFF, Virginia; and KLC, Alaska. Prelaunch spacecraft processing, including final assembly, propellant loading, and checkout of payload systems would be performed in Payload Processing Facilities (PPFs) located at CCAFS, KSC, VAFB, USAKA/RTS, WFF, and KLC. In the case of most of the NRP spacecraft, after processing, the spacecraft would be transported to Space Launch Complexes (SLC) at CCAFS or VAFB, or launch pads at USAKA/RTS, WFF, or KLC, where they would be integrated with and launched on an expendable launch vehicle. There are a few launch vehicles that undergo complete integration in the processing facilities and then are rolled out to the launch pad for launch. An example of this is the Pegasus, which is usually fully integrated at VAFB and then flown to the launch site on its dedicated L-1011 airplane.

For the purposes of this document, a launch vehicle is considered to be expendable if most of the significant parts of it, *i.e.,* stages, are not retrieved and reused. The launch vehicles proposed for launching the NRP spacecraft represent all presently or soon to be available domestic (U.S.) launch vehicles suitable for launching the NRP spacecraft. All NRP spacecraft would utilize launch vehicles and payload processing facilities for which environmental impacts have been evaluated in existing National Environmental Policy Act (NEPA) documents, or will be NEPA compliant by future NEPA documents. This EA incorporates by reference the existing NEPA documentation in Appendix A. The launch vehicles included in this proposed action include the following: the Athena family, Atlas V family, Delta family, Taurus family, Pegasus XL, Falcon family, and Minotaur family. These launch vehicles would accommodate the desired range of payload masses, would provide the needed trajectory capabilities, and would meet NASA's requirements for highly reliable launch services. Individual launch vehicles would be carefully matched to the launch requirements of each particular NRP spacecraft during the preliminary design phase of the mission.

In the event that other launch vehicles or other launch sites become available after the publication of this NEPA document, they would be considered NEPA-compliant under this EA if they meet the following criteria:

1. NASA has been a cooperating agency in the NEPA compliance with the Department of Defense (DoD) or FAA on the launch vehicle for that given launch site and has issued a finding of no significant impact (FONSI) or record of decision (ROD), as appropriate; or,

2. NASA has published NEPA documentation for that specific launch vehicle at that specific launch site; or,

3. NASA formally adopts another agency's NEPA documentation and has issued a FONSI or ROD, as appropriate.

In addition, launch vehicles provided NEPA compliance in this EA could be eligible for launch from commercial spaceports or DoD installations not covered by this document if (1) NASA is a cooperating agency on the NEPA documents developed by the FAA or DoD for that site and has

issued a FONSI or ROD concerning the combination of launch site and vehicle, (2) NASA formally adopts those documents as its own pursuant to Council on Environmental Quality (CEQ) regulations and has issued a FONSI or ROD concerning the combination of launch site and vehicle; or, (3) NASA completes its own NEPA documentation on a specific launch site.

ES.2 PURPOSE AND NEED FOR THE ACTION

The National Aeronautics and Space Act of 1958, as amended (42 U.S.C. 2451(d)(1)(5)) establishes a mandate to conduct activities in space that contribute substantially to "(t)he expansion of human knowledge of the Earth and of phenomena in the atmosphere and space", and to "(t)he preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere." In response to this mandate, NASA, in coordination with the National Academy of Sciences (NAS), has developed a prioritized set of science and technology objectives to be met through a long-range program of spacecraft missions. As part of the U.S. Space and Earth exploration effort, these missions are designed to be conducted in a specific sequence based on technological readiness, launch opportunities, timely data return, and a balanced representation of scientific disciplines. These missions are anticipated to have characteristics consistent with the description of a NRP spacecraft (see Table 2-1 for EPCs) based on prior NASA experience and associated NEPA analyses.

By collecting a range of unique scientific and engineering data from space and transmitting the data to Earth, NRP spacecraft would support NASA's primary objectives:

1. To understand the origin, evolution, and present state of the Solar System;

2. To establish the scientific and technical database required for undertaking major human endeavors in space, including the survey of near-Earth resources and the characterization of planetary surfaces and atmospheres; and

3. To create the capability to forecast and assess the health of the Earth system.

NASA cannot meet the specific objectives of U.S. space and Earth exploration using Earth-based instrumentation alone. Data acquired from ground-based instruments, sounding rockets, balloons, and Earth-based techniques, are limited. Therefore, NASA uses a variety of scientific spacecraft that must be designed and launched to collect these data.

To fulfill these objectives, a continuing series of scientific spacecraft would need to be designed, built, and launched into Earth orbit or towards other bodies in the Solar System. These spacecraft would fly by, encounter, orbit about, land on, or impact these bodies in order to collect various scientific data that would be transmitted back to Earth via radio frequencies for analysis. The scientific missions that would be carried out by NRP spacecraft could not be accomplished without launching the missions.

In addition to its own Earth observing spacecraft, NASA also launches payloads in conjunction with the National Oceanic and Atmospheric Administration (NOAA). Often these NOAA spacecraft fit within the NRP envelope spacecraft EPCs. The Geostationary Operational Environmental Satellite (GOES)/Polar Operational Environmental Satellite (POES) program is a

key element in NOAA/National Weather Service (NWS) operations. Both GOES and POES are necessary for providing a complete global weather monitoring system. The GOES/POES program is a joint effort of NASA and NOAA.

ES.3 PURPOSE OF THE NASA ROUTINE PAYLOAD SPACECRAFT EA

To reduce data and excessive paperwork, CEQ regulations encourage Federal agencies to analyze the potential environmental impacts of similar actions in one environmental assessment. Many of the Earth and space exploration missions planned by NASA and NOAA over the next decade would require spacecraft that are similar in overall design, materials, and engineering as well as instrument or payload systems. It is estimated that NASA would launch a maximum of eight NRP spacecraft per year. Furthermore, these spacecraft would be launched using a ELVs selected from a group of domestic launch vehicles. The missions would also have other common elements, including spacecraft prelaunch processing, launch scenarios, and resource use.

NASA would evaluate the proposed spacecraft design against the Routine Payload Checklist (RPC) (see Section 2.1.2 and Appendix C) to determine if it meets the description of a NRP spacecraft. If the mission meets the definition of a NRP spacecraft, this finding would be documented by processing a Record of Environmental Consideration (REC) in accordance with NASA's NEPA procedural requirements and guidance, citing this EA. If one or more NRP spacecraft characteristics exceed or are not included in the EPCs specified in Table 2-1 and Appendix C, further environmental analysis to meet NEPA and other environmental regulatory requirements would be conducted, in consultation with NASA Headquarters, as necessary and appropriate.

ES.4 ALTERNATIVES CONSIDERED

The scope of this EA includes all spacecraft that would meet specific criteria in their design and launch, would accomplish the requirements of NASA's research objectives, and would not present new or substantial environmental impacts or hazards. These spacecraft would meet the limitations set forth in the RPC (see Appendix C), which was developed to provide upper bounds on the characteristics and environmental impacts of this group of spacecraft. Preparation and launch of all spacecraft that are members of the class of NRP spacecraft would not have, individually or cumulatively, substantial environmental impact. Moreover, if the NEPA documentation for the launch vehicle to be used was the subject of a FONSI, the combined environmental impacts arising from the NRP spacecraft and launch vehicle would not have a substantially greater impact than that from the launch vehicle itself. Alternative spacecraft designs that exceed the limitations of the RPC may have new or substantial environmental impacts or hazards would require additional environmental review and documentation to satisfy the requirements of NEPA.

The nature of environmental impacts, payload processing, launch sites, and other related information for foreign launch systems are generally not as well known or as well documented as for launches from the U.S. In addition, use of non-U.S. launch vehicles requires individual consideration, review, and additional documentation. Therefore, foreign launch vehicles were not considered to be reasonable alternatives for the purpose of this routine payload spacecraft EA.

ES.5 NO ACTION ALTERNATIVE

Specific criteria and thresholds presented in the existing *NPR 2002 EA* would continue to be used to determine a mission's eligibility to be considered a NRP spacecraft launching on the Pegasus, Taurus, Atlas and Delta families of the vehicles from CCAFS and VAFB until the original *2002 NRP EA* is updated. After that time, such launches from CCAFS and VAFB would be subject to individual mission NEPA analysis with no presumption that certain payloads have no potential for significant environmental impact. Also, the No Action alternative would mean that NASA would not launch scientific and technology demonstration missions defined as NRPs on the Falcon and Minotaur families of launch vehicles from any of the launch sites, nor would NASA launch NRPs from USAKA/RTS, WFF, or KLC without individual mission NEPA review and documentation. Duplicate analyses and redundant documentation would not present any new information nor identify any substantially different environmental impacts.

ES.6 SUMMARY OF ENVIRONMENTAL IMPACTS

Potential environmental impacts, including cumulative impacts, of the proposed action are summarized in this section. A more extensive discussion is presented in Chapter 4. NASA missions provided NEPA compliance by this EA would be launched from CCAFS, VAFB, USAKA/RTS, WFF, and KLC and would be within the total number and mix of launch operations previously analyzed in launch vehicle or launch site NEPA documents. Thus, no additional individual or cumulative environmental effects are anticipated from NRP launches.

Air Quality

Ground operations during NRP processing and launch vehicle preparation would temporarily create very small increases in emissions from electrical power generators, vehicle traffic, and hazardous air pollutants (HAPs). These increases would be within the scope of emissions from ongoing and routine operations at all proposed launch sites, and would not substantially impact local air quality, either individually or cumulatively.

The air quality impacts of ongoing and routine operations at the launch facilities have been considered in previous NEPA documentation (see Appendix A). All proposed launch sites are in attainment for the ozone National Ambient Air Quality Standards. The conformity analysis required for non-attainment and maintenance areas under the Clean Air Act Section 176 indicates that the proposed action would not contribute substantially to the formation of ozone and ozone precursors.

At all proposed launch sites, combustion emissions from launch vehicles would dissipate before reaching sensitive human, flora, or fauna receptors. Previous NEPA documentation, which are largely based on the Rocket Exhaust Effluent Diffusion Model (REEDM) for CCAFS, VAFB, USAKA/RTS, and WFF and/or the Open Burn/Open Detonation Dispersion Model for USAKA/RTS and KLC, show that launching NRP spacecraft would result in gas and particle concentrations below all applicable Federal, State and local standards.

Previous NEPA documentation show that upper atmospheric impacts would be limited to a miniscule amount of global ozone loss from rocket combustion emissions. These analyses are included in the cumulative effects discussion.

Public Health and Safety

NRP spacecraft may carry small quantities of encapsulated radioactive materials for instrument calibration or similar purposes. Use of these radioactive materials would be reviewed and approved by the NASA Nuclear Flight Safety Assurance Manager (NFSAM) or designee prior to launch. The NASA NFSAM may approve launch for small quantities of radioactive material that have been shown to present no substantial public hazard. The NFSAM would certify that preparation and launching of NRP spacecraft that carry small quantities of radioactive materials would not exceed his (her) decision authority. If the radioisotope material is over a certain activity level as specified in Chapter 6 of the NASA Procedural Requirement (NPR) 8715.3B, it would not be within the scope of this EA. Additional documentation and analyses would be required.

NRP spacecraft may carry a variety of low-power radio transmitters for telemetry, tracking, and data downlink and high-power radar transmitters for remote studies of planetary surfaces, including Earth. The power and operating characteristics of these transmitters would be within defined limits to assure that their operation meets Institute of Electrical and Electronic Engineers (IEEE) standards for human health and safety and would present no substantial environmental impact, health hazard, or safety hazard on the ground during space operations.

NRP spacecraft may carry low power (Class I) lasers as part of a spacecraft subsystem. NRP spacecraft may carry medium and high power (Class IIIB and Class IV) lasers as part of scientific instrumentation that have the capability to observe the earth or for optical communication. For medium and high power lasers, NASA adherence to ANSI Z136.1-2007 (American National Standard for Safe Use of Lasers) and ANSI Z136.6-2005 (Safe Use of Lasers Outdoors) standards would ensure that the lasers do not pose a health or safety hazard.

Safety hazards associated with activities required to prepare NRP spacecraft for launch are within the scope of documented and mitigated hazards at all proposed launch sites. Hazards to launch site personnel and to the public from catastrophic payload and launch vehicle failures would be within the scope of such hazards mitigated by comprehensive Range Safety design and operating requirements on flight and ground equipment. Remaining risks would be minimized by controlling access of nonessential personnel and by training and protection of essential personnel.

Hazardous Material

Hazardous and solid waste management activities would comply with all applicable Federal, State, and local regulations. At CCAFS and VAFB the use of hazardous materials for spacecraft processing would be minimized through the use of "pharmacy" control systems, that is, systems that monitor quantities of specific chemicals that would be checked out and unused portions would be returned for reuse, recycling, or disposal. Adherence to appropriate USAF, U.S. Army, FAA, and NASA safety procedures would minimize the potential for accidental release of liquid propellants. At all launch sites except for WFF, liquid propellants, including kerosene (Rocket Propellant-1 or RP-1), liquid oxygen (LOX), liquid hydrogen (LH_2), hydrazine (N_2H_4), unsymmetrical dimethylhydrazine (UDMH), monomethylhydrazine (MMH), and nitrogen tetroxide (NTO or N_2O_4), would be stored in tanks near the launch pad within appropriate cement containment basins. The Mid-Atlantic Regional Spaceport (MARS) at WFF is currently

constructing a Liquid Fueling Facility (LFF) adjacent to the expanded and refurbished Pad 0-A. The LFF would contain RP-1, LOX, liquid nitrogen, gaseous helium, gaseous nitrogen, and possibly liquid methane. At WFF, hypergolic propellants would be stored within DOT-approved containers in specially designed facilities on Wallops Island.

NASA has issued and implemented a plan to manage hazardous materials in compliance with the Resource Conservation and Recovery Act (RCRA). The plan, NPR 8715.3B, NASA General Safety Program Requirements, assures that any accumulated hazardous materials are properly handled and characterized, and that appropriate methods and means for spill control are in place.

Geology, Soils and Land Resources

NRP spacecraft would not require the construction of new facilities or industrial infrastructure so new excavation would not be required. The near-field effects of deposition of emissions from combustion of launch vehicle fuels would be within the scope of ongoing and acceptable launch activity at all proposed launch sites.

Water Resources

Existing water utility infrastructure would be used to meet miscellaneous needs of payload processing, launch vehicle preparation, and fire or explosion control. There would be no related impacts to the ground water, surface water, or wastewater processing systems.

Deep ocean release of toxic materials such as residual propellants, hydraulic fluids, and eroding metals from spent booster structures would not produce substantial concentrations due to the small amount of such materials and the large quantity of water available for dilution in the deep ocean environment.

Noise and Sonic Boom

Noise associated with NRP spacecraft processing would be within the scope of normal and routine activities at the PPFs and launch site facilities as discussed in previous NEPA launch vehicle documentation (Appendix A), which is incorporated by reference.

Substantial launch noise from launch vehicles occurs for only a brief period at liftoff and would not present a direct or cumulative impact to nearby communities beyond the impact of normal and accepted launch activities.

Biological Resources

The USFWS and the National Marine Fisheries Service (NMFS) have previously reviewed actions that would be associated with the launch of proposed NRP spacecraft on launch vehicles from all proposed launch sites. NRP spacecraft processing and launch activities would not require any permits and/or mitigation measures beyond existing permits and mitigation measures already required, or in coordination, for launches from all proposed launch sites.

NRP spacecraft launches would not have an impact on launch site terrestrial or aquatic biota, including threatened and endangered species, beyond that already permitted and mitigated under

Marine Mammal Protection Act (MMPA) or the Environmental Standards and Procedures for the U.S. Army Kwajalein Atoll (USAKA) Activities in the RMI (UES) for ongoing launch activities.

Cultural Resources

NRP spacecraft activities would not affect archeological, historic, or cultural properties listed or eligible for listing in either the U.S. or Republic of the Marshall Islands (RMI) *National Register of Historic Places*. Archeological and paleontological sites have been identified and would not be affected by routine payload activities.

Socioeconomic Factors

NRP spacecraft activities would cause no adverse or beneficial impacts on community facilities, on services, or on existing land uses. The number and type of prelaunch and launch activities would be within the scope of operations previously analyzed in existing NEPA documentation for all proposed launch sites.

Environmental Justice

NRP spacecraft activities would be within the scope and number of launches previously analyzed in NEPA documentation for all proposed launch sites, which would have no high and disproportionate effects on children, minority populations and low-income populations. No substantial environmental effects are likely to occur outside launch site boundaries, thus no disproportionately adverse impact is anticipated to occur to any minority or low-income populations or any disproportionate health and safety risks to children.

Orbital and Reentry Debris

NRP spacecraft mission operations must comply with all requirements of NASA Policy Directive NPR 8715.6 (NASA Procedural Requirement for Limiting Orbital Debris) and NASA Standard (NASA-STD) 8719.14 (Process for Limiting Orbital Debris), which specify techniques to mitigate the generation of orbital debris from spacecraft, including end-of-mission spacecraft disposal.

Perchlorate Deposition

The probability for an aborted launch to occur is extremely low. If an early abort were to occur, actions would immediately be taken for the recovery and cleanup of unburned liquid or solid propellants, and any other hazardous materials that might fall on beaches or in shallow waters. Any propellants remaining in offshore waters would be subject to constant wave action and currents. Localized build-up of perchlorate concentrations from solid propellants has been shown to be a slow process. Thus, water circulation, in particular, would help to prevent localized build-up of perchlorate concentrations. As a result, no substantial impacts on biological resources are expected to occur.

Stratospheric Ozone Depletion and Global Warming

Launch emissions would include ozone-depleting substances; however, the rate of deposition would depend on the type of launch vehicle propellant, the launch profile, and the rate at which

propellant is consumed within the stratosphere. In general, data from previous launches of vehicles with solid rocket propellant indicate that short-term impacts include a temporary hole in the ozone layer, but that ozone concentrations would return to prelaunch levels within two hours. It is estimated that the annual emissions of hydrogen chloride (HCl) and aluminum oxide (Al_2O_3) from a representative eight NRP spacecraft launches, for purposes of analysis, would induce less than 0.0032 percent of the estimated annual global average ozone reduction for corresponding years.

Cumulative Effects

NRP spacecraft activities would not cause the annual number of launches for the proposed launch vehicles to exceed the number analyzed and approved in previous NEPA documentation for CCAFS, VAFB, USAKA/RTS, WFF, and KLC. Therefore, the proposed action would not result in cumulative impacts in excess of those previously documented and approved.

ES.7 SUMMARY

Spacecraft that comply with the RPC (see Section 2.1.2 and Appendix C) would utilize materials, quantities of materials, launch vehicles, and have operational characteristics that would be consistent with normal and routine spacecraft preparation and flight activities at all proposed launch sites. Therefore, the environmental impacts of launching NRP spacecraft would fall within the range of routine, ongoing, and previously documented impacts associated with approved programs that have been determined not to have significant environmental impacts (see Appendix A for previously vetted missions provided NEPA compliance by the NASA *2002 NRP EA*. These 27 missions were all successful).

Lastly, NASA will review the EA periodically for completeness and adequacy to support future routine payloads.

High Level Substantive Changes In This Document From The Final Environmental Assessment For The Launch Of NASA Routine Payloads On Expendable Launch Vehicles From Cape Canaveral Air Force Station, Florida And Vandenberg Air Force Base, California, June 2002

The Final Environmental Assessment for the Launch of NASA Routine Payloads on Expendable Launch Vehicles from Cape Canaveral Air Force Station, Florida and Vandenberg Air Force Base, California, June 2002 (2002 NRP EA) provided National Environmental Policy Act (NEPA) compliance for launches of routine payload spacecraft from Cape Canaveral Air Force Station (CCAFS) and Vandenberg Air Force Base (VAFB), and payload processing at CCAFS, VAFB, and Kennedy Space Center (KSC), aboard a certain defined set of approved expendable launch vehicles (ELVs). The purpose of this EA is to include the potential impacts of launching NRPs on approved launch vehicles from the following additional launch sites: United States Army Kwajalein Atoll Reagan Test Site (USAKA/RTS) in the Republic of the Marshall Islands, NASAs Wallops Flight Facility (WFF) in Virginia, and Kodiak Launch Complex (KLC) in Alaska. This EA also includes the proposed action of launching NRP spacecraft on two additional expendable launch vehicle families (Falcon 1 / 9 and Minotaur), and the Taurus II launch vehicle from WFF and potentially from KLC in the future

Similar to the original 2002 NRP EA, the design and operational characteristics and, therefore, the environmental impacts of NRP spacecraft would be rigorously bounded. NRP spacecraft would utilize materials, launch vehicles, facilities, and operations that are normally and customarily used at CCAFS, KSC, VAFB, USAKA/RTS, WFF, and KLC. NRP spacecraft would use these materials, launch vehicles, facilities, and operations only within the scope of activities already approved or permitted.

Prior to the development of the original *2002 NRP EA*, NASA developed NEPA documents for each individual NRP spacecraft missions. Since the majority of NASA missions launched on a previously defined set of launch vehicles from CCAFS and VAFB, it was found that the biggest difference between missions was in spacecraft design. The launch vehicle was the biggest contributor of potential impacts and, upon evaluation, the potential impacts from the payload were found not to be substantial either individually or when added to those contributed by the launch vehicle. Therefore, duplicate analyses and redundant documentation did not present any new information or identify any substantially different environmental impacts. In accordance with Council of Environmental Quality guidelines, this EA incorporates by reference existing NEPA documentation for launch vehicles and launch sites.

In the NASA paradigm at the time of developing the original *2002 NRP EA*, i.e., launching a greater number of smaller payloads more often, it became strategic to develop a NRP EA to cover a range of spacecraft and instruments. In keeping with the way NASA did environmental evaluations for individual missions, 20 recent and currently proposed NASA and USAF payloads were evaluated to determine the range of Envelope Payload Characteristics (EPCs). Analyses of the EPCs in conjunction with the set of approved launch vehicles determined that no substantial impact would result and NASA published a Finding of No Significant impact (FONSI). Soon after the *2002 NRP EA* and FONSI were published, the paradigm shifted such that proposed spacecraft were getting larger and more complex. The change in NASA's mission paradigm created a need to project the propellant load amounts that future missions might requireThe EPCs

were evaluated to determine if they needed to be revised, and if an update to the 2002 NRP EA would be required for projected future missions.

NASA completed a limited analysis on the potential impacts of spacecraft failure and subsequent sub-orbital or orbital reentry of hydrazine propellant. The results of that study are summarized in this document.

In addition to updates on the launch sites and vehicles in the original *2002 NRP EA*, the Orbital Debris sections in Chapters 3 and 4 have been rewritten to align with the NASA's Orbital Debris requirements in effect as of December 2010. Discussions of greenhouse gas emissions from rocket launches that might contribute to global warming have been included in Chapters 3 and 4. Due to Council of Environmental Quality guidance, the text has been expanded to also include greenhouse gases.

Some of the EPCs have been increased because it has been determined that the maximum allowable limit in the *2002 NRP EA* were unnecessarily low. Because spacecraft have gotten larger with longer mission durations, a change in these upper limits was deemed appropriate. A solid technical rationale is given for why each of these increases does not constitute an additional substantial impact. Moreover, the spacecraft and launch vehicle fuel loads can be evaluated as a sum to determine if the payload might create a substantial environmental impact, i.e., if it fits within previous NEPA documentation showing no substantial impacts. Additionally, NASA did a limited analysis on the potential impacts of a spacecraft carrying hydrazine and the findings are included in Chapter 4. The checklist, provided in Appendix C of this EA, has been modified to address these hazardous propellants onboard NRP spacecraft.

Lastly, NASA has also determined that the EA will be reviewed periodically for completeness and adequacy to support routine payloads.

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1 PURPOSE AND NEED

1.1 PROPOSED ACTION

The National Aeronautics and Space Administration (NASA) in compliance with 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 NASA policy and procedures (14 CFR Part 1216) has prepared this environmental assessment (EA) for launching scientific spacecraft and technology demonstrations that meet specific criteria (see Table 2-1, Envelope Payload Characteristics [EPCs] consistent with a description of NASA routine payloads[2] (NRP) based on NASA experience and previous environmental reviews. The *Final Environmental Assessment for the Launch of NASA Routine Payloads on Expendable Launch Vehicles from Cape Canaveral Air Force Station, Florida and Vandenberg Air Force Base, California (June 2002)* (*2002 NRP EA*) provided NEPA documentation for launches of NRPs aboard a certain set of expendable launch vehicles (ELVs) from Cape Canaveral Air Force Station (CCAFS) and Vandenberg Air Force Base (VAFB) and payload processing at CCAFS, VAFB and the Kennedy Space Center (KSC).

This EA updates the *2002 NRP EA* information, and includes additional launch sites and launch vehicles that have become available since 2002. For this EA the proposed action is comprised of preparing, launching, and decommissioning[3] missions designated as NRPs. This EA includes the potential impacts of launching Routine Payloads from additional launch sites, including: The Ronald Reagan Ballistic Missile Defense Test Site, U. S. Army Kwajalein Atoll, and Republic of the Marshall Islands, Wallops Flight Facility, Virginia, and Kodiak Launch Complex, Alaska. This EA also includes the addition of two launch vehicle families (Falcon and Minotaur), and the addition of Taurus II to the Taurus launch vehicle family.

The Federal Aviation Administration (FAA) and the U. S. Air Force Space and Missile System Command are cooperating agencies in this update to the *2002 NRP EA*. In addition, the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Army Space and Missile Defense Command are also cooperating agencies on this EA. Topics discussed in this EA include, but are not limited to, definition and objectives of the proposed action, alternatives to the proposed action, including the No-Action Alternative, and the potential environmental impacts of each action.

This EA will assist NASA decision-makers (and other federal agencies) in accordance with NEPA. This EA considers the environmental impacts associated with the proposed action and the No Action Alternative. No final action will be taken on the proposed action until NEPA compliance is complete.

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[2] As used in this document, a payload is defined as items that the launch vehicle carries over and above what is necessary for the operation of the launch vehicle in flight. A payload can be a spacecraft, an instrument, etc.

[3] Decommissioning includes the deconstruction, diversion, reuse, and disposal of component parts/materials/substances from a launch system.

1.2 PURPOSE OF THE PROPOSED ACTION

The National Aeronautics and Space Act of 1958, as amended (42 U.S.C. 2451(d)(1)(5)) establishes a mandate to conduct activities in space that contribute substantially to "(t)he expansion of human knowledge of the Earth and of phenomena in the atmosphere and space", and to "(t)he preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere." In response to this mandate, NASA, in coordination with the National Academy of Sciences, has developed a prioritized set of science objectives to be met through a long-range program of spacecraft missions. As part of the U. S. space and Earth exploration effort, these missions are designed to be conducted in a specific sequence based on technological readiness, launch opportunities, timely data return, and a balanced representation of scientific disciplines. The purpose of these spacecraft is to gather scientific information and to demonstrate advanced, low-cost technologies for exploring and utilizing space that meet NASA's objectives for Earth and space science. NASA also partners with the National Oceanic and Atmospheric Administration (NOAA) in launching satellites for weather monitoring. The primary characteristic of weather monitoring information is that it cannot be obtained using ground-based instruments. These NOAA missions are anticipated to have characteristics consistent with a NRP spacecraft (see Table 2-1 for EPCs) based on prior NASA experience and associated NEPA analyses.

By collecting a range of unique scientific and engineering data from space and transmitting the data to Earth, NRP spacecraft would support NASA's primary objectives:

4. To understand the origin, evolution, and present state of the solar system

5. To establish the scientific and technical database required for undertaking major human endeavors in space, including the survey of near-Earth resources and the characterization of planetary surfaces and atmospheres

6. To create the capability to forecast and assess the health of the Earth system.

Examples of the kinds of data that would be collected by NRP spacecraft for transmission to Earth in order to meet NASA's primary objectives include:

7. Multi-spectral and high resolution images of planetary surfaces and atmospheres

8. Measurements of planetary geophysical characteristics such as magnetic field strength, mass properties, and dynamical state

9. Detailed measurement of the composition, meteorology, and radioactive properties of Earth's atmosphere

10. Measurement of the Sun's electromagnetic, particle radiation, and their interaction with Earth.

1.3 NEED FOR THE PROPOSED ACTION

NASA cannot meet the specific objectives of U.S. space and Earth exploration using Earth based instrumentation alone. Ground-based instruments, such as cameras, telescopes, Light Detection and Ranging (LIDARs),[4] spectrographs, etc., lack global coverage, are limited in resolution and sensitivity by atmospheric conditions, and cover only limited portions of the electromagnetic spectrum. Sounding rockets, without orbiting spacecraft instrumentation, are limited to a few minutes of data collection and lack global coverage. Balloons not only have limited altitude coverage and flight duration but also cannot reach beyond Earth's middle atmosphere. Furthermore, Earth-based techniques are unable to measure certain planetary geophysical data that can only be obtained in-situ (i.e., on orbit, within an atmosphere, or on a planetary surface) or by positioning instrumentation near enough to planetary environments to ensure sufficient instrument sensitivity and resolution. Therefore, NASA must use a variety of scientific spacecraft that must be designed and launched to collect these data. These spacecraft would carry instruments into Earth orbit or to other planetary bodies where they would collect the required data over extended periods and transmit the data to Earth.

1.4 NEPA STRATEGY

To reduce data and excessive paperwork, CEQ regulations encourage Federal agencies to analyze the potential environmental impacts of similar actions in one environmental assessment. Many of the space exploration missions planned by NASA over the next decade would require spacecraft that are similar in overall design, materials, and engineering as well as instrument or payload systems. Furthermore, these spacecraft would usually be launched using a launch vehicle selected from a group of domestic launch vehicles. For the purposes of this document, a launch vehicle is considered to be expendable if any significant part of it is not retrieved and reused, i.e., a stage. The missions would also have other common elements, including spacecraft prelaunch processing, launch scenarios, and resource use.

Once the design for a proposed NASA science mission is sufficiently well determined (i.e., during the Phase B Preliminary Design studies), NASA would use the Routine Payload Checklist (see Chapter 2, Section 2.1.2 and Appendix C) to evaluate the proposed design to determine if it meets the description of a NRP spacecraft. If the mission meets the definition of a NRP spacecraft, this finding would be documented by processing a Record of Environmental Consideration in accordance with NASA's NEPA procedural requirements and guidance, citing this EA. If one or more characteristics are outside of or not included in the EPCs specified in Chapter 2, Table 2-1 and Appendix C, further environmental analysis would be conducted, in consultation with NASA Headquarters, to meet NEPA and other environmental regulatory requirements.

Similar to the *2002 NRP EA*, this EA will be subject to review periodically, to maintain currency with relevant rules, regulations, scientific findings, space technologies, available launch vehicles and sites, and the evolving requirements of NASA's space research program. In the event that a

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4 LIDAR uses the same principle as RADAR. The LIDAR instrument transmits light out to a target. The transmitted light interacts with and is changed by the target. Some of this light is reflected / scattered back to the instrument where it is analyzed. The change in the properties of the light enables some property of the target to be determined. The time for the light to travel out to the target and back to the LIDAR is used to determine the range to the target.

change in applicable laws, regulations or statutes occurs before an internal review, NASA will immediately review the EA and the potential for significant impacts.

In the event that other launch vehicles or new launch sites become available after the publication of this NEPA document, they would be considered NEPA compliant under this EA if they meet one of the following criteria:

1. NASA has been a cooperating agency with the Department of Defense (DoD) or FAA on the launch vehicle for that given launch site and a Finding of No Significant Impact (FONSI) or Record of Decision (ROD) has been issued by NASA.

2. NASA has adopted another agency's NEPA compliance document for a specific launch vehicle and/or launch site and a FONSI or ROD has been issued by NASA.

3. NASA has completed the NEPA process for the specific launch vehicle at a specific launch site. In addition, launch vehicles provided NEPA compliance in this EA could be eligible for launch from U. S. Commercial Spaceports or DoD installations not evaluated by this document if:

    a. NASA is a cooperating agency on NEPA documents developed by the FAA or DoD for that site and a FONSI or ROD has been issued by NASA.

    b. NASA formally adopts another agency's documents as its own pursuant to CEQ regulations and a FONSI or ROD has been issued by NASA.

    c. NASA completes the NEPA documentation on a specific commercial or DoD launch site.

For those situations specified in the immediately preceding paragraph, NASA would issue a memo for the record indicating that NASA has determined the launch vehicle and/or launch site falls within the umbrella of this EA and that it meets the criteria as outlined above.

2 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

NASA proposes to design, launch, and operate a variety of scientific spacecraft that can be considered routine as defined by NASA's Routine Payload Checklist (RPC) (see Appendix C of this Environmental Assessment [EA]). These spacecraft would be launched using U.S. domestic expendable launch vehicles whose impacts have been examined in previous EAs and environmental impact statements (EISs) (see Appendix A of this EA). (A launch vehicle is considered to be expendable if any significant part of it, *i.e.,* a stage, is not retrieved and reused.) These existing National Environmental Policy Act (NEPA) documents are incorporated by reference. By meeting the criteria of the RPC (see Section 2.1.2 and Appendix C of this EA) and by having no new or substantial environmental impacts or hazards, spacecraft would be considered NASA routine payload (NRP spacecraft) and would fall under the scope of this EA for Launch of NASA Routine Payloads on Expendable Launch Vehicles (NRP EA).

2.1 PROPOSED ACTION

NASA proposes to carry out a variety of missions involving the launch of spacecraft over the next several decades. Some missions may be part of a larger NASA program with multiple missions, such as the Earth Observing System (EOS), the Discovery Program, the New Frontiers (NF) Program, and the Mars Exploration Program (MEP). In addition to NASA spacecraft and technology demonstrations, NASA also partners with and launches missions with the National Oceanic and Atmospheric Administration (NOAA), specifically the Geostationary Operational Environmental Satellite (GOES) and Polar-orbiting Operational Environmental Satellite (POES) mission sets. There would be a number of spacecraft launched per year at the approved launch sites. These spacecraft would not increase the number of launches on the National Launch Forecast (a list of the planned and projected mission launches). These spacecraft would perform scientific study of the Earth, other bodies in the solar system and the cosmos and would further the development of advanced, low-cost technologies for exploring and utilizing space. These spacecraft, together with their associated launches (i.e., missions), would be considered to be routine if they would present no new or substantial environmental hazards, and their hazards would not exceed the specific thresholds described by the RPC (see Section 2.1.2 and Appendix C). Such missions are referred to as NRP spacecraft.

Once an acceptable detailed design concept is proposed for a NASA science or technology demonstration mission, NASA would evaluate the proposed design against the RPC to determine if the proposed design is within the definition of a NRP spacecraft as described in this EA. If the mission meets the requirements of the RPC (see Appendix C), a finding that it fits within the envelope of a NRP spacecraft would be documented by processing a Record of Environmental Consideration (REC) in accordance with NASA's NEPA procedures and guidance, citing this EA. If the proposed mission were found to be inconsistent with the NRP spacecraft categorization, additional environmental analysis and documentation would be required.

NRP spacecraft would be placed into Earth orbit or into Earth-escape trajectories (i.e., solar orbit) using one of a group of launch vehicles routinely and exclusively launched from Cape Canaveral Air Force Station (CCAFS), Florida; Vandenberg Air Force Base (VAFB), California; United States Army Kwajalein Atoll Reagan Test Site (USAKA/RTS), Wallops Flight Facility (WFF), Virginia; and the Kodiak Launch Complex (KLC), Alaska. The use of these launch

vehicles and of these launch ranges for the launch of the NRP spacecraft have been analyzed and are within the scope of existing NEPA documents for operations at these launch facilities (see Appendix A). This existing NEPA documentation is incorporated by reference.

The specific launch vehicle and trajectory selected for a particular mission would depend on the specific mission objectives and requirements for that NRP spacecraft. For quality control and safety reasons, proposed NRP spacecraft would only be prepared for launch at Kennedy Space Center (KSC) (launch processing center for CCAFS), VAFB, USAKA/RTS, WFF, or KLC, and their associated facilities.

Each NRP spacecraft would be designed to meet specific and unique mission requirements but all spacecraft would be assembled from similar components (subsystems). These subsystems could be grouped according to function:

- mechanical structure
- propulsion
- communication
- control, avionics, data storage
- power generation, storage, and distribution
- science and engineering instrumentation

Each subsystem would be made of materials and components commonly used in the space industry. Use of these subsystems in NRP spacecraft would pose no adverse environmental or health impacts beyond those already analyzed and documented in existing NEPA analyses.

All NRP spacecraft would follow similar procedures to prepare for launch. NRP spacecraft would be designed, fabricated, assembled, and tested at various government and contractor offices and laboratory facilities and would be in compliance with associated permits.

Approximately 30 to 90 days before launch, the spacecraft would be transported to one of several existing payload processing facilities (PPFs) at CCAFS, KSC, VAFB, USAKA/RTS, WFF, or KLC, where various subsystem components (e.g., pyrotechnics, batteries, instruments) would be installed and loaded. After a final test, the spacecraft would be encapsulated in a payload fairing, transported to the launch pad, and mated with the launch vehicle. Final preparation and cryogenic propellant loading of the launch vehicle would take place during a period beginning up to 72 hours before launch. A successful launch would place the spacecraft into Earth orbit or into an escape trajectory. NRP spacecraft would flyby, orbit, soft land on, or impact other planetary bodies and if considered an NRP mission, would not return a sample to Earth as identified in the RPC.

Figure 2-1 presents the process flow for a typical spacecraft from delivery at the launch site, through prelaunch processing, and to launch. While the processing requirements for a particular NRP spacecraft may not conform exactly to Figure 2-1, deviations would not be substantial with respect to environmental impacts or safety concerns. Furthermore, processing would be in accordance with NASA, USAF, U.S. Army, and FAA policies and guidelines for environmental protection and worker health and safety.

2.1.1 Envelope Spacecraft Description

The concept of an envelope spacecraft derives from the need to provide a benchmark that describes a bounding case for quantities and types of materials, emissions, and instrumentation. These bounding quantities comprise the Envelope Payload Characteristics (EPCs) that are found in Table 2-1. In addition, insofar as the prelaunch activities that are required to prepare NRP spacecraft for launch are routine and are provided NEPA compliance by existing NEPA documentation at each proposed launch site, these prelaunch activities are implicitly bounded by the envelope spacecraft and EPCs as well. Within this context, the EA should be considered a hypothetical spacecraft whose components, materials, and associated quantities and flight systems represent a comprehensive bounding reference design for NRP spacecraft. Any proposed spacecraft that presents lesser or equal values of environmentally hazardous materials or sources in comparison to the envelope spacecraft as per the RPC (see Section 2.1.2 and Appendix C) may be considered an NRP spacecraft within the purview of this EA.

Table 2-1 Summary of Envelope Payload Characteristics by Spacecraft Subsystem

Structure	• **Unlimited:** aluminum, beryllium, carbon resin composites, magnesium, titanium, and other materials unless specified as limited.
Propulsion*	• Liquid propellant(s); 3,200 kg (7,056 lb) combined hydrazine, monomethyl hydrazine and/or nitrogen tetroxide. • Solid Rocket Motor (SRM) propellant; 3,000 kg (6,614 lb) Ammonium Perchlorate (AP)-based solid propellant (examples of SRM propellant that might be on a spacecraft are a Star-48 kick stage, descent engines, an extra-terrestrial ascent vehicle, etc.)
Communications	• Various 10-100 Watt (Radio Frequency) transmitters
Power	• Unlimited Solar cells; 5 kilowatt-Hour (kW-hr) Nickel-Hydrogen (NiH_2) or Lithium ion (Li-ion) battery, 300 Ampere-hour (A-hr) Lithium-Thionyl Chloride (LiSOCl), or 150 A-hr Hydrogen, Nickel-Cadmium (NiCd), or Ni-H_2 battery.
Science Instruments	• 10 kilowatt radar • American National Standards Institute safe lasers (see Section 4.1.2.1.3)
Other	• U. S. Department of Transportation (DoT) Class 1.4 Electro-Explosive Devices (EEDs) for mechanical systems deployment • Radioactive materials in quantities that produce an A_2 mission multiple value of less than 10 • Propulsion system exhaust and inert gas venting • Sample returns are considered to be outside the scope of this environmental assessment

Key: Kg=kilograms; lb=pounds.

*Propellant limits are subject to range safety requirements.

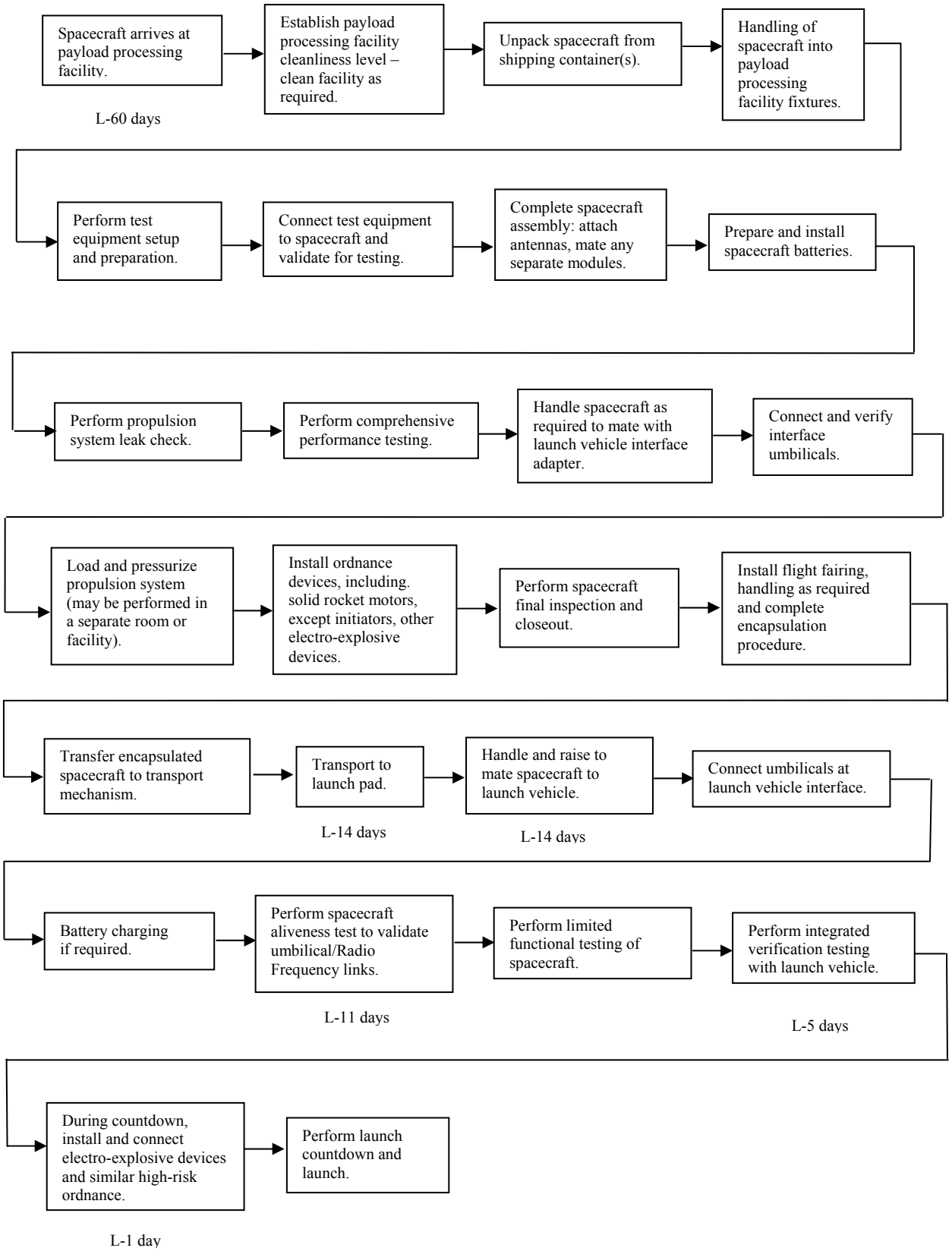


Figure 2-1 Typical Process Flow for NASA Routine Payload Spacecraft (L- x days = X is the number of days before launch)

The EPCs for propellant loads in the existing *2002 NRP EA* were derived based on the environmental analyses of propellant quantities that missions had launched prior to 2002 or were proposing to launch in a future timeframe. The original set of launch vehicles included the Titan II (mostly hydrazine-fueled) vehicle that is currently not in service. The Delta II is also largely hydrazine-fueled. Prior to the Atlas V and Delta IV launch vehicles, the solid rocket motor (SRM) kick (third) stage was considered to be part of the launch vehicle. On the Atlas V and Delta IV evolved expendable launch vehicles (ELVs), the kick stage is now considered to be on the spacecraft side of the launch vehicle/spacecraft interface. For this reason, the solid rocket propellant in the EPCs must be increased to allow for this on the spacecraft side. The upper limits of propellants have also been increased to allow for solid rocket propellant for uses such as, but not limited to, descent engines, extra-terrestrial ascent vehicles, etc.

In the 2002 NRP EA, the liquid propellants were listed individually as mono- and bipropellant fuels and bipropellant oxidizer. This has been modified to simply provide a 3,200 kg total liquid propellant load. Actual maximum propellant permitted is launch-location specific and thus must not exceed the range safety requirements. The hydrazine/nitrogen tetroxide (A-50/NTO) propellant-fueled LVs, i.e., the Titan II, Titan IVB, and Deltas II and III, were extensively evaluated for environmental impacts, and even in the case of a launch accident, were not deemed to contribute substantial impacts. Because the Titans and Delta III LVs have been retired from service, and the Delta II is reportedly soon to be retired from service, the A-50/NTO propellant loads on launch vehicles will no longer be a contributor of environmental impacts. Therefore, if the hydrazine/NTO propellant load carried by the spacecraft/payload is smaller than that of a Delta II, and the environmental impacts of a Delta II were deemed not to be substantial, it follows that the potential impacts due to hydrazine/NTO carried on the spacecraft must necessarily be bounded by the contribution of the propellant load of the Delta II and impacts from it's hydrazine load would also not be substantial.

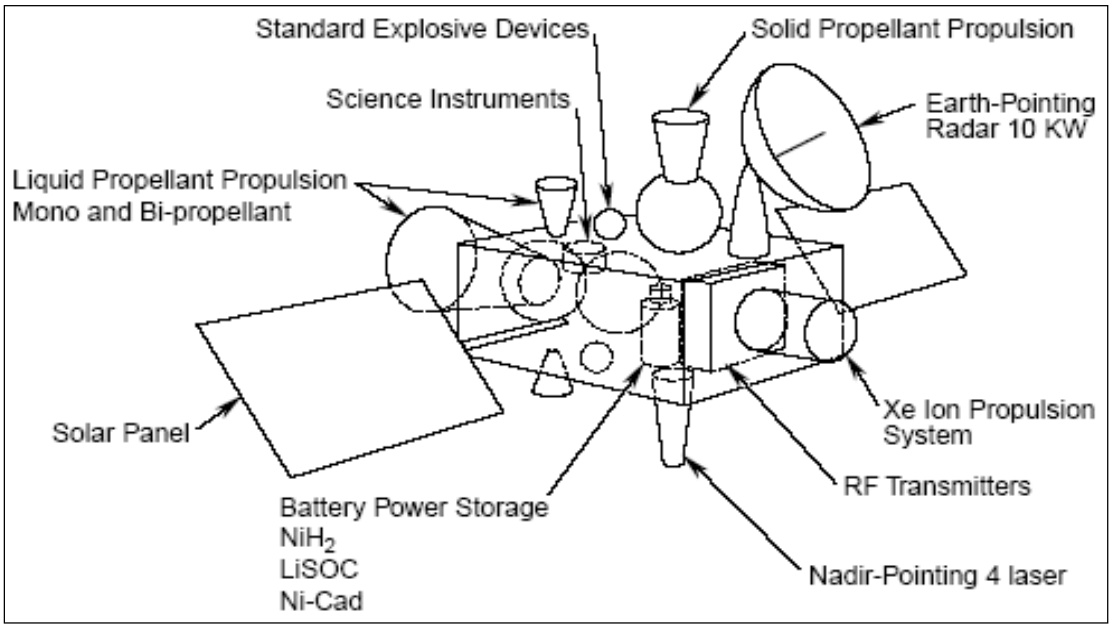
Of the proposed payloads, those incorporating characteristics with unusual potential for substantial environmental impact were excluded. These characteristics include the use of radioisotope power system (RPS), such as radioisotope thermoelectric generators (RTGs), and radioisotope heater units (RHUs), as well as spacecraft returning samples to Earth. Of the remaining proposed payloads, spacecraft systems with minor potential for environmental impact were identified and evaluated for the following:

- solid, liquid, and electric (ion) propellant types and quantities
- laser power levels and operating characteristics
- explosive hazard potentials
- battery electrolyte types and quantities
- hazardous structural materials quantities
- radio frequency transmitter power
- radioisotope instrument components
- potential biological hazards

In the *2002 NRP EA* a representative "envelope" spacecraft was defined by the magnitudes of all of these characteristics equal to the maximum found in all the evaluated payloads (including payloads that had previously launched and payloads proposed for launch within the period of the *2002 NRP EA*), and then increased by 25 percent to reasonably allow for future growth potential,

based on the size and proposed mission lifetimes that were characteristic of the NASA paradigm of the time.

Figure 2-2 illustrates the relevant features of an envelope spacecraft. Table 2-1 presents the maximum quantities of the major materials EPCs that would be carried by the envelope spacecraft and that are reflected in the RPC (see Section 2.1.2 and Appendix C). Minor materials that are not listed may be included on the envelope spacecraft as long as they pose no substantial hazard and have been identified in the RPC (see Appendix C).



Key: Kw=kilowatt; LiSOC=Lithium-thionyl chloride; NiH2=nickel hydride; Ni-Cad=nickel cadmium; RF=radio frequency; Xe=xenon.

Source: 2002 NRP EA

Figure 2-2 Envelope Spacecraft

2.1.2 Routine Payload Checklist

In addition to determining whether the launch site and processing facilities are among those listed in Section 2.1.4 and 2.1.5, NEPA compliance under this EA is determined by evaluating a series of questions that serve as a RPC. The RPC should be evaluated following the format in Appendix C as soon as the proposed spacecraft subsystems are sufficiently well defined (i.e., the end of Phase A/beginning of Phase B—during the Formulation Phase).

If responses to all checklist questions are negative (i.e., the condition is not present), the candidate mission would be considered NEPA compliant by this EA. If answers to any of the checklist questions are positive, further analysis and documentation or clarification would be required. The nature and scope of any incremental environmental review process, analysis, and documentation required would be determined in consultation with NASA Headquarters (HQ).

When evaluating the criteria questions against a candidate mission, the EPCs presented in Table 2-1 and Appendix C would be compared against the associated candidate mission characteristics. The EPCs represent upper limits to specific material quantities, power, and

exposures. Proposed spacecraft that present lesser or equal quantities than the limits documented for the envelope spacecraft may be considered a NRP spacecraft within the purview of this EA.

A1. Would the candidate mission return a sample from an extraterrestrial body?

Spacecraft that would return air, soil, or other materials from any extraterrestrial body or from interplanetary space are not provided NEPA compliance by this EA. This includes spacecraft that would return a sample to Earth's surface and spacecraft that would return a sample only to Earth's orbit.

B1. Would the candidate spacecraft carry radioactive materials in quantities that produce an A2 mission multiple value of 10 or more?

Spacecraft carrying any radioactive material for power, heat sources, instrument calibration, structural members, or any other purpose must be analyzed and reviewed for launch approval with the level of analysis and approval determined by the quantity of radioactive material. The NASA Nuclear Flight Safety Assurance Manager (NFSAM) or designee, may approve launch for small quantities of radioactive material that have been shown to present no substantial public hazard so considered as NRP. Spacecraft that would carry greater quantities of radioactive sources requiring a higher signature authority of launch approval at the Chief Safety and Mission Assurance Officer Level or above are not provided NEPA compliance by this EA. The following steps would be used to determine the A2 Mission Multiple[5]: (1) obtain the A2 activity value for each radioactive isotope source in the mission inventory using the current International Atomic Energy Agency (IAEA) published values for the Safe Transport of Radioactive Material; (2) for each isotope, divide the total isotope activity by the A2 activity value for that isotope; (3) sum the values for each isotope from Step 2 to get the A2 Mission Multiple.

C1. Would the candidate spacecraft be launched on a vehicle and launch site combination other than those listed in Table 2-3 of the EA?

The group of existing launch vehicles selected for NRP spacecraft has been evaluated for launch from the launch sites listed. The environmental impacts of these vehicles have been reported in existing NEPA documentation. Instrument or spacecraft which are developed at NASA Centers, and in some cases, undergo payload processing at the facilities mentioned in this document, are considered to covered under this NRP EA, even if they are launched on a foreign launch vehicle. The foreign launch would be covered under EO 12114.

C2. Would launch of the proposed mission exceed the approved or permitted annual launch rate for the particular launch vehicle or launch site?

NEPA documentation for each potential proposed launch vehicle has been completed assuming a particular number of annual launches from each proposed launch site. If adding the launch required by the proposed spacecraft to the existing launch manifest would cause the number of launches to exceed the given annual number for any year, further NEPA analysis would be

[5] The A2 Mission Multiple is a calculated value based on the total amount of radioactive material being launched. This value is used in defining the level of review and approval required for launch.

required. NASA would consult with the respective launch support organizations: 30th Space Wing (30SW/CES) and 45th Space Wing (45SW/CES) at VAFB and CCAFS, respectively: the U.S. Army Kwajalein Atoll for USAKA/RTS, for WFF, NASA Goddard Space Flight Center for WFF. Consultation with the FAA is necessary when NASA or another agency is proposing the launch of spacecraft that is also operating under an FAA license or permit at the site.

D1. Would the candidate mission require the construction of any new facilities or substantial modification of existing facilities?

NRP spacecraft would use only existing launch site facilities, including roads, utilities, payload and launch vehicle processing facilities, and launch complexes. Minor modifications to existing facilities required for the proposed spacecraft launch would be provided NEPA compliance by this EA only if the associated activities remain within the scope of permitted operations at all proposed launch sites. Any major modification or new construction would require further NEPA analysis.

E1. Would the expected risk of human casualty from spacecraft planned orbital reentry exceed the criteria specified by NASA standard 8719.14?

To minimize the risk of impacts associated with the reentry and eventual Earth impact of debris, NASA missions encompassed in this EA would comply with the reentry requirements of NASA Standard 8719.14, Process for Limiting Orbital Debris. This NASA standard (i.e., Requirement 4.7-1) limits the risk of human casualty from reentry debris to 1 in 10,000 and requires that missions be designed to assure that in controlled re-entries that domestic and foreign landmasses are avoided.

E2. Would the candidate spacecraft utilize batteries, ordnance, hazardous propellants, radiofrequency transmitter power, or other subsystem components in quantities or levels exceeding the EPCs in Table 2-1 in the EA?

The NRP envelope spacecraft defines the upper limits of quantities and levels of commonly used materials and systems that NRP spacecraft could carry. These values are presented in Table 2-1. NRP spacecraft could carry small quantities of hazardous materials that are not included as part of the envelope spacecraft description. If so, the required local permit(s) must be identified (if currently in force) or obtained (if new or renewed) before the material is used at the launch site.

E3. Would the candidate spacecraft utilize any potentially hazardous material as part of a flight system whose type or amount precludes acquisition of the necessary permits prior to its use or is not included within the definition of the EPC?

NRP EA spacecraft would only utilize materials that fit within the existing permits of the specific site from which they would undergo assembly and test, payload processing, and launch.

E4. Would the candidate mission release material other than propulsion system exhaust or inert gases into Earth's atmosphere or space?

NRP spacecraft would not release or vent any material into the atmosphere that could present a hazard or substantial environmental impact during either launch preparations or launch.

E5. Are there changes in the preparation, launch or operation of the candidate spacecraft from the standard practices described in Chapter 3 of this EA?

The environmental impact of NRP spacecraft is bounded by the potential impact of preparation and launch of envelope spacecraft as presented in Chapter 4 of this EA. Changes in preparation, launch, or operation from standard practices described in Chapter 3 would require review to determine if the changes or associated environmental impacts are substantial enough to require further NEPA review.

E6. Would the candidate spacecraft utilize an Earth-pointing laser system that does not meet the requirements for safe operations according to the analysis techniques in ANSI Z136.1-2007 and ANSI Z136.6-2005?

NRP spacecraft could carry Earth-pointing laser systems as part of scientific instrumentation and optical communication systems. Laser systems on NRP spacecraft must meet performance criteria that eliminate the potential for the laser energy to present a health hazard for persons on the ground or in aircraft. Laser systems that would operate only in interplanetary space or in orbit around other planets are not required to meet the eye-safe requirement if they have systems that would prevent use when pointing toward Earth. Section 4.1.2.1 documents the laser safety standards and the required notifications and permits that must be obtained prior to use of Earth-pointing laser systems.

E7. Would the candidate spacecraft contain pathogenic microorganisms (including bacteria, protozoa, and viruses) which can produce disease or toxins hazardous to human health or the environment beyond Biosafety Level 1 (BSL 1)?[6]

The use of biological agents on payloads is limited to materials with a safety rating of "Biosafety Level 1."

F1. Would the candidate spacecraft have the potential for substantial effects on the environment outside the United States?

If the launch or operation of the candidate spacecraft in the course of normal operations might cause substantial effects outside of the United States, further analysis must be performed according to Executive Order 12114 (Environmental Effects Abroad of Major Federal Actions).

[6] The use of biological agents on payloads is limited to materials with a safety rating of "Biosafety Level 1." This classification includes defined and characterized strains of viable microorganisms not known to consistently cause disease in healthy human adults. Personnel working with Biosafety Level 1 agents follow standard microbiological practices, including the use of mechanical pipetting devices, no eating, drinking, or smoking in the laboratory, and required hand washing after working with agents or leaving a laboratory where agents are stored. Personal protective equipment, such as gloves and eye protection is also recommended when working with biological agents.

F2. Would launch and operation of the candidate spacecraft have the potential to create substantial public controversy related to environmental issues?

Based on prior NASA experience and associated reviews, spacecraft are considered routine in that they would not present any environmental impacts that are new or unusual and would not raise or be likely to create substantial public controversy related to environmental concerns.

F3. Would any aspect of the candidate spacecraft that is not addressed by the EPCs have the potential for substantial effects on the environment (i.e., previously unused materials, configurations or material not included in the checklist)?

Because the mass of a spacecraft is limited by what a launch vehicle can carry to a given orbit, the field of materials science continues to push toward lighter materials. In the near future, new materials might become available for use in spacecraft components or instruments. Based on best available information and test and predictive data, NASA would determine whether the proposed mission falls within the scope of this EA or if additional detailed NEPA analysis and documentation would be required.

2.1.3 NASA Routine Payload Launch Vehicles

NRP spacecraft would be launched using one of the launch vehicles listed in Table 2-2 and in the RPC (see Section 2.1.2 and Appendix C) that are approved for launch at CCAFS, VAFB, USAKA/RTS, WFF, or KLC. Launches with two or more payloads on a single launch vehicle would be provided NEPA compliance by this EA if together they do not exceed the EPCs. If together they would exceed the EPCs, additional NEPA review would be required.

Table 2-2 describes the type of motors and propellants associated with each of the launch vehicles proposed in this EA. Not all of the proposed launch vehicles in the following table can be launched from all of the proposed launch sites. Table 2-3 lists the current launch vehicles that could be launched from the proposed launch sites. In addition, Tables 2-4 through 2-8 list the current launch vehicles that can be launched from each specific launch.

Table 2-2 List of Expendable Launch Vehicles with Motor Types and Propellants

Name	Motor type	Potential Maximum Propellant
Athena Ic[a]	1st stage: Castor 120 solid motor 2nd stage: Castor 120 solid motor Orbit Adjust Module 3rd Stage: Castor 30 solid motor	48,596 kg (107,137 lb) AP/AI/HTPB 48,596 kg (107,137 lb) AP/AI/HTPB 435 kg (960 lb) hydrazine 12,814 kg (28,250lb)
Athena IIc[a]	1st stage: 2-Castor 120 solid motors 2nd stage Castor 120 solid motor Orbit Adjust Module 3rd Stage: Castor 30 solid motor	97,192 kg (214,274 lb) AP/AI/HTPB 48,596 kg (107,137 lb) AP/AI/HTPB 435 kg (960 lb) hydrazine 12,814 kg (28,250lb)
Athena III Class[b]	1st stage: 8 Castor 120 solid motors Orbit Adjust Module	388,768 kg (857,096 lb) AP/AI/HTPB 435 kg (960 lb) hydrazine
Atlas V	Single RD-180 engine – common core booster (CCB) Centaur upper stage (1 or 2 engines) 1 Strap-on solid rocket motor (SSRM) 5 SSRMs	195,311 kg (429,685 lb) LOX 88,778 kg (195,311 lb) RP-1 20,672 kg (45,500 lb) LOX and LH_2 46,494 kg (102,300 lb) HTPB each 232,470 kg (511,500 lb) HTPB
Atlas V-H	3 common core boosters	585,933 kg (1,289,055 lb) LOX

Name	Motor type	Potential Maximum Propellant
		266,334 kg (585,935 lb) RP-1
Delta II	1st stage: RS-27A main engine, 2 Rocketdyne venier engines 1 graphite epoxy motor (GEM) (GEM-40s) 9 GEMs 2nd stage: Aerojet AJ10-118K engine 3rd stage: Star-48B Motor	66,000 kg (145,000 lb) LOX 29,900 kg (65,700 lb) RP-1 11,765 kg (25,937 lb) HTPB 105,885 kg (233,433 lb) HTPB 2,064 kg (4,540 lb) A-50 3,922 kg (8,630 lb) NTO 2,009 kg (4,418 lb) HTPB
Delta II-H	1st stage: RS-27A main engine, 2 Rocketdyne venier engines 1 Large Diameter eXtra Long (LDXL) GEM-46 9 LDXL GEMs 2nd stage: Aerojet AJ10-118K engine 3rd stage: Star-48B Motor	66,000 kg (145,000 lb) LOX 29,900 kg (65,700 lb) RP-1 16,738 kg (36,900 lb) HTPB 150,642 kg (332,100 lb) HTPB 2,064 kg (4,540 lb) A-50 3,922 kg (8,630 lb) NTO 2,009 kg (4,418 lb) HTPB
Delta IV	Single Common Booster Core (CBC): 1st stage: Rocketdyne RS-68 engine 2nd stage: cryogenic Pratt & Whitney RL10B-2 engine (5-meter (m), 15.7-foot (ft) fairing = largest fuel load) 1 GEM-60 4 GEM-60s (maximum)	28,500 kg (62,700 lb) LH_2 171,000 kg (376,000 lb) LOX 23,377 kg (51,429 lb) LOX/ 3,896 kg (8,751 lb) LH_2 29,949 kg (65,888 lb) HTPB 119,796 kg (263,551 lb) HTPB
Delta IV-H	3 CBCs	85,500 kg (188,100 lb) LH_2/ 510,000 kg (1,128,000 lb) LOX
Falcon 1/1e	1st stage: SpaceX Merlin 2nd stage: SpaceX Kestrel	15,587 kg (34,362 lb) LOX/ 7,159 kg (15,782 lb) RP-1 2,695 kg (5,941 lb)LOX/ 1,142 kg (2,517 lb) RP-1
Falcon 9	1st stage: nine SpaceX Merlin engines 2nd stage: one SpaceX Merlin engine	179,562 kg (395,844 lb) LOX/ 81,648 kg (179,993 lb) RP-1 33,895 kg (74,722 lb) LOX/ 15,120 kg (33,332 lb) RP-1
Minotaur 1-III	1st stage: Minuteman II M-55A-1 2nd stage: Minuteman II SR-19-AJ-1 Orion-50-XLG 3rd stage: Pegasus XL Orion-50XL 4th stage: Pegasus XL Orion-38 Additional motors that could be a 3rd, 4th, or 5th stages: Hydrazine Auxiliary Propulsion System (HAPS) M57A-1 SR73-AJ-1 Star 48 G (upper bounding case)	20,788 kg (45,830 lb) AP/Al 6,238 kg (13,753 lb) AP/AI/CTPB 15,072 kg (33,227 lb) AP/AI/HTPB 3,916 kg (8,633 lb) AP/AI/HTPB 771 kg (1,699 lb) AP/HI/HTPB 59 kg (130 lb) liquid hydrazine and pressurized helium gas. 1,660 kg (3,660 lb) AP/Cyclotetramethylene, Tetranitramine, Al, Nitrocellulose, Nitroglycerine, Triacetin 3,307 kg (7,290 lb) CTBP 2,010 kg (4,040 lb) HTPB
Minotaur IV-V	1st stage: Peacekeeper SR-118 2nd stage: Peacekeeper SR-119 3rd stage: Peacekeeper SR-120	44,662 kg (98,462 lb) AP/Al/HTPB 24,557 kg (54,138 lb) AP/Al/HTPB 7,069 kg (15,584 lb) AP/AI/Cyclotetramethylene

Name	Motor type	Potential Maximum Propellant
		Tetranitramine, Nitroglycerine, Polyethylene Glycol
	4th stage: Orion 38 or Star 48 motor	771 kg (1,699 lb) AP/Al/HTPB 2,010-2,430 kg (4,431-5,357 lb) AP/AI/HTPB
	5th stage: Star-37 HAPS propulsion system	1,066 kg (2,350 lb) AP/Al/HTPB 59 kg (130 lb) liquid hydrazine and pressurized helium gas
Pegasus XL	1st stage: Orion 50S XL 2nd stage: Orion 50 XL 3rd stage: Orion 38	15,048 kg (33,105 lb) HTPB 3,934 kg (8,655 lb) HTPB 770 kg (1,697 lb) HTPB
Taurus	0 stage: Castor 120 1st stage Orion 50S-G 2nd stage: Orion 50 3rd stage: Orion 38	50,000 kg (110,000 lb) HTPB 12,152 kg (26,734 lb) HTPB 3,029 kg (6,664 lb) HTPB 7771 kg (1,710 lb) HTPB
Taurus II	1st stage: 2 AJ26-62 engines	177,436 kg (391,179 lb)LOX/ 65,000 kg (142,33 lb) RP-1 12,814 kg (28,250 lb) HTPB 18,597 kg (41,000 lb) LOX/ 6,803 kg (15,000 lb) RP-1
	2nd stage: ATK Castor-30B SRM 2nd stage (optional): High Energy Second Stage (HESS) 3rd stage (optional) Orbit Raising Kit (ORK): 3rd stage (optional) Star 48V: SRM kick stage	322 kg (710 lb) NTO 358 kg (789 lb) MMH 2,010 kg (4,431 lb) HTPB
Titan II[c]	1st stage: LR-87 liquid engine	40,855 kg (89,941 lb) A-50/ 77,279 kg (170,015 lb) of NTO
	2nd Stage: LR-91 liquid engine	9,781 kg (21,519 lb) of A-50 / 17,176 kg (37,787 lb) of NTO
	Attitude Control System	~41 kg (90 lb) hydrazine

a. Are to be available for launch as of 2012,.
b. Plans are in work to make the Athena III available in the near term for launch of NASA payloads
c) Retired from service, but included for comparison and bounding cases.

Key: A-50=Aerozine-50; AP/Al=Ammonium Perchlorate, Polybutadiene-Acrylic acid-Acrylonitile/Aluminum powder; CTPB=Carboxyl-Terminated Polybutadiene, a solid propellant; HTPB=Hydroxyl-Terminated Polybutadiene, a solid propellant; LH_2=liquid hydrogen; LOX=liquid oxygen; MMH=monomethylhydrazine; NTO=Nitrogen-Tetroxide; RP-1=Rocket Propellant-1; SRM=Solid rocket motor.

Source: Boeing 2010a, 2010b; LM 2003; USAF 2005, 2006, 2007; USASMDC 2003, 2007.

Table 2-3 Launch Vehicles and Launch Sites

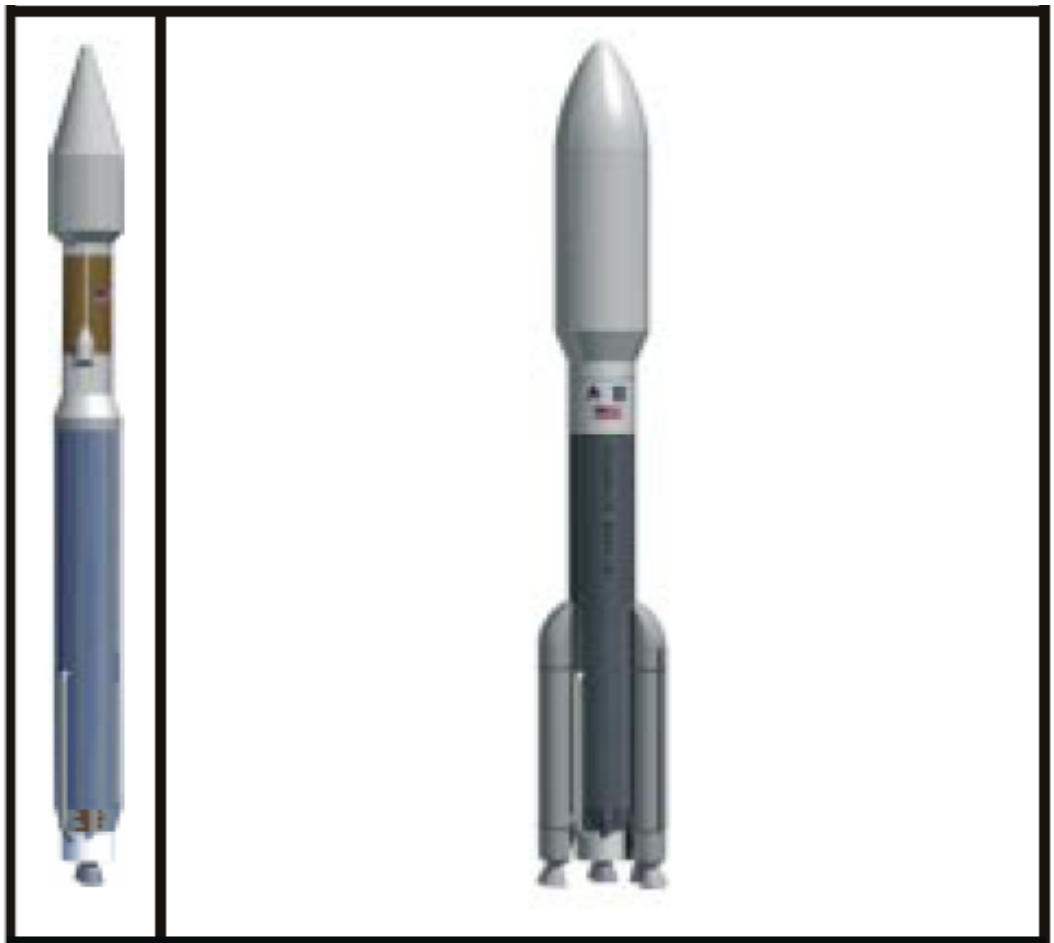
Launch Vehicle and Launch Vehicle Family	Space Launch Complexes and Pads				
	Eastern Range (CCAFS)	Western Range (VAFB)	USAKA/RTS	WFF	KLC
Athena family	LC-46	CA Spaceport	N/A	Pad 0	LP-1[a]
Atlas V Family	LC-41	SLC-3	N/A	N/A	N/A
Delta II Family	LC-17	SLC-2	N/A	N/A	N/A
Delta IV Family	LC-37	SLC-6	N/A	N/A	N/A
Falcon 1/1e	LC-36	SLC-4W	Omelek Island	Pad 0	LP-3[b]
Falcon 9	LC-40	SLC-4E	Omelek Island	Pad 0	LP-3[b]
Minotaur I	LC-20 and/or LC-46	SLC-8	N/A	Pad 0	LP-1
Minotaur II-III	LC-20 and/or LC-46	SLC-8	N/A	Pad 0	LP-1
Minotaur IV	LC-20 and/or LC-46	SLC-8	N/A	Pad 0	LP-1
Minotaur V	LC-20 and/or LC-46	SLC-8	N/A	Pad 0	LP-1
Pegasus XL	CCAFS skidstrip KSC SLF	VAFB Airfield	Kwajalein Island	WFF Airfield	N/A
Taurus	LC-46 or -20	SLC-576E	N/A	Pad 0	LP-1
Taurus II	N/A	N/A	N/A	Pad 0	LP-3[b]
Any other launch vehicle/launch site combination for which NASA has completed or cooperated on the NEPA compliance.					

a. except for Athena III, which is currently in the design phase.
[B.]LP-3 is currently in design.
KEY: CA=California; CCAFS=Cape Canaveral Air Force Station; KSC=Kennedy Space Center; LC=Launch Complex; LP=Launch Pad; MARS=Mid-Atlantic Regional Spaceport; SLC=Space Launch Complex; SLF=Shuttle Landing Facility; USAKA/RTS=United States Army Kwajalein Atoll/Reagan Test Site; VAFB=Vandenberg Air Force Base; WFF=Wallops Flight Facility.
Source: FAA 1993, 2004b; NASA 2005, 2009; USAF 2003; 2005, 2006, 2007; USASMDC 2003, 2007: LM 2010a; OSC 2009a-b.

2.1.3.1 The Atlas Launch Vehicle Family

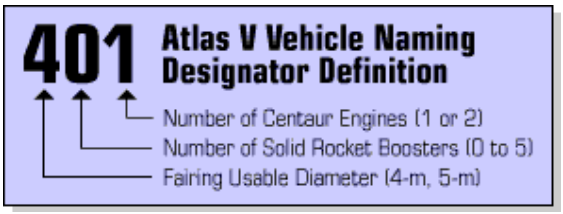
Since the Atlas II and Atlas III launch vehicles have been retired from service, the Atlas group of launch vehicles (Figure 2-3) now is solely composed of the Atlas V (400 and 500 Series). The Atlas V launch vehicle system is based on the newly developed common core booster (CCB) powered by a single RD-180 engine; its inaugural flight occurred in August 2002. The CCB propellant tanks hold a total of 284,089 kilogram (kg) (625,000 pound [lb]) of liquid oxygen (LOX) and Rocket Propellant-1 (RP-l). Using the total propellant capacity of 284,089 kg (625,000 lb) of LOX and RP-1 combined and the propellant ratio of 2.2:1 for oxidizer to fuel, the propellant capacity is 195,311 kg (429,685 lb) LOX and 88,778 kg (195,311 lb) RP-1.

The Atlas V 400 series uses a 4 meter (m) (13 feet [ft]) diameter payload fairing while the Atlas V 500 series uses a 5 m (16 ft) diameter payload fairing. Both the 400 and 500 series vehicles use a stretched version of the Centaur as an upper stage. The Centaur can be configured with one or two engines and holds a total of 20,672 kg (45,500 lb) of LOX and liquid hydrogen (LH_2).



Atlas V 400			Atlas V 500			
401	501	511	521	531	541	551
Performance to GTO, kg (lb)						
4,950	3,970	5,270	6,285	7,200	7,980	8,670
(10,913)	(8,752)	(11,618)	(13,856)	(15,873)	(17,593)	(19,114)

Performance to Low Earth Orbit (LEO), kg (lb)		
401	**431**	**551**
12,500 (27,558)	13,620 (30,020)	18,500 (40,780)



Source: LM 2010a.

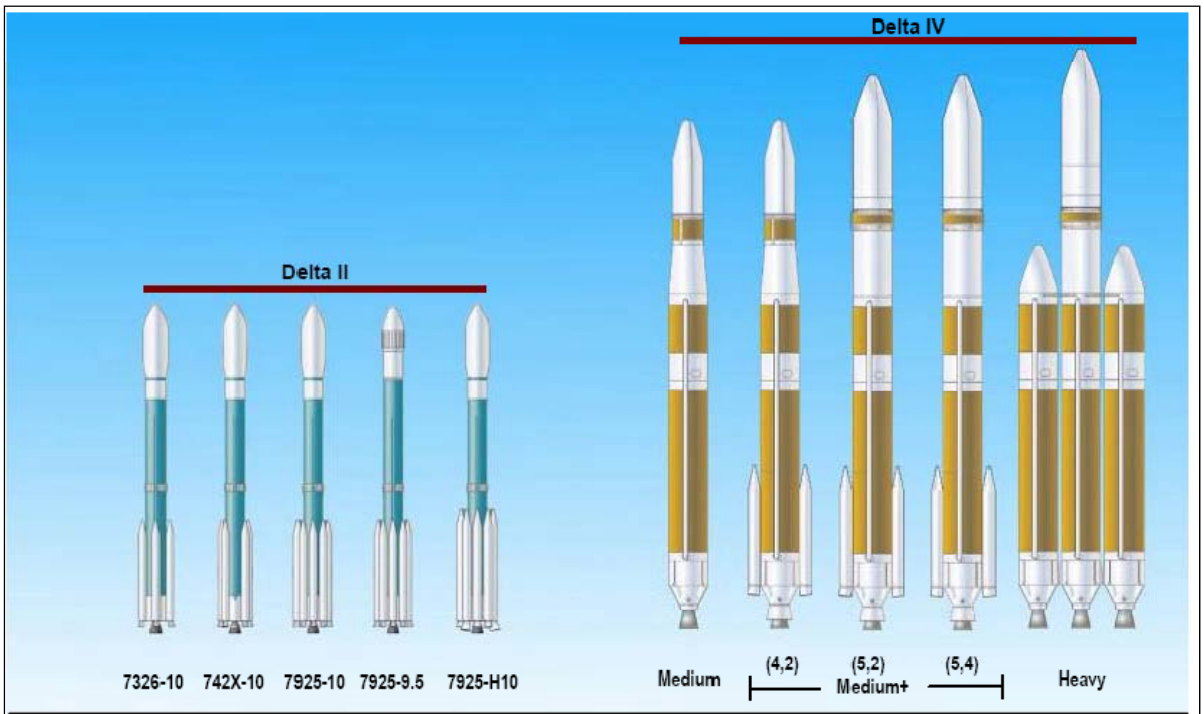
Figure 2-3 Atlas V Family of Launch Vehicles and Payload Mass that can be Lifted to Specific Orbits

The Atlas V 500 vehicles can also be supplemented with one to five strap-on SSRMs that are ignited on the ground. Each SSRM contains 46,494 kg (102,300 lb) of solid propellant. The Atlas V 400 series can lift payloads of up to 4,950 kg (10,900 lb) to Geosynchronous Transfer Orbit (GTO). Depending on the number of SSRMs employed, the Atlas V 500 series is capable of lifting payloads from 3,970 to 8,670 kg (8,700 to 19,100 lb) to GTO. The Atlas V launches from LC-41 at CCAFS and from Space Launch Complex (SLC) SLC-3W at VAFB (ILS 2004; LM 2005).

The Atlas V Heavy evolved ELV uses three CCB stages strapped together to provide the capability necessary to lift 12,650 kg (27,800 lbs) to GTO.

2.1.3.2 Delta Family of Launch Vehicles

The Delta Family (see Figure 2-4) consists of Delta II, IV, and Delta IV Heavy. The Delta III launch vehicle has been retired from service.



	7326-10	742X-10	7925-10	7925-9.5	7925-H10	Medium	(4,2)	(5,2) Medium+	(5,4)	Heavy
GTO (kg)	894	1,032	1,759	1,832	2,133	4,231	5,941	4,869	6,822	12,757
LEO (kg)	2,472	2,880	4,598	4,783	5,648	9,106	12,305	10,616	13,864	21,892
GEO (kg)						1,138	2,036	1,686	2,786	6,276

GTO = 185 x 35,786 km at 28.7 deg Delta II and 27.0 deg Delta IV. LEO = 407 km circular at 28.7 deg.
GEO = 35,786 km circular at 0 deg

Source: Boeing 1999.

Figure 2-4 Delta Family of Launch Vehicles and Payload Mass that can be Lifted to Specific Orbits

Delta II: The Delta II is a two- or three-stage launch vehicle with SSRMs. The Delta II may be flown in several configurations with variable numbers and types of SSRMs, as designated by the sequence of numbers, e.g., 2326, 2425, 2426, 2925, and 2925-Heavy. The first digit denotes that it is a Delta II; the second number denotes the number of SSRMs; and the third and fourth digits

denotes whether there is a third stage, and if so, which third-stage motor. A 2920 is a Delta II with nine SSRMs and no third stage. The 2326 is a Delta II with three SSRMs and Star-37 third stage. (Note: Figure 2-4 shows these vehicles with designations of 7XXX; however, a 7925 became a 2925 when Boeing renumbered the Delta II series during the Delta IV's development phase). The first stage of a Delta II is powered by a Boeing Rocketdyne-built RS-27A main engine, two Rocketdyne venire engines (roll and attitude control), and an optional Alliant Techsystems' solid rocket strap-on graphite-epoxy motors (GEMs) (added boost during liftoff). The propellant load for the first stage consists of 66,000 kg (145,000 lb) of LOX and 29,900 kg (65,700 lb) of RP-1.

Thrust is augmented by up to nine 1.02-m (40-in) diameter GEM SSRMs or, for the heavy vehicle, nine 1.17-m (46-in) diameter SSRMs (of the type formerly used on the Delta III). The solid propellant weight in each 1.0-m diameter GEM is 11,765 kg (25,937 lb). When nine GEMs are used, six GEMs are ignited on the ground (ground-lit), and the remaining three GEMs are ignited in the air (air-lit) after burnout of the first six. Other versions of the Delta II use three or four ground-lit SSRMs. The Delta II second stage has an Aerojet AJ10-118K engine that uses 2,064 kg (4,540 lb) of Aerozine-50 (A-50) as fuel and 3,922 kg (8,630 lb) of NTO as oxidizer. The Delta II often utilizes a third stage, which consists of a Thiokol Star solid rocket motor, usually a Star 48-B. Thiokol Corporation produced this motor, and it contains 2,009 kg (4,420 lb) of solid propellant.

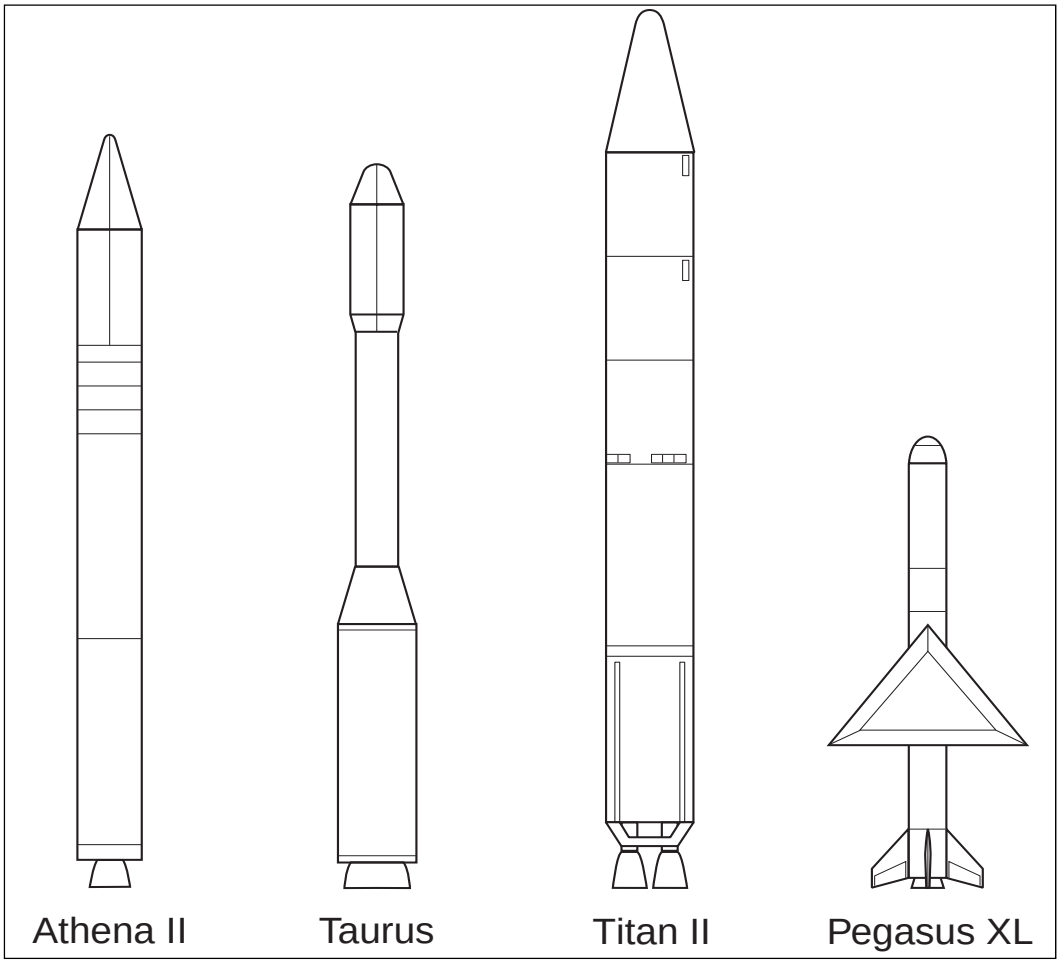
The Delta II is launched from Launch Complex (LC)-17 at CCAFS and from SLC-2 at VAFB. It provides a payload capacity of over 2,133 kg (4,702 lb) to GTO (Boeing 1999).

Delta IV: The Delta IV family is a suite of five two-stage launch vehicles designed to launch medium to heavy payloads. The five vehicles are the Delta IV Medium (Delta IV-M), three versions of the Delta IV Medium-Plus (Delta IV-M+), and the Delta IV Heavy (Delta IV-H). All five configurations are based on a common booster core (CBC) first stage that uses a Rocketdyne RS-68 engine powered by LH_2 and LOX. Using a total propellant mass of 199,600 kg (439,120 lb) and a ratio of 6:1 ratio for LOX to LH_2, the CBC first stage would use 28,500 kg (62,700 lb) of LH_2 and 171,000 kg (376,000 lb) of LOX. There are two second-stage configurations. The first configuration is a 4-m (13-ft or 157.5-inch) version (11,225 kg (24,750 lb) total propellant with a 6:1 ratio for LOX to LH_2) that is used on the Delta IV-M as well as the Delta IV-M+. The second configuration is a 5-m (16-ft or 197-inch) version (27,200 kg (60,000 lb) total propellant with a 6:1 ratio for LOX to LH_2) that is used on the Delta IV-M+ (5,2) as well as the Delta IV-H. Both second-stage configurations use the Delta III cryogenic Pratt & Whitney RL10B-2 engine. The Delta IV Medium is built around the CBC first stage and includes the baseline second stage derived from the 4-m (157.5-in) diameter Delta III, but with stretched fuel and oxidizer tanks for increased performance. It could lift up to 4,231 kg (9,328 lb) to GTO. The three versions of the Medium-Plus use the CBC and are augmented by either two or four strap-on solid rocket GEM-60s. Each GEM-60 contains 29,949 kg (65,888 lb) hydroxyl-terminated Polybutadiene (HTPB) propellant; four GEM-60s would contain 119,796 kg (263,552 lb) of HTPB propellant. The largest version of the Delta IV with four GEM-60s could lift 6,822 kg (15,040 lb) to GTO. The Delta IV Heavy joins together three CBCs and uses the larger Medium-Plus second stage engine and propellant tanks. It is designed to lift 12,757 kg (28,124 lb) to GTO and can lift over 23,000 kg (50,000 lb) to LEO.

The Delta IV family is launched from LC-37 at CCAFS and from SLC-6 at VAFB (Boeing 1999). The first Delta IV-M+ launch occurred in November 2002 and the first Delta IV Heavy launched in December 2004 from CCAFS.

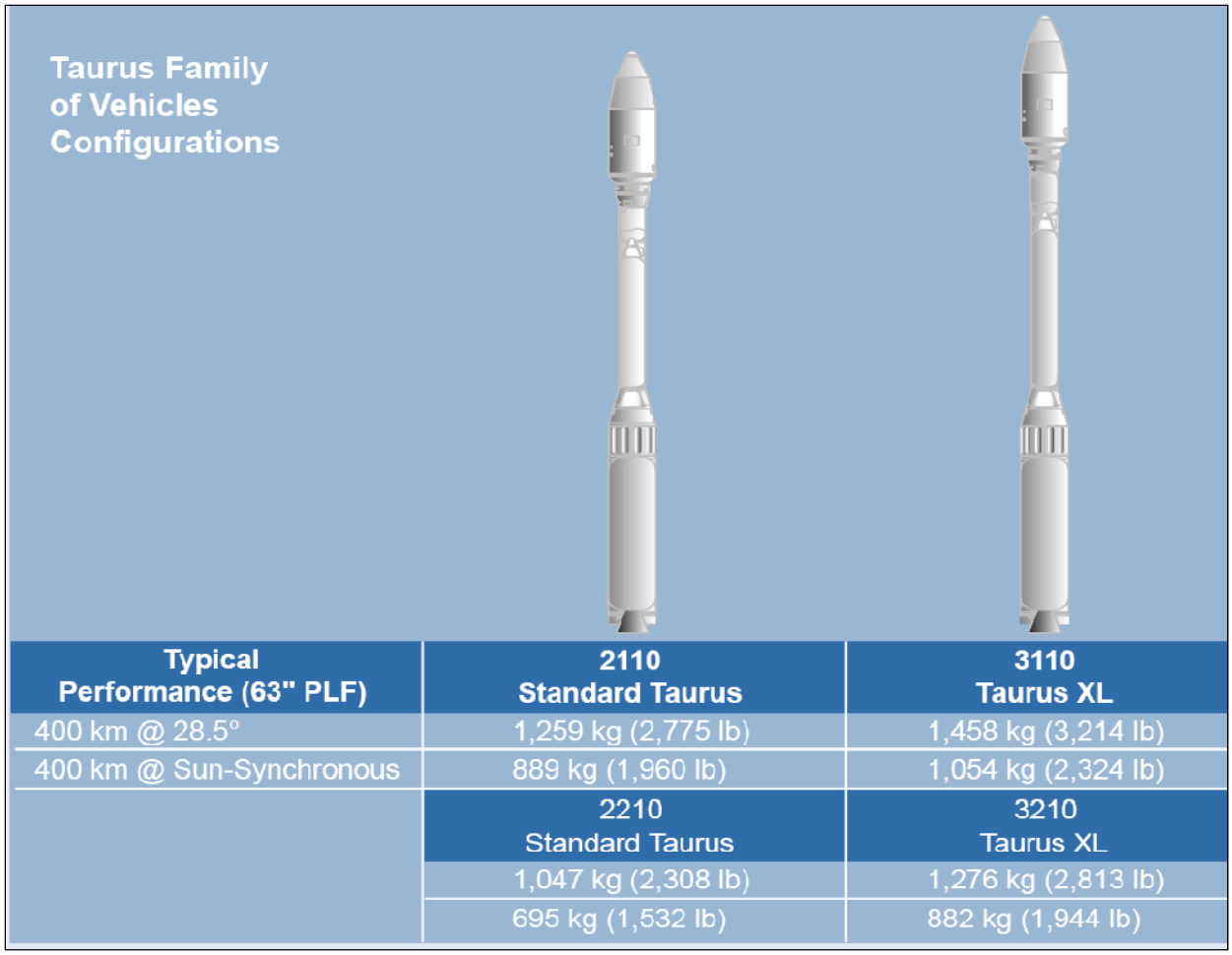
2.1.3.3 Taurus Launch Vehicle

The Taurus family of launch vehicles, manufactured by Orbital Sciences Corporation (OSC) (see Figures 2-5 and 2-6), include the Taurus Standard, the Taurus XL, and the Taurus II.



Source: *2002 NRP EA.*

Figure 2-5 Athena II, Taurus, Titan II, and Pegasus XL ELVs



Source: OSC 2007.

Figure 2-6 Taurus Launch Vehicle and Payload Mass that can be Lifted to Specific Orbits

Taurus Standard and Taurus XL

Both of these vehicles are powered by four solid-propellant stages. Stage 0 utilizes a Thiokol Castor-120 motor. The Taurus standard and XL upper stages (Stages 1, 2, and 3) are the Alliant Orion 50S, 50, and 38 motors, respectively. These motors were originally developed for the Pegasus launch vehicle and have been adapted for use on the Taurus. All four motors are loaded with solid propellant. Solid propellant quantities per stage are 50,000 kg (110,000 lb) for Stage 0, 12,152 kg (26,734 lb) for Stage 1, 3,029 kg (6,664 lb) for Stage 2, and 777 kg (1,710 lb) for Stage 3.

The Taurus Standard and Taurus XL are launched from LC-46 or LC-20 at CCAFS, from Facility 576E on north VAFB, from Pad 0 at WFF, and from LP-1 at KLC. Taurus Standard and XL launch vehicles can deliver satellites of up to 1,364 kg (3,000 lb) into LEO and payloads up to 409 kg (900 lb) into GTO (OSC 2003).

Taurus II Launch Vehicle

The Taurus II (see Figure 2-7 and 2-8) is a two-stage launch vehicle with a gross lift-off weight of 290,000 kg (639,340 lbs). Taurus II incorporates both solid and liquid stages; the first stage uses LOX and RP-1 as the propellants; the second stage is a Castor-30 SRM propelled by HTPB. The enhanced second stage is methane/LOX fueled. An optional third stage, which utilizes hydrazine and NTO can be added. It is designed to lift a maximum of 7,600 kg (16,755 lb) to LEO. OSC plans to launch the first Taurus II from WFF in 2011 (OSC 2009a). AAC has received approval to begin the construction of Launch Pad 3 (LP-3) for the purpose of launching liquid fueled rockets like the Taurus II. The Taurus II is launched from WFF and after construction of LP-3, and completion of environmental review, at KLC.

Source: NASA 2009b.

Figure 2-7 Artist's Rendering of Taurus II Launch Vehicle

VEHICLE CONFIGURATION	KILOGRAMS	KILOMETERS
Low-Earth Orbit (Circular)		
2 Stage	1,000 - 5,400	1,000 - 200
2 Stage Enhanced Second Stage	4,800 - 7,600	1,000 - 200
3 Stage	3,200 - 5,200	1,000 - 200
Earth Escape Energy		
3 Stage	350 - 2,050 (50 to - 5 km^2/sec^2)	185 (Perigee)

Source: OSC 2009a.

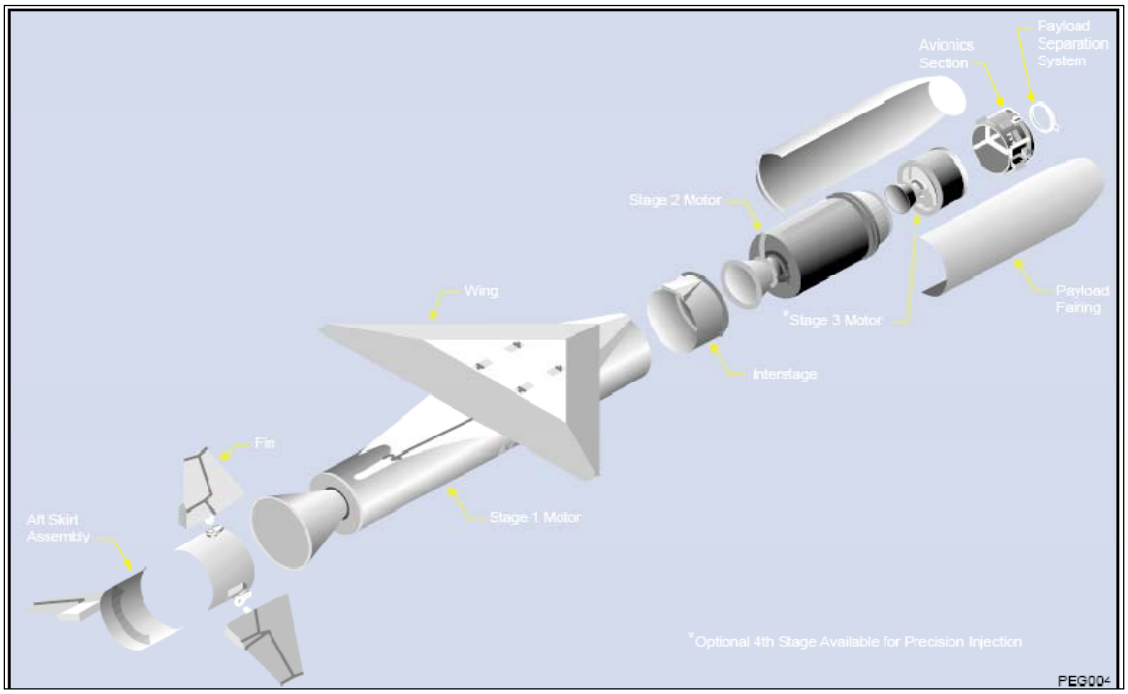
Figure 2-8 Taurus II Performance

2.1.3.4 Pegasus XL Air-Launched Vehicle

The Pegasus XL (see Figures 2-9 and 2-10), also manufactured by OSC, is a winged, three-stage, solid rocket booster that measures 16.9 m (55.4 ft) in length and has a wingspan of 6.7-m (22-ft). The Orbital Carrier Aircraft (OCA) (a specially equipped L-1011 airplane) lifts the Pegasus XL to a level flight condition of about 11,900 m (39,000 ft) and Mach 0.80. The Stage 1 motor ignition occurs about 5 seconds after release from the aircraft. This Stage 1 motor (Orion 50S XL) contains 15,048 kg (33,105 lb) of solid propellant. The Stage 2 motor (Orion 50 XL) contains 3,934 kg (8,655 lb) of solid propellant, and the Stage 3 motor (Orion 38) contains 777 kg (1,710 lb) of solid propellant. Pegasus also has the option for a liquid propellant fourth stage for increasing payload injection accuracy and payload capacity. This Hydrazine Auxiliary Propulsion System (HAPS) contains approximately 59 kg (130 lb) of hydrazine propellant. (OSC 2007)

Source: LASP 2003.

Figure 2-9 Pegasus Launching from an L-1011



Source: OSC 2007.

Figure 2-10 Pegasus Launch Vehicle

The primary integration site for Pegasus is at Orbital's Vehicle Assembly Building at VAFB. Payloads are received, processed, and mated with Pegasus at this facility. The integrated Pegasus is then transported to the VAFB airfield and mated with the L-1011 aircraft. The Pegasus is typically launched from the L-1011 in the Western Range (VAFB) off the California coastline. Alternatively, it can be launched from locations in the Eastern Range (CCAFS). Launches from the CCAFS, KLC, WFF, and USAKA/RTS would usually be supported by payload integration at VAFB. They could also be integrated at CCAFS or WFF, which would entail initial integration at VAFB of the Pegasus launch vehicle, without the payload, onto OCA aircraft, flying it to the alternate integration site, demating the Pegasus from the OCA, removing the payload faring, integrating it with the payload, reattaching the payload fairing, and reintegrating the Pegasus with the OCA (OSC 2007). The 3-stage Pegasus is capable of boosting small satellites weighing up to 455 kg (1,000 lb) into LEO. (OSC 2007)

2.1.3.5 Falcon Family of Launch Vehicles

The Falcon Launch Vehicle Program is a commercial venture by Space Exploration Technologies, Inc. (Space X), to develop launch vehicles to put payloads into orbit from launch facilities such as CCAFS, VAFB and USAKA/RTS. As of the preparation of this EA, the vehicles planned in the program are the Falcon 1/1e and the Falcon 9, as well as a Falcon 9 Heavy. The Falcon launch vehicles are two-stage vehicles, of which the first stage has a parachute and is intended to be recovered, and parts thereof reused. The second stage is intended to be expendable and would not be recovered. The Falcon launch vehicles use only liquid fuels, specifically, LOX and RP-1.

The Falcon launch vehicles would carry small payloads consisting mostly of non-hazardous materials. However, small amounts of ordnance, such as small explosive bolts, pressurized helium, and yet-to-be-defined batteries could be used in the payloads. The lift capability of the Falcon launch vehicle family is given in Figure 2-11.

Source: SpaceX 2011

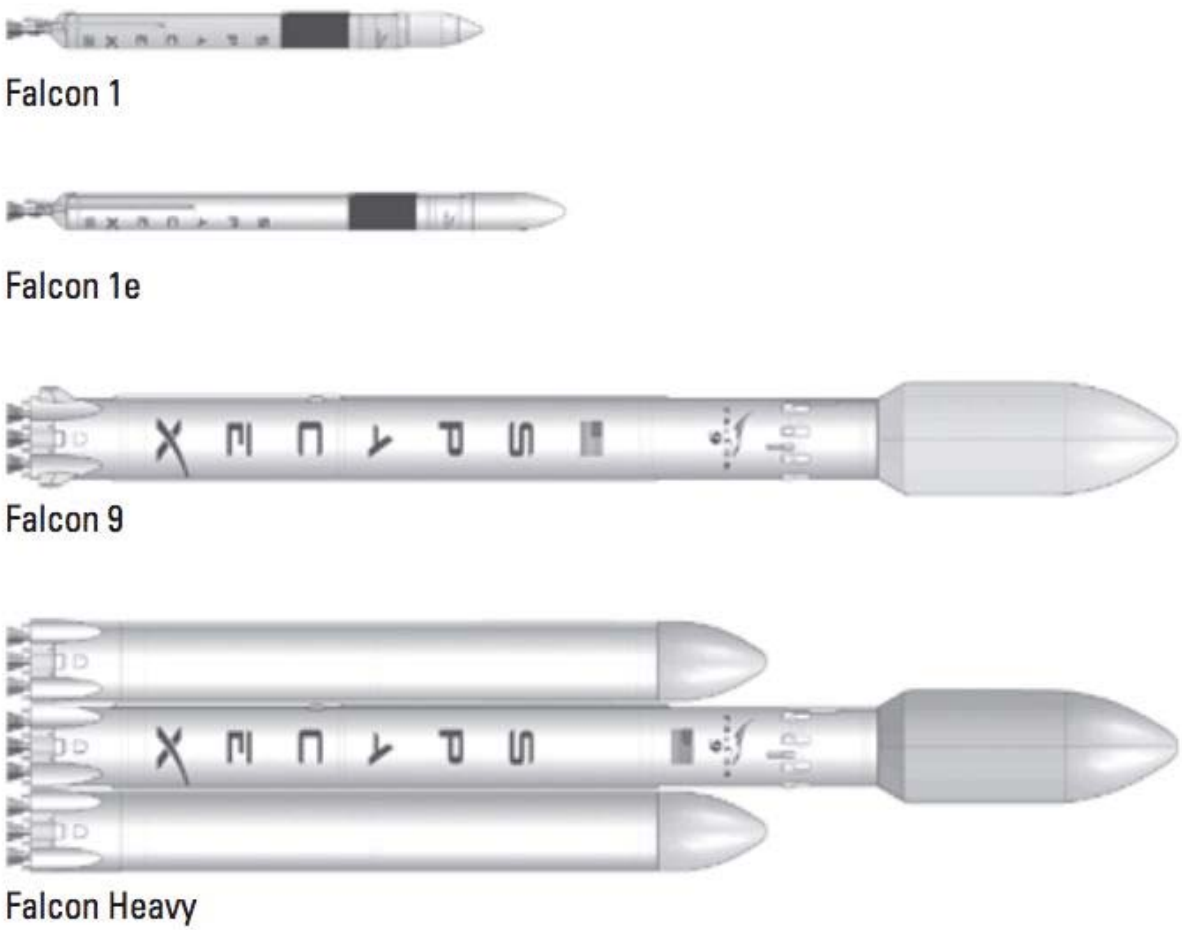


Figure 2-11 Falcon Family of Launch Vehicles.

Falcon 1/1e

The Falcon 1/1e is the smallest member of the Falcon family of launch vehicles (see Figure 2-11). It is a two-stage liquid-fueled rocket using a SpaceX Merlin (First stage) and a Space X Kestrel (Second stage) engine. It is about 21.3 m (70 ft) long, has a diameter of 1.7 m (5.5 ft), and a lift-off mass of 27,200 kg (60,000 lb). The Falcon 1/1e uses LOX and RP-1 to carry payloads into orbit. It is designed to lift up to 1010 kg (2,230 lb) into LEO. The Falcon 1/1e can be launched from CCAFS, VAFB, WFF, USAKA/RTS, and KLC after launch pad construction planned allowing direct launch to any inclination. Through the USAKA/RTS launch site on Omelek Island, Space X would be the only U.S. heavy lift provider with an equatorial launch location.

The first stage consists of LOX and kerosene tanks that hold 14,490 kg (31,940 lb) of LOX and 6,737 kg (14,850 lb) of RP-1. The second stage contains 2,511 kg (5,537 lb) of LOX and

1,083 kg (2,387 lb) of RP-1 in tanks with a common bulkhead. The Falcon launch vehicle uses helium gas stored in high-pressure composite over wrapped cylinders to pressurize the propellant tanks. Quantities of helium required for Falcon processing are 16.5 kg (36.9 lb) for first-stage pressurization, engine spin start, and purging and 9.8 kg (21.7 lb) for second-stage pressurization. The helium flow is controlled through solenoid valves.

Falcon 9

For the Falcon 9 launch vehicle, Space X plans to utilize the exact same first- and second-stage tank structure, with the only difference being the number of engines on the first stage. The Falcon 9 has nine Merlin engines clustered together. These vehicles are designed to be capable of sustaining an engine failure at any point in flight and still successfully completing its mission. This would result in a higher level of reliability than a single-engine stage. The nine-engine architecture is the evolved version of those employed by the Saturn V and Saturn I rockets of the Apollo Program, which had flawless flight records despite losing engines on a number of missions. CCAFS is the East Coast launch site for Falcon 9. KLC and VAFB are in discussion with SpaceX to become the West Coast launch site.

At the time of publication, only the Falcon 1/1e and Falcon 9 configurations are being developed and tested. Development of the Falcon 9 Heavy is underway to provide additional thrust to lift heavier payloads. It is designed to lift up to 32,000 kg (70,400 lb) into LEO and 19,500 kg (42,900 lb) into GTO. Falcon 9 can be launched from CCAFS, VAFB, USAKA/RTS, WFF, and KLC (after completion of environmental review and LP-3 construction).

2.1.3.6 The Minotaur Family of Launch Vehicles

The family of Minotaur space launch vehicles (SLVs) being produced for the USAF SMC under the Orbital/Suborbital Program (OSP) would provide a low-cost, reliable solution for launch services of government-sponsored payloads. All payload customers must be U.S. Government agencies or be sponsored by such agencies. The Secretary of Defense holds approval power for allowing the use of a Minotaur for each launch mission. If NASA were to use any of the Minotaur vehicles, the contract would remain between USAF and OSC (USAF 2006).

All versions of the vehicle utilize inertially guided 3- or 4-stage solid rocket propulsion. The Minotaur I and IV are capable of launching payloads into orbit, whereas the Minotaur II and III have a suborbital maximum range. These vehicles could be launched from CCAFS, VAFB, WFF, and KLC. At present, there are no Minotaur launches planned for USAKA/RTS. The avionics and flight software are highly common across all Minotaur family vehicles. The Minotaur V, a 5-stage version of the Minotaur IV, is discussed at the end of this section for completeness (USAF 2006).

A launch requirement forecast analysis indicates a maximum flight rate of six per year, beginning in 2006. All six annual launches could occur from just one of the four ranges (CCAFS, VAFB, WFF, or KLC), or be spread across the different ranges. VAFB and KLC would be capable of handling up to six launches per year, while CCAFS and WFF could support up to five launches per year (USAF 2006).

Under OSP, a wide variety of small and micro-satellites could be launched from any of the proposed launch sites into LEO, such that orbital paths could vary from equatorial to polar. Such orbits are generally 500 to 2,000 km (270 to 1,080 nautical miles [nmi]) above the earth's surface and are not in a fixed position (are not geostationary). Based on a 185-km (100-nmi) orbit insertion altitude, the Minuteman-derived launch vehicles would have a maximum payload capacity of approximately 545 kg (1,200 lb), while the larger Peacekeeper-derived vehicles (Minotaur IV-V) would have the ability to boost payloads weighing more than 1,750 kg (3,860 lb). As the orbit insertion altitude increases, the payload capacities of the vehicles decrease (USAF 2006).

Minotaur I

The Minotaur I SLV rocket (see Figure 2-12) is a ground-based variant of the air-launched Pegasus rocket, and is capable of launching up to 1,363 kg (3,005 lb) into a LEO and up to 363 kg (800 lb) into GTO. It is built by OSC and utilizes a combination of U.S. Government-supplied Minuteman II motors and existing OSC space launch technologies. The Minuteman rocket motors serve as the vehicles first and second stages, reusing motors that have been decommissioned as a result of arms reduction treaties (OSC 2006a; USAF 2006).

Source: OSC 2006a.

Figure 2-12 Minotaur I Launch Vehicle

Minotaur I's third and fourth stages, structures and payload fairing are common with the Pegasus XL rocket.

The Minotaur I made its inaugural flight in January 2000, successfully delivering a number of small military and university satellites into orbit. It launches from SLC-8 on south VAFB, from Pad 0 at WFF, and from Launch Pad 1 at KLC.

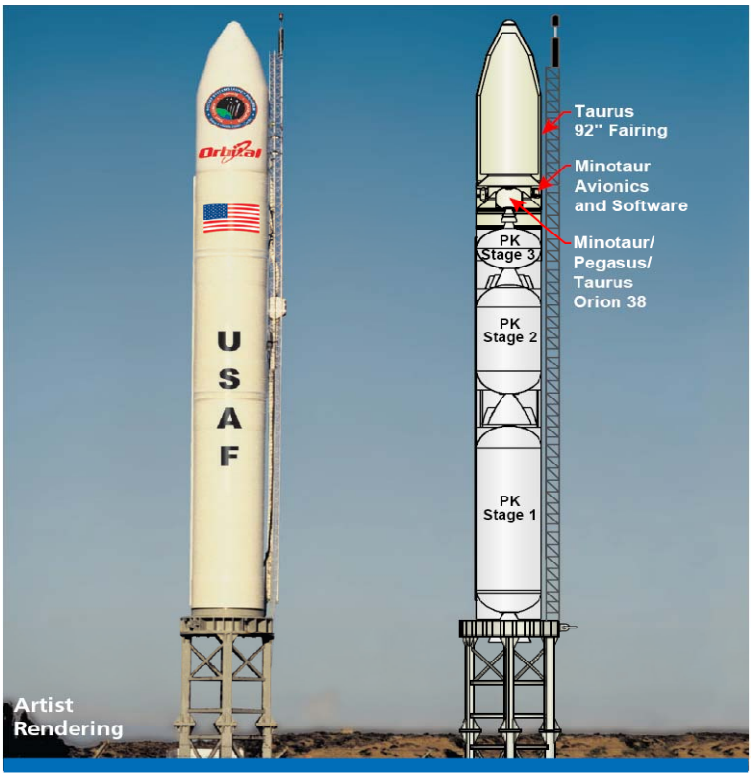
Based on a 185-km (100-nmi) orbit insertion, the Minotaur launch vehicles would have the capacity to lift approximately 545 kg (1,200 lb) to LEO.

Minotaur II-III

The Minotaur II and III are suborbital target vehicles, which utilize Minuteman II rocket motors for the first two stages and other Minuteman or commercial rocket motors for the third and fourth stages (if required). The first-stage contains 20,788 kg (45,810 lb) of ammonium perchlorate polybutadiene solid propellant. The second-stage contains 6,238 kg (13,753 lb) of ammonium perchlorate, carboxyl-terminated polybutadiene-based solid propellant, and 15,072 kg (33,227 lb) of ammonium perchlorate HTPB-based solid propellant. Third and fourth stages would also be solid propellant. See Table 2-2 for more information about the amounts of propellants for these optional upper stages (OSC 2006a; USAF 2006).

Minotaur IV

Minotaur IV SLV (Figure 2-13) combines elements of government-furnished decommissioned Peacekeeper boosters with technologies from Pegasus, Taurus, and Minotaur I launch vehicles. The vehicle consists of three Peacekeeper solid rocket stages, a commercial Orion 38 fourth stage motor and subsystems derived from OSC established space launch boosters.



Source: OSC 2006b.

Figure 2-13 Minotaur IV Launch Vehicle

The Minotaur IV SLV incorporates a standard 2.3-m (92-in) fairing from the Taurus booster and supports dedicated or shared launch missions. Capable of boosting payloads more than 1,750 kg (3,850 lb) into LEO orbit, the vehicle is compatible with multiple U.S. Government and commercial launch sites. The Minotaur IV is designed to provide an 18-month mission response, including payload integration and launch by OSC's launch crews (OSC 2006b; USAF 2006).

The first Minotaur IV launched the USAF's Space Based Surveillance System satellite successfully on September 25, 2010.

Minotaur V

The Minotaur V would be a five-stage version of the Minotaur IV launch vehicle that could carry small payloads into high-energy trajectories, including geosynchronous transfer orbits and translunar missions. The Minotaur V avionics, structures, and fairing are common with the Minotaur IV SLV, with relatively minor changes to create the five-stage configuration. Moreover, the avionics and flight software are highly common across all Minotaur family vehicles.

The first three stages of the Minotaur V would be the unmodified former Peacekeeper SRMs that would be provided by the USAF Rocket System Launch Program (RSLP). The fourth and fifth stages would be commercial motors that could be selected, depending on flight performance requirements. The stage-four motor would normally be a Star-48 V configuration (SRM). The fifth stage could be either attitude controlled or spinning. The attitude controlled version normally would use the same Orion-38 motor that has been used on multiple OSC launch

vehicles, including Pegasus, Taurus, and Minotaur 1. For a spin-stabilized configuration (i.e., a spacecraft that spins to maintain its 3-axis stabilization), a Star-37FMV motor with a gimbaled, flexseal nozzle would be used to provide maximum performance (OSC 2009b).

Based on an 185-km (100-mi) orbit insertion, the Minotaur IV and V vehicles would have the capacity to lift approximately 1,750 kg (3,860 lb) into LEO and between 544 and 640 kg (1,200 to 1,408 lb) to GTO. A representative envelope spacecraft was defined by the magnitudes of all of the envelope payload characteristics, all of which fall within the bounds of the EPCs of the NRP EA. Staying within OSP launch vehicle capabilities for placing satellites into LEO, the representative spacecraft would have a maximum weight of 1,815 kg (4,000 lb). (OSC 2009b)

2.1.3.7 Athena Family of Launch Vehicles

The Athena family in the 2002 NRP EA included the first generation of the I and II LVs. The Athena LVs in this update include the two-stage Athena Ic and three-stage Athena IIc, which are the upgraded second generation vehicles. Both the Athena Ic and IIc use an ATK CASTOR 120 solid rocket motor (SRM) for Stage I and the Athena IIc uses a second Castor 120 for the second stage. They have a newly-developed and ground-tested CASTOR 30 SRM for their upper stage, and modernized electronic systems. An Orbit Assist Module (OAM), containing 435 kg (960 lb) hydrazine of hydrazine, is available. Each Castor 120 motor contains 48,596 kg (107,137 lb) of solid rocket propellant (SRP). The Castor 30 motor contains 12,814 kg (28,250 lb) of SRP. Lockheed Martin and ATK have plans to make the Athena III LV available sometime in the near future. (FAA 2011)

The Athena launchers can provide launch services with a minimum performance capability of placing a 740-kilogram (1631 lb) spacecraft in a 185-kilometer low Earth orbit (LEO) at an inclination of 28.5 degrees. The Athena IIc can carry payloads up to 1,712 kg (3774 lb) to LEO. (FAA 2011) Utilizing a large volume 92-inch diameter payload fairing, the vehicle can accommodate a wide range of satellites and missions as well as lunar missions. (FAA 2011)

The Athena LVs can be launched from LC-46 on CCAFS, Pad 0 at WFF, the California Spaceport (SLC-8) on VAFB, and LP-1 on KLC.

2.1.4 Space Launch Complexes and Pads

NRP spacecraft would be launched only from existing space launch complexes at VAFB and CCAFS, and at the launch pads located at USAKA/RTS, WFF, and KLC

2.1.4.1 Launch Complexes — CCAFS

Launch vehicles that would launch from CCAFS are listed in Table 2-4. In the case of a launch vehicle family such as the Atlas V and Delta IV, it is important to note that different vehicles in the family can use different types of propellants, (i.e., the Atlas V 551 uses 5 SSRMs), in addition to the liquid propellants in its CCB, versus an Atlas V Heavy, which uses only liquid propellant CCBs. In these cases, the launch vehicles with the largest quantities of all types of propellants are listed. See Chapter 3, Figure 3-2 for a regional map of CCAFS.

Table 2-4 Launch Vehicles Launching from CCAFS

Launch Vehicle	Launch Complex	Propellant	
		Type	Quantity
Athena Ic, IIc, III[a]	LC-46	AP/AI/HTPB hydrazine	388,768 kg (857,096 lb) HTPB 435 kg (960 lb) hydrazine
Atlas V 551 (5 SRMs)	LC-41	LOX RP-1 LOX & LH AP/AI/HTPB	195,311 kg (429,685 lb) 88,778 kg (195,311 lb) 20,672 kg (45,500 lb) 232,470 kg (511,500 lb)
Atlas V-H	LC-41	LOX RP-1	585,933 kg (1,289,055 lb) 266,334 kg (585,935 lb)
Delta IV (4 SRMs)	LC-37	LH_2 LOX AP/AI/HTPB	32,395 kg (71,451 lb) 194,377 kg (427,429 lb) 119,796 kg (263,551 lb)
Delta IV-H	LC-37	LH_2 LOX	85,500 kg (188,100 lb) 510,000 kg (1,128,000 lb)
Delta II-H (includes Star-48B Solid Rocket Motor and 9 LDXL GEMs)	LC-17	LOX RP-1 A-50 NTO AP/AI/HTPB	66,000 kg (145,000 lb) 29,900 kg (65,700 lb) 2,064 kg (4,540 lb) 3,922 kg (8,630 lb) 169,389 kg (373,418 lb)
Falcon 1/1e and 9 (Note: quantities are for Falcon 9)	LC-40	LOX RP-1	198,645 kg (437,912 lb) 89,370 kg (197,017 lb)
Minotaur I-III (includes Star-48 class upper stage)	LC-20 & LC-46	AP/AI CTPB HTPB Liquid Hydrazine & pressurized helium gas AP/Cyclotetramethylene, Tetranitramine, Al, Nitrocellulose, Nitroglycerine, Triacetin	20,788 kg (45,830 lb) 9,545 kg (21,043 lb) 27,169 kg (47,332 lb) 59 kg (130 lb) 1,660 kg (3,660 lb)
Minotaur IV-V (Star 48 class 4th stage, and for Minotaur V, Star 37 5th stage)	LC-20 & LC-46	AP/AI/HTPB AP/AI/Cyclotetramethylene Tetranitramine, Nitroglycerine, Polyethylene Glycol liquid hydrazine and pressurized helium gas	72,330 kg (159,451 lb) 7,069 kg (15,584 lb) 59 kg (130 lb)
Pegasus XL	CCAFS skid strip	AP/AI/HTPB	19,752 kg (43,457 lb)
Taurus	LC-46 or LC-20	AP/AI/HTPB	65,958 kg (145,108 lb)

a. Athena III launch vehicle is in the design phase.

Source: Compiled from various launch vehicle and launch site references in Chapter 6

LC-17 — is located in the southeastern section of CCAFS. It consists of two launch pads (17A and 17B), a blockhouse, ready room, shops, and other facilities necessary to prepare, service, and launch the Delta II and, in the past, Delta III vehicles. The Delta II is launched from both pads.

LC-20 provides a processing and launch capability for small-scale rockets. This capability is currently being augmented with additional facilities for NASA's Advanced Technology Development Center (ATDC), which will provide resources for the research, development, demonstration, testing, and qualification of spaceport and range technologies (NASA, 2001b). Initial development of the ATDC should be completed in 2006. Conducting OSP launches from LC-20 would require approval from NASA, and sharing use of the launch complex with ATDC operations.

LC-36 — is located near the tip of Cape Canaveral. According to the 2010 FAA Final Supplemental EA to the September 2008 EA for Space Florida Launch Site Operator License, in 2005 and 2006, much of LC-36 and its associated infrastructure were demolished. Presently, densely vegetated, undeveloped land immediately surrounds LC-36 and a paved road provides access to the site. Redevelopment activities at LC-36 would include building access roads; erecting a security fence; reconstituting several existing facilities; constructing an elevated launch deck, associated flame ducts, water storage tank, and water deluge containment pool; and installing electrical communication, and air systems.

LC-37 — is located in the northeastern section of CCAFS between LC-36 and LC-41. It consists of one launch pad (Pad B), a mobile service tower, a common support building, a support equipment building, ready room, shops, and other facilities needed to prepare, service, and launch the Delta IV vehicles. The pad can launch any of the five Delta IV vehicle configurations (Boeing 2007).

LC-40 — is located at the north end of Cape Canaveral. The launch complex was used since early 1960 to support the Titan Program until the discontinuation of Titan launch operations in 2005. LC-40 is now being used by SpaceX to provide commercial launch operations for the Falcon family of launch vehicles. Various launch support buildings located at the site include a ready building, complex support building, protective clothing building, and refrigeration building. The complex also contains two security buildings, and is a restricted access area that is only accessible by authorized personnel. The complex is an Installation estoration Program (IRP) site and has recently undergone clean-up activities for poly-chlorinated biphenyl (PCB) contaminated soil which ended in April 2007. (USAF 2007)**LC-41** — is located on the northern end of CCAFS. Since the final Titan IV launched from CCAFS on April 2005, it has been reconfigured to support launches of Atlas V.

LC-46 — is a commercial launch pad located at the eastern tip of CCAFS near LC-36. The Florida Spaceport Authority (now Space Florida) converted it in 1997 to support orbital vertical launch systems, including Athena and Taurus. The launch site and Mobile Access Structure (MAS) are both available for commercial use. Through an agreement with the USAF and U.S. Navy, Space Florida shares LC-46 with the Naval Ordnance Test Unit. Many different types and sizes of launch vehicles can be accommodated at the complex. LC-46 offers approved vehicles payload lift capabilities for LEO in excess of 2,227 kg (4,900 lb). Current infrastructure

supports launch vehicles with maximum dimensions of 36 m (120 ft) in height, and multiple vehicle/payload diameters between 125 to 300 centimeters (cm) (50 and 120 inches [in]).

LC-47 — Space Florida has secured a real property license from the 45th Space Wing (45 SW) in order to operate and maintain LC-47. Space Florida plans to be sponsoring a number of Florida-based higher education academic institutions and businesses that would train future aerospace technicians, and conduct research in support of university aerospace programs, as well as research and development activities for potential U.S. Department of Defense (DoD) and NASA programs. These efforts would include processing and launch of the type of small rockets historically launched from LC-47. The 45 SW, Florida Space Institute (FSI), University of Central Florida (UCF), and Brevard Community College are partners in this launch site endeavor. Space Florida is acting as the liaison between the customers listed above and the appropriate agencies within the 45 SW in support of any upcoming launch activity.

2.1.4.2 Space Launch Complexes at VAFB

Launch vehicles that would launch from VAFB are listed in Table 2-5. In the case of a launch vehicle family such as the Atlas V and Delta IV, it is important to note that different vehicles in the family can use different types of propellants. In these cases, the launch vehicles with the largest quantities of both types of propellants are listed. See Chapter 3, Figure 3-4 for a regional map of USAKA/RTS.

Table 2-5 Launch Vehicles Launching from VAFB

Launch Vehicle	Launch Complex	Propellant	
		Type	Quantity
Atlas V 551 (5 SSRMs)	SLC-3	LOX RP-1 LOX & LH AP/AI/HTPB	195,311 kg (429,685 lb) 88,778 kg (195,311 lb) 20,672 kg (45,500 lb) 232,470 kg (511,500 lb)
Atlas V-H	SLC-3E	LOX RP-1	585,933 kg (1,289,055 lb) 266,334 kg (585,935 lb)
Athena Ic, IIc, III[a]	N/A	AP/AI/HTPB hydrazine	388,768 kg (857,096 lb) 435 kg (960 lb)
Delta II-H (includes Star-48B Solid Rocket Motor and 9 LDXL GEMs)	SLC-2	LOX RP-1 A-50 NTO AP/AI/HTPB	66,000 kg (145,000 lb) 29,900 kg (65,700 lb) 2,064 kg (4,540 lb) 3,922 kg (8,630 lb) 169,389 kg (373,418 lb)
Delta IV (4 SRMs)	SLC-6	LH_2 LOX AP/AI/HTPB	32,395 kg (71,451 lb) 194,377 kg (427,429 lb) 119,796 kg (263,551 lb)
Delta IV-H	SLC-6	LH_2 LOX	85,500 kg (188,100 lb) 510,000 kg (1,128,000 lb)
Falcon 1/1e	SLC-4W	LOX RP-1	18,282 kg (40,303 lb) 8,301 kg (18,300 lb)
Falcon 9	SLC-4E	LOX RP-1	198,645 kg (437,912 lb) 89,370 kg (197,017 lb)
Minotaur I-III	SLC-8	AP/AI	20,788 kg (45,830 lb)

Launch Vehicle	Launch Complex	Propellant	
		Type	Quantity
(includes Star-48 class upper stage)		CTPB HTPB Liquid Hydrazine & pressurized helium gas AP/Cyclotetramethylene, Tetranitramine, Al, Nitrocellulose, Nitroglycerine, Triacetin	9,545 kg (21,043 lb) 27,169 kg (47,332 lb) 59 kg (130 lb) 1,660 kg (3,660 lb)
Minotaur IV-V (includes Star-48 class 4th stage and for Minotaur V, Star-37 5th Stage)	SLC-8	AP/AI/HTPB AP/AI/Cyclotetramethylene Tetranitramine, Nitroglycerine, Polyethylene Glycol liquid hydrazine and pressurized helium gas	72,330 kg (159,451 lb) 7,069 kg (15,584 lb) 59 kg (130 lb)
Pegasus XL	VAFB airfield	AP/AI/HTPB	19,752 kg (43,457 lb)
Taurus Std & XL	SLC-576E	AP/AI/HTPB	65,958 kg (145,108 lb)
Titan II	N/A	A-50 NTO Hydrazine	50,637 kg (111,634 lb) 94,455 kg (208,235 lb) ~ 41 kg (90 lb)

a.Athena III launch vehicle is in the design phase.

Note: N/A=launch pad not applicable because the launch vehicle has either been retired from service or is not currently in service.

Source: Compiled from various launch vehicle and launch site references in Chapter 6

SLC-2 — is located on north VAFB. It consists of one launch pad, a blockhouse, a Delta operations building, shops, a supply building, and other facilities necessary to prepare, service, and launch the Delta II vehicle. SLC-2 is also known as SLC-2W, which is the only active pad at this complex.

SLC-3 — is located on south VAFB. It consists of two launch pads: SLC-3 East and SLC-3 West. SLC-3 East was upgraded in 1996 to support launches of Atlas IIA and Atlas IIAS, and again in 2007 to support Atlas V. Major facilities at SLC-3 East include the mobile service tower, the launch support building, the umbilical tower, and a launch operations building. The Atlas launch control center has been relocated from the existing SLC-3 blockhouse to a remote location on north VAFB.

SLC-4 — is located on south VAFB. It consists of two launch pads. SLC-4 West is configured to launch the Titan II. SLC-4 East will be configured to launch SpaceX Falcon 9.

SLC-6 — is located on south VAFB near Point Arguello. It consists of one launch pad, the Delta Operations Center, an integrated processing facility, a support equipment building, a horizontal integration facility, and other facilities necessary to prepare, service, and launch the Delta IV vehicles.

California Spaceport (SLC-8) — The California Spaceport is located on south VAFB immediately south of SLC-6. It is a commercial launch site leased from the USAF and is

designed to launch small vehicles such as the Athena. The launch facility includes an exhaust duct with steel frame and a launch ring. There is also a support equipment building, a launch equipment vault, a mobile scaffold tower, a launch control room (SLC-6), and a large item storage facility.

SLC 576E — Complex 576E is located on north VAFB and is the primary launch facility for the Taurus standard and XL launch vehicles at VAFB. The facility was formerly used for launching Atlas ICBMs. It is relatively austere with few permanent structures. It consists of a launch pad, lighting towers, and camera towers. Launch support equipment is installed at the launch pad prior to launch. This equipment includes a launch stand, scaffolding, and an integration tent.

2.1.4.3 Launch Pad at USAKA/RTS

Five types of rockets are presently launched from USAKA/RTS: meteorological rockets, sounding rockets, SLVs, the Pegasus XL, and the Falcon launch vehicle. NASA could launch NRP spacecraft from USAKA/RTS on the launch vehicles listed in Table 2-6. See Chapter 3, Figure 3-4 for a map.

Table 2-6 Launch Vehicles Launching from USAKA/RTS

Launch Vehicle	Launch Pad	Propellant	
		Type	Quantity
Falcon 1/1e	Omelek Island	LOX RP-1	18,282 kg (40,303 lb) 8,301 kg (18,300 lb)
Falcon 9	Omelek Island	LOX RP-1	198,645 kg (437,912 lb) 89,370 kg (197,017 lb)
Pegasus XL	Kwajalein Island	AP/AI/HTPB	19,752 kg (43,457 lb)

Source: Compiled from various launch vehicle and launch site references in Chapter 6.

The Falcon launch vehicles would be launched from the USAKA/RTS site on Omelek Island. Space X built a new 12-m by 12-m by 0.3-m (40-ft by 40-ft by 1-ft) launch pad at Omelek, which includes an impermeable berm (a minimum of 5 cm [2 in] high) to contain an accidental release of kerosene prior to launch. The berm has a section of removable curb. Once the Falcon launch vehicle is positioned on the launch pad, the removable curb is replaced and sealed with a rubber seal that either is a part of the curb or put in after the curb is in place. (Malleable rubber curbs are commonly used to contain fluids and spills). The berm is of sufficient height to contain up to approximately 7,570 liters (2,000 gallons [gal]) of deluge water spray used during launch. A valved drainage system allows rainwater drainage when the pad is not in use.

The Falcon would carry small payloads consisting mostly of non-hazardous materials. However, small amounts of ordnance, such as small explosive bolts, pressurized helium, and yet-to-be-defined batteries could be used in the payloads.

Pegasus XL vehicles would be launched from Kwajalein Island at USAKA/RTS. The Pegasus would undergo payload processing and be mated to the L-1011 at VAFB. The L-1011 would land at USAKA/RTS with the Pegasus fully assembled and attached to the aircraft.

2.1.4.4 Launch Pads at WFF

The WFF Launch Range includes Wallops Island and extends for 4.8 km (3 mi) over the Atlantic Ocean, using the surface area and airspace above to conduct flight operations. The principal Wallops Island facilities are those required to process, qualify, and launch rockets carrying scientific payloads on orbital or suborbital trajectories. Support facilities for the launch range include launch pads, launchers (mobile and fixed), blockhouses, rocket preparation and payload processing and integration buildings, dynamic balancing equipment, wind-measuring devices, communications and control instrumentation, television and optical tracking stations, surveillance and radar tracking units, and other facilities. The launch areas are located on the southern half of Wallops Island. Additional special-use facilities are located on the northern portion of Wallops Island. Occasionally, ground-based scientific equipment that requires isolation from other activities is temporarily located on the northern half of the island.

In 2005, NASA completed a sitewide EA for WFF providing NEPA compliance for the launch of approximately 82 rockets a year from the launch areas on Wallops Island. These include 50 from the sounding rocket program, 12 from orbital rocket missions, and 20 from Navy missiles and drones. The Wallops Island launch areas are located approximately 4 km (2.5 mi) from Wallops Mainland (NASA 2005a). In August 2009, NASA published an EA and FONSI for the expansion of the Wallops Flight Facility Launch Range (NASA 2009b). A maximum of six additional orbital-class launches per year would occur from Pad 0-A, resulting in a maximum of 18 orbital-class launches from Mid-Atlantic Regional Spaceport (MARS) (12 existing launches from Pad 0-B, and 6 additional launches from Pad 0-A under the expanded WFF Range). Launches may be conducted during any time of the year, and any time of the day or night. In addition to launches, static test firing of rocket engines would occur at Pad 0-A up to two times per year (NASA 2009b).

Three of the six launch pads at WFF can accommodate design loads rated up to a maximum of 22,727 kg (50,000 lb) and can support all types of launches. The remaining three launch pads are used for launching sounding rockets. In addition to the fixed launch sites, Wallops can support airborne launches. The Pegasus would launch from the Wallops Airfield. See Chapter 3, Figure 3-5 for a regional map of WFF.

Pad 1 is capable of launching up to 22,727 kg (50,000 lb) maximum load. It has a movable environmental shelter and a 13.9 kg (45.5 ft) overall boom length.

Launch Complex 0 - Virginia Commercial Space Flight Authority holds a Launch Site Operator License to operate the MARS at Launch Complex 0, which includes both Pad 0-A and 0-B, lies between the Atlantic Ocean and Hog Creek on the southern end of the island and is used for launching orbital rockets. Launches may be conducted during any time of the year and any time of the day or night.

Pad 0-A is multi-level launch complex for commercial launch vehicles with up to 90,909 kg (200,000 lb) maximum load. Originally designed for the Conestoga launch vehicle, which was

launched once in October 1995 and has since been retired from service, Pad 0-A has since been inactive. Its launch service gantry (a large vertical structure with platforms at different levels used for erecting and servicing ELVs before launch) and portions of the existing launch pad were removed in fall 2008, rendering Pad 0-A unusable for launching until a new gantry is built. In August 2009, WFF published an EA for the Expansion of the Wallops Flight Facility Launch Range (NASA 2009b). A new MARS launch complex, including a pad access ramp, launch pad, and deluge system is being built in the same location as the existing Pad 0-A. The Taurus II will be the largest launch vehicle to launch from this pad. The combined improvements to Pad 0-A will result in an overall pad complex footprint of approximately 2.8 hectares (6.8 acres). New construction would add approximately 1.5 hectares (3.7 acres) of impervious surface (primarily concrete).

Pad 0-B is a 1,766-m^2 (19,000-ft^2) pad with a 31-m (102-ft)-high service tower (gantry), which supports the launching of vehicles with gross lift-off weights up to 227,273-kg (500,000-lb) into orbit. Vehicle and payload handling within the pad and service tower area are accomplished by a transporter-erector vehicle and a mobile crane.

NASA could launch NRP spacecraft from WFF on the launch vehicles listed in Table 2-7. For launch vehicle families, only the launch vehicle with the largest propellant load is listed. See Chapter 3, Figure 3–5 for a map of WFF.

Table 2-7 Launch Vehicles Launching from WFF

Launch Vehicle	Launch Pad	Propellant	
		Type	Quantity
Athena III[a] Class	0	AP/AI/HTPB Hydrazine	398,547 kg (878,654 lb) 435 kg (960 lb)
Falcon 1/1e, & 9	0	LOX RP-1	198,645 kg (437,912 lb) 89,370 kg (197,017 lb)
Minotaur I-III (includes Star-48 class upper stage)	0	AP/AI CTPB HTPB Liquid Hydrazine & pressurized helium gas AP/Cyclotetramethylene, Tetranitramine, Al, Nitrocellulose, Nitroglycerine, Triacetin	20,788 kg (45,830 lb) 9,545 kg (21,043 lb) 27,169 kg (47,332 lb) 59 kg (130 lb) 1,660 kg (3,660 lb)
Minotaur IV-V (includes Star-48 class 4th stage, and for Minotaur V Star 37 5th stage)	0	AP/AI/HTPB AP/AI/Cyclotetramethylene Tetranitramine, Nitroglycerine, Polyethylene Glycol liquid hydrazine and pressurized helium gas	72,330 kg (159,451 lb) 7,069 kg (15,584 lb) 59 kg (130 lb)
Pegasus XL	Wallops airfield	AP/AI/HTPB	19,752 kg (43,457 lb)
Taurus	0	AP/AI/HTPB	65,958 kg (145,108 lb)

Launch Vehicle	Launch Pad	Propellant	
		Type	Quantity
Taurus II (includes: 2nd stage (optional) High Energy Second Stage (HESS); 3rd stage (optional) Orbit Raising Kit (ORK) or Star 48V: solid kick motor)	0	LOX RP-1 AP/AI/HTPB[a] NTO MMH	177,436 kg (391,179 lb) 65,000 kg (142,33 lb) 14,824 kg (32,681 lb) 322 kg (710 lb) 358 kg (789 lb)

a. Athena III launch vehicle is in design..

Sources: OSC 2009a-b; USAF 2007: (USAF 2006), NASA 2009b

2.1.4.5 Launch Pads at KLC

NASA could launch NRP spacecraft from KLC on the launch vehicles listed in Table 2-8. For families of vehicles, only the launch vehicle with the largest fuel load is listed.

Table 2-8 Launch Vehicles Launching from KLC

Launch Vehicle	Launch Pad	Propellant	
		Type	Quantity
Athena I-II	LP-1	AP/AI/HTPB hydrazine	106,971 kg (235,818 lb) 435 kg (960 lb)
Falcon 1/1e & 9	LP-3[b]	LOX RP-1	198,645 kg (437,912 lb) 89,370 kg (197,017 lb)
Minotaur I-III (includes Star-48 class upper stage)	LP-1	AP/AI CTPB HTPB Liquid Hydrazine & pressurized helium gas AP/Cyclotetramethylene, Tetranitramine, Al, Nitrocellulose, Nitroglycerine, Triacetin	20,788 kg (45,830 lb) 9,545 kg (21,043 lb) 27,169 kg (47,332 lb) 59 kg (130 lb) 1,660 kg (3,660 lb)
Minotaur IV-V (includes Star-48 class 4th stage, and for Minotaur V Star-37 5th stage)	LP-1	AP/AI/HTPB AP/Cyclotetramethylene, Tetranitramine, Al, Nitrocellulose, Nitroglycerine, Triacetin Liquid Hydrazine & pressurized helium gas	72,230 kg (159,451 lb) 1,660 kg (3,660 lb) 59 kg (130 lb)
Pegasus XL	Wallops Airfield	AP/AI/HTPB	19,752 kg (43,457 lb)
Taurus	LP-1	AP/AI/HTPB	65,958 kg (145,108 lb)
Taurus II	LP-3[b]	LOX RP-1 AP/AI/HTPB* NTO	168,470 liters (44,505 gal) 81,247 liters (25,363 gal) 14,824 kg (32,681 lb) 322 kg (710 lb)

		MMH	358 kg (789 lb)

a. LP-3 is currently under design.

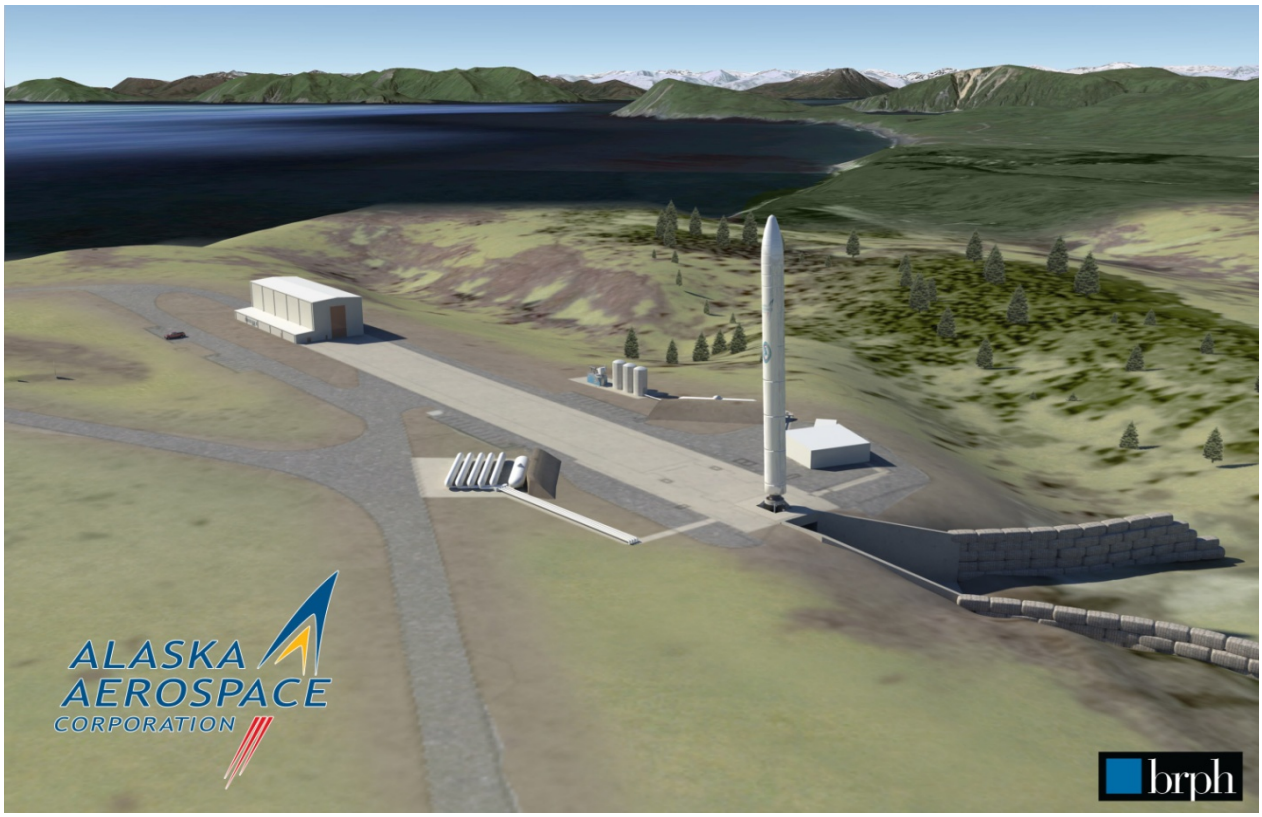
Source: Compiled from various launch vehicle and launch site references in Chapter 6

Launch Pad 1, suitable for launching orbital missions, is serviced by a 53-m (173-ft) enclosed and movable gantry called the Launch Service Structure (LSS). The LSS consists of the pad apron, a 6-m (20-ft) diameter throat by 12-m (40-ft) deep flame duct (a concrete tunnel jutting out from underneath the launch pad through which the rocket blast is channeled), and three main substructures: a fixed service structure, a rotating service structure, and a rotating service door. The substructures rotate around the launch stool, which allow launch vehicles and payloads to be readied for launch completely indoors, out of inclement weather.

This pad was designed to support up to Castor 120 boosted launch vehicles, including, but not limited to, Taurus and Minutemen orbiting and suborbital derivatives. The pad gantry height can accommodate future expansion to Delta class vehicles. This pad is designed for all-weather operations.

Launch Pad 2, suitable for suborbital launches, is enclosed and serviced by the Spacecraft and Assemblies Transfer (SCAT) facility. This pad is located about 122 m (400 ft) west of LSS and about 31 m (100 ft) east of the Integration and Processing Facility (IPF). It is capable of launching single and multi-stage combinations of Minuteman second- and third-stage (Minotaur) rockets and commercial Castor IV class boosters, such as the Athena III launch vehicle, is currently an inactive vehicle.

Launch Pad 3, suitable for launching orbital missions, would be serviced by a horizontal Vehicle Processing Facility (VPF) in close proximity to the launch pad specifically designed for liquid fueled buildings. The VPF and launch pad are currently in the design phase. AAC has received approval to begin construction. Figure 2-14 provides an artist's rendering of KLC LP-3.



Source: AAC 2011.

Figure 2-14 Artist Rendering of LP-3 at KLC

2.1.5 Payload Processing Facilities

NRP spacecraft would be prepared for launch using only existing facilities at CCAFS, KSC, VAFB, USAKA/RTS, WFF, or KLC.

2.1.5.1 Payload Processing Facilities in the CCAFS Area

Astrotech Satellite Processing Facility (SPF) — The SPF is located in Titusville, FL. It was designed and built specifically to accommodate evolved ELV payloads, both 4-m- and 5-m-class satellites, with weights in excess of 11,364 kg (25,000 lb) and payload fairings up to 22 m (75 ft) long. The SPF is the only facility at KSC/CCAFS launch complex specifically designed to accommodate satellites and payload fairings for Lockheed Martin Atlas V and Boeing Delta IV evolved ELV missions. The SPF is dedicated to spacecraft hazardous and non-hazardous processing, payload and hardware storage, and customer office accommodations.

Multi-Payload Processing Facility (MPPF) — The MPPF is located in the KSC Industrial area. It is designed for non-hazardous processing activities. The MPPF consists of an equipment airlock and processing highbay and lowbay.

Payload Hazardous Servicing Facility (PHSF) — The PHSF is a NASA facility located southeast of the KSC Industrial area near the SAEF-2 facility. It is designed to accommodate both hazardous and non-hazardous payload processing. Hazardous operations include ordnance

installation, loading of liquid propellants, hazardous systems tests, mating of a payload to a solid propellant upper-stage motor, and propellant leak tests.

Defense Secure Communication Satellite (DSCS) Processing Facility (DPF) — The DPF is an USAF facility that accommodates both hazardous and non-hazardous payload processing and encapsulation activities. It is located near the skid strip on CCAFS. It was designed to service a DSCS III class payload consisting of the payload and integrated apogee boost subsystem. The facility can accommodate propellant loads of 9,000 kg (19,800 lb) of liquid bipropellant and/or 9,000 kg (19,800 lb) of solid-propellant motors.

Spacecraft Processing and Integration Facility (SPIF) — The SPIF is an USAF facility designed for hazardous and non-hazardous payload processing and encapsulation. It is located in the Solid Motor Assembly Building (SMAB) on CCAFS near LC-40 and LC-41. It can support loading of liquid fuels and oxidizers, as well as integration of payloads with solid-propellant motors.

2.1.5.2 Payload Processing Facilities at VAFB

Astrotech Payload Processing Facility (Building 1032) — The Astrotech facility is located on north VAFB along Tangier Road. It is approximately 3.2 km (2 mi) southeast of the Delta II launch complex (SLC-2). Building 1032 houses two explosion-proof high bays and an explosion-proof air lock/high bay for non-hazardous and hazardous operations. This building is used for final assembly and checkout of the spacecraft, liquid propellant, and solid rocket motor handling operations, third-stage preparations, and payload final assembly.

NASA Hazardous Processing Facility (Building 1610) — Building 1610 is located on north VAFB along Tangier Road. It is approximately 3.2 km (2 mi) southeast of SLC-2. This facility provides capabilities for spacecraft balancing and can be used for fairing processing, solid-motor build-up, spacecraft build-up, ordnance installation, and loading of hazardous propellants.

California Spaceport Integrated Processing Facility — The Integrated Processing Facility is located at SLC-6 on south VAFB. The facility provides hazardous payload processing and has six major processing areas: airlock, high bay, three payload checkout cells, transfer tower area, fairing storage and assembly area, and seven payload processing rooms. The processing rooms can be used for small payload processing or processing support. The transfer tower area is used to encapsulate processed payloads inside the payload fairing.

2.1.5.3 Payload Processing Facilities at USAKA/RTS

The Pegasus and the Falcon family of vehicles launch from USAKA/RTS. Integration of the Pegasus with the payload and its dedicated L-1011 would be performed at VAFB, the base of Pegasus operations. The L-1011 would land at USAKA/RTS with the Pegasus launch vehicle assembled and attached to the aircraft. Pegasus prelaunch processing at USAKA/RTS would include launch monitoring, flight termination system testing, and removal of safety pins prior to flight.

The Falcon Launch Vehicle Program is designed to require minimal time for vehicle assembly or payload processing on the launch pad; much of the assembly would be accomplished at the

SpaceX facilities in El Segundo, California. The Falcon launch vehicle would arrive at Kwajalein fully assembled and installed in its Transporter/Erector system. Payloads would be processed at Omelek also. The Falcon launch vehicle would be fueled on the bermed pad at Omelek. RP-1 would be loaded the day before the launch, and LOX would be loaded the day of the launch.

The goal is to launch within a few days to one week of payload arrival at the launch site. This requires minimal time for processing the payload and minimal use of the launch pad.

Missile Assembly Building (MAB) — SpaceX has constructed a missile assembly building on Omelek Island and has made minimal modifications to the existing Omelek site, such as building refurbishment. The MAB consists of a 12-m by 30.5-m by 0.3-m (40-ft by 100-ft by 1-ft) concrete pad with a metal-framed "Butler" building constructed over it. The maximum height of the facility would be 8 m (25 ft). This facility is connected to the power systems on the island.

2.1.5.4 Payload Processing Facilities at WFF

WFF actions associated with payload processing also include storage, transportation, assembly, and fueling. These actions take place at the Main Base, Wallops Mainland, and Wallops Island.

Payload processing occurs in Buildings F-7, F-10, M-16, M-20, W-65 X-15, and Y-15. If necessary, a portable air scrubber would be used at the PPF during hazardous fueling operations to ensure that fumes from fueling do not harm NASA staff or the local air quality. The PPF provides quality assurance and quality control inspections for assembled payloads. WFF can support multiple payload processes simultaneously, including fabrication, environmental testing, integration, and clean room facilities. Work areas are available to perform preparatory and post-integration inspections.

Spacecraft and target payloads would arrive at WFF via truck or military aircraft. Once unloaded, they would be placed either in the Hazardous Processing Facility on Wallops Island (Y-15), or in the Payload Processing Facility (H-100) on the Wallops Main Base. If liquid fueling of the payload or HAPS (if used) were required, this operation would be conducted at Y-15. From either building, the payload would then be transported to W-65 for integration with the launch vehicle upper stack (MM-derived vehicles) or for payload assembly (Peacekeeper-derived vehicles) (NASA 2005a, 2008b).

Building F-7 — The Multi-Payload Processing Facility (MPPF/F-7) is located on the Wallops Main Base and houses multiple areas for scientific balloon and small spacecraft payload processing. It has a Class 100,000 clean room with an electrostatic discharge (ESD) floor and a truck lock.

Building F-10 — The Payload Fabrication and Integration Laboratory, located in Building F-10 on the Wallops Main Base supports multiple payload processes simultaneously, including telemetry ground stations and clean room facilities. A fully equipped machine shop in Building F-10 is capable of fabricating sounding rockets, payloads, and launch vehicle components.

Building H-100 — This 1,858 m^2 (20,000 ft^2) payload processing facility is located on the Wallops Main Base. It has a high bay and an intermediate bay. Both bays are in the process of

conversion to Class 100,000 clean rooms. Certification should be finished around the April 2011 timeframe.

Building M-16 — This payload processing facility is located on the Wallops Main Base. It is 1,792 m^2 (19,290 ft^2) and has two. Both bays are Class 100,000 clean rooms with a 10,000 clean tent.

Building M-20 — This 1,076 m^2 (11,585 ft^2) assembly building is located on the Wallops Main Base. It has a single bay with two doors. It is approved for explosives.

Hazardous Assembly/Processing Facility (W-65) —This 1,231 m^2 (13,255 ft^2) facility has six bays used to store, stage, and process the rocket motors before they are moved to one of the two launch pads. It also has pyrotechnic storage rooms and is approved for explosives.

Payload Processing Facility, X-15 — This facility is 533 m^2 (5,740 ft^2) and can accommodate any of the three NASA portable clean room shelters available to range users. It has collocated optical and crash/fire/rescue facilities.

Hazardous Processing Facility (Y-15) — Y-15 is 765 m^2 (8,240 ft^2), has one high bay (Bay 8) and seven other bays.

Horizontal Integration Facility (HIF) — NASA recently completed a HIF in the middle of Wallops Island to support the pre-flight processing, horizontal integration and preparation of launch vehicles and payloads (NASA 2009b). The HIF has a footprint of approximately 2,322 m^2 (25,000 ft^2) and has been designed to accommodate temporary storage of fueled spacecraft and vehicle stages. Activities in the HIF will included, but are not limited to, removal of flight hardware from cargo containers, inspection, testing, and encapsulation of launch vehicle motors and stages, and final integration of the payload within the launch vehicle.

North Island Facilities — As presented in its 2009 Launch Range Expansion EA and FONSI, NASA is also proposing to construct two dedicated payload facilities on North Wallops Island in the 2012-2013 timeframe. The first, a 700 m^2 (7,500 ft^2) PFF, would include a high bay, employee dress-out room, several equipment rooms, and a loading dock. Payloads would be handled by bridge cranes located within the high bay area. The second, a 180 m^2 (12,000 ft^2) payload processing facility, would be constructed approximately 180 m (600 ft) east of the proposed PFF. Payloads would be transported from offsite locations to this facility prior to fueling for initial assembly, inspection, cleaning, and testing. Following fueling, the fueled payload could be transported back to the processing facility for final assembly prior to being integrated into the launch vehicle.

2.1.5.5 Payload Processing Facilities at KLC

Flight preparations at KLC include booster flight preparation, payload flight preparation, and flight communications preparation.

Payload Processing Facility (PPF) — Spacecraft are received in the PPF, processed, fueled, checked out, mated to the interface adapter, and encapsulated in the flight fairing. The PPF has a Class 100,000 clean room, which can be operated as a Class 10,000 clean room, if desired. The

PPF includes two 12 by 18 by 20 m (40 by 60 by 66 ft) high processing bays with an equipment entry air lock bay.

Integration and Processing Facility (IPF) — The IPF is the rocket/missile assembly building. It is a multi-function building used for receiving flight hardware and equipment storage. Depending on the type of rocket launched, payloads can be attached to rocket motors; multi-stage motors can be assembled; and integrated spacecraft assemblies can be electronically tested. It is designed for vehicles requiring horizontal processing or for any other related covered, horizontal operations, and supports integration checkout of rocket motors and related flight components. It is a 15 by 30 m (50 by 100 ft) environmentally controlled structure with roll up doors on each end. After testing and assembly, processed rocket components and payloads are moved from the IPF to either the LP-1 (Orbital Launch Pad) or LP-2 (Suborbital Launch Pad).

Spacecraft and Assemblies Transfer (SCAT) Building — Is an environmentally controlled, roller-mounted, rail traveled structure with two roll up doors at each end that mate to the LSS and IPF. When mated, the SCAT becomes an integral structure with the other joining facility and expands the environmentally controlled work space of either facility. The SCAT also provides an environmentally controlled structure for LP2 (Suborbital Launch Pad). At LP2, the SCAT provides an overhead crane for payload mating while the launch vehicle is in the vertical.

2.2 ALTERNATIVES TO THE PROPOSED ACTION

The scope of this EA includes all spacecraft that would meet specific criteria on their design and launch, would accomplish the requirements of NASA's research and technology objectives, and would not present new or substantial environmental impacts or hazards. These spacecraft would meet the limitations set forth in the RPC, which were developed to delimit the characteristics and environmental impacts of this group of spacecraft. Preparation and launch of all members of the class of NRP spacecraft would not have substantial environmental impacts. Alternative spacecraft designs that exceed RPC limits may have new or substantial environmental impacts or hazards and are not afforded NEPA compliance by this EA.

The nature of environmental impacts, payload processing, launch sites, and other related information for foreign launch systems is generally not as well known or as well documented as for launches from the United States. In addition, NASA Policy Directive (NPD) 8610.7C requires that the launch of U.S. Government-sponsored spacecraft utilize all reasonable sources of U.S. launch services. Utilization of a non-U.S. vehicle requires a waiver from the Office of Science and Technology Policy, or the no-cost provision of the non-U.S. vehicle as part of an international cooperative mission. Additional review and documentation would be required for the use of non-U.S. launch vehicles. Therefore, for the purpose of this *NASA Routine Payload EA*, foreign launch vehicles were not considered to be reasonable alternatives.

2.3 NO-ACTION ALTERNATIVE

Under the No-Action Alternative, specific criteria and thresholds presented in the *2002 Final Environmental Assessment for Launch of NASA Routine Payloads on Expendable Launch Vehicles from Cape Canaveral Air Force Station Florida and Vandenberg Air Force Base California* (*2002 NRP EA*) would continue to be used to determine a spacecraft's eligibility to be considered a NRP spacecraft launching on the Athena, Pegasus, Taurus, Atlas and Delta families

of the vehicles from CCAFS and VAFB under the original *2002 NRP EA*. The No-Action Alternative would also mean that NASA would not launch scientific and technology demonstration spacecraft missions defined as NRP spacecraft on the Falcon and Minotaur families of launch vehicles from any of the launch sites, nor would NASA launch NRP spacecraft from USAKA/RTS, WFF, or KLC without individual, mission-NEPA review and documentation.

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3 AFFECTED ENVIRONMENT

3.1 INTRODUCTION

This chapter describes the existing environment in and around the proposed launch sites discussed in this Environmental Assessment (EA): Cape Canaveral Air Force Station (CCAFS) and Kennedy Space Center (KSC) Florida, Vandenberg Air Force Base (VAFB) California, the United States Army Kwajalein Atoll Reagan Test Site (USAKA/RTS) Republic of the Marshall Islands (RMI), National Aeronautics and Space Administration (NASA) Wallops Flight Facility (WFF) Virginia, and the Kodiak Launch Complex (KLC) Alaska. This information serves as a baseline from which to identify and evaluate environmental changes resulting from activities associated with the proposed launching of spacecraft that have been determined to be NASA routine payloads (NRP spacecraft). The greater part of the information contained in this chapter is extracted from existing documents, as listed below. References specific to the topic being discussed are in parentheses and are incorporated by reference. A list of sources for information used in Chapter 3 can be found in Appendix A. The reader is referred to these documents for additional information regarding the existing environmental settings at all proposed launch sites. These documents are incorporated by reference.

Discussions of land use and aesthetics/visual resources at each of the launch sites can be found in the following sections:

- CCAFS/KSC - Section 3.3.1.1
- VAFB - Section 3.3.2.1
- USAKA/RTS - Section 3.3.3.1
- WFF - Section 3.3.4.1
- KLC - Section 3.3.5.1

3.2 ENVIRONMENTAL TOPICS COMMON TO ALL LAUNCH SITES

The following is a discussion of topics common to all of the proposed launch sites. It is followed by a section dedicated to describing the unique environmental conditions at each of the proposed launch sites.

3.2.1 Hazardous Materials

Hazardous materials are substances defined as hazardous by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Toxic Substances Control Act (TSCA), and the Hazardous Materials Transportation Act (HMTA). In general, hazardous materials include substances that, because of their quantity, concentration, or physical, chemical, or infectious characteristics, may present substantial danger to public health or welfare, or to the environment, when released. U.S. Air Force (USAF) Instruction (AFI) 32-7086, Hazardous Materials Management, establishes procedures and standards that govern management of hazardous materials on USAF installations (CCAFS and VAFB). NASA applies its safety standards at KSC (NPR 8715.5, 2005 and NPR 8715.7, 2008) and

WFF (WSM 2002). The Federal Aviation Administration (FAA) requires that each commercial launch site and each launch have a safety review that includes a complete disclosure of each hazardous material in the ground safety analysis report as well as a hazardous materials management plan (FAA 2009).

Management of hazardous waste must comply with the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984 (HSWA). The U.S. Environmental Protection Agency (EPA) administers RCRA, which requires that hazardous wastes be treated, stored, and disposed of to minimize the present and future threat to human health and the environment. USAF guidance in AFI 32-7042, Solid and Hazardous Waste Compliance, provides a framework for complying with environmental standards applicable to hazardous waste for USAF installations and actions.

The Federal Pollution Prevention Act (PPA) of 1990 established pollution prevention as a national objective. It is a U.S. Department of Defense (DoD) acquisition policy to eliminate and reduce the use of hazardous materials during a system's acquisition (Defense Acquisition Guidebook). USAF Policy Directive (AFPD) 32-70, Environmental Quality, outlines the USAF policy for pollution prevention and references AFI 32-7080, Pollution Prevention Program, which defines the USAF's Pollution Prevention Program requirements. AFI 32-7080 instructs all USAF installations to reduce hazardous material usage and pollutant releases (USAF 1998), and AFI 32-7086 provides requirements for the Hazardous Materials Management Program.

NASA promotes the Agency strategy of Environmental Excellence consistent with the requirements of Executive Order (EO) 13423 "Strengthening Federal Environmental, Energy and Transportation Management". NPR 8530.1A describes NASA's plan for Environmentally Preferable Products and NPR 8570.1 outlines Energy Efficiency and Water Conservation practices. Detailed discussions of hazardous materials at each of the launch sites can be found in the following sections:

- CCAFS/KSC - Section 3.3.1.2
- VAFB - Section 3.3.2.2
- USAKA/RTS - Section 3.3.3.2
- WFF - Section 3.3.4.2
- KLC - Section 3.3.5.2

3.2.2 Health and Safety

The areas in and around CCAFS, KSC, VAFB, USAKA/RTS, WFF, and KLC that could be affected by payload processing, transport, and launch are the subject of health and safety concerns. Range safety regulations for both CCAFS and VAFB are contained in Air Force Space Command Manual 91-710 (AFSPCMAN 91-710), which incorporates information formerly found in Eastern and Western Range Safety Policies and Processes (EWR 127-1, 1999). As mandated by AFSPCMAN 91-710, Range Safety organizations review, approve, monitor, and impose safety holds, when necessary, on all prelaunch and launch operations. The objective of the Range Safety Program is to ensure that the general public, launch area personnel, foreign landmasses, and launch area resources are provided an acceptable level of safety, and that all aspects of prelaunch and launch operations adhere to public laws.

Range Safety regulations for USAKA/RTS are mandated by the Range Commanders Council (RCC) 321-07, Common Risk Criteria for National Test Ranges (RCC 2007). RCC 321-07 sets requirements for minimally acceptable risk criteria to occupational and non-occupational personnel, test facilities, and nonmilitary assets during range operations.

WFF complies with the Goddard Space Flight Center/WFF Range Safety Manual, Revision A (RSM-2002, Revision B [NASA 2008b]), the Wallops Safety Manual (WSM 2002), the NASA Integrated Contingency Plan, the NASA Hydrazine Response Plan, and the NASA Aviation Safety Policy. Range safety regulations for KLC are contained in the KLC Range Safety Manual.

Hazardous materials such as propellant, ordnance, chemicals, and booster/payload components are transported in accordance with U.S. Department of Transportation (DOT) regulations for interstate shipment of hazardous substances (Title 49 CFR 100-199). Hazardous materials such as liquid rocket propellant are transported in specially designed containers to reduce the potential risk of an unintentional release should an accident occur (USAF 1998).

Detailed discussions of health and safety at each of the launch sites can be found in the following sections:

- CCAFS/KSC - Section 3.3.1.3
- VAFB - Section 3.3.2.3
- USAKA/RTS - Section 3.3.3.3
- WFF - Section 3.3.4.3
- KLC - Section 3.3.5.3

3.2.3 Water Quality

The Federal Clean Water Act (CWA) establishes a comprehensive approach to cleaning up and maintaining the quality of the nation's surface waters. This approach is most commonly known by the National Pollution Discharge Elimination System permits (NPDES), which control point source pollution, and by Section 319 (formerly Section 208) area-wide non-point source (NPS) pollution control management planning and associated best management practices (BMPs). The CWA authorizes delegation of the NPDES permitting program to qualified states and federally recognized tribes and transfer of Federal funds for water quality management to states and federally recognized tribes that agree to adopt NPS plans and develop BMPs. Florida, California, Virginia, and Alaska have been delegated NPDES permitting authority and have adopted section 319 NPS plans and BMPs. The CWA, in section 404, also creates a wetlands permitting program, which has been delegated by EPA to the Army Corps of Engineers. A related statute, the Safe Drinking Water Act, establishes federally delegated state-implemented programs for regulating groundwater quality.

Executive Order (EO) 11988, Floodplain Management, directs Federal agencies to avoid to the extent possible the long- and short-term adverse impacts associated with occupancy and modification of floodplains and notify landowners of proposed activities affecting the floodplain. AFI 32-7064 (Chapter 4, Floodplain Management and Wetlands Protection) requires the USAF to prepare a Finding of No Practicable Alternatives (FONPA) before construction within a floodplain (USAF 1998). EO 11990, Protection of Wetlands, directs

Federal agencies to provide leadership and to take action to minimize the destruction, loss or degradation of wetlands. NASA regulations at Title 14 CFR subpart 1216.2 govern compliance by NASA with EO 11988 and EO 11990.

Perchlorate Deposition

Perchlorate is both a naturally occurring and manmade anion consisting of chlorine bonded to four oxygen atoms (ClO_4). It is typically found in the form of perchloric acid and salts such as ammonium perchlorate, potassium perchlorate, and sodium perchlorate. While perchlorate was once thought to occur naturally only in one location in Chile, ongoing study has found naturally occurring perchlorate in other locations as well.

As a manmade compound, Perchlorate has been manufactured since before the turn of the last century, primarily for use in defense activities and the aerospace industry. Highly soluble and mobile in water, perchlorate is also very stable. Most of the perchlorate manufactured in the United States is used as an oxidizer in solid rocket propellant and other pyrotechnics, such as fireworks, gunpowder, explosives, car airbag initiators, and highway flares. Perchlorate is also used in a wide variety of industrial processes, including tanning and leather finishing, rubber manufacture, paint and enamel production, and as additives in lubricating oils. Wastes from the manufacture and improper disposal of perchlorate-containing chemicals are increasingly being discovered in soil, groundwater, drinking water, and irrigation water around the United States.

In general, past management practices did not prevent the release of perchlorate to the environment because it was not recognized or regarded as a contaminant of concern. Perchlorate in the United States was found to be widespread after the spring of 1997, when an analytical method with a reporting limit of four parts per billion (ppb) was developed. Additional sampling and analysis techniques have since been developed that can detect perchlorate at concentrations of one ppb and lower (ITRC 2005). One ppb is equivalent to a single kernel of corn in a silo measuring 4.9 m (16 ft) in diameter and 13.7 m (45 ft) high full of corn (DoD 2007).

Since perchlorate moves easily through the soil and can persist for many years in groundwater, there is growing concern of contamination of the food supply. The use of farmland for waste disposal, the deposition of airborne perchlorate on farmland, and the use of contaminated groundwater for irrigation and drinking have all resulted in some unknown level of exposure. Evaluation of this exposure has also uncovered the difficulty of detecting perchlorate in food at low levels.

Most of the attention focused on perchlorate concerns amounts found in groundwater and surface water. However, perchlorate can also be found in soil and vegetation. High doses of perchlorate can decrease thyroid hormone production by inhibiting the uptake of iodide by the thyroid. Thyroid hormones are critical for normal growth and development of the central nervous system of fetuses and infants. In 1985, perchlorate contamination was discovered at Superfund sites in California; however, the extent of perchlorate contamination of water sources nationwide was not revealed until 1997. Today, over 11 million people have perchlorate in their public drinking-water supplies at concentrations of 4 ppb (4 grams/L) or higher. Because of the controversy surrounding the concentration at which perchlorate should

be regulated, the DoD, the U.S. Department of Energy (DOE), NASA, and the EPA asked the National Research Council (NRC) to assess the potential adverse health effects of perchlorate ingestion from clinical, toxicologic, medical, and public-health perspectives. They also asked the NRC to evaluate the relevant scientific literature and key findings underlying EPA's 2002 draft risk assessment, Perchlorate Environmental Contamination: Toxicological Review and Risk Characterization.

The resulting report by the committee titled Health Implications of Perchlorate Ingestion completed in 2005, evaluated the potential health effects of perchlorate. The scientific underpinnings of the 2002 draft risk assessment issued by the EPA found that the body can compensate for iodide deficiency, and that iodide uptake would likely have to be reduced by at least 75 percent for months or longer for adverse health effects, such as hypothyroidism (low amounts of thyroid hormones), to occur. The report recommends using clinical studies of iodide uptake in humans as the basis for determining a reference dose rather than using studies of adverse health effects in rats that serve as EPA's basis. The report suggests that daily ingestion of 0.0007 milligrams of perchlorate per kilograms of body weight, an amount more than 20 times the reference dose proposed by EPA, should not threaten the health of even the most sensitive populations (NRC 2005).

The EPA conducted extensive review of scientific data related to the health effects of exposure to perchlorate from drinking water and other sources and found that in over 99 percent of public drinking water systems, perchlorate was not at levels of public health concern. Therefore, based on the Safe Water Drinking Act criteria, the Agency determined there is not a "meaningful opportunity for health risk reduction" through a national drinking water regulation (EPA 2008).

Detailed discussions of water quality at each of the launch sites can be found in the following sections:

- CCAFS/KSC - Section 3.3.1.5
- VAFB - Section 3.3.2.5
- USAKA/RTS - Section 3.3.3.5
- WFF - Section 3.3.4.5
- KLC - Section 3.3.5.5

3.2.4 Air Quality

The air quality section discusses resources at all proposed launch sites for the atmosphere at altitudes below 914 m (3,000 ft), which contains the atmospheric boundary layer for all launch sites as documented in the following sections. The lower atmosphere, also known as the troposphere, is composed of two layers: (1) the atmospheric boundary layer ranging from 0 to 2,000 m (0 to 6,600 ft) in altitude and, (2) the free troposphere ranging from 2,000 to 10,000 m (6,600 to 32,800 ft) in altitude. Rapid mixing within the atmospheric boundary layer insures that chemicals released within it quickly mix throughout the atmospheric boundary layer. Atmospheric monitoring for chemicals at all proposed launch sites is within the atmospheric boundary layer where people live and work.

Air quality at all proposed launch sites, except USAKA/RTS, is regulated federally under Title 40 CFR 50 (National Ambient Air Quality Standards [NAAQS]), Title 40 CFR 51 (Implementation Plans), Title 40 CFR 61 and 63 (National Emission Standards for Hazardous Air Pollutants [NESHAPs]), and Title 40 CFR 70 (Operating Permits). Air quality for USAKA/RTS is regulated under the Environmental Standards and Procedures for the U.S. Army Kwajalein Atoll (USAKA) Activities in the Republic of the Marshall Islands (UES), and standards are 80 percent of the NAAQS (i.e., air quality standards under the UES are more stringent).

The National Primary Ambient Air Quality Standards define the levels of air quality necessary to protect the public health with an adequate margin of safety. The National Secondary Ambient Air Quality Standards define levels of air quality necessary to protect the public welfare from adverse effects of a pollutant. There are standards for ozone, carbon monoxide (CO), oxides of nitrogen (NO_X), sulfur dioxide (SO_2), particulate matter equal to or less than 10 microns in diameter (PM_{10}), particulate matter equal to or less than 2.5 microns in diameter ($PM_{2.5}$), and lead. An area with air quality better than the NAAQS is designated as being in attainment while areas with worse air quality are classified as non-attainment areas.

Federal actions are required to conform to any State Implementation Plan approved or promulgated under Section 110 of the Clean Air Act (CAA). A conformity determination is required for each pollutant resulting from a Federal action for which the total of direct and indirect emissions in a non-attainment or maintenance area would equal or exceed de minimis thresholds (listed in Title 40 CFR 51.853). De minimis is Latin for "of minimum importance" or "trifling." Essentially de minimis thresholds refer to values so small that the law will not consider them.

NESHAPs regulate hazardous air emissions from stationary sources. The EPA lists emission standards for specific types of stationary sources. These standards are referred to as Maximum Available Control Technology (MACT) standards. The only section of the NESHAPs regulations that applies to the proposed activity is Title 40 CFR 63 Subpart GG, which applies to facilities that manufacture or rework commercial, civil, or military aerospace vehicles or components and that are major sources of hazardous air pollutants (HAPs).

Title V of the CAA Amendments of 1990 requires all major sources to have an operating permit. This permit incorporates all applicable Federal requirements under the CAA. A major source is defined as one that can: (1) emit 90.7 metric tons (mt) (100 tons) per year of any regulated air pollutant within an area that is in attainment for that pollutant; (2) emit 9.1 mt (10 tons) per year of any one of the 189 HAPs; or (3) emit 22.7 mt (25 tons) per year of total HAPs. The major source thresholds can be lower if the source is in a non-attainment area for a pollutant.

Title 40 CFR 82 seeks to prevent damage to the ozone layer by Class I and Class II Ozone-Depleting Substances (ODSs). It contains subparts addressing production and consumption controls, servicing of motor vehicle air conditioners, bans on nonessential products, Federal procurement, recycling and emissions reduction, and alternative compounds.

Greenhouse gases are discussed in Section 3.2.9.2.

Detailed discussions of air quality at each of the launch sites can be found in the following sections:

- CCAFS/KSC - Section 3.3.1.6
- VAFB - Section 3.3.2.6
- USAKA/RTS - Section 3.3.3.6
- WFF - Section 3.3.4.6
- KLC - Section 3.3.5.6

3.2.5 Noise and Vibration

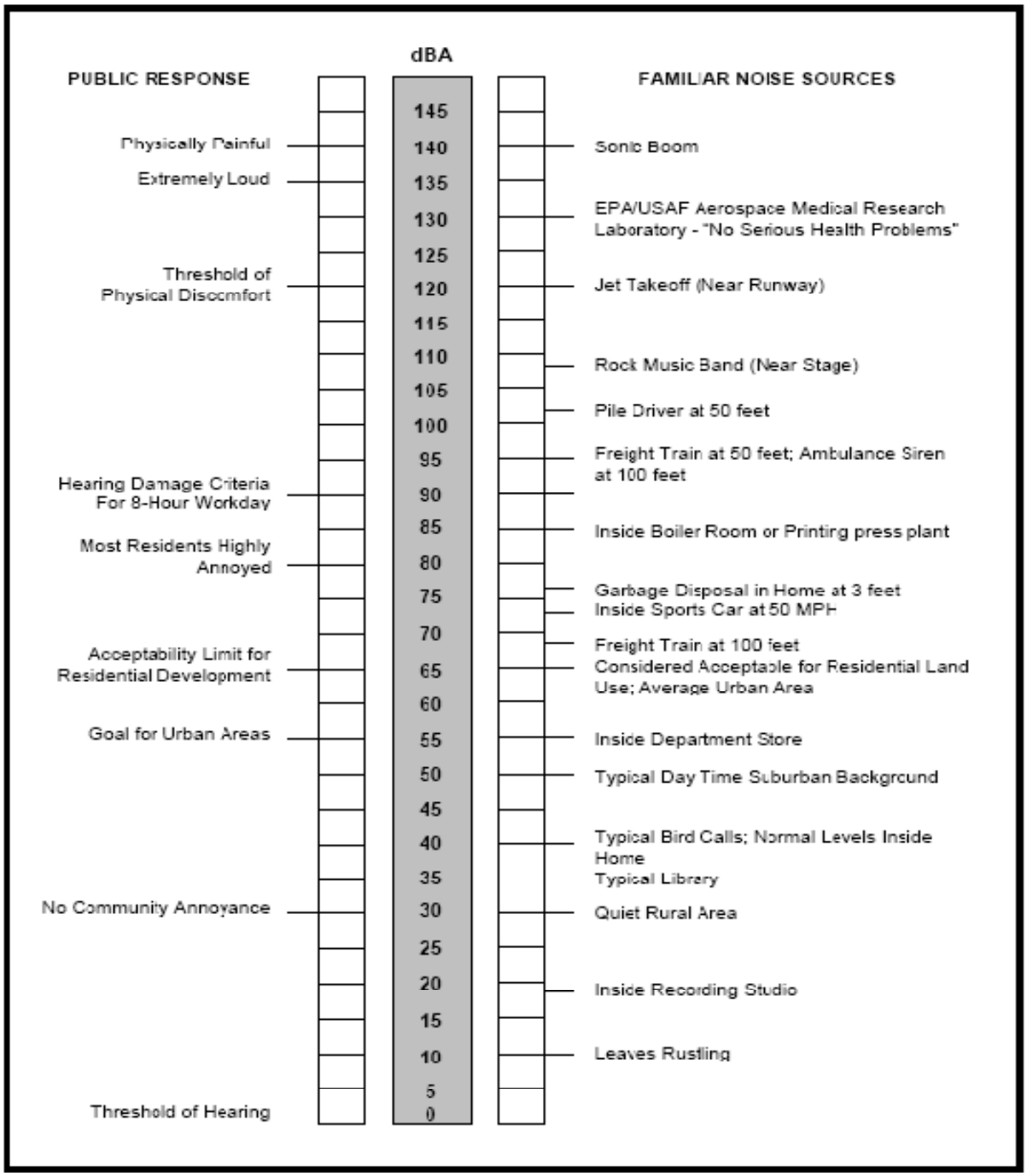
Noise can be defined as unwanted sound. Highly intense noise can be unwanted because of potential structural damage. The decibel (dB) is the accepted standard unit for the measurement of sound intensity. It is a logarithmic unit that accounts for the large variations in amplitude (sound intensity level). For instance, going from 90 to 93 dB does not mean a 3 percent increase in the noise energy. Sound levels that have been adjusted to correspond to the frequency sensitivity of the human ear are referred to as A-weighted sound pressure levels (AWSPL). Weighted measurements emphasizing frequencies within human sensitivity are called A-weighted decibels (dBA). Established by the American National Standards Institute, A-weighting significantly reduces the measured pressure level for low-frequency sounds, while slightly increasing the measured pressure level for some high-frequency sounds. In summary, A-weighting is a filter used to relate sound frequencies to human-hearing thresholds. Typical A-weighted sound levels measured for various sources are provided in Figure 3-1.

If structural damage is a concern, then the overall sound pressure level (OSPL) is used. Some damage, especially from rocket launches, could be caused by induced low frequency ground waves.

A number of descriptors have been developed that account for changes in noise with time and provide a cumulative measure of noise exposure. The most widely used cumulative measure is the day-night average sound level (DNL). This is a daylong average of the AWSPL, with a 10-dB penalty applied at night. A quantity falling between single-event measures like AWSPL and cumulative measures like DNL is the sound exposure level (SEL), a measure of the total sound from a single event combining the level of the sound with its duration. For a sound with an effective duration of one second, SEL is equal to AWSPL. For sounds with longer effective duration, SEL is larger than AWSPL and thus reflects the greater intrusion of the longer sound.

According to U.S. Occupation Safety and Health Administration (OSHA) noise standards, no worker shall be exposed to noise levels higher than 115 dBA. The exposure level of 115 dBA is limited to 15 minutes or less during an 8-hour work shift. Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level. The OSHA standards are the maximum allowable noise levels for the personnel near the launch pad.

Under 29 CFR 1910.95, Occupational Noise Exposure, employers are required to monitor employees whose exposure to hazardous noise could equal or exceed an 8-hour time weighted average of 85 dBA.



Source: USAF 2006.

Figure 3-1 Typical Noise Levels of Familiar Noise Sources and Public Responses

The largest portion of the total acoustic energy produced by a launch vehicle is usually contained in the low-frequency end of the spectrum (1 to 100 Hz). Launch vehicles also generate sonic booms. A sonic boom, the shock wave resulting from the displacement of air in supersonic flight, differs from other sounds in that it is impulsive and very brief (up to several seconds for launch vehicles). Because a sonic boom is not generated until the vehicle reaches

supersonic speeds, the launch site itself does not experience a sonic boom. The entire sonic boom footprint is some distance downrange of the launch site (USAF 1998).

Detailed discussions of noise at each of the launch sites can be found in the following sections:

- CCAFS/KSC - Section 3.3.1.7
- VAFB - Section 3.3.2.7
- USAKA/RTS - Section 3.3.3.7
- WFF - Section 3.3.4.7
- KLC - Section 3.3.5.7

3.2.6 Biological Resources

Any Federal action that may affect federally listed species (threatened or endangered) or their critical habitats requires consultation with the U. S. Fish and Wildlife Service (USFWS) and/or National Marine Fisheries Service (NMFS) under Section 7 of the Endangered Species Act of 1973 (Any action that may affect marine mammals or their habitat requires consultation with the NMFS under the Marine Mammal Protection Act [MMPA] of 1972) as amended. In addition, potential effects on essential Fish Habitat in offshore waters, requires consultation and analysis by NMFS under the Magnuson-Stevens Fisheries Conservation and Management Act (MSFCMA) of 1996.

Biological resources include the native and introduced plants and animals within the area potentially affected by the proposed activity. These are divided into vegetation, wildlife, threatened or endangered species, and sensitive habitats. Sensitive habitats include, but are not limited to, wetlands, plant communities that are unusual or of limited distribution, and important seasonal use areas for wildlife. They also include critical habitat as protected by the Endangered Species Act and sensitive ecological areas as designated by State or Federal rulings.

Because CCAFS/KSC, VAFB, WFF, USAKA/RTS, and KLC are located near the coastline, the Marine Mammal Protection Act (MMPA) applies. The MMPA was enacted on October 21, 1972 and protects all marine mammals. It prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the United States. The term "take" means to harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill any marine mammal.

Detailed discussions of biological resources at each of the launch sites can be found in the following sections:

- CCAFS/KSC - Section 3.3.1.8
- VAFB - Section 3.3.2.8
- USAKA/RTS - Section 3.3.3.8
- WFF - Section 3.3.4.8
- KLC - Section 3.3.5.8

3.2.7 Historical and Cultural Resources

Cultural resources include prehistoric and historic sites, structures, districts, artifacts, or any other physical evidence of human activity considered important to a culture or community for scientific, traditional, religious, or any other reasons. The primary laws that pertain to the treatment of cultural resources during environmental analysis are the National Historic Preservation Act (NHPA), the Archaeological Resources Protection Act (ARPA), the American Indian Religious Freedom Act (AIRFA), and the Native American Graves Protection and Repatriation Act (NAGPRA). To be considered eligible for the National Register of Historic Places (NRHP), a cultural resource must meet one or more of the criteria established in the National Register Evaluation Criteria (36 CFR §60). Detailed discussions of historical and cultural resources at each of the launch sites can be found in the following sections:

- CCAFS/KSC - Section 3.3.1.9
- VAFB - Section 3.3.2.9
- USAKA/RTS - Section 3.3.3.9
- WFF - Section 3.3.4.9
- KLC - Section 3.3.5.9

3.2.8 Environmental Justice

Executive Order 12898, Environmental Justice, was issued on February 11, 1994. Objectives of EO 12898 include development of Federal agency implementation strategies, identification of minority and low-income populations where proposed Federal actions have disproportionately high and adverse human health and environmental effects, and participation of minority populations and low-income populations. Accompanying EO 12898 was a Presidential Transmittal Memorandum that referenced existing Federal statutes and regulations to be used in conjunction with EO 12898. The memorandum addressed the use of the policies and procedures of NEPA. Specifically, the memorandum states that, "Each Federal agency shall analyze the environmental effects, including human health, economic and social effects, of Federal actions, including effects on minority communities and low-income communities, when such analysis is required by the NEPA 42 U.S.C. 4321, et seq."

In addition, Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks requires Federal agencies to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children.

Detailed discussions of environmental justice at each of the launch sites can be found in the following sections:

- CCAFS/KSC - Section 3.3.1.10
- VAFB - Section 3.3.2.10
- USAKA/RTS - Section 3.3.3.10
- WFF - Section 3.3.4.10
- KLC - Section 3.3.5.10

3.2.9 Global Environment

The troposphere is the lowest region of the atmosphere, extending from the Earth's surface to a height of about 6 to 10 km (19,700 to 32,800 ft) (the lower boundary of the stratosphere). The atmosphere above 914 m (3,000 ft) includes the free troposphere ranging from 914 m (3,000 ft) to between 2 and 10 km (6,600 to 32,800 ft) in altitude and the stratosphere extending from 10 km (32,800 ft) to 50 km (164,000 ft). These boundaries should be taken as approximate annual mean values as the actual level of the boundary between the troposphere and stratosphere (tropopause) is variable on a seasonal and day-to-day basis.

3.2.9.1 Troposphere

The upper (free) troposphere ranges from 2 km (6,600 ft) to 10 km (32,800 ft) and is generally referred to as the free troposphere. This layer is characterized by vigorous mixing driven by convective upwelling, horizontal and vertical winds, as well as transport and washout of gases that have been introduced into this region by industrial sources. This layer does not contain any uniquely important atmospheric constituents and it does not generally influence air quality in the lower troposphere (i.e., atmospheric boundary layer [ABL], the lower part of the troposphere, which extends from Earth's surface to about 3 km [6,600 ft]). The air temperature of the ABL decreases with increasing altitude until it reaches the inversion layer where the temperature increases with increasing altitude. The ABL is considered the most important boundary layer with respect to the emission, transport and dispersion of airborne pollutants. The part of the ABL between Earth's surface and the bottom of the inversion layer is known as the mixing layer. Almost all of the airborne pollutants emitted into the ambient atmosphere are transported and dispersed within the mixing layer. Some of the emissions penetrate the inversion layer and enter the free troposphere above the ABL.

The concentrations of gases and particles emitted into the free troposphere by transient sources such as launch vehicles are quickly diluted to very low levels before they can be deposited onto or transported near the ground by precipitation or strong down-welling events.

3.2.9.2 Stratosphere

The stratosphere extends from 10 km (32,800 ft) to 50 km (164,000 ft) and is important because of ozone formed within the stratosphere. The stratospheric ozone layer is usually taken to lie between about 16 km (52,100 ft) and 26 km (84,700 ft) altitude. The stratospheric ozone absorbs most of the most harmful ultraviolet (UV-B) radiation from the sun. Depletion of ozone following the introduction of man-made materials can result in an increase in solar UV on the ground, which can pose a serious ecological and health hazard. The importance and global nature of the ozone layer requires a careful consideration of all sources of disturbance.

The concentration (typically parts per million [ppm]) and distribution of stratospheric ozone is controlled by various chemical reactions, the most important of which are the catalytic reactions involving nitrogen, chlorine, bromine, and hydrogen compounds known as radicals. The importance of these oxides lies in the fact that they destroy ozone molecules without being destroyed themselves. Small (less than a millionth of a meter) aerosol particles in the stratosphere (mainly sulfate) also play a role in stratospheric chemistry by providing a surface on which chemical reactions can proceed. Thus even though radicals and particles are present

in the unperturbed stratosphere in only relatively small amounts (hundreds to thousands of times less than ozone), they exert a controlling influence on ozone concentrations. Ultimately, this means that relatively small amounts of radicals and particles can sufficiently perturb the stratosphere to cause ecologically substantial ozone loss.

In 1980, ozone was not significantly depleted by the chlorine and bromine then present in the stratosphere. At the present time, the ozone layer is characterized by a substantial disturbance caused by the introduction of chlorine and bromine (halocarbon) radicals from the photochemical breakdown of man-made halocarbons after they have mixed into the stratosphere. Global ozone loss from halocarbons is thought to be about 4 percent at the present time (WMO 2006). Most halocarbon production and use have been banned by international agreement and so the expectation is that the ozone layer will return to 1980 levels by the mid-21st century as the previously released halocarbons are consumed by sunlight and natural processes slowly remove the liberated chlorine and bromine (WMO 2006).

Sufficiently intense natural events can also cause substantial, though transient, ozone loss. Violent volcanic explosions can inject gases and particles into the stratosphere that reduce ozone. The El Chichon event in 1991, for example, reduced ozone globally by about 1 percent for approximately 3 to 4 years. In 1991, the eruption of Mount Pinatubo in the Philippines provoked a 15 percent decrease, over several years, and is believed to have caused an increase in the size of the ozone hole over Antarctica (WMO 2003).

Solid and liquid rocket propulsion systems emit a variety of gases and particles directly into the stratosphere (WMO 1991). A large fraction of these emissions, carbon dioxide (CO_2) for example, are chemically inert and do not affect ozone levels directly. Other emissions such as hydrogen chloride (HCl) and water are not highly reactive but they do have an impact on ozone since these gases participate in chemical reactions that help determine the concentrations of the ozone destroying radical gases. A small fraction of rocket engine emissions are highly reactive radicals. Particulate emissions such as aluminum oxide powder and carbon (soot) may mimic or enhance the role of natural stratospheric particles by enabling or enhancing ozone-related chemical reactions.

Greenhouse gases absorb the radioactive energy from the Sun and Earth. Some of the greenhouse gases (e.g., CO_2, chlorofluorocarbons [CFCs], and water) are emitted during the processes of preparing for and launching NRP spacecraft. Other gases (e.g., NO_X and VOCs) emitted from these processes contribute indirectly by forming ozone and other reactive species that photochemically react with the greenhouse gases and control the radiation penetrating to the troposphere. Greenhouse gases are thought to potentially have a negative effect on the ozone protective layer of the atmosphere. Research on greenhouse gas production (and possible effects of certain related pollutants, such as pollutants contributing to global warming) is ongoing by the EPA and some states.

Certain ozone depleting substances not produced by the proposed launch vehicles (e.g., as CFCs) are discussed within Title VI of the CAA of 1990. The USAF has a proactive ODS tracking program presently, and complies with provisions within Title VI for lower atmosphere generated sources. NASA KSC's Environmental Tracking System (NETS) tracks data on

pollution prevention, hazardous waste, recycling, solid waste, ODS, energy and water management, etc.

3.2.10 Orbital and Reentry Debris

Space debris can be classified as either natural or man-made objects. The measured amount of man-made debris equals or exceeds that of natural meteoroids at most low-Earth orbit altitudes (i.e., below 2,000 km [1,243 mi]). Man-made debris consists of material left in Earth orbit from the launch, deployment, deactivation, and fragmentation of spacecraft and launch vehicle components. It exists at all inclinations and has the greatest density at Low Earth Orbit (LEO) altitudes of approximately 800 to 1,000 km (500 to 625 mi) (UN 1999). Orbital debris moves in many different orbits and directions, at velocities ranging from 3 to over 8 km/s (1.9 to over 5 mi/s) relative to Earth (NASA-HDBK 8719.14).

Although space debris is not explicitly mentioned in any U.S. legislation, the President of the United States issued the U.S. National Space Policy (NSP) of 2010, which states in Section 11:

> "Orbital Debris poses a risk to continued reliable use of space-based services and operations and to the safety of persons and property in space and on Earth. The United States shall seek to minimize the creation of orbital debris by government and non-government operations in space in order to preserve the space environment for future generations."

Space programs managed by U.S. Government organizations are directed to follow the U.S. Government Orbital Debris Mitigation Standard Practices, while commercial operations are addressed in regulations by the Department of Transportation, the Department of Commerce, and the Federal Communications Commission.

In the 1990s, NASA established policy (NASA Policy Directive [NPD]) and procedures (NASA Safety Standard [NSS] 1740.14) for limiting the generation of orbital debris. NASA's policy is to employ design and operations practices that limit the generation of orbital debris, consistent with mission requirements and cost-effectiveness. In 2007, NASA issued an update to both of these documents with NPR 8715.6 and NASA Standard (NASA-STD 8719.14), respectively, and NPD 8710.3 was canceled. This update reflects the current NSP, changes in NASA organization, and contract management, as well as NASA's goals to return to the Moon. Additionally, the new document set includes more emphasis on limiting generation of orbital debris at the End of Mission (EOM) (per NPR 8715.6, EOM is defined as the time of completion of all mission activities, experimental operations, and stand-by status immediately preceding passivation and disposal of the spacecraft or launch vehicle stage).

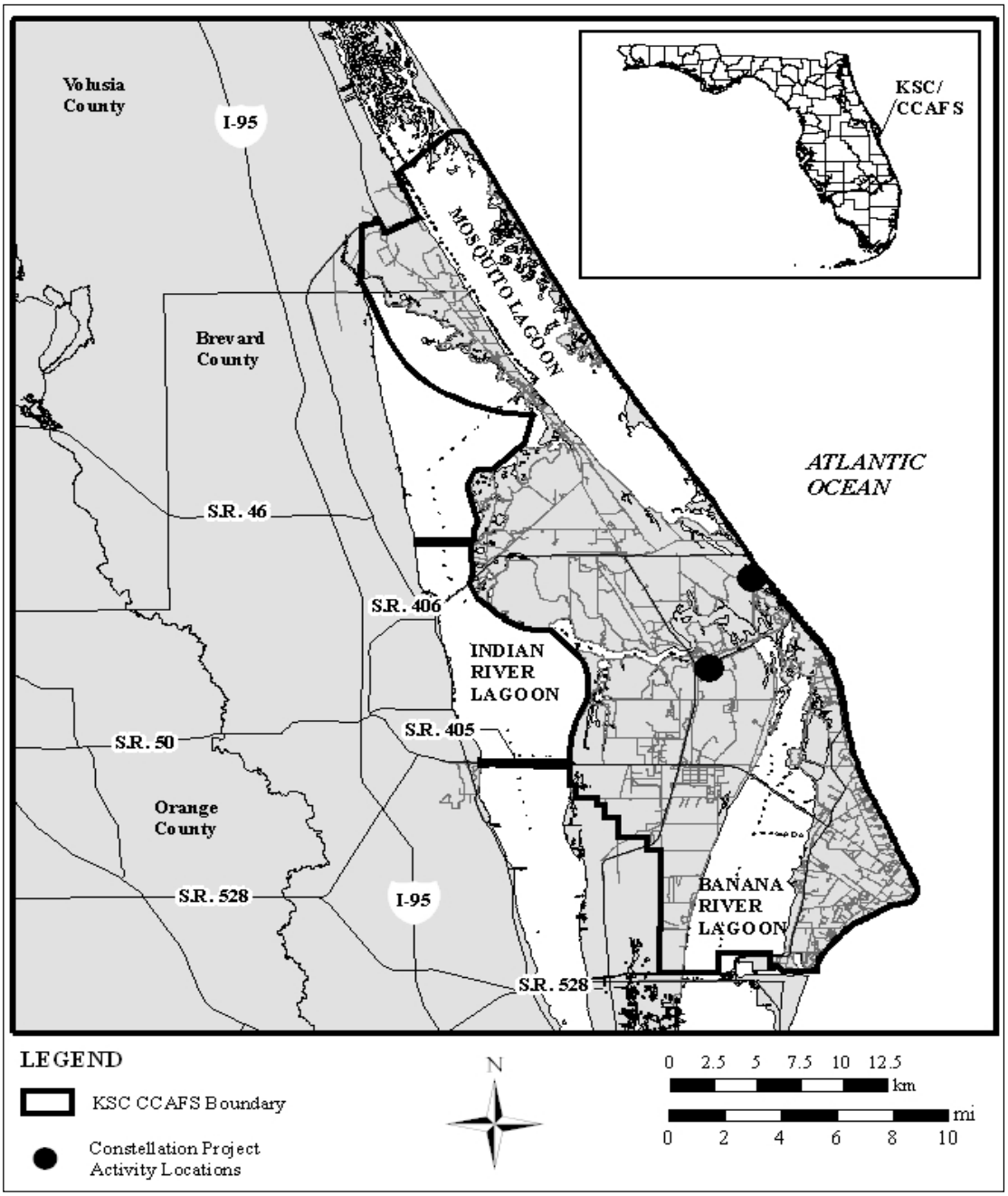
NASA-STD 8719.14, Procedures for Limiting Orbital Debris, provides requirements and details on assessments, reporting and engineering process needed for limiting orbital debris. NPR 8715.6 contains provisions that allow for the use of NSS 1740.14 for legacy programs (i.e., programs that have already submitted or completed their orbital debris requirements under the previous guidance).

Orbital debris becomes a NEPA issue when either existing debris or a spacecraft reenters the atmosphere.

3.3 SPECIFIC LAUNCH SITE ENVIRONMENTS

3.3.1 Cape Canaveral Air Force Station (CCAFS) and Kennedy Space Center (KSC)

CCAFS and the KSC are situated on Cape Canaveral and northern Merritt Island along the east-central Atlantic coast in Brevard County, Florida. Cities and towns within Brevard County include Cape Canaveral, Titusville, Cocoa, Melbourne, West Melbourne, Palm Bay, Palm Shores, Cocoa Beach, Indialantic, Indian Harbor Beach, Malabar, Satellite Beach, and Rockledge. The total population of Brevard County increased from 398,978 in 1990 to 476,230 in 2000, which was a 19.4 percent increase. For comparison, the U.S. Bureau of the Census (USCB) reports the number of persons in Brevard County to be 543, 376 for the 2010 Census , and increase of 14.1 percent (USCB 2010a). The CCAFS and KSC area is shown in Figure 3-2.



Source: NASA 2008a.

Figure 3-2 Regional Map of CCAFS and KSC

3.3.1.1 Land Use and Aesthetics/Visual Resources

CCAFS encompasses an area of 6,397 hectares (15,800 acres), representing approximately 2 percent of the total land area of Brevard County. Land uses at CCAFS include launch operations, launch and range support, airfield, port operations, station support area, and open space. The launch operations land use category is present along the Atlantic Ocean shoreline and includes the active and inactive launch sites and support facilities. The launch and range support area is west of the launch operations area and is divided into two sections by the

airfield (skid strip). The airfield includes a single runway, taxiways, and apron, and is in the central part of the station. The port operations area is in the southern part of the station and includes facilities for commercial and industrial activities. The major industrial area is located in the center of the western portion of the station. This area also includes administration, recreation, and range-support facilities. Open space is dispersed throughout the station. There are no public beaches located on CCAFS. All land uses at CCAFS are under the operational control of the USAF 45th SW, located at Patrick Air Force Base (PAFB) (USAF 2001).

KSC is located on the northern part of Merritt Island adjacent to CCAFS and consists of approximately 56,449 hectares (139,490 acres) of land and lagoon waters. All zoning and land use planning is under NASA directive for implementation of the Nation's Space Program. Land use at KSC is carefully planned and managed to provide required support for missions and to maximize protection of the environment.

This area includes both the Canaveral National Seashore (CNS) and the Merritt Island National Wildlife Refuge (MINWR). NASA maintains operational control over approximately 1,704 hectares (4,212 acres) of KSC. This area comprises the functional area that is dedicated to NASA operations. Approximately 70 percent of the NASA operational area is developed as facility sites, roads, lawns, and maintained right-of-ways.

The remaining undeveloped operational areas are dedicated as safety zones around existing facilities or held in reserve for planned and future expansion. The National Park Service (NPS) and the U.S. Fish and Wildlife Service (USFWS) manage the 54,745 hectares (135,278 acres) that are outside of NASA operational control. The NPS administers 2,693 hectares (6,655 acres) of the CNS, while the USFWS administers 20,616 hectares (50,945 acres) of the CNS and the 30,506 hectares (75,383 acres) of the MINWR (NASA 2010).

Florida's Indian River Lagoon Estuary System includes Mosquito Lagoon, Canaveral Inlet, Banana River, Indian River, and the Sebastian Inlet. Recreational activities primarily involve the coastal beaches and inland waters of the Indian and Banana rivers. Boating, surfing, water skiing, and fishing are common activities. The beaches along CCAFS are used for launch operations and are restricted from public use. The nearby CNS and MINWR are open to the public, but are closed during some launch operations. Port Canaveral has several cruise-ship terminals.

Topography of the area is generally flat, with elevations ranging from sea level to approximately 6 m (20 ft) above sea level. The most visually significant aspect of the natural environment is the gentle coastline and flat-island terrain. The area has a low visual sensitivity because the flatness of the area limits any prominent vistas. CCAFS and KSC are fairly undeveloped. The most significant man-made features are the launch complexes and various support facilities. Most areas of CCAFS and KSC outside of the developed areas are covered with native vegetation.

3.3.1.2 Hazardous Materials and Hazardous Waste Management

Hazardous Materials Management

Numerous types of hazardous materials are used to support the missions and general maintenance operations at CCAFS and KSC. Management of hazardous materials, excluding hazardous fuels, is the responsibility of each individual or organization. Each organization has a supply organization and uses a "pharmacy" control approach to track hazardous materials and to minimize hazardous waste generation by minimizing the use of hazardous materials. The PAFB supply system is the primary method of purchasing or obtaining hazardous materials. The Joint Propellants Contractor (JPC) controls the purchase, transport, and temporary storage of hazardous propellants (USAF 1996a). Response to spills of hazardous materials is covered under JHB-2000 revision A (March 2002), the Consolidated Comprehensive Emergency Management Plan (CCEMP). CCEMP establishes uniform policy guidelines for the effective mitigation of, preparation for, response to, and recovery from a variety of emergency situations. The CCEMP is applicable to all NASA, USAF, and NASA/USAF Contractor organizations and to all other Government agencies located at KSC, CCAFS, and Florida Annexes. To ensure continuity of operations, the application of the provisions of the CCEMP will be executed by responding organizations through the Incident Management System (IMS). RCRA requirements will be accomplished by the directives listed in the respective permits issued to KSC/CCAFS (as per 45 SW OPlan 32-3 and Kennedy NASA Procedural Requirement (KNPR) 8500.1) (NASA 2010).

Hazardous Waste Management

Hazardous waste management at CCAFS is regulated under RCRA and the Florida Administrative Code (FAC) 62-730. These regulations are implemented by 45th SW OPlan 32-3, which addresses the proper identification, management, and disposition of hazardous waste on CCAFS (USAF 1996a).

All DoD-generated hazardous waste is labeled with the EPA identification number for CCAFS, under which it is transported, treated, and disposed of. Individuals or organizations generating hazardous waste at CCAFS are responsible for administering all applicable regulations and plans regarding hazardous waste. Producers of hazardous waste must also comply with applicable regulations regarding the temporary accumulation of waste at the process site. Typical hazardous wastes include various solvents, paints and primers, sealants, photograph-developing solutions, adhesives, alcohol, oils, fuels, and various process chemicals (USAF 1998).

Individual contractors and organizations maintain hazardous waste satellite accumulation points (SAPs) and 90-day hazardous waste accumulation areas in accordance with 45th SW OPlan 19-14. A maximum of 208 liters (55 gal) per waste stream of hazardous waste can be accumulated at a SAP. There is no limit to the volume of waste that can be stored at a 90-day accumulation area, but wastes must be taken to the permitted storage facility or disposed of off site within 90 days.

The permitted storage facility (RCRA Part B Permit, Number HO01-255040) is operated within Buildings 44200/44205. The facility is permitted to store hazardous wastes for up to

1 year under the current Florida Department of Environmental Protection (FDEP) permit and is operated by the Launch Base Support (LBS) contractor. However, the permit does not allow the waste storage site facility to store waste hydrazine (N_2H_4), monomethylhydrazine (MMH), or nitrogen tetroxide (NTO). At KSC and CCAFS, the JPC is responsible for the collection and transportation of most hazardous waste, including propellant waste, from accumulation sites to a 90-day hazardous waste accumulation area, to the permitted hazardous waste storage facility, or to a licensed, permitted disposal facility off station (Ouellette 2002; USAF 1998).

NASA has developed a program of managing and handling hazardous and controlled waste at KSC in compliance with RCRA and Florida regulations. The organizational and procedural requirements of the KSC hazardous waste management program are contained in KNPR 8500.1 "Hazardous Waste Management". This manual and its supporting documents delineate the procedures and methods to obtain/provide hazardous waste support, establish and approve operations and maintenance instructions, and provide instructions to maximize resource recovery and minimize costs (NASA 2010).

The control of most hazardous wastes at KSC and CCAFS is assigned to the Joint Base Operations Support Contractor. The Joint Base Operations Support Contractor directs and documents relevant actions for hazardous or controlled waste handling, sampling, storage, transportation, treatment, and disposal/recovery for compliance with all local, state, and Federal regulations. KSC has an operating permit from the FDEP for the storage, treatment, and disposal of hazardous waste. The main facilities operating under this permit are the Hazardous Waste Storage Facility (K7-165) in the LC-39 area, which handles liquid hazardous wastes, and an adjacent Facility (K7-164), which handles solid hazardous wastes (NASA 2010; Ouellette 2002).

Pollution Prevention

The 45th SW Pollution Prevention Program Guide (PPPG) and Pollution Prevention Management Action Plan satisfy requirements of the Pollution Prevention Act of 1990. The PPPG also complies with requirements in DoD Directive 4215.4, AFI 32-7080, and the USAF Installation PPPG. The PPPG establishes the overall strategy, delineates responsibilities, and specifies objectives for reducing pollution of the ground, air, surface water, and groundwater (USAF 1998).

KSC has established a Pollution Prevention Working Group to review all aspects of the KSC Pollution Prevention Program and to identify areas for additional pollution prevention activities. The team consists of KSC and contractor personnel. The NASA Acquisition Pollution Prevention Office assists KSC and other NASA centers in identifying, validating, and implementing less hazardous materials and processes.

3.3.1.3 Health and Safety

Regional Safety

CCAFS, KSC, the City of Cape Canaveral, and Brevard County have a mutual-aid agreement in the event of an on- or off-station emergency. During launch activities, CCAFS maintains communication with KSC, Brevard County Emergency Management, the Florida Marine

Patrol, the USCG, and the State coordinating agency, Division of Emergency Management. Range Safety monitors launch surveillance areas to ensure that risk to people, aircraft, and surface vessels is within acceptable limits. Control areas and airspace are closed to the public as required (USAF 1998).

On-Station Safety

Launches are not allowed if an undue hazard exists for persons and property due to potential dispersion of hazardous materials or propagation of blast overpressure. The 45th SW has prepared detailed procedures to be used to control toxic gas hazards. Atmospheric dispersion computer models are run to predict toxic hazard corridors (THCs) for both normal and aborted launches, as well as spills or releases of toxic materials from storage tanks or that occur during loading or unloading of tanks. Range Safety uses the THCs to reduce the risk of exposure of CCAFS and KSC personnel and the general public to toxic materials, including toxic gases.

JHB-2000 revision A (March 2002) is the CCEMP as described in Section 3.3.1.2. The USAF 45th SW OPlan 32-3 addresses emergency response to hazardous material incidents. For a NASA launch, the Launch Disaster Control Group (LDCG) is a joint NASA/USAF emergency response team formed prior to each launch and situated at a fallback location. For a NASA launch, the Disaster Control Group (DCG) is a joint NASA/USAF emergency response team that is activated for nonlaunch-related disasters at CCAFS (USAF 1998).

3.3.1.4 Geology and Soils

The barrier island forming Cape Canaveral and underlying CCAFS is composed of old beach ridges formed by wind and wave action. The average land surface elevation is approximately 3 m (10 ft) above mean sea level (MSL). The higher naturally occurring elevations occur along the eastern portion of CCAFS. From these higher elevations, there is a gentle slope to lower elevations (i.e., the marshlands along the Banana River). Merritt Island is composed of relict beach ridges on the eastern side of the island and has an undulating land surface. The troughs are near sea level, and the ridges rise to a maximum of about 3 m (10 ft) above sea level. Surface deposits on Merritt Island are of Pleistocene and Recent ages and consist primarily of sand and sandy coquina (NASA 2010a).

While sinkholes are the principal geologic hazard in central Florida, CCAFS and KSC are not prone to sinkholes, since the limestone formations are over 30 m (100 ft) below the ground surface, and confining units minimize recharge to the limestone (USAF 1996b). CCAFS and KSC are located in Seismic Hazard Zone 0 as defined by the Uniform Building Code. Seismic Zone 0 represents a very low potential risk for large seismic events (NASA 2010a; USAF 1998). The Uniform Building Code is referenced here since it provides a useful metric for comparison of seismic hazards.

3.3.1.5 Water Resources

The St. John's River Water Management District (SJRWMD) and the FDEP issue the Environmental Resource Permits, which include storm water and wetlands management, in coordination with the U.S. Army Corps of Engineers.

Groundwater

There are three aquifer systems underlying CCAFS and KSC: the surficial aquifer system, the intermediate aquifer system, and the Floridian aquifer system. The surficial aquifer system, which comprises generally sand and marl, is under unconfined conditions and is approximately 21 m (70 ft) thick. The water table in the aquifer is generally 1 m (3.3 ft) or less below the ground surface. Recharge to the surficial aquifer is principally by percolation of rainfall and runoff. A confining unit composed of clays, sands, and limestone separates the surface aquifer from the underlying Floridian aquifer. The Floridian aquifer is the primary source of potable water in central Florida and is composed of several carbonate units with highly permeable zones. These two main aquifers are separated by nearly impermeable confining units and contain three shallow aquifers referred to as the intermediate aquifer system. Groundwater in the Floridian aquifer at CCAFS is highly mineralized. CCAFS and KSC receive their potable water from the city of Cocoa, which pumps water from the Floridian aquifer (USAF 1998).

Surface Water

CCAFS and KSC are located within the Florida Middle East Coast Basin. Florida's Indian River Lagoon Estuary System includes Mosquito Lagoon, Pone Inlet, Banana River, Indian River, and the Sebastian Inlet. Surface drainage at CCAFS generally flows to the west into the Banana River. The 100-year floodplain on CCAFS extends 2.1 m (7 ft) above MSL on the Atlantic Ocean side and 1.2 m (4 ft) above MSL on the Banana River side. Local areas designated as Outstanding Florida Water (OFW) include most of Mosquito Lagoon and the Banana River, Indian River Aquatic Preserve, Banana River State Aquatic Preserve, Pelican Island National Wildlife Refuge, and CNS. These water bodies are afforded the highest level of protection, and any compromise of ambient water quality is prohibited. The EPA has also designated the Indian River Lagoon System as an Estuary of National Significance. Estuaries of National Significance are identified to balance conflicting uses of the estuaries while restoring or maintaining their natural character. The Banana River has been designated a Class III surface water, as described by the CWA. Class III standards are intended to maintain a level of water quality suitable for recreation and the production of fish and wildlife communities (USAF 1998).

Water Quality

NASA manages the monitoring of surface water quality on and near CCAFS and KSC at 11 long-term monitoring stations. The FDEP has classified water quality in the Florida Middle East Coast Basin as poor to good based on the physical and chemical characteristics of the water. The upper reaches of the Banana River and the lower reaches of Mosquito Lagoon have generally good water quality due to lack of urban and industrial development in the area. Nutrients and metals, when detected, have generally been below Class II standards (NASA 1995a). Areas of poor water quality exist along the western portions of the Indian River, near the city of Titusville, and in Newfound Harbor in southern Merritt Island.

Coastal Zone Management

Federal activity in, or affecting, a coastal zone requires preparation of a Coastal Zone Consistency Determination in accordance with the Federal Coastal Zone Management Act

(CZMA) of 1972, as amended (P.L. 92-583), and implemented by the National Oceanic and Atmospheric Administration (NOAA) through the State coastal zone management offices. The Florida Department of Environmental Protection, Florida Coastal Management Program reviews coastal zone consistency determinations for the State of Florida is the State's coastal management agency. NASA is responsible for making consistency determinations and obtaining concurrence from the respective State coastal zone management agency for NASA approved or funded actions within the coastal zone and the USAF is responsible for making the final coastal zone consistency determinations for its activities within the State. The FDCA reviews the coastal zone consistency determination (USAF 1998). The State of Florida's coastal zone includes the area encompassed by the state's 67 counties and its territorial seas (i.e., the entire state).

Perchlorate Deposition

The NRC completed its toxicological review of perchlorate on January 10, 2005. Based on the results of this review, the EPA adopted an oral reference dose (RfD) of 0.0007 milligrams of perchlorate per kg of body weight per day, which, when used to calculate a Drinking Water Equivalent Level (DWEL), is equivalent to 24.5 ppb. A reference dose is a scientific estimate of a daily exposure level that is not expected to cause adverse health effects in humans. Based upon the EPA guidance of an Interim Drinking Water Health Advisory (Interim Health Advisory), (dated January 8, 2009), DoD updated their policy to conform to the Interim Drinking Water Advisory, set at 15 ppb (EPA 2009).

3.3.1.6 Air Quality

Florida Regulatory Framework

Air quality for the CCAFS and KSC area is regulated under FAC 62-200 et seq. As shown in Table 3-1, the Florida Ambient Air Quality Standards (FAAQS) are not significantly different from the NAAQS. FAC 62-210 establishes general requirements for stationary sources of air pollutant emissions and provides criteria for determining the need to obtain an air construction or air operation permit. FAC 62-213 implements Federal Rule Title 40 CFR 70, which provides a comprehensive operation permit system for permitting major sources of air pollution (Title V sources). CCAFS and KSC are classified as major sources because emissions are above major source thresholds. KSC and CCAFS have Title V permits.

Meteorology

The climate in the CCAFS and KSC area 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°C (71°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 percent. The winter is drier with humidity ranges of 55 to 65 percent.

Prevailing winds during the winter are steered by the jet stream aloft and are frequently from the north and west. As the jet stream retreats northward during the spring, the prevailing winds shift and come out of 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.

Table 3-1 National and Florida Ambient Air Quality Standards

Pollutant	Averaging Time (National)	National Standards	Florida Standards
		Primary	
Carbon monoxide (CO)	8 Hours[a]	9 ppm	9 ppm
	1 Hour[a]	35 ppm	35 ppm
Lead	Rolling 3-month average	0.15 micrograms/m^3[b]	1.5 micrograms/m^3
	Quarterly average	1.5 micrograms/m^3	1.5 micrograms/m^3
Nitrogen dioxide (NO_2)	Annual	53 ppb[c]	0.053 ppm
	1 Hour[d]	100 ppb	100 ppb
Ozone	8 Hours[h]	0.75 ppm	0.075 ppm
	1 Hour[i]	0.12 ppm	N/A
$PM_{2.5}$	Annual[f]	15 micrograms/m^3	15 micrograms/m^3
	24 Hours[g]	35 micrograms/m^3	N/A
PM_{10}	24 Hours[e]	150 micrograms/m^3	15 micrograms/m^3
Sulfur dioxide (SO_2)	Annual	0.03 ppm	0.02 ppm
	24 Hours[a]	0.5 ppm	0.10 ppm
	1 Hour[j]	75 ppb	N/A

a. Not to be exceeded more than once per year.
b. Final rule signed October 15, 2008.
c. The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.
d. To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb (effective January 22, 2010).
e. Not to be exceeded more than once per year on average over 3 years.
f. To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m^3.
g. To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m^3 (effective December 17, 2006).
h. To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. (effective May 27, 2008).
i. a) EPA revoked the 1-hour ozone standard in all areas, although some areas have continuing obligations under that standard ("anti-backsliding").
b) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is < 1.
j. Final rule signed June 2, 2010. To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 ppb.

Key: m^3=cubic meter; N/A=Not Applicable.
Source: FDEP 2007; USAF 2010.

Under normal midday weather conditions, surface mixing occurs over a layer with an average daily maximum value of 700 to 900 m (2,300 to 2,950 ft) during the winter and 1,190 to 1,400 m (3,900 to 4,600 ft) during the summer. The mixed layer is rarely capped by a strong temperature inversion. At the surface, easterly sea breezes with moderate speeds of 8 to 16 kph (5 to 10 mph) and depths on the order of 150 to 305 m (500 to 1,000 ft) occur nearly every day during the summer and early fall.

Hurricanes can also occur, normally between August and October (USAF 1998).

Regional Air Quality

CCAFS and KSC are in Brevard County, which has been designated by both the EPA and the FDEP to be in attainment for ozone, SO_2, NO_2, CO, PM_{10} and $PM_{2.5}$. Table 3-2 shows ambient air concentrations measured at nearby monitoring stations for criteria pollutants.

Table 3-2 Ambient Air Concentrations for Criteria Pollutants near CCAFS and KSC

Pollutant	Averaging Time	Florida State Standard	2002
CO	1-hr Average	35 ppm	5 ppm
	8-hr Average	9 ppm	3 ppm
Lead	Rolling 3-month Average	micrograms/m^3	N/A
NO_2	Annual	0.053 ppm	0.011 ppm
Ozone	1-hr Average	0.12 ppm	0.090 ppm
	8-hr Average	N/A	0.076 ppm
$PM_{2.5}$	24-hr Average	35 micrograms/m^3	24 ppm
	Annual	No Standard	7.8 ppm
PM_{10}	24-hr Average	150 micrograms/m^3	67 ppm
	Annual	15 micrograms/m^3	18 ppm
SO_2	3-hr Average	0.5 ppm	0.013 ppm
	24-hr Average	0.10 ppm	0.005 ppm
	Annual	0.02 ppm	0.001 ppm

Key: N/A=Not Available.
Source: FDEP 2008.

Air Emissions

Presented in Table 3-3 is a summary of both the 2004 and 2005 Air Emissions Inventory Report for CCAFS (most recent) actual and potential annual emissions estimates for all NAAQS and FAAQS regulated criteria pollutants and total HAPS (included in the current Title V Air Operating Permits. Additional HAPS limitations making CCAFS a "synthetic minor" source for HAPS was later added in a permit modification in November 2005. CCAFS remains a Title V "major" source of criteria pollutants.

Table 3-3 Summary of CCAFS Criteria Pollutant and HAPs Emissions (Tons per Year-TPY) for 2004 and 2005

Pollutant	2004 Actual TPY	2004 Potential TPY	2005 Actual TPY	2005 Potential TPY
CO	29.96	31.09	25.39	31.80
HAPs	7.70	8.11	7.65	18.35
NO_X	129.90	141.56	110.53	121.60
PM	170.5	232.82	206.96	270.62
PM_{10}	83.30	99.39	99.00	114.76
SO_2	8.25	14.29	6.85	6.90
VOC	17.54	75.11	14.12	72.53

Source: USAF 2007.

3.3.1.7 Noise

Noise levels around facilities at CCAFS and KSC approximate those of any urban industrial area, reaching levels of 60 to 80 dBA. Additional on-site sources of noise are the aircraft landing facilities at the CCAFS Skid Strip and the KSC Shuttle Landing Facility. Other less frequent but more intense sources of noise in the region are launches from CCAFS and KSC. Noise from a Delta II launched from LC-17 was measured during a July 1992 launch (McInerny 1993). Table 3-4 shows the noise levels measured during the launch and the prelaunch predicted overall sound pressure levels.

Table 3-4 Measured Delta II Sound Levels, July 1992

Distance from Pad (ft/m)	Noise Levels (dB)			
	Predicted Maximum OSPL	Measured Maximum OSPL	Measured Maximum AWSPL	Measured A-weighted SEL
1,500/458	135.4	130.6	120.2	127.5
2,000/610	132.9	130.4	117.7	125.5
3,000/915	129.4	125.8	115.1	123.0

Key: AWSPL=A-weighted sound pressure level; dB=decibel; OSPL=overall sound pressure level; SEL=sound exposure level (A-weighted).
Source: McInerny 1993.

The relative isolation of the CCAFS and KSC facilities reduces the potential for noise to affect adjacent communities. The closest residential areas to CCAFS are to the south, in the cities of Cape Canaveral and Cocoa Beach. Expected sound levels in these areas are normally low, with higher levels occurring in industrial areas (Port Canaveral) and along transportation corridors. Residential areas and resorts along the beach would be expected to have low overall noise levels, normally about 45 to 55 dBA. Infrequent aircraft fly-overs and rocket launches from CCAFS and KSC would be expected to increase noise levels for short periods of time. The highest recorded levels are those produced by launches of the Space Shuttle, which in the launch vicinity can exceed 160 dBA. Space Shuttle launch noise at Port Canaveral would be expected to be typical of those at an industrial facility, reaching levels of 60 to 80 dBA (USAF 1998).

Sonic booms produced during vehicle ascent occur over the Atlantic Ocean are directed in front of the vehicle and do not impact land areas.

3.3.1.8 Biological Resources

CCAFS and KSC occupy a combined total of about 62,753 hectares (155,000 acres) of coastal habitat on a barrier island complex that parallels Florida's mid-Atlantic coast. The area of interest for biological resources consists of CCAFS and KSC, the adjacent Atlantic Ocean, and three major inland water bodies (the Banana and Indian Rivers and Mosquito Lagoon).

Vegetation

CCAFS and KSC support numerous ecologically significant upland and wetland communities. Upland communities include coastal dunes, coastal strand, oak scrub, palmetto scrub, slash pine flatlands, cabbage palm hammock, oak-cabbage palm hammock, and xeric hammock. Wetland communities include non-saline wetlands, hardwood swamp, willow swamp, freshwater swale swamp, cattail marsh, cabbage palm savanna, brackish or saline wetlands, sand cordgrass/black rush, mixed salt-tolerant grasses marsh, sea oxeye, saltwort-glasswort, saltmarsh cordgrass, and mangrove (NASA 2010).

Wildlife

The coastal scrub and associated woodlands provide habitat for mammals, including the white-tailed deer, armadillo, bobcat, feral hog, raccoon, long-tailed weasel, round-tailed muskrat, and the Florida mouse (a state species of special concern). At CCAFS and KSC, the resident and the migrating bird species include numerous common land and shore birds.

Amphibians observed at CCAFS and KSC include the spade-foot and eastern narrow-mouth toads, squirrel and southern leopard frogs, and green tree frogs. Reptiles observed include the American alligator, the Florida box turtle, the gopher tortoise, the Florida softshell, the green anole, the six-lined racerunner, the broadhead skink, the southern ringneck snake, the everglades racer, the eastern coachwhip, and the mangrove salt marsh snake.

Numerous marine mammals populate the coastal and lagoon waters, including the bottlenose dolphin, the spotted dolphin, and the manatee. The seagrass beds in the northern Indian River system provide important nursery areas, shelter, and foraging habitat for a wide variety of fish and invertebrates, and for manatees. The inland rivers and lagoons provide habitat for marine worms, mollusks, and crustaceans. The Mosquito Lagoon is an important shrimp nursery area.

A number of saltwater fish species can be found within the Indian and Banana River systems, including the bay anchovy, pipefish, goby, silver perch, lined sole, spotted sea trout, and oyster toadfish. The small freshwater habitats found on CCAFS and KSC contain bluegill, garfish, largemouth bass, killifishes, sailfin molly, and top minnow (USAF 1998).

Threatened and Endangered Species

CCAFS and KSC contain habitat utilized by a large number of Federally and State-listed species. Listed species that are known to be present or near the station boundaries are presented in Table 3-5.

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 2007).

Table 3-5 Threatened, Endangered, and Candidate Species Occurring or Potentially Occurring on or Around CCAFS and KSC, Florida

Common Name	Scientific Name	Federal Status	State Status
Plants			
Beach-star[a]	*Remirea maritima*	–	E
Coastal vervain[a]	*Glandulareia maritima*	–	E
Curtiss' milkweed[a]	*Asclepias curtissii*	–	E
Florida lantana[a]	*Lantana depressa var. floridana*	–	E
Hand fern[a]	*Ophioglossum palmatum*	–	E
Inkberry[a]	*Scaevola plumieri*	–	T
Nakedwood, Simpson's Stopper[a]	*Myciantheſ fragrans*	–	T
Nodding pinweed[a]	*Lechea cernua*	–	T
Sand dune spurge[a]	*Chamaesyce cumulicola*	–	E
Satin-leaf [a]	*Chrysophyllum olivaeforme*	–	E
Sea lavender[a]	*Tournefortia gnaphalodes*	–	E
Shell mound prickly-pear cactus[a]	*Opuntia stricta*	–	T
Reptiles and Amphibians			
American alligator[a]	*Alligator mississippiensis*	T(S/A)	SSC
Atlantic (Kemp's) Ridley sea turtle[a]	*Lepidochelys kempi*	E	E
Atlantic green turtle	*Chelonia mydas*	E	E
Eastern indigo snake	*Drymarchon corais couperi*	T	T
Florida gopher frog	*Rana capito*	–	SSC
Florida pine snake	*Pituophis melanoleucus mugitus*	–	SSC
Gopher tortoise	*Gopherus polyphemus*	–	T
Hawksbill sea turtle[a]	*Eretmochelys imbricata imbricata*	E	E
Leatherback sea turtle	*Dermochelys coriacea*	E	E
Loggerhead sea turtle	*Caretta caretta*	T	T
Birds			
American oystercatcher[a]	*Haematopus palliatus*	–	SSC
Black skimmer	*Rynchops niger*	–	SSC
Brown pelican	*Pelecanus occidentalis*	–	SSC
Florida scrub jay[a]	*Aphelocoma coerulescens*	T	T
Least tern[a]	*Sterna antillarum*	–	T
Little blue heron	*Egretta caerulea*	–	SSC
Peregrine falcon[a]	*Falco peregrinus*	–	E
Piping plover[a]	*Charadrius melodus*	T	T

Table 3-5. Threatened, Endangered, and Candidate Species Occurring or Potentially Occurring on or Around CCAFS and KSC, Florida (*continued*)

Common Name	Scientific Name	Federal Status	State Status
Birds (*continued*)			
Reddish egret	*Egretta rufescens*	–	SSC
Roseate spoonbill[a]	*Ajaia ajaja*	–	SSC
Roseate tern	*Sterna dougallii dougallii*	T	T
Snowy egret	*Egretta thula*	–	SSC
Southeastern American kestrel[a]	*Falco sparverius paulus*	–	T
Tricolored heron	*Egretta tricolor*	–	SSC
White ibis	*Eudocimus albus*	–	SSC
Wood stork[a]	*Mycteria americana*	E	E
Mammals			
Finback whale[a]	*Balaenoptera physalus*	E	E
Florida mouse	*Podomys floridanus*	–	SSC
Humpback whale[a]	*Megaptera novaeangliae*	E	E
Northern right whale[a]	*Eubalaena glacialis*	E	E
Sei whale[a]	*Balaenoptera borealis*	E	E
Southeastern beach mouse	*Peromyscus polionotus niveiventris*	T	T
Sperm whale[a]	*Physeter catodon*	E	E
West Indian manatee	*Trichechus manatus latirostris*	E	E

a. Only found at CCAFS.
Key: C=candidate (former Category C1); C2=former Category 2; E=endangered; SSC=State species of special concern; (S/A)=listed by similarity of appearance to a listed species; T=threatened.
Sources: NASA 2010; USAF 2007.

Sensitive Habitats

Sensitive habitats on CCAFS and KSC include wetlands, critical habitats for threatened and endangered species as defined by the Endangered Species Act, and the nearby Canaveral National Seashore and Merritt Island National Wildlife Refuge. This refuge (a part of KSC) contains a large number of manatees. Manatee critical habitat, located in the Banana River system, includes the entire inland sections of the Indian and Banana rivers, and most of the waterways between the two rivers. The National Marine Fisheries Service (NMFS) is proposing to designate the water adjacent to the coast of Florida as critical habitat for the northern right whale. Threatened or endangered species that inhabit the scrubby flatwoods of Merritt Island include the Florida scrub jay, the eastern indigo snake, and the southern bald eagle.

The Indian River Lagoon area (Indian River, Banana River, and Mosquito Lagoon) is home to more than 4,300 kinds of plants and animals. The lagoon has a gradation of brackish water to salt water where it opens to the ocean. It is listed as an Estuary of National Significance and contains more species than any other estuary in North America (2,965 animals, 1,350 plants, 700 fish, and 310 birds). It also provides important migratory bird habitat. The lagoon

contains one of the highest densities of nesting turtles in the western hemisphere, is a rich fishery, and is used by up to one third of the United States' manatee population (USAF 1998).

3.3.1.9 Historical and Cultural Resources

Human occupation of the CCAFS and KSC area first occurred approximately 4,000 years ago. There is archaeological evidence that the entire area was exploited for a wide variety of marine, estuarine, and terrestrial resources. European exploration of the Florida coast began in the 15th century. The area remained sparsely populated until 1843 when a lighthouse was established. Maritime activities increased during the early 1900s, and additional homesteads and roads were established. The U.S. Government began purchasing land for the establishment of a long-range proving ground and missile test center in the late 1940s (USAF 1998).

Sixteen archaeological sites have been identified on CCAFS, 11 of which have been determined eligible for listing in the NRHP but have not currently been listed. Of these, five are burial mounds with a settler's cemetery associated with one mound. The remaining five sites have been determined to be ineligible for listing. Additionally, there are five historic sites of which two are cemeteries of the early settlers; these are not protected under current legislation but are monitored as historically significant.

In addition, there are seven CCAFS sites listed as National Historic Landmarks (NHLs). Four are launch complexes, one is just the Mobile Service Tower at LC 13, and two are NASA property and, therefore, not under the jurisdiction of the 45th SW. In addition, eight other sites are eligible for NHL listing, including six launch complexes, Hangar C, and the Cape Lighthouse.

In 1973, LC-39 became the first NASA site at KSC to be listed in the NRHP. The nomination highlighted the national significance of those principal facilities associated with the Apollo Manned Lunar Landing Program. LC-39, built between November 1962 and October 1968, was evaluated as significant in the areas of architecture, communications, engineering, industry, science, transportation, and space exploration.

In 2006, the original Multiple Property documentation for the NRHP-listed Apollo facilities was updated to include a new historic context, the Space Shuttle program (SSP) (ca. 1969-2010) and its associated property. Twenty-six assets were considered to individually meet the criteria of eligibility for listing in the NRHP, including 11 buildings, 14 structures and one object. All meet NRHP Criterion A for their exceptional significance and most also meet Criterion C in the area of engineering. The total 26 facilities include six NRHP-listed Apollo properties: the Vehicle Assembly Building, Launch Control Center, Crawlerway, two Crawler Transporters, and the Press Site: Clock and Flag Pole. Twenty additional properties were newly assessed as individually eligible under the SSP. These include LC-39 Pads A and B, the Shuttle Landing Facility Runway, the Landing Aids Control Building, the Mate-Demate Device, the Orbiter Processing Facility (High Bays 1 and 2), the Orbiter Processing Facility High Bay 3, the Thermal Protection System Facility, the Rotation/Processing Facility, the Manufacturing Building, the Parachute Refurbishment Facility, the Canister Rotation Facility, the Hypergol Module Processing North, two Payload Canisters, the two Retrieval Ships (Freedom Star and Liberty Star), and three Mobile Launcher Platforms. Four newly historic districts were determined eligible under the SSP (the SLF Area Historic District, the Orbiter

Processing Historic District, the SRB Disassembly and Refurbishment Complex Historic District, and the Hypergolic Maintenance and Checkout Area Historic District) along with the two previously listed Apollo districts (LC-39: Pad A Historic District and LC-39: Pad B Historic District) for their exceptional significance.

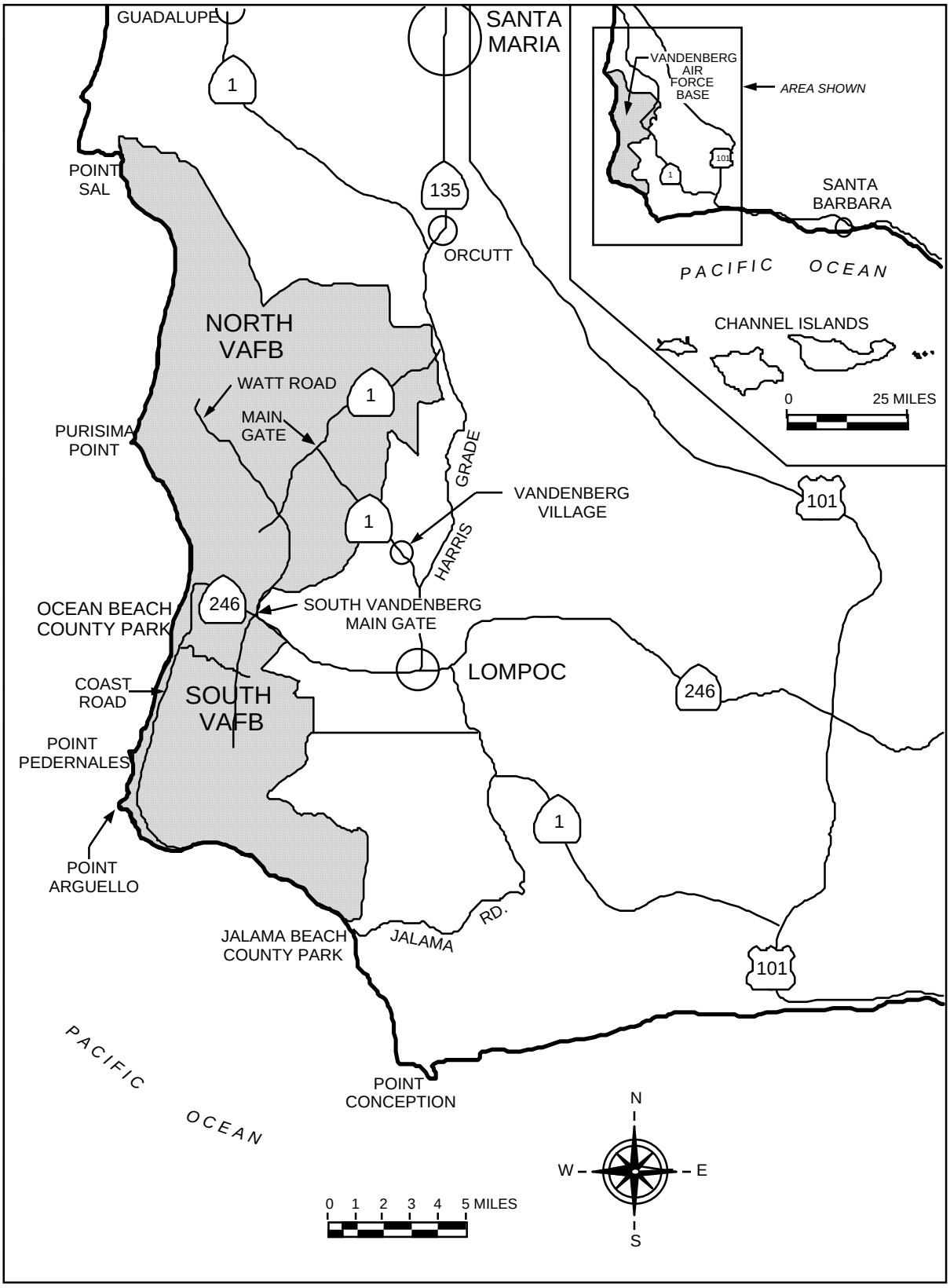
3.3.1.10 Environmental Justice

Based upon the 2000 Census of Population and Housing, Brevard County had a population of 476,230 persons. Of this total, 63,339 persons (13.3 percent) were minority and 53,814 persons (11.3 percent) were low-income as defined by USCB criteria. The U.S. Census Board estimates that Brevard County had a population of 536,521 people in 2008. Of this population, 14.1 percent are estimated to be minority and 8.6 percent were estimated to be low-income (USCB 2009a).

3.3.2 Vandenberg Air Force Base (VAFB)

VAFB is in the western part of Santa Barbara County, California. The Santa Ynez River divides the base into North and South VAFB. North VAFB generally includes the developed portions of the base, whereas South VAFB includes primarily open space. The city of Lompoc lies to the east, the city of Santa Maria lies to the northeast, and the city of Guadalupe lies to the north. Two unincorporated communities, Vandenberg Village and Mission Hills, are north of the city of Lompoc; and the unincorporated community of Orcutt is north of the base. The 2000 census lists the following cities and towns in Santa Barbara County: Buellton, Carpinteria, Guadalupe, Lompoc, Santa Barbara, Santa Maria, and Solvang.

The total population of Santa Barbara County increased from 369,608 persons in 1990 to 399,347 in 2000, which was an 8 percent increase. The USCB reports that the population of Santa Barbara County in 2010 was 423,895, which is a 6.1 percent increase over the 2000 census (USCB 2010b). The VAFB area is shown is Figure 3-3.



Source: NASA 1998.

Figure 3-3 Regional Map of VAFB

3.3.2.1 Land Use and Aesthetics/Visual Resources

VAFB encompasses approximately 39,838 hectares (98,400 acres), representing approximately 6 percent of the total land area of Santa Barbara County. The greatest use of land on VAFB (90 percent) is for open space. Six percent of VAFB is industrial use. Aircraft operations and maintenance combined with space and missile launch activities account for only 2 percent of the land use of VAFB. The primary developed area on North VAFB includes residential, administrative, industrial, recreational, open space, and community land uses. The remaining developments on north base include an airfield, as well as several testing and launch facilities. The majority of South VAFB is undeveloped. The developed portion of the south base includes launch complexes, test and launch facilities, technical support areas, several mountaintop tracking stations, and an administrative and industrial area. Some of the undeveloped areas on South VAFB are leased for grazing.

VAFB provides limited public access to the base's shoreline up to the mean high tide line. Jalama Beach County Park is situated just beyond the southern end of the base. The park is closed to the public during some Atlas, Delta, and Titan launches. Ocean Beach County Park is located between North and South VAFB. It is also closed for Atlas, Delta, Falcon, and Minotaur launches.

The visual environment in the vicinity of VAFB is varied and characterized by rolling hills covered with chaparral and oak trees, valleys utilized for grazing or agriculture, and urbanized areas of the Lompoc Valley. Topography is mostly dominated by the Santa Ynez Mountains, which terminate at Point Arguello. Views of the coastline are generally not available from inland locations due to access limitations and topographic barriers.

3.3.2.2 Hazardous Materials and Hazardous Waste Management

Hazardous Materials Management

VAFB requires all contractors using hazardous materials to submit a hazardous materials contingency plan prior to working on base. Distribution of hazardous materials at VAFB is coordinated from a single-issue point. Management of hazardous materials obtained directly from off-base suppliers by contractors is the responsibility of the individual contractor. Hazardous propellants are controlled by the base propellant contractor, which handles the purchase, transport, temporary storage, and loading of hypergolic fuels and oxidizers. They are stored at the Hypergolic Storage Facility (Buildings 974 and 975) on South VAFB. Spills of hazardous materials are covered under the Hazardous Materials Emergency Response Plan, 30 SW Plan 32-4002, which ensures that adequate and appropriate guidance, policies, and protocols regarding hazardous material incidents and associated emergency response are available to all installation personnel (USAF 1998).

Hazardous Waste Management

RCRA and the California Environmental Protection Agency's (CAL-EPA) Department of Toxic Substances Control (under the California Health and Safety Code and the California Administrative Code) regulate hazardous wastes at VAFB. These regulations require that hazardous waste be handled, stored, transported, disposed, or recycled according to defined

procedures. The VAFB Hazardous Waste Management Plan (HWMP), 30 SW Plan 32-7043-A, implements the above regulations and outlines the procedures for disposing of hazardous waste. All hazardous waste generated is labeled with the EPA identification number for VAFB, under which it is transported, treated, and disposed. Individual contractors and organizations at VAFB are responsible for administering all applicable regulations and plans regarding hazardous waste.

Typical hazardous wastes include various solvents, paints and primers, sealants, photograph-developing solutions, adhesives, alcohol, oils, fuels, and various process chemicals. Hazardous waste is stored at its point of origin until the waste container is full, or until 60 days following the day the container first received waste (whichever is first). The waste is then transported to the permitted consolidated Collection Accumulation Point (CAP) for temporary storage for no longer than 30 days. Waste hypergolic fuel is stored at a separate consolidated Hypergolic Storage Facility CAP. Hazardous waste can be stored at the permitted storage facility (Building 3300) for up to 1 year from the date of accumulation. Waste not listed in the Part B permit must be shipped to an off-base treatment, storage, or disposal facility within the allowable 90-day storage period (USAF 1998).

Pollution Prevention

The VAFB Pollution Prevention Management Program (PPMP), 30 SW Plan 32-7080, satisfies requirements of the Pollution Prevention Act of 1990 (USAF 1996b). The PPMP also complies with requirements in DoD Directive 4210.15, AFI 32-7080, and the USAF Installation PPPG. The PPMP establishes the overall strategy, delineates responsibilities, and sets specific objectives for reducing pollution of the ground, air, surface water, and groundwater.

3.3.2.3 Health and Safety

Regional Safety

Santa Barbara County has prepared a Hazardous Material Response Plan that is used to coordinate disaster response countywide. The county requires communities to have their own emergency response plans. The county incorporated these plans into a comprehensive Multi-hazard Functional Plan. Because of the potential for VAFB operations to affect off-base areas, VAFB plays a prime role in regional emergency planning. VAFB and the city of Lompoc have entered into a mutual aid agreement. VAFB would assume control of the response action if a launch mishap occurs in Lompoc. In the event of a launch vehicle mishap affecting other areas outside VAFB, the On-Scene DCG from VAFB would respond to the accident upon request of the county (USAF 1998).

On-Base Safety

Range Safety recommends a launch hold if an undue hazard to persons and property exists due to potential dispersion of hazardous materials or debris, or propagation of blast overpressure. A base contractor runs hazard prediction models before a launch to predict toxic hazard corridors, debris impact areas, and overpressure focusing areas. The 30SW reviews the plotted output from the air dispersion models, which reveal predicted downwind concentrations of

toxic gases resulting from potential liquid propellant spills. Range Safety uses these predictions to reduce the risk of exposure of VAFB personnel and the general public to toxic materials, including toxic gases.

3.3.2.4 Geology and Soils

Topography within VAFB is varied, ranging from sea level to about 600 m (2,000 ft) MSL in the Santa Ynez Mountains. North VAFB lies within the Coast Range geomorphic province, while South VAFB lies within the Transverse Ranges geomorphic province. Coastal sand dunes, alluvium, and underlying marine sedimentary rocks characterize the geology of VAFB.

Earthquakes are a major hazard in California. According to the U.S. Geological Survey (USGS), the severity of an earthquake is expressed in terms of both magnitude (seismic energy) and intensity. Intensity, which is commonly measured using the Modified Mercalli Intensity Scale, relates to the observed effects of ground shaking on people, buildings, and natural features and varies from place to place (USGS 1989). Numerous onshore and offshore faults have been mapped within the vicinity of VAFB. While most faults are inactive and not capable of surface fault rupture or of generating earthquakes, more than 90 earthquakes ranging in magnitude from 3.0 to 7.3 on the Richter Magnitude Scale have occurred within a 32 km (20 mi) radius of the project area since 1900. VAFB is located in a Seismic Zone IV, as defined by the Uniform Building Code. Seismic Zone IV is characterized by areas likely to sustain major damage from earthquakes, and corresponds to intensities of VIII or higher on the Modified Mercalli Intensity Scale (USAF 1998). The Uniform Building Code is referenced here since it provides a useful metric for comparison of seismic hazards.

3.3.2.5 Water Resources

The State Water Resources Control Board and the Regional Water Quality Control Board (RWQCB) administer the CWA and State water regulations in California. The Central Coast Region RWQCB is the local agency responsible for the VAFB area. The RWQCB is responsible for management of the NPDES permits process for California. State regulations require a Waste Discharge Requirement for permitting discharge. A Report of Waste Discharge is required for actions that would involve discharge of waste to surface and/or groundwater. The California Porter-Cologne Water Quality Act implements the NPDES program for the State (USAF 1998).

Groundwater

The main sources of potable water in the region are from the San Antonio Creek Valley groundwater basin, the Lompoc Plain groundwater basin, the Lompoc Upland groundwater basin, and the Lompoc Terrace groundwater basin. These groundwater basins are pumped for potable water for VAFB and the surrounding communities.

Surface Water

The Santa Ynez River and San Antonio Creek are the two major surface water features on VAFB. The Santa Ynez River has a drainage area of approximately 2,333 km^2 (900 mi^2) and discharges into the Pacific Ocean. Flow in the river is generally intermittent and mainly in

response to rainfall events. San Antonio Creek has a drainage area of 400 km^2 (154 mi^2) and discharges into a small lake in the dunes area of North VAFB. Its flow is intermittent in its upper reaches, but perennial throughout VAFB. Other major drainages on VAFB include Cañada Tortuga Creek, Bear Creek, Cañada Honda Creek, and Jalama Creek (Astrotech 1993).

Water Quality

The majority of water used at VAFB is supplied by the local aquifers. VAFB also receives supplemental potable water from the State Water Project. Groundwater quality is variable but meets all National Primary Drinking Water Regulation standards. Continued overdraft of the groundwater basins could lead to a decline in water table levels and a compaction of the basins. A slight decrease in water quality has been occurring in the region due to the use of water for irrigation. As this water flows through the soil back to the basin, it carries salts and leads to a buildup of salts in the groundwater (USAF 1998).

Coastal Zone Management

Federal activity in, or affecting, a coastal zone requires preparation of a Coastal Zone Consistency Determination, in accordance with the CZMA. The California Coastal Zone Management Program is consistent with the California Coastal Zone Conservation Act of 1972, as amended. The USAF is responsible for making final coastal zone consistency determinations for its activities within the State, and the California Coastal Commission reviews federally authorized projects for consistency with the California Coastal Zone Management Program. The coastal zone extends inland on VAFB from approximately 1.2 km (0.75 mi) at the northern boundary to 7.2 km (4.5 mi) at the southern end of the base (USAF 1998).

Perchlorate Deposition

On October 1, 2004, the DoD and the CAL-EPA finalized a procedure for prioritizing perchlorate-sampling efforts at DoD facilities throughout California. The procedure document provides guidance to California and DoD officials on the steps each party will take to identify and prioritize areas on military sites where perchlorate has likely been released in proximity to drinking water sources. If perchlorate releases are discovered, DoD intends to fully characterize and respond to the problem under its existing environmental response programs (DoD 2004).

Currently, no drinking water standard for perchlorate has been adopted. California recently set a public health goal of 6 parts per billion and that state's department of health services has begun efforts to adopt a maximum contaminant limit. EPA is working with the State of California on monitoring perchlorate occurrence in public water systems.

Volatile organic compounds and perchlorate have been identified in the groundwater at the "Site 8 Cluster," which includes both SLC-4E and SLC-4W. In November 2003, an interim remedial action began operation at the site for plume containment (horizontal extraction well), source reduction (vacuum enhanced groundwater extraction wells), groundwater and vapor treatment (granular activated carbon), and perchlorate treatment (ion exchange technology). The extraction system is no longer operated with TCE and perchlorate currently being treated

with injections of enzymes to bioremediate subsurface contamination. The contaminants are the result of earlier launch operations. Except for SLC-4, there are no other known perchlorate contamination sites on VAFB (USAF 2006).

3.3.2.6 Air Quality

Air quality for the VAFB area is regulated under the California Code of Regulations (CCR), Title 17. Under CCR 17-Section 70200, the California Air Resources Board (CARB) has developed ambient air quality standards (see Table 3-6), which represent the maximum allowable atmospheric concentrations that may occur and still ensure protection of public health. Subchapter 7 of CCR 17-93000 defines toxic air pollutants as well as HAPs. Subchapter 7.5 contains requirements for air-toxics control measures for specific industries. Subchapter 7.6 incorporates the requirements of the Air Toxics "Hot Spots" Information and Assessment Act of 1987. Section 44340 of the Air Toxics "Hot Spots" Information and Assessment regulations requires preparation and submission of a comprehensive emissions inventory plan (USAF 1998).

The Santa Barbara County Air Pollution Control District (SBCAPCD) also regulates VAFB. SBCAPCD Regulation XIII incorporates the Federal regulation for Operating Permits under Title 40 CFR Part 70.

Table 3-6 California Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards micrograms/m^3 (ppm)
Carbon monoxide	8 Hours	10,000 (9 ppm)
	1 Hour	23,000 (20 ppm)
Hydrogen sulfide	1 Hour	42 (0.03 ppm)
Lead	30 Days	1.5
	Quarterly	N/A
	Rolling 3-month average[a]	N/A
Nitrogen dioxide	Annual	57 (0.030 ppm)
	1 Hour	339 (0.18 ppm)
Ozone	1 Hour	180 (0.09 ppm)
	8 Hour	137 (0.070 ppm)
$PM_{2.5}$	Annual	12
	24 Hours	N/A
PM_{10}	Annual	20
	24 Hours	50
Sulfates	24 Hours	25

Table 3-6. California Ambient Air Quality Standards (*continued*)

Pollutant	Averaging Time	California Standards micrograms/m^3 (ppm)
Sulfur dioxide	Annual	N/A
	24 Hours	105 (0.04 ppm)
	3 Hours	N/A
	1 Hour	655
Vinyl chloride	24 Hours	26 (0.01 ppm)
Visibility-Reducing Particles	8 Hours (10 a.m. to 6 p.m. PST)	In a sufficient amount to produce an extinction coefficient of 0.23 per km

a. National lead standard, rolling 3-month average: final rule signed October 15, 2008.
Key: N/A=Not Applicable.
Source: CARB 2008.

Meteorology

The climate at VAFB is characterized as dry and subtropical. The area experiences moderate seasonal and day to night variation in temperature and humidity. Temperatures are mild, ranging from 8°C to 30°C (45°F to 85°F) with an annual mean temperature of 13°C (55°F). Temperatures below freezing and above 38°C (100°F) are rare. The rainy season extends from November to April. Annual precipitation is 33 cm (13 in) with the most rain falling during February 6.5 cm (2.6 in) and the least during July 0.025 cm (0.01 in). The annual relative humidity is 77 percent. The driest periods occur during the fall, when Santa Ana winds can result in humidity as low as 10 percent.

The mean annual wind speed and direction in the area is 12 kph (7 mph) out of the northwest. The strongest winds occur during the winter and midday. Calms are rare, and the lowest wind speeds occur during the evening and early-morning hours. Nighttime and early-morning low clouds and coastal fog characterize the day to night weather pattern. Cloud cover occurs almost half of the time. The fog burns off by mid-morning and is replaced by a sea breeze as the land begins to warm. Sea breezes are less frequent during the winter.

Storms and fronts move through the area during the winter, resulting in gusty and rainy conditions. Thunderstorms are relatively infrequent, occurring two or three times each year. The average annual ceiling height for the cloud cover is approximately 305 m (1,000 ft). The entire area experiences a persistent subsidence temperature inversion due to a pacific high-pressure region. The temperature inversion occurs below the 1370-m level (4,500-ft) and caps the planetary boundary layer. The average maximum daily inversion height over Point Arguello ranges from 490 m (1,600 ft) during the summer to 850 m (2,800 ft) during the winter (USAF 1998).

Regional Air Quality

Air quality in California is assessed on a county and regional basis. Both the EPA and CARB have designated the South Central Coast Air Basin (SCCAB) as being in attainment of the NAAQS for SO_X, NO_X, and CO. VAFB has been designated by the EPA to be in attainment with the Federal PM_{10} standard but has been designated by CARB to be in non-attainment with the more stringent California standard for PM_{10}. The EPA has classified Santa Barbara County as being in attainment for the Federal ozone standard (DOI 2005). Table 3-7 shows average ambient air concentrations for criteria pollutants as measured at VAFB. As of 2004, Santa Barbara County is not in attainment for the California State Ozone or PM_{10} standards, but is in attainment of the Federal standards (SBCAPCD 2009).

Table 3-7 Ambient Air Concentrations for Criteria Pollutants at VAFB

Pollutant in microgram/m^3	Averaging Period	2000	2001	2002	2003	2004	2005
Carbon Monoxide[a]	1-Hr highest	1.0	0.7	1.3	0.5	0.4	0.70
Nitrogen Oxides[b]	1-Hr highest	33	49	18	23	23	N/A
Ozone[a]	1-Hr highest	81	79	84	89	90	0.72
	8-Hr highest	69	70	78	77	83	66
$PM_{2.5}$	24-Hr highest	ND	ND	ND	ND	28[c]	N/A
	Annual	ND	ND	ND	ND	11[a]	N/A
PM_{10}	24-Hr highest	48	45	49	95.7	37	N/A
	Annual	19	19	18	20.4	17.8	N/A
Sulfur Dioxide[b]	1-Hr highest	4	4	6	7	9	N/A

a. measured as parts per million.
b. measured in parts per billion.
c. Santa Barbara station only, which is the higher of the two stations that gathered data.
Key: ND=No Data, N/A=Not Available.
Source: SCB 2004, 2006.

Air Emissions

The CARB classifies areas of the state that are in attainment or nonattainment for the California Ambient Air Quality Standards (CAAQS). Both the EPA and CARB have designated Santa Barbara County as being in attainment of the NAAQS and CAAQS for CO, NO_2, and SO_2. As the data in Table 3-7 demonstrates, the county area is in attainment with the Federal PM_{10} standard, but has been designated by the CARB to be in nonattainment with the more stringent California standard for PM_{10}. Although Federal and state standards for $PM_{2.5}$ have been set, an attainment status for Santa Barbara County has not been determined because of insufficient data. Santa Barbara County as a whole does not meet the state ozone standard and has only recently, and by a small margin, attained the Federal ozone standard (USAF 2006).

In addition to the seven criteria pollutants previously discussed, California state standards also exist for sulfates, hydrogen sulfide, vinyl chloride (chloroethene), and visibility-reducing particles. Santa Barbara County is in attainment for all four of these pollutants (USAF 2006).

Annual emissions, the quantity of pollutants released into the air during a year, normally are estimated from the amounts of material consumed or product produced. Most emissions

estimates are provided to the EPA by state environmental agencies. Some estimates are for individual sources, such as factories, and some estimates are county totals for classes of sources, such as vehicles. Emission estimates for individual sources are based on their normal operating schedule, and take into account the effects of installed pollution control equipment and of regulatory restrictions on operating conditions (USAF 2006). At VAFB, wind and other meteorological conditions are critical for the dispersion of emissions. The mean annual wind speed in the area is 11 kph (7 mph) out of the northwest. The strongest winds occur during the winter and midday, and at ridgelines. Over half of the time, the wind blows at speeds greater than 11 kph (7 mph). The entire south-central coastal region experiences a persistent subsidence inversion resulting from a Pacific high-pressure region. The average maximum daily inversion height ranges from 488 m (1,600 ft) during the summer to 853 m (2,800 ft) during the winter (USAF 1998).

3.3.2.7 Noise

Noise levels measured on North VAFB are generally typical of levels in urban areas with little industrialization. Noise levels on South VAFB would be expected to be similar to levels found in rural areas, except around active launch complexes, where noise levels during operations may be similar to those at an industrial site. An additional source of noise in the area is the VAFB Airfield, which follows California state regulations concerning noise and maintains a Community Noise Equivalent Level (CNEL) (similar to DNL, except that a penalty of 5 dB is applied to noise in the evening) equivalent to 65 dBA or lower for off-base areas (USAF 1998).

Other less frequent, but more intense, sources of noise in the region are rocket launches from VAFB. Even though the Titan IV has been replaced by the Atlas V launch vehicle, it still provides the upper bound of noise levels and is used here for the purposes of comparison. Table 3-8 shows the maximum noise levels measured at five locations during the launch of a Titan IVA from SLC-4. Of particular interest are the measurements at the 13,150 m (43,129 ft) distance in Lompoc: AWSPL was 88.0 dB, A-weighted SEL was 93.7 dB, and OSPL was 112.8 dB (USAF 1998).

Table 3-8 Measured Titan IV Sound Levels, August 1993

Distance from Pad (feet/meter)	Noise Levels (dB)			
	Measured Maximum OSPL	SLM Measured Maximum OSPL	Measured Maximum AWSPL	Measured A-weighted SEL
2,700/823	141.7	141.0	124.4	133.0
6,680/2,036	131.4	–	112.4	121.9
11,200/3,414	129.0	129.9	110.6	116.2
19,000/5,791	122.1	127.6	99.0	109.0
43,129/13,146[a]	112.8	–	88.0	93.7

a. In city of Lompoc.
Key: AWSPL=A-weighted sound pressure level; dB=decibel; OSPL=overall sound pressure level; SEL=sound exposure level (A-weighted); SLM=sound level meter.
Source: Do 1994.

The area immediately surrounding VAFB is mainly undeveloped and rural. Sound levels measured for most of the region are normally low, with higher levels appearing in industrial

areas and along transportation corridors. Rural areas in the Lompoc and Santa Maria valleys would be expected to have low overall CNEL levels, normally about 40 to 45 dBA. Infrequent aircraft fly-over and rocket launches from VAFB would be expected to increase noise levels for short periods of time. The maximum sonic boom overpressure for the Titan IVB was calculated and measured to be about 49 kg/m^2 (10 lb/ft^2). Sonic boom effects on human population centers have been minor because most launch azimuths at VAFB are over the Pacific Ocean (USAF 1998).

3.3.2.8 Biological Resources

The area of interest for biological resources consists of VAFB, the adjacent Pacific Ocean, and the northern Channel Islands.

Vegetation

VAFB occupies a transition zone between the cool, moist conditions of northern California and the semi-desert conditions of southern California. Many plant species and plant communities reach their southern or northern limits in this area. Natural vegetation types on VAFB include southern foredunes; southern coastal, central dune, central coastal, and Venturan coastal sage scrub; and chaparral, including central maritime chaparral. Also found are coast live oak woodland and savanna; grassland; tanbark oak and southern bishop pine forest; and wetland communities, including coastal salt marsh and freshwater marsh, riparian forests, scrub, and vernal pools (USAF 1998).

Wildlife

Terrestrial animal life consists of species common to coastal sage scrub, grassland, and chaparral communities. Common mammalian species occurring at VAFB include mule deer, coyote, bobcat, jackrabbit, cottontail, skunk, ground squirrel, and numerous nocturnal rodents. South VAFB provides high-quality foraging habitat for wide-ranging carnivores like mountain lion, bobcat, black bear, badger, gray fox, and coyote, in addition to several regionally rare or declining hawks and owls. The region contains a diversity of bird species, such as red-tailed hawks, American kestrels, white-tailed kites, and numerous common land birds. Shore birds are abundant on all sandy beaches. Tthe California least tern occur at several locations along the coast. Brown pelicans do not breed on VAFB, but are transient visitors to the coast (SLC2W 1993). The western snowy plover is considered a year-round resident of VAFB (Schmalzer 1998).

An abundance and diversity of marine birds are found along the offshore waters and Channel Islands. The open-ocean water along the continental shelf is known to harbor as many as 30 species of seabirds. The Channel Islands host breeding colonies of marine birds. California has nesting colonies of brown pelicans on Anacapa Island, Prince Island, and at an islet adjacent to Santa Cruz Island (UCSC 2006).

Harbor seals haul out (i.e., leave the water) at a total of 19 sites on VAFB between Point Sal and Jalama Beach. California sea lions do not breed on VAFB, but do use Point Sal as a haul-out site. Northern elephant seals are periodically observed on VAFB. San Miguel and San Nicolas islands are major rookeries for California sea lions and northern elephant seals.

Small-toothed whales, including bottlenose, common, and Pacific white-sided dolphins, and killer whales are common near VAFB and in the Channel Islands. The gray whale is found close to shore off VAFB during migration. Minke whales have been reported within a few miles of the leeward sides of San Miguel, Santa Rosa, Santa Cruz, and Anacapa islands.

As required by Section 101(a)(5)(A) of the Marine Mammal Protection Act of 1972 (as amended), the NMFS approved a letter of authorization for the incidental take of marine mammals during programmatic operations at VAFB. The 2009 rulemaking allows the incidental take of marine mammals specific to launching up to 30 space and missiles vehicles and up to 20 rockets each year over the 5-year period." Another request for incidental take will be submitted in 2012 to cover the next 5-year period.

Threatened and Endangered Species

A number of threatened and endangered species is known or expected to occur on VAFB and in the adjacent offshore waters. Table 3-9 lists all of the federally- and state-listed threatened and endangered species, and species of concern that are known to occur or that may potentially occur in the VAFB area.

Table 3-9 Threatened, Endangered, and Species of Concern Occurring or Potentially Occurring at VAFB, California

Common Name	Scientific Name	Federal Status	State Status
Plants			
Aphanisma	*Aphanisma blitoides*	SC	N/A
Beach layia	*Layia carnosa*	E	E
Beach spectaclepod	*Dithyrea maritime*	SC	T
Black flowered figwort	*Scrophularia atrata*	SC	N/A
Blochman's dudleya	*Dudleya blochmaniae ssp blochmaniae*	SC	N/A
Crisp monardella	*Monardella crispa*	SC	N/A
Dune larkspur	*Delphinium parryi ssp blochmaniae*	SC	N/A
Gambel's watercress	*Rorippa gambell*	E	T
Gaviota tarplant	*Hemizonia increscens ssp villosa*	PE	E
Kellog's horkelia	*Horkelia cuneata ssp sericea*	SC	N/A
La Graciosa thistle	*Cirsium loncholepis*	C	T
Lompoc yerba santa	*Eriodictyon capitatum*	E	N/A
San Luis Obispo monardella	*Monardella frutescens*	SC	N/A
Seaside's bird's beak	*Cordylanthus rigidus ssp. Littoralis*	SC	E
Shagbark manzanita	*Arctostaphylos rudis*	SC	N/A
Straight-awned spineflower	*Chorizanthe rectispina*	SC	N/A
Surf thistle	*Cirsium rhothophilum*	SC	T
Fish			
Arroyo Chub	*Gila orcutti*	S	SC
Steelhead trout	*Oncorhynchus mykiss irideus*	E	SC
Tidewater goby	*Eucyclogobius newberryi*	E	SC
Unarmored threespine stickleback	*Gasterostreus aculeatus williamsonii*	E	E

Table 3-9. Threatened, Endangered, and Species of Concern Occurring or Potentially Occurring at VAFB, California (*continued*)

Common Name	Scientific Name	Federal Status	State Status
Reptiles and Amphibians			
California horned lizard	*Phyrnosoma coronatum frontale*	SC	SC
California red-legged frog	*Rana aurora draytonii*	T	SC
Green sea turtle	*Chelonia mydas*	T	N/A
Leatherback sea turtle	*Dermochelys coriacea*	E	N/A
Loggerhead sea turtle	*Caretta caretta*	T	N/A
Pacific Ridley sea turtle	*Lepidochelys olivacea*	T	N/A
Silvery legless lizard	*Anniella pulchra pulchra*	SC	SC
Southwestern pond turtle	*Clemmys marmorata pallida*	SC	SC
Two-striped garter snake	*Thamnophis hammondii*	SC	SC
Western spadefoot toad	*Spea hammodnii*	SC	SC
Birds			
American bittern	*Botaurus lentiginosus*	MC	N/A
American peregrine falcon	*Falco peregrinus anatum*	FD	E
Belding's savannah sparrow[a]	*Passerculus sandwichensis beldingi*	N/A	E
Bell's sage sparrow	*Amphispiza belli belli*	MC	SC
Black swift	*Cypseloides niger*	MC	SC
Burrowing owl	*Athene cunicularia hypugea*	MC	SC
California black rail	*Laterallus jamaicensis coturniculus*	N/A	T
California least tern	*Sterna antillarum browni*	E	E
Elegant tern	*Sterna elegans*	MC	SC
Ferruginous hawk	*Buteo regalis*	MC	SC
Golden eagle	*Aquila chrysaetos*	P	SC
Grasshopper sparrow	*Ammodramus savannarum*	MC	N/A
Lawrence's goldfinch	*Carduelis lawrencei*	MC	N/A
Least Bell's vireo	*Vireo bellii pusillus*	E	E
Little willow flycatcher	*Empidonax trailii extimus*	SC	E
Loggerhead shrike	*Lanius ludovicianus*	MC	SC
Mountain plover	*Charadrius montanus*	PT	SC
Olive-sided flycatcher	*Contopurs borealis*	MC	N/A
Short-eared owl	*Asio flammeus*	MC	SC
Southwestern willow flycatcher	*Empidonax traillii extimus*	E	N/A
Tri-colored blackbird	*Agelaius tricolor*	MC	SC
Western least bittern	*Ixobrychus exilis hesperis*	MC	SC
Western snowy plover	*Charadrius alexandrinus nivosus*	T	CSC
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	N/A	E
White-tailed kite	*Elanus leucurus*	MC	N/A
Mammals			
Blue whale	*Balaenoptera musculus*	E	N/A
Finback whale	*Balaenoptera physalus*	E	N/A

Table 3-9. Threatened, Endangered, and Species of Concern Occurring or Potentially Occurring at VAFB, California (*continued*)

Common Name	Scientific Name	Federal Status	State Status
Mammals (*continued*)			
Fringed myotis	*Myotis thysanodes*	SC	SC
Guadalupe fur seal	*Arctocephalus townsendi*	T	T
Humpback whale	*Megaptera novaeangliae*	E	N/A
Long-eared myotis	*Myotis evotis*	SC	N/A
Long-legged myotis	*Myotis volans*	SC	SC
Pacific harbor seal	*Phoca vitulina richardii*	P	N/A
Pallid bat	*Antrozous pallidus*	S	SC
Right whale	*Balaena glacialis*	E	N/A
Sei whale	*Balaenoptera borealis*	E	N/A
Small-footed myotis	*Myotis ciliolabrum*	SC	N/A
Southern sea otter	*Enhydra lutris nereis*	T	P
Sperm whale	*Physeter catodon*	E	N/A
Steller sea lion	*Eumetopias jubatus*	T	N/A
Townsend's western big-eared bat	*Plecotus townsendii townsendii*	SC	SC
Western mastiff bat	*Eumops perotis*	SC	SC
Insects			
El Segundo blue butterfly	*Euphilotes battiodes allyni*	E	N/A

a. Taxonomic status of subspecies is pending.

Key: E=endangered; C=candidate (former Category C1); N/A=Not Applicable; PE=potentially endangered; SC=species of concern; R=rare (State designation); T=threatened; MC=management concern; PT=proposed threatened; P=protected; FD=Federally delisted; S=sensitive.

Source: DOI 2003; USAF 2005, 2006.

Sensitive Habitats

Designated sensitive habitats on VAFB include butterfly trees, marine mammal hauling grounds, seabird nesting and roosting areas, white-tailed kite habitat, Burton Mesa chaparral, coast buckwheat habitat, and wetlands, including streams/riparian woodlands. The Monarch butterfly is a regionally rare and declining insect known to winter in eucalyptus and cypress groves on VAFB. These trees are protected as a monarch wintering habitat. The VAFB coastline between Oil Well Canyon and Point Pedernales is designated as a marine ecological reserve. This includes a beach area south of Rocky Point used by harbor seals as haul-out and pupping areas.

Foraging habitat for white-tailed kites includes grassland and open coastal sage scrub. The Santa Ynez River, San Antonio Creek, and Cañada Honda Creek watersheds provide substantial habitat for many wildlife species and for listed fish species. Burton Mesa chaparral is considered a regionally rare and declining plant community with a highly localized occurrence (USAF 1998).

3.3.2.9 Historical and Cultural Resources

Human occupation of the area first occurred approximately 9,000 years ago and over 2,000 prehistoric and historic archaeological sites have been recorded on VAFB. Prehistoric site types include dense shell middens, scatters of stone tools and debris, concentrations of ground stone milling tools, village sites, stone quarries, and temporary encampments. At the time of European contact, peoples speaking one of the languages of the Chumashan branch of the Hokan language family populated the VAFB area. There are numerous traditional resources sites associated with the Chumash at VAFB, including prehistoric villages and campsites, rock art panels, burial sites, resource gathering areas, trails, and wetlands (USAF 1998).

Fossils found in the vicinity of VAFB include remains of both vertebrate and invertebrate animals. Remnants of Pleistocene Epoch (2 million to 8,000 years ago) terraces are found on South VAFB. Fossil remains found in this area include mammoth and horse fossils approximately 45,000 years old (USAF 1998).

The number of cultural resources of all types total 2,556 at VAFB. The 2,556 resources include the following types: 2,215 prehistoric and historic archaeological sites; 72 cold war structures/buildings (all eligible for listing in National Register of Historic Places [NRHP]); 110 early historical structures and ruins; 141 native American traditional and heritage sites; and 18 historic roads, trails, and landscapes. There is one National Historic Landmark (Space Launch Complex 10 with seven individual buildings and structures). There is one National Historic Trail (the Anza Trail associated with Spanish Exploration and Settlement). Out of the 2,556 cultural resources, there are 260 sites that have been determined to be eligible for listing in the NRHP. Out of the 2,556 cultural resources, there are only 22 that have been determined ineligible for listing in NRHP.

3.3.2.10 Environmental Justice

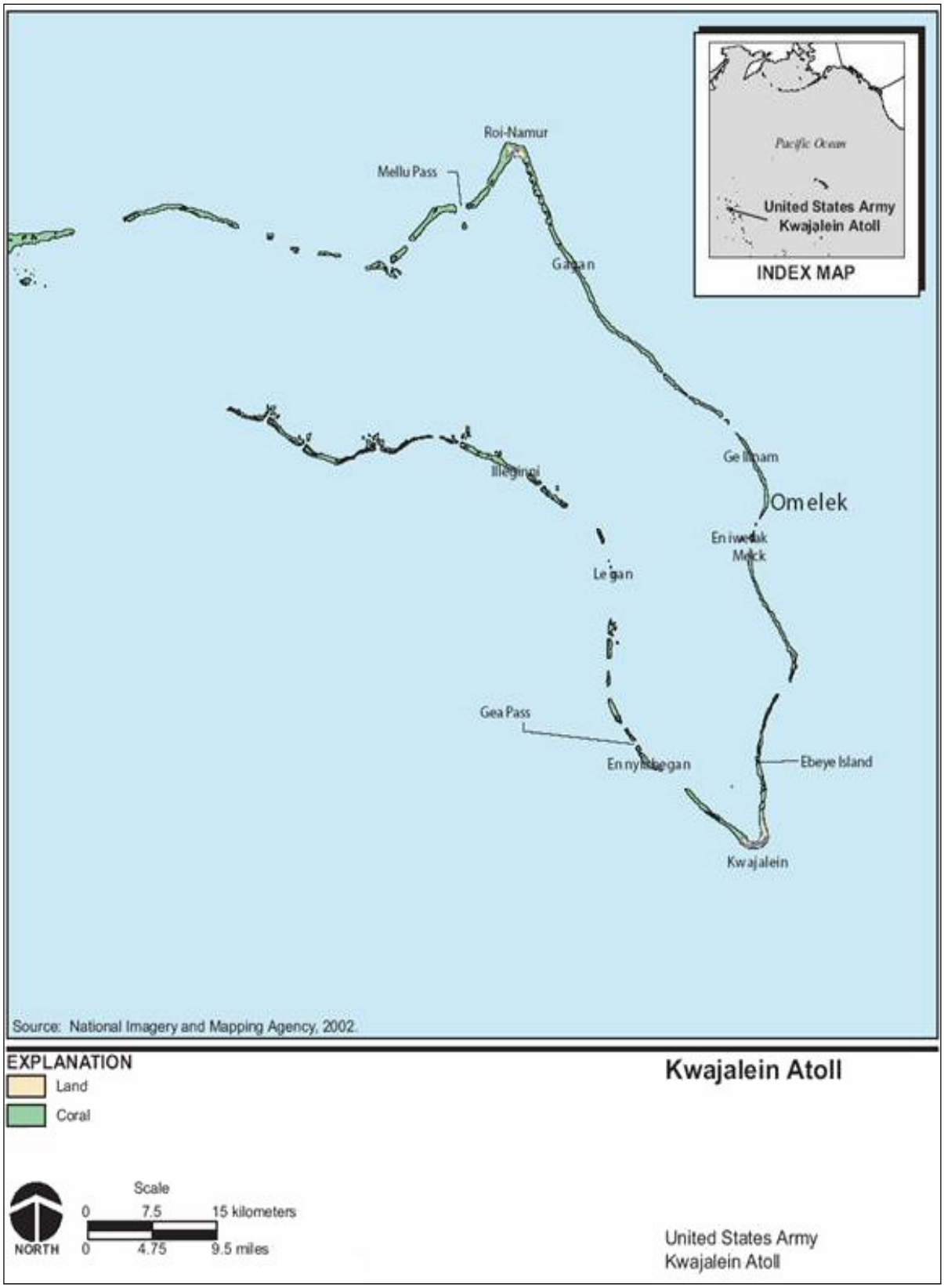
Based upon the 2000 Census of Population and Housing, Santa Barbara County had a population of 399,347 persons. Of this total, 109,022 persons (27.3 percent) were minority and 58,305 persons (14.6 percent) were low-income as defined by USCB criteria. The U.S. Census Board estimated that Santa Barbara County's population in 2008 was 405,396 people. Of this population, 47.4 percent were estimated to be minority, and 12.2 percent were estimated to be low-income (USCB 2009b).

3.3.3 U.S. Army Kwajalein Atoll/Reagan Test Site (USAKA/RTS)

Kwajalein Atoll is located in the western chain of the Republic of the Marshall Islands in the West Central Pacific Ocean (see Figure 3-4). USAKA/RTS leases all or part of 11 islands in the Atoll, including Omelek. Omelek is a 3.2-hectare (8-acre) island located about halfway between Kwajalein and Roi-Namur islands. Kwajalein Island is the headquarters and residence for most of the American personnel (USAF 2007).

Since World War II, portions of Kwajalein Atoll have been continuously used for military purposes by the U.S. Government. It was first a refueling and communications base, subsequently a support facility for the testing of nuclear weapons on Bikini and Enewetak

Atolls, and later a test site for the Nike-Zeus Anti-Missile Program. After several changes in command, the Kwajalein Missile Range (KMR), since renamed U.S. Army Kwajalein Atoll/Reagan Test Site (USAKA/RTS), was designated for testing of guided and ballistic missiles.



Source: USASMDC 2003

Figure 3-4 Regional map of USAKA/RTS

The U.S. Army organization regulates access to the USAKA/RTS islands thereby controlling the level of resident population. USAKA/RTS' permanent resident population is limited to nonindigenous personnel and their dependents, with the exception of some RMI citizens and their dependents who are based on Kwajalein Island. Dependents over 18 years of age are not allowed to remain as USAKA/RTS residents after they graduate from high school unless they are employed at USAKA/RTS. Transient personnel are allowed at USAKA/RTS only for their period of temporary duty. Visitors are allowed only if they are sponsored by a USAKA/RTS resident. The operations employees included 40 military, 84 federal civil service, and 1,379 civilian contract personnel. As of 2003, the resident population had increased to approximately 2,500 people, including dependents. However, it must be noted that this figure varies depending on mission status and construction activity (USASMDC 2003).

The Compact of Free Association between the RMI and the United States (U.S. P.L 99-239, hereafter referred to as the Compact) declares that it is the policy of the two nations to "promote efforts to prevent or eliminate damage to the environment and biosphere and to enrich understanding of the natural resources of the Marshall Islands ..." (Title One, Article VI, Section 161). Section 161 delineates a framework for development of environmental standards and procedures for U.S. actions at USAKA that reflects the particular environment of Kwajalein and the "special governmental relationship" between the two nations cited by the Compact.

The Environmental Standards and Procedures for the U.S. Army Kwajalein Atoll (USAKA) Activities in the RMI, commonly referred to as UES, is mandated in the Compact and provide the regulatory framework for the environmental requirements that must be met in order to operate at USAKA/RTS. The UES is a one-of-a-kind regulatory program document with substantively similar U.S. and RMI statutes and regulations. As required in the UES, a program or facility project issues Documents of Environmental Protection (DEP), similar to Federal and state permits, for conducting activities with potential to affect the environment. The DEP are streamlined environmental protection documents for specific environmental activities (e.g., air emissions from major stationary sources; construction and operation of power plants; point source discharges) that specify in detail how UES compliance will be maintained. The DEP are tailored specifically for conditions and considerations at USAKA (USASMDC 2003).

3.3.3.1 Land Use and Aesthetics/Visual Resources

At USAKA/RTS, a variety of Army and other DoD facilities and activities carry out sensitive missile research, development, and testing. These activities and the services necessary to support them exist in a very small area in which all spatial patterns of land use are closely controlled and efficiently managed.

Kwajalein Island

USAKA/RTS strictly regulates access to Kwajalein. The population fluctuates monthly depending on program activities, but totaled 2,440 in 2005. This number consisted of military, civil service, and contractor personnel and their dependents. Kwajalein's population shares a land area of approximately 303 hectares (748 acres). It has a land use pattern that locates housing and most community facilities toward the eastern end of the island; air operations are in the center, and research, development, and communications operations are toward the western end of the island. Structures are set back from the ocean side of the island in order to minimize the potential adverse effects of high-wave action (USASMDC 2003).

Land use, including the siting, heights, and setbacks or buildings, is accommodated to air safety and noise constraints relative to the airfield, explosive (storage and handling) safety quantity distances, and electromagnetic radiation safety zones surrounding radars, radio antennas, and microwave emitters.

A range of recreational facilities is essential for maintaining morale and health in an isolated installation such as USAKA/RTS. The recreational facilities include many sport/fitness-oriented facilities (tennis, volleyball, basketball, and handball courts; softball fields; a running track; swimming pools; two camps; a nine-hole regulation golf course and driving range; and swimming beaches), outdoor theaters, a marina with full services for marine recreation, and various hobby clubs. Formal recreational facilities and services are limited to Roi-Namur and Kwajalein Islands.

Meck Island

Meck Island has been used as a missile launch site for several decades. The island is almost entirely altered by mission-support facilities. Its visual character is dominated by currently used and deactivated mission-support facilities; little vegetation remains.

Omelek Island

Omelek is used as a Falcon launch site, currently for Falcon 1 launches. Omelek is uninhabited. However, three to six Marshallese are employed part-time or as-needed in support of ground and facility maintenance on Omelek, and one Marshallese is employed full-time as technical support on the island (USASMDC 2007).

The USAKA islands have a long history of human occupation and modification, and a significant portion of the natural landscape features have been altered or replaced by built structures.

On the islands of Kwajalein and Roi-Namur, operations and land area constraints require that a wide range of activities takes place in a small area. The proximity of diverse uses results in a variety of building types, forms, materials, and landscaping, and creates a visually heterogeneous environment. The landscapes on the two islands vary from built-up industrial zones to areas of man-made greenery and landscaping (e.g., the golf course and lawns). Landscaping for aesthetics purposes is concentrated in housing and community facilities areas in both Kwajalein and Roi-Namur Islands.

The visual character of Omelek Island is mixed: three small stands of native trees are separated by cleared grassy areas within which range support facilities are located.

3.3.3.2 Hazardous Materials and Hazardous Waste Management

Hazardous Materials Management

The use of hazardous materials at USAKA/RTS, including Omelek, is limited primarily to materials used in facility infrastructure support and flight operations, with some additional quantities of hazardous materials used by various test operations. Hazardous materials used in infrastructure-support activities include various cleaning solvents (chlorinated and non-chlorinated), paints, cleaning fluids, pesticides, motor fuels and other petroleum products, and other materials. A hazardous materials management plan is prepared for all hazardous materials or petroleum products shipped to USAKA/RTS. The plan outlines the procedures for storage, use, transportation, and disposal of the hazardous materials or petroleum products (USASMDC 2003). These substances are shipped to USAKA/RTS by ship or by air. Upon arrival at USAKA/RTS, hazardous materials to be used are distributed, as needed, to various satellite supply facilities, from which they are distributed to the individual users. Distribution is coordinated through the base supply system; however, the issue of such materials requires prior authorization by the USAKA/RTS Environmental Office to prevent unapproved uses of hazardous materials.

An activity-specific Hazardous Materials Procedure must be submitted to the Commander, USAKA/RTS for approval within 15 days of receipt of any hazardous material or before use, whichever comes first. Hazardous materials to be used by organizations on the test range and its facilities are under the direct control of the user organization, which is responsible for ensuring that these materials are stored and used in accordance with UES requirements. The use of all hazardous materials is subject to ongoing inspection by USAKA/RTS environmental compliance and safety offices to ensure the safe use of all materials. The majority of these materials are consumed in operational processes. Aircraft flight operations conducted at USAKA/RTS involve the use of various grades of jet propellant, which are refined petroleum products (kerosene). Fuels are stored in above ground storage tanks located on several islands at USAKA/RTS. Fuels are transported to USAKA/RTS in accordance with the UES and applicable DOT and DoD regulations. Significant quantities of waste fuels are not normally generated since fuels are used up in power generation, flight operations, marine vessels, and vehicle and equipment usage.

Falcon components would be brought to Kwajalein as the initial arrival point at USAKA/RTS. Kwajalein would also serve as the supply point for consumable materials to be employed during vehicle preflight assembly and checkout operations. Some of the materials in these consumable supplies are considered to be hazardous materials (e.g., cleaning solvents, motor fuels, and household pesticides). These materials would be stored on Kwajalein in appropriate warehouse facilities before issuance for use on Omelek. These materials are similar to hazardous materials already in use for other operations, including standard facility maintenance activities, and represent only a small increase in the total amount of materials to be handled. The quantity of these materials that would be used represents a de minimis increase above those already in use and could, therefore, easily be accommodated by the current hazardous materials management systems. (De minimis is Latin for “of minimum importance” or

"trifling." Essentially, de minimis thresholds refer to values so small that the law will not consider them.)

Falcon launch vehicle equipment and components, including ordnance and hazardous materials, would be transported, stored, and handled in accordance with applicable USAKA/RTS and the DOT regulations and military standards. These materials are similar to hazardous materials already in use for other operations and would represent only a small increase in the total amount of materials to be handled and could easily be accommodated by current hazardous materials management systems.

Hazardous Waste Management

Hazardous waste management at USAKA/RTS is performed in accordance with the UES, which requires shipment of hazardous waste back to the Continental United States for treatment and/or disposal. Personnel trained in the appropriate procedures to handle potentially hazardous waste, including spill containment and cleanup, would be on standby should a mishap occur. Such personnel involved in these operations would wear appropriate protective clothing, as necessary.

The types of hazardous waste that would potentially be generated from Falcon launches are similar to wastes already handled at USAKA/RTS. The quantity of hazardous waste that may be generated would represent a small increase over current conditions and would be collected in accordance with the Kwajalein Environmental Emergency Plan and UES. If the deluge water is determined to contain hazardous materials, it would be containerized and removed from the island. Kerosene and the helium storage trailer would be removed from the island after completion of the mission. The liquid oxygen (LOX) and liquid nitrogen would be allowed to boil off (cryogenic fluids such as LOX and liquid nitrogen boil naturally at normal temperatures, evaporating away over time) and the plant would be secured. Collected waste would be sent first to the point of generation accumulation point on Omelek, and on to the USAKA/RTS Hazardous Wastes Collection Point on Kwajalein for eventual shipment to the continental United States and final disposition. The de minimis increase in the quantity of hazardous waste would not significantly impact the existing hazardous waste management and disposal system.

Fresh water would be used for initial cleanup of the launch pad. Fresh water would also be used to rinse the pad and stand before securing them for storage. This cleanup water would be pumped into the evaporative pond and tested for contaminants. At the conclusion of a launch, the launch service provider contractor personnel would remove all hazardous and non-hazardous material from Omelek and dispose of it in accordance with USAKA/RTS regulations.

Hazardous waste treatment or disposal is not allowed at USAKA/RTS under the UES. Hazardous waste, whether generated by USAKA/RTS activities or range users, is collected at individual work sites in waste containers. These containers are labeled in accordance with the waste that they contain and are dated the day that the first waste is collected in the container. Containers are kept at the point of generation accumulation site until full or until a specified time limit is reached. Once full (250 liters [55 gal]), containers are collected from the generation point within 12 hours and are prepared for transport to the USAKA/RTS Hazardous

Waste 90-Day Storage Facility, located on Kwajalein. Each of the point of generation accumulation sites is designed to handle hazardous waste and provide the ability to contain any accidental spills of material, including spills of full containers, until appropriate cleanup can be completed (USASMDC 2003).

At the 90-Day Storage Facility any sampling of waste is performed (for waste from uncharacterized waste streams), and waste is prepared for final off-island shipment for disposal. Wastes are shipped off-island within 90 days of arrival at USAKA/RTS Hazardous Waste 90-Day Storage Facility.

Pollution Prevention

Pollution prevention, recycling, and waste minimization activities are performed in accordance with the UES and established contractor procedures in place at USAKA/RTS. The Installation Restoration Program is not applicable to USAKA/RTS, since it is located in a foreign country. Remedial action is performed as needed, in accordance with the UES.

In accordance with DoD regulation 5200.2R, Personal Security Program Regulation and requirements of the UES, launch service provider personnel would perform pollution prevention, waste minimization, and recycling measures where applicable.

3.3.3.3 Health and Safety

Regional Safety

Flight safety provides protection to USAKA/RTS personnel, inhabitants of the Marshall Islands, and ships and aircraft operating in areas potentially affected by these missions. Specific procedures are required for the preparation and execution of missions involving aircraft, rocket and missile launches, and reentry payloads. These procedures include regulations, directives, and flight safety plans for individual missions. The area affected by aircraft and missile operations varies according to the type of mission.

Flight safety activities include the preparation of a flight safety plan that includes evaluating risks to inhabitants and property near the flight, calculating trajectory and debris areas, and specifying range clearance and notification procedures.

The Marshallese individuals who have written permission from USAKA/RTS to stay temporarily on Omelek while fishing from the adjacent islands such as Gellinarn would be asked by the USAKA/RTS Commander to evacuate the launch hazard area once the Falcon rocket has been brought to the Island. Infrequent Falcon launches should not substantially affect this practice. Islands of the atoll and access to the mid-Atoll corridor are routinely closed during launch events. Once the launch has been accomplished and the associated facilities secured, the Marshallese can resume their temporary habitation. Access to Omelek would be limited to all but mission essential persons and personnel would be evacuated from the island prior to launch. Some emergency lighting would be provided around the dock area to facilitate an evacuation at night.

Notification is made to inhabitants near the flight path, and international air and sea traffic in the caution area designated for specific missions. Notices to Mariners (NOTMARs) and

Notices to Airmen (NOTAMs) are transmitted to appropriate authorities to clear caution areas of this traffic and to inform the public of impending missions. The warning messages contain information describing the time and area affected and safe alternate routes. The RMI is informed in advance of launches and reentry payload missions.

In missions that involve the potential for reentry debris near inhabited islands, precautions are taken to protect personnel. In Mid-Atoll hazard areas, where an island has a high probability of impact by debris, personnel are evacuated. In caution areas, where the chance of debris impact is low, precautions may consist of evacuating or sheltering non-mission-essential personnel. Sheltering is required for reentry vehicle missions impacting the Mid-Atoll Corridor in Kwajalein Atoll. The Mid-Atoll Corridor is declared a caution area when it contains a point of impact.

Rockets launched from USAKA/RTS are equipped with flight termination systems that allow destruction of the rocket if the flight deviates significantly from planned criteria or otherwise poses a threat to the public. For example, a flight would be terminated if the rocket path intersects a protection circle, an artificial boundary around inhabited atolls and islands in the RMI.

On-base Safety

In the event a launch vehicle varies from its planned trajectory, the launch vehicle is equipped with a thrust termination system, rather than a destructive flight termination system. The thrust termination system would be activated by a command from the Range Safety Officer and would disable power to the vehicle engines.

3.3.3.4 Geology

Kwajalein Atoll is a crescent-shaped coral reef that encloses the world's largest lagoon, which has a surface area of 2849 km^2 (1,100 mi^2). The atoll's longest dimension is 121 km (75 mi), from Kwajalein to Ebadon, and its greatest width is approximately 32 km (20 mi). The lagoon enclosed by the reef is generally between 36.6 to 54.9 m (120 to 180 ft) deep, although numerous coral heads approach or break the surface.

In contrast to the immensity of its water area, the land area of the atoll is only 14.5 km^2 (5.6 mi^2 [3,584 acres]). Although there are approximately 100 islands dotted along the coral reef margin of the atoll, the three largest islands (Kwajalein, Roi-Namur, and Ebadon), each located at the extremities of the atoll, account for nearly half the total land area. The typical size of the remaining islands is a few acres and the smaller islands are no more than ephemeral sand cays that just break the water's surface at high tide. All islands of the atoll are nearly flat, with few natural points that exceed 4.6 m (15 ft) above mean sea level.

The reefs and islands of RMI consist entirely of the remains of coral reef rock and sediments to a thickness of approximately a km (several thousand feet) atop submarine volcanoes, which formed 70 to 80 million years ago. Around Kwajalein Atoll the ocean depth is as much as 1.8 km (6,000 ft) within 3.3 km (2 mi) of the atoll, and 4 km (13,200 ft) within 8 km (5 mi). The top of the Kwajalein Atoll reef (or reef flat) lies at intertidal level, mostly exposed at low tide and submerged at high tide. Approximately 25 passages from the open ocean into the

lagoon admit small boats. Ocean-going ships ordinarily use the deeper Gea Pass, 16 km (10 mi) north-northwest of Kwajalein Island.

Soils

The soils of Kwajalein Atoll, like most ocean atolls, have poor fertility and are particularly deficient in two major constituents, nitrogen and potash. The generally low fertility of the atoll soils is due to three factors: the soil particles are generally coarse, the content of organic matter is low, and the soils are alkaline. The first two factors impair the water-holding capacity of the soil and the retention of elements essential for plant growth. The alkalinity of the soils inhibits the absorption of iron, manganese, zinc, boron, and aluminum. All three factors severely inhibit plant growth.

Omelek's soils are poor and considered to be low in fertility and almost exclusively composed of calcium carbonate from the accumulation of reef debris and oceanic sediments. Consequently, soils are extremely deficient in major soil constituents such as nitrogen, potash, and phosphorous. Major physical factors, which characterize Omelek's soil, include coarse soil particles, minimal amounts of organic matter, and alkaline soil pH. In addition, water-holding capacity of the soil is poor due to the generally coarse grained-sands (USASMDC 2003).

3.3.3.5 Water Resources

The primary source of freshwater at USAKA/RTS is rainfall, which is usually abundant. Rainfall is collected directly into catchments or, after percolation through the soil, is pumped from the groundwater for freshwater use. The principal rainfall season extends from May through November. The December through April period, often referred to as the "dry season," is characterized by light showers of short duration. Kwajalein had an unusually severe dry season in 1983 (19 weeks passed with no appreciable rainfall) and 1984 was the driest year on record.

Groundwater

Groundwater is a major source of potable water on Kwajalein and Roi-Namur Islands, along with rainwater catchment. Therefore, preservation of groundwater quantity and quality is important to ensure a continued supply of drinking water.

Fresh groundwater on the atolls consists of a lens of freshwater that floats atop deeper marine waters in the subsurface rock strata of larger and wider islands. Rainwater percolates down through the surface to collect in the lens and the consistency and permeability of the rock strata maintains the integrity of the lens, slowing the mixing of the freshwater lens with surrounding marine water. The thickness of the lens system for a particular island depends on many factors, but they tend to be of greater thickness for larger islands.

Currently, freshwater use usually exceeds rainfall collected in catchments and, in order not to deplete the supply of stored water from which day-to-day needs are met; additional water is obtained from the groundwater lens well system. A study to evaluate the long-term sustainable yield of the Kwajalein groundwater found that the freshwater storage in the lens averaged

about 102 million decaliters (270 million gal), and that it fluctuates more than 20 percent in response to recharge and discharge events. Water quality is a constant concern because of the uncertainty of rainwater supply and the limited amount of freshwater in the groundwater lens. Water supply may become a critical concern during a year when rainfall is less than normal.

Surface Water

For sources of freshwater, Kwajalein uses water from 21 hectares (52 acres) of paved catchment areas that are located adjacent to the runway and from several groundwater lens wells. The catchment areas collect approximately 14,819 decaliters per mm (1 million gal per in) of rainfall. The average capture of rainwater is 3.3 million decaliters (8.8 million gal) per month assuming 100 percent yield of water from the catchment areas for an average month.

Drinking Water

Drinking water on Kwajalein is supplied by a conventional package filter drinking water system for potable water production. The capacity of the system is 1.7 million liters (450,000 gal) per day. In 2005, water consumption on Kwajalein was approximately 1.1 million liters (300,000 gal) per day. The conventional filtration system (drinking water) is supplemented by a reverse osmosis treatment system. There are seven different fields, which provide supplemental water (USASMDC 2007). Three portable reverse osmosis water purifying units are used to process the lens well water to reduce suspended and dissolved solids content before treatment. Drinking water quality is produced to meet the standards of the UES. These standards are essentially the same as the Environmental Protection Agency standards for public systems that serve a population of 10,000 people.

Omelek does not have an active, developed potable water system (USASSDC 1995). When needed, bottled or potable water for drinking, food preparation, hand-washing and bathing is shipped from Kwajalein and stored on the island. Freshwater is used for pad cleanup, deluge spray, and firefighting. The water for the deluge system is supplied from a pressurized water tank that is filled with water from the water system. The deluge system uses ocean water that has been desalinated in a reverse osmosis system and stored in a 37,854-liter (10,000-gal) tank. The reverse osmosis system also provides water for other non-potable uses. The water is used for industrial purposes only.

Marine Water Quality

Marine water quality around USAKA/RTS islands has generally been satisfactory except in the immediate vicinity of a few point and nonpoint sources. These sources include sewage, suspended sediment, heated water, storm drain runoff, sandblasting material (associated with corrosion prevention), construction debris, and landfill leachate. Water quality generally remains satisfactory because tidal, tradewind, and wave-generated offshore currents dilute and carry away pollutants.

The waters around Kwajalein Atoll are well mixed and are not affected by large nearby land masses and continents. The Pacific Ocean is deep and its waters are pollution-free, pristine, and extremely transparent around Kwajalein and other atolls in the Marshall Islands.

3.3.3.6 Air Quality

The RMI Regulatory Framework

Air quality for the Kwajalein area is regulated under the UES. These standards are based upon the U.S. CAA and its promulgated regulations, but do not include many of the procedural and technology based requirements. The standards are designed to maintain the current air quality at USAKA/RTS. Pollutant ambient air concentrations may not increase above the baseline level by more than an increment of 25 percent of the applicable Ambient Air Quality Standards (AAQS). The UES AAQS (see Table 3-10) are set at 80 percent of the NAAQS. The UES requires a DEP, similar to an operating permit in the United States, for all new major stationary sources, or sources regulated under the U.S. National Emissions Standards for Hazardous Air Pollutants. Existing sources are covered by the Air Emissions from Major Sources at USAKA/KMR Document of Environmental Protection, as revised November 2000. This Document of Environmental Protection establishes operational requirements and limitations for sources at Omelek Island. The Pollutant Thresholds for USAKA/RTS are listed in Table 3-11.

Meteorology

Kwajalein Atoll is located less than 1,000 km (600 mi) north of the equator and has a tropical marine climate characterized by relatively high annual rainfall and warm to hot, humid weather throughout the year. The mean annual temperature at Kwajalein is 28°C (82°F). The average annual precipitation is 256 cm (101 in). The main rainfall season lasts from mid-May to mid-December, with about 30 cm (10 in) of rainfall per month. Kwajalein's relative humidity averages between 70 and 85 percent throughout the year. Virtually constant cloud cover, light easterly winds, and frequent moderate to heavy rain showers prevail during the wet season.

Trade winds are dominant throughout the year and strongest from November to June. The prevailing winds blow from the east to the northeast with an average speed of 26 km (16 mi) per hour in the winter and 10 km (6 mi) per hour in the summer.

Table 3-10 USAKA/RTS Ambient Air Quality Standards

Criteria Pollutant	Averaging Time	Standard micrograms/m^3 (ppm)	USAKA/RTS Increment Degradation Standard micrograms/m^3
Carbon monoxide	8-hr	8,000 (7.2)	2,500
	1-hr	32,000 (28)	10,000
Lead	Quarterly[b]	1.2	0.375
Nitrogen dioxide	Annual[b]	80 (0.0424)	25
Ozone	8-hr[a]	128(1) (0.064)[b]	40
$PM_{2.5}$	Annual[c]	12	3.8
	24-hr[d]	52	16.3

Table 3-10. USAKA/RTS Ambient Air Quality Standards (*continued*)

Criteria Pollutant	Averaging Time	Standard micrograms/m^3 (ppm)	USAKA/RTS Increment Degradation Standard micrograms/m^3
PM_{10}	Annual[b]	40	12.5
	24-hr[e]	120	37.5
Sulfur oxides	Annual[b]	64 (0.024)	20
	24-hr	292 (0.112)	91
	3-hr	1,040 (0.4)	325

a. Calculated as the 3-year average of the fourth highest daily maximum 8-hour ozone concentration.

b. Calculated as the arithmetic mean.

c. Calculated as the 3-year average of the arithmetic means.

d. Calculated as the 98th percentile of 24-hour $PM_{-2.5}$ concentration in a year (averaged over 3 years) at the population oriented monitoring site with the highest measured values in the area

e. Calculated as the 99th percentile of 24-hour PM_{-10} concentrations in a year (averaged over 3 years).

Key: $PM_{2.5}$=fine particulate matter equal to or less than 2.5 microns in size;
PM_{10}=particulate matter equal to or less than 10 microns in size (also called respirable particulate and suspended particulate); ppm=measured as parts per million.

Source: UES 2009.

Table 3-11 USAKA/RTS Pollutant Thresholds

Pollutant	Threshold (per year)
Carbon monoxide	90.7 metric tons (100 tons)
Nitrogen oxides	36.3 metric tons (40 tons)
Ozone	36.3 metric tons (40 tons)
Particulate matter	22.7 metric tons (25 tons) – total PM ($PM_{2.5}$ and PM_{-10} combined)
Sulfur dioxide	36.3 metric tons (40 tons)

Source: UES 2009.

Regional Air Quality

The ambient air on Kwajalein was analyzed in a U.S. Army Environmental Hygiene Agency study completed in 1993. This testing was conducted before the adoption of the UES and its unique UES AAQS. In this study the concentration of criteria pollutants was measured both upwind and downwind of power plants 1A and 1B (Table 3-12). The concentrations of sulfur dioxide, lead, and particulate matter with an aerodynamic diameter of less than or equal to 10 micrometers (PM_{10}) were found to be below their NAAQS. Since there is no short-term NAAQS for nitrogen dioxide, the study compared the measured concentrations at Kwajalein to the 1-hour California AAQS for NO_2; the concentrations at Kwajalein were below this standard. The concentrations measured at Kwajalein were below the 1-hour NAAQS for CO, but downwind concentrations were greater than the 8-hour NAAQS for carbon monoxide (USASMDC 2004).

Table 3-12 Ambient Air Quality at Kwajalein Island

			Measured Ambient Concentrations	
Pollutant	**USAKA/RTS Ambient Air Quality Standards**		**Upwind**	**Downwind**
Carbon monoxide	1-hr maximum	28 ppm	13.9 ppm	27.9 ppm
	8-hr maximum	7.2 ppm	5.2 ppm	11.4 ppm
Lead	Quarterly	1.5 μg/m^3	< 0.1 μg/m^3	< 0.1 μg/m^3
Nitrogen dioxide[a]	1-hr maximum	0.25 ppm	0.05 ppm	0.10 ppm
	Annual	0.424 ppm	N/A	N/A
$PM_{-2.5}$	Annual	12 μg/m^3	N/A	N/A
	24-hr	52 μg/m^3	N/A	N/A
PM_{-10}	24-hr maximum	120 μg/m^3	114 μg/m^3	107 μg/m^3
	Annual (arithmetic mean)	40 μg/m^3	N/A	N/A
Sulfur dioxide	3-hr maximum	0.4 ppm	0.05 ppm	0.14 ppm
	24-hr maximum	0.112 ppm	0.01 ppm	0.01 ppm
	Annual	0.024 ppm	N/A	N./A

a. As no short-term NAAQS exist for nitrogen dioxide, the California Ambient Air Quality Standard was used for comparison.

Key: N/A=not applicable; ppm=parts per million; μg/m^3=micrograms per cubic meter.

Source: USASMDC 2003, 2004.

No ambient air quality data are known to exist for Omelek. However, since there are only extremely minor sources of air pollution such as occasional helicopter landings, strong persistent trade winds, and lack of topographic features to inhibit dispersion, the ambient air quality at Omelek is expected to be in compliance with the maximum pollution levels established in the UES (UES 2009).

Air Emissions

Ambient air quality in generally characterized as good due to the relatively small number of air pollution sources and because of good dispersion produced by the strong, persistent tradewinds and lack of topographic features to inhibit pollution dispersion. The electric power generating facilities are the primary source of air emissions on Kwajalein. The concentration of the criteria air pollutants was measured both upwind and downwind of power plants 1A and 1B. The concentrations of sulfur dioxide, lead, and PM_{10} were found to be below their UES AAQS both upwind and downwind.

The existing primary pollution sources include power plants (1A and 1B), fuel storage tanks, solid waste incinerators; diesel fired commercial boilers, a concrete batching plant, and transportation. Rocket launches tend to be smaller sources of emissions. Table 3-13 gives the pollutant thresholds applicable to USAKA/RTS. USAKA/RTS performs an Air Emissions Inventory on a biennial basis in accordance with the UES (Table 3-14).

Table 3-13 Generator Emissions at Omelek in Metric Tons (Tons) Per Year

	Volatile Organic Compounds	Oxides of Nitrogen	Carbon Monoxide	Oxides of Sulfur	PM_{10}
Generators	0.5 (.55)	6.13 (6.76)	1.32 (1.46)	0.4 (0.44)	0.44 (0.48)

Source: USASMDC 2007.

Table 3-14 Summary of Emissions of Regulated Air Pollutants on Kwajalein

PM_{10} metric tons (tons)/year	Sulfur Dioxide metric tons (tons)/year	Carbon Monoxide metric tons (tons)/year	Nitrogen Dioxide metric tons (tons)/year	Volatile Organic Compounds metric tons (tons)/year
72.35 (79.75)	199.98 (220.44)	318.39 (350.96)	1,180.16 (1,300.90)	48.45 (53.41)

Source: USASMDC 2004.

Rocket launch emissions are also considered to be sources of pollutants, which result in short term, temporary increases in pollutants. Table 3-15 lists the estimated rocket launch emissions per year for a high level of activity (USASMDC 2004). For Meck, the estimated number of launches was 28 per year for SLVs (assuming the use of SR-19 rocket motors).

Table 3-15 Estimated Rocket Launch Emissions for a High Level of Activity at USAKA/RTS

Carbon Monoxide Metric tons (tons)/launch	Hydrogen Chloride Metric tons (tons)/launch	Aluminum Oxide Metric tons (tons)/launch
7.14 (7.88)	5.18 (5.71)	9.27 (10.22)

Source: USASMDC 2003.

3.3.3.7 Noise

As a conservative method, the area within the maximum sound level of 85 dB generated by launches and prelaunch activities for Omelek Island is a 12-km (7.5-mi) radius-circle contour, centered on the proposed launch site.

The primary sources of man-made noises on Omelek Island include helicopter operations and infrequent launching of meteorological rockets. Since Omelek has been developed as a launch support facility and has no inhabitants occupied in unrelated activities, aside from personnel working the launch, no noise-sensitive receptors have been identified. The nearest inhabited island to Omelek is Gugeegue, which is approximately 21 km (13 mi) away and outside of the 85 dB contour (USAMDC 2003).

3.3.3.8 Biological Resources

Biological resources discussed in this section include rare, threatened, or endangered terrestrial and marine species known to occur within Kwajalein Atoll and the surrounding ocean areas. Species discussed include sea turtles, giant clams, and seagrasses.

Omelek is a highly developed islet currently being used for Falcon launches. Approximately two-thirds of Omelek has been cleared, and this area is dominated by non-native grasses and weeds. The remaining habitat contains three separate patches of mixed broadleaf forest:

eastern patch, northern patch, and southern patch. The vegetation around the helipad is mowed to about 10 cm (4 in). The rest of the relatively open interior of the island is mostly free of woody plants and is overgrown in areas with a dense mat dominated by beach pea and beggar's tick. Native *Scaevola sericea shrubs*, also known as saltbush, are slowly invading areas of Omelek. *Pisonia grandis*, a stocky tree common to the Marshall Islands, can be found on Omelek, as well (USASMDC 2007).

Vegetation

The types of vegetation currently found on USAKA/RTS consist of managed vegetation, herbaceous (green, leaf-like) strand, littoral (relating to the shore) shrubland, littoral forest, and coconut plantation. Managed vegetation is disturbed vegetation dominated by alien weeds and is usually maintained by mowing. Herbaceous strand is a narrow zone of vegetation on upper sandy or rocky beaches dominated by grasses, sedges, and vines. Littoral shrubland consists of vegetation in coastal areas dominated by wide spread shrubs. Littoral forest is usually the most common type of vegetation on tropical islands dominated often by a single tree species. Coconut plantations are dominated by planted coconut palms (USASMDC 2003).

A species of seagrass (*Halophila minor*) is found in the lagoon on two islands, Kwajalein and Roi-Namur. Previously, *Thalassia hemprichii* was the only seagrass known from the Marshall Islands (USASMDC 2003), but it is not found at USAKA/RTS. The only currently known seagrass beds identified at USAKA/RTS are Halophila.

Wildlife

The native forest patches on Omelek provide nesting, roosting, and resting habitat for a variety of seabirds. Pisonia in particular is typically a favored nesting or rookery tree for sea birds, including the black noddy. Several white terns and a brown noddy were observed perched in trees during the 2004 inventory. No nesting seabirds have been observed during the USAKA/RTS biological surveys. The island supported relatively little bird activity during the 2002 inventory. Black and brown noddies and black-naped terns have been observed foraging offshore. Black-naped terns have been observed occasionally at the north and south tips of the island where principal roosting habitat occurs. Open areas also provide habitat for black-naped terns. A pair of black-naped terns may have been nesting on the roof of a building east of the helicopter pad in 2004. The reef heron, Pacific golden plover, gray-tailed and wandering tattlers, ruddy turnstone, and whimbrel have also been observed foraging on the island. A bristle-thighed curlew and one redfooted booby were observed in 2002. An unusual migratory bird, the long-tailed cuckoo, was seen in 2004 flying across the interior of the islet to the northern forested area (USASMDC 2007).

Giant clams, black-lipped pearl oyster, coral, sponges, and top shell snails are species of concern that have been observed in the vicinity of Omelek. A wide variety of reef fish have been recorded in the waters surrounding Omelek.

Common Greenshanks were observed for the first time on Kwajalein in 2002. In addition, Black-naped Terns were observed nesting on Kwajalein in 2002 for the first time. Prior to that, White Terns were the only seabirds observed breeding on the islet since the USFWS surveys

began in 1996. White Terns were observed nesting again in 2002 in trees located in front of Kwaj Lodge.

Threatened and Endangered Species

No threatened or endangered vegetation species have been identified on Omelek and Kwajalein Islands (USASMDC 2007).

Species identified as threatened or endangered that exist in the Pacific Ocean area around USAKA/RTS, listed in Table 3-16, include the blue whale, finback whale, humpback whale, sperm whale, loggerhead sea turtle, green sea turtle, leatherback sea turtle, hawksbill sea turtle, and olive ridley sea turtle.

Table 3-16 Threatened, Endangered, and Species of Concern Occurring or Potentially Occurring at USAKA/RTS, RMI

Common Name	Scientific Name	Status Federal	Status RMI
Marine Species			
Blue whale	*Balaenoptera musculus*	E	N/A
Dugong	*Dugong dugon*	E	E
Finback whale	*Balaenoptera physalus*	E	N/A
Green sea turtle	*Chelonia mydas*	T	N/A
Hawksbill sea turtle	*Eretmochehelys imbricate*	E	E
Humpback whale	*Megaptera novaeangliae*	E	N/A
Leatherback sea turtle	*Dermochelys coriacea*	E	E
Loggerhead sea surtle	*Caretta caretta*	T	N/A
Olive Ridley sea turtle	*Lapidochelys olivacea*	T	N/A
Sperm whale	*Physeter catodon*	E	E
Bird Species			
Ratak Micronesian pigeon	*Ducula coeania ratakensis*	NA	E

Key: E=Endangered; N/A=Not Applicable; T=Threatened.
Source: UES 2009.

The green sea turtle (*Chelonia mydas*) is listed as a threatened species and the hawksbill turtle (*Eretmochelys mbricata*) is listed as an endangered species by the United States. Potential habitat for sea turtles on Omelek includes sandy beaches along the southern and northern tips of the island and the area of the lagoon shoreline from the northern tip of the island south to the north jetty.

Species protected under the various RMI Statutes are listed in Table 3-17.

Table 3-17 Species Protected Under the RMI Statutes Known or Expected to Occur at USAKA/RTS

Common Name	Scientific Name	RMI Statute
All sponges	*Various spp*	RMIMRA
Any small-toothed cetacean	*Various spp*	RMIMMPA
Black-lip mother-of-pearl-oyster	*Pinctada margaritifera*	RMIMRA
Blue whale	*Balaenoptera musculus*	RMIESA
Coastal spotted dolphin	*Stenella attenuate graffmani*	RMIMMPA
Common dolphin	*Delphinus delphis*	RMIMMPA
Costa Rican spinner dolphin	*Stenella longirostris centroamericana*	RMIMMPA
Eastern spinner dolphin	*Stenella longirostris orientalis*	RMIMMPA
Green sea turtle	*Chelonia mydas*	RMIMRA
Hawksbill sea turtle	*Eretmochehelys imbricate*	RMIESA & RMIMRA
Leatherback sea turtle	*Dermochelys coriacea*	RMIESA
Loggerhead sea turtle	*Caretta caretta*	RMIMRA
Offshore spotted dolphin	*Stenella attenuata attenuata*	RMIMMPA
Olive Ridley sea turtle	*Lapidochelys olivacea*	RMIMRA
Ratak Micronesian pigeon	*Ducular oceania ratakensis*	RMIESA
Sperm whale	*Physeter catodon*	RMIESA
Striped dolphin	*Stenella coeruleoalba*	RMIMMPA
Trochus	*Trochus niloticus*	RMIMRTA
Trochus	*Tochus maximus*	RMIMRTA
Whitebelly spinner dolphin	*Stenella longirostris longirostris*	RMIMMPA

Key: RMIESA=Republic of the Marshall Islands Endangered Species Act, COM P.L. 6-55(1975) 45 TTC 1980; RMIMRA=Republic of the Marshall Islands Marine Resources Act, TTC 1970, COM P.L. 4C-35 (1972), COM P.L. 4C-57 (1972), 45 TTC 1980; RMIMMPA=Republic of the Marshall Islands Marine Mammal Protection Act of 1990, P.L. 1990-84; RMIMRTA=Republic of the Marshall Islands Marine Resources (Trochus) Act of 1993, P.L. 1983-15, 1.

Source: UES 2009.

Sea turtle nesting has been observed on Kwajalein on several occasions since 2008. One successful hatch occurred in 2010. Riprap placement along the lagoon side of the islet prevents the formation of open sandy beaches preferred by nesting turtles.

Although there are five species of giant clams found throughout the Marshall Islands, the largest species (*Tridacna*) has been significantly reduced in numbers throughout the Marshall Islands and has been removed from the Caroline Islands. The only reproductively viable population of T. glgas has been found off Gellinam Island (USASMDC 2003). Although not currently listed as an endangered or threatened species, its status is being evaluated by the RMI government and the NMFS for possible classification as such. These giant clams are harvested by foreign fishermen (the muscle of the clam sells for around $100 per pound in Asian markets). The native Marshallese eats any of the giant clam species, but prefers the smaller, more common species.

Kwajalein has the greatest diversity of birds of all the USAKA/RTS islets. Most of these birds have been observed in the managed vegetation around the airport runway and adjacent catchment areas. Shorebirds use the shoreline and exposed reef flat during low tide, but also use the golf course grounds, airport runway, and mowed lawns. Birds commonly observed include black noddies, great crested terns, brown noddies, and white terns. Since 1996, white terns have been the only species observed nesting on the islet. However, in 2002 black-naped

terns were observed nesting on the concrete pier structures at the harbor fuel loading docks. A broken black-naped egg was found in 2004. Common greenshanks were also observed on the islet for the first time.

A marine survey was conducted in September and November of 2002. Fourteen stations were monitored to determine biodiversity around USAKA/RTS. The following is a combined list of the Species of Concern (SOC) that were observed among the 14 stations:

Mollusks: Top-shell snails (*Trochus niloticus, T. intextus, T. pyramus, and T. aculatus*), finger conchs (*Lambis truncata and Lambis lambis*), black-lipped pearl oysters (*Pinctada margaritifera*), and giant clams (*Tridacna maxima and Hippopus hippopus*).

Sponges: *Acanthella cavernosa, Adocia sp, Agelas mauritiana, A. viola, Aka sp, Aplysilla sp, Axinella sp, Axinyssa sp, Callyspongia sp, Chelonaplysilla violacea, Clathria mima, Clathria sp, Cliona sp, Crella sp, C. calypta, Cribrochalina olemda, Dorypleres splendens, Druinella purpurea, Dysidea avara and granulosa, Euplacella sp, Haliclona sp, Hippospongia metachroma, Hyrtios sp, Ianthella basta, Igernella sp, Katiba milnei, Leucetta sp, Liosina paradoxa, Monanchora ungiculata, Nara nematifera, Oceanapia sp, Parrahigginsia sp, Pericharax heterorhaphis, Plakortis sp, Psammocinia sp, Pseudoceratina sp, Spheciospongia sp, Stylissa flabeliformis, Stylotella aurantium, Tethya sp, Theonella sp*, and *Xestospongia* were observed.

Corals: Of the more than 80 coral species observed within various stations, a majority were SOC from the genera *Acropora, Favia, Fungia, Halomitra, Heliopora, Lobophyllia, Merulina, Millepora, Pavona, Pectinia, Platygyra, Pocillopora*, and *Stylophora*.

Reef fish: Giant coral groupers (*Plectropomus laevis*), squaretail coral groupers (*P. areolatus*), lyretail groupers (*Variola louti*), and wrasses (*Cheilinus undulatus*) were observed.

Sea turtles: Green sea turtles (*Chelonia mydas*) of various ages were observed at 4 of the 14 stations.

Table 3-18 lists the species protected under U.S. Marine Mammal Protection Act and Table 3-19 lists the species protected under the U.S. Migratory Bird Conservation Act that are known or expected to occur at USAKA/RTS.

Table 3-18 Species Protected by the Marine Mammal Protection Act Known or Expected to Occur at USAKA/RTS

Common Name	Scientific Name	Status
Protected Under U.S. Marine Mammal Protection Act		
Blainville's beaked whale	*Mesoplodon densirostris*	Migratory
Blue whale	*Balaenoptera musculus*	Migratory
Bottlenose dolphin	*Tursiops sp.*	Resident
False killer whale	*Pseudorca crassidens*	Migratory

Finback whale	*Balaenoptera physalus*	Migratory
Humpback whale	*Megaptera novaeangliae*	Migratory
Killer whale	*Orchinus orca*	Resident
Melon headed whale	*Peponocephala electra*	Resident
Pacific bottlenose dolphin	*Tursiops gilli*	Resident
Pygmy killer whale	*Feresa attenuate*	Resident
Pygmy sperm whale	*Kogia breviceps*	Migratory
Risso's dolphin	*Grampus griseus*	Resident
Short-finned Pilot whale	*Globicephala macrorhychus*	Migratory
Sperm whale	*Physeter catodon*	Resident
Spinner dolphin	*Stenella longirostris*	Resident

Source: USASCMD 2007.

Table 3-19 Species Protected under the U.S. Migratory Bird Conservation Act

Common Name	Scientific Name	Status
Bar-tailed godwit	*Limosa lapponica*	Uncommon Migrant
Black noddy	*Anous minutus*	Abundant Resident
Black-bellied plover	*Pluvialis squatrarola*	Uncommon Migrant
Black-naped tern	*Sterna sumatrana*	Common Resident
Black-tailed godwit	*Limosa limosa*	Rare Migrant
Bristle-thighed curlew	*Numenius tahitiensis*	Uncommon Migrant
Brown booby	*Sula leucogaster*	Uncommon Resident
Brown noddy	*Anous stolidus*	Common Resident
Canada Goose	*Branta Canadensis*	Accidental Vagrant
Cattle egret	*Bubulcus ibis*	Rare Vagrant
Common greenshank	*Tringa nebularia*	Rare Migrant
Common ringed plover	*Charadrius hiaticula*	Accidental Migrant
Common snipe	*Gallinago gallinago*	Rare Migrant
Curlew sandpiper	*Calidris ferruginea*	Accidental Migrant
Fork-tailed swift	*Apus pacificus*	Accidental Vagrant
Franklin's gull	*Larus pipixcan*	Accidental Migrant
Garganey	*Anas querquedula*	Accidental Vagrant
Great frigate bird	*Fregata minor*	Uncommon Resident
Greater yellowlegs	*Tringa melanoleuca*	Accidental Migrant

Table 3-19. Species Protected under the U.S. Migratory Bird Conservation Act (*continued*)

Common Name	Scientific Name	Status
Green-winged teal	*Anas crecca*	Uncommon Migrant
Grey-tailed tattler	*Heteroscelus brevipes*	Uncommon Migrant
Hudsonian godwit	*Limosa haemastica*	Accidental Migrant
Lesser Golden plover	*Pluvialis dominica*	Abundant Migrant
Lesser yellowlegs	*Tringa flavipes*	Accidental Migrant
Little tern	*Sterma albifrons*	Accidental Visitor
Long-billed dowticher	*Limnodromus scolopaceus*	Rare Migrant
Mallard	*Anas platyrhyncos*	Rare Migrant
Marsh sandpiper	*Tringa stagnatilis*	Accidental Migrant
Mongolian plover	*Charadrius mongolus*	Uncommon Migrant
Mottled petrel	*Pterodroma inexpectata*	Rare Migrant
Northern pintail	*Anas acuta*	Uncommon Migrant
Northern shoveler	*Anas clypeata*	Uncommon Migrant
Pacific reef heron	*Egretta sacra*	Common Resident
Pectoral sandpiper	*Calidris melanotos*	Accidental Migrant
Red knot	*Calidris canutus*	Accidental Migrant
Red-footed Booby	*Sula sula*	Uncommon Resident
Red-necked stint	*Calidris ruficolla*	Rare Migrant
Red-tailed tropicbird	*Phaethon rubricauda*	Rare Visitor
Ruddy turnstone	*Arenaria interpres*	Abundant Migrant
Ruff	*Philomachus pugnax*	Accidental Migrant
Sanderling	*Calidris alba*	Uncommon Migrant
Semipalmated plover	*Charadrius semipalmatus*	Accidental Migrant
Sharp-tailed sandpiper	*Calidris acuminate*	Uncommon Migrant
Sooty shearwater	*Puffinus griseus*	Common Migrant
Sooty tern	*Sterna fuscata*	Uncommon Visitor
Tufted duck	*Aythya fuligula*	Accidental Vagrant
Wandering tattler	*Heteroscelus incanus*	Common Migrant
Wedge-tailed shearwater	*Puffinus pacificus*	Uncommon Visitor
Whimbrel	*Numenius phaeopus*	Common Migrant
White tern	*Gygis alba*	Common Resident
White-tailed tropicbird	*Phaethon lepturus*	Rare Visitor
White-winged tern	*Childonias leucopterus*	Rare Vagrant
Wood sandpiper	*Tringa glareola*	Accidental Migrant

Source: UES 2009.

Sensitive Habitats

Hundreds of species of coral, as well as 250 species of reef fish, can be found in the atolls of the Marshall Islands. Food cultivation on these islands is limited; as a result, fish and seafood are staples of the Marshallese diet. The multilateral fisheries agreement between the United States and South Pacific island governments, including the Marshall Islands, seeks to protect

the fisheries in the Exclusive Economic Zones. This has contributed to the adoption of the United Nations Agreement on Highly Migratory Fish Stocks and Straddling Fish Stocks, a treaty that promotes the long-term sustainable use of highly migratory species, such as tuna, by balancing the interests of coastal states and states whose vessels fish on the high seas (USASMDC 2003, 2007).

Extensive dredge and fill activities since the 1930s have degraded the marine habitat surrounding Kwajalein, particularly on the lagoon side. A remnant of the original reef flat is located just north of Echo Pier, outside the harbor. Despite the lack of natural vegetation, the islet provides limited habitat for several species of birds, particularly migrant shorebirds and waterfowl. Extensive dredging and the deposition of fill on the lagoon reef flat have greatly altered the marine environment of Meck. Most of the island is surrounded by riprap intended for shoreline protection. The only remaining undisturbed reef flats occur at the north and south tips of the island. Giant clams are found on the reef (USASMDC 2003, 2007).

Marine and terrestrial habitats on Omelek that are considered of significant biological importance include: (marine) the lagoon area facing the reef slope and reef flat; the interisland reef flat; lagoon floor; ocean area facing the reef slope and reef flat; quarry pits; and intertidal zone, and (terrestrial) mixed broadleaf forest areas; seabird colonies; and shorebird sites.

Although the harbor area has been dredged, the lagoon-facing reef flat on either side of the jetties provides good quality marine habitat with high to moderate coral diversity and giant clams. The large quarried area on the ocean side also exhibits a diversity of marine life; coral diversity has remained high. Both areas had been affected by storm damage prior to the 2004 inventory (USASMDC 2007).

An abundance of corals are in the area, but some areas show signs of stress, while still others have areas of dead coral, particularly off the north point on the lagoon side.

3.3.3.9 Historical and Cultural Resources

The standards for cultural resources for USAKA/RTS are derived from the NHPA, and are included in the UES, also referred to as the Standards. The regulations for promoting cultural preservation that are in the RMI's Historic Preservation Act 1991 (45 MIRC, Chapter 2) also were consulted.

Cultural resources are material remains of human activity that are significant in the history, prehistory, architecture, or archaeology of the RMI. They include prehistoric resources (produced by preliterate indigenous people) and historic resources (produced since the advent of written records).

The Standards for cultural resources are similar, with a few exceptions, to the U.S. statutes and regulations on which they are based. Under the Standards, the U.S. Advisory Council on Historic Preservation (ACHP) does not have a formal role, but may be used as a resource by the RMI Historic Preservation Officer (RMIHPO). The RMI ACHP reviews documentation of interaction between USAKA/RTS and RMI EPA in certain instances and may be called upon to mediate disagreements between the RMIHPO and the Commander, USAKA/RTS. Under the Standards, the RMIHPO shall execute the function of the state historic preservation office.

All communication between USAKA/RTS and the RMIHPO is conducted through RMI EPA. The Standards substitute the RMI NRHP and its listing criteria for the corresponding U.S. NRHP and listing criteria.

The Standards require submitting to the appropriate agencies a draft programmatic DEP on protecting cultural resources at USAKA/RTS that must address the potential effects of routine operations at USAKA/RTS on cultural resources and the procedures for identifying potential cultural resources in areas where they are not known. The programmatic DEP also must establish mitigation procedures for all adverse effects on previously unidentified cultural resources. For proposed activities not covered by the programmatic DEP, a specific DEP that discusses the potential for effects on cultural resources is required.

Kwajalein Atoll's environment is the product of millions of years of natural development, followed by a brief but critical period of human influence. The Japanese occupation from the end of World War I until 1944 initiated a period of intense change. During World War II, the atoll, and particularly Kwajalein Islands, were subjected to severe air, land, and sea bombardment. After World War II, the U.S. Navy used the atoll as a base to support the Korean conflict and weapons testing during the 1940s and 1950s. Construction and change have continued on Kwajalein Atoll through the 1980s.

More than half a century of change has affected the atoll unevenly. Several Kwajalein Atoll islands, including Kwajalein, Roi-Namur, Meck, and Ebeye, are now dominated by manmade features.

3.3.3.10 Environmental Justice

EO 12898 does not apply to the RMI.

3.3.4 Wallops Flight Facility (WFF)

The sources of information for this WFF section are The Final Site-Wide EA, Wallops Flight Facility, January 2005 (NASA 2005), and the *Final EA for the Expansion of Wallops Flight Facility Launch Range,* August 2009 (NASA 2009b). Rather than list these references after every paragraph or number, please assume these references are used throughout Section 3.3.4, unless otherwise noted.

WFF is located in the northeastern portion of Accomack County, Virginia, on the Delmarva Peninsula, and is comprised of the Main Base, Wallops Mainland, and Wallops Island (see Figure 3-5). The Main Base is located off Virginia Route 175, approximately 3.2 km (2 mi) east of U.S. Route 13. The entrance gate for Wallops Mainland and Wallops Island is approximately 11 km (7 mi) south of the Main Base.

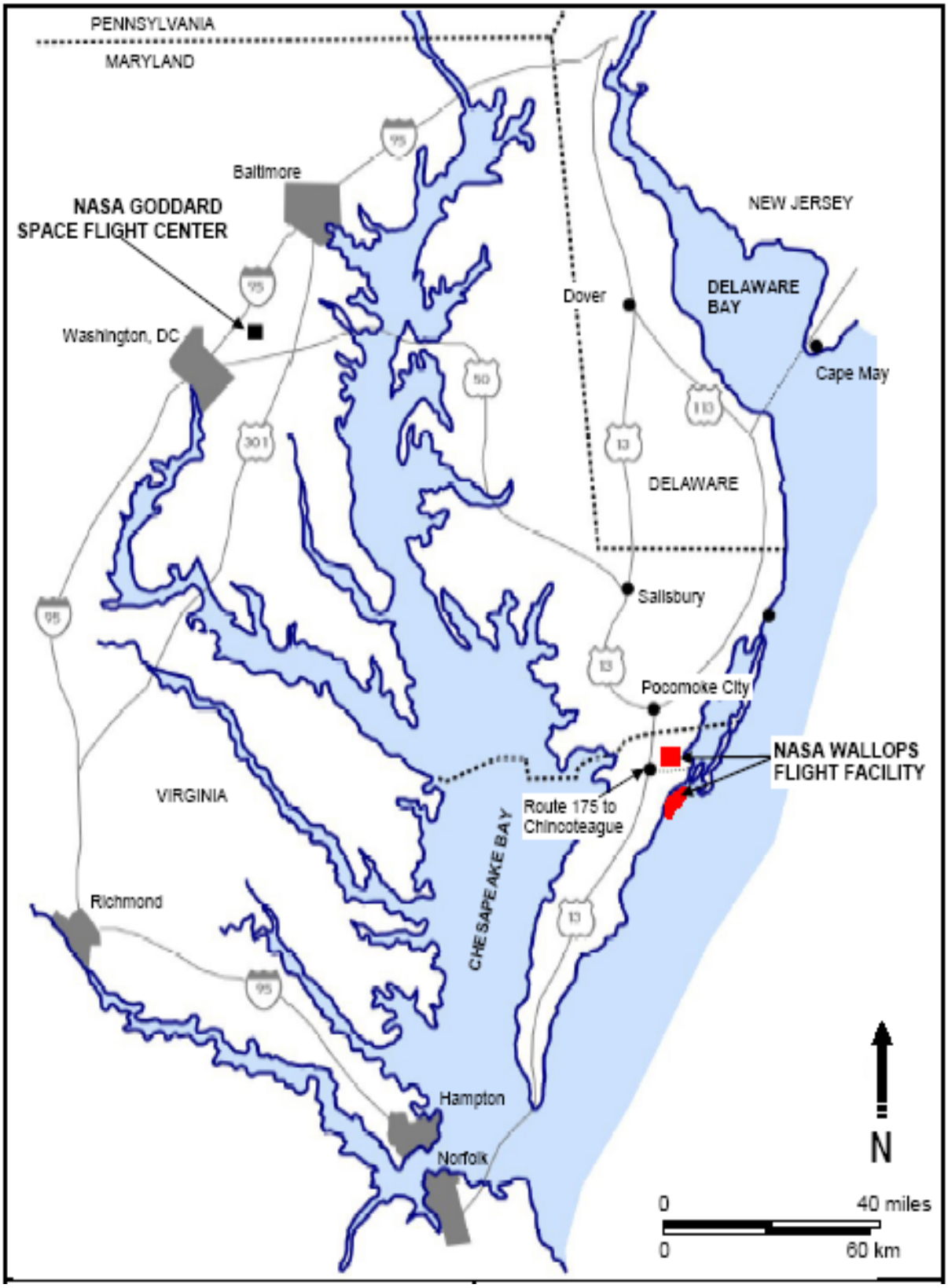
WFF is a NASA facility under the management of NASA Goddard Space Flight Center (GSFC). NASA is the land owner with multiple tenants, including the U.S. Navy, U.S. Coast Guard (USCG), Mid-Atlantic Regional Spaceport (MARS), and NOAA. Each tenant has its own missions, but partially relies on NASA for institutional and programmatic services.

Wallops Mainland consists mostly of marshland and is bordered by agricultural land to the north, south, and west. Wallops Main Base is bordered by agricultural land to the south, west,

and north, and by marshland to the northeast, east, and southeast. Most of the agricultural land surrounding WFF, as well as part of the Main Base, is designated as prime or unique farmland based upon the soil classification.

Rural residential land borders the Main Base to the southwest and small villages and businesses are scattered throughout this area. The businesses include fuel stations, retail stores, markets, and restaurants. Horntown is located 4 km (2.5 mi) north of the Main Base and has a land area of approximately 578 hectares (1,446 acres); Wattsville is located 1.6 km (1 mi) to the west and has a land area of approximately 330 hectares (826 acres); and Atlantic is located 4.4 km (2.75 mi) to the southwest and has a land area of approximately 183 hectares (459 acres).

The Town of Chincoteague, located approximately 8 km (5 mi) east of the Main Base on Chincoteague Island, Virginia, is the largest of the surrounding communities with approximately 4,317 year-round residents, and attracts a large tourist population during the summer months because of the beaches and the annual Assateague Island pony swim and round-up (NASA 2009b).



Source: NASA 2005a.

Figure 3-5 Regional Map of WFF

3.3.4.1 Land Use and Aesthetics/Visual Resources

WFF is located in the northeastern portion of Accomack County, Virginia, on the Delmarva Peninsula. WFF has its own land use classification based on operational areas on the Main Base, Wallops Mainland, and Wallops Island.

The Main Base comprises 720 hectares (1,800 acres). Main Base facilities include offices, laboratories, maintenance and service facilities, a NASA-owned airport, air traffic control facilities, hangars, runways, and aircraft maintenance and ground support buildings. In addition, there are water and sewage treatment plants, rocket motor storage magazines, NOAA data acquisition center, U.S. Navy administration and housing as well as USCG housing, and other miscellaneous structures.

Wallops Mainland consists of 40.5 hectares (100 acres) with long-range radar, communications, and optical tracking installations. Wallops Island comprises 1,680 hectares (4,600 acres), most of which is marshland, and includes launch and testing facilities, blockhouses, rocket storage buildings, assembly shops, dynamic balancing facilities, tracking facilities, U.S. Navy facilities, and other related support structures.

Wallops Island consists of 1,680 hectares (4,150 acres), most of which is marshland, and includes launch and testing facilities, blockhouses, rocket storage buildings, assembly shops, dynamic balancing facilities, tracking facilities, U.S. Navy facilities, and other related support structures.

Most of the Main Base and all of Wallops Mainland and Island are located within an agricultural zoning district. The area surrounding WFF consists of rural farmland and small villages and is regulated by local County government and several town councils.

WFF is geographically proximate to a number of areas managed for conservation purposes, most of which have a particular focus on fostering high quality habitat for migratory birds.

Immediately east of Wallops Main Base is the Wallops Island National Wildlife Refuge, an approximately 152-hectares (375-acre) preserve managed by USFWS. Transferred to USFWS from NASA in 1975, the parcel is comprised mainly of salt marsh and woodlands. Approximately 9.7 kilometers (6 miles) northeast of WFF is Assateague Island, a barrier island managed by the USFWS as part of the Chincoteague National Wildlife Refuge (CNWR), a 5,670-hectares (14,000-acre) complex consisting of beach, dunes, marsh, and maritime forest. CNWR is one of the most visited refuges in the U.S. The Refuge's boundaries also extend onto properties immediately south of Wallops Island and encompass all or part of Assawoman, Metompkin, and Cedar Islands.

Further south, a majority of the remaining undeveloped barrier islands are owned and managed by the Nature Conservancy as components of its Virginia Coast Reserve.

<u>Aesthetics/Visual Resources</u>

The topography of WFF is typical of the Mid-Atlantic coastal region, and is mostly flat without unusual features. The Main Base, Mainland, and Wallops Island are relatively flat with no extreme deviations in the topography. The maximum elevation on the Main Base is

approximately 12 m (40 ft) above mean sea level. The Mainland consists of flat areas with gradual eastern slopes leading to the tidal marsh. Elevation on Mainland reaches approximately 6 m (20 ft) above mean sea level. Presently, the highest elevation on Wallops Island is approximately 5 m (15 ft) above MSL. The area has a low visual sensitivity because the flatness of the area limits any prominent vistas. The land on WFF is fairly undeveloped. The most significant man-made features are the launch pads and various support facilities. Most areas of WFF outside of the developed areas are covered with native vegetation and marshes.

3.3.4.2 Tenants and Other On-Site Organizations

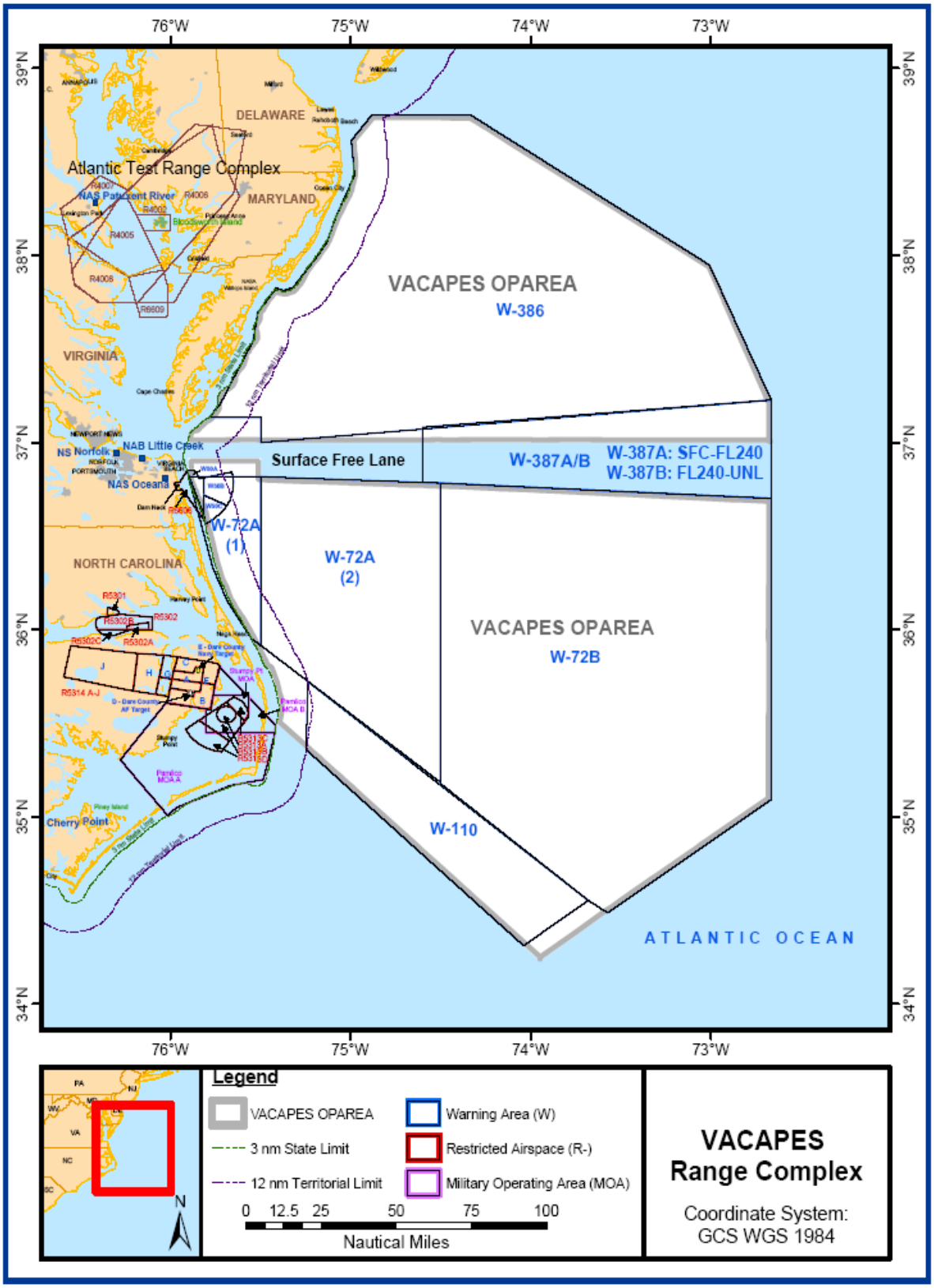
Mid-Atlantic Regional Spaceport (MARS)

The Virginia Space Flight Authority holds an FAA launch site operator license to operate a commercial launch site at Wallops Flight Facility Launch Complex 0. MARS operates the orbital Launch Complex 0, which includes both Pad 0-A and 0-B, and provides facilities and services for commercial launches of payloads into space. Activities include launch vehicle and payload preparation, integration and testing, prelaunch operations, launch range integration, and launch and post-launch operations.

U.S. Navy Surface Combat Systems Center

The U.S. Navy Surface Combat Systems Center is WFF's largest partner. Wallops Island is home to the unique replica of an Aegis cruiser and its destroyer combat systems, used to train naval officers and enlisted personnel in the operation and maintenance of sophisticated equipment used by the fleet. The systems are also used to test concepts and solve operational problems. Other technical missions include Lifetime Support Engineering, In-Service Engineering, Systems Level operations, and maintenance training. The Surface Combat Systems Center supports the Aegis Training Unit by providing equipment on which replacement crew training is held. The U.S. Navy Ship Self Defense System Facility on Wallops Island conducts research, development, testing, and evaluation elements of shipboard systems, integration, and demonstrations of new shipboard systems. WFF also provides missile launch support for the U.S. Navy. Drone vehicles are used for target tracking and are engaged by both the Aegis facility and operational naval forces.

The Virginia Capes Operating Area (VACAPES OPAREA) is a surface and subsurface operating area off the Virginia and North Carolina coasts (see Figure 3-6). It includes the area covered by Warning Areas (W) -386, W-387, W-72, W-50, W-108, W-1 10, R-6606, and the Submarine Transit Lanes. The VACAPES OPAREA is used for various surface, subsurface, and air-to-surface exercises, and is managed by the Fleet Area Control and Surveillance Facility, Virginia Capes (FACSFAC VACAPES), located in Virginia Beach, Virginia. As a designated air traffic control facility, it is required to provide air traffic separation consistent with the guidelines used by the FAA controllers, and provide for the safe, efficient and expeditious flow of air traffic.



Source: USN 2008.

Figure 3-6 Virginia Capes (VACAPES) Complex

Warning Area 386 (W-386) is special-use airspace over VACAPES OPAREA — Areas 1–12 off the coast of Maryland located approximately 96 km (60 mi) east of the Naval Air Station Patuxent River, Channel 1231. W-3 86 extends from the surface to unlimited altitude, except that portion of the area west of 75° 30'W, which is surface to, but not including, 2000-ft MSL. R-6604, located west of W-386, is part of WFF. Air-to-air, air-to-surface, surface-to-air, and surface-to-surface missile, gunnery, and rocket exercises using conventional ordnance are authorized. Antisubmarine Rocket exercises may be scheduled in W-386E.

National Oceanic and Atmospheric Administration (NOAA)

The NOAA National Environmental Satellite Data Information Service Command (NESDIS) operates environmental satellites, which collect information on atmospheric, oceanic, and terrestrial environmental conditions. This data is distributed to various organizations to prepare short-term and long-range meteorological forecasts, monitor important environmental parameters, provide information critical to aviation and maritime safety, aid search and rescue missions, and assist in national defense and security. NESDIS satellites track the movement of storms, volcanic ash, and icebergs; measure cloud cover; measure temperature profiles in the atmosphere and temperature of the ocean surface; collect infrared and visual information; and measure atmospheric ozone levels. The Wallops Command and Data Acquisition Station, an 11.7-hectare (29-acre) facility operated by NESDIS, gathers the data from the satellites via radio downlinks from 12 receiving antennas and controls satellites via transmission of radio signals through 5 transmitting antennas.

U.S. Coast Guard

The USCG maintains housing units on 2.8 hectares (7 acres) south of the Main Base Entrance for personnel assigned to the Chincoteague Station.

Marine Science Consortium (MSC)

The MSC was founded in 1968 by a consortium of three colleges, although it was known by a different name at that time. This Consortium established a list of objectives that included the establishment and maintenance of a marine field station, promoting and encouraging learning and research in the marine and environmental sciences, and promoting activities that will create a broader understanding of the marine and environmental sciences. Fifteen academic institutions now comprise the MSC, whose main campus, the Wallops Island Marine Science Center, is located adjacent to the WFF Main Base and consists of over 23 hectares (57 acres) containing classrooms, wet and dry laboratories, a computer laboratory, residence buildings, faculty and staff residences, a cafeteria, library, recreational facilities, and an administrative building.

Students from MSC frequently launch boats behind the WFF Visitors Center and conduct research in the nearby marshes.

Recreation

WFF is located on Virginia's Eastern Shore, which is a popular tourist destination, and the surrounding counties offer numerous recreational opportunities, including the NASA WFF

Visitors Center. For most of the year the Visitors Center is open free of charge to the public from Thursday through Monday, from 10:00 am to 4:00 pm. The WFF Visitors Center is open 7 days a week from July 4 through Labor Day.

Many tourists and vacationers visit the Eastern Shore throughout the late spring, summer, and early fall. Regional attractions include the Assateague Island National Seashore, which has 24 km (15 mi) of undeveloped shoreline in Virginia and Maryland, and the Chincoteague National Wildlife Refuge, which is home to many species of animals, including the Chincoteague wild ponies. Winter hunting season draws people to hunt local game, including dove, quail, deer, fox, and many types of geese and ducks. The Marine Recreational Fishery Statistics Survey (MRFSS) conducted by the NMFS provides estimates of fishing effort, catch, and participation by recreational anglers in the marine waters of the U.S. According to the MRFSS estimates, almost 1.9 million people participated in recreational, marine fishing in waters off the coast of Virginia.

3.3.4.3 Hazardous Materials and Hazardous Waste Management

Hazardous Materials Management

In August 2006, Virginia DEQ issued its formal approval of WFF's latest Integrated Contingency Plan (ICP). The ICP, developed by the Environmental Office in accordance with 29 CFR 1910, Subpart H (Hazardous Materials), includes the following procedures:

- The Environmental Office provides annual ICP to all Civil Service and Contractor employees who handle hazardous materials and petroleum as part of their job;
- WFF labels each container of hazardous material in English with the following minimal description: name of the chemical and all appropriate hazard warnings;
- WFF has on file in each work area Material Safety Data Sheets (MSDS) for each hazardous material used onsite. WFF utilizes an online electronic chemical inventory (MSDS-Pro) that contains links to appropriate MSDSs and is accessible to all WFF personnel through the GSFC intranet;
- Individual WFF support contractor offices train their personnel in the applicable hazardous communication pertinent to the requirements for each employee; and
- WFF prepares and implements spill contingency and response procedures.

Hazardous Waste Management

The regulations, which govern hazardous waste management, are 40 CFR 260-270 (Federal) and 9VAC20-60 (Commonwealth of Virginia Administrative Code [VAC]). The Environmental Office manages hazardous waste generated at WFF. They are responsible for tracking manifests and certificates of disposal for hazardous wastes, which leave the facility. The Environmental Office also provides annual Hazardous Waste training to all Civil Service and Contractor employees who handle hazardous waste as part of their job.

The generators at each operation or activity are responsible for:

- Properly containing waste.
- Properly completing and transferring of a disposal inventory sheet to the Environmental office.

- Properly labeling waste containers with information pertaining to the contents and with the words: "Hazardous Waste."

The Hazardous Waste Technicians at each operation or activity are responsible for inspecting the material and transporting the waste to a satellite accumulation area.

The Environmental Office is responsible from transporting hazardous waste from the satellite accumulation areas to one of the Less-Than-90-day accumulation areas at WFF. Building B-29 is the accumulation area for hazardous waste on the Main Base. Buildings N-223 and E-2 are also classified as accumulation areas. Building N-223 is the Main Base facility for the storage of used oil. Building E-2 is used to store photographic process waste. Additionally, an accumulation area is located on the Mainland at Building U-81 for storage of waste generated on the Mainland and Wallops Island.

The Main Base is classified as a large-quantity generator due to the fact that it generates greater than 1,000 kg (2,200 lb) of hazardous waste and/or 1 kg (2.2 lb) of acute hazardous waste per month. Wallops Island and Mainland are also classified as a large quantity generator.

Hazardous waste may be stored on-site at an accumulation area for up to 90 days from the date of initial accumulation. WFF uses a licensed hazardous waste transporter to transport hazardous waste to a licensed treatment, storage, and disposal Facility (TSDF). In calendar year 2009, WFF generated 10,585 kilograms (23,335 lbs) of hazardous waste.

A RCRA Part B permitted treatment storage and disposal facility is maintained on the southern end of Wallops Island. Rocket motors are treated at the facility by open burning until the casings are certified to be free of contamination.

Pollution Prevention

WFF has an active Pollution Prevention program, which includes source and/or toxicity reduction, recycling, and green purchasing. Recent pollution prevention projects include a closed loop garnet metal cutting machine, which has saved 163,000 liters (43,000 gal) of water over the past year, a coolant reconditioning system, which has reduced off-site disposal by 45 percent, and new cafeteria grill cleaner which is 100 times less hazardous to employees. In fiscal year 2009, WFF recycled a total of 234,000 kg (516,070 lbs) of aluminum, antifreeze, batteries, cardboard, grease, drums, electronics, florescent lamps, plastic, solvents, tires, toner cartridges, used oil, and white paper. A Sustainability Team has been formed to gauge progress in meeting the goals of the recent Executive Orders Program (NASA 2009b).

Virginia Pollutant Discharge Elimination System (VPDES) regulations also require permitted facilities to develop a Stormwater Pollution Prevention Plan (SWPPP). WFF's most recent SWPPP was developed in 2001, and was revised in April 2009. The SWPPP describes current stormwater management systems and associated outfalls, potential pollutant sources, and BMPs implemented to reduce runoff. In addition, the SWPPP details stormwater sampling activities, procedures for completing annual comprehensive site compliance evaluations, and the employee training program.

Scheduled samplings of stormwater drainage areas are performed in accordance with VPDES water quality monitoring requirements. Analysis is conducted in accordance with EPA analytical laboratory test methods, and quality control/quality assurance reviews are conducted to ensure the validity of results. Sample results are submitted to DEQ in a monthly Discharge Monitoring Report. No discharge violations were reported during the most recent permit term.

3.3.4.4 Health and Safety

Regional Safety

WFF maintains a security force that is responsible for the internal security of the base. The force provides 24-hour-per-day protection services for 2,428 hectares (6,000 acres) of real estate, 513 buildings and structures, and approximately 1,600 employees and 11,000 visitors per year (NASA 1999a). Two entrance gates to the WFF are used to control and monitor daily employee and visitor traffic. Other services provided by the security force include security patrols, employee and visitor identification, mail delivery, after-hours security checks, and police services. The Main Base perimeter is surrounded by a chain-link fence. The only overland access to Wallops Island is via a causeway from the Mainland. The ocean provides an additional safety buffer zone.

On-base Safety

Inherent risks associated with rocket launch operations could impact public safety and the safety of WFF personnel and contractors. NASA has established ground and flight safety guidelines to minimize these impacts. WFF's Safety Office is responsible for implementing these safety guidelines. NASA document RSM-2002, Range Safety Manual for Goddard Space Flight Center (GSFC)/Wallops Flight Facility (WFF), revision B, outlines ground and flight safety requirements, range user and tenant responsibilities, and safety data requirements to which all range users must conform (NASA 2008c).

To ensure the safety of personnel, property, and the public, WFF requires all range users to submit formal documentation pertaining to their proposed operations for safety review. Mission-specific safety plans are prepared by WFF's Ground and Flight Safety Groups. These plans address all potential ground and flight hazards related to a given mission in accordance with the Range Safety Manual. It is the responsibility of the Safety Office to coordinate review of the proposed operations with all applicable organizations. Risks to human health and safety must be thoroughly addressed and managed by the plans.

The Ground Safety Plan outlines operational management procedures for minimizing risks to human health and the environment. Ground safety focuses on potential hazards associated with activities such as fueling, handling, assembly, and checkout for all prelaunch activities. System designs and safety controls are established to minimize the potential hazards associated with the operations of a launch range.

The Ground Safety Plan specifically addresses the following areas:

- Hazardous materials handling;
- Explosive safety;

- Personal protective equipment;
- Health and safety monitoring;
- Training; and
- Operational security, controls, and procedures.

The Flight Safety Plan outlines flight management procedures for minimizing risks to human health and the environment. Flight safety focuses on the flight of the launch vehicle. WFF coordinates all operations with the FAA, U.S. Navy, USCG, and other organizations as required in order to clear potential hazard areas. NOTMARS and NOTAMS, which list restricted or hazardous areas, are announced at least 24 hours prior to a launch. All launch limitations are published in the Flight Safety Plan.

A preliminary flight trajectory analysis is completed prior to each launch to define the flight safety limits for guided and unguided systems. Vehicle systems with Flight Termination Systems will be terminated by destruction of the vehicle if the flight is deemed erratic or transverses the established destruct boundary. All stages are required to be equipped with flight termination systems unless the maximum range of the vehicle is less than the range to all protected areas or the vehicle is determined to be inherently safe.

Flight termination boundaries are designed to ensure that vehicle destruction occurs within a predetermined safety zone. This safety zone is established for the protection of the public, personnel, and the environment. While failures have occurred in the past, there has been no evidence of acute or cumulative safety impacts as a result of launch failures.

3.3.4.5 Geology and Soils

Geology

The topography at WFF is typical of the Mid-Atlantic coastal region, and is mostly flat without unusual features. Located within the Atlantic Coastal Plain Physiographic Province, WFF is underlain by approximately 2,133 m (7,000 ft) of sediment. The sediment lies atop crystalline basement rock. The sedimentary section, ranging in age from Cretaceous to Quaternary, consists of a thick sequence of terrestrial, continental deposits overlain by a much thinner sequence of marine sediments. These sediments are generally unconsolidated and consist of clay, silt, sand, and gravel.

The regional dip of the stratigraphic units is to the east, toward the ocean. The two uppermost stratigraphic units at WFF are the Yorktown Formation and the Columbia Group, which is not subdivided into formations. The Yorktown Formation is the uppermost unit in the Chesapeake Group and was deposited during the Pliocene epoch of the Tertiary Period. The Yorktown Formation generally consists of fine to coarse, glauconite quartz sand, that is greenish gray, clayey, silty, and in part, shelly. The Yorktown Formation occurs at depths of 18.28 to 42.67 m (60 to 140 ft) in Accomack County.

The Main Base, Wallops Mainland, and Wallops Island lie within the Tidewater region of the Embayed section of the Atlantic Coastal Plain Physiographic Province. The three major landforms found at the WFF site are mainland, tidal marsh, and Barrier Island. Wallops Island is separated from the Main Base and Wallops Mainland by numerous inlets, marshes, bays,

creeks, and tidal estuaries. During storms, flood water from the Atlantic Ocean moves through these inlets and across the marshes to low-lying areas along the coast.

The mainland includes low and high terraces separated by a discontinuous escarpment at 7.62 m (25 ft) above MSL. Low terraces are found west of Route 13 and on the extreme eastern edge of Wallops Mainland. The low terrace consists of broad to narrow flats bordered by tidal marshes on the east and a discontinuous escarpment on the west. The high terrace ranges in elevation from 7.62 to 15.24 m (25 to 50 ft) above MSL. The high terrace topography is more complex than the low terrace, and is generally characterized by broad, nearly level terraces that are broken by narrow elliptical ridges (Carolina Bay features), gentle escarpments, tidal creek, and drainage ways.

Extensive tidal marshes are located between the mainland and barrier islands. The marshes flood regularly with the tides, are drained by an extensive system of meandering creeks, and have immature soils. Barrier islands are approximately parallel to the mainland and are generally less than 3 m (10 ft) above MSL. Topography varies from nearly level to steep, and soils are immature and vary widely from very poorly to excessively drain.

Soils

The dominant agricultural soils are high in sand content, which results in a highly leached condition, an acidic pH, and a low natural fertility (NASA 2005a). Adequate artificial drainage improves productivity for poorly drained soils. The Main Base and inland areas have Bojac fine sandy loam soils, which are suitable for agriculture (this type of soil is classified as prime and unique farmlands in Accomack County). The Wallops Mainland and most of Wallops Island have soil suitable for wildlife habitat.

The majority of the WFF Main Base is located on a high terrace landform (7.62 to 12.19 m [25 to 40 ft] above MSL) with the northern and eastern portions located on low terraces (0 to 7.62 m [0 to 25 ft] above MSL) and tidal marsh. The Wallops Mainland is primarily located on low terrace and tidal marsh, and Wallops Island is a barrier island with extensive tidal marshes between the island and the Wallops Mainland. Presently, the highest elevation on Wallops Island is approximately 4.57 m (15 ft) above MSL. However, topography on barrier islands changes due to the dynamics of ocean currents, wind erosion, and severe weather conditions.

Extensive marsh wetland systems border all three areas at WFF. The Main Base has tidal and nontidal wetlands along its perimeter in association with Mosquito Creek, Jenney's Gut, Simoneaston Bay, and Simoneaston Creek. Wallops Island has nontidal wetlands in its interior and marsh wetlands on the western edge. Marsh wetlands also fringe Wallops Mainland along Arbuckle Creek, Hogs Creek, and Bogues Bay.

3.3.4.6 Water Resources

WFF is located in the Eastern Lower Delmarva and the Chincoteague watersheds. The entire Main Base, portions of Wallops Mainland north of Route 803, and the western portion of Wallops Island north of Route 803 are part of the Chincoteague watershed. The portion of

Wallops Mainland south of Route 803 and the portions of Wallops Island south of Route 803 and all along the eastern edge of the island are part of the Eastern Lower Delmarva watershed.

Groundwater

The Virginia DEQ identified four major aquifers on the Eastern Shore of Virginia: the Columbia aquifer and the three separate units of the Yorktown-Estover Multi-Aquifer system.

The water table aquifer, known as the Columbia aquifer, is unconfined and typically overlain by wind-deposited beach sands, silts, and gravel. The aquifer occurs between depths of 1.5 to 18.3 m (5 and 60 ft) below the ground surface. The water table ranges from depths of 0 to 9.1 m (0 to 30 ft) below the ground surface.

In general, the water table (Pleistocene) aquifer on the Delmarva Peninsula is recharged by surface waters or infiltration of precipitation. The confined aquifers are recharged by the same process; however, this recharge occurs over a much smaller area along the "spine" of the Eastern Shore, several miles west of WFF. The annual average rainfall for WFF is 93.5 cm (36.8 in) with an annual net precipitation of 35.6 cm (14 in).

WFF contains 17 water supply wells that are screened in the Columbia and Yorktown-Eastover Multiaquifer System, which is protected by the EPA as a sole source aquifer. A sole source aquifer is a drinking water supply located in an area with few or no alternative sources to the groundwater resource, and if contamination occurred, using an alternative source would be extremely expensive. The designation protects an area's groundwater resource by requiring the EPA to review any proposed projects within the designated area that are receiving Federal financial assistance. All proposed projects receiving Federal funds are subject to review to ensure they do not endanger the water source.

NASA operates five supplies wells on the Main Base and two on Wallops Mainland, eight wells are operated under easement by the Town of Chincoteague. Most of the supply wells are several hundred feet deep and are constructed to withdraw water from one of the Yorktown Aquifers. Three of the wells that are operated by the Town of Chincoteague (located near the eastern boundary of the Main Base) are 18.3 m (60 ft) or less in depth and withdraw water from the Columbia Aquifer.

Groundwater is the sole source of potable water for WFF and the general vicinity. No major streams or other fresh surface water supplies are available as alternative sources of water for human consumption. A groundwater management planning program has been established by the Virginia DEQ for the entire Eastern Shore to ensure that an optimal balance exists between groundwater withdrawals and recharge rates. This balance helps to minimize the problems of water quality due to saltwater intrusion, aquifer de-watering, and well interference in the general area.

Groundwater appropriation within WFF and its immediate vicinity can be categorized into agricultural, private, public, and industrial uses. Agricultural uses include crop irrigation and poultry.

Industrial and public water users withdrawing at least 37,805 liters per day (lpd) (10,000 gal per day [gpd]) are required to obtain a DEQ permit. WFF is presently limited to approximately 37.6 million liters (10 million gal) per month. Actual WFF withdrawals are approximately 11.8 million liters (3.1 million gal) per month. Under an easement agreement with NASA, the Town of Chincoteague operates a series of drinking water production wells to the east of Runway 04-22 of the Wallops Airfield. WFF also has an agreement with the Town of Chincoteague to allow them to draw treated water from NASA during high use periods. The Town of Chincoteague 1999 water usage data supplied by the Town of Chincoteague Public Works indicates a total withdrawal of over 7.6 million liters (2 million gal) annually from wells located within WFF property.

Surface Water

Surface waters in the vicinity of WFF are saline to brackish and have tidal influences due to the coastal location. The surface waters in the vicinity of WFF are designated as Class II (Estuarine Waters) by the Commonwealth of Virginia. The Atlantic Ocean, which lies to the east of Wallops Island, is designated as Class I (Open Ocean). These classifications include water quality standards for dissolved oxygen, pH, and maximum temperature. In addition, numerical water quality standards are applied according to water classification. For Class I and II waters, the saltwater numerical standards apply. These standards are listed in the Virginia DEQ regulations 9 VAC 25-31-110. These standards, as well as effluent limitations on point source discharges, are mechanisms used by the Commonwealth of Virginia to protect and maintain surface water quality.

The CWA is administered for WFF by the Virginia DEQ. The Commonwealth of Virginia, in a federally approved program, has the authority to issue VPDES. A VPDES permit, issued by the DEQ, authorizes potential or actual discharge of pollutants from a point source to surface waters under prescribed conditions and limitations.

WFF currently holds VPDES Permit No. VA0024457 for 13 outfalls, three point source discharges drain into Little Mosquito Creek, Jenney's Gut, and Simoneaston Bay. As a result of the process discharge, a portion of Little Mosquito Creek is closed for shellfish harvesting by the Virginia Department of Health. The closure serves as a buffer zone to ensure protection of human health. Buffer zone closures in the vicinity of point source discharges are a standard practice to provide protection of public health.

Water Quality

Previous evaluations of the two principal aquifers underlying WFF indicated that the groundwater quality for the Columbia and Yorktown-Eastover aquifers is good, though moderately hard and with little or no fluoride present. Most shallow wells and a few deep wells located within the tidal areas show evidence of brackish water due to saltwater intrusion. Localized iron problems have also occurred throughout the general area.

Coastal Zone Management

The Virginia Department of Environmental Quality (DEQ) is the lead agency for the Virginia Coastal Resources Management Program (VCRMP), which is authorized by the NOAA to

administer the CZMA of 1972. Any Federal agency development in Virginia's Coastal Management Area (CMA) must be consistent with the enforceable policies of the VCRMP. Although Federal lands are excluded from Virginia's CMA, any activity on Federal land that has reasonably foreseeable coastal effects must be consistent with the VCRMP (NASA 2005a).

Perchlorate Deposition

The probability for accidental release of rocket propellant in the early stage of flight is small (estimated at 1 percent probability). Rockets launched from WFF may be equipped with radio receivers and ordnance for in-flight destruction if the flight is determined to be erratic. The system is designed to terminate rocket motor thrust upon activation; however, it is possible that a portion of the fuel may fall into the ocean. Due to the low toxicity of ammonium perchlorate leaching from the propellant, impacts to marine life would occur only in the immediate vicinity of the propellant, if at all. Toxic concentrations of ammonium perchlorate would be quickly dissipated by the ocean currents.

3.3.4.7 Air Quality

Virginia Regulatory Framework

Air quality for the WFF area is regulated under the Virginia DEQ, by the State Air Pollution Control Board. WFF is located in an attainment area for the Ambient Air Quality Standards, therefore, is not required to complete the CAA conformity process.

The Virginia DEQ does not currently perform ambient air quality monitoring in the vicinity of WFF. The Virginia DEQ considers the Eastern Shore of Virginia to be an attainment area for ozone, indicating compliance with primary and secondary standards. Accomack County is not designated as an Air Quality Maintenance Area. An Air Quality Maintenance Area is defined as "any area which, due to current air quality or projected growth rate or both, may have the potential for exceeding any ambient air quality standard (for criteria pollutants) within a subsequent 10-year period. WFF has an air permit from the Virginia DEQ that allows it to maintain emissions for criteria pollutants and hazardous air pollutants below major source thresholds.

Meteorology

WFF is located in the climatic region known as the humid continental warm summer climate zone. Large temperature variations during the course of a single year and lesser variations in average monthly temperatures typify the region. The climate is tempered by the proximity of the Atlantic Ocean to the east and the Chesapeake Bay to the west. Also affecting the climate is an air current, known as the Labrador Current, which originates in the polar latitudes and moves southward along the Delmarva coastline. The current creates a wedge between the warm Gulf Stream offshore and the Atlantic coast. The climate of the region is dominated in winter by polar continental air masses and in summer by tropical maritime air masses. Clashes between these two air masses create frontal systems, resulting in thunderstorms, high winds, and precipitation.

Temperature and precipitation in this climate zone vary seasonally. Four distinct seasons each demonstrate characteristic temperatures. In winter, sustained snowfall events are rare. Spring is wet with increasing temperatures. Summer is hot and humid with precipitation occurring primarily from thunderstorm activity. Autumn is characterized by slightly decreasing temperatures and strong frontal systems with rain and sustained winds.

Severe weather such as hurricanes, northeasters, and thunderstorms can result in high winds, heavy rain, and reduced visibility. All of these factors can result in significant impacts to operations at WFF, particularly those related to the airport, launch vehicles, and sounding rockets program. Hurricanes are the most severe type of storm in this area, with high winds and heavy rainfall. Hurricanes, or remnants of hurricanes, have affected the WFF area within the last 50 years.

Northeasters are also cyclonic-type storms, but normally develop near the Atlantic coast, intensify, and produce high winds, waves, tides, and rainfall along the coast. This type of storm occurs most frequently in the winter, but can occur at any time and develop very rapidly, sometimes in a matter of hours. Major northeasters can do as much damage or more than some hurricanes.

Thunderstorms are a common occurrence during the summer months, often providing the only source of precipitation during the season. During June, July, and August, thunderstorms occur on an average of four to seven days per month. Most of the thunderstorms occur during late afternoon and evening and are accompanied by wind gusts up to 74.1 to 92.6 km per hour (40 to 50 knots).

Tornadoes have been known to affect the area occasionally, with four records in the past 50 years (NASA 2005a). Wallops Island also has infrequent snow storms.

Regional Air Quality

The AAQS published by the Commonwealth of Virginia are equal to, or more stringent than, NAAQS. The Commonwealth promulgates air quality standards through the State Air Pollution Control Board.

The WFF is located in Air Quality Control Region 4 and Administrative Region 6. WFF is located in an attainment area for the AAQS. The Standards are contained in Section 9 VAC 5-30 of the Virginia Administrative Code Regulations for the Control and Abatement of Air Pollution. Primary standards for protection of human health, and secondary standards for protection of public welfare, are included in Section 9 VAC 5-30 for criteria pollutants. The Standards are summarized in Table 3-20.

Table 3-20 Commonwealth of Virginia Ambient Air Quality Standards

Parameter (Criteria Pollutant)	Primary		Secondary	
	(μg/m^3)	(ppm)	(μg/m^3)	(ppm)
Carbon monoxide				
Average 8-hour concentration[a]	10,000	9	10,000	9
Average 1-hour concentration[a]	40,000	35	40,000	35
Lead				
Annual arithmetic mean (averaged over calendar year)	1.5	–	1.5	–
Nitrogen dioxide				
Annual arithmetic mean	100	0.053	100	0.053
Ozone				
Maximum 1-hour concentration	235	0.12	235	0.12
Particulate Matter ($PM_{2.5}$)				
24-hour average concentration				
Annual arithmetic mean	15[a]	65		
Particulate Matter (PM_{10})				
24-hour average concentration	150	–	150	–
Annual arithmetic mean	50	–	50	–
Sulfur oxides (sulfur dioxide)				
Annual arithmetic mean	80	0.03	–	–
Maximum 24-hour concentration[a]	365	0.14	–	–
Maximum 3-hour concentration[a]	–	–	1300	0.50

a. Not to be exceeded more than once per year.

Key: ppm=parts per million; (μg/m^3)=Micrograms per cubic meter.

Source: NASA 2005a.

Air Emissions

Significant potential emission sources at WFF include:

- Rocket Launches
- Static Rocket Motor Testing
- Airport Activities
- Open Burn Area
- Central Boiler Plant, Building D-8
- Paint Spray Booth, Building F-16
- Industrial Shops, Buildings F-10 and F-16
- Paint Shop, Building X-30 Wallops Island
- Paint Shop, NOAA Maintenance Facility

Less significant potential emissions sources include gasoline storage tanks, stand-by generators, boilers for individual buildings, laboratory hoods, process vents, construction-related activities, and vehicular traffic.

Rocket launches generate emissions through the combustion of fuel and self-contained oxidizers. Combustion products emitted are predominantly aluminum oxide, CO, HCl, water, nitrogen oxides, CO_2, and hydrogen.

Of the predominant combustion products, CO is the only one regulated by the EPA and the Commonwealth of Virginia under the State adopted NAAQS. Aluminum oxide, chlorine, hydrochloric acid, and lead are rocket launch combustion products that have been identified as Priority Chemicals by the Commonwealth of Virginia. Exposure guidelines used by the Commonwealth of Virginia are derived from the American Conference of Governmental Industrial Hygienists Threshold Limit Values (TLVs).

The values presented in Table 3-21 are as Time-Weighted Averages (TWA), ceilings, and short-term exposure limits (STEL). The Time-Weighted Average is the average concentration for a normal 8-hour workday to which nearly all workers may be repeatedly exposed, without adverse effects. The ceiling is the concentration that should not be exceeded during any part of the working exposure. The short term exposure limit is the concentration to which workers can be exposed continuously for a short period of time without suffering from irritation, chronic or irreversible tissue damage, or narcosis severe enough to increase the possibility of accidental injury, impair self-rescue, or reduce work efficiency. The Commonwealth of Virginia uses these values to determine exempt emission rates for toxic pollutants emitted by a stationary source or an operation that is not part of stationary source.

Table 3-21 Air Quality Guidelines for Exposure to Rocket Exhaust

Combustion Product	CAS No.	TWA mg/m^3	Ceiling mg/m^3	STEL mg/m^3
Aluminum oxide (as Aluminum)	1344-28-1	10	–	–
Chlorine	7782-50-5	1.5	–	2.9
Hydrochloric acid	7647-01-0	–	7.5	–
Lead, inorganic dusts and fumes (as Pb)	7439-92-1	0.15	–	–

Key: CAS No.=Chemical Abstract System Number; CL=Ceiling Limits; mg/m^3=milligrams per cubic meter; STEL=Short-Term Exposure Limits; TWA=Time-Weighted Average.

Source: NASA 2005a.

The emitted combustion products are distributed along the rocket trajectory under normal launch conditions. The quantities emitted per unit length of the trajectory are greatest at ground level and decrease continuously. Some launch vehicles are equipped with destruct systems that rupture the propellant tanks and release all remaining propellants in the event of an in-flight vehicle failure.

Table 3-22 presents the dispersion characteristics of selected atmospheric layers. Table 3-23 lists the combustion products, emitted into each layer. Emissions from the larger Atlas/Centaur and Titan/Centaur rockets are substantially more than the rockets currently launched from WFF. The Atlas/Centaur and Titan/Centaur data is presented for comparison purposes.

Table 3-22 Dispersion Characteristics within Selected Atmospheric Layers

Atmospheric Layer Altitude Range	Temperature Structure	Wind Structure	Characteristic Mixing Rate
Below nocturnal inversion 0–500 m	Increase with height	Very light or calm	Very poor
Below subsidence inversion 0–1,500 m	Decrease with height to inversion base	Variable	Generally fair to inversion base
Troposphere 0.5–20 km	Decrease with height	Variable; increase with height	Generally very good
Stratosphere 20–67 km	Isothermal or increase with height	Tends to vary seasonally	Poor to fair
Mesosphere-Thermosphere Above 67 km	Decrease with height	Varies seasonally	Good

Source: NASA 2005a.

Table 3-23 Quantities of Potential Pollutants Emitted into Selected Atmospheric Layers

	Atmospheric Layer Altitude Range				
Vehicle	**Nocturnal Inversion 0–500 m (Emissions/kg)**	**Subsidence Inversion 0–1500 m (Emissions/kg)**	**Troposphere 0.5–20 km (Emissions/kg)**	**Stratosphere 20–67 km (Emissions/kg)**	**Mesosphere-Thermosphere Above 67 km (Emissions/kg)**
Atlas/Centaur					
CO	0	1,003	24,310	17,500	4,540
CO_2	0	0	0	13,100	3,300
HCL	0	0	0	0	0
NO*	6,310	0	0	0	0
Delta (3C)					
CO	2,600	4,120	10,780	14,400	3,360
CO_2	0	0	0	10,700	3,970
HCL	690	1,130	1,710	0	0
NO[a]	1.8	3.2	4.5	0	70
Delta (6C)					
CO	830	1,840	3,920	14,900	4,930
CO_2	2.3	5.0	11	11,000	4,540
HCL	0	0	0	0	0
NO[a]	2,500	4,260	11,320	0	70
Delta (9C)					
CO	1,100	1,750	5,630	13,350	5,830
CO_2	3.2	4.5	15	9,600	4,540
HCL	0	0	0	410	0
NO[a]	3,020	4,550	13,740	0.9	70

Table 3-23. Quantities of Potential Pollutants Emitted into Selected Atmospheric Layers (*continued*)

Vehicle	Atmospheric Layer Altitude Range				
	Nocturnal Inversion 0–500 m (Emissions/kg)	**Subsidence Inversion 0–1500 m (Emissions/kg)**	**Troposphere 0.5–20 km (Emissions/kg)**	**Stratosphere 20–67 km (Emissions/kg)**	**Mesosphere-Thermosphere Above 67 km (Emissions/kg)**
Scout					
CO	60	180	2,290	970	830
CO_2	0.07	0.5	6.4	100	64
HCL	0	0	0	760	450
NO[a]	110	310	4,000	2.3	1.4
TIIIE/Centaur[b]					
CO	9,800	14,920	47,170	43,320	3,060
CO_2	30	41	126	10,700	20,400
HCL	0	0	0	24,040	0
NO[a]	17,510	26,540	83,000	750	1,520

a. The NO formed from H_2 impurity in the stages using liquid oxygen (Atlas, Thor, Centaur), is not included. The concentration of NO in the exhaust of such stages has been estimated at 3 ppm for an N_2 impurity level of 600 ppm. The resulting NO emissions are negligible.

b. The Titan IIIC is equivalent to the TIIIE/Centaur except for changes in the emissions above 67 km. These changes are not significant in terms of upper atmospheric effects.

Source: NASA 2005a.

Ground level concentrations of potential emission pollutants were estimated by NASA using the Marshall Space Flight Center multilayer atmospheric diffusion model. The exhaust cloud was assumed to rise buoyantly. The exposure criteria indicated are the TLVs for controlled populations (considered conservative for short duration infrequent exposures) and the criteria for exposure of uncontrolled populations to ordinary operations. The distance scales represent the maximum distances at which the graphed concentrations could be found.

3.3.4.8 Noise

Mechanical noise sources from daily operations at WFF include rocket launches, aircraft operations, vehicular traffic, stationary and portable generators, pumps, fire engines, heating and air conditioning units, grounds maintenance equipment, and equipment used in industrial shops. For many of these sources, exposure to noise is either short-term (e.g., fire engines), or can be minimized through use of personal hearing protection. The Range Safety Office is responsible for occupational safety and determining the need for personal hearing protection.

Cannon-like noises generated by a propane tank are used for bird control in the vicinity of the runways. The use of firearms by the U.S. Department of Agriculture (USDA)-licensed sharpshooters for deer and bird control is sometimes necessary. Human exposures to noise from firearms, which can be addressed by personal hearing protection, are infrequent and of short duration.

As long as the rocket motors on the launch vehicles are burning, noise would be generated, especially at the lower altitudes when the air density is appreciable. The attenuation due to

increasing distance and the thinning of the atmosphere would reduce sound transmission. Above a 10-km (6-mi) altitude where vacuum conditions are approached, no sound would be propagated. When the rockets become spent, only aerodynamic noise would prevail as the spent rockets (and there may be two, three, or four stages in a launch vehicle) follow a ballistic path to the water. Oblique shock systems are formed as the denser air slows down the incoming projectile objects to lower but still supersonic speeds near the 1,000 meters/second (0.62 mile/second) level. The characteristic "screaming" or "roaring" frequently reported when such high-velocity projectiles approach the Earth in close to vertical trajectories has not been analyzed. It is clear, though, that the sound levels must be smaller than when the rockets are burning.

The launch areas on the island are located approximately 4 km (2.5 mi) from the mainland. The marshland and water surrounding the island act as a buffer zone for noise generated during rocket launches due to the sound absorption capacity of the vegetation. The noise levels generated during launches depend principally upon the thrust of the rocket motors. The expected launch noise from a Castor-120™ motor on the Athena-3 class vehicle is 125 dB at the launch pad and drops to approximately 80 dB at 12 km (7.5 mi). The towns of Atlantic and Chincoteague, as well as private farms, are located within this 12-km (7.5-mi) radius. The town of Assawoman would experience noise levels around 100 dB. While some observers may, under appropriate atmospheric conditions, find the noise from a launch to be an annoyance, the noise occurs for about 20 seconds, is of low frequency, attenuates rapidly, and occurs infrequently. The public is notified in advance of launch dates and noise levels experienced by the public would be well within the OSHA standard of 115 dBA over 15 minutes (29 CFR 1910.95(b)(2)) for permissible noise exposures.

Rockets and Navy missiles are generally launched over water from Wallops Island and the noise generated is usually low frequency and of short duration. Rocket launches can be heard throughout the surrounding community; however, not at levels that generates complaints or damage property. All non-essential personnel are evacuated from the safety zone during a launch. All essential personnel are restricted to a blast-proof building called a blockhouse. Personnel outside the hazard area may be restricted to their buildings depending on the size of the hazard area.

3.3.4.9 Biological Resources

The USFWS has determined that the area of potential environmental impact for the launch pad portion of Wallops Island is within 1,000 m (0.62 mi) radius of launch pad 0-B.

Vegetation

Hydrophytic vegetation is vegetation or plant life adapted to growth and reproduction under periodically saturated root zone conditions during at least a portion of the growing season. The substrates to which these plants adapt are periodically oxygen deficient as a result of excessive water content and organically enriched soils. Hydrophytic vegetation identified at WFF during previous wetland investigations include the following: Saltmeadow Cordgrass (*Spartina patens*), Seaside Goldenrod (*Solidago sempervirens*), Marsh Elder (*Iva frutescens*), Common Reed (*Phragmites australis*), Groundsel-tree (*Baccharis halimifolia*), American Threesquare (*Scirpus americanus*), and Spike Rush (*Eleocharis ambigens*).

Wetland delineation is coordinated with the Accomack County Wetlands Board, the Commonwealth of Virginia, and the U.S. Army Corps of Engineers. There are three predominant wetland systems in the Wallops area: marine wetlands, estuarine wetlands, and palustrine wetlands. All marine and estuarine wetlands, and some palustrine wetlands, are considered tidal wetlands. Non-tidal wetlands can include palustrine, lacustrine, and riverine wetlands.

Wildlife

WFF lies on the Eastern Shore of the Coastal Plain Province. The facility has an extensive variety of biota. The habitats of the biotic communities include barrier islands, tidal wetlands, and inland areas.

A diversity of plants and animals live in the area. Biologists have documented approximately 32 species of mammals and 18 amphibian species at the Chincoteague National Wildlife Refuge. Approximately 61 species of mammals exist in the general area of WFF and approximately 54 species of amphibians and reptiles. WFF is in the Atlantic Flyway for migratory birds and over 300 species of birds either breed (summer) or winter in the area of WFF, or stop at the facility during migration. In all, approximately 934 plant species exist in the area of WFF. Documented species are on Assateague Island rather than Wallops Main Base or Wallops Island, but the numbers may be expected to be nearly the same due the proximity and similar conditions. No similar documentation has occurred within the WFF. The Site Wide EA for WFF provides lists in the Appendices of the known flora and fauna species in the WFF area.

Threatened and Endangered Species

Table 3-24 shows the State and federally listed threatened or endangered species that may occur in the vicinity of WFF. The only documented federally listed threatened species on WFF are the piping plover and loggerhead sea turtle. Piping plovers have nested at the north and south ends of Wallops Island. The plover nesting area on the north end of the island is approximately 7 km (4 mi) from the launch site. Because no impacts are expected to occur to the plovers on the north end of the island, only information about the plover at the southern end of the island is detailed in Table 3-25.

Table 3-24 Status of Threatened or Endangered Species

Common Name	Scientific Name	Status
Reptiles		
Atlantic green sea turtle	*Chelonia mydas*	Federal Threatened
Green sea turtle	*Chelonia mydas*	Federal Threatened/ State Threatened
Hawksbill sea turtle	*Eretmochelys imbricata*	Federal Threatened
Kemp's Ridley sea turtle	*Lepidochelys kempi*	Federal Threatened
Leatherback sea turtle	*Dermochelys coriaces*	Federal Threatened
Loggerhead sea turtle	*Caretta caretta*	Federal Threatened
Birds		
Bald eagle	*Haliaeetus leucocephalus*	State Threatened
Gull-billed tern	*Sterna nilotica*	State Threatened

Table 3-24. Status of Threatened or Endangered Species (*continued*)

Common Name	Scientific Name	Status
Birds (*continued*)		
Henslow's sparrow	*Ammodramus henslowii*	State Threatened
Loggerhead shrike	*Lanius ludovicianus*	State Threatened
Migrant loggerhead shrike	*Lanius ludovicianus migrans*	State Threatened
Peregrine falcon	*Falco peregrinus*	State Endangered
Piping plover	*Charadrius melodus*	Federal Threatened/ State Threatened
Red knot	*Calidris canutus*	Federal Candidate Species
Upland sandpiper	*Bartramia longicauda*	State Threatened
Wilson's plover	*Charadrius wilsonia*	State Endangered
Marine Mammals		
Fin whale	*Baleanoptera physalus*	Federal Endangered
Humpback whale	*Megaptera novaeangliae*	Federal Endangered
Right whale	*Eubalaena glacialis*	Federal Endangered
Mammals		
Delmarva fox squirrel	*Sciurus niger cinereus*	Federal Endangered/ State Endangered
Rafinesque's eastern bigeared bat	*Corynorhinus rafinesquii macrotis*	State Endangered
Invertebrates		
Northeast beach tiger beetle	*Cicindela dorsalis dorsalis*	Federal Threatened/ State Threatened
Plants		
Seabeach amaranth	*Amaranthus pumilus*	Federal Threatened/ State Threatened

Source: NASA 2009b.

Table 3-25 Record of Piping Plover Pairs and Number of Young Fledged at South WFF from 1986-2009

Year	# Pairs	# Young Fledged	Comments
1986	2	0	
1987	2	3	
1988	0	0	
1989	5	Unknown	
1990	5	Unknown	
1991	3	Unknown	
1992	4	5	1.25 young fledge/pair
1993	3	4	1.33 young fledge/pair
1994	3	2	0.67 young fledge/pair
1995	2	4	2.00 young fledge/pair
1996	3	2	0.67 young fledge/pair
1997	0	0	No nesting
1998	1	0	
1999-2009	0	0	No nesting

Source: NASA 2005a, 2006.

Five federally endangered sea turtle species are transient in the waters off Wallops Island; the Leatherback, Hawksbill, Kemp's Ridley, Loggerhead, and Atlantic green sea turtles, which are known to migrate along east coast beaches. One loggerhead sea turtle nest was discovered on north Wallops Island in summer 2008. NASA coordinates with CNWR and USDA personnel in monitoring the Wallops Island beaches for sea turtle activity. Sea turtle crawl tracks, a sign of potential nesting activity, have historically seldom been found on Wallops Island beaches, but have increased in recent years. The USFWS recorded five nests on Wallops Island between 1974 and 2009, one of which was a loggerhead sea turtle nest on north Wallops Island in the summer of 2008. Following flood inundation from several fall storms, CNWR personnel recovered approximately 170 eggs from the nest in October 2008. None were viable. According to a 2009 biological memorandum (USFWS), staff did not locate any sea turtle crawl tracks or nesting related activity on CNWR or Wallops Island from June to September 2009.

For the 2010 nesting season, NASA recorded four loggerhead sea turtle nests on north Wallops Island within the NASA recreational beach area. All of the nests have had the presence of eggs confirmed. In addition, NASA personnel documented a false crawl in the narrow beach in front of the seawall near the northern extent of the existing seawall, where it appears the turtle returned to sea without nesting due to the absence of a suitable beach (USFWS 2010a). Suitable plover nesting habitat at the southern end of the island was mapped and measured before and after the storms of 1991-1992. There was a 77 percent increase in the amount of nesting habitat available between years. Despite this increase, there was no significant increase in numbers of nesting piping plovers, (see Table 3-25) and their distribution throughout the available habitat remained similar to previous years, suggesting that birds were not available to colonize the newly created habitat. At the present time, the habitat at the southern end of Wallops is becoming less suitable due to encroaching vegetation. Nesting plovers have not been observed on South Wallops Island since 1999.

The Red Knot is a medium-sized shorebird that undertakes an annual 30,000 km (19,000 m) hemispheric migration, from breeding grounds in the high Arctic to wintering grounds in South America. During the 2009 migration season, flock sizes of 100 to 145 birds were observed on Assateague Island. In late May 2009, flocks of 5 to 30 individuals were observed on south Assawoman Island. On May 8, 2009, USFWS observed a flock size of almost 1,300 individuals on north Wallops Island. In late May 2009, flocks of approximately 20 to 200 Red Knots were observed on the beach at North Wallops Island.

Northeastern beach tiger beetles inhabit wide, sandy, ocean beaches from the intertidal zone to the upper beach. Eggs are deposited in the mid- to above-high tide drift zone. Larval beetles occur in a relatively narrow band of the upper intertidal to high drift zone, where they can be regularly inundated by high tides. Eight protected populations exist within the Eastern Shore of Chesapeake Bay, VA, geographic recovery area; however, there are no recorded populations on Wallops Island. The closest documented population is approximately 30 km (20 m) southwest of Wallops Island (USFWS 2009c).

Seabeach amaranth habitat is restricted to sandy ocean beaches and consists of the sparsely vegetated zone between the high tide line and the toe of the primary dune. There have been no

known or recorded occurrences of seabeach amaranth on Wallops Island to date. A single plant was identified by USFWS on the southern end of Assateague Island in 2004.

Sensitive Habitats

According to U.S. Fish and Wildlife Service Biological Opinion that responded to NASA's Biological Assessment on May 10, 2010, critical habitat for the piping plover and sea turtles has been designated.

3.3.4.10 Historical and Cultural Resources

Since 1945, NASA's WFF has launched more than 15,000 rockets from Wallops Island for science studies, technology development, and as targets for the U.S. military.

In 1981, Wallops became a part of the GSFC and was renamed the Wallops Flight Facility. This change brought additional mission responsibilities, including the management of the scientific balloon program.

An inventory of WFF for historical preservation purposes identified 124 buildings and structures fifty years old or older. Of those, only one resource was recommended as eligible for the NRHP: the Wallops Beach Lifeboat Station (Department of Historic Resources [DHR] Survey No. 001-0027-0100; WFF #V-065) and its associated Coast Guard Observation Tower (DHR Survey No. 001-0027-0101; WFF V-070). The consultants recommend the combined property eligible under Criteria A and C. The period of significance begins at the date of construction, 1936; and ends in 1947 when the USCG decommissioned the properties. The consultants also recommend that there is not the potential for a historic district due to a large amount of modern infill construction and a lack of historic integrity for most of the buildings and structures from the period of significance.

The DHR for the Commonwealth of Virginia concurred that the Lifeboat Station with the Observation Tower as a contributing structure appeared to be potentially eligible for listing in the NRHP, and that there did not seem to be justification for a historic district at WFF (VDHR File No. 2003-0571).

3.3.4.11 Environmental Justice

Based upon the 2009 Census of Population and Housing, Accomack County had a population of 38,462 persons. Of this total, 38.1 percent were minority and 6,549 (17.1 percent) were persons below the poverty line as defined by USCB criteria (USCB 2000b). Of this population, 39 percent were estimated to be minority in 2009 and 20.6 percent were estimated to be low-income in 2008 (USCB 2010).

NASA employed 242 permanent, full-time, civil service personnel at WFF in 2007, of which 41 Navy (17 percent were non-Caucasian) and NOAA personnel (75 to 80 personnel) are also working at the facility. At NASA, there are approximately 1,089 employed personnel, including the civil service employees and contractor employees. WFF employs approximately 5 percent of the total work force in Accomack and Northampton Counties, and is the third largest employer in Accomack County.

Employment in Accomack and Northampton Counties fluctuates seasonally, throughout the agricultural and seafood industries. During the months of June to October, the greatest numbers of residents are employed in the civilian labor force. These months also result in the lowest rates of unemployment, usually between 6 and 4 percent, respectively.

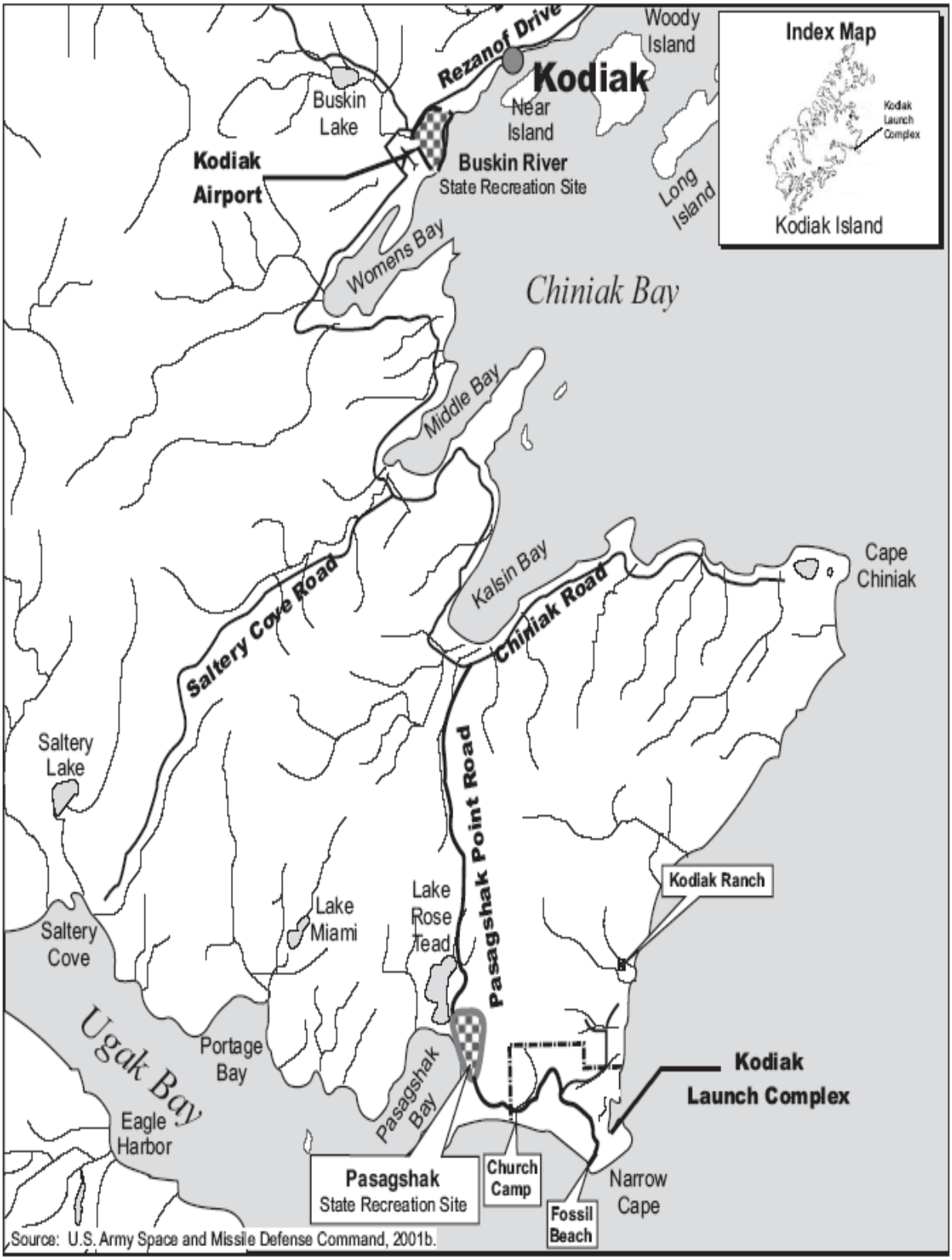
NASA has prepared an Environmental Justice Implementation Plan (EJIP) to comply with EO 12898 (NASA 1996). The EPA's Environmental Justice Coordinators Council has defined minority communities as exceeding a 50 percent minority population.

3.3.5 Kodiak Launch Complex (KLC)

Kodiak Island is situated in the northern Gulf of Alaska, just east of the Alaska Peninsula (see Figure 3–7). It has an area of about 890,000 hectares (2.2 million acres), making it the second-largest island in the United States after the island of Hawaii. Its land use generally consists of KLC, Kodiak Harbor and airport, the City of Kodiak and neighboring USCG Station, Pasagshak State Recreation Site, and the Kodiak National Wildlife Refuge. The remainder of the island is primarily undeveloped and utilized for an extensive number of recreational activities with small locales of residential and business uses.

Approximately 40 km (25 mi) southwest of the City of Kodiak lies Narrow Cape, where KLC is located within the Kodiak Island Borough. KLC sits on a 1,504 hectare (3,717 acre) coastal plateau leased and managed by the Alaska Aerospace Corporation (AAC) from the Alaska Department of Natural Resources, Division of Land through an Interagency Land Management Agreement. Land management plans, expressed by the KLC Master Plan, are intended to improve the efficiency of land use by minimizing conflicts and protecting the human and natural environments. KLC consists of primary facilities and a number of support facilities, which cover approximately 17 hectares (43 acres). Approximately 1 percent of KLC is considered disturbed, leaving the remainder in its natural state. In accordance with the Interagency Land Management Agreement, most undeveloped areas of KLC are made available for ranch animal and wildlife grazing.

The public population of concern consists of people living in the vicinity of KLC, including occupants of Bear Paw Ranch and Burton (Kodiak) Ranch, members of the public who utilize the KLC area for recreation via Pasagshak Point Road (see Figure 3–7), and residents of eastern Kodiak Island, including the City of Kodiak, and the USCG Station (USASMDC 2003). In general the area surrounding KLC is sparsely populated. The rest of the island is largely uninhabited with roughly two thirds of the western side being made up of the Kodiak National Wildlife Refuge. The City of Kodiak and the USCG Station (approximately 13 percent of the population is attributed to the USCG Station personnel), located approximately 48 to 64 km (30 to 40 mi) from KLC, are the only sizable population centers on the island. Additional smaller population centers are located southwest of KLC and include Old Harbor (237) and Akhiok (80). There are also several dozen cabins located along the southeast coast of Kodiak Island that are occupied on a seasonal basis (FAA 1996; USASMDC 2003).



Source: USASMDC 2003.

Figure 3-7 Regional Map of KLC

The population on Kodiak Island is concentrated primarily in Kodiak and in other smaller population centers along the roadway within the northeastern portion of the island. As of the 2010 Census, the population in Kodiak Island Borough was recorded to be 13,346 in 2009. The 2000 Census reports the population in Kodiak City was 6,334 (USCB 2000b, 2009d).

The population on Kodiak Island tends to be transient because of the seasonal nature of the fishing industry, changes in personnel at the USCG Station, and cyclical construction projects.

3.3.5.1 Land Use and Aesthetics/Visual Resources

Land Use

Approximately 174,000 km^2 (43 acres) of land were converted to commercial use from its previous use for grazing. Land use for the rest of the 13-km^2 (3,717-acre) site has remained essentially unchanged. The KLC site is state-owned land and represents less than one-tenth of one percent of the state-owned land area in the Kodiak Island Borough (FAA 1996).

Recreation

The site is closed immediately before and during launch activities but remains open for recreational activities at all other times. Launches present additional recreational opportunities because AAC works with local government and community groups to arrange for viewing sites and bus transportation for interested residents to view launches.

Kodiak Island offers extensive outdoor recreational opportunities that are important to both residents and nonresidents. These include fishing, hunting, hiking, camping, boating, beachcombing, and wildlife and scenic viewing. These activities are also an important source of income for residents who provide related services. Recreation activities occur year-round, peaking during the summer months. These activities take place at specific recreation facilities such as state parks, along the road system that offers access to other locations, and at remote locations such as the Kodiak National Wildlife Refuge, which occupies roughly the southwest half of Kodiak Island, approximately 48 km (30 air-miles) from KLC. Recreational opportunities in the Kodiak Island Borough include 15 designated facilities owned by the Borough, three State parks, and the Federal Kodiak National Wildlife Refuge.

Aesthetics/Visual Resources

Scenic values in the vicinity of KLC at Narrow Cape are high. Natural values dominate, with low, grass-covered mountains that level to flatlands near the shore. The mountains are covered with wildflowers in season, with patches of Sitka spruce, alder and willow. Bedrock beaches border Narrow Cape, and barrier beaches and lagoon systems dominate the eastern shoreline.

With the addition of the Rocket Motor Storage Facility and the former USCG Loran Station, AAC has eight man-made structures at KLC. The six man-made structures and the antenna field of KLC affect the visual resources of Narrow Cape. Due to the flat terrain of the Narrow Cape site, the Launch Service Structure, which is 52 m (170 ft) in height, is visible over most of the cape and from offshore. The structures have been painted a color (steel blue or gray) that blends into the background of the most common viewing angles. The isolation of the site and limited number of viewers further diminish visual impacts.

3.3.5.2 Hazardous Materials and Hazardous Waste Management

Hazardous Materials Management

Hazardous material use, storage, and disposal are managed in adherence with the KLC Safety Policy, the KLC Emergency Response Plan, AAC's HazCom Program, the Kodiak Area Emergency Operation Plan, and applicable state and federal environmental laws, in such a way as to minimize impacts to the environment.

The KLC Ground Safety Officer (GSO) is the point of contact for all matters pertaining to hazardous materials at KLC and is to be notified before the arrival of any hazardous materials. All contractors must provide hazardous materials information (in the form of MSDS), label and warning signs, and a plan indicating material handling/storage procedures, spill/release prevention measures, and emergency response protocol, including cleanup and disposal procedures and first aid/medical treatment procedures (USASMDC 2003).

Hazardous Waste Management

Alaska Aerospace Corporation is authorized to operate KLC as a Conditionally Exempt Small Quantity Generator (GESQG) regulated by 40 CFR 262 (USEPA Standards Applicable to Generation of Hazardous Wastes). With this designation, KLC can produce no more than 100 kg (220 lb) of hazardous waste per month.

These waste are handled and disposed of in accordance with AAC's HazCom Program, KLC Safety Policy, and applicable state and federal environmental laws. Pollution prevention, waste minimization and recycling procedures are indicated in the KLC Spill Prevention Control and Countermeasures (SPCC) Plan, and Emergency Response Plan.

There are no Installation Restoration Program issues associated with KLC, since it is not a DoD installation. No National Priorities List (NPL) site is listed for Kodiak Island in the EPA's CERCLA Information System database.

Pollution Prevention

Pollution prevention, waste minimization and recycling procedures are indicated in the KLC SPCC Plan, Emergency Response Plan and Contamination Control Procedures.

3.3.5.3 Health and Safety

Regional Safety

The Local Emergency Planning Committee is a committee appointed by the Alaska State Emergency Response Commission to perform local emergency planning and community right-to-know activities. The Kodiak Area Emergency Operation Plan is a four-volume plan, assembled in part by the Division of Emergency Services, Alaska Department of Military and Veterans Affairs, to direct preparation for, response to, mitigation of, and recovery from natural and man-caused disaster emergencies within the Kodiak Island Borough, including KLC. The Plan is activated when a disaster emergency significantly threatens human health, property, or the environment. The Chief of the Kodiak Area Fire and Rescue Department is

the Kodiak Emergency Services Coordinator. The KLC maintains a site-specific General Compliance Plan for the Emergency Planning and Community Right to Know Act (EPCRA). The plan is used to guide KLC staff in chemical reporting procedures and coordination with the Local Emergency Planning Committee.

The City of Kodiak Fire and Rescue Department has three firefighters/emergency medical technicians under the supervision of a lieutenant and two chiefs on duty at all times. During emergencies, on-line firefighters are supported by 15 to 20 volunteer firefighters with various levels of emergency medical technician training. The Kodiak Fire Department does not provide general/routine firefighting service for AAC/KLC, but would respond to wildland fires at AAC/KLC by agreement with the Alaska Department of Natural Resources, Division of Forestry. KLC is equipped with an up-to-date infirmary and ambulance, which is staffed as needed by Emergency Medical Technician IIIs, or a physician, depending on customer needs; back up medivac services are provided by the USCG through a cooperative agreement between AAC and USCG. The Kodiak Fire Marshal provides fire cause investigation and other fire prevention services for AAC/KLC and also works with the USCG Marine Safety Detachment in the planning and oversight for rocket component off loading (USASMDC 2003).

The City of Kodiak Fire and Police Departments provide as-needed support for closure and security of the KLC and Kodiak Island road system during rocket transport and launch. Support for transportation of rocket components, including closure and security of KLC and the Kodiak Island road system, is mostly provided by the USCG and Alaska State Troopers.

KLC has a fire truck and a 946-liter (250-gal) pumper mounted on a 0.9-mt (1-ton) truck to fight any brush fires that may occur during a launch. The KLC water system includes a 150,000-gallon storage tank that can be used to supply fire-fighting operations. The KLC also has an ambulance to transport any injured patients. During missions, Emergency Medical Technicians are present at the KLC with the oversight of Northwest Medical. During launch day operations a doctor is in attendance at the KLC.

On-base Safety

The KLC Safety Policy mandates the establishment of launch safety levels that meet or exceed those of the RCC Common Risk Criteria for National Test Ranges and Standard 321-02 (RCC 321-02), AFSCMAN 2004, FAA Notice of Proposed Rulemaking (FAA NPRM). In accordance with the KLC Safety Policy, the criteria per year of Range operations for public casualty is limited to 1 in 1 million, and the casualty criteria for personnel involved in the launch is limited to 1 in 300,000.

Standard Range Safety procedures at KLC are conducted in accordance with RCC 321-07, AFSCMAN 2004, FAA NPRM, etc. These procedures provide for ground safety, flight safety, range clearance and surveillance, sea-surface area clearance and surveillance, and commercial air traffic control. KLC works with state and federal agencies to publish NOTAMS and NOTMARS, coordinates security closures of lands and waters around KLC with the USCG, FAA, and the Alaska Department of Transportation and Public Facilities, and announces imminent launches on local radio as well as in the newspaper.

The AAC range organization assures that all aspects of safety are covered, including transport of rocket components (e.g., solid propellant boosters), handling of the booster and rocket (pre-loaded fuel and oxidizer tanks) once they arrive at KLC, operations at the launch site, flight safety, and radio frequency interference. The KLC range organization is responsible for assuring that the rockets, under any flight condition, will not endanger any life or property. The launch vehicle operator and/or payload operator submits a Ground Safety Plan to AAC for review and approval before launch operations.

During launch preparation, ground safety at KLC is the responsibility of AAC. Hazardous operations will be performed in compliance with mission-specific operating procedures that will provide the requirements and direction for the activities at KLC, including explosives handling safety, hazardous operations control, explosives storage, launch pad operations and launch.

Safe operating procedures are followed in accordance with DoD Standard 6055.9. A hazard potential is present during prelaunch transport, prelaunch processing, and launch of rockets due to the significant amounts of propellant contained in the boosters. The exposure to launch mishaps is greatest within the early portions of the flight after launch. Measures are currently in place to limit the number of personnel involved in the launch operations and to ensure that hazardous operations are performed by highly skilled personnel. Regulations and practices that have been established to minimize or eliminate potential health and safety risks to the general public include, but are not limited to, OSHA and DOT regulations and USAF procedures for transporting hazardous materials, DoD procedures for handling explosives, and the DoD Range Safety program for the processing and launch of rockets (USASMDC 2003).

Using standard explosive safety rules, AAC would determine areas that would be evacuated for each launch to assure that the public is not exposed to unacceptable levels of risk, that physical security and safety measures can be enforced, and that adverse environmental effects are minimized. The size of the evacuation area is based upon the potential for variability of the impact due to influences of local weather conditions, and small variances in the rocket guidance and engineering systems.

To ensure public safety during launch days, KLC security personnel would close Pasagshak Point Road at the site boundary (the only road access to KLC) and ensure that no unauthorized personnel enter the Ground Hazard Area. The safety zone is under constant surveillance during the day of launch and during any hazardous operations. If the safety zone is compromised, the launch is delayed until the area is confirmed clear. Prelaunch notifications to aviators and mariners are issued 24 hours before launches.

Each launch at KLC has an established flight termination line. These lines are established to minimize potential adverse impacts on populated areas. In addition, procedures call for various contingency plans to be in effect.

Previous launches have had no effect related to either public health and safety or Range Safety issues.

3.3.5.4 Geology and Soils

Narrow Cape is underlain by folded, faulted, thickly bedded to massive course clastic sedimentary rocks of the Sitkalidak and Narrow Cape formations. Lithologies include siltstone, fine and medium lithic sandstone, pebbly sandstone and conglomerate. The formations are thickly bedded to massive and in many places contain large concretions up to 2 m (7 ft) in diameter. Weathered bedrock has a field textural classification of sand with traces of some silt, grading to highly weathered bedrock with a textural classification of sand with trace silt and gravel, with particles of sandstone core stones making up the gravel fraction. The thickness of the completely weathered bedrock is about 0.3 to 2 m (1 to 7 ft), with the thicker weathered zones occurring in topographically low areas.

Kodiak Island is located on the upper plate of the Aleutian subduction zone, the convergent boundary between the Pacific and North American plates. The Aleutian Megathrust Zone (the line of contact between the two plates) is the greatest source of seismicity in Southcentral Alaska and has produced three of the world's six largest magnitude earthquakes of the last 100 years, including the great (moment magnitude[7] [M_w] 9.2) 1964 "Good Friday" or Great Alaska earthquake. In addition to the megathrust, the subduction zone also includes several other active fault systems. Numerous faults with high levels of historical activity are contained at depth and within the subducting Pacific plate. Since 1999, in the Kodiak Island region these "slab" earthquakes include several in the magnitude range of 6.5 to 7+. A second system of active faults is present in the upper plate (North American plate) of the subduction zone. These faults comprise a wide fold and thrust belt that extends along the eastern side of Kodiak Island and continues to the northeast into the Prince William Sound region. These faults also produce frequent earthquakes. During the 1964 "Good Friday" earthquake, two of the fold and thrust belt faults produced large surface displacements on Montague Island in Prince William Sound and others probably also ruptured the sea floor offshore of Kodiak, contributing to the generation of the destructive tsunami's (seismic sea waves).

In addition to the Aleutian Megathrust Zone (and the subducting Pacific Plate), there are several significant fault sources in the Kodiak region that could generate large earthquakes. In 2002, the USCG Civil Engineering Unit identified four active faults or zones of faults capable of generating large magnitude earthquakes at Narrow Cape. These include the Albatross Bank fault zone, the Kodiak Shelf fault zone, the Narrow Cape fault and the Kodiak Island fault. Each of these faults includes several individual faults or fault segments that are seismogenic; however, the characteristics of the earthquake sources are poorly known. In support of probabilistic and deterministic seismic hazard evaluations for the USCG Loran Station, a table characterizing the seismic sources for Narrow Cape was prepared, including maximum earthquake magnitude and recurrence interval estimates. Based on the source models selected for the probabilistic seismic hazard analysis, the potential maximum magnitude (Mmax) events (judged to generate the largest ground motions at the site) were a M7.5–8.0 on the Narrow Cape fault zone and M8.5 on the Kodiak Interplate Subduction Segment.

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7 The moment magnitude scale was introduced in 1979 by Thomas C. Hanks and Hiroo Kanamori as a successor to the Richter scale and is used by seismologists to compare the energy released by earthquakes. The symbol for the moment magnitude scale is Mw, with the subscript w meaning mechanical work accomplished. The United States Geological Survey does not use this scale for earthquakes with a magnitude of less than 3.5.

The Narrow Cape fault also poses a surface rupture potential at KLC. The USGS mapped the Narrow Cape fault off-shore for a proposed off-shore oil lease. The USGS concluded that the fault was active and provisional maps projected the main trace and several subsidiary branches on-shore at Narrow Cape within a 6-km (3.7-mi) zone. The main trace is about 2 km (1.2 mi) west of the Loran site and one of the subsidiary branches was demonstrated to traverse the Loran site. Paleoseismic investigations concluded that the scarps were tectonic in origin and that there may have been three to four episodes of Holocene displacement on each of three trenched branch faults of the Narrow Cape fault. Topographic scarps, offset drainages, and other geomorphic evidence of youthful deformation to the marine terrace were also mapped at Narrow Cape. Detailed fault studies have not been performed for the entire KLC site.

Great earthquakes generated in the Gulf of Alaska often generate tsunamis. In southern Alaska, 37 significant historical earthquakes of M7.0 or greater have generated evidence of 14 tsunamis. The tsunami resulting from the 1964 earthquake was reported by a Narrow Cape rancher to have inundated low-lying areas along the eastern shore. KLC facilities are located above the 30-m (100-ft) elevation above sea level recommended by the City of Kodiak for safe refuge from flooding due to tsunamis.

There are no active volcanoes on Kodiak Island. KLC can be subject to ash falls from active volcanoes in the Aleutian chain. Over 40 volcanoes are active in the Aleutian arc, generating 256 eruptions over recorded history. Such eruptions could cause nuisance ash falls at the site, create a significant hazard to various types of equipment and electronics, or possibly create atmospheric conditions that would temporarily delay air transport or flight tests.

3.3.5.5 Water Resources

Potentially affected water resources include freshwater surface and groundwater resources and marine waters near KLC. Potential changes in the availability of water supplies as a result of project water use requirements also are addressed below. As required by EO 11988, Floodplain Management, potential effects to floodplains were considered; however, none of the facilities that would be used during payload processing and launch are constructed in a floodplain.

<u>Ground and Surface Water</u>

Kodiak Island has a marine climate with many natural streams, lakes, and lagoons. Precipitation is common and typically occurs in all months of the year; average precipitation was reported in the 1995 Environmental Baseline of Narrow Cape as 188.57 cm (74.24 in) per year. Streams near KLC are relatively short (generally less than 3.2 km [2 mi] in length) and steep, and they have an average discharge of less than 1.3 m^3 (46 ft^3) per second. The major lakes in the area are West and East Twin Lakes, which are shallow, freshwater lakes, while Triple Lakes and Barry Lagoon are saltwater-influenced lagoons. While some water-bearing zones have been found in underlying bedrock, most of the groundwater in the coastal area near KLC is in an unconfined aquifer composed of sand and gravel. Information concerning potential groundwater yields is not available (USASMDC 2003).

Water Quality

Water quality is generally good, and water quality sampling has shown that water quality in the vicinity of KLC is within historical ranges for Kodiak Island as a whole. Water quality samples were taken during 1994, and an analysis of surface water collected at East Twin Lake and Triple Lakes showed that none of the following contaminants were present: volatile organic compounds, pesticides, herbicides, PCBs, nitrates or nitrites, gross alpha radioactivity, total cyanide, and most metals of concern.

However, two metallic elements were found: cadmium and beryllium. Cadmium was found in both East Twin Lake and Triple Lakes at a concentration of 0.1 microgram/liter (mg/l) (0.006 pound/cubic foot [lb/ft^3]), and beryllium was detected in Triple Lakes at a concentration of 0.054 lb/ft^3 (0.9 mg/l) (USASMDC 2003). These levels of cadmium and beryllium are both below the EPA's national water quality criteria for the protection of aquatic organisms (the standards are 0.25 and 5.3 mg/l (0.156 and 0.33 lb/ft^3), respectively). The cadmium concentrations were both well below the 5.0 mg/l (0.3 lb/ft^3) maximum contaminant levels allowed by the EPA and the State of Alaska's drinking water regulations (FAA 1996). In the absence of any human-related sources, it is assumed the cadmium and beryllium are from natural sources. The sampling also found coliform bacteria levels in East Twin Lake and Triple Lakes that exceed the "no detect" criteria of the State of Alaska drinking water regulations; therefore, drinking water would require some treatment before it could be used. The likely sources of the bacteria are the bison, cattle, and horses that are raised on the nearby ranch.

KLC is in a fairly remote area, with other nearby water uses limited to a ranch and a local business. The town of Kodiak has its own water supply and treatment system and is located approximately 40 km (25 mi) to the north. Though the City of Kodiak is the supplier of water services in and around the city, outlying residents rely on private wells, as does KLC, which maintains water supply wells on KLC property.

The KLC operates a single, site-wide public water system, which is currently supplied by the well at the Maintenance Storage Facility (MSF). The public water system also has the capability to be run off of the existing well at the Launch Control Center, though that well is kept in a stand-by status during normal operations. It can be placed rapidly into use to support peak demand or in the case of a fault in the MSF system.

The well that was formerly used to supply the Payload Processing Facility and Integration Processing Facility has been abandoned, and is slated to be decommissioned and removed. Those two facilities are now run off of the site-wide public water system. The recently constructed Rocket Motor Storage Facility has no potable drinking water or sanitation facilities, but it is also connected to the public water system for fire suppression and heating needs. Each installation (Payload Processing Facility, Launch Control Center, etc) –with the exception of the Rocket Motor Storage Facility – treats its incoming water using a packaged domestic water treatment system that provides bag filtration, disinfection by chlorination, and corrosion control by ortho-polyphosphate solution. The fire storage tank near the Payload Processing Facility is supplied by the public water system.

The source of water for the public water system is classified as groundwater not under the influence of surface water. AAC has secured its right to use of the groundwater with a Certificate of Appropriation from the State of Alaska Department of Natural Resources. AAC is entitled to use 1,270,486 liters (1.03 acre-feet) per year of groundwater.

Water system demand for the Launch Control Center, Payload Processing Facility, and Integration and Processing Facility during a mission has been estimated at 50 percent of the available design capacity of 13,060 liters (3,450 gal) per day. During non-mission status the demand has been estimated at 5 percent of this available capacity.

Coastal Zone Management

The KLC is located in the "zone of direct influence" of the coastal environment (USASMDC 2003). All federal development projects in a coastal zone and all federal activities, which could directly affect a coastal zone, must be reviewed to determine their consistency with the local Coastal Zone Management Plan. The initial development of KLC, as examined in the Environmental Assessment of the Kodiak Launch Complex (FAA 1996), was reviewed and received a positive determination that the activities were consistent with the state and local standards and policies. Additional actions involving the development of KLC and the launch of missiles and rockets have also undergone Coastal Consistency Determinations, resulting in positive determinations that the activities are consistent with the state and local standards and policies.

Perchlorate Deposition

The ground-based interceptors, target missiles, and rockets launched from KLC would disperse certain exhaust emission products over a large area. The primary emission products of concern from a water quality-standpoint are hydrogen chloride and aluminum oxide. These emissions are not expected to cause a significant water quality impact. Environmental monitoring was required as part of the KLC launch site operator license launch-specific environmental monitoring of surface water quality and marine mammal distribution/behavior has been conducted for each launch from the KLC. As summarized in Summary Findings of KLC Environmental Monitoring Studies 1998-2001, and as presented in each launch environmental monitoring report since 2001, water quality data gathered during previous launch campaigns indicates that launches from the KLC have no measurable impact on local surface water quality. Water quality was sampled before and after KLC launches, including pH level, total aluminum, alkalinity, and perchlorate concentration (EPA method 314.0 for water).

3.3.5.6 Air Quality

Alaska Regulatory Framework

Air quality for Kodiak Island is regulated under the Alaska Department of Environmental Conservation (ADEC). The air quality at Narrow Cape can be generally classified as unimpaired. Ranching, occasional vehicular traffic, and the occasional operation of two standby generators at the USCG Loran Station are the only human activities within the vicinity of Narrow Cape that would affect background air quality. Wind-blown volcanic dust is the primary air contaminant on the Island (FAA 1996).

The ADEC Division of Air and Water Quality does not maintain air monitoring activities on the island due to minimal industrial activity and overall good air quality in the area.

Meteorology

The climate of Kodiak is characterized as maritime, including short, cool summers and long mild winters. Winter weather tends to last from November to March, with an average daily temperature of -1°C (30°F). Average wind speeds reach 19 km (12 mi) per hour during these winter months. The months of September and October are considered fall, with temperatures between 4°C and 10°C (40°F and 50°F) and winds averaging 16 km (10 mi) per hour. The summer months, June to August, are characterized by average daily highs of 15.6°C (60°F). April and May are regarded as spring months, in which the average monthly temperatures are from 1°C to about 4°C (34°F to about 40°F), and the windspeeds are approximately 19 km (12 mi) per hour.

Surface winds along the coast are much stronger and more persistent than at inland areas. While winds tend to be from the northwest at about 19 km (12 mi) per hour, high winds occur throughout the year. Peak gusts range from 56 km (35 mi) per hour in June to 134 km (83 mi) per hour in December. Typically, 1 day of heavy fog occurs per month, with visibility of 0.4 km (0.25 mi) or less. During July, fog averages 3 days per month (FAA 1996). The largest monthly snowfall occurs during December and January, with the maximum snowfalls ranging from 100 to 110 cm (40 to 45 in) per month.

Regional Air Quality

Kodiak Island is classified as a Class II attainment area. It is part of a larger area that is in attainment with the NAAQS. The island's climatology includes periods of high winds and overcast skies, which make the island's atmosphere optimal for dispersion of air pollutants. The atmosphere is classified as neutral (D stability) for this dispersion capability (USASMDC 2003).

Air Emissions

Wind-blown volcanic dust is the primary air contaminant on the island. Human activities in the vicinity of KLC that would affect background air quality are ranching, occasional vehicular traffic, the occasional operation of two standby generators at the USCG Loran-C Station, and the periodic use of KLC for vehicle launches. Backup power at KLC is provided by diesel-driven standby generators located at the Launch Control Center, Payload Processing Facility, and Integration and Processing Facility. All generators at the complex have block heaters and are contained in heated enclosures. Gas particulate air emissions from launch operations at KLC include the rocket-motor exhaust plume emitted during launch and diesel generator emission. Table 3-26 lists the estimated emissions generated by the four standby generators at KLC.

Table 3-26 Existing Generator Emissions at KLC

Emissions (240 hours/year)			
Oxides of Nitrogen metric tons (tons)/year	**Hydrogen Chloride metric tons (tons)/year**	**Carbon Monoxide metric tons (tons)/year**	**PM-10 metric tons (tons)/year**
12.7 (14)	0.37 (0.41)	3.46 (3.81)	0.14 (0.15)

Source: USASMDC 2003, Pendergast 2006

Analyses on generator and transportation emissions conducted at KLC showed that emissions associated with the use of the facility and associated equipment for launches would be below the 90.7-mt (100-ton) per year criteria pollutant Federal de minimis levels that apply to a non-attainment area.

Table 3-27 lists the estimated concentration of the principal pollutants in the exhaust products from the Athena-2 (an inactive Lockheed Martin launch vehicle) as presented in the KLC EA (FAA 1996). The Athena-2 was selected because it represented the largest class of solid rocket booster that could be flown from KLC, and although it is not currently available, information on its effluent concentrations is used to bind the case for all vehicles launched from KLC.

Table 3-27 Estimated Rocket Launch Pollutant Emission Concentrations from Athena-2 at KLC

Pollutant	U.S. Air Force Standard for Noncriteria Pollutant Guidance Level	Athena-2[a] Launch
Aluminum Oxide	150 $\mu g/m^3$	146 $\mu g/m^3$
Hydrogen Chloride	10 ppm	8 ppm

a. Castor 120 motor.

Key: $\mu g/m^3$=micrograms per cubic meter, ppm=parts per million.

Source: FAA 1996.

Under worst-case meteorological conditions, which are estimated to occur 2 percent of the time, the maximum downwind concentrations of hydrogen chloride and aluminum oxide would occur at an uninhabited 610-m (2,000-ft) high mountain peak and would be within the applicable air quality standards (FAA 1996). USAF Standards are appropriate since the ceiling limit set by OSHA is for stationary sources (such as inside an industrial plant). However, launches are classified as mobile sources and their emissions are temporary. The standard is based on measured and estimated launch emission exposure concentrations and durations in the event of normal and catastrophic launches (NRC 1998).

3.3.5.7 Noise

Baseline studies of noise levels in the Narrow Cape area have not been conducted; however, KLC is remote from typical man-made sources of noise. Based on the land use of the Narrow Cape area, the most common man-made noise is from occasional traffic on the road from the City of Kodiak to Narrow Cape, from nearby off-road recreational vehicles, intermittently, from standby generators at the nearby USCG Loran Station, and occasional rocket launches.

Critical human receptors for noise from proposed KLC construction and operation are located at the nearest residence (Kodiak Ranch; 3 km [2 mi]), the nearest business (Church Camp; 5 km [3 mi]), and the nearest public facility (Pasagshak State Recreation Area; 10 km [6 mi]).

Critical wildlife receptors are located at the shoreline around Narrow Cape and Ugak Island. It is estimated that launch noise on the eastern shore of Narrow Cape could exceed 110 dBA, while the noise at the northern shoreline of Ugak Island, approximately 5.6 km (3.5 mi) downrange, and could exceed 90 dBA. Recorded noise levels at Ugak Island are shown in Table 3-28. Sonic booms from vehicles are expected to be most intense 34 to 56 km (21 to 35 mi) down range, over open ocean, and should have no effect on marine mammals (FAA 1996).

Table 3-28 Recorded Noise Levels at Ugak Island during Previous Rocket Launches

	Rockets Launched			
Noise Metric (dBA)	**ait-1**	**ait-2**	**QRLV**	**Athena-II**
Lmax[a]	78.2	81.5	73.3	90.8

a. Recorded at Ugak Island (5.6 km [3.5 mi]) away from KLC.

Key: ait=*atmospheric interceptor technology*; dBA=A-weighted decibels; Lmax=Maximum Sound Level; QRLV=Quick Reaction Launch Vehicle.

Source: USASMDC 2003.

Due to the short duration of launches, an A-weighted scale is used and dBA measurements are employed to adequately characterize the operational noise.

Maximum Sound Level (Lmax) is applied to compare noise levels because of its ability to cover the entire sound spectrum, especially sounds audible to humans. Sensitive human receptors from activities at KLC are located at Kodiak Ranch (the nearest residence), a distance of 3 km (2 mi); Church Camp (the nearest business), a distance of 5 km (3 mi); and Pasagshak State Recreation Area (the nearest public facility), a distance of 10 km (6 mi) (USASMDC 2003).

Wildlife receptors are located at the shoreline around Narrow Cape and Ugak Island at or near the water surface. The following section, Section 3.3.5.8, Biological Resources, describes wildlife found at KLC.

3.3.5.8 Biological Resources

Vegetation

The predominant vegetation types covering KLC include hairgrass-mixed forb (broad leaved herbs) and open willow-hairgrass-mixed forb meadow, shrublands, wetlands, and intermittent stands of spruce. Some of the most common plants are hairgrass, meadow fescue, alder, willow, and Sitka spruce. The vegetation community structure of the Narrow Cape region has been affected by grazing from farmed cattle, bison, and horses.

Wildlife

Over 140 species of bird are known to, or likely may utilize habitat annually within or near the KLC site. Examples of the characteristic and most common resident and breeding birds at Narrow Cape include Gadwall, Mallard, Bald Eagle, Black-billed Magpie, Northwestern Crow, Common Raven, Black-capped Chickadee, Winter Wren, Golden-crowned Kinglet, Varied Thrush, Savannah Sparrow, Fox Sparrow, Golden-crowned Sparrow, Pine Grosbeak, Common

Redpoll, and Pine Siskin. Characteristic seabirds most commonly found annually in the rich near-shore marine waters adjacent to the KLC include King Eider, Harlequin Duck, White-winged Scoter, Black Scoter, Long-tailed Duck, Red-breasted Merganser, Common Loon, Pelagic Cormorant, Black-legged Kittiwake, Mew Gull, Glaucous-winged Gull, Common Murre, and Pigeon Guillemot.

The seabird colony closest to the KLC site, believed to be an Arctic and Aleutian tern colony, is approximately 3 to 5 km (2 to 3 mi) north of the launch pad. This colony was not active during a 1994 survey, and has not been active since (USASMDC 2003). Ugak Pass is attractive to marine birds year-round due to its shallow waters and abundant fish and invertebrates.

The bald eagle, which is protected by the Bald and Golden Eagle Protection Act, and the Migratory Treaty Act, is common throughout the year on Kodiak Island and is often seen in the Narrow Cape area. Aerial surveys were conducted in the spring of 1999, 2000, and 2001 to document bald eagle nesting activities at KLC. One active nest was observed at Narrow Cape and one at Lone Point, 8 km (5 mi) north of Narrow Cape. Nine bald eagles were observed in 2000, with the same two nests appearing active. Twelve bald eagles were observed in 2002, with indications of possibly three active nests (Narrow Cape and Lone Point, and Bird Point, which is approximately 3 km [2 mi] north of Narrow Cape).

Little brown bat, tundra vole, red fox, brown bear, short-tailed weasel, and river otter are common terrestrial mammals found at KLC. Snowshoe hare, red squirrel, muskrat, beaver, Sitka blacktailed deer, buffalo, and mountain goat are examples of species introduced to Kodiak Island. Horses, cattle, and bison graze nearby under lease to a local ranch. A 2-m (7-ft) chain link fence surrounds each of the structures at KLC to prevent animals from wandering onto the launch complex.

The fence and nearby steep topography keep grazing animals away from the launch pad. The nearest game trail passes approximately 76 m (250 ft) south of the launch pad location.

The harbor seal is a year-round resident of the area. Several haul out and general use areas occur near KLC, the closest of which is Ugak Island, approximately 5 km (3 mi) southeast. The northern fur seal occurs offshore of the KLC site from January through April. A number of cetacean species, including Dall's and harbor porpoise, as well as killer whales, are found year-round in the water surrounding Kodiak Island. Pacific white-sided dolphin may occur occasionally. Risso's dolphins are rare as far north as Kodiak. The migratory path of the recently delisted gray whale includes the eastern near shore edge of Kodiak Island. The greatest number of gray whales in this area occurs during April, May, November, and December.

Threatened and Endangered Species

No federally proposed or listed candidate, threatened, or endangered plant species have been observed within the boundaries of KLC. However, several species of the threatened or endangered marine mammals occur within a 9.7-km (6-mi) radius of launch pad 1, including Ugak Island and Narrow Cape, as well as marine waters in the area (see Table 3-29). The Steller sea lion (*Eumetopias jubatus*) western distinct population segment near Kodiak Island

was included in the population classified as endangered in 1997. Ugak Island, approximately 5 km (3 mi) southeast of KLC, contains the closest sea lion haulout. No Steller sea lion rookeries have been identified within this radius. Although seven whale species are found in the waters near Kodiak Island, only the delisted gray whale and the endangered humpback whale (*Megaptera novaeangliae*) use the nearshore waters of Kodiak Island. Humpback whales are generally found in the nearshore areas of Kodiak Island in the summer. They have been occasionally observed in the Narrow Cape and Ugak Island area. The sea otter is found along most of Kodiak Island's coast in all months of the year.

Table 3-29 Threatened and Endangered Species Within a 9.7-km (6-mile) radius of Kodiak Launch Pad-1

Common Name	Scientific Name	Federal Status	State Status
Birds			
Short-tailed albatross	*Phoebastria albatrus*	E	E
Steller's eider	*Polysticta stelleri*	T	SSC
Mammals			
Blue whale	*Balaenoptera musculus*	E	E
Fin whale	*Balaenoptera physalus*	E	NL
Humpback whale	*Megaptera novaeangliae*	E	E
Northern right whale	*Balaena glacialis*	E	E
Sei whale	*Balaenoptera borealis*	E	NL
Sperm whale	*Physeter macrocephalus*	E	NL
Steller sea lion	*Eumetopias jubatus*	E	SSC
Sea Otter	*Enhydra Lutris*	E	

Key: E=Endangered; NL=Not Listed; SSC=State Species of Special Concern; T=Threatened.
Source: USASMDC 2003.

Most of the world's Steller's eiders (*Polysticta stelleri*) winter along the Alaskan Peninsula, an area that includes Kodiak Island, and through the Aleutian Islands. Most of the world's Steller's eiders nest in northeastern Siberia with a small portion (less than 5 percent) nesting in Alaska. The USFWS has classified this Alaska nesting population as threatened. The Steller's eiders occur in the Kodiak Island area primarily during the winter months. Rafts of Steller's eiders were primarily observed offshore of North and South Lagoons and offshore of Pasagshak Bay during surveys conducted in 1997 and 1998.

The federally and state endangered short-tailed albatross (*Phoebastria albatrus*) could occur in the 9.7-km (6-mi) radius around LP-1 primarily during the summer months. The short-tailed albatross is a very large seabird with narrow 2-m-long (7-ft-long) wings. Adults also spend the summer non-breeding season at sea, feeding on squid, fish, or other organisms. Most summer sightings are in the Aleutian Islands, Bering Sea, and Gulf of Alaska. The world population, which is increasing, is estimated to be 2,200.

Sensitive Habitats

Approximately 12 percent of the KLC site is occupied by open water, including small streams, two freshwater lakes, and a series of lagoons. Two of the streams have been incorporated into the Alaska Department of Fish and Game's anadromous stream catalog (fish, such as salmon,

live in the sea mostly, and breed in fresh water) since coho salmon juveniles were detected there. The waters south of Kodiak Island, including the Narrow Cape vicinity, are essential habitat for commercially important fish species year-round. Habitat areas of particular concern include all streams, lakes, and other freshwater areas used by salmon and other anadromous fish. The closest major salmon stream to KLC is the Pasagshak River, which is approximately 10 km (6 mi) to the northwest. Alternate barge landing sites 1, 2, and 3 are close to small order anadromous fish streams, which support pink salmon and are listed in the Alaska Department of Fish and Game's "Anadromous Fish Stream Catalogue." The most common marine fish in nearshore and offshore water around Kodiak Island are flounder, sole, pollock, skate, cods, and halibut. Other common marine organisms include crabs, scallops, octopus, shrimp, and clams.

Wetlands

Wetlands in Alaska are defined by the U.S. Army Corps of Engineers as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." The U.S. Army Corps of Engineers Alaska District and the EPA regulate wetlands through the CWA Section 404 Permitting Program. Wetlands cover approximately 29 percent of the KLC site. Palustrine, emergent, persistent, seasonally flooded and palustrine scrub/shrub, broad-leaved deciduous, saturated wetlands are located within the KLC.

Critical Habitat

In surveys around Kodiak and southern Afognak Islands, Steller's eiders were reported to be present, and hundreds to low thousands are counted during the Christmas Bird Count in Kodiak. Consistent and extensive use of the Kodiak area by the Steller's eider has been observed. Although critical habitat has not been designated in the Kodiak Archipelago, the area still contains important habitat for Steller's eiders and protection afforded by the Endangered Species Act still applies.

Critical habitat for the Steller sea lion includes a special aquatic foraging area in the Shelikof Strait area consisting in part of an area between the Alaskan Peninsula and Kodiak Island (50 CFR 226.202, Critical Habitat for Steller Sea Lions). This area is along the western side of Kodiak Island and outside the 9.7-km (6-mi) radius of interest.

3.3.5.9 Historical and Cultural Resources

The primary native population of Kodiak is a group of Alaska Native people known as the Alutiiqs. Some archaeologists believe that the Alutiiq people have occupied the Kodiak region for at least 7,000 years. Several distinct cultural traditions have been identified in the Kodiak Island region, including the Ocean Bay (ca. 4500–1400 BC), the Kachemak (ca. 1400 BC-1200 AD), the Koniag (ca. 1200–1784 AD), and the Chugach, who were present when the first Europeans arrived.

The Koniags and Chugach lived in permanent sod houses in the winter and set up temporary fish camps in the summer. They hunted whales, seals, sea lions, and sea otters with harpoons and clubs. Salmon was also a major dietary staple of all the Alutiiqs.

The first recorded contact with the Kodiak natives occurred in 1763 by the Russian Stephen Glotov and in 1792 by the Russian fur trapper Alexander Baranov. The Russians continued to explore the area primarily to search for sea otter. As the Russians began to settle the area, Kodiak became the first capital of Russian Alaska. As the area was settled, the sea otter population fell to near extinction and the Kodiak natives' culture significantly declined. By 1867, Alaska had become a U.S. territory. In 1882, the opening of a fish cannery produced the development of commercial fishing in the area. In 1940, the Town of Kodiak was established.

Kodiak Island was used extensively by the U.S. Army and the U.S. Navy during World War II, and the population of the island rose to more than 25,000. The U.S. Navy constructed a submarine base and an air station while the U.S. Army constructed an outpost near the Buskin River.

Previous archaeological surveys have indicated that cultural resources are not present in upland areas occupied by KLC. However, records have indicated the presence of cultural resources near two of the barge landing sites Koniag house pits and refuse have been identified near Barge Landing Site 1 – Narrow Cape Vicinity, and Koniag house pits and shell midden have been found near Site 3 – Pasagshak Bay Area.

Paleontological resources on the upland areas of KLC are generally found in the Narrow Cape formation, which is located below the surface soils. These resources include shallow-water marine invertebrates of Oligocene and Miocene age.

In 1994, the Alaska State Office of History and Archaeology performed an archaeological survey in and around the KLC site. The study focused primarily on areas near the following facilities: the Integration and Processing Facility, Launch Pad-1 (LP-1), the Missile Assembly Building, the GBI silos, the Payload Process Facility, the Oxidizer Storage, and the Launch Control Center. There was no evidence of cultural resources recorded during this survey. However, there are two archaeological sites and a World War II bunker complex within approximately 1.6 km (1 mi) of KLC.

3.3.5.10 Environmental Justice

Based on the characteristics of the proposed action, the potentially affected community is the entire Kodiak Island Borough. Census 2000 data show the borough population of approximately 15,000 as 30.2 percent minority (non-white) and Kodiak City as 36.7 percent minority. Approximately 57 percent of the borough's total minority population resides in Kodiak City. The Kodiak Island Borough is estimated to have 13,346 people in 2009, of which 44.9 percent are minority, and 7.5 percent are estimated to be under the poverty level. There are six traditional villages on the island (Akhiok, Karluk, Larsen Bay, Old Harbor, Ouzinkie, and Port Lions), considered minority communities under the Executive Order. The population of these villages is more than 83 percent Native American, predominantly Aleut (FAA 1996).

Poverty status data for census tracts and block groups is not available. Median household income is available for block groups and can be used as an indicator of community income status. The two block groups that comprise the southern portion of Kodiak Island, including the traditional villages of Old Harbor, Akhiok, Larsen Bay and Karluk, have median household incomes of $33,000 and $21,667, compared to median household income of $44,815 for the Kodiak Island Borough as a whole (FAA 1996).

4 ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

This chapter describes the environmental impacts of the proposed action and the No Action Alternative. Briefly, the proposed action and the No Action Alternative both include the preparation, processing, testing, assembly, final launch preparations, launch and operation of NASA Routine Payloads (NRP) spacecraft. Payloads covered by this Environmental Assessment (EA) are considered to be routine in that their characteristics fall within the Envelope Payload Characteristics (EPCs) listed in Chapter 2, Table 2-1, and they present no new or substantial environmental impacts or hazards as compared to previously analyzed and documented impacts at these launch facilities.

For the No Action Alternative, NASA would not launch scientific spacecraft missions defined as NRP spacecraft using the specific criteria and thresholds described in this EA from Wallops Flight Facility (WFF), the Reagan Test Site at U.S. Army Kwajalein Atoll (USAKA/RTS), and Kodiak Launch Complex (KLC), and would not launch Falcon or Minotaur family launch vehicles. NASA would then propose spacecraft missions to launch from the additional launch sites and/or on Falcon or Minotaur family launch vehicles for individualized review under the U.S. National Environmental Policy Act (NEPA). Duplicate analyses and redundant documentation would not present any new information or identify any substantially different environmental impacts.

NEPA documentation for all launch vehicle operations has been previously completed for all candidate launch vehicles that would be used to launch NRP spacecraft; these proposed launch vehicles are listed in Chapter 2, Table 2-2. Appendix A is a list of previous NEPA documents which are incorporated by reference. Existing permits and approvals applicable to all proposed launch sites cover prelaunch processing of proposed NASA payloads falling within the envelope of characteristics defined in this EA. Applicable permits are on file with the Environmental Managers at each facility.

4.1 IMPACTS OF THE PROPOSED ACTION

This chapter includes a summary of launch vehicle impacts and a detailed discussion of potential environmental impacts of spacecraft activities, including payload processing, launches and launch failures. Launch vehicle impacts from launches and at launch sites covered by this EA have been analyzed in previous NEPA documents. See the summary below and the list of previous NEPA documents in Appendix A. As a starting point, those launch vehicles with the greatest potential for adverse environmental impacts are listed as examples. These example launch vehicles include the following: the Atlas V (largest solids propellant load from Cape Canaveral Air Force Station (CCAFS) and Vandenberg Air Force Base (VAFB), Delta II 2,925 (largest hypergolic propellant load from CCAFS), Titan II (largest hypergolic propellant load from VAFB[8]), the Athena IIc and III (largest solid and hypergolic propellant loads from KLC and WFF, respectively), and the Falcon 9 (which bounds the upper case of propellant loads for USAKA/RTS). As indicated parenthetically in the previous sentence, these example launch vehicles were selected based on the types and quantities of propellants used by each vehicle at

[8] Although the Titan II has been retired from service, this vehicle has the highest propellant load, and is used as the benchmark to bound the upper case of potential impacts.

each launch site. The remaining candidate launch vehicles are discussed in Chapter 2, Section 2.1.3 and have a lesser potential to cause environmental impacts or hazard due to the use of lesser quantities of propellants than the example launch vehicles.

The following sections include discussions of potential impacts common to all of the proposed launch sites. The discussions are followed by a section that discusses topics for which launch sites might have some different characteristics. In each of the topics common to all launch sites, the text will refer the reader to the specific subsection that discusses that topic for a specific launch site.

4.1.1 Hazardous Materials and Hazardous Waste

As described in Chapter 3, Section 3.2.1, hazardous materials and hazardous wastes are controlled in accordance with Federal and state regulations. All proposed launch sites have established plans to implement these regulations, and those plans are documented in Section 3.2.1. Responsibilities and procedures for management of hazardous materials and hazardous wastes are clearly defined in those operating plans. On-site and off-site payload processing facilities (PPFs) must prepare and retain a written contingency plan and emergency procedures for responding to emergencies involving hazardous materials. As detailed in Section 3.2.1, all proposed launch sites have active pollution prevention programs to reduce the use of hazardous materials and generation of hazardous waste.

4.1.1.1 Spacecraft Processing Use of Hazardous Materials

The approximate quantities of materials that would be used during processing of a routine payload spacecraft are listed in Table 4-1. Any materials remaining after completion of processing would be properly stored for future use or disposed of in accordance with all applicable regulations.

In addition to these processing materials, NRP spacecraft may also incorporate structural materials that present a minor hazard in certain circumstances. For example, beryllium metal in powder form has been identified as a respiratory carcinogen that enters the body through inhalation of respirable-sized particles. Beryllium is used in optical mirrors and windows as well as in structural and electrical components. Beryllium would only become a hazard if it becomes airborne as fine particles as a result of drilling, sanding, grinding or other modification of these particles at the launch site. Although there are no plans for modification of any components of NRP spacecraft at the launch site, should the need for modifications at the launch site arise, the use of approved respiratory protection and the careful removal and containment of residue would mitigate this hazard. In the unlikely event of a launch accident, the anticipated maximum temperature of burning solid propellants, 2,770 ºCelsius (ºC) (5,019 ºFahrenheit [ºF]), is lower than the boiling temperature, 2,970 ºC (5,378 ºF), of beryllium metal. There is an even lower likelihood, in an accident scenario, that burning solid propellant pieces would come into direct contact with beryllium metal or remain in direct contact long enough to transfer sufficient heat to boil beryllium metal. Vaporization of beryllium would be highly improbable. In the case of spacecraft reentry, wherein the metal is eroded into small particles that enter the atmosphere, the potential hazard is mitigated by dilution since the particles would be dispersed throughout the Earth's atmosphere before any particles would reach ground.

Table 4-1 Payload Processing Materials of a Representative NRP Spacecraft

Material	Quantity	Purpose
Acetone	4.5 liter (1 gal)	Epoxy cleanup
Chromate Conversion Coating	0.5 liter (1 pt)	Metal passivation
Denatured Alcohol	22.7 liter (5 gal)	Wash
Epoxy Adhesive	4.5 liter (1 gal)	Part bonding
Epoxy, Resin	4.5 liter (1 gal)	Repairs
Flux, Solder, MA	0.5 liter (1 pt)	Electronics
Flux, Solder, RA	0.5 liter (1 pt)	Electronics
Ink, Black	0.5 liter (1 pt)	Marking
Ink, White	0.5 liter (1pt)	Marking
Isopropyl Alcohol	22.7 liter (5 gal)	Wash
Lacquer Thinner	4.5 liter (1 gal)	Thinning lacquer
Lubricant, Synthetic	0.5 liter (1 pt)	Mechanism lube
Mineral Spirits	4.5 liter (1 gal)	Enamel thinner
Paint, Enamel	4.5 liter (1 gal)	Repair & marking
Paint, Lacquer	4.5 liter (1 gal)	Repair & marking

Source: NASA 1998.

Liquid hypergolic propellants make up the largest proportion of hazardous materials used in processing NRP spacecraft. As described in Chapter 3, Sections 3.2.1 and 4.1.1, these propellants are extremely hazardous and toxic. They are transported and controlled by the facility propellant contractor. They are not stored at the PPFs. Each facility that is permitted to process hypergolic propellant transfers is configured to manage hypergolic propellants and waste products.

4.1.1.2 Spacecraft Processing Hazardous Waste Production

The hazardous materials used to process NRP spacecraft could potentially generate hazardous waste. The spacecraft contractor would be responsible for identifying, containing, labeling, and accumulating the hazardous wastes in accordance with all applicable Federal, state, and local regulations. These regulations are described in Chapter 3, Section 3.2.1. All hazardous wastes generated from spacecraft processing would be transported, treated, stored and disposed of by the responsible base contractor.

Table 4-2 presents the annual estimated hazardous waste amounts produced by the processing of two U.S. Air Force (USAF) Defense Secure Communication Satellites (DSCS) at CCAFS. The USAF DSCS payloads were selected as an example because they are typical of payloads within the scope of the NRP EA.

Table 4-2 Annual Hazardous Waste Associated with Payload Processing

Waste Description	Estimated Volume of Waste kg/yr (lb/yr)[a]
Liquid Hazardous Waste	
Potable water rinsate of hydrazine transfer equipment	417 (917)
IPA and demineralized water rinsate of hydrazine transfer equipment	417 (917)
Potable water rinsate of MMH transfer equipment	417 (917)
IPA and demineralized water rinsate of MMH transfer equipment	417 (917)
Potable water rinsate of NTO transfer equipment	417 (917)
Sodium hydroxide (oxidizer scrubber solution)	2,841 (6,251)[b]
Hydrazine and MMH mixture collected from liquid separator on scrubber	50 (110)[c]
Solid Hazardous Waste	
Pads, wipes, and other solids contacting hydrazine	25 kg (56 lb)
Pads, wipes, and other solids contacting MMH	25 kg (56 lb)
Pads, wipes, and other solids contacting NTO	25 kg (56 lb)
Total Exclusive of Scrubber Solution and Reclaimed Propellant	**2,160 kg (4,753 lb)**

a. Refers to amounts associated with the processing of two U.S. Air Force DSCS payloads.
b. Sodium hydroxide scrubber solution will actually be changed approximately once every 5 to 10 years. The amount presented reflects the total amount that will be wasted when the solution is changed. This amount is not included in the annual hazardous waste total used for comparison with the baseline hazardous waste generated annually at CCAFS.
c. The hydrazine and MMH is reclaimed and not included in the annual hazardous waste total used for comparison with the baseline hazardous waste generated annually at CCAFS.

Key: Isopropyl alcohol (IPA), monomethylhydrazine (MMH), and nitrogen tetroxide (NTO) are abbreviated in the table.

Source: USAF 1995c.

Liquid waste would be generated almost exclusively from fuel and oxidizer transfer operations. Separate propellant transfer equipment is used for each of the two fuels (N_2H_4 and MMH) and the one oxidizer (NTO). After loading hydrazine into the satellite, transfer equipment and lines would be flushed first with potable water and then with an isopropyl alcohol and demineralized water mixture. After MMH has been loaded, equipment and lines used to transfer MMH would also undergo potable water flushes followed by isopropyl alcohol/demineralized water flush. Similarly, potable water would be used to flush oxidizer transfer equipment and lines after NTO has been transferred to the satellite. The rinses resulting from the first three flushes of potable water for MMH and NTO lines and equipment are considered hazardous waste. Further flushes with isopropyl alcohol and demineralized water may or may not be hazardous waste depending on the waste characterization. Approximately 23 liters (5 gal) of sodium hydroxide solution used for soaking small oxidizer transfer equipment parts (e.g., seals and fittings) would be added to the oxidizer rinse water. All five rinse-water waste streams would be collected in separate, Department of Transportation (DOT)-approved containers. The containers would be placed in the waste propellant area (satellite accumulation points) outside the facility until retrieved by the base contractor.

The fuel and oxidizer rinse-water waste may or may not be hazardous depending on how the waste was generated and/or the characteristics of the waste. Waste from each drum would be sampled and characterized based on laboratory analysis and the generation process. Based on

the results of the waste characterization, drums would be labeled as hazardous or non-hazardous and disposed of according to applicable regulations by the base contractor.

The sodium hydroxide solution used in the oxidizer scrubber would be changed about once every 5 to 10 years. The base contractor would pump the spent solution into approved containers, and then dispose of the waste according to its tested characteristics. The citric acid solution used in the fuel scrubber would be collected and disposed of by the base contractor as non-hazardous waste.

During gaseous nitrogen purging of equipment and lines used to transfer anhydrous hydrazine and MMH to the satellite, a liquid separator would collect liquid droplets remaining in the equipment as the air streams pass through the hypergolic vent scrubber system. Prior to loading with NTO, approximately 23 liters (5 gal) of a mixture of hydrazine and MMH would be transferred from the liquid separator to an approved container. The container would be placed in the waste propellant area outside the facility until retrieved by the base contractor.

Solid hazardous waste would also be generated almost exclusively from fuel and oxidizer transfer operations. Pads, wipes, and other solids would be used to clean drips of anhydrous hydrazine, MMH, and NTO. Solids that could come into contact with a fuel or oxidizer would be double-bagged and placed in a DOT-approved container. A separate container would be used for each fuel or oxidizer. Containers would be labeled as hazardous waste and accumulated in the waste fuel and oxidizer areas until collected by the base contractor. Because solids contaminated with hydrazine, MMH and NTO are acutely toxic hazardous waste, these containers would be moved to a 90-day waste accumulation facility within 72 hours if amounts exceed 1.1 liter (1 quart).

Processing of NRP spacecraft would increase hazardous waste production at the launch sites by very small percentages. As an example, the hazardous waste total in Table 4-2 for processing two payloads per year would increase hazardous waste production at CCAFS by about 1 percent.

4.1.1.3 Launch Vehicle Impacts

The processing of launch vehicles at the launch site requires the use of hazardous materials. It also results in the production of hazardous waste. The Atlas V is used as an example of hazardous materials usage and hazardous waste generation by a launch vehicle system since it is a large vehicle with strap-on solid rocket motors (SSRMs). Table 4-3 lists the estimated amounts of hazardous materials to be used per launch for the Atlas V 500 series vehicle with five SSRMs. Table 4-4 lists the quantities of hazardous waste that would be generated by each launch of an Atlas V 500 vehicle.

Table 4-3 Hazardous Materials Used per Atlas V 500 Launch

Material	Quantity	Purpose
Petroleum, oil, lubricants	2,177 kg (4,790 lb)	Booster processing
VOC-based primers, topcoats, coatings	145 kg (320 lb)	External maintenance
Non-VOC-based primers, topcoats, coatings	86 kg (190 lb)	External maintenance
VOC-based solvents, cleaners	627 kg (1,380 lb)	Surface cleaning
Non-VOC-based solvents, cleaners	432 kg (950 lb)	Surface cleaning
Corrosives	2,500 kg (5,500 lb)	Surface preparation
Adhesives, sealants	1,036 kg (2,280 lb)	Structural, electronic
Other	291 kg (640 lb)	Booster processing
Electron QED cleaner	5.7 liter (5 qt)	SRM cleaning
MIL-P-23377 primer	2.8 liter (5 pt)	SRM exterior
Silicone RTV-88	45 liter (10 gal)	SRM sealant
Electric insulating enamel	0.1 kg (5 oz)	SRM touchup
Acrylic primer	22 liter (5 gal)	SRM touchup
Conductive paint	45 liter (10 gal)	SRM antistatic coating
Chemical conversion coating	0.3 kg (10 oz)	SRM surface preparation
Cork-filled potting compound	5.7 liter (5 qt)	SRM thermal protection
Epoxy adhesive	5.7 liter (5 qt)	SRM modification

Source: Derived from USAF 2000a to illustrate quantities associated with Atlas V 500 using 5 SSRMs.

Table 4-4 Estimated Hazardous Waste Generated per Atlas V 500 Launch

Characteristic RCRA Wastes	Quantity
Ignitable D001 RCRA Waste	445 kg (980 lb)
Characteristic RCRA Waste	18 kg (40 lb)
Corrosive D002 RCRA Waste	2,500 kg (5,500 lb)
Commercial Chemical Products (U) RCRA Waste	1,409 kg (3,100 lb)
Reactive D003 RCRA Waste	227 kg (500 lb)
Miscellaneous Waste	114 kg (250 lb)
Total	**4,714 kg (10,370 lb)**

Source: USAF 2000a.

4.1.1.4 Pollution Prevention

No Class I ozone-depleting substances (ODSs) would be used in the NRP spacecraft processing facilities. Small quantities of materials that contain Environmental Protection Agency-17 (EPA-17) targeted industrial toxic materials may be used during spacecraft processing. These include coatings and thinners that typically contain toluene and xylene, which are also listed chemicals under the Emergency Planning and Community Right-to-Know Act (EPCRA) Section 313. Payload processing contractors must track usage of all EPCRA-listed chemicals and report emissions to the responsible government organization at all proposed launch sites.

All NRP spacecraft processing activities would be in compliance with the Pollution Prevention Management Plans (PPMP) at all of the proposed launch sites. This compliance would minimize pollution and meet the regulatory requirements relative to pollution prevention as described in

Section 3.2.1. Processing of NRP spacecraft would not substantially affect the ability of any of the proposed launch sites to achieve pollution prevention goals.

4.1.2 Health and Safety

As described in Section 3.2.2, Range Safety regulations at all proposed launch sites ensure that the general public, launch area personnel, and foreign landmasses are provided an acceptable level of safety, and that all aspects of prelaunch and launch operations adhere to public laws. Range Safety organizations review, approve, monitor, and impose safety holds, when necessary, on all prelaunch and launch operations.

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

Hazardous materials such as propellants, ordnance, chemicals, and booster/payload components are transported in accordance with DOT regulations for interstate shipment of hazardous substances (Title 49 CFR 100-199). Hazardous materials such as liquid rocket propellant are transported in specially designed containers to reduce the potential of a mishap should an accident occur.

4.1.2.1 Spacecraft Processing Impacts

<u>Hazardous and Toxic Propellants</u>

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

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

Spills, fires, and explosions would be possible outcomes from accidents during payload processing. A violent fire or an explosion could produce severe injuries or even death. A catastrophic accident of this type during payload processing would be extremely unlikely. Most propellant spills would be contained within the processing facility with no health impacts on personnel. The most likely consequences of a severe accident during processing would be some level of damage to the spacecraft and the immediate liquid propellant transfer area. Facility design would limit damage to the spacecraft and the transfer area. Injuries would not be anticipated if facility personnel follow emergency procedures.

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

Inadvertent Ignition of SRM

NRP spacecraft may be equipped with solid rocket motors (SRMs) as kick stages with up to 3,000 kg (6,600 lb) of solid propellant. SRMs are installed under rigidly controlled safety requirements in facilities sited for the proper type of propellant and amount of explosive yield. Static electricity, a potential ignition energy source, is controlled using wrist- and leg-stats on personnel, antistatic Kevlar coveralls, and careful grounding of all flight and ground hardware. Electric circuits are tested for stray currents before connections are made. These measures reduce the likelihood of accidental motor ignition to an extremely low level, minimizing risks on health and safety.

Nonionizing Radiation

Most of the proposed spacecraft would be equipped with radar, telemetry, and tracking system transmitters. For radar, a power limit of 10 kilowatts (kW) encompasses the proposed programs. A radar instrument of this size on a nadir-viewing satellite can provide useful information with no risk to people on Earth or in aircraft above the Earth. A 2-kW radar (94 Gigahertz [GHz] with a 1.95 m [6.4 ft]) antenna drops to safe levels in less than 2.5 km (1.6 mi) from the satellite. Considering that Low Earth Orbit (LEO) altitudes range from 200 to 800 km (124 to 497 mi), such a system presents no nonionizing radiation hazard to populated regions of Earth or its' atmosphere.

The accepted levels for human exposure to radio frequency electromagnetic fields (3 kilohertz [kHz] to 300 GHz) are described in the "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz" (IEEE C95.1-2005). IEEE C95.1-2005 is recognized as a standard of the American National Standard Institute (ANSI). IEEE Standard C95.3-2002, entitled "IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave", is also recognized as an ANSI standard and provides formulas needed to determine the fields associated with RF and microwave sources.

The proposed action involves the use of lasers for science instrumentation and optical communication. Admissible safety analysis techniques are well established based on ANSI Z136.1-2007 and ANSI Z136.6-2005. According to ANSI Z136.6-2005, the maximum

permissible exposure (MPE) values are below known injury levels. Therefore, for the purpose of this EA, a laser is considered to be eye-safe when potential exposure levels are below the MPE value. The ANSI safety analysis applies to any laser (not only nadir-pointing [pointing to the center of mass of the object] laser systems) that might be operationally or accidentally pointed toward people or wildlife on Earth or aircraft. Laser systems meeting the Routine Payload Checklist (RPC) must be evaluated and found to be within ANSI standards for safe operations if they can be operated in an Earth-pointing mode. Earth-pointing laser systems are safely and routinely used from a variety of airborne and orbital platforms for scientific measurements.

Since the energy threshold for skin damage exceeds that for eye injury, any system found to be eye-safe would not present a substantial hazard to skin, structures, or plants. Gases and particles in the atmosphere can absorb the energy from laser systems and so cause changes in atmospheric chemistry by initiating various chemical reactions. However, for a typical laser system utilized by Earth-orbiting spacecraft, the mean beam power and, therefore, the maximum available rate at which energy could be deposited into the atmosphere is not substantial when compared to that of the Sun, so that substantial atmospheric impacts are not expected. For Light Detection and Ranging (LIDAR) and topographical mapping applications, the local impact from use of the laser is "infrequent" since the system only samples a particular location occasionally (e.g., once a week or month) and the sampling time corresponds to a few nanoseconds (i.e., only one pulse of the laser).

Per NPR 8715.3C Section 3.15.7, there are Federal (21 CFR Part 1040), USAF (AFOSH Standard 48-12), and NASA-requirements for the safe use of lasers. ANSI documents outline permissible exposure limits needed to avoid eye and skin injury from lasers (ANSI Z136.1-2007 and ANSI Z136.2-2005) and to safely use visible lasers outdoors (ANSI Z136.6-2005). In addition to eye and skin hazards, ANSI Z136.6-2005 also requires that visible lasers, used outdoors, do not cause interference with spacecraft and aircraft operations. For visible lasers, the Federal Aviation Administration (FAA) must provide a letter of non-objection for outdoors scientific use of lasers. This added requirement for visible lasers is needed to protect potentially exposed persons from hazardous reactions to bright light. These hazards include transient visual effects of laser beams such as flash blindness, afterimage, glare, and startle. ANSI Z136.6-2005 also documents the need for a standard operating procedure (SOP) for use of all Class 3B (formerly 3b) and Class 4 lasers. Per NPR 8715.3C and ANSI Z136.6-2005, when a planned laser operation has the potential for the beam to strike an orbiting craft, the program manager or designated Laser Safety Officer must contact the laser safety-clearing house to obtain a "Site Window" clearance. The clearance is obtained from the Orbital Safety Officer, U.S. Space Command/J3SOO at Cheyenne Mountain Air Force Base.

Per NPR 8715.3, Section 3.15.7, airborne Class III-B and IV laser operations shall include system interlocks to prevent inadvertent exposure to laser beam output and shall only proceed in accordance with the prescribed mission or test plan. The mission and test plans must include a hazard evaluation as well as written safety precautions. The hazard analysis will consider catastrophic events and the need for very reliable, high-speed laser shutdown should such events occur (ANSI Z136.1-2005). Qualified personnel shall perform the laser hazard evaluations, which shall consider and document the atmospheric effects of laser beam propagation, the transmission of laser radiation through intervening materials, the use of optical viewing aids, and other resultant hazards (e.g., electrical, cryogenic, and toxic vapors).

Ionizing Radiation

NRP spacecraft could use small amounts of radioactive materials as scientific instrument components. As part of the NEPA compliance and nuclear safety launch approval processes, the spacecraft Program Manager must prepare a Radioactive Materials On-Board (RMOB) Report that describes all of the radioactive materials to be used on the spacecraft. The RMOB Report would be submitted to the NASA Nuclear Flight Safety Assurance Manager (NFSAM) for safety review and would be included in the RPC (Appendix C).

As per Table 6.1 of NASA's NPR 8715.3C Chapter 6, the type of radioactive material determines its activity (A_1 and A_2 values)[9] (see Table 1 of Appendix D in NPR 8715.3C), and the amount of radioactive material determines the A_1 and A_2 multipliers. For the radioactive instrument calibration and measurement sources NRP spacecraft would launch, the sum of all of the A_2 values onboard the spacecraft contributes to a value known as the "A_2 mission multiple". The level of signature authority for launching radioactive material(s) is determined by the A_2 mission multiple. The amount of radioactive material that could be carried is strictly limited by the approval authority level delegated to the NASA NFSAM by NPR 8715.3C; (the upper limit of the NFSAM's signature authority is less than 10 times the A_2 mission multiple).

Therefore, the amount of radioactive materials used on NRP spacecraft would be limited to small quantities, typically no more than a few millicuries. Therefore, the use of radioactive materials in NRP spacecraft would not present any substantial impact or risk on the public or on the environment during normal or abnormal launch conditions.

Payload Transport Accidents

When payload processing is completed, the payload would be encapsulated and transported to the launch site, (or in the case of an Atlas V LV, to the launch vehicle). Accidents during transport would be extremely unlikely because movement of the payload would be carefully controlled in convoys with security escorts. Several factors would minimize the consequences of an accident should one occur. The forces imparted to the encapsulated spacecraft during an accident would be small because of the low speeds involved during transport to the pad. The spacecraft would be protected from damage by the capsule and a protective blanket. Should the spacecraft be damaged, it would be unlikely that the propellant tanks would be damaged. In the highly unlikely event of a propellant leak, transport and security personnel would be protected by following emergency procedures and by the wearing appropriate protective clothing (NASA 1993b).

4.1.2.2 Launch Vehicle Impacts

The Range Safety organizations at all proposed launch sites use models to predict launch hazards to the public and on-site personnel prior to every launch. These models calculate the risk of injury resulting from toxic gases, debris, and blast overpressure from both normal launches and launch failures. Launches are postponed if predicted risk of injury exceeds acceptable limits.

[9] The A_2 multiplier for each radioactive source is based upon the International Atomic Energy Agency (IAEA), Safety Series Number 6, Regulations for the Safe Transport of Radioactive Material, 1985 Edition as amended in 1990, Section III, paragraphs 301 through 306, and summed to determine the A_2 mission multiple.

The allowable collective public risk limit in use at all proposed launch sites is extremely low (30×10^{-6}, or 1 in 33,000).

The proposed action involves launch vehicles that have previously been approved for launch of spacecraft from each of the proposed launch sites. This action would not increase launch rates nor utilize launch systems beyond the scope of approved programs at any of the launch sites proposed.

4.1.3 Geology and Soils

4.1.3.1 Spacecraft Processing Impacts

The proposed processing of NRP spacecraft does not include any construction or modification of facilities or roadways that would potentially impact land resources. Processing activities would take place within closed structures, and precautions would be taken to prevent spills and control hazardous materials in accordance with facility operating plans. Spills of liquid propellants would be controlled through catchment systems and holding tanks in the processing facilities and would not impact surrounding soils or land resources.

Propellant spills could occur during propellant transfer to or from the processing facility or during spacecraft transport to the launch pad. Propellant spills onto soils could occur as a result of spacecraft impact following a launch failure. Emergency response personnel would mitigate the impact of any spill. Spilled propellant would be collected and disposed of by a certified disposal contractor. Contaminated soils would be removed and treated as hazardous waste in accordance with Federal, state, and local regulations. Short-term impacts on localized soils may result, but long-term impacts would not be substantial.

4.1.3.2 Launch Vehicle Impacts

The use of SSRMs on launch vehicles would result in the deposition of hydrogen chloride (HCl) and aluminum oxide (Al_2O_3) particulates on soils near the launch pad. During a Delta II launch on November 4, 1995, pH in the surrounding air was monitored to detect any changes caused by HCl vapors or deposition. Test strips were placed as near as the perimeter of the launch pad. Launch conditions were calm, which would yield maximum HCl deposition. No pH changes were observed on any test strips, and there was no evidence of acid deposition. The lack of pH changes associated with the small ground cloud indicates that even with exposure to the concentrated cloud, acid deposition would be minimal (USAF 1996c).

<u>Soils</u>

Soils typically contain a substantial amount of organic matter, which results in a natural buffering capacity that would potentially counteract the effects of any HCl they receive. The soils of the barrier islands are alkaline with high buffering capacity (Schmalzer 1998). For example, despite additions of substantial amounts of acidic deposition from 43 launches over a 10-year period, the affected soils at CCAFS showed no decrease in buffering capacity. (There have been more launches from CCAFS than any of the other launch sites mentioned in this EA.) The HCl content of the exhaust plume from SSRMs would not be expected to adversely affect soils around launch sites at any of the proposed launch sites. In addition, aluminum oxide would

not affect the soils because it would be deposited as a stable compound. Therefore, no measurable direct or indirect, short- or long-term effects on soil chemistry would be expected as a result of launch activities (USAF 1998).

Launch anomalies could result in impacts on near-field soils due to contamination from rocket propellant. In the unlikely occurrence of a launch anomaly, any spilled propellant would be collected and disposed of by a certified disposal contractor in accordance with the Spill Prevention Control and Countermeasures (SPCC) Plan. Contaminated soils would be removed and treated as hazardous waste in accordance with Federal, State, and local regulations. Short-term impacts to soils may result, but long-term impacts would not be significant (USAF 1998).

4.1.4 Water Resources

An impact on water resources may be considered significant if the action interfered with drainage, exceeded the capacities of the regional supply systems, or resulted in degradation of surface water or groundwater quality such that existing surface water uses would be impaired.

4.1.4.1 Spacecraft Processing Impacts

There would be no impacts on water resources from spacecraft processing. Processing activities would take place within existing structures and precautions would be taken to prevent and control spills of hazardous materials. Large spills of spacecraft liquid propellant would be controlled through catchment systems in the processing facilities. All chemicals used for processing would be managed to prevent contamination of surface waters and groundwater.

The typical operation of the facility proposed for NRP spacecraft processing use would require an average of approximately 500 liters (110 gal) of water per day for potable use and for payload processing activities (Astrotech 1993). This water would be supplied by the existing water distribution systems at all proposed launch sites and would have a negligible impact on system capacity or surface and groundwater resources. The total volume of wastewater generated by the facility has been estimated to average about 500 liters (110 gal) per day (Astrotech 1993). This wastewater would be processed through the existing wastewater handling and treatment systems at all proposed launch sites and would have a negligible impact on system capacity or surface and groundwater resources. The proposed action fits within the current scope of water discharge permit definitions. Local and regional water resources would not be affected since there would be no substantial increase in use of surface or groundwater supplies.

4.1.4.2 Launch Vehicle Impacts

For all launch sites other than USAKA/RTS, water supplied by municipal sources would be used at all proposed launch complexes and pads for deluge water, launch pad wash-down, and potable water. Most of the deluge and launch pad wash-down water would be collected in concrete basins; however, minor amounts could drain directly to grade. If the wastewater in the collection basins meets the criteria set forth in the industrial wastewater discharge permit, the wastewater would be discharged directly to grade at the launch site. If the wastewater fails to meet the criteria, it would be treated on-site and disposed to grade or collected and disposed of by a

certified contractor. No discharges of contaminated water are expected to result from launch vehicle operations.

At Omelek, SpaceX uses non-potable water for pad cleanup, deluge spray, and firefighting. The water for the deluge system is supplied from a pressurized tank that is filled using the water system. The deluge system uses ocean water that has been desalinated in a reverse osmosis system and stored in a 37,854-liter (10,000-gal) tank. The reverse osmosis system also provides water for other non-potable uses. Spray nozzles on the launch stand direct deluge water to structures such as the flame diverter and the concrete. The deluge spray keeps surfaces below their respective melting points. The deluge rate is approximately 3,785 liters (1,000 gal) in 30 seconds. Approximately 35 to 50 percent of the deluge water is reduced to steam. After each launch, the deluge water that remains on the launch pad is containerized and tested for contaminants. Disposal of contaminated deluge water would occur in accordance with the UES.

The Falcon 9 has the largest propellant load and is used to bound the case of launch vehicles impacts at USAKA/RTS. The exhaust plume produced by the Falcon launch vehicle would consist mainly of steam and carbon dioxide (CO_2). The CO_2, when mixed with the deluge water, would create carbonic acid, which would then break down into bicarbonate and hydrogen ions and create a mild acid.

The emission of HCl and aluminum oxide particulates by solid rocket propellant of the Pegasus launching from Omelek Island would be the primary concern associated with the impact of normal launches on water quality. Short-term acidification of surface water could result from contact with the exhaust cloud and through HCl fallout from the cloud. Wet deposition of HCl may occur during rainfall. Impacts on surface waters would be restricted to the area immediately adjacent to the launch pad. No substantial impacts on surface waters of nearby oceans, lagoons, or large inland water bodies should occur due to the buffering capacities of these bodies. A short-term decrease in pH could occur in small streams and canals near the launch pad. Since there would only be a temporary decrease in pH, aluminum oxide deposition should not contribute to increased aluminum solubility in area surface waters (Schmalzer 1998). A normal launch would have no substantial impacts on the local water quality.

Under normal flight conditions, vehicle stages that do not reach orbit have trajectories that result in ocean impact. Stages that reach initial orbit would eventually reenter the atmosphere as a result of orbital decay. Corrosion of stage hardware would contribute various metal ions to the water column. Due to the slow rate of corrosion in the deep-ocean environment and the large quantity of water available for dilution, toxic concentrations of metals are not likely to occur. Since the liquid stages and SRM fuel would be burned to depletion in-flight, there would be only relatively small amounts of propellant left in the stages that impact the ocean. The release of solid propellants into the water column would be slow, with potentially toxic concentrations occurring only in the immediate vicinity of the propellant. Insoluble fractions of RP-1 propellant would float to the surface and spread rapidly to form a localized surface film that would evaporate. Hydrazine fuels are soluble and would also disperse rapidly. Because of the limited number of launch events scheduled, the small amount of residual propellants present, and the large volume of water available for dilution, no adverse impacts are expected from the reentry of spent stages (USAF 1998).

On-pad accidental or emergency releases of small quantities of propellants are unlikely to occur. However, in the event of a release, spilled propellants would be collected and disposed of by a certified disposal contractor in accordance with the SPCC plan. Potential contamination of groundwater or surface water resulting from accidental or emergency spills of propellants during propellant loading would be minimized through adherence to safety procedures. Potential leakage or spills from propellant storage tanks would be contained in holding basins that surround the tanks. Any accidental or emergency release of propellants after loading would be channeled to an impermeable concrete catch basin. Contaminants collected in the catch basin would be disposed of in accordance with appropriate state and Federal regulations (USAF 1998).

Launch accidents could result in impacts on local water bodies due to contamination from rocket propellant. In the unlikely occurrence of a launch accident, spilled propellant could enter water bodies close to the launch pad. Potential contamination would primarily occur from hydrazine, MMH, NTO, and SRM propellant. Powdered aluminum from the SRM propellant would rapidly oxidize to aluminum oxide, which is non-toxic at the pH that prevails in surface waters surrounding all proposed launch sites (USAF 2000a).

Perchlorate Deposition

In the unlikely event of a failure during launch, or an early termination of flight, the launch vehicle would most likely fall into the ocean, along with scattered debris. Flight termination ruptures the casings of the SSRMs such that pieces of unburned propellant, which is composed of ammonium perchlorate, aluminum, and other materials, could be widely dispersed by the explosion and could fall on surface waters. Of concern is the ammonium perchlorate, which, once in the water, could slowly leach out of the solid propellant resin-binding agent. Studies have shown that the rate of perchlorate extraction is a function of water temperature and salinity, with the highest rates observed at the highest temperature and lowest salinity (USAF 2005).

Trace amounts could disassociate into ammonium ion and perchlorate ion. At low to moderate concentrations, the ammonium ion is a plant nutrient and could stimulate plant growth for short periods of time. At higher concentrations, the ammonium ion is toxic to aquatic life and could cause short-term mortalities of aquatic animals within the immediate vicinity of the launch vehicle impact. The perchlorate ion reacts with (oxidizes) organic matter with which it comes into direct contact. Hydroxyl-Terminated Polybutadiene (HTPB) could be biologically degraded over time.

Effects of perchlorate on primary and secondary aquatic production and on decomposition processes in sediments, wetland peat, and soil material have recently been the subject of laboratory studies. Aquatic primary production was affected only by perchlorate concentrations of 1,000 ppm, and this effect was minimal compared to control samples. Bacterial production was not adversely affected, except at very high levels in seawater samples. Since coastal waters are constantly circulating through wave action and currents, it is unlikely that phytoplankton or bacterioplankton would encounter such high levels of perchlorate for more than a few minutes (USAF 2005).

Soil samples exhibited significant decreases in respiration activity in the presence of perchlorate at levels between 100 and 1,000 ppm. Therefore, it is possible that the deposition of perchlorate on coastal soils, following an aborted flight, could decrease the rate that material is decomposed

in soil, which could adversely affect the recycling of nutrients and eventual plant growth (USAF 2005).

The presence of potassium perchlorate at concentrations up to 10 ppm and perchlorate concentrations nearing 30 ppm in laboratory aquariums containing solid propellant had no effect on unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*) mating or the birth and growth of fry. Fry mortality occurred in all treatments, but none were statistically different from the controls. The laboratory study demonstrated that perchlorate accumulated in both fish and the algal/bacterial community. Although no severe effects of perchlorate stress were detected, it is likely that the continued accumulation of perchlorate could lead to harmful effects at some level (USAF 2005). Studies would need to be conducted over a longer period of time to ascertain the effects of perchlorate accumulation in an ocean environment.

Recovered solids would be removed from near-shore ocean and/or river environments and treated as hazardous waste in accordance with Federal, state, and local regulations. Short-term impacts on the near-shore environments may result, but long-term impacts would not be significant due to the buffering capacity of large water bodies (USAF 1998).

4.1.5 Air Quality

The Federal Clean Air Act (CAA), as amended in 1990, covers a range of potential environmental effects from the release of air pollutants, ranging from criteria pollutants (CAA Section 108, or CAA 108) to hazardous air pollutants (CAA Section 112). Control of chemicals that cause depletion of stratospheric ozone is also included. The U.S. manufacture and use of these ozone-depleting chemicals is strictly prohibited or controlled by the CAA.

CAA Section 112 addresses the reduction of emissions of 188 hazardous chemicals (EPA 2006b). It is implemented by a system of regulations called the National Emission Standards for Hazardous Air Pollutants (NESHAPs). These regulations have been developed for 766 industrial source categories and subcategories organized into 18 industry groups. The NESHAPs having potential impact on the spacecraft and launch industries are:

- Aerospace industries (surface coatings, adhesives, depainting etc.)
- Hard and decorative chromium electroplating & chromium anodizing tanks
- Halogenated solvent cleaning
- Miscellaneous organic chemical processes – explosives/propellants

The potential for impacts of any of these NESHAPs on spacecraft launch site operations is largely yet to be determined, since some of the above NESHAPs are still under development, promulgation, or revision. However, the NESHAPs are oriented toward manufacturing processes and substantial impacts on operations are minimal. However, in cases where paint application or removal, solvent wipe cleaning or adhesive bonding is planned at the launch site, the Aerospace NESHAPs would be consulted and followed. Likewise, if launch site processing includes cleaning with halogenated solvents by immersion or vapor cleaning, that NESHAP would be consulted and followed. The controlled halogenated solvents are listed as any product containing more than 5 percent of one or more of the following chemicals: methylene chloride, perchloroethylene, trichloroethylene, 1,1,1-trichloroethane, carbon tetrachloride, and chloroform.

4.1.5.1 Impacts from Payload Processing

NRP Spacecraft Processing

As described in Chapter 2 and Figure 2.1, the processing of NRP spacecraft would consist of a number of steps to assemble, test, service, integrate, and launch the spacecraft. Some of these steps would be hazardous (such as propellant loading or ordnance installation). Specific activities identified as having potential environmental impact are described in this section.

The cleaning of the PPF and shipping container surfaces involves the use of solvents to remove organic contaminants. The standard solvent used is isopropyl alcohol (IPA), and approximately 208 liters (55 gal) of IPA are used per mission. IPA is used because of its low toxicity and low flammability. Ethyl alcohol may also be used for optical surfaces and possibly for cleaning the spacecraft to meet planetary protection requirements, (less than 378 liters [100 gal] of IPA and ethyl alcohol would be used for meeting planetary protection requirements). It is non-toxic and somewhat flammable. Small amounts of other chemicals are often used incidentally in preparing spacecraft for assembly, test, loading, and launch. These are listed in Table 4-1 and are used in such minor amounts and are of such low toxicity that they present no substantial potential for environmental impact.

Loading of hypergolic propellants is performed either in the principal PPF or in an auxiliary facility. The fuel can be either hydrazine for mono- or bipropellant systems or MMH for bipropellant systems. The oxidizer used for bipropellant systems is NTO. Each loading operation is independent, sequential and conducted using a closed-loop system. During the operation, all propellant liquid and vapors are contained. If small leaks occur during propellant loading, immediate steps are taken to stop loading, correct the leakage, and clean leaked propellant with approved methods before continuing. Personnel wear protective clothing during hazardous propellant operations. Leakage is absorbed in an inert absorbent material for later disposal as hazardous waste, or aspirated into a neutralizer solution. Propellant vapors left in the loading system are routed to air emission scrubbers. Liquid propellant left in the loading system is either drained back to supply tanks or into waste drums for disposal as hazardous waste.

The facility at WFF mirrors the Titusville Astrotech PPF in estimates of portable scrubber emission rates during fueling operations. Estimates of scrubber emission rates during fueling operations, based on the Titusville Astrotech PPF experience, are 0.045 kg/hr (0.099 lb/hr) for N_2H_4, 0.13 kg/hr (0.28 lb/hr) for NTO and 0.064 kg/hr (0.14 lb/hr) for MMH. These rates are for typical periods of less than 30 minutes per spacecraft (Astrotech 1993). Although both NTO and hydrazine are classified as hazardous air pollutants (HAPs), the NESHAP regulations under Title III of the CAA have not yet established control standards. The packed bed scrubber systems usually used are considered Best Available Control Technology (BACT) and should be considered acceptable when NESHAPs regulations are promulgated.

Many PPF also incorporate emergency power generators, either propane or diesel powered. Emissions from these generators are regulated as stationary sources by the Florida Department of Environmental Protection (FDEP) for CCAFS and KSC, the Santa Barbara County Air Pollution Control District (SBCAPCD) for VAFB, the UES for USAKA/RTS, the Virginia Air Pollution Control District (VAPCD) for WFF, and the Alaska Aerospace Corporation (AAC) for KLC, and the generators require permits from these agencies.

Payload Propellant Spills

Inadvertent releases of toxic air contaminants are possible as a result of accidents during payload processing, transportation, and launch. The largest releases would result from the spillage of the entire quantity of liquid propellants. Lesser releases could result from fires or explosions that would consume significant amounts of the propellants. Safety procedures in place at all of the proposed launch sites ensure that these events are unlikely to occur. In addition, spill response planning procedures are in place to minimize spill size and duration, as well as possible exposures to harmful air contaminants. The magnitude of air releases from payload accidents would be relatively small compared to possible releases from accidents involving launch vehicles. They would have no substantial impact on ambient air quality.

Appendix B contains documents for the mean hazard distance predictions at CCAFS, KSC, and VAFB for release of 1,000 kg (2,200 lb) total propellant load of hydrazine, 1,000 kg (2,200 lb) of MMH, and 1,200 kg (2,640 lb) of NTO. The USAF Toxic Chemical Dispersion Model (AFTOX) Version 4.0 (Kunkel 1991), was used to predict the mean hazard distances resulting from the spillage of each of the three liquid propellants. AFTOX is a simple Gaussian puff/plume dispersion model that assumes a uniform windfield. AFTOX was used to predict mean distances to selected downwind concentrations of each toxic vapor. The selected concentrations used for this analysis were the Short-Term Emergency Guidance Levels (STEGLs) for hydrazine (0.12 ppm 1-hour average), MMH (0.26 ppm 1-hour average), and NO_2 (1.0 ppm 1-hour average). AFTOX runs were conducted for daytime and nighttime conditions at two different wind speeds (2 and 10 m/s [7 and 32 ft/s]). These meteorological conditions were selected to illustrate possible hazard distances. Other meteorological conditions would produce different hazard distances but would not change the conclusion that the concentrations fall below hazardous levels within a relatively short distance of the release. Appendix B provides AFTOX output relevant to this EA.

Spillage of the entire payload propellant load, while unlikely, could occur during payload processing, payload transportation, payload mating to the launch vehicle, or during the actual launch operation. A launch accident could result in payload ground impact resulting in propellant tank rupture and spillage. The cases modeled by AFTOX are worst-case scenario since they assume that the spills are unconfined and evaporate to completion without dilution or other mitigating action. The following sections summarize the results presented in Appendix B and document the areas and distances that would temporarily have hazardous levels of the propellants in the event of a spill. These results indicate that the chemicals are diluted to non-hazardous levels in reasonably short distances.

Detailed discussions of air quality payload propellant spills at each of the launch sites can be found in the following sections:

- CCAFS and KSC – Section 4.1.13.1
- VAFB – Section 4.1.13.2
- USAKA/RTS – Section 4.1.13.3
- WFF – Section 4.1.13.4
- KLC – Section 4.1.13.5

Air Quality Impacts from Launch Vehicles

All candidate launch vehicles considered for launch of NRP spacecraft have been reviewed through the environmental impact analysis process and have been determined to have no substantial impact on ambient air quality. These findings are provided in existing NEPA documentation. A listing of applicable NEPA documentation is provided in Appendix A. In addition, Range Safety regulations at all of the proposed launch sites prohibit launches when air dispersion models predict a toxic hazard to the public. Consequently, the public in and around the launch sites is unlikely to be exposed to concentrations of any launch vehicle emissions that exceed the allowable public exposure limits adopted by the range safety organizations.

Air dispersion models are used at all launch sites considered in this EA to predict toxic hazard corridors for normal launches, catastrophic launch failures, and spills of liquid propellants. Among the models used are the Rocket Exhaust Effluent Diffusion Model (REEDM) and AFTOX. The following sections provide a summary of model results performed previously for several of the candidate launch vehicles. As documented in previous EAs and EISs performed for the candidate launch vehicles, these emissions would not substantially impact ambient air quality or endanger public health. The potential for an accidental release of liquid propellants would be minimized by adherence to applicable USAF, FAA, and NASA safety procedures. All spills would be managed in accordance with a spill-response plan already in place at all the launch sites considered in this EA.

This summary uses the Atlas V and Delta IV vehicles as examples for the normal launch cloud since these vehicles have the largest emission rates of the candidate vehicles at lift-off. The Titan II (VAFB) and Delta II (CCAFS) are used as examples for toxic clouds generated by liquid propellant spills and catastrophic launch failures since these vehicles carry the largest quantity of toxic hypergolic propellants (hydrazines and NTO) of the candidate vehicles. The REEDM is the primary air dispersion model used at CCAFS, VAFB, USAKA/RTS, and WFF to predict toxic vapor concentrations and toxic hazard corridors for launch operations. KLC uses AFTOX and EPA's INPUFF model for predictions.

Normal Launches

The candidate vehicles described in Chapter 2 include the Athena family, the Atlas V family, the Delta family, the Pegasus family, the Taurus family, the Falcon family, and the Minotaur family. The Athena III launch vehicle, although not in service at the time this EA was prepared, has been considered as the bounding case for vehicles launching out of WFF and KLC. The liquid engines and SSRMs on these vehicles produce air emissions during lift-off and flight. The primary emission products from liquid engines using RP-1 and LOX are carbon dioxide (CO_2), carbon monoxide (CO), water vapor, oxides of nitrogen (NO_X), and carbon particulates. Liquid engines using Aerozine-50 (A-50) (a 50/50 mixture of hydrazine and unsymmetrical dimethylhydrazine [UDMH]) and NTO emit CO_2, CO, water vapor, and NO_X. Liquid engines using LH_2 and LOX emit water vapor and oxides of nitrogen. Emissions from SSRMs include HCl, aluminum oxide particulates, CO, CO_2, water vapor, and NO_X. Most CO emitted by liquid engines and SSRMs is oxidized to CO_2 during afterburning in the exhaust plume.

Table 4-5 lists the quantity of criteria pollutants and HCl that would be emitted into the lowest 915 m (3,000 ft) of atmosphere during each launch of five candidate launch vehicles. The launch vehicles represent the maximum exhaust products that could be emitted into the atmosphere, and as such bound the case for all the launch vehicles that would be launched from all launch sites. The criteria pollutants include volatile organic compounds (VOC), NO_X, CO, sulfur dioxide (SO_2), and particulate matter less than 10 microns in diameter (PM_{10}). Emission of aluminum oxide from the SSRMs is included in the PM_{10} column. These five vehicles represent the largest emission sources from various combinations of liquid engines and SSRMs on the candidate vehicles. Specifically, they represent: (a) LH_2/LOX engines (Delta IV-H), (b) RP-1/LOX engines (Atlas V Heavy), (c) A-50/NTO engines (Titan II), (d) LH_2/LOX engines with SSRMs (Delta IV M+ (5,4), and (e) RP-1/LOX engines with SSRMs (Atlas V 551/552). The emissions from other candidate vehicles would be within the emission envelope of these five vehicles.

Detailed discussions of air quality impacts from launch vehicles - normal launches at each of the launch sites - can be found in the following sections:

- CCAFS and KSC – Section 4.1.13.1
- VAFB – Section 4.1.13.2
- USAKA/RTS – Section 4.1.13.3
- WFF – Section 4.1.13.4
- KLC – Section 4.1.13.5

Launch Vehicle Propellant Spills

The potential for an accidental release of liquid propellants would be minimized by adherence to applicable safety procedures as specified in Range Safety Requirements such as AFSPCMAN 91-710. All spills would be managed in accordance with existing SPCC plans. Liquid propellants, typically either RP-1 and liquid oxygen or A-50 and NTO, would be stored in tanks near the launch pad within cement containment basins designed to retain 110 percent of the storage tank volumes. Propellant spills from the launch vehicle would be channeled into sealed concrete catchment basins and disposed of according to the appropriate Federal and state regulations. Propellant loading operations would be postponed if Range Safety models predict that a potential propellant spill would result in a toxic hazard to the public or unprotected personnel.

Detailed discussions of launch vehicle propellant spills at each of the launch sites can be found in the following sections:

- CCAFS and KSC – Section 4.1.13.1
- VAFB – Section 4.1.13.2
- USAKA/RTS – Section 4.1.13.3
- WFF – Section 4.1.13.4
- KLC – Section 4.1.13.5

4.1.5.2 Clean Air Act Conformity

CAA Conformity Applicability Analyses are required for proposed actions in areas that are designated either as nonattainment or are within the 10 years of maintenance after having

reached attainment status. A CAA Conformity Determination is not needed for CCAFS, WFF, or KLC because they are located in an area that is in full attainment with NAAQS. NAAQS do not apply to USAKA/RTS. Because VAFB was a nonattainment area for ozone, a CAA Conformity Applicability Analyses was required for ELV operations (i.e., the largest of the launch vehicles considered in this action). The CAA Conformity Applicability Analyses have established that ELV operations meet *de minimis* requirements and are not considered a regionally significant action (USAF 2000a). Table 4-5 in this EA illustrates the VOC and NO_X emissions from the five largest ELVs considered in this EA. The ELVs represent four of the five vehicles and emit more than an order of magnitude more ozone precursors than the Titan II. Therefore, use of any other ELV considered in this EA will be equally or less polluting. Hence, the emissions from any launch vehicle considered in this EA are below *de minimis* and are not considered regionally significant. Review of the CAA conformity analyses for DSC (USAF 1995) and Earth Observing System (EOS) (NASA 1997), payload EAs documents that those payload-processing operations contribute only a small fraction (~1/25) of the emissions associated with the EELV launch and operations. The fraction-of-a-ton quantity exemplified by DSCS and EOS payload processing EAs represent the quantities and processes considered routine in this EA and are *de minimis* and not regionally significant. Therefore, further CAA conformity analyses pursuant to 40 CFR 93.153(c) is not required, and this action does not require a new CAA Conformity Determination. As documented previously in the EELV conformity analysis, Santa Barbara County Air Pollution Control District's (SBCAPCD) Rule 702 is adopted from the Federal General Conformity regulation, and the EELV conformity analysis satisfied both the state and the Federal requirements. This EA considers launches within the approved and analyzed launch rates, hence the EA does not add any launches or their impacts. As stated in RPC Item C2, a proposed mission that would exceed the approved launch rates must consult with the appropriate launch support organizations for further analysis.

Table 4-5 Air Emission per Launch of Candidate Vehicles Into Lowest 916 m (3,000 ft) of Atmosphere

Vehicle	Pollutant in metric tons (tons)					
	VOC	**NO_X**	**CO**	**SO_2**	**PM_{10}**	**HCl**
Athena II	N/A	N/A	N/A	N/A	7.9 (8.7)	4.2 (4.7)
Atlas V 551/552	0	1.1	0.01	0	15	7.8
Atlas V H	0	1.2	0	0	0	0
Delta IV M+	0	0.71	0.0054	0	10	5.1
Delta IV-H	0	1.6	0	0	0	0
Falcon 1	0	0	86.8 (95.7)	0	0	N/A
Falcon 9	0	0	781.3 (861.3)	0	0	N/A
Titan II	0	0.04	0.06	0	0	0

Sources: USAF 1987, 2000a.
N/A=Not Applicable.

VAFB is located within the SBCAPCD, which has been in attainment for the Federal ozone and PM_{10} standards, but is not in attainment for the California State ozone and PM_{10} ambient air quality standards. Santa Barbara County has attained the Federal 1-hour standard for ozone. The government is required to make a formal determination as to whether operations comply with the General Conformity Rule of the Clean Air Act. Section 176(c) requires all Federal agencies or agency-supported activities to comply, where applicable, with an approved or

promulgated State Implementation Plan (SIP) or Federal Implementation Plan (FIP). Conformity means compliance with a plan's purpose of attaining or maintaining the NAAQS. Specifically, this means ensuring the activity would not: (1) cause a new violation of the NAAQS; (2) contribute to an increase in the frequency or severity of existing NAAQS violations; or (3) delay the timely attainment of any NAAQS, interim milestones, or other milestones to achieve attainment (USAF 1995b). The rule does not apply to actions where the total direct and indirect emissions of nonattainment criteria pollutants do not exceed threshold levels for criteria pollutants established in 40 CFR 93.153(b). In addition to meeting *de minimis* requirements, a Federal action is considered regionally significant when the total emissions from the action equal or exceed 10 percent of the air quality control area's emission inventory for any criteria pollutant. If a Federal action meets *de minimis* requirements and is not considered a regionally significant action, then it is exempt from further conformity analyses pursuant to 40 CFR 93.153(c).

Launch vehicles are not stationary sources, and, therefore, the exhaust from launch vehicles is not subject to stationary emissions permits. Section 4.1.5.3 discusses the potential impacts of launch vehicle exhaust on stratospheric ozone.

The only emissions from spacecraft processing that would potentially impact NAAQS would be small amounts of volatile organic compounds (VOCs), which are precursors to ozone formation, and relatively minor NO_X emissions from spacecraft propellant transfers. The use of VOC-containing products, including solvents, coatings, and adhesives, is regulated by the SBCAPCD. These regulations assure that any release of VOCs would be small in comparison to launch vehicle releases, and hence no analysis has been required by regulation. NO_X emissions similarly would be small in comparison to launch vehicle emissions and hence have not been considered so long as launch vehicle emissions do not approach minimum threshold limits (*de minimis* limits).

The proposed launches of NRP spacecraft would not increase previously approved launch rates or utilize launch systems beyond the scope of approved programs at any of the proposed launch sites. CAA general conformity analyses have previously been completed for the licensing of the proposed sites, as appropriate.

4.1.5.3 Stratospheric Ozone Layer

Spacecraft and Launch Vehicle Processing

Ozone-depleting substances (ODSs), commonly used at launch sites in cooling systems and fire-suppression systems, may be utilized during prelaunch processing of NRP spacecraft and launch vehicles. Any ODS use would be accomplished in accordance with Federal, state, and local laws regulating ODS use, reuse, storage, and disposal. Release of materials other than propulsion system exhaust would be limited to inert gases. Since preparation and launch of NRP spacecraft would result in no release of ODSs into the atmosphere, there would be no impact on stratospheric ozone.

Launch Vehicle Emissions

The CAA does not list rocket engine combustion emissions as ODSs, and therefore rocket engine combustion emissions are not subject to limitations on production or use. While not regulated,

rocket engine combustion is known to produce gases and particles that reduce stratospheric ozone concentrations locally and globally (WMO 2006).

The propulsion systems utilized by launch vehicles that would launch NRP spacecraft emit a variety of gases and particles directly into the stratosphere. A large fraction of these emissions, CO_2 for example, are chemically inert, and do not affect ozone levels directly. Other emissions, such as HCl and H_2O, are not highly reactive, but they do have an impact on ozone globally since they participate in chemical reactions that help determine the concentrations of ozone-destroying gases known as radicals. A small fraction of rocket engine emissions are the highly reactive radical compounds that attack and deplete ozone in the plume wake immediately following launch. Particulate emissions, such as alumina and carbon (soot), may also be reactive in the sense that the surfaces of individual particles enable important reactions that would not proceed otherwise.

Table 4-6 presents the emissions from propulsion systems of the type utilized by launch vehicles that could most affect stratospheric ozone, grouped according to oxidizer and fuel combination: solid propellant using ammonium perchlorate and aluminum, LOX and liquid hydrogen, LOX and kerosene, and A-50 and NTO. Table 4-6 does not account for all emissions, only those most relevant to ozone chemistry. For example, all of the systems emit CO_2, but CO_2 does not play a direct role in ozone chemistry in the stratosphere.

Table 4-6 Launch Vehicle Emissions

Propellant	Launch Vehicles	Emissions
LOX/H_2	Delta IV	H_2O, (NO_X, HO_X)
LOX/RP-1	Atlas series, Delta II, Falcon series	H_2O, (NO_X, HO_X), soot (carbon), sulfate (H_2SO_4)
NTO/Aerozine-50	Delta II, Titan II & Titan IV	H_2O, NO_X, (HO_X, soot)
Solid	Atlas & Delta series with SRMs Taurus, Pegasus, Athena series, Minotaur series,	H_2O, HCl, Cl_X, NO_X, (HO_X), alumina (Al_2O_3)

Note:
Alumina, soot, and sulfate particles less than 5 microns.
NO_X includes NO, NO_2, NO_3.
HO_X includes OH, H_2O.
Cl_X includes Cl, Cl_2, and ClO.
Parenthesis denotes compounds that have not yet been measured but are expected to be present.

The relative emission rate (mass of emitted compound per mass of propellant consumed) has not been accurately determined for all of the compounds listed in Table 4-6. Rocket engine combustion computer models have been used to estimate the emission rates for some compounds (Aerospace 1994). Direct measurements using high-altitude aircraft have validated the model predictions in some cases (Ross 2000). The combustion models have not yet been used to estimate the rates for some important compounds (hydrogen oxides [HO_X] for example), although theoretical considerations suggest they should be present in the exhaust in small quantities.

The impact of rocket emissions is conveniently separated into an immediate local response following each launch and a long-term global response that reflects the steady, cumulative influence of all launches. Fast chemical reactions between reactive plume gases, particles, and

the surrounding air cause the local response. This can result in 100 percent ozone loss within the plume (Ross 2000). This phase lasts for several days until the reactive exhaust gases have been largely deactivated, and the plume has substantially dispersed. The ozone loss in this phase, while dramatic, does not likely contribute significantly to the global impact (Danilin 2001), at least for SRM emissions.

The global response is driven by the accumulation of all gas and particulate emissions over a long period of time after the exhaust has been mixed throughout the stratosphere. An approximate steady state is achieved as exhaust from newer launches replaces the exhaust from older launches, which is removed from the stratosphere by the global atmospheric circulation, a process that takes about 3 years. The emitted compounds add to the natural reservoirs of reactive gases and particle populations that control ozone amounts.

Of the four propellant combinations that would be utilized by the proposed launch vehicles and listed in Table 4-6, only SSRM emissions have been studied in depth. The local and global impact of chlorine emitted by SSRMs has been extensively measured and modeled and is relatively well understood (i.e., WMO 1991, 1999, 2006). The Space Shuttle solid booster and other SSRMs release reactive chlorine gases directly in the stratosphere and in this case, the quantities are small in comparison with other tropospheric sources. Additional modeling and observation results have been reported on rocket combustion emissions and plume wake chemistry since the previous Assessment (WMO 1999), in which it was concluded that stratospheric accumulation of chlorine and alumina exhaust from current launch activities leads to small (less than 0.1 percent) global column ozone decreases. The new data support this conclusion (WMO 2006).

The conclusions and findings of the various studies have been incorporated into the NEPA analysis for the proposed launch vehicles listed in Appendix A. The impact of alumina and soot particulate, NO_X and HO_X emissions are less well understood than chlorine emissions. Laboratory and plume data suggest that the impact of alumina particulate is not substantial, although some uncertainty remains. For some plausible model assumptions, the global impact of alumina particulate is comparable to the chlorine impact (Jackman 1998). NO_X and HO_X emissions are small, and their impacts are likely not significant compared to chlorine and alumina, although they have not been included in models.

In contrast to SSRMs, the impacts of liquid propellant rocket engine emissions have not been extensively studied. Detailed computer models of liquid engine emissions have not yet been developed. Laboratory and plume measurements of relevant compounds and chemical reactions have not been made. Finally, the global atmospheric models that have been successfully applied to SSRM emissions have not been applied to liquid emissions. The few findings that have been published highlight the reactive gas and soot emissions of kerosene-fueled engines and associated potential for ozone impacts (Newman 2001; Ross 2000). Because of the scant data and lack of modeling tools, it is not possible to estimate the impact of liquid propellant systems with the same degree of confidence as has been done for solid propellant systems. Further research is required before the stratospheric impacts of LOX/LH_2, LOX/RP-1 (kerosene), and NTO/A-50 combustion emissions can be quantified.

Among the proposed launch vehicles, the Atlas V 551 emits the greatest amount of SSRM exhaust into the stratosphere. In order to estimate an upper limit on ozone loss, it is assumed that three NRP spacecraft would be launched each year using the Atlas V 551. The global ozone loss associated with SSRM emissions from steady state Atlas V 551 operations is about 0.077 percent (i.e., (30+15) * 0.000017) per launch (USAF 2000a). Recalling that the ozone impact of kerosene-fueled rocket engines is not known and in keeping with interest in estimating an upper limit, it is also assumed that the ozone loss caused by the Atlas V liquid propellant engines equals the ozone loss caused by the SSRMs. Thus the global ozone loss from NRP spacecraft launches would not exceed 0.46 percent (i.e., 0.00077 per launch times three launches per year times factor of 2 for soot). The present state of the stratosphere is characterized by global ozone loss of about 4 percent, caused by past use of chlorofluorocarbons (CFCs) and other controlled materials (WMO 1999). NRP spacecraft launches would cause an additional ozone loss of not more than 0.46 percent to the already existing 4 percent loss and would therefore increase the preexisting loss by less than one eighth of 1 percent.

Reentry Debris Particles

This section discusses the potential impact of reentry debris upon stratospheric ozone. Orbital debris and reentry of debris have other potential environmental impacts and hazards that are discussed in Section 4.1.7. An emerging area of concern is the potential influence of metallic particulate generated as reentering spacecraft and upper stages vaporize during atmospheric entry. The vaporized material condenses as micron-sized particles that populate the upper atmosphere. A class of metallic particles that have been attributed to this source increased in stratospheric concentration by a factor of 10 between 1976 and 1984 (Zolensky 1989). The sources of these particles and their potential to affect stratospheric ozone is not understood, and further research is required to determine if they represent a substantial potential to impact stratospheric ozone. A number of NRP spacecraft may be deorbited at their end of life as part of the requirement to control orbital debris (see Section 4.1.7), and a fraction of their structure would contribute to the population of particles attributed to entry vaporization. Whatever the impact of these particles, the small number of possible NRP spacecraft reentry events ensures that they would not add substantially to the existing stratospheric burden and; therefore, would not have a substantial impact on ozone. See NASA-HDBK 8719.14 for more information on reentry debris.

4.1.6 Noise and Sonic Boom

An impact may be considered substantial if (1) the proposed action increased substantially the ambient noise level for adjoining areas, and (2) the increased ambient noise affected the use of the adjoining areas. NASA, the FAA, and USAF consider noise, including sonic boom, impacts on endangered species, marine mammals, historic structures, or any other protected property.

4.1.6.1 Spacecraft Processing Impacts

The processing of the proposed spacecraft would not produce any substantial amount of noise outside of the processing facilities. The facilities employed for spacecraft processing, however, may generate moderate amounts of industrial noise due to operating machinery, generators, public address systems, and similar typical industrial systems. All such systems are subject to OSHA, AFOSH, or Army/OSH regulations, and hearing protection would be utilized if and

when required. The standard for noise, such as from generators, is based on the Noise Control Act of 1972 (NCA) (P.L. 92-574), as amended. State and local standards serve as a guide if these are at least as stringent as Federal standards. There would not be an increase in the noise at the assembly site. Impact on the environment outside of the facility would be minimal, and the potential for overall environmental impact on biota or personnel is not considered substantial.

4.1.6.2 Launch Vehicle Impacts

The noise and sonic booms from launches are typical of routine operations at all of the proposed launch sites. Noise from launch-related activity appears to be an infrequent nuisance rather than a health hazard on the surrounding community. Sonic boom impacts on wildlife at all of the proposed launch sites are discussed in the following sections:

- CCAFS and KSC – Section 4.1.13.1
- VAFB – Section 4.1.13.2
- USAKA/RTS – Section 4.1.13.3
- WFF – Section 4.1.13.4
- KLC – Section 4.1.13.5

Peak launch noises for all proposed launch vehicles would be experienced for a brief time period (approximately 5 seconds), and therefore, are not expected to exceed EPA or OSHA, AFOSH, or Army/OSH requirements and recommendations (see Table 4-7). Moreover, any personnel at the launch site exposed to high noise levels would wear protective gear.

Table 4-7 Typical Launch Vehicle Noise Levels at 1.6 Kilometers (1 Mile)

Launch Vehicle	Maximum Noise Level (dBA)	Standard
Athena	99	OSHA Requirements Not to exceed 115 dBA for > 15 min. Not to exceed 90 dBA for an 8-hr day
Delta II	110	
Taurus	100	EPA Recommendation Not to exceed 70 dBA for the general public as a 24-hr average
Titan II	112	

Key: dBA=a-weighted decibels.
Source: Data acquired from USAF 1995a to compare measured to regulated noise levels.

4.1.7 Launch Accident Suborbital, Orbital and Reentry Debris

4.1.7.1 Orbital and Reentry Debris

This section addresses the potential environmental impacts associated with the reentry and eventual impact of NRP spacecraft.

Orbital debris is defined as artificial objects, including derelict spacecraft and spent launch vehicle orbital stages, left in orbit and no longer serving a useful purpose. As a result of U.S. and foreign space activities, objects in orbit may reenter the Earth's atmosphere. From 1957 through 2010, more than 21,000 objects had reentered the atmosphere. The vast majority of these reentries (nearly 20,000) were in an uncontrolled manner. To date, no reports of human injuries or fatalities from reentering objects have been confirmed (SAIC 2010). NASA, on

behalf of the U.S. Government, annually presents reentry statistics to the United Nations (UN) Committee on the Peaceful Uses of Outer Space (COPUOS) Scientific and Technical Subcommittee (STSC). In February 2011, NASA reported that 382 man-made objects reentered the atmosphere in 2010. Of these, 356, including 22 spacecraft and 27 launch vehicle stages with a total aggregate mass of approximately 54 tonnes (60 tons), reentered in an uncontrolled manner. The number of reentries is normally driven by satellite fragmentations and solar activity. The annual mass of reentries has varied significantly with changes in the world-wide launch rate and solar activity, reaching a high of 350 tonnes (385 tons) in 1988.

During atmospheric reentry, the extreme heat generated while descending through the Earth's atmosphere would cause the majority of the reentry vehicle to burn up; however, in some instances reentry vehicle parts could survive to impact. During a controlled reentry, such debris would land in a predetermined ocean area no closer than 370 km (230 m) from foreign land masses, 46 km (29 m) from U.S. territories and the Continental United States, and 46 km (29 m) from the permanent ice pack of Antarctica (NASA-STD 8719.14).

As part of the standard safety review process, NASA missions encompassed under this EA would comply with the re-entry requirements of the NASA Standard 8719.14, Process for Limiting Orbital Debris. This NASA Standard (i.e. Requirement 4.7.1) limits the risk of human casualty from re-entry debris to 1 in 10,000 and requires that missions be designed to assure that in both controlled and uncontrolled entries that domestic and foreign landmasses are avoided. Further, beyond the broad assessment in this EA, individual missions are required to prepare an orbital debris assessment to assess conformance with orbital debris guidelines. NASA is in the process of expanding the implementation of this Standard beyond consideration of the kinetic energy of surviving debris (that could result in blunt force injuries) to encompass consideration of potential toxic and related hazards such as those associated with onboard propellants. The implementation of this NASA Standard through a formal safety review process for each mission will inform NASA decision makers in the early phases of a mission (prior to the preliminary design review) on the potential environmental hazards associated with the mission, and will provide a means for limiting and mitigating the potential environmental impacts from spacecraft onboard propellants. Every mission to be encompassed under this Routine Payload EA will satisfy this Orbital Debris Assessment Report requirement.

The environmental impact of objects falling into the ocean would depend on the physical properties of the materials (e.g., size, composition, quantity, and solubility) and the marine environment of the impact region. Based on past analyses of other space components, it is expected that the environmental impact of reentering orbital debris would be negligible (NASA 1996, 2005b; USAF 1998). There is a remote possibility that surviving pieces of debris could impact marine life or vessels on or near the ocean surface. Once the pieces travel a few feet below the ocean surface, their velocity would be slowed to the point that the potential for direct impact on sea life would be low (NASA 2008a). It is anticipated that most components would sink and slowly corrode on the ocean floor. Toxic concentrations of metals would be unlikely because of slow corrosion rates and the large volume of ocean water available for dilution (USAF 1996). The potential for long-term environmental impact from the debris on the ocean floor is small (NASA 2008c). The spacecraft would be constructed mostly of carbon-based composites and aluminum. At the end of a normal mission, propellant and oxidizer in the spacecraft would be expected to vent fully prior to debris impact, but trace amounts could

remain. After being placed into orbit by the rocket's uppermost stage, the spacecraft would perform their design functions until the end of their respective missions. After inserting the spacecraft into orbit and at the missions' end, the upper stages and spacecraft, respectively, would be required to follow one of three disposal options discussed below to mitigate the accumulation of orbital debris:

1. Atmospheric Reentry – the spacecraft and/or upper stage would either leave its orbit by uncontrolled reentry caused by natural orbital decay or by a controlled de-orbit trajectory.
2. Storage Orbit – the spacecraft and/or upper stage would maneuver to an orbital altitude that would minimize its potential for impacting current or future orbiting spacecraft or missions. This option would only be executed by space structures with a capable on-board propulsion system adequate to raise their altitude to an appropriate storage orbit of at least 2,000 km (1,240 mi) above the Earth's surface.
3. Direct Retrieval – the spacecraft and/or upper stage would be collected by another on-orbit mission and disposed of as part of that mission in accordance with applicable orbital debris and reentry requirements. Although not currently exercised by NASA, this option may become available in the future.

Because of the increasing number of objects in space and their potential for reentry, NASA adopted guidelines and assessment procedures to reduce the number of non-operational spacecraft and spent rocket upper stages orbiting the Earth.

NASA's launch Project Managers must employ design and operation practices that limit the generation of orbital debris, consistent with mission requirements and cost effectiveness. NPR 8715.6A, "NASA Procedural Requirements for Limiting Orbital Debris," requires that each program or project conduct a formal assessment for the potential to generate orbital debris and to analyze the impacts of space structure reentry. NASA also has in place a technical standard (NASA-STD 8719.14) and corresponding handbook (NASA-NHBK 8719.14) to provide specific guidelines and methods to limit orbital debris generation.

General methods to accomplish this policy include:

- Depleting onboard energy sources after completion of the mission;
- Limiting orbit lifetime after mission completion to 25 years or maneuvering to a disposal orbit;
- Limiting the generation of debris associated with normal space operations;
- Limiting the consequences of impact with existing orbital debris or meteoroids;
- Limiting the risk from space system components surviving reentry as a result of post mission disposal;
- Limiting the size of debris that survives reentry.

Orbital missions originating from any of the proposed launch facilities would comply with the orbital and reentry debris processes described above.

In addition, each NASA program and project would be required to submit a debris assessment to the NASA Office of Safety and Mission Assurance. The following categories must be addressed in the debris assessment:

- Debris released during normal operations;
- Debris generated by explosions and intentional breakups;
- Debris generated by on-orbit collisions during mission operations;
- Reliable disposal of spacecraft and launch vehicle orbital stages after mission completion;
- Structural components impacting the Earth following post-mission disposal by atmospheric reentry;
- Disposal of spacecraft and launch vehicle stages in orbits about the Moon; and
- Debris generated by on-orbit collisions with a tether system.

If an orbital debris requirement cannot be met because of an overriding conflict with mission requirements, technical capabilities, or prohibitive cost impact, then a waiver can be requested through the NASA program manager per NPR 8715.3C, "NASA General Safety Program Requirements," with the orbital debris assessment report containing the appropriate rationale and justification. Deviations from such requirements are highly mission dependent and would be considered on a case-by-case basis.

As stated previously, to mitigate potential safety and environmental impacts from orbital debris generation and space structure reentry, all NASA orbital missions originating from the proposed launch facilities would comply with the processes outlined in NPR 8715.6 and NASA-STD 8719.14, both of which establish requirements for (1) limiting the generation of orbital debris, (2) assessing the risk of collision with existing space debris, (3) assessing the potential of space structures to impact the surface of the Earth, and (4) assessing and limiting the risk associated with the end of mission of a space object. These requirements apply to both full spacecraft and jettisoned components, including launch vehicle orbital stages.

Potential Impacts on Human Health of Spacecraft Propellants Released in Reentry Accidents

NASA studied the potential risks associated with reentry and Earth impact of spacecraft propellant tanks, specifically in regard to a late launch failure into a typical parking orbit for later deep space trajectoty injection. The study relied primarily on existing data and analyses supplemented by a detailed assessment of the potential impacts of a suborbital accident from the Eastern Range (CCAFS) involving approximately 400 kg (882 lb) of hydrazine reaching land. This case was determined to represent a wide range of potential accidents involving hydrazine propellants.

The study of a postulated release of approximately 400 kg of residual hydrazine as a result of a suborbital accident for a launch from the Eastern Range indicates there is less than 1 chance in 10,000 (including the probability of the launch failure and ground impact) of harming any

individual based on the 1-hour interim Acute Exposure Guideline Level-2 (AEGL-2)[10] value of 13 ppm (17mg/m^3) established by the EPA for hydrazine [http://www.epa.gov/oppt/aegl/index.htm]. In fact, a larger release of hydrazine (i.e., a factor of 2 to 3 higher) or approximately 1,200 kg under the same circumstances would still pose less than 1 chance in 10,000 of harming any individual (including the probability of the launch failure and ground impact).

Analyses indicate that orbital re-entry accidents involving tanks up to 1,850 kg (4,144 lb) of hydrazine - the largest tanks currently used in NASA missions similar to those addressed by this EA - would not likely contain on the order of more than 1,000 kg (2,204 lb) of their propellant after an orbital re-entry accident due to propellant tank inlet and outlet fittings failing during re-entry and dispersing propellants at high altitude.

Available studies of NASA spacecraft launched with heat shields protecting their propellant tanks from re-entry heating (e.g., NASA Mars science missions to the surface of Mars) indicate that the spacecraft would break up during orbital re-entry and (similar to spacecraft with no heat shields) disperse their propellants at high altitude.

The potential impact on human health from reentry involving spacecraft and launch vehicles propellant and other hazardous materials could be comparable to, greater than, or less than the impacts discussed above. An assessment of potential impacts for planned end of mission re-entry is performed for each mission to determine compliance with the requirements of NPR 8715.6 and NASA-STD 8719.14. The prelaunch review also collects payload data that enable NASA to analyze, plan for and respond to contingency re-entry.

4.1.7.2 Spacecraft Impacts

The NRP spacecraft encompassed in this EA would comply with all requirements of NPR 8715.6, "Policy for Limiting Orbital Debris Generation" and NASA-STD 8719.14. A debris assessment would be prepared as required by this policy.

Over the period 1957 to 2010 more than 21,000 payloads and debris objects reentered the atmosphere. To date, there have been no confirmed human injuries or fatalities from reentering objects (SAIC 2010).

4.1.7.3 Launch Vehicle Impacts

The implementation of launch vehicle mitigation measures is discussed in the individual NEPA documents for specific launch vehicles (See Appendix A for those NEPA documents). By way of summary, in a normal launch, lower stages and SSRMs would burn to depletion and impact in the open ocean with little remaining fuel.

Upper stages that achieve LEO are usually programmed after spacecraft separation to burn residual propellants to depletion in a vector that would result in reentry in 2 to 3 months. These

[10] AEGLs represent threshold exposure limits for the general public and are applicable to emergency exposure periods ranging from 10 minutes to 8 hours. AEGL-2 is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects, or an impaired ability to escape.

objects would be mostly consumed by reentry heating, but some pieces would be expected to survive reentry and would be tracked by the U.S. Space Command to assure harmless impact. Upper stages reaching higher orbits are not subject to controlled reentry and would contribute to debris. Their location would be tracked by the U.S. Space Command to permit avoidance with future launch trajectories. However, the accumulation of such debris is of international concern, and potential reasonable mitigation measures are under study.

4.1.8 Biological Resources

An impact to biological resources may be considered substantial if the Federal action would materially impact a threatened or endangered species, substantially diminish habitat for a plant or animal species, substantially diminish a regionally or locally important plant or animal species, interfere substantially with wildlife movement or reproductive behavior, and/or result in a substantial infusion of exotic plant or animal species.

Any action that may affect federally listed species or their critical habitats requires consultation with the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the Endangered Species Act of 1973 (as amended). In addition, the Marine Mammal Protection Act (MMPA) of 1972 prohibits the taking of marine mammals, including harassing them, and may require consultation with the National Marine Fisheries Service (NMFS). The NMFS is also responsible for evaluating potential impacts on essential fish habitat and enforcing the provisions of the 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (50 CFR 600.905 et seq.). The USFWS and the NMFS have previously reviewed NEPA documentation for the proposed launch vehicles at all proposed launch sites and have specified required launch restrictions and other impact mitigation measures. No payload processing or launch activities connected with this proposed action would require permits and/or mitigation measures beyond the baseline permits and mitigation measures already necessary or in coordination with VAFB, CCAFS, USAKA/RTS, WFF, and KLC launches.

4.1.8.1 Spacecraft Processing Impacts

Processing of NRP spacecraft would occur in existing facilities, and payloads would be transported on existing roadways. Adjacent habitats would not be disturbed. Exterior lighting at all facilities used for spacecraft processing at CCAFS would comply with established lighting policy for minimizing disorienting effects on sea turtle hatchlings.

4.1.8.2 Launch Vehicle Impacts

Impacts from launch activities may be described in terms of the following categories: (1) exhaust emissions directly at the launch pad that remain and are deposited in the area, (2) near-field impacts from the exhaust cloud (generally within 500 m [1,640 ft]) but sometimes up to 1 km (0.62 mi) from the pad, (3) impacts from far-field deposition of the buoyant portion of the launch cloud (more than a few km from the launch pad), and (4) impacts on the stratosphere as the launch vehicle passes through it. The fourth category is described in detail in Section 4.1.5.3.

The near–field impacts from an exhaust cloud depend primarily on the amount of sound-suppression water (its evaporation lowers the temperature and the altitude of the exhaust cloud) and on the time the launch vehicle remains near the launch pad during ascent. The

observations of near-field impacts from launches have been well documented based on years of launching the Space Shuttle and expendable launch vehicles. They include destruction of sensitive plant species followed by re-growth during the same growing season, 2 to 3 days drop in pH (a measure of acidity/alkalinity) in nearby waters down to 1 m (3.3 ft), which results in fish kills in nearby shallow surface waters. This is followed by a return to normal pH levels. There could possibly be deaths of burrowing animals in the path of the exhaust cloud. The near-field impacts from exhaust clouds have been observed at distances up to a few hundred meters from the launch pad, well within launch site boundaries, and do not reach human populations offsite (NASA 2007).

Minor brush fires are infrequent by-products of launches and are usually contained and limited to ruderal vegetation (species of plants growing where the natural vegetational cover has been disturbed by humans) within the launch complexes. HCl could be created by rain falling through the SSRM exhaust cloud. Wet deposition of HCl on leaves has been observed to persist on leaf surfaces for considerable periods, no mortality of these plants and no changes in plant community composition or structure have been observed in the far field related to launch effects (NASA 2007). Wet deposition is not expected to occur outside the pad fence perimeter due to the small initial size and rapid dissipation of the ground cloud (Boeing 1996).

During a normal launch, the launch vehicle and spacecraft would fly over CCAFS, VAFB, the RMI, Wallops Island, and Kodiak Island coastal waters and into orbit without impacts of any kind on the marine life or habitat. Only in the event of an early launch abort or failure where the spacecraft and launch vehicle debris would fall into this area would there be a potential impact. Launch vehicle debris from a liquid propellant vehicle is considered a negligible hazard because virtually all hazardous materials are consumed in the destruct action or dispersed in the air, and only structural debris remains could strike the water. The exception arises when solid rocket motors with residual propellant impact the ocean. This introduces ammonium perchlorate oxidizer into the water by leaching from the rubber-base propellant over a period of time. The low toxicity of this compound together with the slow release into the water does not present a known substantial health hazard to marine life.

Even in a destruct action, spacecraft could survive to impact the water essentially intact, presenting some potential for habitat impact. This potential arises because spacecraft can be carrying onboard hypergolic propellants, which may be toxic to marine organisms. A lesser potential hazard exists from small amounts of battery electrolyte also carried on all spacecraft. However, the risk from electrolyte is minimal due to small quantities, lower toxicity, and more rugged containment.

The reliability of the Delta II launch vehicle is estimated to be approximately 98 percent, the highest demonstrated reliability of any American launch vehicle. Reliabilities of the other vehicles are close to this percentage. Using the Delta case of three launches per year, its 0.98 probability of success for each launch, and an assumption that all failures result in ocean impact of the spacecraft, the probability of one failure in eight launches is calculated to be 0.06 (i.e., $8 \times 0.98^2 \times 0.02$). In the event of a failure, launches of that vehicle would be suspended until the cause could be corrected. However, depending on the precise timing and failure mechanism, several scenarios are possible if an ocean impact did occur:

- The entire spacecraft, with onboard propellants, is consumed in a destruct action,
- The spacecraft is largely consumed in the destruct action, but residual propellant escapes and vaporizes into an airborne cloud,
- The spacecraft survives to strike the water essentially intact, whereupon the propellant tanks rupture, releasing liquid propellants into surface waters,
- The spacecraft survives water impact without tank rupture and sinks to the bottom, but leaks propellant into the water over time.

The probability of any one of these scenarios is unknown, but only the last two would offer potential impact on marine life or habitat. No. 3 would release the entire propellant load into surface waters, producing the highest concentrations (assuming no combustion on contact of fuel with oxidizer) whereas No. 4 would produce lower concentrations over time. No. 3 may expose a few individuals of marine species to acute concentrations.

The toxicology of hydrazine, MMH and NTO to marine life is not well known. NTO almost immediately forms nitric and nitrous acid on contact with water and would be quickly diluted and buffered by seawater; hence, there would be negligible potential for harm to marine life. With regard to hydrazine fuels, these highly reactive substances quickly oxidize, forming amines and amino acids, which are beneficial nutrients to simple marine organisms. Prior to oxidation, there is some potential for exposure of marine life to toxic levels, but for a very limited area and time. A half-life of 14 days for hydrazine in water is suggested based on the unacclimated aqueous biodegradation half-life (half-life refers to the amount of time it takes for half of the chemical to break down [degrade]) (Howard 1991).

The results of a launch area accident, including extreme heat, fire, flying debris, percussive effects of the explosion, and HCl deposition, could damage adjacent vegetation. An accident on the launch pad involving SSRMs could also present potential impacts on biological resources due to the possibility of solid propellant fragments that might impact in surface waters. Most, if not all, pieces of unburned solid propellant falling on land or in shallow, fresh-water areas would be collected and disposed of as hazardous waste.

The near-field impacts on vegetation and wildlife should be similar to the near-field impacts of normal launches. Observations of near-field impacts from launches have been documented and include destruction of sensitive plant species followed by re-growth within the same growing season, a rapid drop in pH levels in nearby waters down to 1 m (3 ft) (resulting in fish kills) followed by a return to normal pH levels, and possibly deaths of burrowing animals in the path of the exhaust cloud or solid propellant fire plume (NASA 2007).

Unrecovered ammonium perchlorate in the SSRM fuel contains chemicals that, in high concentrations, have the potential to result in adverse impacts on the marine environment. After consultation with the NMFS, the USAF found “no greater than minimal adverse effects” on essential fish habitat under NMFS regulations (USAF 2000b).

The predominant impacts of an early ascent accident or mission abort on the ocean environment would be due to unspent fuel and unrecoverable accident debris. The magnitude of the impact

would depend on the physical properties of the materials (e.g., size, composition, quantity) and the physical oceanography of the impact area. It is expected that the components would slowly corrode. Toxic concentrations would be unlikely because of the slow corrosion rates and the volume of ocean water available for dilution. Falling launch vehicle fragments would be unlikely to strike a marine mammal due to the extent of the open ocean and the relatively low density of marine mammals in the surface waters of open ocean areas (USAF 1998).

Detailed discussions of biological impacts from launch vehicles at each of the launch sites can be found in the following section:

- CCAFS and KSC – Section 4.1.13.1
- VAFB – Section 4.1.13.2
- USAKA/RTS – Section 4.1.13.3
- WFF – Section 4.1.13.4
- KLC – Section 4.1.13.5

4.1.9 Historical and Cultural Resources

Impacts on cultural resources could be considered substantial if the Federal action resulted in disturbance or loss of values or data that qualify a site for listing in the NRHP; substantial disturbance or loss of data from newly discovered properties or features prior to their recordation, evaluation and possible treatment; or substantial changes to the natural environment or access to it such that the practice of traditional culture or religious activities would be lost.

The proposed action would use existing facilities for payload processing, existing roadways for payload transportation, and existing launch facilities. Since no surface or subsurface areas would be disturbed by construction activities, no substantial archeological, historic, or other cultural properties would be affected by the proposed action.

4.1.10 Economic Factors

Launching the proposed spacecraft would have a negligible, if any, impact on local communities, since no additional permanent personnel are expected beyond the current launch site staff. The action would cause no additional adverse impacts on community facilities, services, or existing land uses.

4.1.11 Environmental Justice

EO 12898 directs Federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on low-income populations and minority populations in the United States. Given the launch direction and trajectories of the proposed spacecraft and protection provided by Range Safety regulations, there would be little or no potential for substantial environmental effects on any human populations, including children outside CCAFS, VAFB, USAKA/RTS, WFF, and KLC boundaries.

4.1.12 Cumulative Effects

The use of facilities at all proposed launch sites for processing and launch of NRP spacecraft would be consistent with existing uses and would pose no new types of impacts. The proposed action includes a variety of launches. The maximum number of launches of the candidate launch vehicles would not exceed those approved for the launch sites. The number of payloads processed and launched by the proposed action per year would be small when compared to ongoing programs at all proposed launch sites. For instance, the EELV program projects 28.3 launches of Delta IV and Atlas V vehicles per year over the next 20 years. This includes annual averages of 10.5 Atlas V and 10.9 Delta IV launches from CCAFS, and 3.3 Atlas V and 3.3 Delta IV launches from VAFB (USAF 2000a). At VAFB, permits and mitigation measures exist for up to 10 Deltas II launches per year from SLC-2 (NASA 1994), and a total of 25 launches per year from the California Commercial Spaceport (SLC6 1995). WFF is permitted for 18 launches per year. These launch rates would be supplemented by additional launches of Taurus, Falcon 1 and 9, and Delta II vehicles at CCAFS; the Falcon I, Taurus, Pegasus, Falcon, and Minotaur launches at VAFB, the Falcon I and 9 launches from USAKA/RTS, Taurus, Falcon, and Minotaur launches from WFF, and tMinotaur, Falcon and Taurus launches from KLC. The proposed launch of NRP spacecraft would not increase previously approved launch rates nor utilize launch systems beyond the scope of approved launch vehicle programs at all proposed launch sites.

Greenhouse gases absorb the infrared energy from the Sun and Earth. Some direct greenhouse gases, (e.g., CO_2, chlorofluorocarbons, and water) are emitted from these processes described in this EA. Other gases (e.g., NO_X and VOCs) emitted from these processes contribute indirectly by forming ozone and other reactive species that photochemically react with the greenhouse gases and control the radiation penetrating to the troposphere.

The global warming potentials for many greenhouse gases (expressed in metric tons [mt] of carbon dioxide [CO_2] equivalent) have been developed to allow comparisons of heat trapping in the atmosphere. The principal source of carbon emissions that could be associated with NRP spacecraft launches would be from NASA's energy use in support of the launches. Launches would also contribute to the production of carbon monoxide (CO) and CO_2. The following annual greenhouse gas emissions were reported for 2008 in the U.S.: 6,956.8 million metric tons (7.8 trillion tons) of CO_2 equivalent, 17.1 million mt (18.8 million tons) of NO_X, and 87.6 million mt (96.6 million tons) of CO (EPA 2006a). Although water vapor is considered a greenhouse gas, it is not tracked in the EPA inventory (NASA 2007).

Emissions from rocket exhaust would also deposit carbon into the atmosphere based on the vehicles proposed for launch of NRP spacecraft, and a representative number (eight) of NRP spacecraft launches per year.

Since the launch rate for the proposed action would be within the rate previously approved for these vehicles at these launch sites, there would not be any substantial increase in cumulative impact for payload processing and launch. Therefore, the long-term, cumulative effects to the local and regional environment by the proposed action would not be substantial.

4.1.13 Detailed Discussion of Impacts of Proposed Action at Each Launch Site

4.1.13.1 CCAFS and KSC

Air Quality

Payload Propellant Spills

Inadvertent releases of toxic air contaminants are possible as a result of accidents during payload processing, transportation, and launch. The largest releases would result from the spillage of the entire quantity of liquid propellants. Safety procedures in place at all of the proposed launch sites ensure that these events are unlikely to occur.

The mean hazard distances predicted by AFTOX for the CCAFS and KSC area are displayed in Table 4-8 in the event the entire quantity of liquid propellants is spilled. An unconfined spill of 1,000 kg (2,200 lb) of hydrazine would produce a spill area of 107 m^2 (1,156 ft^2) and a mean hazard distance of up to 1,493 m (4,897 ft). An unconfined spill of 1,000 kg (2,200 lb) of MMH would produce a spill area of 114 m^2 (1,231 ft^2) and a mean hazard distance of up to 1,452 m (4,763 ft). An unconfined spill of 1,200 kg (2,640 lb) of NTO would produce a spill area of 80 m^2 (864 ft^2) and a mean hazard distance of up to 5,680 m (18,630 ft) for NTO.

Air Quality Impacts from Launch Vehicles — Normal Launches

The maximum ground-level concentrations resulting from normal launches of Atlas V and Delta IV vehicles from CCAFS are shown in Table 4-9. These concentrations of rocket exhaust emissions are predicted by REEDM for a meteorological condition where a low-altitude temperature inversion traps the launch cloud near ground. Other meteorological conditions would yield different results.

Table 4-8 Mean Hazard Distances to SPEGL (1-Hr Average) Exposure Limits as Predicted by AFTOX for Payload Maximum Liquid Propellant Spills at CCAFS and KSC

Chemical (SPEGL)	Spill Quantity	Wind speed	Day (32°C [90°F])	Night (5°C [41°F])
Hydrazine	1,000 kg (2,200 lb)	2 m/s (6.6 ft/s)	655 m (2,148 ft)	669 m (2,194 ft)
(0.12 ppm)		10 m/s (33 ft/s)	1,493 m (4,897 ft)	747 m (2,450 ft)
MMH	1,000 kg (2,200 lb)	2 m/s (6.6 ft/s)	641 m (2,102 ft)	769 m (2,522 ft)
(0.26 ppm)		10 m/s (33 ft/s)	1,452 m (4,763 ft)	773 m (2,535 ft)
NTO	1,200 kg (2,640 lb)	2 m/s (6.6 ft/s)	1,230 m (4,034.4 ft)	2,574 m (8,443 ft)
(1.0 ppm)		10 m/s (33 ft/s)	5,680 m (18,630 ft)	3,411 m (11,188 ft)

Note: AFTOX predicts that NTO liquid spills would be gas releases at 32°C (90°F) ambient temperature. For modeling purposes, the gas release was assumed to have a duration of 5 minutes. In summary, all mean hazard distances for toxic air releases from payload accidents at CCAFS and KSC would be less than 5.7 km (3.4 mi) for the meteorological conditions considered. This would be the maximum distance downwind that would require evacuation and control by Range Safety authorities.
Source: *2002 NRP EA.*

Table 4-9 Maximum Downwind Concentrations for Normal Launches at CCAFS

Vehicle	Averaging Time	NO_X (ppm)	HCl (ppm)	Al_2O_3 (mg/m^3)
Atlas V 551/552	Instantaneous	0.000	0.466	1.051
	60-minute	0.000	0.030	0.045
Atlas V Heavy	60-minute	0.025	N/A	N/A
Delta IV H	30-minute	0.012	N/A	N/A
Delta IV M+(5,4)	Instantaneous	0.000	0.634	0.996
	60-minute	0.000	0.029	0.040

Key: N/A=Not Applicable.
Sources: USAF 1998; 2000a: Appendix T.

Launch Vehicle Propellant Spills

The most severe propellant spill accident scenario at CCAFS related to launch of the candidate vehicles would be the release of the entire Delta II second-stage load of NTO. Ground-level NO_2 vapor concentrations resulting from this size spill are predicted to be reduced to less than 5 ppm at 150 m (500 ft) downwind of the spill site, and to less than 1 ppm at 300 m (1,000 ft) downwind (Boeing 1996).

Launch Failures

An in-flight or on-pad failure of the Delta II launch vehicle represents the greatest toxic hazard at CCAFS resulting from the launch failure of a candidate vehicle. This is due to the load of hypergolic propellants (hydrazine and NTO) on the Delta II second stage. Table 4-10 displays the chemical concentrations resulting from a Delta II fireball (deflagration) as predicted by REEDM. Although much of the hypergolic propellants would be consumed in the deflagration fireball, emissions would include hydrazine (N_2H_4), unsymmetrical dimethylhydrazine (UDMH), NO_2, ammonia (NH_3), and nitric acid (HNO_3). Any NTO that does not react with other propellants is predicted by REEDM to convert to NO_2.

Table 4-10 Peak Concentrations and 60-Minute Mean Concentrations for a Catastrophic Launch Pad Failure (Deflagration) of the Delta II 7,925 at CCAFS During Worst Case Meteorological Conditions

Exhaust Cloud Constituent	Peak Concentration (ppm)	Maximum 60-Minute Mean (ppm)	Distance From LC-17 Peak/Mean in km (miles)
Al_2O_3[a]	0.405 mg/m^3	0.012 mg/m^3	10/12 (6.25/7.5 mi)
CO	8.701	0.255	10/12 (6.25/7.5 mi)
HCl	0.511	0.015	10/12 (6.25/7.5 mi)
HNO_3	0.002	No HNO_3 found	14/– (8.75/– mi)
N_2H_4	0.016	No N_2H_4 found	10/– (6.25/– mi)
NH_3	0.260	0.008	10/12 (6.25/7.5 mi)
NO_2	0.660	0.019	10/12 (6.25/7.5 mi)
UDMH	0.044	0.001	10/12 (6.25/7.5 mi)

a. Al_2O_3 concentrations are in mg/m^3 because the aluminum oxide is a particulate rather than a gas. Note that current naming convention would refer to Delta II 7925 as Delta II 2925.

Source: Data acquired from NASA 1998 to document predicted concentrations resulting from a Delta II fireball.

Biological Impacts from Launch Vehicles

Birds, reptiles, and small mammals would be most at risk from impacts due to a launch accident. Potential fires could result in temporary loss of habitat and mortality for species that do not leave the area. An accident on the launch pad would frighten nearby sensitive animal species that use the Indian and Banana Rivers (such as birds in rookeries and neo-tropical land birds). Threatened and endangered species, such as manatees, sea turtles, and other aquatic species would not be expected to be adversely affected by a launch accident.

NASA has mapped the effects on local vegetation of 14 Delta, 20 Atlas, and 8 Titan launches from CCAFS (Schmalzer 1998). Titan launches are included to bound the case for certain effluents. Vegetation scorching has been limited to small areas (less than 1 hectare [2.5 acres]) within 150 m (495 ft) of the launch pad for Atlas and Titan launches. Acid and particulate deposition for Delta launches has extended less than 1 km (0.6 mi) from the launch pad and affected relatively small areas (up to 46 hectares [114 acres]). Continuous acid deposition has not exceeded a radius of 1 km (0.6 mi) from the launch pad for Titan launches. However, isolated acid deposition has occurred up to 9.3 km (5.8 mi) from the launch pad under certain meteorological conditions. Particulate deposition from Titan launches has occurred over larger areas (2,366 hectares [5,847 acres]) and up to 14.6 km (9.1 mi) from the launch pad. No discernable vegetation or other environmental damage appears to be caused by this particulate deposition.

Debris from launch failures has the potential to adversely affect managed fish species and their habitats. There are over 200 fish species that inhabit the waters in the vicinity of KSC and CCAFS that are managed by regional management councils. Localized fish kills occur for a short time after most Space Shuttle launches as a direct result of surface water acidification. NASA has consulted with the NMFS on essential fish habitat regarding launches of the Ares vehicles from KSC. NASA indicated to NMFS that with over 25 years of Space Shuttle operations, there have been no documented long-term impacts on marine life or marine habitats from these operations.

However, the smaller launch clouds produced by Delta, Atlas, and Titan launches have not produced substantial acidification and have resulted in no recorded fish kills. Without substantial acidification of surface waters, any aluminum oxide deposited in surface waters would remain insoluble and nontoxic to the biota. No animal mortality has been observed at CCAFS that could be attributed to Delta, Atlas, or Titan launches (Schmalzer 1998).

Boeing has conducted sampling of the post-launch wash-water from a Delta IV launch vehicle that employed solid rocket motors at CCAFS. Perchlorates were not detected using EPA Method 314.0. Additional sampling of launch pad deluge water was conducted to determine if deluge water could be released to the sewer. The results of all samples analyzed for perchlorate were nondetect. Based on these samplings and various studies of sampling results and many other technical and environmental documents, perchlorate is not emitted from the ignition and firing of SSRMs, and does not survive the combustion process. Similar tests have been conducted at KLC and VAFB, with similar results (Boeing 2005).

Florida scrub jays and southeastern beach mice occur in the vicinity of launch facilities at CCAFS. A small potential exists that individuals of these species would be directly impacted by launch operations. Previous environmental analyses (USAF 1995a), concluded that impacts on these species are expected to be minimal. The behavior of scrub jays observed after Delta, Atlas, and Titan launches has been normal, indicating no noise-related effects (Schmalzer 1998). The proposed action's maximum rate of eight launches per year spread over a number of launch sites would not be expected to substantially impact Florida scrub jay or southeastern beach mice.

Night lighting at the launch pads has been a concern at CCAFS because of the potential for sea turtle hatchlings at the beach to be drawn toward the lights instead of toward the surf. This has been mitigated by a 45th Space Wing Instruction SWI 32-7001 "Exterior Lighting Management" which has been implemented by a series of management plans specific to all active launch complexes as well as the CCAFS Industrial Area. These plans require the use of low-pressure sodium light fixtures, shielding, and special light management steps where lights are visible from the beach areas. Specifically covered are Launch Complexes 17, 20, 36A/B, ITL area, 40, 41 (EELV), 46, 37 (EELV), the Port Canaveral, and Industrial Areas.

Sonic booms created by launches from CCAFS would occur over the open Atlantic Ocean. Because these sonic booms are infrequent, the marine species in the ocean's surface waters are present in low densities (although spring and fall migration will see periodic groups of migrating whales that follow the coastline), and the sonic boom footprint lies over 48 km (30 mi) from CCAFS. The sonic booms from launches are not expected to negatively affect the survival of any marine species (USAF 1998).

4.1.13.2 VAFB

Air Quality

VAFB is located within the SBCAPCD, which has been in attainment for the Federal ozone and PM_{10} standards, but is not in attainment for the California State ozone and PM_{10} ambient air quality standards. Santa Barbara County has attained the Federal 1-hour standard for ozone. The government is required to make a formal determination as to whether operations comply with the General Conformity Rule of the Clean Air Act. Section 176(c) requires all Federal agencies or agency-supported activities to comply, where applicable, with an approved or promulgated State Implementation Plan (SIP) or Federal Implementation Plan (FIP). Conformity means compliance with a plan's purpose of attaining or maintaining the NAAQS. Specifically, this means ensuring the activity would not: (1) cause a new violation of the NAAQS; (2) contribute to an increase in the frequency or severity of existing NAAQS violations; or (3) delay the timely attainment of any NAAQS, interim milestones, or other milestones to achieve attainment (USAF 1995b). The rule does not apply to actions where the total direct and indirect emission of nonattainment criteria pollutants do not exceed threshold levels for criteria pollutants established in 40 CFR 93.153(b). In addition to meeting *de minimis* requirements, a Federal action is considered regionally significant when the total emissions from the action equal or exceed 10 percent of the air quality control area's emission inventory for any criteria pollutant. If a Federal action meets *de minimis* requirements and is not considered a regionally significant action, then it is exempt from further conformity analyses pursuant to 40 CFR 93.153(c).

Payload Propellant Spills

The mean hazard distances predicted by AFTOX for VAFB are displayed in Table 4-11 In the event the entire quantity of liquid propellants is spilled. An unconfined spill of 1,000 kg (2,200 lb) of hydrazine would produce a spill area of 99 m^2 (1,069 ft^2) and a mean hazard distance of up to 1,140 m (3,739 ft). An unconfined spill of 1,000 kg (2,200 lb) of MMH would produce a spill area of 115 m^2 (1,242 ft^2) and a mean hazard distance of up to 1,170 m (3,838 ft). An unconfined spill of 1,200 kg (2,640 lb) of NTO would produce a spill area of 81 m^2 (875 ft^2) and a mean hazard distance of up to 3,390 m (11,119 ft) for nitrogen dioxide. In summary, all mean hazard distances for toxic air releases from payload accidents at VAFB would be less than 3.4 km (2.1 mi) for the meteorological conditions considered. This would be the maximum distance downwind that would require evacuation and control by Range Safety authorities.

Table 4-11 Mean Hazard Distances to SPEGL (1-Hr Average) Exposure Limits as Predicted by AFTOX for Payload Maximum Liquid Propellant Spills at VAFB

Chemical (SPEGL)	Spill Quantity	Wind speed	Day (20°C (68°F))	Night (5°C (41°F))
Hydrazine (0.12 ppm)	1,000 kg (2,200 lb)	2 m/s (7 ft/s)	524 m (1,719 ft)	667 m (2,188 ft)
		10 m/s (33 ft/s)	1,140 m (3,739 ft)	738 m (2,421 ft)
MMH (0.26 ppm)	1,000 kg (2,200 lb)	2 m/s (7 ft/s)	537 m (1,761 ft)	773 m (2,535 ft)
		10 m/s (33 ft/s)	1,170 m (3,838 ft)	780 m (2,558 ft)
NTO (1.0 ppm)	1,200 kg (2,640 lb)	2 m/s (7 ft/s)	924 m (3,031 ft)	2,580 m (8,462 ft)
		10 m/s (33 ft/s)	2,940 m (9,643 ft)	3,390 m (11,119 ft)

Source: *2002 NRP EA*

Air Quality Impacts from Launch Vehicles During Normal Launches

The maximum ground-level concentrations resulting from normal launches of Atlas V and Delta IV vehicles from VAFB are shown in Table 4-12. These REEDM predictions are based on the meteorological cases in Appendix B.

Table 4-12 Maximum Downwind Concentrations for Normal Launches at VAFB

Vehicle	Averaging Time	NO_X (ppm)	HCl (ppm)	Al_2O_3 (mg/m^3)
Atlas V 551/552	Instantaneous	0.000	1.896	5.401
	60-minute	0.000	0.067	0.381
Atlas V Heavy	60-minute	0.025	N/A	N/A
Delta IV H	30-minute	0.012	N/A	N/A
Delta IV M+ (5,4)	Instantaneous	0.000	1.270	13.499
	60-minute	0.000	0.045	1.032

Key: N/A=Not Applicable.
Sources: USAF 1998, 2000a: Appendix T.

Launch Vehicle Propellant Spills

The most severe propellant spill accident scenario at VAFB involving a candidate launch vehicle would be the release of the entire Titan II load of NTO at the launch pad. Under adverse weather conditions, it was predicted that a plume from this size spill could reach as far as 4 km (2.5 mi) before nitrogen oxide concentrations are lowered to 5 parts per million (ppm), and could travel several miles farther before being lowered to 1 ppm (USAF 1988).

Launch Failures

Although this launch vehicle has been recently retired from service, an in-flight or on-pad failure of a Titan II represents the greatest toxic hazard at VAFB from the launch failure of a candidate vehicle. This is due to the large quantities of hypergolic liquid propellants used on the vehicle. Residual hydrazine fuel and NTO oxidizer that survive the deflagration fireball are believed to thermally decompose or vaporize. Ammonia and methane are predicted to form as byproducts of the hydrazine and UDMH thermal decomposition. Further atmospheric decay of vaporized UDMH is predicted to form nitrosodimethylamine (NDMA) and formaldehyde dimethylhydrazone (FDA). The concentration predictions for these and other chemicals predicted to result from a Titan II launch failure are listed in Table 4-13 (NASA 1998).

Initiating flight termination after launch would split or vent the solid propellant motor casing, releasing pressure and terminating propellant combustion. Pieces of unburned propellant, which is composed of ammonium perchlorate, aluminum, and other materials, could be dispersed over an ocean area of up to several square miles. Of concern is the ammonium perchlorate, which can slowly leach out of the solid propellant resin-binding agent once the propellant enters the water. However, due to continually mixing of the water, it is unlikely that perchlorate concentrations would accumulate to a level of concern. The overall concentration and toxicity of dissolved solid propellant from the unexpended rocket motors, or portions of them, is expected to be negligible and without any substantial effect. Any pieces of propellant expelled from a destroyed or exploded rocket motor would sink hundreds or thousands of feet to the ocean floor. At such depths, the material would be beyond the reach of most marine life (USAF 2005).

Table 4-13 Peak Concentration and 60-Minute Mean Concentration Predictions for Titan II Launch Abort Emissions at VAFB Using a Hypothetical No Wind Shear Meteorological Profile

Exhaust Cloud Constituent	Peak Concentration (ppm)	Maximum 60-Minute Mean (ppm)	Distance From SLC-4 Peak-Mean in km (miles)
CO	1.59	0.53	9-13 (5.6–8.1 mi)
CO_2	0.98	0.33	9-13 (5.6–8.1 mi)
FDH	0.03	0.01	13-21 (8.1–13.1 mi)
HNO_3	0.66	0.33	13-21 (8.1–13.1 mi)
N_2H_4	0.38	0.11	8-11 (5–6.785 mi)
NDMA	Trace[a]	Trace[a]	No Data
NH_3	7.51	2.50	9-13 (5.6–8.1 mi)
NO_2	19.44	6.39	9-13 (5.6–8.1 mi)
UDMH	1.24	0.41	9-13 (5.6–8.1 mi)

a. Trace quantities are <0.01.
Source: Data acquired from NASA 1998 to illustrate predicted concentrations resulting from a Titan II abort.

Biological Impacts from Launch Vehicles

Substantial impacts on local vegetation from launch operations have not been detected at VAFB. Since VAFB has a high hazard risk for wildfire, a launch accident could present potential impacts on vegetation. The launch response teams at VAFB would mitigate the effects of fires started by launch accidents.

Boeing has conducted sampling of the post-launch wash-water from a launch vehicles that employed solid rocket motors at VAFB. Perchlorates were not detected using EPA Method 314.0. Additional sampling of launch pad deluge water was conducted to determine if deluge water could be released to the sewer. The results of all samples analyzed for perchlorate were non-detect. Based on these samplings and various studies of sampling results and many other technical and environmental documents, perchlorate is not emitted from the ignition and firing of SSRMs, and does not survive the combustion process (Boeing 2005).

Launch noise impacts on endangered species of birds (snowy plover and least tern) in the dune area adjacent to SLC-2 have been analyzed. After consultation with USFWS, mitigation measures have been developed to protect these species from impacts from SLC-2 activities (NASA 1993a). Formal consultations with the USFWS have resulted in a no-jeopardy opinion, stating that Taurus is allowed to launch from SLC-576E once during the combined nesting period of the snowy plover and least tern, subject to compliance with certain mitigation requirements (USAF 2005). The mitigation requirements are under review.

Launch noise at levels as low as 80 dBA caused a short-term (30-minute) abandonment of a pinniped haul-out area at VAFB (USAF 1997). However, short-term, haul-out area abandonment has not caused noticeable impacts on the pinniped populations at these locations. Therefore, effects from launches would be temporary and minor, and would not be expected to negatively affect these populations. Launch noise effects on cetaceans appear to be somewhat attenuated by the air/water interface. The cetacean fauna in the area have been subjected to sonic booms from military aircraft for many years without apparent adverse effects (USAF 1997).

The only sonic boom issue at VAFB relates to possible impacts on wildlife on the Channel Islands. The ascent track of some VAFB launches passes over the Channel Islands, which are inhabited by protected marine mammals (seals and sea lions). Due to potential disturbances prohibited under the Marine Mammal Protection Act, take permits from the NMFS are in place to accommodate possible impacts from sonic booms for the proposed launch vehicles. Monitoring and mitigation plans developed by Spaceport Systems International and McDonnell Douglas Aerospace (now Boeing) identified comprehensive monitoring and mitigation activities that would be performed on behalf of all users. Individual users would not be expected to perform natural resource monitoring for their missions; instead this is provided as a launch support service.

4.1.13.3 USAKA/RTS

Air Quality

Payload Propellant Spills

The maximum spill for NRP launches from USAKA/RTS would be the fuel load of the Falcon 9. There could be as much as 89,370 kg (197,017 lb)of RP-1 (kerosene) spilled if there was a flight termination or explosion on the pad.

Air Quality Impacts from Launch Vehicles During Normal Launches

No ambient air quality data are known to exist for Omelek. However, since there are only extremely minor sources of air pollution, such as occasional helicopter landings, strong persistent trade winds, and lack of topographic features to inhibit dispersion, the ambient air quality at Omelek is expected to be in compliance with the maximum pollution levels established in the UES.

Existing primary pollution sources at USAKA/RTS include power plants, fuel storage tanks, solid waste incinerators, and transportation. Rocket launches are generally a smaller source of emissions. Previously existing Omelek facilities have been abandoned and are no longer in use; therefore, no existing emission sources are currently located at Omelek.

Launch Vehicle Propellant Spills

A calculation regarding a maximum credible spill of the various propellants and fluids used for the Falcon launch vehicle has been conducted. The maximum credible spill is 100 percent of the first-stage main flight tank. Secondary containment of the kerosene storage vessel is assumed to contain any storage vessel leaks or rupture, and leakage of kerosene load lines to the vehicle would be detected prior to an equivalent volume being released. This spill would be contained within the concrete containment system of the launch pad. To prevent accidental ignition of the fluid or vapors during normal launch activities, all handling equipment involved in the storage, shipping, and loading of kerosene would be grounded to prevent electrostatic discharge.

Spills of LOX, liquid nitrogen, or helium would evaporate quickly and would not require containment. LOX presents both cryogenic and flammability hazards, though it is not toxic to personnel or the environment. To prevent accidental ignition of this fluid during normal launch activities, all materials coming in contact with LOX would be thoroughly cleaned to remove organic materials that could combust. In addition, all equipment that comes in contact with LOX during storage, shipment, handling, and loading of LOX would be certified LOX compatible.

The kerosene that would be used as a fuel for the Falcon would be pumped to the launch vehicle via an over-the-road transport trailer and lines between the loading equipment and the launch pad. Any kerosene spills that occur during the fueling process would be contained and cleaned up in accordance with the USAKA/RTS spill containment procedures, and therefore are anticipated to have no contribution to the overall emissions generated during the flight test activities.

Launch Failures

An early-flight termination or mishap on the pad or shortly thereafter, which is not a planned or high probability event, could result in debris impacts on the entire island as well as along the flight corridor. This debris could strike and potentially kill migratory birds and marine species. However, measures are implemented into the launch process to minimize the potential for such occurrences. Should this low-probability event occur, the launch service provider and USAKA/RTS would evaluate if or how to proceed with cleanup in accordance with the UES. The potential for effects to biological resources would also be evaluated at that time in coordination with the USFWS. The Flight Termination System of the Falcon, which disables

power to the vehicle engines and disrupts flight, should result in basically a whole-body impact into the ocean. The potential ingestion of toxins by fish species, which may be used for food sources, would be remote because of the diluting effect of the ocean water and the relatively small area that would be affected.

Biological Impacts from Launch Vehicles

No threatened or endangered vegetation has been identified in the project areas. Personnel would be instructed to avoid all contact with sea turtles or turtle nests that might occur within the area. Launch Service Provider or USAKA/RTS personnel would install fencing 100 m (328 ft) on either side of the launch site just above the wave surge area at a sufficient height to prevent sea turtles from hauling out on the beach adjacent to the launch site and thus would prevent a take (e.g., injury or fatality) during a normal launch. No site preparation activities would take place offshore, and thus marine mammals would not be affected.

Disturbance to wildlife from the launches would be brief and is not expected to have a lasting impact or a measurable negative effect on migratory bird populations. No evidence has indicated that serious injuries to wildlife have resulted from prior launches in the region, and no long-term adverse effects are anticipated. The brief noise peaks that would be produced by the launch are comparable to levels produced by close-range thunder (120 to 140 dB peak). There is no species known to be susceptible to hearing damage following exposure to this noise source (USAF 2001). Launches are not anticipated to result in direct effects to nesting, resting, or roosting birds other than the temporary disturbance during the launch itself (USASMDC 2003).

Vegetation is generally sparse at the proposed launch sites, although some vegetation clearing may be required. Any ground fire would be quickly extinguished. During a normal launch, the likelihood of launch vehicle debris impacting marine mammals is considered remote. Threatened or endangered species have not been identified at any of the activity locations.

An early flight termination or mishap could result in debris impacting along the flight corridor. However, sensitive marine species in this region are widely scattered, and the probability is rather low that migratory whales or sea turtles would be impacted by this falling debris.

The ammonium perchlorate found in solid propellants is contained within the matrix of rubber or plastic and would dissolve slowly. The toxicity is expected to be relatively low. As a most conservative case, toxic concentrations of ammonium perchlorate would be expected only within a few meters (yards) of the source. This would have no effect on sea-life if the rocket propellants fall into the ocean more than 2 or 3 km (1.2 to 1.9 mi) from shore where the ocean depth is generally greater than 3,000 m (10,000 ft). If propellants fall in shallow water near Bigen Island, marine animals attached to the substrate in this area could be affected. Due to high mixing rates of the ocean waters in the near shore area and the slow dissolution rate of solid propellants, swimming animals are not likely to be affected.

4.1.13.4 WFF

Air Quality

Payload Propellant Spills

The cleaning of payloads, electronic hardware, and shipping container surfaces involves the use of solvents to remove organic contaminants. The standard solvent used is isopropyl alcohol (IPA), and approximately 208 liters (55 gal) of IPA are used per mission. IPA is used because of its low toxicity and flashpoint of 11.6°C (53°F). Ethyl alcohol may also be used for optical surfaces, but in very small quantities. It has a low toxicity level and a flashpoint of 17°C (62°F). Small amounts of other chemicals are often used incidentally in preparing spacecraft for assembly, test, loading, and launch. These are used in such minor amounts and are of such low toxicity that they present no substantial potential for environmental impact.

Loading of hypergolic propellants is performed either in the principal PPF or in an auxiliary facility. The fuel can be either hydrazine for mono- or bipropellant systems, or MMH for bipropellant systems. The oxidizers used for these systems include NTO, MAF-4 and IRFNA. Each loading operation would be independent, sequential and conducted using a closed loop system. During the operation, all propellant liquid and vapors would be contained. If small leaks occur during propellant loading, immediate steps would be taken to stop loading, correct the leakage, and clean up leaked propellant with approved methods before continuing. Personnel would wear protective clothing during hazardous propellant operations. Leakage would be absorbed in an inert absorbent material for later disposal as hazardous waste, or aspirated into a neutralizer solution. Propellant vapors left in the loading system would be routed to portable air emission scrubbers. Liquid propellant left in the loading system would be either drained back to supply tanks or into waste drums for disposal.

The facilities at WFF can be compared to the Titusville Astrotech PPF in estimates of portable scrubber emission rates during fueling operations. Based on the Titusville Astrotech PPF experience, emissions are estimated to be 0.045 kg/hr (0.099 lb/hr) for N_2H_4, 0.13 kg/hr (0.28 lb/hr) for NTO, and 0.064 kg/hr (0.14 lb/hr) for MMH. These rates are for typical periods of less than 30 minutes per spacecraft (Astrotech 1993). Although both NTO and hydrazine are classified as hazardous air pollutants (HAPs), the National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations under Title III of the CAA have not yet established control standards. The packed bed scrubber systems usually used are considered BACT and should be considered acceptable when NESHAP regulations are promulgated (NASA 2002).

Inadvertent releases of toxic air contaminants are possible as a result of accidents during payload processing, transportation, and launch. The largest releases would result from the spillage of the entire quantity of liquid propellants. Lesser releases would result from fires or explosions that would consume significant fractions of the propellants. Safety procedures would be implemented at WFF to ensure that these events are unlikely to occur. In addition, spill response planning procedures are in place to minimize spill size and duration, as well as possible exposures to harmful air contaminants. The magnitude of air releases from payload accidents would be relatively small compared to possible releases from accidents involving launch vehicles. Impacts would be temporary and transient, and therefore have no substantial impact on ambient air quality (NASA 2005a).

Air Quality Impacts from Launch Vehicles During Normal Launches

Table 4-14 lists the average exhaust emission compounds of composite and double-base propellant rocket motors launched from WFF.

Table 4-4 Average Exhaust Emission from Rocket Motors at WFF

Compound	Composite Rocket Motor			
	Minimum Requirements		Maximum Requirements	
	Kg	lb	kg	lb
Aluminum chloride	0	0	N/A	N/A
Aluminum oxide	N/A	N/A	3600	7920
Carbon dioxide	0.10	0.22	250	550
Carbon monoxide	0.37	0.81	2100	4620
Hydrogen	0.12	.026	200	440
Hydrogen chloride	0	0	2100	4620
Lead	N/A	N/A	N/A	N/A
Nitrogen	0.11	0.24	850	1870
Water	0.19	0.42	850	1870
Other	N/A	N/A	100	220
	Double-Base Propellant Rocket Motor			
Aluminum chloride	0	0	N/A	N/A
Aluminum oxide	9.9	21.8	N/A	N/A
Carbon dioxide	N/A	N/A	175	385
Carbon monoxide	6.5	13.6	333	733
Hydrogen	0.8	1.8	8	17.6
Hydrogen chloride	5.7	12.5	N/A	N/A
Lead	N/A	N/A	11	24
Nitrogen	1.8	4	102	224
Water	N/A	N/A	125	275
Other	0.4	0.88	0	0

Table 4-14 Average Exhaust Emission from Rocket Motors at WFF (*continued*)

Compound	Composite Rocket Motor			
	Minimum Requirements		Maximum Requirements	
	kg	lb	kg	lb
	LOX-Kerosene (RP1) Rocket Motor			
Carbon dioxide	108,318	238,801	649,910	1,432,806
Carbon monoxide	62,210	137,150	373,261	822,900
Hydoxide	181	400	1,089	2,400
Hydrogen	14.5	32	87	192
Oxygen	12.2	27	73.5	162
Water	69,905	154,116	419,435	924,696

Key: N/A=Not Applicable.
Source: NASA 2005a.

Launch Vehicle Propellant Spills

Health and safety impacts on personnel involved in propellant loading operations at the PPF would be minimized by adherence to OSHA regulations. These regulations require use of appropriate protective clothing and breathing protection. Toxic vapor detectors would be used in the facilities to monitor for leaks and unsafe atmospheres.

Launch Failures

In the event of a launch failure, debris from reentered hardware could impact the ocean much closer to shore than would occur with a successful launch, and could result in more substantial impacts. However, the probability of such an event is extremely small (estimated at 1 percent probability); therefore, such an event should not pose a substantial environmental impact (NASA 2005a).

Biological Impacts from Launch Vehicles

No rare, threatened, or endangered vegetation exists at WFF. Damage to local biological resources resulting from launch activities can be anticipated within a 1 km (0.62 mi) radius of the launch pad. The principal impacts radiate approximately 200 to 300 m (656 to 984 ft) within the combustion path. Searing of vegetation and injury or death to fauna can occur within this zone. Interruption of faunal activities is expected within 1 km (0.62 mi) radius of the launch pad for 2 to 10 minutes during launch operations. The combustion products and initial sound blast would be directed toward the Atlantic Ocean. Impacts from launches are anticipated to be minor and temporary, since vegetated areas recover after being subjected to rocket exhaust.

No significant impacts from the proposed launches are anticipated because most operations generate only temporary noise on an infrequent basis. Wildlife management activities already occur at WFF to maintain safe airfield operations, so future operations should not cause additional impacts.

As part of the 2009 Environmental Assessment for the Expansion of the Wallops Launch Range, NASA conducted formal consultation with USFWS under Section 7 of the Endangered Species

Act. On May 10, 2010, in its Biological Opinion Regarding Expansion and Ongoing Activities at WFF, USFWS authorized the following Incidental Take Statement for Endangered Species at Wallops:

Piping Plover — The Service anticipates that up to two clutches of piping plovers, which equates to eight eggs or young plovers, could be taken per year through injury, direct mortality, and harassment affecting an entire nest and its contents, or individual young plovers after they leave the nest. This is most likely to occur in suitable habitat as a result of human activities that occur on the beach which interfere with breeding, feeding, or sheltering. In addition, take in the form of harassment may result in reduced productivity of up to one plover pair. This will result from effects of disturbance that prevent a pair from nesting.

Loggerhead Sea Turtle — The Service anticipates that no more than one loggerhead sea turtle nest or the equivalent number of hatchling turtles could be taken per year. Incidental take is expected to be in the form of injury or death of turtle eggs and hatchlings, as well as harm and harassment of both adult and hatchling turtles. No adult turtles are anticipated to be killed. This take may result from vehicles crushing nestling turtles resulting in injury or death, crushing an undetected turtle nest by either staff- or civilian-operated vehicles, creation of ruts in sand that impede hatchlings from moving from nest to water, interference with sea-finding behavior in hatchling turtles leading to disorientation resulting from artificial and vehicle lighting, and impacts on nests resulting from sand compaction or vibration caused by vehicle use. This amount of take may also result from the disturbance of a nesting female that prevents her from nesting successfully.

Green Sea Turtle and Leatherback Sea Turtle — Because of the low likelihood that green or leatherback sea turtles will occur or nest in the action area due to their rarity, no incidental take of these species is anticipated. Additionally, the USFWS requested the following conservation measures:

1. Continue to implement the Wallops Island Protected Species Monitoring Plan for the duration of the proposed action, and provide an annual report summarizing the survey and monitoring efforts, the location and status of all occurrences of protected species that are recorded, and any additional relevant information. Reports should be provided to the Service's Virginia Field Office in digital format at the address provided on the letterhead by December 31 of each year.

2. Report any evidence of potential nesting activity of green sea turtles or leatherback sea turtles on Wallops Island to the Virginia Field Office at the address provided on the letterhead within 1 business day of observing the activity.

3. Implement video monitoring of plover nests most likely to be affected by launch activities (those located closest to launch pads) during launches to measure and record bird responses. This monitoring shall be conducted for at least each of the first 10 large rocket launches (those launches for which noise levels are expected to exceed 100 dB within potential plover nesting habitat) that occur after issuance of this biological opinion. If no plover nests are active within areas expected to be subjected to sound levels greater than 100 dB, other similar shorebird species nesting in similar habitat

should be monitored as surrogates to provide information on species responses. Monitoring shall include measurement of actual sound intensity at the monitoring site during launch, weather conditions, and other factors that may contribute to responses. Monitoring shall take place 2 hours prior to, during, and at least 2 hours after the launch. Within 5 business days of each launch, a DVD of the monitoring and a report in digital format containing the additional measurements will be provided to the Service's Virginia Field Office at the address provided on the letterhead. Following documentation of avian responses from the first launches, NASA may request Service concurrence to discontinue this monitoring. If this is not requested or if concurrence is not provided, this monitoring will continue.

4. Develop a training and familiarization program for all security personnel conducting patrols in areas where listed species may occur. This training program shall include basic biological information about all listed species and be sufficient to allow personnel to at least tentatively identify the species and provide basic information to recreational users about appropriate avoidance and minimization measures. This training should be offered to interested recreational beach users.

5. Develop a reporting system so that any personnel who observe listed species or potential occurrences of listed species on WFF can provide the information to personnel who can investigate the report. The intent of this is to use every opportunity possible to implement avoidance and minimization measures. Within 60 days of the date of this biological opinion, provide the Service with an electronic draft of the reporting system for review and approval.

6. Care must be taken in handling any dead specimens of proposed or listed species that are found to preserve biological material in the best possible state. In conjunction with the preservation of any dead specimens, the finder has the responsibility to ensure that evidence intrinsic to determining the cause of death of the specimen is not unnecessarily disturbed. The finding of dead specimens does not imply enforcement proceedings pursuant to the ESA. The reporting of dead specimens is required to enable the Service to determine if take is reached or exceeded and to ensure that the terms and conditions are appropriate and effective. Upon locating a dead specimen, notify the Service's Virginia Law Enforcement Office at 804-771-2883, 7721 South Laburnum Avenue, Richmond, Virginia 23231, and the Service's Virginia Field Office at 804-693-6694 at the address provided on the letterhead above.

Any action that may affect marine mammals or their habitat requires consultation with the NMFS. Launches would have an adverse effect only if a launch vehicle or payload fell on a marine mammal or school of fish — and, through consultation with NMFS, they concur that the risk of such an event occurring is extremely low.

WFF does not use municipal water sources. All water – potable and for launch systems – is drawn from onsite deep water wells owned and operated by WFF.

As the new launch pad would be designed to support both normal launches and on-pad static firing for launch vehicle testing. There is a risk to the launch pad resulting from

exposure to extended heat load and excessive vibration and noise; therefore, a water deluge system would be constructed to absorb the heat load and suppress vibration and noise from the engines. The deluge system would include a 950,000-liter (250,000-gallon) aboveground water storage tank, pumps, and a trench and retention basin for the deluge water. Each launch would utilize nearly the entire capacity of the tank for water suppression of engine vibration and noise. Up to 1,325,000 liters (350,000 gallons) of water would be used for static fire tests, and up to two static fire tests per year could occur (NASA 2009b).

The additional water required for static fire testing would be withdrawn from temporary water tanks placed on the south side of Pad 0-A prior to the static fire test date. The temporary water tanks would be stored off-site when not in use at Pad 0-A. The water source for the deluge system would be NASA's potable water system, which is permitted by the Virginia Department of Environmental Quality (VDEQ) to withdraw groundwater from the underlying aquifer.

Used deluge water for both launch and static fire testing would be discharged to a newly constructed 1,200-square-meter (12,500-square-foot), lined earthen retention basin (lined for imperviousness). The deluge water would then be tested and approved for release via a manual gate to a newly constructed unlined stormwater basin. If necessary, the deluge water would be treated (i.e., pH adjusted) before release, or removed for disposal if it does not meet the standards for discharge to surface water. If the deluge water is discharged to the unlined stormwater basin, the release period may last several days due to the large quantity of water to be discharged.

4.1.13.5 KLC

Air Quality

Payload Propellant Spills

During normal propellant tank installation, the propellants remain sealed inside their tanks. The likelihood of an accidental release of the liquid fuel or oxidizer would be low. However, if such an accident were to occur, it would most likely occur during rocket assembly. Table 4-15 indicates the results of analysis using the USAF Toxic Corridor Model computer model to determine distances at which the National Institute of Occupational Safety and Health (NIOSH) Immediately Dangerous to Life and Health (IDLH) health standard could be exceeded assuming all 7.5 liters (2 gal) of fuel and 5.5 liters (1.5 gal) of oxidizer were released to the atmosphere during an accident.

Table 4-14 Potential Exceedances Due to Accidental Fuel Leak at KLC

Chemical (SPEGL)	Spill Quantity	Health Standard	Standard Limit	Exceedence Distance
Hydrazine	7.5 liters (2.0 gal)	NIOSH IDLH	(50 ppm) (66.5 mg/m^3)	Not exceeded
MMH	7.5 liters (2.0 gal)	NIOSH IDLH	(20 ppm) (38.4 mg/m^3)	Not exceeded
NTO (liquid)	7.5 liters (2.0 gal)	NIOSH IDLH	(20 ppm) (38.4 mg/m^3)	60 m (197 ft)
NTO (gas)	7.5 liters (2.0 gal)	NIOSH IDLH	(20 ppm) (38.4 mg/m^3)	30 m (98 ft)

Source: USASMDC 2003.

Actual hazard distances would depend on the propellant released, the amount released, meteorological conditions, and emergency response measures taken. AAC's approved SOPs would be implemented and would include personal protection equipment procedures. Establishment of and adherence to these SOPs would minimize the potential hazards to personnel in the unlikely event of an unplanned propellant release. The low likelihood of such an event and the implementation of approved emergency response plans would limit the impact of such a release.

Air Quality Impacts from Launch Vehicles During Normal Launches

Three standby diesel generators operate at a maximum of 5 hours during launches, 1 hour per week for testing during non-launch periods and during commercial power outages (approximately 240 hours per year). Air quality impacts from these sources are considered to be temporary (FAA 1996). Operational emissions from the use of diesel generators would be temporary and are not expected to be appreciable off-site.

Ambient air quality impacts due to particulate emissions from expendable launch vehicles have been estimated to be less than the 24-hour average National Ambient Air Quality Standard. Emissions of hydrogen chloride (which converts to hydrochloric acid in the atmosphere) and aluminum oxide from launches would negligibly degrade local air quality, but impacts would be temporary and are not expected to be substantial. Emissions of toxic air pollutants from liquid fuels are expected to be minimal due to the enclosed nature of storage and the small quantities (maximum 379 liters [100 gal]) involved. Potential contributions to the upper atmosphere include emissions from ground-level operations as well as exhaust emissions from launch vehicles. Emissions from the proposed nine yearly KLC rocket launches would have a small impact on the levels of ozone found in the stratosphere; however, the release of chlorine and aluminum into the stratosphere would make a minimal contribution to the overall impact of ozone depletion. A Clean Air Act conformity analysis is not required because the air quality control region is in attainment (FAA 1996).

Launch Vehicle Propellant Spills

Some payloads that would launch from KLC might use a hydrazine-based liquid mono-propellant for attitude adjustment. The quantities involved would be small, from a few ounces to less than approximately 379 liters (100 gal).

Liquid propellant would be transported to the proposed KLC within an approved container or within a specially designed storage cart; there would be no permanently installed payload fueling system at KLC. The launch operator would be responsible for transporting the fuel in accordance with DOT requirements. Because of the sealed nature of this mode of transport, the likelihood of release and environmental effect is small.

Hydrazine-based propellant handling onsite would be performed in accordance with KLC safety procedures required by the DOT's (FAA's) Office of Commercial Space Transportation (OCST). Storage carts would be stored near the Payload Processing Facility in a Fuel Storage Shed that would be designed to fully contain a "worst case" propellant spill. For fueling operations, the cart would be moved into the Facility processing bay where trenches filled with a non-reactive absorbent material would be provided to contain spilled material. Fueling would be monitored

by safety personnel, and portable detectors would be used to monitor for hazardous vapors. Personnel would be trained to respond to unplanned releases (inside or outside) in accordance with the site spill response plan, and spill response equipment would be maintained in a readily available condition. Waste generated from spill response activities would be managed in accordance with Federal and state requirements. Because (1) fuel storage and handling would occur inside, (2) small quantities would be involved, and (3) appropriate spill response measures would be implemented, the potential for environmental impact from liquid propellant fueling operations or spills is small (FAA 1996).

Solid rocket propellants present at the launch area would be (1) contained in the launch vehicles themselves, (2) fueled at the factory and (3) delivered in completely assembled, painted, encapsulated units.

Launch Failures

The public population of concern for launches at KLC consists of people living in the vicinity of KLC, including occupants of Bear Paw Ranch and Burton (Kodiak) Ranch, U.S. Coast Guard (USCG) personnel who periodically work at the Loran-C Coast Guard Station at Narrow Cape, members of the public who utilize the KLC area for recreation, and residents of eastern Kodiak Island, including the City of Kodiak and the USCG Station (USASMDC 2003). In general, the area surrounding KLC is sparsely populated. The City of Kodiak and the USCG Station, located approximately 48 to 64 km (30 to 40 mi) from KLC, are the only sizable population centers on the island. Additional smaller population centers are located southwest of KLC and include Old Harbor and Akhiok. There are also several dozen cabins located along the southeast coast of Kodiak Island that are occupied on a seasonal basis. The Range Safety program will assure that potential impacts will be well within the debris limit corridor and away from these populated areas.

A hazard potential is present during prelaunch transport, prelaunch processing, and launch of rockets due to the significant amounts of propellant contained in the boosters. The exposure to launch mishaps is greatest within the early portions of the flight after launch. Measures are currently in place to limit the number of personnel involved in the launch operations and to ensure that hazardous operations are performed by highly skilled personnel. Regulations and practices that have been established to minimize or eliminate potential health and safety risks to the general public include, but are not limited to, OSHA and DOT regulations and USAF procedures for transporting hazardous materials, Department of Defense (DoD) procedures for handling explosives, and the DoD Range Safety program for the processing and launch of rockets (USASMDC 2003).

The February 2005 Environmental Monitoring Report for KLC shows that water samples were collected for alkalinity, total aluminum and perchlorate analyses. All water chemistry measurements were consistent with recorded values for the area, as well as those from the previous 5 years of analyses. Perchlorate was not detected at any site (KLC 2005). Water quality data gathered during previous launch campaigns indicates that launches from the KLC have no measurable impact on local surface water quality.

Biological Impacts from Launch Vehicles

Boeing has conducted sampling of the post-launch wash-water from a launch vehicles that employed solid rocket motors at KLC. Perchlorates were not detected using EPA Method 314.0. Additional sampling of launch pad deluge water was conducted to determine if deluge water could be released. The results of all samples analyzed for perchlorate were non-detect. Based on these samplings and various studies of sampling results and many other technical and environmental documents, perchlorate is not emitted from the ignition and firing of SSRMs, and does not survive the combustion process (Boeing 2005).

A Biological Opinion prepared for the FAA and AAC in 1998 addressed the potential for impacts on the Steller's eider and short-tailed albatross as a result of operation of the KLC. Launches would be infrequent, up to five per year over a period of 10 years. Five annual launches would fall within the parameters previously analyzed for KLC and are also not likely to adversely affect listed species. Disturbance to wildlife from single launches would be brief and is not expected to have a lasting impact nor a measurable negative effect on migratory bird populations. Waterfowl would quickly resume feeding and other normal behavior patterns after a launch is completed. Waterfowl driven from preferred feeding areas by aircraft or explosions usually return soon after the disturbance stops, as long as the disturbance is not severe or repeated (FAA 1996).

The effects of sound pressure on marine mammals are highly variable and were categorized by Richardson et al. 1995 to include: (1) sound pressures below the hearing threshold of the species or less than prevailing ambient noise, (2) sound pressures within the audible range of the species but not strong enough to elicit a behavioral response, (3) sound pressures that elicit behavioral response, (4) sound pressures for which repeated exposure elicits either diminishing responses (habituation) or persistence of effects, (5) sound pressures strong enough to reduce the ability to hear natural sounds at similar frequencies, (6) sound pressures of such magnitude/frequency that they induce physiological stress and affect the well-being or reproductive success of individuals, and (7) sound pressures that lead to permanent hearing impairment. With regard to number 7, received sound levels must far exceed an animal's hearing threshold for there to be even temporary hearing threshold shift, and as any explosive events that might occur would be distant from Ugak Island, this effect is not considered further. The first six effects listed have varying potentials ranging from likely to unlikely in the vicinity of Ugak Island. For example, numbers 2 through 5 above are likely depending on the launch vehicle, while numbers 1 and 6 are unlikely.

Spent rocket motors will fall into the open ocean over deep water, far from Ugak Island and do not pose a threat to seals or sea lions. Similarly, sonic booms will occur well past the edge of the Outer Continental Shelf break over the deep ocean, and do not pose any threat to marine mammals.

All of the above potential effects have been considered by the National Marine Fisheries Service in granting AAC's marine mammal take permit..

4.1.14 No Action Alternative

Specific criteria and thresholds would continue to be used to determine a spacecraft's eligibility to be considered a spacecraft launching on the Pegasus, Taurus, Atlas and Delta families of the

vehicles from CCAFS, KSC, and VAFB. The No Action Alternative would mean that NASA would not launch scientific and technology demonstration spacecraft missions or NOAA missions defined as NRP spacecraft on the Falcon and Minotaur families of launch vehicles from any launch site, nor would NASA launch NRP spacecraft from USAKA/RTS, WFF, or KLC without individual mission NEPA review and documentation. NASA would instead propose all spacecraft missions launching on rockets and from sites not covered by the original *2002 NRP EA* for individual fully independent review under NEPA. Duplicate analyses and redundant documentation would not present any new information or identify any substantially different regional or cumulative environmental impacts.

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	Mission	Center Managed	Year of Launch
	VAFB		
1	AQUARIUS	JPL	2011
2	GRAIL	JPL	2011
3	Orbiting Carbon Observatory (OCO)	JPL	2009
4	OCO-2	JPL	2012
5	Ocean Surface Topography Mission (OSTM)/Jason-2	JPL	2008
6	Wide-field Infrared Survey Explorer (WISE)	JPL	2009
7	CHIPS	Goddard	2003
8	SORCE	Goddard	2003
9	SCISAT (non-NASA)	Goddard	2003
10	NOAA N	Goddard	2005
11	ST-5	Goddard	2006
12	AIM	Goddard	2007
13	NOAA N’	Goddard	2009
14	GLORY	Goddard	2010
15	NPP	Goddard	2011
	CCAFS		
1	Contour	JPL	2002
2	Dawn	JPL	2007
3	Deep Impact/Epoxi	JPL	2005
4	Juno	JPL	2011
5	Kepler	JPL	2009
6	Mars Reconnaissance Orbiter	JPL	2005
7	Messenger	Goddard	2004
8	Phoenix	JPL	2007
9	TDRS J	Goddard	2002
10	GALEX	Goddard	2003
11	SWIFT	Goddard	2004
12	GOES N	Goddard	2006
13	STEREO	Goddard	2006
14	THEMIS	Goddard	2007
15	GLAST	Goddard	2008
16	LCROSS (w/LRO)	Ames	2009
17	LRO (w/LCROSS)	Goddard	2009
18	GOES O	Goddard	2009
19	SDO	Goddard	2010
20	GOES P	Goddard	2010
21	LDCM	Goddard	2012
22	TDRS K	Goddard	2012
23	RBSP	Goddard	2012
24	TDRS L	Goddard	2013
25	MAVEN	Goddard	2013
26	MMS	Goddard	2014
	RMI		
1	IBEX	Goddard	2008
1	NuSTAR	JPL	2012

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APPENDIX B
AFTOX Model Predictions for Dispersion of Vapors from Spills of Payload Liquid Propellants

The U.S. Air Force Toxic Chemical Dispersion Model (AFTOX) was used to predict downwind dispersion distances for propellant vapors that would be generated by worst case spills from NASA routine payload spacecraft. AFTOX was officially endorsed by the Air Weather Service in 1988 and is used extensively throughout the U.S. Air Force. It is a Gaussian puff/plume model designed to simulate a variety of releases including continuous or instantaneous, liquid or gas, surface or elevated, and point or area. It includes several evaporation models for predicting emission rates from liquid spills. AFTOX is a simple model that assumes a uniform windfield and flat terrain (Kunkel 1991). This appendix provides the results of the AFTOX runs relevant to the NASA routine payload spacecraft.

Worst case spills of three liquid propellants were considered: 1,000 kg (2,200 lb) of hydrazine, 1,000 kg (2,200 lb) of monomethylhydrazine (MMH), and 1,200 kg (2,640 lb) of nitrogen tetroxide (NTO). These are the maximum propellant loads for the routine payload spacecraft. Worst case assumptions were that the spills were instantaneous and unconfined, and that they completely evaporated without any mitigating actions such as removal, dilution, or neutralization. These worst case assumptions are very unlikely to occur considering the regulations governing the use and transport of these hazardous propellants.

AFTOX was used to predict mean distances to selected downwind concentrations of each air toxin. Model output also provides a toxic hazard corridor distance that is the 90% probability distance. The selected concentrations used for this analysis were the Short-Term Emergency Guidance Levels (SPEGLs) for hydrazine (0.12 ppm 1-hour average), MMH (0.26 ppm 1-hour average), and nitrogen dioxide (1.0 ppm 1-hour average). The Committee on Toxicology, National Research Council, issues SPEGLs.

Four AFTOX model predictions were generated for each propellant at each launch site (CCAFS and VAFB). The four predictions at each site covered daytime releases at two different wind speeds (2 and 10 m/s; 7 and 33 ft/s) and nighttime releases at two different wind speeds (2 and 10 m/s; 7 and 33 ft/s). Daytime temperatures were assumed to be 32°C (90°F) at CCAFS and 20°C (68°F) at VAFB. Nighttime temperatures were assumed to be 5°C (41°F) at both sites. These meteorological conditions were selected to represent a variety of possible dispersion cases. Selection of other conditions would result in different model results.

AFTOX predicted the following results for spills at CCAFS: (1) an unconfined spill of 1,000 kg (2,200 lb) of hydrazine would produce a spill area of 107 m^2 (1,150 ft^2) and a mean hazard distance of up to 1,493 m (4,897 ft); (2) an unconfined spill of 1,000 kg (2,200 lb) of MMH would produce a spill area of 1,14 m^2 (1,227 ft^2) and a mean hazard distance of up to 1,452 m (4,763 ft); and (3) an unconfined spill of 1,200 kg (2,640 lb) of NTO would produce a spill area of 80 m^2 (861 ft^2) and a mean hazard distance of up to 5,680 m (18,630 ft) for nitrogen dioxide. Note: AFTOX predicts that NTO liquid spills are gas releases at 32°C (90°F) ambient temperature. For modeling purposes, the gas was assumed to have a release duration of five minutes.

AFTOX predicted the following results for spills at VAFB: (1) an unconfined spill of 1,000 kg (2,200 lb) of hydrazine would produce a spill area of 99 m^2 (1,065 ft^2) and a mean hazard distance of up to 1,140 m (3,740 ft); (2) an unconfined spill of 1,000 kg (2,200 lb) of MMH would produce a spill area of 115 m^2 (1,237 ft^2) and a mean hazard distance of up to 1,170 m (3,838 ft); and (3) an unconfined spill of 1,200 kg (2,640 lb) of NTO would produce a spill area of 81 m^2 (872 ft^2) and a mean hazard distance of up to 3,390 m (11,120 ft) for nitrogen dioxide.

These mean hazard distances are for one-hour average concentrations. However, for spills that evaporated in less than one hour (many of the NTO spills) the vapor concentration averaging time calculated by AFTOX is the evaporation time rather than for one hour. Therefore, the calculated hazard distance for many of the NTO spills is much longer than the actual one-hour average hazard distance. This is another conservative factor in the AFTOX results.

The following is the AFTOX-generated results for each of the 24 model runs that were needed for the NASA routine payload spacecraft NEPA analysis.

HYDRAZINE SPILLS AT VAFB

```
        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Vandenberg AIR FORCE BASE,
DATE: 03-01-01
TIME: 1400 LST

INSTANTANEOUS RELEASE
HYDRAZINE
TEMPERATURE = 20 C
WIND DIRECTION = 0
WIND SPEED = 2 M/S
SUN ELEVATION ANGLE IS 41 DEGREES
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS .5
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,000 KG
AREA OF SPILL IS 99 SQ M
CALCULATED POOL TEMPERATURE IS 17.2 C
EVAPORATION RATE IS 2.52 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 396.1 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
ELAPSED TIME SINCE START OF SPILL IS 396 MIN
HEIGHT OF INTEREST IS 2 M

-------------------------------------------------------
AT 396 MIN, THE MAXIMUM DISTANCE FOR .12 PPM IS 524 M
MAXIMUM TOXIC CORRIDOR LENGTH = 1.1 KM AT 396 MIN
DIRECTION & WIDTH 180 +/- 75 DEG

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HYDRAZINE SPILLS AT VAFB

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        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Vandenberg AFB
DATE: 03-01-01
TIME: 1400 LST

INSTANTANEOUS RELEASE
HYDRAZINE
TEMPERATURE = 20 C
WIND DIRECTION = 0
WIND SPEED = 10 M/S
SUN ELEVATION ANGLE IS 41 DEGREES
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 3.35
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,000 KG
AREA OF SPILL IS 99 SQ M
CALCULATED POOL TEMPERATURE IS 16.6 C
EVAPORATION RATE IS 2.74 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 364.4 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
ELAPSED TIME SINCE START OF SPILL IS 364 MIN
HEIGHT OF INTEREST IS 2 M

-------------------------------------------------------
AT 364 MIN, THE MAXIMUM DISTANCE FOR .12 PPM IS 1.14 KM
MAXIMUM TOXIC CORRIDOR LENGTH = 2.41 KM AT 364 MIN
DIRECTION & WIDTH 180 +/- 32 DEG

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HYDRAZINE SPILLS AT VAFB

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        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Vandenberg AFB
DATE: 03-01-01
TIME: 0200 LST

INSTANTANEOUS RELEASE
HYDRAZINE
TEMPERATURE = 5 C
WIND DIRECTION = 0
WIND SPEED = 2 M/S
NIGHTTIME SPILL
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 6
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,000 KG
AREA OF SPILL IS 99 SQ M
CALCULATED POOL TEMPERATURE IS 2 C
EVAPORATION RATE IS .08 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 11,578.3 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
HEIGHT OF INTEREST IS 2 M

-----------------------------------------------------
THE MAXIMUM DISTANCE FOR .12 PPM IS 667 M
MAXIMUM TOXIC CORRIDOR LENGTH = 1.4 KM
DIRECTION & WIDTH 180 +/- 45 DEG

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HYDRAZINE SPILLS AT VAFB

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        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Vandenberg AFB
DATE: 03-01-01
TIME: 0200 LST

INSTANTANEOUS RELEASE
HYDRAZINE
TEMPERATURE = 5 C
WIND DIRECTION = 0
WIND SPEED = 10 M/S
NIGHTTIME SPILL
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 3.53
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,000 KG
AREA OF SPILL IS 99 SQ M
CALCULATED POOL TEMPERATURE IS 2 C
EVAPORATION RATE IS 1.09 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 913.1 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
ELAPSED TIME SINCE START OF SPILL IS 913 MIN
HEIGHT OF INTEREST IS 2 M

-------------------------------------------------------
AT 913 MIN, THE MAXIMUM DISTANCE FOR .12 PPM IS 738 M
MAXIMUM TOXIC CORRIDOR LENGTH = 1.56 KM AT 913 MIN
DIRECTION & WIDTH 180 +/- 22 DEG

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HYDRAZINE SPILLS AT CCAFS

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        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Cape Canaveral AFS
DATE: 03-01-01
TIME: 1400 LST

INSTANTANEOUS RELEASE
HYDRAZINE
TEMPERATURE = 90 F
WIND DIRECTION = 0
WIND SPEED = 4 KNOTS
SUN ELEVATION ANGLE IS 49 DEGREES
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS .5
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,000 KG
AREA OF SPILL IS 1067 SQ FT
CALCULATED POOL TEMPERATURE IS 24.8 C
EVAPORATION RATE IS 3.83 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 260.8 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
ELAPSED TIME SINCE START OF SPILL IS 260 MIN
HEIGHT OF INTEREST IS 6 FT

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AT 260 MIN, THE MAXIMUM DISTANCE FOR .12 PPM IS 2,148 FT
MAXIMUM TOXIC CORRIDOR LENGTH = 4,545 FT AT 261 MIN
DIRECTION & WIDTH 180 +/- 75 DEG

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HYDRAZINE SPILLS AT CCAFS

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        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Cape Canaveral AFS
DATE: 03-01-01
TIME: 1400 LST

INSTANTANEOUS RELEASE
HYDRAZINE
TEMPERATURE = 90 F
WIND DIRECTION = 0
WIND SPEED = 20 KNOTS
SUN ELEVATION ANGLE IS 49 DEGREES
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 3.29
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,000 KG
AREA OF SPILL IS 1,067 SQ FT
CALCULATED POOL TEMPERATURE IS 24.1 C
EVAPORATION RATE IS 4.07 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 245.3 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
ELAPSED TIME SINCE START OF SPILL IS 245 MIN
HEIGHT OF INTEREST IS 6 FT

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AT 245 MIN, THE MAXIMUM DISTANCE FOR .12 PPM IS 4,897 FT
MAXIMUM TOXIC CORRIDOR LENGTH = 1.97 MI AT 245 MIN
DIRECTION & WIDTH 180 +/- 33 DEG

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HYDRAZINE SPILLS AT CCAFS

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        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Cape Canaveral AFS
DATE: 03-01-01
TIME: 0200 LST

INSTANTANEOUS RELEASE
HYDRAZINE
TEMPERATURE = 40 F
WIND DIRECTION = 0
WIND SPEED = 4 KNOTS
NIGHTTIME SPILL
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 6
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,000 KG
AREA OF SPILL IS 1,067 SQ FT
CALCULATED POOL TEMPERATURE IS 2 C
EVAPORATION RATE IS .08 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 11,724.7 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
HEIGHT OF INTEREST IS 6 FT

-----------------------------------------------------

THE MAXIMUM DISTANCE FOR .12 PPM IS 2,196 FT
MAXIMUM TOXIC CORRIDOR LENGTH = 4,610 FT
DIRECTION & WIDTH 180 +/- 45 DEG

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HYDRAZINE SPILLS AT CCAFS

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        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Cape Canaveral AFS
DATE: 03-01-01
TIME: 0200 LST

INSTANTANEOUS RELEASE
HYDRAZINE
TEMPERATURE = 40 F
WIND DIRECTION = 0
WIND SPEED = 20 KNOTS
NIGHTTIME SPILL
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 3.54
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,000 KG
AREA OF SPILL IS 1,067 SQ FT
CALCULATED POOL TEMPERATURE IS 2 C
EVAPORATION RATE IS 1.02 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 972.5 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
ELAPSED TIME SINCE START OF SPILL IS 972 MIN
HEIGHT OF INTEREST IS 6 FT

-------------------------------------------------------

AT 972 MIN, THE MAXIMUM DISTANCE FOR .12 PPM IS 2,452 FT
MAXIMUM TOXIC CORRIDOR LENGTH = 5,221 FT AT 973 MIN
DIRECTION & WIDTH 180 +/- 22 DEG

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MMH SPILLS AT VAFB

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        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Vandenberg AFB
DATE: 03-01-01
TIME: 1400 LST

INSTANTANEOUS RELEASE
MONOMETHYLHYDRAZINE(MMH)
TEMPERATURE = 20 C
WIND DIRECTION = 0
WIND SPEED = 2 M/S
SUN ELEVATION ANGLE IS 41 DEGREES
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS .5
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,000 KG
AREA OF SPILL IS 115 SQ M
CALCULATED POOL TEMPERATURE IS 9.2 C
EVAPORATION RATE IS 7.61 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 131.4 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
ELAPSED TIME SINCE START OF SPILL IS 131 MIN
HEIGHT OF INTEREST IS 2 M

-------------------------------------------------------
AT 131 MIN, THE MAXIMUM DISTANCE FOR .24 PPM IS 537 M
MAXIMUM TOXIC CORRIDOR LENGTH = 1.13 KM AT 131 MIN
DIRECTION & WIDTH 180 +/- 75 DEG

-----------------------------------------------------
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MMH SPILLS AT VAFB

```
        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Vandenberg AFB
DATE: 03-01-01
TIME: 1400 LST

INSTANTANEOUS RELEASE
MONOMETHYLHYDRAZINE(MMH)
TEMPERATURE = 20 C
WIND DIRECTION = 0
WIND SPEED = 10 M/S
SUN ELEVATION ANGLE IS 41 DEGREES
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 3.35
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,000 KG
AREA OF SPILL IS 115 SQ M
CALCULATED POOL TEMPERATURE IS 8.6 C
EVAPORATION RATE IS 8.21 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 121.7 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
ELAPSED TIME SINCE START OF SPILL IS 121 MIN
HEIGHT OF INTEREST IS 2 M

-----------------------------------------------------
AT 121 MIN, THE MAXIMUM DISTANCE FOR .24 PPM IS 1.17 KM
MAXIMUM TOXIC CORRIDOR LENGTH = 2.46 KM AT 122 MIN
DIRECTION & WIDTH 180 +/- 32 DEG

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```

MMH SPILLS AT VAFB

```
        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Vandenberg AFB
DATE: 03-01-01
TIME: 0200 LST

INSTANTANEOUS RELEASE
MONOMETHYLHYDRAZINE(MMH)
TEMPERATURE = 5 C
WIND DIRECTION = 0
WIND SPEED = 10 M/S
NIGHTTIME SPILL
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 3.53
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,000 KG
AREA OF SPILL IS 115 SQ M
CALCULATED POOL TEMPERATURE IS -4.6 C
EVAPORATION RATE IS 3.41 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 292.6 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
ELAPSED TIME SINCE START OF SPILL IS 292 MIN
HEIGHT OF INTEREST IS 2 M

-----------------------------------------------------

AT 292 MIN, THE MAXIMUM DISTANCE FOR .24 PPM IS 773 M
MAXIMUM TOXIC CORRIDOR LENGTH = 1.62 KM AT 293 MIN
DIRECTION & WIDTH 180 +/- 22 DEG

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MMH SPILLS AT VAFB

```
        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Vandenberg AFB
DATE: 03-01-01
TIME: 0200 LST

INSTANTANEOUS RELEASE
MONOMETHYLHYDRAZINE(MMH)
TEMPERATURE = 5 C
WIND DIRECTION = 0
WIND SPEED = 2 M/S
NIGHTTIME SPILL
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 6
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,000 KG
AREA OF SPILL IS 115 SQ M
CALCULATED POOL TEMPERATURE IS -1.9 C
EVAPORATION RATE IS .32 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 3,086.6 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
ELAPSED TIME SINCE START OF SPILL IS 3,086 MIN
HEIGHT OF INTEREST IS 2 M

-----------------------------------------------------

AT 3086 MIN, THE MAXIMUM DISTANCE FOR .24 PPM IS 780 M
MAXIMUM TOXIC CORRIDOR LENGTH = 1.65 KM AT 3,087 MIN
DIRECTION & WIDTH 180 +/- 45 DEG

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MMH SPILLS AT CCAFS

```
        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Cape Canaveral AFS
DATE: 03-01-01
TIME: 1400 LST

INSTANTANEOUS RELEASE
MONOMETHYLHYDRAZINE(MMH)
TEMPERATURE = 90 F
WIND DIRECTION = 0
WIND SPEED = 4 KNOTS
SUN ELEVATION ANGLE IS 49 DEGREES
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS .5
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,000 KG
AREA OF SPILL IS 1,242 SQ FT
CALCULATED POOL TEMPERATURE IS 15 C
EVAPORATION RATE IS 10.55 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 94.7 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
ELAPSED TIME SINCE START OF SPILL IS 94 MIN
HEIGHT OF INTEREST IS 6 FT

-----------------------------------------------------

AT 94 MIN, THE MAXIMUM DISTANCE FOR .24 PPM IS 2,105 FT
MAXIMUM TOXIC CORRIDOR LENGTH = 4456 FT AT 95 MIN
DIRECTION & WIDTH 180 +/- 75 DEG

-----------------------------------------------------
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MMH SPILLS AT CCAFS

```
        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Cape Canaveral AFS
DATE: 03-01-01
TIME: 1400 LST

INSTANTANEOUS RELEASE
MONOMETHYLHYDRAZINE(MMH)
TEMPERATURE = 90 F
WIND DIRECTION = 0
WIND SPEED = 20 KNOTS
SUN ELEVATION ANGLE IS 49 DEGREES
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 3.29
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,000 KG
AREA OF SPILL IS 1,242 SQ FT
CALCULATED POOL TEMPERATURE IS 14.5 C
EVAPORATION RATE IS 11.2 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 89.2 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
ELAPSED TIME SINCE START OF SPILL IS 89 MIN
HEIGHT OF INTEREST IS 6 FT

-----------------------------------------------------

AT 89 MIN, THE MAXIMUM DISTANCE FOR .24 PPM IS 4,765 FT
MAXIMUM TOXIC CORRIDOR LENGTH = 1.9 MI AT 89 MIN
DIRECTION & WIDTH 180 +/- 33 DEG

-----------------------------------------------------
```

MMH SPILLS AT CCAFS

```
        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Cape Canaveral AFS
DATE: 03-01-01
TIME: 0200 LST

INSTANTANEOUS RELEASE
MONOMETHYLHYDRAZINE(MMH)
TEMPERATURE = 40 F
WIND DIRECTION = 0
WIND SPEED = 4 KNOTS
NIGHTTIME SPILL
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 6
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,000 KG
AREA OF SPILL IS 1,242 SQ FT
CALCULATED POOL TEMPERATURE IS -2.3 C
EVAPORATION RATE IS .31 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 3,222.2 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
ELAPSED TIME SINCE START OF SPILL IS 3,222 MIN
HEIGHT OF INTEREST IS 6 FT

-----------------------------------------------------

AT 3,222 MIN, THE MAXIMUM DISTANCE FOR .24 PPM IS 2,524 FT
MAXIMUM TOXIC CORRIDOR LENGTH = 1 MI AT 3,222 MIN
DIRECTION & WIDTH 180 +/- 45 DEG

-----------------------------------------------------
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MMH SPILLS AT CCAFS

```
        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Cape Canaveral AFS
DATE: 03-01-01
TIME: 0200 LST

INSTANTANEOUS RELEASE
MONOMETHYLHYDRAZINE(MMH)
TEMPERATURE = 40 F
WIND DIRECTION = 0
WIND SPEED = 20 KNOTS
NIGHTTIME SPILL
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 3.54
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,000 KG
AREA OF SPILL IS 1,242 SQ FT
CALCULATED POOL TEMPERATURE IS -4.9 C
EVAPORATION RATE IS 3.13 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 318.5 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
ELAPSED TIME SINCE START OF SPILL IS 318 MIN
HEIGHT OF INTEREST IS 6 FT

-----------------------------------------------------

AT 318 MIN, THE MAXIMUM DISTANCE FOR .24 PPM IS 2,535 FT
MAXIMUM TOXIC CORRIDOR LENGTH = 1 MI AT 319 MIN
DIRECTION & WIDTH 180 +/- 22 DEG

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NITROGEN TETROXIDE SPILLS AT VAFB

```
        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Vandenberg AFB
DATE: 03-01-01
TIME: 1400 LST

INSTANTANEOUS RELEASE
NITROGEN TETROXIDE
TEMPERATURE = 20 C
WIND DIRECTION = 0
WIND SPEED = 2 M/S
SUN ELEVATION ANGLE IS 41 DEGREES
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS .5
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,200 KG
AREA OF SPILL IS 83 SQ M
CALCULATED POOL TEMPERATURE IS -11.2 C
EVAPORATION RATE IS 91.3 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 13.1 MIN
CONCENTRATION AVERAGING TIME IS 13.14 MIN
ELAPSED TIME SINCE START OF SPILL IS 13 MIN
HEIGHT OF INTEREST IS 2 M

-----------------------------------------------------

AT 13 MIN, THE MAXIMUM DISTANCE FOR 1 PPM IS 924 M
MAXIMUM TOXIC CORRIDOR LENGTH = 1.94 KM AT 13 MIN
DIRECTION & WIDTH 180 +/- 75 DEG

-----------------------------------------------------
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NITROGEN TETROXIDE SPILLS AT VAFB

```
        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Vandenberg AFB
DATE: 03-01-01
TIME: 1400 LST

INSTANTANEOUS RELEASE
NITROGEN TETROXIDE
TEMPERATURE = 20 C
WIND DIRECTION = 0
WIND SPEED = 10 M/S
SUN ELEVATION ANGLE IS 41 DEGREES
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 3.35
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,200 KG
AREA OF SPILL IS 83 SQ M
CALCULATED POOL TEMPERATURE IS -11.2 C
EVAPORATION RATE IS 103.35 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 11.6 MIN
CONCENTRATION AVERAGING TIME IS 11.61 MIN
ELAPSED TIME SINCE START OF SPILL IS 11 MIN
HEIGHT OF INTEREST IS 2 M

-----------------------------------------------------

AT 11 MIN, THE MAXIMUM DISTANCE FOR 1 PPM IS 2.94 KM
MAXIMUM TOXIC CORRIDOR LENGTH = 6.24 KM AT 12 MIN
DIRECTION & WIDTH 180 +/- 32 DEG

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NITROGEN TETROXIDE SPILLS AT VAFB

```
        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Vandenberg AFB
DATE: 03-01-01
TIME: 0200 LST

INSTANTANEOUS RELEASE
NITROGEN TETROXIDE
TEMPERATURE = 5 C
WIND DIRECTION = 0
WIND SPEED = 2 M/S
NIGHTTIME SPILL
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 6
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,200 KG
AREA OF SPILL IS 81 SQ M
CALCULATED POOL TEMPERATURE IS -11.2 C
EVAPORATION RATE IS 8.03 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 149.4 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
ELAPSED TIME SINCE START OF SPILL IS 149 MIN
HEIGHT OF INTEREST IS 2 M

-----------------------------------------------------

AT 149 MIN, THE MAXIMUM DISTANCE FOR 1 PPM IS 2.58 KM
MAXIMUM TOXIC CORRIDOR LENGTH = 5.43 KM AT 149 MIN
DIRECTION & WIDTH 180 +/- 45 DEG

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```

NITROGEN TETROXIDE SPILLS AT VAFB

```
        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Vandenberg AFB
DATE: 03-01-01
TIME: 0200 LST

INSTANTANEOUS RELEASE
NITROGEN TETROXIDE
TEMPERATURE = 5 C
WIND DIRECTION = 0
WIND SPEED = 10 M/S
NIGHTTIME SPILL
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 3.53
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,200 KG
AREA OF SPILL IS 81 SQ M
CALCULATED POOL TEMPERATURE IS -11.2 C
EVAPORATION RATE IS 101.17 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 11.8 MIN
CONCENTRATION AVERAGING TIME IS 11.86 MIN
ELAPSED TIME SINCE START OF SPILL IS 11 MIN
HEIGHT OF INTEREST IS 2 M

-----------------------------------------------------

AT 11 MIN, THE MAXIMUM DISTANCE FOR 1 PPM IS 3.39 KM
MAXIMUM TOXIC CORRIDOR LENGTH = 7.16 KM AT 12 MIN
DIRECTION & WIDTH 180 +/- 22 DEG

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NITROGEN TETROXIDE SPILLS AT CCAFS

```
        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Cape Canaveral AFS
DATE: 03-01-01
TIME: 1400 LST

CONTINUOUS RELEASE
NITROGEN TETROXIDE
TEMPERATURE = 90 F
WIND DIRECTION = 0
WIND SPEED = 4 KNOTS
SUN ELEVATION ANGLE IS 49 DEGREES
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS .5
SPILL SITE ROUGHNESS LENGTH IS 10 CM

THIS IS A GAS RELEASE
HEIGHT OF LEAK ABOVE GROUND IS 1 FT
EMISSION RATE IS 240 KG/MIN
ELAPSED TIME OF SPILL IS 5 MIN
TOTAL AMOUNT SPILLED IS 1200 KG
CONCENTRATION AVERAGING TIME IS 5 MIN
ELAPSED TIME SINCE START OF SPILL IS 5 MIN
HEIGHT OF INTEREST IS 6 FT

-----------------------------------------------------

AT 5 MIN, THE MAXIMUM DISTANCE FOR 1 PPM IS 1,659 FT
MAXIMUM TOXIC CORRIDOR LENGTH = 1.62 MI AT 13 MIN
DIRECTION & WIDTH 180 +/- 75 DEG

-----------------------------------------------------

ELAPSED TIME SINCE START OF SPILL IS 13 MIN

-----------------------------------------------------

AT 13 MIN, THE MAXIMUM DISTANCE FOR 1 PPM IS 4,037 FT
MAXIMUM TOXIC CORRIDOR LENGTH = 1.62 MI AT 13 MIN
DIRECTION & WIDTH 180 +/- 75 DEG

-----------------------------------------------------
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NITROGEN TETROXIDE SPILLS AT CCAFS

```
        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Cape Canaveral AFS
DATE: 03-01-01
TIME: 1400 LST

CONTINUOUS RELEASE
NITROGEN TETROXIDE
TEMPERATURE = 90 F
WIND DIRECTION = 0
WIND SPEED = 20 KNOTS
SUN ELEVATION ANGLE IS 49 DEGREES
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 3.29
SPILL SITE ROUGHNESS LENGTH IS 10 CM

THIS IS A GAS RELEASE
HEIGHT OF LEAK ABOVE GROUND IS 1 FT
EMISSION RATE IS 240 KG/MIN
ELAPSED TIME OF SPILL IS 5 MIN
TOTAL AMOUNT SPILLED IS 1200 KG
CONCENTRATION AVERAGING TIME IS 5 MIN
ELAPSED TIME SINCE START OF SPILL IS 5 MIN
HEIGHT OF INTEREST IS 6 FT

-----------------------------------------------------

AT 5 MIN, THE MAXIMUM DISTANCE FOR 1 PPM IS 1.66 MI
MAXIMUM TOXIC CORRIDOR LENGTH = 7.53 MI AT 12 MIN
DIRECTION & WIDTH 180 +/- 33 DEG

-----------------------------------------------------

ELAPSED TIME SINCE START OF SPILL IS 12 MIN

-----------------------------------------------------

AT 12 MIN, THE MAXIMUM DISTANCE FOR 1 PPM IS 3.53 MI
MAXIMUM TOXIC CORRIDOR LENGTH = 7.53 MI AT 12 MIN
DIRECTION & WIDTH 180 +/- 33 DEG

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NITROGEN TETROXIDE SPILLS AT CCAFS

```
        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Cape Canaveral AFS
DATE: 03-01-01
TIME: 0200 LST

INSTANTANEOUS RELEASE
NITROGEN TETROXIDE
TEMPERATURE = 40 F
WIND DIRECTION = 0
WIND SPEED = 4 KNOTS
NIGHTTIME SPILL
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 6
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,200 KG
AREA OF SPILL IS 874 SQ FT
CALCULATED POOL TEMPERATURE IS -11.2 C
EVAPORATION RATE IS 7.92 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 151.4 MIN
CONCENTRATION AVERAGING TIME IS 60 MIN
ELAPSED TIME SINCE START OF SPILL IS 151 MIN
HEIGHT OF INTEREST IS 6 FT

-----------------------------------------------------

AT 151 MIN, THE MAXIMUM DISTANCE FOR 1 PPM IS 1.6 MI
MAXIMUM TOXIC CORRIDOR LENGTH = 3.44 MI AT 151 MIN
DIRECTION & WIDTH 180 +/- 45 DEG

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NITROGEN TETROXIDE SPILLS AT CCAFS

```
        USAF TOXIC CHEMICAL DISPERSION MODEL
                       AFTOX

Cape Canaveral AFS
DATE: 03-01-01
TIME: 0200 LST

INSTANTANEOUS RELEASE
NITROGEN TETROXIDE
TEMPERATURE = 40 F
WIND DIRECTION = 0
WIND SPEED = 20 KNOTS
NIGHTTIME SPILL
CLOUD COVER IS 0 EIGHTHS
GROUND IS DRY
THERE IS NO INVERSION
ATMOSPHERIC STABILITY PARAMETER IS 3.54
SPILL SITE ROUGHNESS LENGTH IS 10 CM

TOTAL AMOUNT SPILLED IS 1,200 KG
AREA OF SPILL IS 874 SQ FT
CALCULATED POOL TEMPERATURE IS -11.2 C
EVAPORATION RATE IS 94.92 KG/MIN
THE CHEMICAL WILL EVAPORATE IN 12.6 MIN
CONCENTRATION AVERAGING TIME IS 12.64 MIN
ELAPSED TIME SINCE START OF SPILL IS 12 MIN
HEIGHT OF INTEREST IS 6 FT

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AT 12 MIN, THE MAXIMUM DISTANCE FOR 1 PPM IS 2.12 MI
MAXIMUM TOXIC CORRIDOR LENGTH = 4.45 MI AT 13 MIN
DIRECTION & WIDTH 180 +/- 22 DEG

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APPENDIX C
NASA Routine Payload Evaluation and Determination Process and Checklist

After a proposed spacecraft mission is sufficiently well formulated (usually the Phase B design study), the Sponsoring Entity, in coordination with the local Environmental Management Office (EMO), will prepare an environmental evaluation. An environmental evaluation is a preliminary review that determines what aspects of the proposal are of potential environmental concern. The environmental evaluation also assists in determining the appropriate level of National Environmental Policy Act (NEPA) documentation (i.e., environmental assessment [EA], or environmental impact statement [EIS]) for the proposal. The local EMO uses a comprehensive checklist to provide a level of rigor to this early evaluation of the proposal, helping to ensure that pertinent considerations are not overlooked. Local EMO review of the Routine Payload Checklist (RPC, below) forms the basis for evaluating the applicability of a NASA Routine Payload (NRP) spacecraft classification for a proposed mission.

The local EMO uses the completed RPC (and required attachments) to evaluate the proposed mission against the NRP EA criteria. If the EMO evaluation of the RPC indicates that a NRP categorization may be appropriate, the Sponsoring Entity documents this in an Evaluation Recommendation Package (ERP). The ERP is then processed for review and approval in accordance with established National Aeronautics and Space Administration (NASA) procedures and guidelines. If approved, the ERP would be attached to a Record of Environmental Consideration (REC).

The Sponsoring Entity can then proceed with the proposal while monitoring the project activities, for changes or circumstances during implementation that could affect classification of the proposed mission as a NRP spacecraft. If a NRP spacecraft categorization is determined to be inappropriate, the local EMO will initiate plans for preparation of additional NEPA documentation.

NASA Routine Payload Checklist (1 of 2)

PROJECT NAME: DATE OF LAUNCH:
PROJECT CONTACT: PHONE NUMBER: MAILSTOP:
PROJECT START DATE: PROJECT LOCATION:
PROJECT DESCRIPTION:

A. SAMPLE RETURN:	YES	NO
1. Would the candidate mission return a sample from an extraterrestrial body?		
B. RADIOACTIVE MATERIALS:	YES	NO
1. Would the candidate spacecraft carry radioactive materials in quantities that produce an A2 mission multiple value of 10 or more?		
Provide a copy of the Radioactive Materials On Board Report as per NPR 8715.3 with the ERP submittal		
C. LAUNCH AND LAUNCH VEHICLES:	YES	NO
1. Would the candidate spacecraft be launched using a launch vehicle and launch combination other than those indicated in Table 1 below?		
2. Would launch of the proposed mission exceed the approved or permitted annual launch rate for the particular launch vehicle or launch site?		
Comments:		
D. FACILITIES:	YES	NO
1. Would the candidate mission require the construction of any new facilities or substantial modification of existing facilities?		
Provide a brief description of the construction or modification required, including whether ground disturbance and/or excavation would occur:		
E. HEALTH AND SAFETY:	YES	NO
1. Would the expected risk of human casualty from spacecraft planned orbital reentry exceed the criteria specified by NASA 8719.14?		
2. Would the candidate spacecraft utilize batteries, ordnance, hazardous propellant, radiofrequency transmitter power, or other subsystem components in quantities or levels exceeding the Envelope Payload Characteristics (EPCs) in Table 2 below?		
3. Would the candidate spacecraft utilize any potentially hazardous material as part of a flight system whose type or amount precludes acquisition of the necessary permits prior to its use or is not included within the definition of the Envelope Payload (EP)?		
4. Would the candidate mission under normal conditions, release material other than propulsion system exhaust or inert gases into the Earth's atmosphere or space?		
5. Are there changes in the preparation, launch or operation of the candidate spacecraft from the standard practices described in Chapter 3 of this EA?		
6. Would the candidate spacecraft utilize an Earth-pointing laser system that does not meet the requirements for safe operation (ANSI Z136.1-2007 and ANSI Z136.6-2005)?		
7. Would the candidate spacecraft contain, by design (e.g., a scientific payload) pathogenic microorganisms (including bacteria, protozoa, and viruses) which can produce disease or toxins hazardous to human health or the environment beyond Biosafety level I[11]?		
Comments:		

Continued on next page

[11] The use of biological agents on payloads is limited to materials with a safety rating of "Biosafety Level 1." This classification includes defined and characterized strains of viable microorganisms not known to consistently cause disease in healthy human adults. Personnel working with Biosafety Level 1 agents follow standard microbiological practices including the use of mechanical pipetting devices, no eating drinking, or smoking in the laboratory, and required hand-washing after working with agents or leaving a lab where agents are stored. Personal protective equipment such as gloves and eye protection is also recommended when working with biological agents.

NASA Routine Payload Checklist (2 of 2)

PROJECT NAME: DATE OF LAUNCH:
PROJECT CONTACT: PHONE NUMBER: MAILSTOP:
PROJECT START DATE: PROJECT LOCATION:
PROJECT DESCRIPTION:

F. OTHER ENVIRONMENTAL ISSUES:	YES	NO
1. Would launch and operation of the candidate spacecraft have the potential to create substantial public controversy related to environmental issues?		
2. Would the candidate spacecraft have the potential for substantial effects on the environment outside the United States?		
3. Would any aspect of the candidate spacecraft that is not addressed by the EPCs have the potential for substantial effects on the environment (i.e., previously unused materials, configurations or material not included in the checklist)?		
Comments:		

Table C–1. Launch Vehicles and Launch Sites

Launch Vehicle and Launch Vehicle Family	Space Launch Complexes and Pads				
	Eastern Range (CCAFS)	Western Range (VAFB)	USAKA/RTS	WFF	KLC
Atlas V Family	LC-41	SLC-3	N/A	N/A	N/A
Athena I,IIc, IIIa	LC-46	CA Spaceport (SLC-8)	N/A	Pad 0	LP-1
Delta II Family	LC-17	SLC-2	N/A	N/A	N/A
Delta IV Family	LC-37	SLC-6	N/A	N/A	N/A
Falcon 1/1e	LC-36	SLC-4W	Omelek Island	Pad 0	LP-3[a]
Falcon 9	LC-40	SLC-4E	Omelek	Pad 0	LP-3[a]
Minotaur I	LC-20 and/or LC-46	SLC-8	N/A	Pad 0	LP-1
Minotaur II-III	LC-20 and/or LC-46	SLC-8	N/A	Pad 0	LP-1
Minotaur IV	LC-20 and/or LC-46	SLC-8	N/A	Pad 0	LP-1
Minotaur V	LC-20 and/or LC-46	SLC-8	N/A	Pad 0	LP-1
Pegasus XL	CCAFS skidstrip KSC SLF	VAFB Airfield	Kwajalein Island	WFF Airfield	N/A
Taurus	LC-46 and/or LC-20	SLC-576E	N/A	Pad 0	LP-1
Taurus II	NA	NA	N/A	Pad 0	LP-3[a]
Any other launch vehicle/launch site combination for which NASA has completed or cooperated on the NEPA compliance					

Key: N/A=Not Applicable.

a: Athena III and LP-3 are currently under design

Table C–2. Summary of Envelope Spacecraft Subsystems and Envelope Payload Characteristics

Structure	• **Unlimited:** aluminum, beryllium, carbon resin composites, magnesium, titanium, and other materials unless specified as limited.
Propulsion*	• Liquid propellant(s); 3,200 kg (7,056 lb) combined hydrazine, monomethyhydrazine and/or nitrogen tetroxide. • Solid Rocket Motor (SRM) propellant; 3,000 kg (6,614 lb) Ammonium Perchlorate (AP)-based solid propellant (examples of SRM propellant that might be on a spacecraft are a Star-48 kick stage, descent engines, an extra-terrestrial ascent vehicle, etc.)
Communications	• Various 10-100 Watt (RF) transmitters
Power	• Unlimited Solar cells; 5 kilowatt-Hour (kW-hr) Nickel-Hydrogen (NiH_2) or Lithium ion (Li-ion) battery, 300 Ampere-hour (A-hr) Lithium-Thionyl Chloride (LiSOCl), or 150 A-hr Hydrogen, Nickel-Cadmium (NiCd), or Ni-H_2 battery.
Science Instruments	• 10 kW radar • American National Standards Institute safe lasers (see Section 4.1.2.1.3)
Other	• U. S. Department of Transportation (DoT) Class 1.4 Electro-Explosive Devices (EEDs) for mechanical systems deployment • Radioactive materials in quantities that produce an A_2 mission multiple value of less than 10 • Propulsion system exhaust and inert gas venting • Sample returns are considered outside of the scope of this environmental assessment

Key: Kg=kilograms; Lb=pounds.

*Propellant limits are subject to range safety requirements

APPENDIX D
Glossary

A2 Multiple – The A2 Mission Multiple is a calculated value based on the total amount of radioactive material being launched. This value is used in defining the level of review and approval required for launch.

Ambient air – The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures. (It is not the air in the immediate proximity of an emission source.)

Aquifer – Underground layers of rock, sand, or gravel that contains water.

Attainment – An area is designated as being in attainment by the U.S. Environmental Protections Agency (EPA) if it meets the National Ambient Air Quality Standards (NAAQS) for a given criteria pollutant. Non attainment areas are areas in which any one of the NAAQS have been exceeded. Maintenance areas are areas previously designated non attainment and subsequently re-designated as attainment. Unclassifiable areas are areas that cannot be classified on the basis of available information as meeting or not meeting the NAAQS for any one criteria pollutant.

A-weighted decibels (dBA) – Most measures of noise for community planning purposes use dBA units, which emphasize noises in the middle range frequencies. The emphasis is placed on the middle range frequencies because some noise occurs in frequencies too high or too low for the human ear to fully perceive.

Breakup – An explosion or disassembly of the spacecraft or launch vehicle which generates orbital debris.

Community noise equivalent level (CNEL) – Describes the average sound level during a 24-hour day in dBA. For noises occurring between 7 pm and 10 pm, 5 dBA are added to the measured noise level, and for noises occurring between 10 pm and 7 am, 10 dBA are added to the measured noise level.

Conjunction Assessment – An analysis done to predict the closest point of approach of two space objects based on their orbital parameters.

Criteria pollutants – The Clear Air Act requires the U.S. EPA to set air quality standards for common and widespread pollutants after preparing criteria documents summarizing scientific knowledge on their health effects. Currently, there are standards in effect for six criteria pollutants: sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter equal to of less than 2.5 microns in diameter ($PM_{2.5}$), particulate matter equal to of less than 10 microns in diameter (PM_{10}), nitrogen dioxide (NO_2), ozone (O_3), and lead (Pb).

Cultural resources – The prehistoric and historic districts, sites, buildings, objects, or any other physical activity of a culture or subculture.

Cumulative impact – The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes other such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Day/night average sound level (L_{dn} or DNL) – Is the average sound level during a 24-hour day. For noises occurring between 10 pm and 7 am, 10 dBA are added to the measured noise level.

dBA – A measurement unit that describes a particular sound pressure quantity to a standard reference value (A-weighted).

De minimis – Latin for "of minimum importance" or "trifling." Essentially de minimis thresholds refer to values so small that the law will not consider them

Decibel (dB) – A unit for describing the ratio of two powers or intensities; or the ratio of a power to a reference power. In measurement of sound intensity, the pressure of the reference sound is usually taken as 2×10^{-4} dyne per square centimeter (equal to one-tenth bel). Also, a logarithmic measurement unit that describes a particular sound pressure quantity compared to a standard reference value.

Decommissioning – Includes the deconstruction, diversion, reuse, and disposal of component parts/materials/substances from a launch system.

Deposition – In atmospheric transport terms, the settling out on ground and building surfaces of atmospheric aerosols and particles (dry deposition) or their removal from the air to the ground by precipitation (wet deposition or rainout).

Endangered species – A plant or animal that is in danger of extinction throughout all or a significant portion of its range.

End-of-Mission (EOM) – The time of completion of all mission activities, experimental operations, and stand-by status; immediately precede passivation and disposal of the spacecraft or launch vehicle stage.

Flight corridor – An area on the Earth's surface estimated to contain the hazardous debris from nominal flight of a launch vehicle, and non-nominal flight of a launch vehicle assuming a perfectly functioning flight termination system or other flight safety system.

Half-life – The amount of time it takes for half of a substance or chemical to breakdown (degrade). This term is most often used in reference to radioactive materials.

Hydrazine – A toxic, colorless liquid fuel that is hypergolic (able to burn spontaneously on contact) when mixed with an oxidizer such as nitrogen tetroxide (NTO or N_2O_4) or placed in contact with a catalyst. Vapors may form explosive mixtures with air.

Isotope – Any of two or more species of atoms of a chemical element with the same atomic number (same number of protons, but the number of neutrons differs) and nearly identical chemical behavior, but with different atomic mass (number of neutrons) or mass number and different physical properties. Most elements have more than one naturally occurring isotope.

Launch – To place or try to place a launch vehicle or reentry vehicle and any payload from Earth – (a) in a suborbital trajectory; (b) in Earth orbit in outer space; or (c) otherwise in outer space, including activities involved in the preparation of a launch vehicle or payload for launch, when those activities take place at a launch site in the United States.

Launch operator – A person who conducts or who will conduct the launch of a launch vehicle and any payload.

Launch site operator license – A license granted by the FAA to launch operator that would authorize them to conduct launches from a specific launch site, within a range of launch parameters of specific launch vehicles, transporting specific classes of payload. The launch vehicles must meet all FAA safety, risk, and indemnification requirements. In addition, the grant of a license to operate a launch site does not guarantee that a launch license will be granted for any particular launch proposed for the site. All launches will be subject to separate FAA review and licensing.

Launch vehicle – A vehicle built to operate in, or place a payload in, outer space or a suborbital rocket.

LIDAR – LIght Detection And Ranging uses the same principle as RADAR. The LIDAR instrument transmits light out to a target. The transmitted light interacts with and is changed by the target. Some of this light is reflected / scattered back to the instrument where it is analyzed. The change in the properties of the light enables some property of the target to be determined. The time for the light to travel out to the target and back to the LIDAR is used to determine the range to the target.

Lmax – The maximum noise level in a noise event.

Magnitude – Commonly measured logarithmically using the Richter Magnitude Scale, relates to the amount of seismic energy released at the hypocenter of the earthquake and is represented by a single number.

Mesosphere – The atmospheric shell between about 45-55 km (28-34 mi) and 80-85 km (50-53 mi), extending from the top of the stratosphere to the mesopause; characterized by a temperature that generally decreases with altitude.

Meteorology – The scientific study of atmospheric phenomenon.

Nitrogen oxides (NO_x) Gases – Form primarily by fuel combustion, which contribute to the formation of acid rain. Hydrocarbons and nitrogen oxides combine in the presence of sunlight to form ozone, a major constituent of smog.

Nitrogen tetroxide (NTO or N_2H_4) – A liquid oxidizer that can cause spontaneous ignition with many common materials; such as, paper, leather, or wood. It also forms strong acids in combination with water, and contact can cause severe chemical burns. It is a yellow-brown liquid which is easily frozen or vaporized.

Orbital debris – Any object placed in space by humans that remains in orbit and no longer serves any useful function. Objects range from spacecraft to spent launch vehicle stages to components and also include materials, trash, refuse, fragments, and other objects which are overtly or inadvertently cast off or generated.

Oxidizer – A substance such as chlorate, perchlorate, permanganate, peroxide, nitrate, oxide, or the like that yields oxygen readily to support the combustion of organic matter, powdered metals, and other flammable material.

Ozone – The tri-atomic form of oxygen, comprising approximately one part in three million of all of the gases in the atmosphere. Ozone is the primary atmospheric absorber of UV-B radiation.

Passivation – The process of removing all forms of stored energy from spacecraft, launch vehicle stages, and propulsion units. Passivation includes, but is not limited to, the depletion of all residual propellants, pressurants, electrical storage devices, and forms of kinetic energy to a level where the remaining internal stored energy is insufficient to cause breakup/disassembly. Some sealed batteries and heat pipes need not be depressurized if their potential for explosion is extremely low.

Payload – An object placed in outer space by means of a launch vehicle or reentry vehicle, including components of the vehicle specifically designed or adapted for that purpose.

Propellants – Balanced mixture of fuels and oxidizers designed to produce large volumes of hot gases at controlled, predetermined rates, once the burning reaction is initiated.

Reentry – Returning or attempting to return, purposefully, a reentry vehicle and its payload, if any, from Earth orbit or from outer space to Earth

Sonic boom – Sound, resembling an explosion, produced when a shock wave formed the noise of an aircraft or launch vehicle traveling at supersonic (greater than the speed of sound) speed reaches the ground.

Stratosphere – The layer of the Earth's atmosphere 20 to 50 km (12 to 31 mi) above the surface; where ozone forms.

Suborbital flight – A flight involving less than one orbit of the Earth.

Suborbital rocket – A vehicle, rocket-propelled in whole or in part, intended for flight on a suborbital trajectory, and the thrust of which is greater than its lift for the majority of the rocket-powered portion of its ascent 49 U.S.C. §70102(19). Suborbital trajectory is the intentional flight path of a launch vehicle, reentry vehicle, or any portion thereof whose vacuum instantaneous impact point (IIP) does not leave the surface of the Earth.

Take – To harass, hunt, capture, collect, or kill, or attempt to harass, hunt, capture, collect, or kill any marine mammal. This includes, without limitation, any of the following: The collection of dead animals, or parts thereof; the restraint or detention of a marine mammal, no matter how temporary; tagging a marine mammal; the negligent or intentional operation of an aircraft or vessel, or the doing of any other negligent or intentional act which results in disturbing or molesting a marine mammal; and feeding or attempting to feed a marine mammal in the wild.

Third stage – The third stage of a 3 or more stage launch vehicle. It provides the final thrust required to place a launch vehicle's payload into its proper trajectory or orbit. It is also known as a "kick" or upper stage.

Threatened species – Plant and wildlife species likely to become endangered in the foreseeable future.

Trajectory – The path described by an object moving through space.

Troposphere – The portion of the atmosphere from the earth's surface to the tropopause, that is, the lowest 10 to 20 km (6 to 12 m) of the atmosphere.

APPENDIX E
ACRONYMS, ABBREVIATIONS AND SYMBOLS

ºC	degrees Celsius
ºF	degrees Fahrenheit
$\mu g/m^3$	micrograms per cubic meter
30SW/CES	30th Space Wing/Civil Engineering Squadron
45SW/CES	45th Space Wing/Civil Engineering Squadron
A-50	Aerozine-50
AAC	Alaska Aerospace Corporation
AADC	Alaska Aerospace Development Corporation (Changed to AAC in 2009)
AAQS	Ambient Air Quality Standards
ADEC	Alaska Department of Environmental Conservation
AFB	U.S. Air Force Base
AFOSH	U.S. Air Force Occupational Safety and Health
AFPD	U.S. Air Force Policy Directive
AFTOX	U.S. Air Force Toxics Model
A-Hr	Amp Hour
AIRFA	American Indian Religious Freedom Act
Al_2O_3	Aluminum Oxide or alumina
ANSI	American National Standards Institute
AP	Ammonium Perchlorate
AWSPL	A-Weighted Sound Pressure Levels
BACT	Best Available Control Technology
Be	Beryllium
BMPs	Best Management Practices
CAA	Clean Air Act
CAL-EPA	California Environmental Protection Agency
CAP	Collection Accumulation Point
CARB	California Air Resources Board
CBC	Common Booster Core
CCAFS	Cape Canaveral Air Force Station
CCB	Common Core Booster
CCEMP	Consolidated Comprehensive Emergency Management Plan
CCR	California Code of Regulations
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CESQG	Conditionally Exempt Small Quantity Generator
CFCs	Chlorofluorocarbons
CFR	Code Federal Regulations
ClO_4	Perchlorate
CMA	Coastal Management Area
CNEL	Community Noise Equivalent Level
CNS	Canaveral National Seashore
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CTPB	Carboxyl-Terminated Polybutadiene
CWA	Clean Water Act
CxP	Constellation Program
CZMA	Coastal Zone Management Act
DAPC	Department of Air Pollution Control
dB	Decibel
dBA	A-weighted Decibels
DCG	Disaster Control Group
DCR	Department of Conservation & Recreation
DEP	Document of Environmental Protection
DEQ	Department of Environmental Quality
DHR	Department of Historic Resources
DNL	Day-Night Average Sound Level (Ldn)
DoD	U.S. Department of Defense
DOT	U.S. Department of Transportation
DPF	DSCS Processing Facility
DSCS	Defense Secure Communication Satellite
DWEL	Drinking Water Equivalent Level
E	Endangered
EA	Environmental Assessment
EED	Electro Explosive Device
EEGL	Emergency Exposure Guidance Level

EELV	Evolved Expendable Launch Vehicle
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ELV	Expendable Launch Vehicle
EMO	Environmental Management Office
EO	Executive Order
EOS	Earth Observing System
EP	Envelope Payload
EPA	U.S. Environmental Protection Agency
EPC	Envelope Payload Characteristics
EPCRA	Emergency Planning and Community Right-to-know Act
ESD	Electro-Static Discharge
ETR	Extended Test Range
EWR 127-1	Eastern and Western Range Safety Policies and Processes
FAA	Federal Aviation Administration
FAAQS	Florida Ambient Air Quality Standards
FAC	Florida Administrative Code
FACSFAC	Fleet Area Control and Surveillance Facility
FCREPA	Florida Commission on Rare and Endangered Plants and Animals
FD	Federally delisted
FDA	Food and Drug Administration
FDCA	Florida Department of Community Affairs
FDEP	Florida Department of Environmental Protection
FEA	Final Environmental Assessment
FONPA	Finding Of No Practical Alternative
FONSI	Finding Of No Significant Impact
FSI	Florida Space Institute
FSS	Flight Safety System
GaAs	Gallium Arsenide
gal	gallons
GEM	Graphite Epoxy Motor
GEO	Geosynchronous Earth Orbit Geostationary Earth Orbit
GHz	Gigahertz (1 billion cycles per second)
GMD	Ground-based Midcourse Defense
GOES	Geostationary Operational Environmental Satellite
GSE	Ground Support Equipment
GSFC	NASA Goddard Space Flight Center
GSO	Ground Support Officer
GTO	Geosynchronous Transfer Orbit
H_2	Diatomic Hydrogen
H_2O	Water
H_2SO_4	hydrogen sulfate
HAP	Hazardous Air Pollutant
HAPS	Hydrazine Auxiliary Propulsion System
HAZMAT	Hazardous Materials
HCl	Hydrogen Chloride
HFCs	Hydrofluorocarbons
HGA	High Gain Antenna
HMTA	Hazardous Materials Transportation Act
HO_X	Hydrogen Oxides
HPF	Hazardous Processing Facility
HQ	Headquarters
HSWA	Hazardous and Solid Waste Amendments
HTPB	Hydroxyl-Terminated Polybutadiene
Hz	Hertz
IAEA	International Atomic Energy Agency
ICBM	Intercontinental Ballistic Missile
ICP	Integrated Contingency Plan
IDLH	Immediately Dangerous to Life or Health
IEEE	Institute of Electrical and Electronic Engineers
IIP	Instantaneous Surface Impact Point
IMS	Incident Management System
in	inches
IPA	Isopropyl Alcohol
IPF	Integrated Processing Facility or Integration & Processing Facility
IR	Infrared
IRNFA	Inhibited Red Fuming Nitric Acid
JPC	Joint Propellants Contractor
JPL	Jet Propulsion Laboratory
KADA	Kwajalein Atoll Development Authority
kg	kilogram
kg/m^2	kilograms per square meter
kg/yr	kilograms per year
KHB	KSC Handbook
KLC	Kodiak Launch Complex
km	kilometer(s)

km/s	kilometers per second
KMR	Kwajalein Missile Range
KSC	Kennedy Space Center
kW	kilowatt
LAP	Launch Assist Platform
lb	pound
lb/ft^2	pounds per square foot
LBS	Launch Base Support
LC	Launch Complex
LDCG	Launch Disaster Control Group
Ldn	Day-Night Average Sound Level
LEO	Low Earth Orbit
LFF	Liquid Fueling Facility
LH_2	Liquid Hydrogen
LIDAR	Light Detection and Ranging
LiSOCl	Lithium-thionyl chloride
LOX	Liquid Oxygen
LP-1	Launch Pad-1 (Orbital)
LP-2	Launch Pad-2 (Sub Orbital)
LP-3	Launch Pad-3 (Orbital)
LSS	Launch Service Structure
LV	Launch Vehicle
m	meters
MAB	Missile Assembly Building
MACT	Maximum Available Control Technology
MAF-4	Hydyne (60%UDMH/40% diethylenetriamine) fuel
MARS	Mid-Atlantic Regional Spaceport
MC	Management Concern
MCL	Maximum Contaminant Level
MEP	Mars Exploration Program
mg/l	milligrams per liter
mg/m^3	milligrams per cubic meter
mi	miles
mi/s	mile per second
MINWR	Merritt Island National Wildlife Refuge
MMH	Monomethyl Hydrazine
MMPA	Marine Mammal Protection Act
MPE	Maximum Permissible Exposure
mph	miles per hour
MPPF	Multi-payload Processing Facility
MRFSS	Marine Recreational Fishery Statistics Survey
MSC	Marine Science Consortium
MSDS	Material Safety Data Sheets
MSF	Maintenance and Support Facility
MSFCMA	Magnuson-Stevens Fisheries Conservation and Management Act
MSL	Mean Sea level
mW	milli-Watt
N_2	Diatomic Nitrogen
N_2H_4	Hydrazine
N_2O_4	Nitrogen Tetroxide (NTO)
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NAWS	Naval Air Weapons Station
NDMA	Nitrosodimethylamine
NEPA	National Environmental Policy Act
NESDIS	NOAA National Environmental Satellite Date Information Service Command
NESHAP(s)	National Emissions Standards for Hazardous Air Pollutants
NF	New Frontiers
NFSAM	Nuclear Flight Safety Assurance Manager
NHL	National Historic Landmark(s)
NHPA	National Historic Preservation Act
NiCd	Nickel Cadmium
NiH_2	Nickel-hydrogen
NMFS	National Marine Fisheries Service
NMI	NASA Management Instruction
NMP	New Millennium Program
NOAA	National Oceanic and Atmospheric Administration
NOHD	Non Optical Hazard Distance Non-Point Source
NOTAM	Notices to Airmen
NOTMAR	Notices to Mariners
NO_X	Oxides of Nitrogen Oxides
NPD	NASA Policy Directive
NPDES	National Pollutant Discharge Elimination System
NPG	NASA Policy Guidance
NPL	National Priorities List
NPR	NASA Procedural Requirements
NPRM	Notice of Proposed Rulemaking
NPS	National Park Service or
NRHP	*National Register of Historic Places*
NRP	NASA Routine Payload
NSHMP	National Seismic Hazard Mapping Project
NSS	NASA Safety Standard
NTO	Nitrogen Tetroxide (N_2O_4)

NWS	National Weather Service
O_2	Diatomic Oxygen
O_3	Ozone
OCA	Orbital Carrier Aircraft
OCST	Office of Commercial Space Transportation
ODS	Ozone Depleting Substance
OFW	Outstanding Florida Water
OH	Hydroxide
OHV	Off-Highway Vehicle
OPAREA	Operation Area
OPlan	Operations Plan
ORK	Orbital Raising Kit
OSC	Orbital Sciences Corporation
OSHA	Occupational Safety and Health Administration
OSMA	Office of Safety and Mission Assurance
OSP	Orbital/Suborbital Program
OSPL	Overall Sound Pressure Level
OSTP	Office of Science & Technology Policy (White House)
P	Protected
PAFB	Patrick Air Force Base
Pb	Lead
PEL	Permissible Exposure Limit
pH	Hydrogen ion concentration
PHSF	Payload Hazardous Servicing Facility
PIC	Pilot in Command
PM_{10}	Particulate Matter < 10 microns
$PM_{2.5}$	Particulate Matter < 2.5 microns
POES	Polar Operational Environmental Satellite
PPA	Pollution Prevention Act
ppb	Parts per billion
PPF	Payload Processing Facility
ppm	parts per million
PPMP	Pollution Prevention Management Program
PPPG	Pollution Prevention Program Guide
PPWG	Pollution Prevention Working Group
PSD	Prevention of Significant Deterioration
pt	pint
PT	Proposed Threatened
R & D	Research and Development
R	Rare
RCC	Range Commanders Council
RCRA	Resource Conservation and Recovery Act
RCS	Reaction Control System
REC	Record of Environmental Consideration
REEDM	Rocket Exhaust Effluent Diffusion Model
RF	Radio Frequency
RfD	Reference Dose
RHU	Radioisotope Heater Units
RMI	Republic of the Marshall Islands
RMOB	Radioactive Materials Onboard Report
ROC	Reactive Organic Compounds
ROD	Record of Decision
RP-1	rocket propellant (thermally stable kerosene)
RPC	Routine Payload Checklist
RPS	Radioisotope Power Source
RS	Radio Science
RSPL	Rocket System Launch Program
RTG	Radioisotope thermoelectric generators
RTS	Reagan Test Site, Kwajalein Atoll
RWD	Report of Waste Discharge
RWQCB	Regional Water Quality Control Board
S	Sensitive
S/A	Similarity of appearance to a listed species
SAP	Satellite Accumulation Point
SB	Senate Bill
SBCAPCD	Santa Barbara County Air Pollution Control District
SC	Species of Concern
SCAPE	Self-Contained Atmospheric Protection Ensemble
SCAT	Spacecraft and Assemblies Transfer Building
SCCAB	South Central Coast Air Basin
SCS	Soil Conservation Service
SEL	Sound Exposure Level
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SJRWMD	St. John's River Water Management District
SLAMS	State and Local Air Monitoring Systems
SLC	Space Launch Complex
SLF	Shuttle Landing Facility
SLM	Space Launch Manifest

SLV	Space or Strategic Launch Vehicle
SMAB	Solid Motor Assembly Building
SMC	Space and Missile Systems Center
SO_2	Sulfur Dioxide
SOC	Species of Concern
SOP	Standard Operating Procedures
SPC	Satellite Processing Facility
SPCC	Spill Prevention Control and Countermeasures
SPEGL	Short-term Public Emergency Guidance Level
SPIF	Spacecraft Processing and Integration Facility
SR	State Road
SRM	Solid Rocket Motor
SSC	Species of Special Concern
SSRM	Strap-on Solid Rocket Motor
STD	Standard
STEL	Short Term Exposure Limit
SWP	State Water Project
SWRCB	State Water Resources Control Board
T	Threatened
THA	Toxic Hazard Assessment
THC	Toxic Hazard Corridor
TLV	Threshold Limit Value
TRCP	Toxic Release Contingency Plan
TRI	Toxic Chemical Release Inventory
TSCA	Toxic Substances Control Act
TSDF	Treatment, Storage, and Disposal Facility
U.S.	United States
U.S.	United States
U.S.C.	United States Code
UCF	University of Central Florida
UDMH	Unsymmetrical Dimethyl-Hydrazine
UES	Environmental Standards and Procedures for the U.S. Army Kwajalein Atoll (USAKA) Activities in the Republic of the Marshall Islands
USAF	United States Air Force
USAKA	United States Army Kwajalein Atoll
USAKA/RTS	United States Army Kwajalein Atoll/Reagan Test Site
USCB	U.S. Census Bureau
USCG	United States Coast Guard
USDA	United State Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UV	Ultraviolet
VAC	Virginia Administrative Code
VACAPES	Virginia Capes
VAFB	Vandenberg Air Force Base
VCRMP	Virginia Coastal Resources Management Program
VHF	Very High Frequency
VIS	Visible
VMRC	Virginia Marine Resources Commission
VOC	Volatile Organic Compounds
VPDES	Virginia Pollutant Discharge Elimination System
VPF	Vertical Processing Facility
W	Watt
WDR	Waste Discharge Requirement
WFF	Wallops Flight Facility
WWII	World War II
Xe	Xenon
XRS	X-ray Spectrometer

APPENDIX F
COMMON METRIC/BRITISH SYSTEM EQUIVALENTS

Length

1 centimeter (cm) = 0.3937 inch	1 inch = 2.54 cm
1 centimeter = 0.0328 foot (ft)	1 foot = 30.48 cm
1 meter (m) = 3.2808 feet	1 ft = 0.3048 m
1 meter = 0.0006 mile (mi)	1 mi = 1609.3440 m
1 kilometer (km) = 0.6214 mile	1 mi = 1.6093 km
1 kilometer = 0.53996 nautical mile (nmi)	1 nmi = 1.8520 km
	1 mi = 0.87 nmi
	1 nmi = 1.15 mi

Area

1 square centimeter (cm^2) = 0.1550 square inch (in^2)	1 in^2 = 6.4516 cm^2
1 square meter (m^2) = 10.7639 square feet (ft^2)	1 ft^2 = 0.09290 m^2
1 square kilometer (km^2) = 0.3861 square mile (mi^2)	1 mi^2 = 2.5900 km^2
1 hectare (ha) = 2.4710 acres (ac)	1 ac = 0.4047 ha
1 hectare (ha) = 10,000 square meters (m^2)	1 ft^2 = 0.000022957 ac

Volume

1 cubic centimeter (cm^3) = 0.0610 cubic inch (in^3)	1 in^3 = 16.3871 cm^3
1 cubic meter (m^3) = 35.3147 cubic feet (ft^3)	1 ft^3 = 0.0283 m^3
1 cubic meter (m^3) = 1.308 cubic yards (yd^3)	1 yd^3 = 0.76455 m^3
1 cubic meter (m^3) = 0.000811 acre-ft	1233 m^3 = 1 acre-ft
1 liter (l) = 1.0567 quarts (qt)	1 qt = 0.9463264 l
1 liter = 0.2642 gallon (gal)	1 gal = 3.7845 l
1 kiloliter (kl) = 264.2 gal	1 gal = 0.0038 kl

Mass/Weight

1 gram (g) = 0.0353 ounce (oz)	1 oz = 28.3495 g
1 kilogram (kg) = 2.2046 pounds (lb)	1 lb = 0.4536 kg
1 metric ton (mt) = 1.1023 tons	1 ton = 0.9072 metric ton

Energy

1 joule = 0.0009 British thermal unit (BTU)	1 BTU = 1054.18 joule
1 joule = 0.2392 gram-calorie (g-cal)	1 g-cal = 4.1819 joule

Pressure

1 newton/square meter (N/m^2) = 0.0208 pound/square foot (psf)	1 psf = 48 N/m^2

Force

1 newton (N) = 0.2248 pound-force (lbf)	1 lbf = 4.4478 N

Radiation

1 becquerel (Bq) = 2.703 x 10-11 curies (Ci)	1 Ci = 3.70 x 1010 Bq
1 sievert (Sv) = 100 rem	1 rem = 0.01 Sv

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