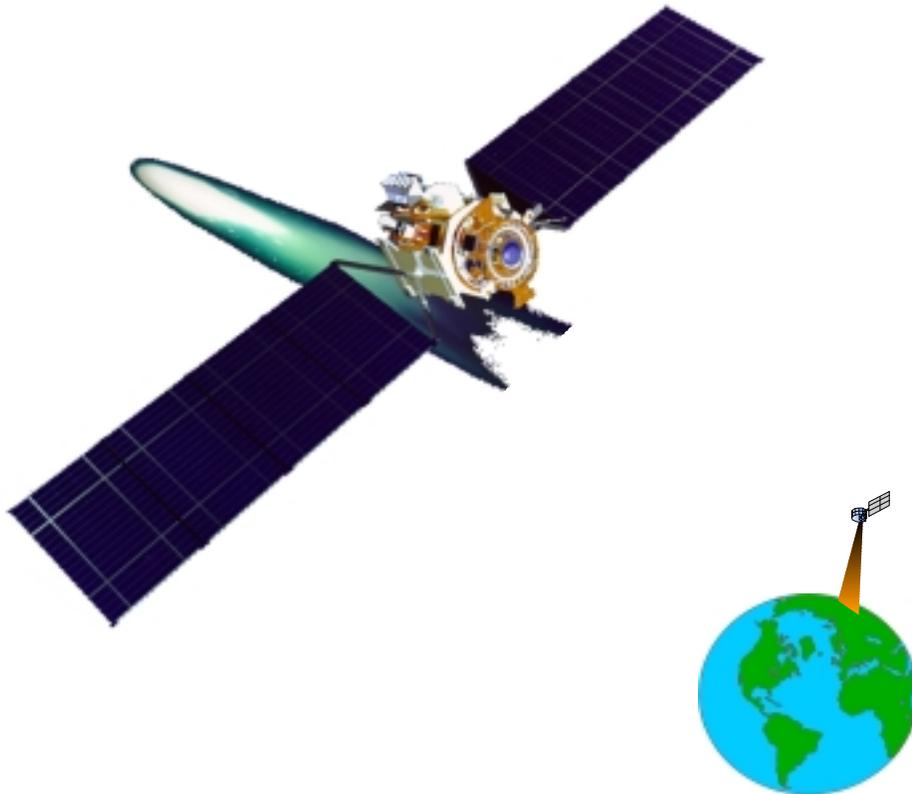




# New Millennium Program

## Programmatic Environmental Assessment



June 1998

National Aeronautics and Space Administration  
NASA Headquarters  
Washington D.C. 20546



Jet Propulsion Laboratory  
California Institute of Technology  
JPL D-14472



National Aeronautics and  
Space Administration

**Headquarters**  
Washington, DC 20546-0001



JUL 24 1998

Reply to Attn. Of SD

To: Federal, State, Local Agencies, and Other Interested Parties

Re: New Millennium Program Programmatic Environmental  
Assessment and Finding of No Significant Impact

The New Millennium Program Programmatic Environmental Assessment (EA) and the Finding of No Significant Impact (FONSI) (NASA Notice 98-100) are enclosed and are being distributed to Federal, State, local agencies, and concerned citizens and organizations that have expressed an interest, as well as selected repositories.

Should you have any comments regarding this EA or FONSI, they must be submitted in writing and received no later than August 31, 1998, and directed to the undersigned at:

Code SD  
NASA Headquarters  
Washington, DC 20546-0001

NASA will take no final action prior to September 1, 1998.

Sincerely,

A handwritten signature in cursive script that reads "William L. Piotrowski".

Dr. William L. Piotrowski  
Senior Program Executive  
Mission & Payload Development Division  
Office of Space Science

Enclosures

entrepreneur as provided by sections 121(b)(5) and 162(b) of the Immigration Act of 1990 and section 203(b)(5) of the Immigration and Nationality Act. The information collected on this form will be used by the service to determine eligibility for the requested immigration benefit.

(5) *An estimate of the total number of respondents and the amount of time estimated for an average respondent to respond:* 2,000 responses at 1.25 hours per response.

(6) *An estimate of the total public burden (in hours) associated with the collection:* 2,500 annual burden hours.

If you have additional comments, suggestions, or need a copy of the proposed information collection instrument with instructions, or additional information, please contact Richard A. Sloan 202-514-3291, Director, Policy Directives and Instructions Branch, Immigration and Naturalization Service, U.S. Department of Justice, Room 5307, 425 I Street, NW., Washington, DC 20536. Additionally, comments and/or suggestions regarding the item(s) contained in this notice, especially regarding the estimated public burden and associated response time may also be directed to Mr. Richard A. Sloan.

In addition information is required contact: Mr. Robert B. Briggs, Clearance Officer, United States Department of Justice, Information Management and Security Staff, Justice Management Division, Suite 850, Washington Center, 1001 G Street, NW., Washington, DC 20530.

Dated: July 23, 1998.

**Robert B. Briggs,**

*Department Clearance Officer, United States Department of Justice.*

[FR Doc. 98-20193 Filed 7-28-98; 8:45 am]

BILLING CODE 4410-18-M

## DEPARTMENT OF JUSTICE

### Immigration and Naturalization Service

#### Agency Information Collection Activities: Extension of Existing Collection; Comment Request

**ACTION:** Notice of Information Collection Under Review; Request to Enforce Affidavit of Financial Support and Intent to Petition for Custody for Public Law 97-359.

The Department of Justice, Immigration and Naturalization Service has submitted the following information collection request for review and clearance in accordance with the Paperwork Reduction Act of 1995. The

proposed information collection is published to obtain comments from the public and affected agencies. Comments are encouraged and will be accepted for "sixty days" until September 28, 1998.

Written comments and suggestions from the public and affected agencies concerning the proposed collection of information should address one or more of the following four points:

(1) Evaluate whether the proposed collection of information is necessary for the proper performance of the functions of the agency, including whether the information will have practical utility;

(2) Evaluate the accuracy of the agencies estimate of the burden of the proposed collection of information, including the validity of the methodology and assumptions used;

(3) Enhance the quality, utility, and clarity of the information to be collected; and

(4) Minimize the burden of the collection of information on those who are to respond, including through the use of appropriate automated, electronic, mechanical, or other technological collection techniques or other forms of information technology, e.g., permitting electronic submission of responses.

Overview of this information collection:

(1) *Type of Information:* Extension of a currently approved collection.

(2) *Title of the Form/Collection:*

Request to Enforce Affidavit of Financial Support and Intent to Petition for Custody for Public Law 97-359.

(3) *Agency form number, if any, and the applicable component of the Department of Justice sponsoring the collection:* Form I-363. Adjudications Division, Immigration and Naturalization Service.

(4) *Affected public who will be asked or required to respond, as well as a brief abstract:* Primary: Individuals or households. This form is used to determine whether an Affidavit of Financial Support and Intent to Petition for Legal Custody requires enforcement.

(5) *An estimate of the total number of respondents and the amount of time estimated for an average respondent to respond:* 50 responses at 30 minutes (.50) per response.

(6) *An estimate of the total public burden (in hours) associated with the collection:* 25 annual burden hours.

If you have additional comments, suggestions, or need a copy of the proposed information collection instrument with instructions, or additional information, please contact Richard A. Sloan 202-514-3291, Director, Policy Directives and

Instructions Branch, Immigration and Naturalization Service, U.S. Department of Justice, Room 5307, 425 I Street, NW., Washington, DC 20536. Additionally, comments and/or suggestions regarding the item(s) contained in this notice, especially regarding the estimated public burden and associated response time may also be directed to Mr. Richard A. Sloan.

If additional information is required contact: Mr. Robert B. Briggs, Clearance Officer, United States Department of Justice, Information Management and Security Staff, Justice Management Division, Suite 850, Washington Center, 1001 G Street, NW., Washington, DC 20530.

Dated: July 23, 1998.

**Robert B. Briggs,**

*Department Clearance Officer, United States Department of Justice.*

[FR Doc. 98-20194 Filed 7-28-98; 8:45 am]

BILLING CODE 4410-18-M

## NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

[Notice 98-100]

### National Environmental Policy Act; New Millennium Program

**AGENCY:** National Aeronautics and Space Administration (NASA).

**ACTION:** Finding of no significant impact.

**SUMMARY:** Pursuant to the National Environmental Policy Act of 1969, as amended (NEPA) (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 subpart 1216.3), NASA has made a finding of no significant impact (FONSI) with respect to the proposed New Millennium Program (NMP) and individual missions (as defined and described in the associated Programmatic Environmental Assessment (PEA)), which would involve a series of Earth orbiting and deep space spacecraft to be launched over the time period of 1998 through 2010 from Vandenberg Air Force Base (VAFB), California, and Cape Canaveral Air Station (CCAS), Florida.

**DATES:** Comments on the FONSI must be provided in writing to NASA on or before August 28, 1998.

**ADDRESSES:** Written comments should be addressed to Dr. William L. Piotrowski, Senior Program Executive, Mission & Payload Development Division, Code SD, NASA Headquarters,

Washington, DC 20546-0001. The PEA prepared for the New Millennium Program which supports this FONSI may be reviewed at the following locations:

(a) NASA Headquarters, Library, Room 1J20, 300 E Street, SW, Washington, DC 20546 (202-358-0167).

(b) Vandenberg Air Force Base, Technical Library, Building 7015, 806 13th Street, Vandenberg AFB, CA 93437.

(c) Jet Propulsion Laboratory, Visitors Lobby, Building 249, 4800 Oak Grove Drive, Pasadena, CA 91109 (818-354-5179).

(d) Spaceport USA, Room 2001, John F. Kennedy Space Center, Florida, 32899. Please call Lisa Fowler beforehand at 407-867-2497 so that arrangements can be made.

The PEA may also be examined at the following NASA locations by contacting the pertinent Freedom of Information Act Office:

(e) NASA, Ames Research Center, Moffett Field, CA 94035 (650-604-4191).

(f) NASA, Dryden Flight Research Center, Edwards, CA 93523 (805-258-2663).

(g) NASA, Goddard Space Flight Center, Greenbelt, MD 20771 (301-286-0730).

(h) NASA, Johnson Space Center, Houston, TX 77058 (281-483-8612).

(i) NASA, Langley Research Center, Hampton, VA 23665 (757-864-2497).

(j) NASA, Lewis Research Center, 21000 Brookpark Rd, Cleveland, OH 44135 (216-433-2755).

(k) NASA, Marshall Space Flight Center, Huntsville, AL 35812 (256-544-5549).

(l) NASA, Stennis Space Center, MS 39529 (228-688-2164).

A limited number of copies of the PEA are available by contacting Dr. William L. Piotrowski at the address or telephone number indicated herein.

**FOR FURTHER INFORMATION CONTACT:** Dr. William L. Piotrowski, 202-358-1544.

**SUPPLEMENTARY INFORMATION:** NASA has reviewed the PEA prepared for the NMP and has determined that it represents an accurate and adequate analysis of the scope and level of associated environmental impacts. The PEA is hereby incorporated by reference in this FONSI.

NASA is proposing to develop, build and launch a series of Earth orbiting and deep space spacecraft over the time period of 1998 through 2010 from VAFB, California and CCAS, Florida. NMP spacecraft would be designed to validate essential technologies and capabilities which contribute to

reducing the cost of future space and Earth science missions. Within the primary objective of technology validation, as much science as possible would be conducted. The program focuses on advanced technologies (i.e., instrumentation and operations), which offer the potential to contribute significantly to reducing the cost of future space and Earth science missions while increasing their relative capability in achieving scientific objectives. The investment now in the NMP could begin to provide tangible benefits, especially in validating solar electric propulsion, before the year 2000. The reduction in size of spacecraft and the increase in capability that NMP is designed to foster could bring about future economic benefits for the U.S. Space Program.

Spacecraft final assembly, propellant loading, and checkout of payload systems would be performed in existing Payload Processing Facilities at VAFB and CCAS. The spacecraft would then be transported to an existing Space Launch Complex at VAFB or CCAS where it would be integrated with the launch vehicle. Due to varying payload weights and mission specific requirements, NMP spacecraft may require different launch vehicles. The launch vehicle selected as an environmental upper "bounding case" (i.e., maximum expected environmental impacts), is the Delta II 7925. The NMP Program would not increase launch rates at CCAS and VAFB above existing or previously approved levels.

In addition to developing and validating spacecraft, instrumentation, and operations technologies, NMP is planned to demonstrate new types of management and engineering techniques that reduce development, launch, and operations costs. Computer-aided design, and concurrent project engineering and design are being used to accelerate and enhance the design process to lead to rapid implementation. NMP flight-validated technologies may also find their way into the consumer market for use in such applications as autonomous rail transportation systems, new microsensors for automotive and biomedical technology, and high quality imagery and enhanced memory media for computer systems.

Alternatives to the proposed action that were considered included those that: (1) Utilize an alternate launch vehicle, or (2) cancel the NMP (the "no action" alternative). Of the launch vehicles evaluated, U.S. launch vehicles proposed for launch of NMP spacecraft (specifically the Delta II, Titan IIG, Athena, Taurus, and the Pegasus) are best suited for the NMP for the following reasons: (1) The alternative

launch vehicles examined are approximately equal in their potential impacts to the environment, and these impacts are not individually or cumulatively significant; (2) proposed U.S. launch vehicles closely match NMP performance requirements and allow for variations in payload size and weight; and/or (3) selected launch vehicles cost the same or less than the examined alternatives and are similar in terms of reliability.

Maximum expected impacts to the human environment associated with the program are bounded by and arise almost entirely from the normal launch of the Delta II 7925. Air emissions from the exhaust produced by the solid propellant graphite epoxy motors and liquid first stage primarily include carbon monoxide, hydrochloric acid, aluminum oxide in soluble and insoluble forms, carbon dioxide, and deluge water mixed with propellant by-products. Air impacts would be short-term and not significant. Short-term water quality and noise impacts, as well as short-term effects on plants and animals would occur only in the vicinity of the launch complex. There would be no impact on threatened or endangered species or critical habitat, cultural resources, wetlands or floodplains. The NMP would follow the NASA guidelines regarding orbital debris and minimizing the risk of uncontrolled reentry into the Earth's atmosphere. Accident scenarios have also been addressed and indicate no potential for substantial impact to the human environment. None of the NMP missions covered under the NMP PEA will have radioactive materials aboard the spacecraft, except for the possibility of very small quantities on certain missions for instrumentation purposes. Consequently, no potential substantial adverse impacts from radioactive substances are anticipated. The PEA provides a set of questions that must be addressed in determining whether or not a proposed future NMP mission falls within the scope of the PEA and this FONSI. No other individual or cumulative impacts of environmental concern have been identified.

The level and scope of environmental impacts associated with the launch of NMP spacecraft are well within the envelope of impacts that have been addressed in previous FONSI's concerning other launch vehicles and spacecraft. NMP spacecraft would not increase launch rates nor utilize launch systems beyond the scope of approved programs at VAFB or CCAS. No NMP-specific processing or launch activities have been identified that would require new permits and/or mitigation measures

beyond those currently in place or in coordination at VAFB and CCAS. No significant new circumstances or information relevant to environmental concerns associated with the launch vehicle have been identified which would affect the earlier findings. As specific spacecraft and missions are fully defined, they will be reviewed in light of the NMP PEA. If NASA determines that future payloads have the potential for substantially different environmental impacts, further NEPA reviews will be conducted and documented, as appropriate.

On the basis of the NMP PEA, NASA has determined that the environmental impacts associated with the NMP and the specified missions identified as within the scope of the PEA would not individually or cumulatively have a significant impact on the quality of the human environment. NASA will take no final action prior to the expiration of the 30-day comment period.

**Wesley T. Huntress, Jr.,**  
*Associate Administrator for Space Science.*

**Michael R. Luther,**  
*Deputy Associate Administrator for Earth Science.*

[FR Doc. 98-20265 Filed 7-28-98; 8:45 am]  
BILLING CODE 7510-01-P

## NATIONAL ARCHIVES AND RECORDS ADMINISTRATION

### Space Planning for the National Archives and Records Administration; Public Meeting

The National Archives and Records Administration announces the following meetings:

—Tuesday, August 6, 1998, from 7 p.m.–9 p.m. at the National Archives and Records Administration, Northeast Region (New York City), 201 Varick Street, New York, NY 10014-4811. For further information call 781-647-8745 or e-mail diane.leblanc@waltham.nara.gov.

—Monday, August 10, 1998, from 5 p.m.–7 p.m. at the National Archives and Records Administration, Central Plains Region (Lee's Summit), 200 Space Center Drive, Lee's Summit, MO 64064. For further information call 816-926-6920 or e-mail john.allshouse4@kansascity.nara.gov.

—Wednesday, August 19, 1998, from 7:30 p.m.–9:30 p.m. at the Wilda Marston Theatre, Loussac Public Library, 3600 Denali Street, Anchorage, Alaska 99501-2145. For further information call 907-271-2443 or e-mail archives@alaska.nara.gov.

—Monday, August 17, 1998, from 4 p.m.–6 p.m., at the National Archives

and Records Administration, National Personnel Records Center, 9700 Page Avenue, St. Louis, MO 63132-5100. For further information call 314-538-4005 or e-mail david.petree@stlouis.nara.gov.

This is a series of meetings at which NARA is seeking public input for a study of its space needs for the next 10 years. NARA representatives will explain the reasons for undertaking a space plan, its objectives, and the planning process, and will invite comments and answer questions. In addition to helping NARA with its planning, this meeting is part of a National Performance Review initiative called *Conversations With America: My Government Listens*. NARA urges everyone interested to attend.

Reservations are not required. The meeting will be open to the public.

Dated: July 23, 1998.

**John W. Carlin,**  
*Archivist of the United States.*

[FR Doc. 98-20234 Filed 7-28-98; 8:45 am]  
BILLING CODE 7515-01-M

## NATIONAL EDUCATION GOALS PANEL

### Task Force on the Future of the Goals; Meeting

**AGENCY:** National Education Goals Panel.

**ACTION:** Notice of Meeting.

**SUMMARY:** This notice sets forth the date and location of a forthcoming meeting of the Task Force on the Future of the Goals. This notice also describes the functions of the National Education Goals Panel and the Task Force on the Future of the Goals.

**DATE AND TIME:** Saturday, August 1, 1998 from 9:00 a.m. to 11:30 a.m.

**ADDRESSES:** Milwaukee Hilton Hotel, 509 West Wisconsin Avenue, (Walker Room), Milwaukee, WI 53203.

**FOR FURTHER INFORMATION CONTACT:** Ken Nelson, Executive Director, 1255 22nd Street, NW, Suite 502, Washington, DC 20037. Telephone: (202) 724-0015.

**SUMMARY:** The National Education Goals Panel (NEGP) was established to monitor, measure and report state and national progress toward achieving the eight National Education Goals, and report to the states and the Nation on that progress. The authorizing legislation for the National Education Goals and the Goals Panel are expected to expire in 1999. At its February, 1998, meeting, the Panel decided to form a Task Force to make recommendations on the future of the Goals after the year 2000.

**AGENDA ITEMS:** The meeting of the Task Force on the Future of the Goals is open to the public. Agenda items will include: (1) A review of the charge to the Task Force; (2) Presentations by Governor Roy Romer, (D), Colorado and Chester E. Finn, of the Hudson Institute, on the History of why the Goals were established, expectation for the Goals and the Panel and Recommendations, possibilities for the future; (3) Staff Responses to Panel Requests; (4) a Panel discussion on the future of the Goals and next steps for the Panel; and (5) the Panel will receive a commissioned paper on Grading State Standards.

Dated: July 23, 1998.

**Ken Nelson,**  
*Executive Director, National Education Goals Panel.*

[FR Doc. 98-20186 Filed 7-28-98; 8:45 am]

BILLING CODE 4010-01-M

## NATIONAL FOUNDATION ON THE ARTS AND HUMANITIES

### Cooperative Agreement for a Study of Jazz Artists

**AGENCY:** National Endowment for the Arts.

**ACTION:** Notification of availability.

**SUMMARY:** The National Endowment for the Arts is requesting proposals leading to the award of a Cooperative Agreement for a study of Jazz Artists in four cities. The cities will be chosen from among the following pairs: New York/Philadelphia, Detroit/Kansas City, Atlanta/New Orleans, San Francisco/Los Angeles. The issues to be considered will include venues for performance, distribution of work through recordings, education and training, and extent of participation in health insurance and retirement programs. Those interested in receiving the Solicitation should reference Program Solicitation PS 98-06 in their written request and include two (2) self-addressed labels. Verbal requests for the Solicitation will not be honored.

**DATES:** Program Solicitation PS 98-06 is scheduled for release approximately August 17, 1998 with proposals due on October 19, 1998.

**ADDRESSES:** Requests for the Solicitation should be addressed to the National Endowment for the Arts, Grants & Contracts Office, Room 618, 1100 Pennsylvania Ave., NW, Washington, DC 20506.

**FOR FURTHER INFORMATION CONTACT:** William Hummel, Grants & Contracts Office, National Endowment for the Arts, Room 618, 1100 Pennsylvania

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## NMP ACRONYMS, ABBREVIATIONS AND SYMBOLS

ACGIH	American Conference of Governmental Industrial Hygienists	FGFWFC	Florida Game and Fresh Water Fish Commission
ACS	Attitude Control Sensor	FOG	Fiber Optic Gyro
AFB	Air Force Base	FONSI	Finding Of No Significant Impact
Al <sub>2</sub> O <sub>3</sub>	Aluminum Oxide	GEM	Graphite Epoxy Motor
ANSI	American National Standards Institute	GSE	Ground Support Equipment
CAA	Clean Air Act	H <sub>2</sub>	Diatomic Hydrogen
CARB	California Air Resources Board	H <sub>2</sub> O	Water
CCAS	Cape Canaveral Air Station	HCl	Hydrogen Chloride
CCS	California Commercial Spaceport	HFCs	Hydrofluorocarbons
C&DH	Command and Data Handling	HTPB	Hydroxyl-Terminated Polybutadiene
CEQ	Council on Environmental Quality	IAEA	International Atomic Energy Agency
CFCs	Chlorofluorocarbons	ICBM	Intercontinental Ballistic Missile
Cl	Chlorine	IDLH	Immediately Dangerous to Life or Health
CO	Carbon Monoxide	IMU	Inertial Measurement Unit
CO <sub>2</sub>	Carbon Dioxide	IPA	Isopropyl Alcohol
dBA	A-weighted Decibels	IPS	Ion Propulsion Subsystem
DRMO	Defense Reutilization Marketing Office	IR	Infrared
DS	Deep Space	JPL	Jet Propulsion Laboratory
DSN	Deep Space Network	kg	kilogram
EA	Environmental Assessment	km	kilometer
EEGL	Emergency Exposure Guidance Level	KSC	Kennedy Space Center
EIS	Environmental Impact Statement	LC	Launch Complex
ELV	Expendable Launch Vehicle	LEO	Low Earth Orbit
EO	Earth Observing	LIDAR	Light Detection And Ranging
EPA	Environmental Protection Agency	LOx	Liquid Oxygen
FCREPA	Florida Commission on Rare and Endangered Plants and Animals	LV	Launch Vehicle
FDEP	Florida Department of Environmental Protection	MELV	Medium Expendable Launch Vehicle
		mg/l	milligrams per liter
		mg/m <sup>3</sup>	milligrams per cubic meter
		MICAS	Miniature Integrated Camera Spectrometer

MOL	Manned Orbital Laboratory	REEDM	Rocket Exhaust Effluent
mW	milli-Watt		Diffusion Model
N <sub>2</sub>	Diatomic Nitrogen	RF	Radio Frequency
NiH <sub>2</sub>	nickel-hydrogen	RP-1	thermally stable kerosene
NAAQS	National Ambient Air Quality Standards	SBCAPCD	Santa Barbara County Air Pollution Control District
NAS	National Academy of Sci- ences	SCAPE	Self-Contained Atmos- pheric Protection Ensem- ble
NASA	National Aeronautics and Space Administration	SCARLET	Solar Concentrator Array with Refractive Linear Element Technology
NEPA	National Environmental Policy Act	SCS	Soil Conservation Service
N <sub>2</sub> H <sub>4</sub>	Hydrazine	SELV	Small Expendable Launch Vehicle
NMI	NASA Management In- struction	SHPO	State Historic Preservation Officer
NMP	New Millennium Program	SLAMS	State and Local Air Moni- toring Systems
NO <sub>x</sub>	Oxides of Nitrogen	SLC	Space Launch Complex
N <sub>2</sub> O <sub>4</sub>	Nitrogen Tetroxide	SO <sub>2</sub>	Sulfur Dioxide
NRHP	National Register of His- toric Places	SPEGL	Short-term Public Emer- gency Guidance Level
O <sub>2</sub>	Diatomic Oxygen	SRM	Solid Rocket Motor
O <sub>3</sub>	Ozone	SSRM	Strap-on Solid Rocket Motor
OFW	Outstanding Florida Water	STEL	Short Term Exposure Limit
OH	Hydroxide	TLV	Threshold Limit Value
OSHA	Occupational Safety and Health Administration	TRI	Toxic Chemical Release Inventory
Pb	Lead	TSDF	Treatment, Storage, and Disposal Facility
PEL	Permissible Exposure Limit	UDMH	Unsymmetrical Dimethyl Hydrazine
PEPE	Plasma Experiment for Planetary Environments	USFWS	United States Fish and Wildlife Service
PIK	Precision Injection Kit	µg/m <sup>3</sup>	micrograms per cubic meter
PM <sub>2.5</sub>	Particulate Matter < 2.5 microns	UV	Ultraviolet
PM <sub>10</sub>	Particulate Matter < 10 mi- crons	VAFB	Vandenberg Air Force Base
PPF	Payload Processing Facil- ity	VOC	Volatile Organic Com- pounds
ppm	parts per million	Xe	Xenon
PSD	Prevention of Significant Deterioration		
RCRA	Resource Conservation and Recovery Act		
RCS	Reaction Control Subsys- tem		

## EXECUTIVE SUMMARY

### PROPOSED ACTION

This Environmental Assessment (EA) addresses the proposed action to develop, build and launch a series of investigative spacecraft over the time period of 1998 through 2010 from Vandenberg Air Force Base (VAFB), California and/or Cape Canaveral Air Station (CCAS), Florida. Spacecraft final assembly, propellant loading and checkout of payload systems would be performed in Payload Processing Facilities (PPFs) at VAFB, CCAS or Kennedy Space Center (KSC). After processing, the spacecraft would be transported to a Space Launch Complex (SLC) where it would be integrated with the launch vehicle. Spacecraft utilizing the Pegasus launch vehicle would be delivered to a vehicle assembly building for vehicle and payload integration. The Pegasus and payload would then be mated to an L-1011 for air launching.

Due to varying payload masses and orbital requirements, New Millennium Program (NMP) spacecraft would require different launch vehicles. The launch vehicle selected as an environmental 'bounding case' is the Delta II 7925. Other launch vehicles that may be used would produce less adverse environmental impacts than the bounding case. The Delta II 7925 consists of a liquid bipropellant main engine, a liquid bipropellant second stage engine, nine Graphite Epoxy Motor (GEM) strap-on solid rockets and a solid propellant 3<sup>rd</sup> stage. With the exception of Pegasus operations, mating of the spacecraft with the launch vehicle, systems integration, and launch vehicle liquid propellant servicing and ordnance installation would be completed at the launch complex.

### PURPOSE AND NEED FOR THE ACTION

The purpose of NMP is to accelerate the development of essential technologies and capabilities required for the new types of missions to be flown in the next century and validate them under challenging spaceflight conditions. The focus of the program is on new technologies which contribute significantly to reducing the cost of future space and Earth science mission while at the same time increasing the relative scientific capability of these missions.

NMP is needed to lay the groundwork for an age of exploration and achievement – by developing and flight validating innovative technologies for 21<sup>st</sup>-century science missions.

## ALTERNATIVES CONSIDERED

### Alternative Launch Vehicles

Of the launch vehicles examined, launch vehicles proposed for launch of NMP spacecraft; the Delta II, Titan IIG, Athena 2, Taurus, Athena 1, and Pegasus are best suited for NMP for the following reasons:

- The proposed launch vehicles most closely match NMP performance requirements and allow for variations in payload size and weight.
- The proposed launch vehicles are similar in terms of reliability when compared to the alternative launch vehicles examined.
- With the exception of the Atlas II, alternative launch vehicles examined do not provide a clear environmental advantage with respect to environmental impacts.
- The proposed launch vehicle suite is the lower cost alternative of those systems meeting NMP performance criteria.

### No-Action Alternative

The No-Action alternative would mean the New Millennium Program would not be undertaken and the immediate local (i.e., launch site) impacts would be avoided. However, no-action would probably impede technology readiness in the 21<sup>st</sup> century. NMP's plans to accelerate the development of essential technologies and capabilities required for the new types of missions to be flown in the next century are imperative in today's environment of economic austerity. Technological advances must be made quickly in order to provide a future for affordable space and Earth science missions.

The investment in the New Millennium Program now would probably begin to provide tangible benefits, especially in validating solar electric propulsion, before the year 2000. The infusion of flight validated technologies into the commercial infrastructure could both strengthen and stimulate the American industrial base, as well as improve the nation's competitive edge in the global market; the nation's space and Earth science program would probably accrue new capabilities and develop a wealth of new and diverse data.

## SUMMARY OF ENVIRONMENTAL IMPACTS

Environmental Assessments (EAs) have been completed and Findings of No Significant Impact (FONSI) issued for launch vehicles proposed for use by NMP at Vandenberg Air Force Base (VAFB) and Cape Canaveral Air Station (CCAS).<sup>1</sup> The New Millennium Program would not increase launch rates nor utilize launch systems beyond the scope of approved programs at VAFB and

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<sup>1</sup> [DELTA 1991], [FONSI 1991], [ATHENA 1994], [ATHENA 1995], [FONSI 1995a], [ATHENA 1997], [FONSI 1997], [DELTA 1995], [FONSI 1995b], [PEGASUS 1989], [TAURUS 1992b], [FONSI 1993], [TITAN 1987] and [FONSI 1987]

CCAS. No NMP specific processing or launch activities have been identified that would require permits and/or mitigation measures beyond those currently in place or in coordination at VAFB and CCAS Payload Processing Facilities (PPFs) and Space Launch Complexes (SLCs).

### Air Quality

Primary constituents of exhaust from solid-fueled rocket motors are hydrogen chloride (HCl), carbon dioxide (CO<sub>2</sub>), carbon monoxide (CO), and aluminum oxide (Al<sub>2</sub>O<sub>3</sub>). Exhaust products are expected to be dissipated before reaching sensitive human, or flora or fauna receptors. Rocket Exhaust Effluent Diffusion Model (REEDM) output predicts the launching of NMP launch vehicles would result in effluent concentrations below all applicable Federal, State and local standards. The ambient air quality impacts due to launch-related activities are expected to not be substantial.

Ground operations would temporarily create a very small increase in emissions from electrical power generators and vehicle traffic. These increases are not expected to have adverse impacts to air quality.

### Water Quality

Local and regional water resources would not be affected since there would be no ground water withdrawals. Water utility piping would be used to meet miscellaneous onsite needs. As a result there would be no related impacts to the ground water, surface water or wastewater processing systems.

### Ocean Environment [DELTA 1994]

In a normal launch, the first and second stages and the Solid Rocket Motors (SRMs) would impact the ocean. The trajectories of spent stages and SRMs would be programmed to impact a safe distance from any U.S. coastal area or other land mass. Toxic concentrations of metals would not be likely to occur due to the slow rate of corrosion in the deep ocean environment and the large quantity of water available for dilution.

Along with the spent stages would be relatively small amounts of propellant. Concentrations in excess of the maximum allowable concentration of these compounds for marine organisms would be limited to the immediate vicinity of the spent stage. No substantial impact would be expected from the reentry and ocean impact of spent stages, due to the small amount of residual propellants and the large volume of water available for dilution.

## Hazardous Waste

Hazardous and solid waste management would comply with all applicable Federal, State, and local base regulations. The potential for an accidental release of liquid propellants would be minimized by strict adherence to United States Air Force and NASA established safety procedures. First stage propellants, thermally stable kerosene and liquid oxygen, would be stored in tanks near the launch pad within cement containment basins designed to retain 110 percent of the storage tank volumes.

## Noise Pollution

Peak launch noise<sup>2</sup> for all potential NMP launch vehicles is experienced for a very brief time period (approximately 5 seconds), and therefore, is not expected to exceed Environmental Protection Agency (EPA) or Occupational Safety and Health Administration (OSHA) requirements and recommendations. Moreover, any personnel at the launch site exposed to high noise levels would wear hearing protective gear.

VAFB has previously consulted with the National Marine Fisheries Service (NMFS) and has obtained a permit addressing unavoidable disturbance to harbor seals that may result from rocket launches. A program of monitoring and reporting noise levels and responses of the harbor seals at various haulout<sup>3</sup> areas on VAFB would be conducted during launch operations. If the results from the monitoring reveal that the effect of the launch noise on harbor seals is more than incidental harassment, NMFS would be immediately notified, and consultation would be requested. Currently no NMP-specific launch activities have been identified that would require permits beyond the baseline permits already in place.

## Ionizing and Nonionizing Radiation

Only very small amounts<sup>4</sup>, if any, of radioactive material would be used aboard NMP spacecraft, with the possible exception of Deep Space 4 (DS4).<sup>5</sup> In accordance with 14 CFR 1216.305 (c) (3), only devices with millicurie quantities or less of radioactive materials would fall within the scope of the NMP Programmatic EA. Additional NEPA documentation would be required of DS4 and any future NMP mission if it were to use radioactive material in excess of the quantities described in Chapter Six of this document. Currently, no other spacecraft designs plan to use radioactive materials. However, it is anticipated that future missions may utilize minute quantities of radioactive material associ-

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<sup>2</sup> Peak launch noise would range from approximately 99 to 112 dBA 1.6 kilometers (1 mile) from CCAS/VAFB launch pads. Launch noise would be reduced to approximately 89 to 103 dBA prior to reaching the nearest uncontrolled area (i.e., general public).

<sup>3</sup> A haulout is an area where marine mammals haul themselves from oceans to congregate, breed, etc.

<sup>4</sup> Quantities equal to or less than 10 times the A<sub>2</sub> limits as defined by the International Atomic Energy Agency [IAEA 1990]

<sup>5</sup> Preliminary spacecraft designs suggest DS4 may carry as many as three Radioisotope Heater Units.

ated with science instruments. As specific spacecraft and missions are fully defined, they will be reviewed in light of this Programmatic EA. If proposed radioactive material usage falls outside the scope of the Programmatic EA, further NEPA review will be conducted, as necessary and appropriate. As a checklist to be applied to future NMP projects, criteria has been established to determine this Programmatic EA's applicability to future flights (see Chapter Six).

Exemplary of NMP spacecraft, Deep Space 1 (DS1) would carry two types of transmitters: an X-band transmitter for telemetry and tracking, and a Ka-band transmitter for downlink. With proper safeguards against electrical shock, there is no human health or safety hazard expected from radio frequency radiation by NMP launch vehicles/spacecraft.

The DS1 attitude control sensor contains a 6 mW laser. The laser is contained within the Fiber Optic Gyro (FOG) which is inside the Inertial Measurement Unit (IMU). There is an opaque enclosure in the IMU that totally contains the laser and all emissions. Furthermore, a minimum of two safety-inhibits within the IMU prevents the laser from operating inadvertently. Because the 6 mW laser and all emissions from it are wholly contained within the opaque enclosure of the IMU, it requires no special handling and poses no hazard. [DS1 1997]

The Earth Observing 2 (EO2) Project plans to use an Earth pointing laser. EO2's currently proposed laser would be eyesafe. However, in accordance with Chapter Six of this document, further risk analyses and NEPA documentation will be required of EO2 and future projects if an Earth pointing medium or high power laser (Class 3b and 4), as defined by the American National Standards Institute [ANSI 1993], is to be utilized.

### Threatened and Endangered Species

Any action that may affect Federally listed threatened or endangered species or their critical habitats requires consultation with the U.S. Fish and Wildlife Service (USFWS) and/or the National Marine Fisheries Service (NMFS) under Section 7 of the Endangered Species Act of 1973 (as amended). The USFWS and the NMFS have previously reviewed those actions which would be associated with the launch of proposed NMP launch vehicles from VAFB and CCAS. Currently no NMP-specific processing or launch activities have been identified that would require permits and/or mitigation measures beyond the baseline permits and mitigation measures already necessary or in coordination for VAFB and CCAS launches.

## Biotic Resources

The NMP would not be expected to substantially impact VAFB/CCAS terrestrial or aquatic biota. Launch noise is of short duration and is not expected to substantially affect wildlife. Wildlife could experience brief exposure to launch generated exhaust particles, but would not be expected to experience substantial impact. Aquatic biota would not be expected to experience any adverse impact, because of the high buffering capacity of the surrounding surface waters [ATHENA 1995].

## Land Resources

The near-field effects of launches at VAFB/CCAS are expected to be minimal or nonexistent. This is consistent with monitoring associated with Space Shuttle launches at Cape Canaveral, Florida. Although the Space Shuttle is much larger than the rockets currently considered for NMP launches, and uses deluge water during its launch, the total near-field area of impact after 43 launches of the Space Shuttle was only 1.2 square kilometers (0.5 square miles). Despite additions of substantial amounts of acidic deposition from 43 launches over a ten year period, the affected soils have shown no decrease in buffering capacity [ATHENA 1995].

## Archeological and Historic Resources

Since no surface or subsurface areas would be disturbed, no significant archeological, historic, or cultural properties listed or eligible for listing in the National Register of Historic Places are expected to be affected by launching NMP spacecraft.

## Socioeconomics

Launching the New Millennium Program spacecraft would have a negligible impact on local communities, since no additional permanent personnel are expected beyond the current CCAS and VAFB staff. The NMP would cause no additional adverse or beneficial impacts on community facilities, services, or existing land uses.

## POTENTIAL LAUNCH ACCIDENTS

### Liquid Propellant Spill

The potential for an accidental release of liquid propellants would be minimized by strict adherence to applicable United States Air Force and NASA safety procedures. Post-fueling spills from the launch vehicle would be channeled into a sealed concrete catchment basin and disposed of according to the appropriate State and Federal regulations. [DELTA 1995]

At VAFB, the most severe propellant spill accident scenario would be releasing the entire Titan II launch vehicle load of nitrogen tetroxide at the launch pad while conducting propellant transfer operations. Under adverse weather conditions, it was predicted that a plume from a spill involving a Titan may reach as far as 4 kilometers (2.5 miles) before nitrogen oxide concentrations are lowered to 5 parts per million (ppm), and would travel several miles farther before being lowered to 1 ppm [USAF 1988]. If the direction of the wind and the critical distance for hazardous vapor dispersal were to include an on-base or offbase uncontrolled area, propellant loading would be postponed [TITAN 1987]. At CCAS, the most severe propellant spill accident scenario would be releasing the entire Delta II 7925 launch vehicle load of nitrogen tetroxide at the launch pad while conducting propellant transfer operations. Using the Titan predictive models and scaling for the Delta propellant loading, incremental airborne NO<sub>x</sub> levels from this scenario should be reduced to 5 ppm within about 150 meters (500 feet) and to 1 ppm within 300 meters (about 1,000 feet) [DELTA 1994]. In both cases, activating the launch pad water deluge system would substantially reduce the evaporation rate, limiting exposure to concentrations that are above Federally established standards to the vicinity of the spill. Propellant transfer personnel would be outfitted with protective clothing and breathing equipment. Personnel not involved in transfer operations would be excluded from the area.

#### Launch Vehicle Destruction [DELTA 1995]

Accidents either on the launch pads or within a few seconds of launch present the most threat to people, mainly the launch complex work force. Due to Range Safety requirements and operational requirements all personnel, including workers, and the general public are sufficiently far away from the launch site so as not to be affected by debris and other direct impacts of such accidents.

Launch failure impacts on water quality would stem from unburned liquid propellant being released into CCAS surface waters. For most launch failures, propellant release into surface waters would be substantially less than the full fuel load, primarily due to the reliability of the vehicle destruct system. However, if there were an early flight termination and failure of the vehicle destruct system, it is remotely possible that the entire Stage II propellant quantity could be released to the ocean. Impacts to ocean biotic systems would be localized, transient in nature, and these systems would be expected to recover rapidly, due to the large amount of ocean water available for dilution.

#### CONCLUSION

The DS1 spacecraft is expected to be representative of all NMP spacecraft (except DS4) in terms of failure modes, hazardous materials and potential impacts. Specific designs are not available now for all instruments but the DS1 suite of instruments and those reviewed from other missions indicate

that the materials used and therefore the hazards anticipated from them would be similar and benign. The components utilized in the instruments and spacecraft are of materials normally encountered in the space industry and present no unique or unacceptable environmental impacts.

The detailed analyses performed in this environmental assessment bound the anticipated potential impacts for the NMP. There is no indication that the expected impacts would be greater than those normally encountered in the general space program nor the specific launch programs at VAFB and CCAS. In conclusion, the NMP environmental impacts fall well within the range of previously defined, but not judged significant, impacts for other authorized and approved programs.<sup>6</sup>

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<sup>6</sup> [DELTA 1991], [FONSI 1991], [ATHENA 1994], [ATHENA 1995], [FONSI 1995a], [ATHENA 1997], [FONSI 1997], [DELTA 1995], [FONSI 1995b], [PEGASUS 1989], [TAURUS 1992b], [FONSI 1993], [TITAN 1987] and [FONSI 1987]

# 1. CHAPTER ONE PURPOSE AND NEED<sup>7</sup>

## GENERAL

The National Aeronautics and Space Administration (NASA) has prepared this Environmental Assessment (EA) for the proposed New Millennium Program (NMP) to comply with the National Environmental Policy Act of 1969, as amended (NEPA) (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). The objective of an EA is to provide decision makers with sufficient information and analysis to determine whether the decision to proceed with the proposed action requires preparation of an Environmental Impact Statement (EIS), or if a Finding of No Significant Impact (FONSI) would be appropriate. Topics discussed in the EA include, but are not limited to, program objectives, potential environmental impacts, and alternatives to the proposed action.

To stimulate the creation of the revolutionary spacecraft and instruments needed for 21st-century missions, NASA has devised a concept for an aggressive technology-validation program to identify new technologies that would reduce mission costs and also increase mission capability to achieve scientific objectives. This program, the New Millennium program, is characterized by a technology-rich series of space flights to systematically flight demonstrate and validate new technologies to benefit NASA's programs in planetary exploration, astrophysics, space physics, and Earth sciences.

### 1.1 PURPOSE OF THE PROPOSED ACTION

The New Millennium Program is a long-term, aggressive technology development program that is designed to move technologies from the laboratory to flight-ready status by spaceflight validation under challenging conditions. The technologies validated by NMP have traditionally been difficult to incorporate into science missions because of the inherently high risk associated with their first use. The program's focus is on advanced technologies which offer the potential to contribute significantly to reducing the cost of future space and Earth science missions while increasing their relative capability in achieving scientific objectives. The reduction in size of spacecraft and the increase in capability that NMP is designed to foster would bring about future economic benefits for the space program.

In addition to developing and validating spacecraft, instrumentation, and operations technologies, NMP is planned to demonstrate management and

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<sup>7</sup> This chapter is summarized from [PLAN 1995]

engineering techniques that reduce development, launch, and operations costs. Computer-aided design and concurrent project engineering and design is being used to accelerate and enhance the design process to lead to rapid implementation. These technologies and techniques could be used by future missions at reduced risk and hence reduced cost. NMP flight-validated technologies may also find their way into the consumer market for use in such applications as autonomous rail transportation systems, new microsensors for automotive technology, and high quality imagery and reduced power consumption for computer systems.

NMP is designed to demonstrate the kinds of innovative methods necessary to accomplish the goals of Earth and space science in a post-2000 environment: Effective management techniques of partnering and teaming among government agencies, industry, nonprofit organizations, and academia; new methods of risk management and cost control; and concurrent engineering and system-level, computer-aided design tools.

## 1.2 NEED FOR THE PROPOSED ACTION

The New Millennium Program is needed to lay the groundwork for an age of exploration and achievement by developing and flight validating innovative technologies for future missions. Probes of the future equipped with NMP-validated technologies could create a 'virtual' human presence in space through communication links to numerous small spacecraft frequently launched from Earth. These microspacecraft explorers would observe Earth and explore the galaxy. Space-based free-flying interferometers, created by several spacecraft flying in precision formation, could make it easier to detect, characterize, and image planets in orbit around neighboring stars. The partnering techniques pioneered by NMP, which teams industry, universities, nonprofit research and development firms, and government agencies could foster new joint technology development among these organizations. State-of-the-art computer-aided design systems would be used to create "paperless" designs, while computer-driven fabrication techniques and automated spacecraft tests could reduce costs and speed mission implementation. NASA's Deep Space Network (DSN) would receive the wealth of new data from 21st-century missions for the benefit of researchers, students, and the public. With applications of advanced technologies, NASA might be able to expand our horizons further out into the universe than has ever been possible.

The technology development acceleration and transition approach the program uses would also provide educational opportunities for in-depth training and experience for engineers and scientists who would participate in 21st-century space and Earth science missions. NMP's Outreach plan would concentrate on building an infrastructure for wide-spread computer-based access to NMP activities, innovations, and discoveries. As these capabilities are developed, more established techniques would be used to inform and educate the

public. As the ultimate customers of NMP endeavors, the public would be provided with timely, accurate NMP information through a wide variety of media.

The investment in the New Millennium Program now could begin to provide tangible benefits, especially in validating solar electric propulsion, before the year 2000. The infusion of flight validated technologies into the commercial infrastructure could both strengthen and stimulate the American industrial base, as well as improve the nation's competitive edge in the global market; the nation's space and Earth science program could accrue new capabilities and develop a wealth of new and diverse data.

### 1.3 PURPOSE OF THE PROGRAMMATIC EA FOR NMP

NMP materials and payloads are expected to be similar and benign. The mission suite has common themes and elements throughout the series of launches including common timing, expected environmental impacts, mission alternatives, methods of implementation, subject matter, affected media, and commonly utilized materials and known hazards associated with those materials. The commonalities and similarities among NMP mission spacecraft and the potentially similar environmental impacts associated with their launch suggest the writing of a programmatic NEPA document. As specific spacecraft and missions are fully defined, they will be reviewed in light of the Programmatic EA. If any fall outside the scope of the Programmatic EA, further NEPA review will be conducted, as necessary and appropriate. As a checklist to be applied to future NMP projects, criteria has been established to determine this Programmatic EA's applicability to future flights (Chapter Six).

## **2. CHAPTER TWO PROPOSED ACTION AND ALTERNATIVES**

### GENERAL

This section describes the proposed action of developing flight projects for the New Millennium Program. Topics covered include Deep Space (DS), and Earth Observing (EO) spacecraft series and their subsequent launches. In addition, there are instruments that would be flown, singularly, as flights of opportunity or piggy back<sup>8</sup> flights on domestic spacecraft. Following the presentation of proposed NMP flight and science projects is a description of proposed launch vehicles, alternative launch vehicles and the No-Action alternative.

### 2.1 NMP FLIGHT AND SCIENCE PROJECTS

NMP plans to launch twelve spacecraft between the time period 1998-2010 from Space Launch Complexes (SLCs) at Cape Canaveral Air Station (CCAS) and Vandenberg Air Force Base (VAFB). NMP flights which are not piggy backed are proposed to use either the Delta II, Titan IIG, Athena 2, Taurus, Athena 1 or the Pegasus, dependent upon payload mass and the specific mission profile. NMP flights which are piggy backed may utilize launch vehicles other than those covered here. There presently are no plans to use foreign launch vehicles for NMP. Environmental impacts associated with the launch of piggy back missions would be covered by separate NEPA documentation done by the carrying mission.

In accordance with the NASA New Millennium guidelines, key areas of concern and objectives for the New Millennium Program are to validate technologies which: 1) lower mass to reduce launch costs, 2) have greater autonomy in space and on the ground to reduce operations costs, and 3) lower life-cycle cost to increase mission frequency.

NMP's spaceflight design and selection would encompass technologies for four of NASA's science areas: planetary, Earth, astrophysics, and space physics studies. Candidate NMP technology-validation flights for the 1998-2004 series include: flybys of asteroids and comets to prove out advanced micro-spacecraft and operations technologies; Earth orbiting spacecraft to validate technologies measuring phenomena such as air pollution and climate change; and a microlander sent to study the Moon, Mars, or a near-Earth asteroid. A free-flying interferometer mission would demonstrate technologies and operating techniques for later missions to detect planetary systems around other stars.

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<sup>8</sup> Flights of opportunity or piggy back flights are flights in which NMP instruments and/or spacecraft are carried on missions and/or programs other than the NMP.

NMP spacecraft would validate technologies that could discern trends, examine planetary climates and atmospheres, and study phenomena such as temperature, pollution levels, and biomass distribution on Earth. Powerful microinstruments developed by NMP on board microspacecraft of the future could enable new types of science investigations. For example a single seismometer monitors tremblors; a network of microseismometer landers could be capable of characterizing a planet's internal structure.

Integrated Product Development Teams, each focusing on a specific technology area, identify proposed technologies now in development that may offer the greatest potential benefits for 21<sup>st</sup>-century space and Earth science missions. The teams create technology development "roadmaps" for key technology areas, determine the cost associated with advancing the technology, and facilitate the final development and infusion of the technologies into validation flights.

Teams are formed as 21<sup>st</sup>-century technology areas are identified. The first six teams that have been formed are:

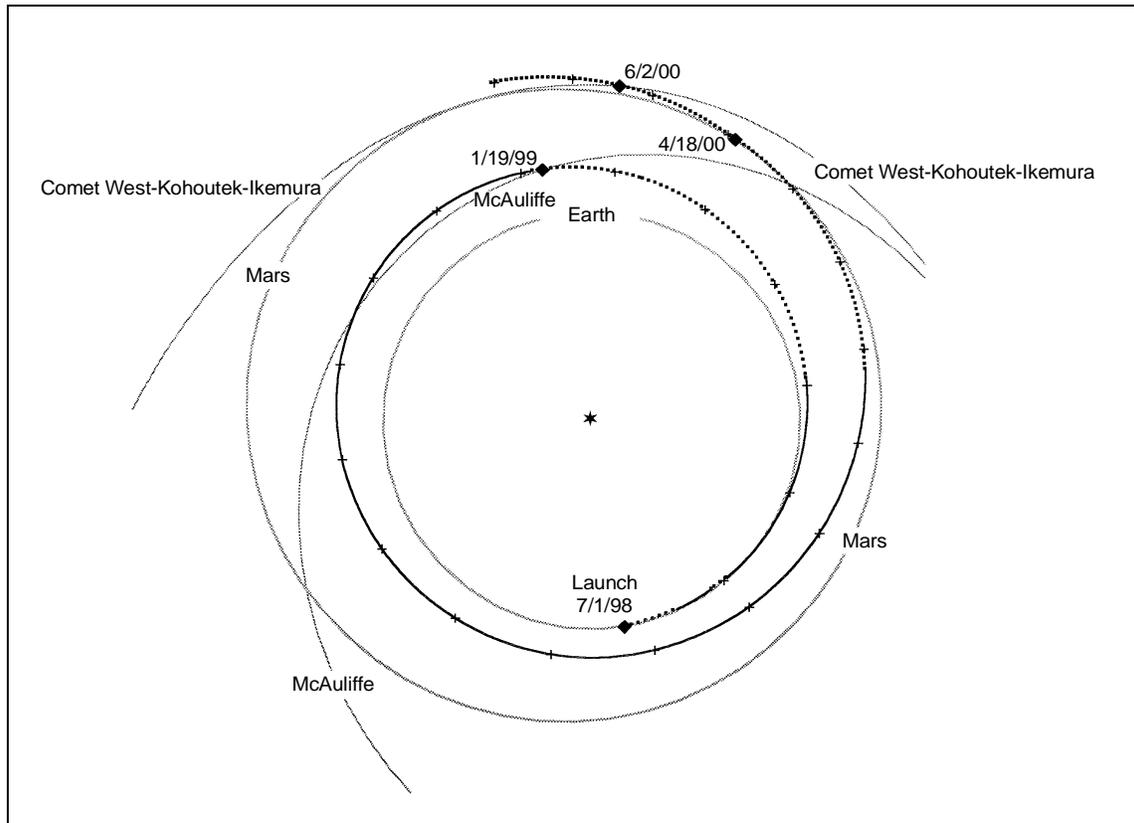
- Autonomy
- Microelectronics
- Instrument Technologies and Architectures
- Telecommunications
- Modular Architectures and Multifunctional Systems
- In-situ Instruments and Micro-Electro-Mechanical Systems

#### 2.1.1 Deep Space Projects

##### 2.1.1.1 Deep Space 1 (DS1 Project): Asteroid, Mars and Comet Flyby

The DS1 Project would validate a selected set of technologies with the key mission-driving technology being the solar electric propulsion system. Deep Space 1 is baselined to launch on a Delta II 7326 in October of 1998. DS1 would be a solar-powered, sun-orbiting spacecraft sent on a heliocentric "test-track" that includes an asteroid flyby, a Mars flyby and a comet flyby (Figure 2-1). DS1 would return images and spectra of asteroid McAuliffe, Mars, and West-Kohoutek-Ikemura comet. DS1 would also monitor solar wind throughout the mission and measure the interaction of the solar wind with the targets during the flybys.

Figure 2-1. Deep Space 1 Trajectory



Tics on spacecraft path are at 30-day intervals.

Solid portion of spacecraft path indicates Ion Propulsion Subsystem (IPS) is thrusting.

DS1 requirements are to validate the following prime technologies through space flight:

- Solar electric propulsion as primary propulsion
- Solar Concentrator Array with Refractive Linear Element Technology (SCARLET)
- Autonomous navigation as primary navigation
- Miniature integrated camera spectrometer

As a goal, the DS1 Project would develop and validate the following additional technologies and systems:

- Miniaturized integrated plasma instrument
- Autonomous onboard operations
- Ka-band solid state power amplifier
- Small deep space transponder
- Low power electronics
- Power activation and switching module
- Multifunctional structure
- Beacon monitor operations experiment

#### 2.1.1.1.1 DS1 Science

Within the constraints of technology validation and performance, as much science as possible would be conducted with the Miniature Integrated Camera Spectrometer (MICAS), the Plasma Experiment for Planetary Environments (PEPE), and the Ion Propulsion Subsystem (IPS) diagnostic sensors. Science opportunities include solar wind monitoring, including coordinated observations with instruments elsewhere in the solar system; determination of asteroid McAuliffe's and comet West-Kohoutek-Ikemura's size, shape, possibly spin state, geomorphology, chemical composition of the surface material, and interaction with the solar wind.

#### 2.1.1.1.2 Spacecraft Overview<sup>9</sup>

##### General

Although specific payloads are currently being developed for other NMP flights, DS1 has been assumed to be a "typical" payload for the purposes of the NMP EA. DS1 is expected to be representative of all NMP spacecraft in terms of failure modes, hazardous materials and potential impacts. Specific designs are not available now for all instruments but the DS1 suite of instruments and those reviewed from other missions indicate that the materials used and therefore the hazards anticipated from them would be similar and benign. The components utilized in the instruments and spacecraft are materials normally encountered in the space industry and present no unique environmental impacts. DS1 would contain no radioactive material.

#### 2.1.1.1.3 DS1 Spacecraft Description

The DS1 flight system would consist of the following subsystems:

- Structure and Mechanisms Subsystem
- Propulsion Subsystem
- Command and Data Handling Subsystem
- Cabling Subsystem
- Attitude Control Subsystem
- Electrical Power Subsystem
- Telecommunications Subsystem
- Thermal Control Subsystem
- Flight Software Subsystem
- Advanced Instruments

The structures subsystem provides for the spatial configuration and physical interface of the spacecraft equipment as well as the load carrying paths during ground, launch and in-orbit environments. This subsystem would be composed of a frame structure with multiple close-out panels upon which the

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<sup>9</sup> This section is summarized from [DS1 1997]

other spacecraft components are mounted. The mechanisms subsystem provides for the deployment of the solar arrays as well as the actuation of the one-axis array drive motors, and the two-axis ion thruster gimbal.

The propulsion subsystem is divided into two subelements: the Reaction Control Subsystem (RCS) and the IPS. The RCS provides the propulsive capability to perform spacecraft attitude control maneuvers as well as small, impulsive trajectory correction maneuvers. The system is composed of one bladder tank and eight thrusters. The tank contains helium pressurant and a maximum of 27.8 kilograms (62.4 pounds) of hydrazine. The IPS is one of the technologies to be validated and would consist of a large ion thruster, a xenon (Xe) feed subsystem, a power processing unit, and a set of control and diagnostic electronics. During ground operations the ion thruster would be under a nitrogen purge to ensure thruster cleanliness throughout the launch environment.

The Command and Data Handling subsystem (C&DH) provides for control and reconfiguration of the spacecraft as well as gathering, storage, and transmission of telemetry and science data. The subsystem would receive baseband command data from either the ground or the flight software. These commands then would be decoded, stored, conditioned and distributed via data buses throughout the spacecraft. In addition, the C&DH would collect information from all of the spacecraft elements, condition it, and provide it to the flight software for management, storage, and transmission. The subsystem would have the additional responsibility of providing the wake-up signal to the spacecraft upon separation from the 3<sup>rd</sup> stage. This wake-up signal would be used to initiate certain software functions which orient the spacecraft, deploy the solar arrays, and place it in a safe configuration for its start-up activities.

The Cabling Subsystem consists of all cabling, connectors, and ancillary hardware within the spacecraft bus as well as between the spacecraft and the launch vehicle.

The Attitude Control Subsystem (ACS) would provide the control capability to autonomously maintain attitude orientation and stability of the spacecraft during all phases of the mission following separation from the 3<sup>rd</sup> stage. The ACS also would provide the control capability to support the required bus functions associated with communications, power, thermal control, and propulsive maneuvers. The subsystem consists of a star tracker, a rate sensor, and a sun sensor. In addition, the ACS calls upon MICAS to take the optical navigation images.

The Electrical Power Subsystem would consist of the Solar Concentrator Array with Refractive Linear Element Technology (SCARLET), a nickel-hydrogen (NiH<sub>2</sub>) battery, a power distribution unit, and a high voltage power conversion unit. This subsystem would supply, control, convert, regulate and distribute all electrical power required for the spacecraft bus functions including the advanced instruments. This capability is required continuously from transi-

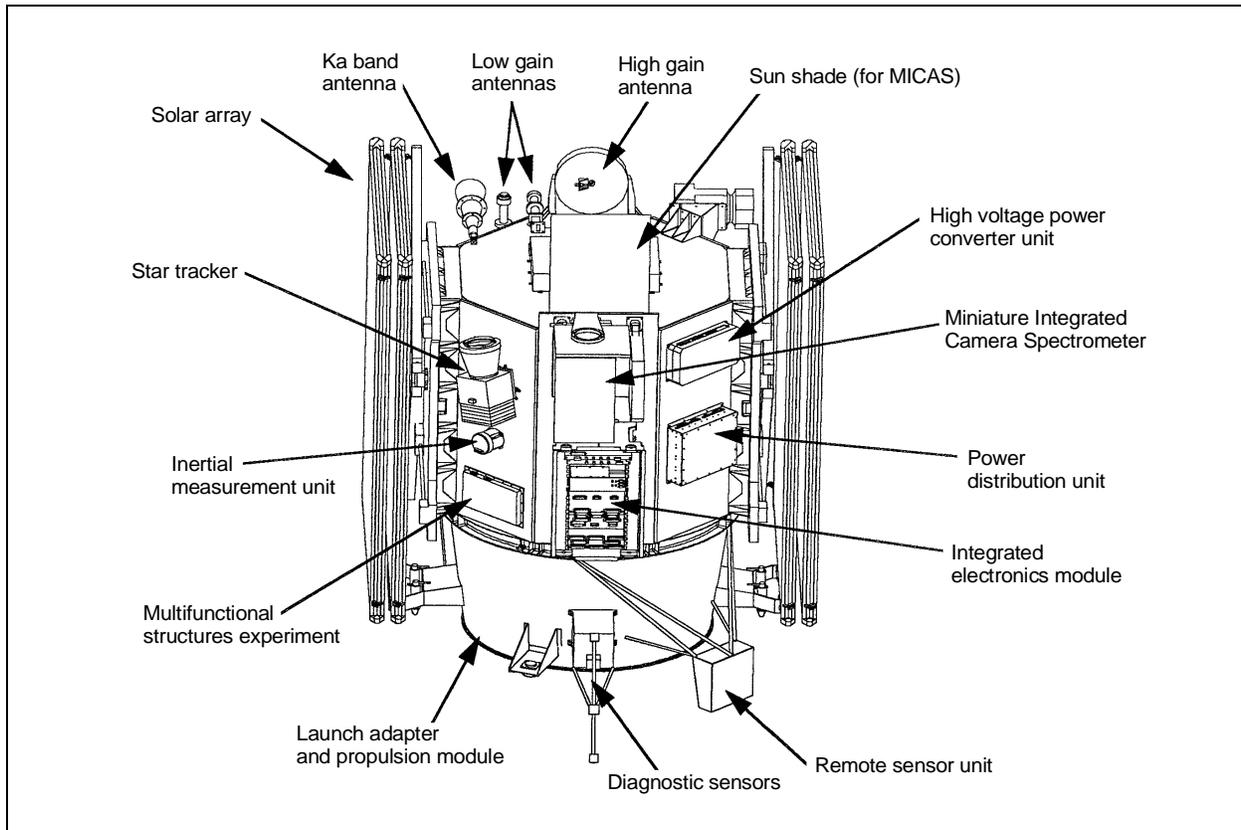
tion to spacecraft internal power prior to launch through all subsequent mission phases.

The Telecommunications Subsystem would provide for Deep Space Network (DSN) compatible X-band and radiometric tracking communications to and from Earth for telemetry and commanding. This subsystem would consist of a small deep space transponder, X-band and Ka-band attenuators and solid state power amplifiers, a diplexer, a high-gain antenna, a Ka-band horn, two waveguide transfer switches, and three low-gain horn antennas. The design would provide for simultaneous telemetry, commanding and radiometric tracking. In addition to the X-band link, the telecommunication design incorporates a Ka-band downlink as one of the technologies to be validated.

The Thermal Control Subsystem would provide the capability to maintain spacecraft components within their flight allowable operating and/or non-operating temperature ranges during all mission phases. This subsystem would consist of heaters, thermostats, temperature sensors, and blankets.

The advanced instrument suite would provide the science function for DS1 as well as diagnostic and optical navigation support. The Miniature Integrated Camera Spectrometer (MICAS) is an optical instrument that takes images in the ultraviolet (UV), visible, and infrared (IR) wavebands. This instrument would also be used to support the optical navigation function of the Autonomous Navigation. PEPE is an instrument whose primary function would be to monitor the ion environment in the vicinity of the spacecraft. This instrument would also provide diagnostic information about the IPS.

Figure 2-2. Deep Space 1 Spacecraft Detailed Design



### 2.1.1.2 Deep Space 2 (DS2 Project): Mars Microprobe

The Mars Microprobe (DS2 Project) would be a piggy back flight or flight of opportunity and is discussed in Section 2.1.3.1.

### 2.1.1.3 Deep Space 3 (DS3 Project): Formation Flying Interferometry

The DS3 Project would validate technologies for separate spacecraft formation flying interferometry. The interferometer instrument would be distributed over three small spacecraft (Figure 2-3): two spacecraft would serve as collectors, directing starlight toward a third spacecraft, which in turn would combine the light and perform the interferometric detection [DS3 1996]. All three spacecraft would be launched from a single Delta II 7325 launch vehicle to a heliocentric orbit during the June 2002 time frame. After launch, the individual spacecraft would be released and deployed into formation.

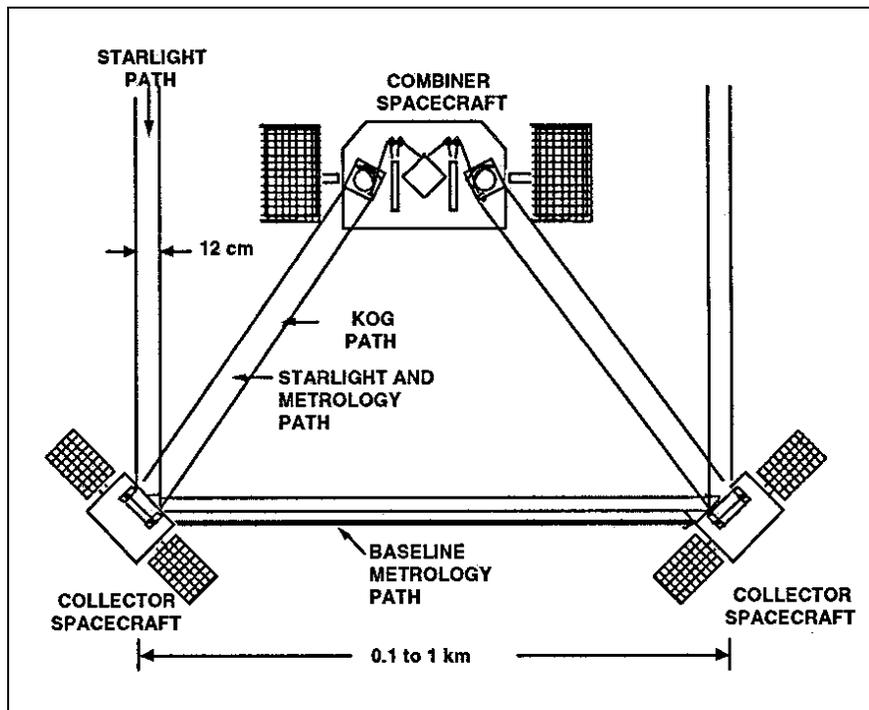
DS3 would validate the following prime technologies through space flight:

- Precision formation flying technologies
- Interferometer components
- Integration for space
- 3-D stack computer as the flight computer

DS3 would contain no radioactive material.

Future 21<sup>st</sup>-century interferometers would utilize a higher number of spacecraft separated by thousands of kilometers to study the origins of stars and galaxies and detect Earth-like planets.

Figure 2-3. Deep Space 3 Separated Spacecraft Interferometer



Source: Adapted from [DS3 1996]

#### 2.1.1.4 Deep Space 4 (DS4 Project): Comet Tempel 1 Rendezvous

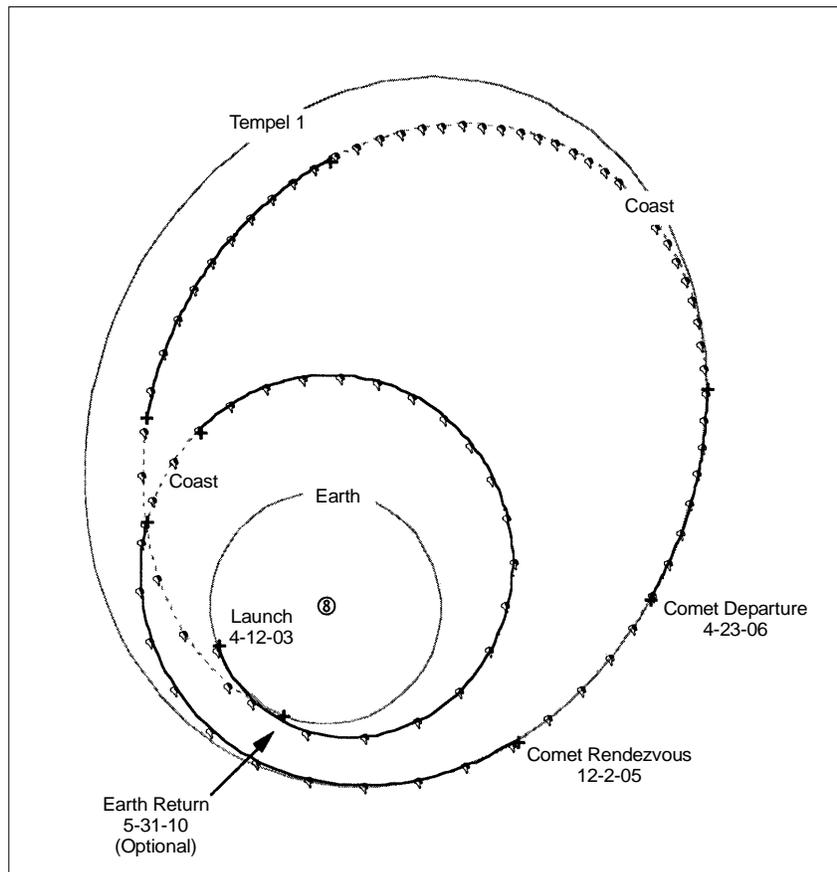
The DS4 Project would perform the first landing of scientific instruments on the surface of a comet. DS4 would demonstrate the feasibility of precision guided landing, remote sample collection, and automated orbital rendezvous. DS4 would launch in April 2003 on a Delta II 7925 from Cape Canaveral Air Station. The DS4 spacecraft would use an advanced version of the solar electric propulsion technology qualified on the first New Millennium mis-

sion, DS1. The solar electric carrier spacecraft would rendezvous with the periodic comet Tempel 1 in December 2005 (Figure 2-4).

An option being considered for DS4 would include the return to Earth of extraterrestrial samples from Tempel 1 for analysis in terrestrial laboratories. Environmental impacts associated with sample returns to Earth fall outside the scope of this Programmatic EA (see Chapter Six). If the Earth sample return option is selected, DS4 would require additional NEPA documentation.

Preliminary spacecraft designs also suggest DS4 may carry as many as three Radioisotope Heater Units. Environmental impacts associated with the use of radioactive material of this quantity fall outside the scope of this Programmatic EA (see Chapter Six). If Radioisotope Heater Units are to be used aboard DS4 additional NEPA documentation would be required.

Figure 2-4. Deep Space 4 Trajectory

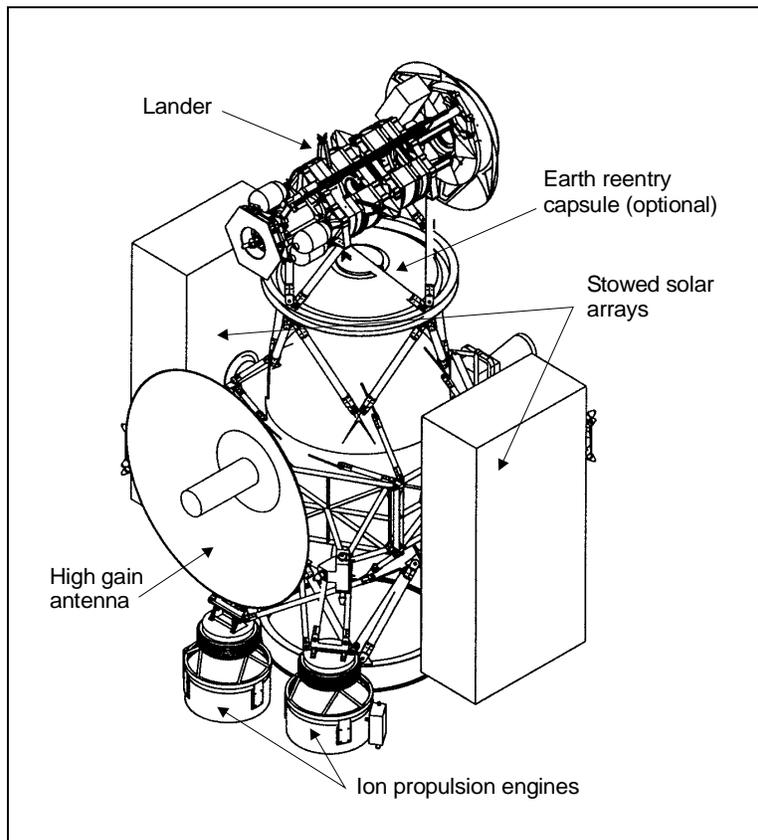


DS4 requirements are to validate the following prime technologies:

- Advanced solar arrays using inflatable deployment
- Advanced solar electric propulsion technology
- Integrated, high performance electronics and software architecture
- Small transponding modem
- Autonomous navigation and operations
- Autonomous precision guidance, control for landing
- Comet/small body landing and anchoring system
- UHF transceiver for lander to carrier communications
- Subsurface sample acquisition and transfer to instruments

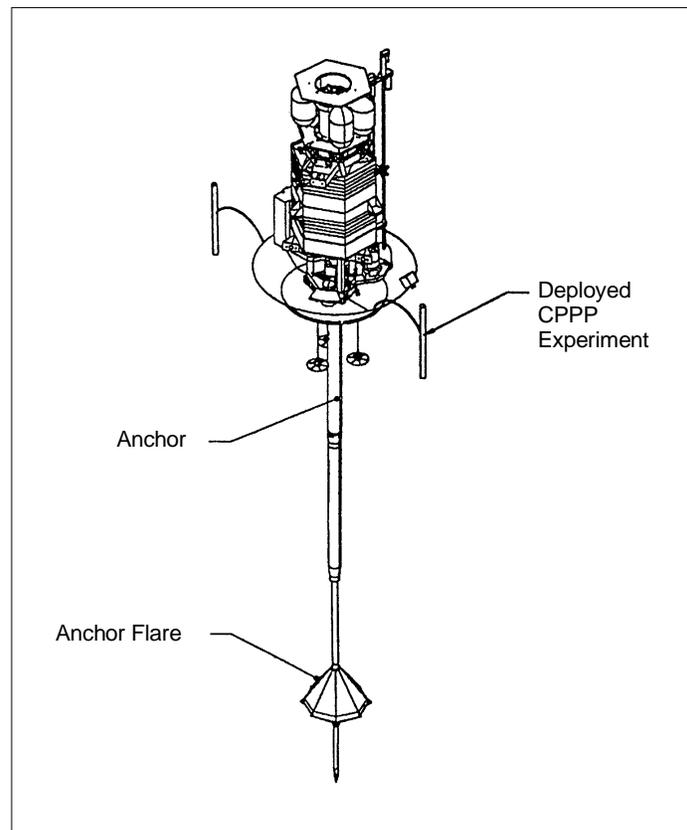
After comet arrival, the spacecraft (Figure 2-5) would slowly approach the comet and be placed in a low orbit around the nucleus of Tempel 1. DS4 would plan to spend four months at the comet in order to map the surface at high resolution and select a landing site. In addition, radio tracking data would be used to determine the nucleus mass and gravity harmonics, and would be combined with imaging data to estimate the bulk density of the cometary nucleus.

Figure 2-5. Deep Space 4 Spacecraft



The Lander would then separate from the carrier spacecraft, descend to the surface, and anchor itself while the solar electric carrier spacecraft would remain in orbit to serve as a radio relay to Earth. The Lander would descend using onboard autonomy and precision guidance to maneuver to a pre-selected site on the comet surface and attach itself. The 120 kilogram (260 pound) Lander (Figure 2-6) would carry the in-situ scientific payload, descent and anchoring subsystems, central computer, data storage, and relay telecommunications system. At touchdown an explosive, deployable harpoon would anchor the spacecraft to the surface to permit drilling operations and other relevant scientific measurements. Operations on the nucleus surface are expected to last approximately 80 hours. The DS4 Lander would perform in-situ science and collect a sub-surface sample, detach itself from the anchor, and take off, leaving the lower portion of the spacecraft and most of the scientific instruments on the comet. The Lander would then autonomously rendezvous with the carrier spacecraft.

Figure 2-6. DS4 Lander



#### 2.1.1.5 Deep Space 5 (DS5 Project)

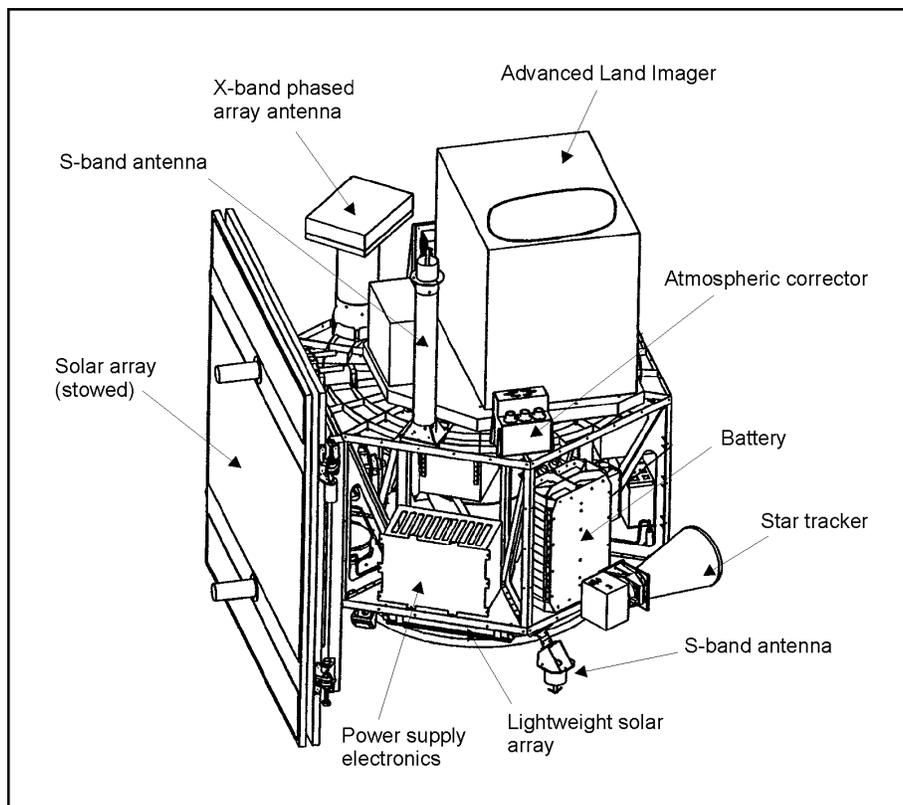
The DS5 Project is planned to be a piggy back flight or flight of opportunity and is discussed in Section 2.1.3.2.

## 2.1.2 Earth Observing Projects

### 2.1.2.1 Earth Observing 1 (EO1 Project): Advanced Land Imaging

The EO1 Project key objectives focus on demonstrating new remote sensing, spacecraft, and operations technologies (both hardware and software). An advanced, lightweight scientific instrument designed to produce visible and shortwave infrared images of Earth has been selected conceptually for the first proposed New Millennium Program Earth Observing (EO) flight. The Advanced Land Imager would feature 10-meter (30 feet) ground resolution in the panchromatic (black-and-white) band and 30-meter (100 feet) ground resolution in its other spectral bands. EO1 (Figure 2-7) would be inserted into a circular sun-synchronous orbit at 705 kilometers (440 miles), one minute behind Landsat-7 to obtain common data sets for direct comparison. EO1 would be launched on a Delta II 7320 from VAFB on May 27, 1999.

Figure 2-7. Earth Observing 1 Spacecraft Detailed Design



EO1 would validate the following technologies through space flight:

- Multispectral imaging capability (including lunar and solar calibration)
- Wide field reflective optics
- Silicon carbide optics

- Wedge imaging spectrometer
- Grating imaging spectrometer

(The 5 technologies above would constitute the Advanced Land Imager.)

- Atmospheric corrector
- X-band phased array antenna
- Fiber optic data bus
- Enhanced formation flying
- Carbon-carbon radiator
- Lightweight solar array
- Pulsed plasma thruster

#### 2.1.2.1.1 EO1 Science

EO1 would acquire remote-sensing measurements of the Earth consistent with data types collected since 1972 through the Landsat series of satellites, which are used by farmers, foresters, geologists, economists, city planners and others for resource monitoring and assessment. In addition, EO1 would acquire data with finer spectral resolution and could lay the technological groundwork for future land imaging instruments to be more compact and less costly.

#### 2.1.2.1.2 EO1 Spacecraft Description

EO1 spacecraft power would be supplied by a single gallium arsenide photovoltaic array of 4.5 square meters (48 square feet) and a nickel-cadmium storage battery. EO1 would contain no radioactive material.

The functions of attitude control as well as command and data handling would be combined into a single box containing two radiation hardened microprocessors that support attitude control and command data handling. Communication throughout the spacecraft would be accomplished with a fiber optic star network, and the instruments would be located on a newly developed fiber optic data bus in a ring configuration.

Propulsion would be provided by a hydrazine subsystem using dual 0.2 pound thrusters about each of the cardinal axes. The propulsion subsystem carries 15 kilograms (33 pounds) of hydrazine which would support initial orbit adjustments, station keeping, rendezvous maneuvers, and formation flying with Landsat 7.

The spacecraft thermal subsystem would be thermally isolated from the instrument. Heaters would provide thermal control for components when they are not in operation or would provide tighter thermal control for more critical components.

The EO1 communication subsystem would use both X and S-band.

### 2.1.2.2 Earth Observing 2 (EO2 Project): Atmospheric Winds

The EO2 Project is planned to be a piggy back flight or flight of opportunity and is discussed in Section 2.1.3.3.

### 2.1.3 Piggy Back Flights or Flights of Opportunity

As stated previously, NMP flights which are piggy backed may utilize launch vehicles other than those covered herein. Environmental impacts associated with launch of piggy back missions would be covered by separate NEPA documentation done by the carrying mission. A description of these flights are included here for completeness.

#### 2.1.3.1 Deep Space 2 (DS2 Project): Mars Microprobe

DS2 is planned to launch on the 1998 Mars Surveyor Lander (Mars '98) aboard a Delta II 7425 as a piggy back flight. Environmental impacts for DS2's launch will be covered by Mars '98 NEPA documentation. The Mars '98 spacecraft is proposed for launch in January 1999 and would arrive at Mars in December 1999. DS2 would consist of two 1.5 kilogram (3.3 pound) microprobes mounted on the Mars '98 Lander cruise ring. The microprobes would not contain radioactive material. DS2 would use Kennedy Space Center (KSC) facilities provided by the Mars '98 Project for integration and launch of these microprobes on the lander spacecraft.

The advanced technologies to be validated aboard DS2 are:

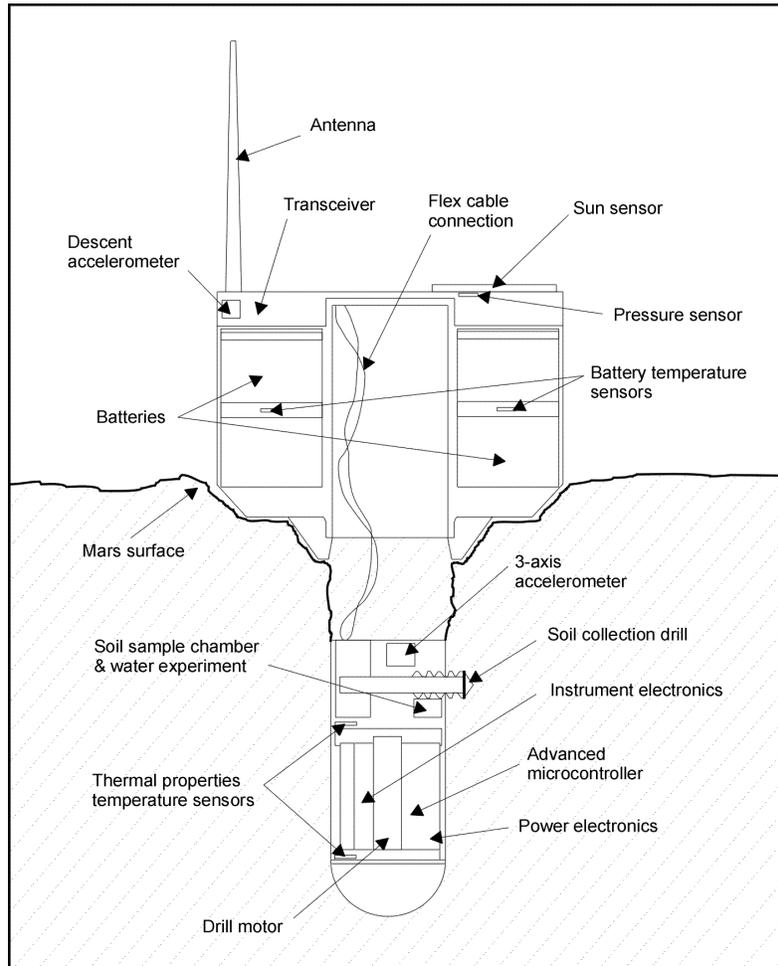
- Meteorological high-g pressure sensor
- Subsurface sampling and water-detection experiment
- Microtelecommunications subsystem with programmable transceiver
- Power microelectronics with mixed digital/analog application-specific integrated circuits
- Ultralow-temperature, lithium ion battery
- Microcontroller with three-dimensional, high-density interconnect packaging
- Flexible interconnects for system cabling

As a goal, the Mars Microprobe Project would develop and validate the following additional technologies and systems:

- Soil conductivity high-g temperature sensors
- Non-erosive, lightweight, single-stage atmospheric entry system

The microprobes would hit the surface of Mars with an impact velocity of 160 to 200 meters per second (360 to 450 miles per hour). During this abrupt landing, each microprobe would separate into a fore and aftbody system (Figure 2-8) connected by a flexible cable. A 3-axis accelerometer would measure the deceleration of the forebody as it comes to rest, which may provide clues to Mars' climate history. A sun detector would verify that the aftbody has remained on the surface. Within minutes of impact, a micromotor would drive a small drill out the side wall of the penetrator (forebody) and pull soil tailings into the water experiment sample cup. The water experiment would be designed to detect any subsurface ice and, power permitting, would characterize subsurface soil composition. Two temperature sensors would measure soil conductivity and would supply information on the operating status of the probes. The probe would collect temperature, pressure, and sun detection measurements every hour for at least the first two martian days. Operations would continue until the probe battery is depleted. Science and engineering data collected during the mission would be temporarily stored in the probes' microcontrollers until they are transmitted to Earth via the Mars Global Surveyor spacecraft, now in orbit about Mars.

Figure 2-8. Deep Space 2: Mars Microprobe



### 2.1.3.2 Deep Space 5 (DS5 Project)

The DS5 Project would also be a piggy back flight and would validate technologies for promising needs of the 21<sup>st</sup> century. This project is under evaluation. Technology validation concepts include:

- Venus or Mars aerobot<sup>10</sup>
- Solar sail spacecraft
- Inflatables (including antennas)
- Inflatable optical mirror demonstration
- Microlander/penetrator
- In-situ experiments
- Microspacecraft

<sup>10</sup> a small unmanned aerial vehicle

### 2.1.3.3 Earth Observing 2 (EO2 Project): Atmospheric Winds

The EO2 Project is proposed for launch as a piggy back flight on the Space Shuttle. EO2 would demonstrate the measurement of tropospheric winds from space using a LIDAR<sup>11</sup> instrument. The LIDAR technology and scanning technique demonstration would be used to improve the performance of weather and climate models. Environmental impacts associated with launch of EO2 would be covered by Space Shuttle NEPA documentation. EO2 would contain no radioactive material.

The advanced technologies/techniques to be validated with EO2 are:

- Launch-survivable laser and optics
- Evaluation of sampling/signal processing strategies for future missions
- Demonstration of the ability to deliver multi-perspective wind measurements

EO2's currently proposed laser would be eyesafe. However, in accordance with Chapter Six of this document, further risk analyses and NEPA documentation will be required of the EO2 Project if an Earth pointing medium or high power laser (Class 3b and 4), as defined by the American National Standards Institute [ANSI 1993], is to be utilized.

## 2.2 PAYLOAD PROCESSING<sup>12</sup>

### General

Ground operations are anticipated to be similar for all NMP payloads. The following discussion, based on DS1, presents a representative estimate of support requirements and activities.

### 2.2.1 Spacecraft Lifting and Handling

The spacecraft would be transported to the Eastern/Western Range using an air-ride truck and would be in an environmental enclosure which is equipped with a recording accelerometer. Structural analysis would be primarily based on the launch system launch loads which significantly exceed the anticipated ground handling and transportation loads. Upon arrival at the Eastern or Western Range, the spacecraft would be thoroughly inspected for damage.

Lifting and turnover operations present potentially hazardous situations for ground processing personnel. These operations would be performed

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<sup>11</sup> Light Detection And Ranging (LIDAR) uses the same principle as RADAR except the energy source used is a laser. A LIDAR instrument transmits light to a target and analyzes the light scattered back to determine properties of and range to the target.

<sup>12</sup> This section is summarized from [DS1 1997]

using fixtures designed and proof tested for the DS 1 system. Hoist and crane rated loads and certification would be checked prior to use. Hoist and crane operators would have received training prior to conducting any operations. Unless specifically approved by KSC/Range Safety, personnel would not be permitted to work beneath the suspended load.

Lifting operations would be conducted by personnel trained for operating hoists and cranes. Assembly, handling and support equipment would be labeled to indicate rated load, proof test load, and date of test.

### 2.2.2 Propellant Loading and Proof Test

Hydrazine ( $N_2H_4$ ) is classified as a hazardous liquid as it is toxic, flammable, reactive and a strong solvent. Hydrazine can decompose on contact with certain metals and strong oxidizing agents. The DS1 spacecraft would contain a maximum of 27.8 kilograms (62.4 pounds) of hydrazine, which is expected to be representative of all NMP spacecraft.

The RCS would be loaded using a detailed step-by-step procedure, developed specifically for the DS1 RCS, using the hydrazine propellant service cart. All propellant transfer operations are performed by trained and certified personnel wearing a Self-Contained Atmospheric Protection Ensemble (SCAPE).

All loading equipment is precision cleaned and detailed maintenance for ground support equipment is performed. A rehearsal of each loading procedure would be performed.

The RCS would be leak tested and functionally tested at the launch site and a loading rehearsal conducted. Loading and pressurization would be conducted in a controlled area with non-essential personnel evacuated. Electrostatic discharge control procedures would be in effect. The system would be leak tested prior to propellant loading and prior to application of flight pressure. Pressure test would be performed remotely and barriers would be used to protect people and property from pressure vessel failure if necessary. Teflon sheet bibs are used to direct any spillage of propellants away from the spacecraft.

Propellant (Hydrazine) Loading. A permitted air emissions control system is used for propellant loading. Propellant loading is accomplished by evacuating the RCS, pressurizing the propellant source tank and flowing the propellant through the fueling cart into the evacuated subsystem. This method eliminates the need for venting fumes from the  $N_2H_4$  tanks and allows the propellant to flow throughout the system wetting up to the thruster valves.

The “vacuum loading” method of fueling the spacecraft and wetting the system up to the thruster valves reduces the potential of leakage and eliminates the potential of an accident due to hydrazine adiabatic compression.

The system is secured after loading and spacecraft hydrazine system temperature and pressures are monitored using the subsystem temperature/pressure monitor in the Ground Support Equipment (GSE) to verify that heating would not take place. If pressure rises or heating is observed, the hydrazine is drained from the system and neutralized.

Propellant (Xenon) Loading. Some NMP spacecraft may use xenon propellant. NMP spacecraft utilizing ion propulsion (e.g., DS1) would be loaded with approximately 75 kilograms (170 pounds) of xenon at the PPF. Xenon is an inert gas and is not toxic; therefore, normal safety handling is all that is required for its use.

### 2.3 NMP PROPOSED LAUNCH VEHICLES

Launch vehicle selection for NMP projects is driven by spacecraft size and mass and desired orbital placement/launch energy — characteristics which differ substantially between the NMP flight series. Other considerations which must be addressed in selection of the launch system include cost, reliability, and potential environmental impacts associated with the use of the launch system. The proposed launch vehicles are similar with respect to reliability and safety. Although specific launch vehicles are not yet designated for projects except DS1 through DS4 and EO1 several are available and under consideration, including Delta II 7925, 7425 and 7326, Athena 2, Titan IIG, Taurus, Athena 1 and Pegasus. For ease of reference, potential U.S. launch vehicles and their payload capabilities are listed in Table 2-1.

Table 2-1. Launch Vehicle Payload Capability

Launch Vehicle	Payload Capability (185 km LEO)
Delta II 7925	5,089 kg
Delta II 7425	3,184 kg
Delta II 7326	2,753 kg
Athena 2	1,990 kg
Titan IIG	1,905 kg
Taurus	1,060 kg
Athena 1	520 kg
Pegasus	375 kg

Source: Data acquired from [ELV 1995] and [DELTA 1996]

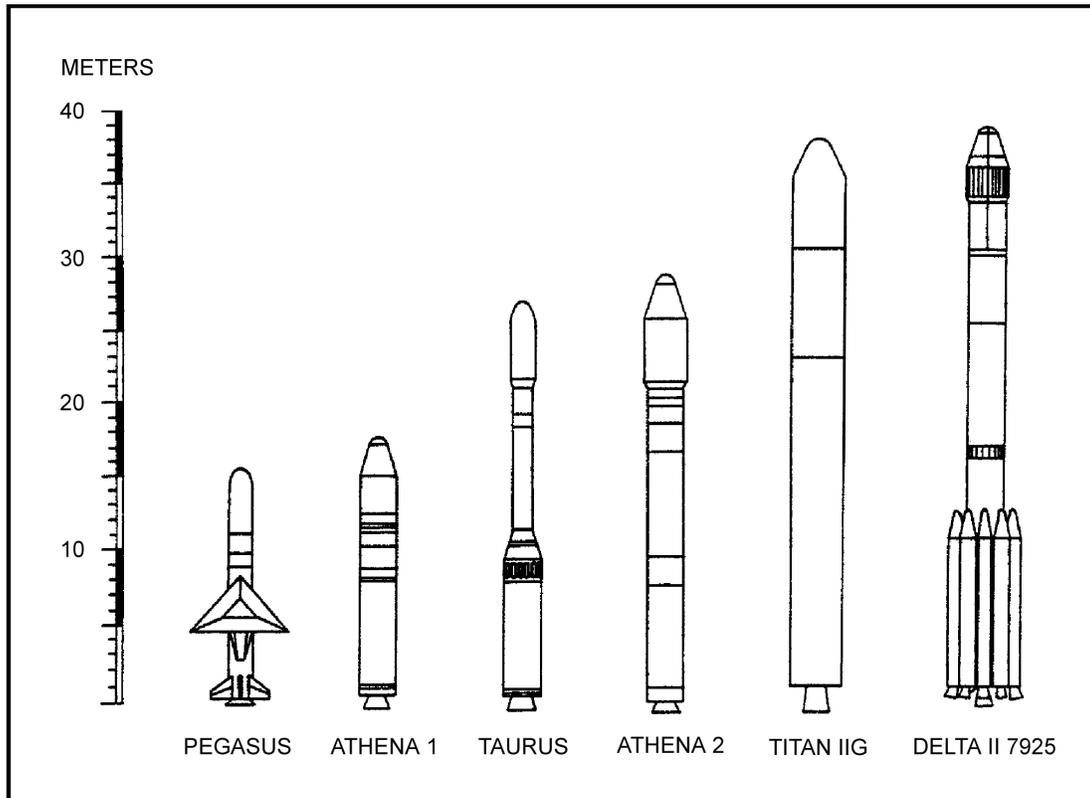
LEO = Low Earth Orbit

Launch vehicle payload capability for deep space missions would be lower for all launch vehicles.

For the purposes of this EA, the Delta II 7925 launch vehicle has been selected to represent an environmental case which is likely to bound the anticipated environmental impacts from launch activities. Anticipated environmental impacts from the launching of all other proposed U.S. launch vehicles are expected to be equal to or less than Delta II 7925 impacts. Emissions data, performance data, and propellant information is readily available for the Delta II. The Delta II 7925 would therefore serve as a “bounding case” for analysis of environmental impacts arising from operation of the launch vehicle.

Potential NMP launch vehicles (illustrated in Figure 2-9) are described briefly in the following subsections. Environmental Assessments (EAs) and Findings Of No Significant Impacts (FONSIs) have been published for all U.S. launch vehicles proposed for use by NMP at VAFB and CCAS.<sup>13</sup>

Figure 2-9. NMP Proposed Launch Vehicles



Note: Delta II launch vehicles are identical in core vehicle height, configuration and diameter. Differences lie in the number of SRMs and the type of upper stage utilized. With the exception of the quantity of SRMs attached to the base of the launch vehicle, all Delta II launch vehicles would appear identical to the one depicted here.

### 2.3.1 Delta II Description

DS4 is proposed for launch on a Delta II 7925 launch vehicle. DS1 and DS2 spacecraft are proposed for launch on Delta II 7326 and 7425 launch vehicles, respectively. These launch vehicle configurations are different from the Delta II 7925 in that they use fewer SRMs to augment first-stage performance. These new configurations have a proven heritage of reliability (the Delta II launch vehicle has a 96 percent success rate [ELV 1995]), as all their components are identical to that of the Delta II 7925. The Delta II launch vehicles can be launched from Space Launch Complex 2 (SLC-2) at VAFB, California or

<sup>13</sup> [DELTA 1991], [FONSI 1991], [ATHENA 1994], [ATHENA 1995], [FONSI 1995a], [ATHENA 1997], [FONSI 1997], [DELTA 1995], [FONSI 1995b], [PEGASUS 1989], [TAURUS 1992b], [FONSI 1993], [TITAN 1987] and [FONSI 1987]

Launch Complex 17A/B (LC-17A/B) at Cape Canaveral Air Station (CCAS), Florida.

Each member of the Delta II family is identical in core vehicle height, configuration, and diameter. The core vehicle configuration includes:

- First stage: Liquid oxygen-kerosene main engine (RS-27A) and two vernier engines
- Second stage: Aerozine-50 and nitrogen tetroxide engine

The first stage of the Delta II is powered by a liquid bipropellant main engine and two vernier engines. The propellant load consists of RP-1 fuel (thermally stable kerosene) and liquid oxygen (LOx) as an oxidizer. Thrust is augmented by nine (Delta II 7925), four (Delta II 7425) or three (Delta II 7326) Graphite Epoxy Motors (GEMs), each fueled with Hydroxyl-Terminated Polybutadiene (HTPB) solid propellant (Table 2-2). During a Delta II 7925 launch the main engine, vernier engines, and six GEMs are ignited at liftoff; the remaining three GEMs are ignited in flight. All GEMs are ignited at liftoff during Delta II 7425 and 7326 launches. The primary products of GEM combustion will be carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), hydrochloric acid (HCl), aluminum oxide (Al<sub>2</sub>O<sub>3</sub>) in soluble and insoluble forms, nitrogen oxides (NO<sub>x</sub>), and water (H<sub>2</sub>O). Major exhaust products of the Delta II first stage will be CO, CO<sub>2</sub>, and water.

Table 2-2. Delta II 7925 Propellant Quantities

Stage/Motor Type	Propellant Type	Propellant Quantity	
Stage 0 (9 GEMs)	Solid (HTPB)	105,318 kg	232,226 lbs*
Stage 1 (RS-27)	Liquid Oxygen	66,842 kg	147,360 lbs
	Kerosene (RP-1)	29,773 kg	65,639 lbs
Stage 2 (AJ10-118)	Aerozine-50	2,064 kg	4,552 lbs
	Nitrogen Tetroxide	3,922 kg	8,648 lbs
Stage 3-PAM-D (Star-48B)	Solid (HTPB)	2,010 kg	4,422 lbs

Source: Adapted from [DELTA 1993]

\* Each GEM contains 11,702 kilograms (25,802 pounds) of HTPB propellant.

The Delta II second stage propulsion system has a bipropellant engine that uses Aerozine-50 as fuel and nitrogen tetroxide as oxidizer. The second stage has a total propellant load of 5,900 kilograms (13,200 pounds).

The Delta Payload Assist Module (PAM-D) is the third stage of the Delta II 7925 and 7425 launch vehicles and provides the final boost required to insert the spacecraft into the required orbit. This upper stage consists of: 1) a spin table to support, rotate, and stabilize the spacecraft before separating from the second stage; 2) a Star 48B solid rocket motor for propulsion; 3) an active Nutation Control System to provide stability after spin-up of the spacecraft/PAM-D stack; and 4) a payload attach fitting to mount the Star 48B motor to the

spacecraft. The Star 48B is fueled with 2,010 kilograms (4,422 pounds) of solid HTPB propellant. [DELTA 1994]

The Delta II 7326 uses only three GEM Strap-on Solid Rocket Motors (SSRMs) and an upper stage (the Star 37 FM) that contains approximately half the propellant of the Delta II 7925 and 7425 upper stage.

### 2.3.2 Titan IIG Description

The Titan IIG is a refurbished Intercontinental Ballistic Missile (ICBM) with a 3 meter (10 foot) diameter payload fairing. The Titan IIG has a success rate of 93 percent [ELV 1995] and would be launched from SLC-4 at VAFB. The Titan IIG is a two-stage, all liquid propulsion vehicle. Both stages use hypergolic propellants (nitrogen tetroxide and Aerozine 50). The first stage of the Titan IIG consists of two LR-87-7 engines. Stage two is a single engine (LR-91-7) using the same propellants. The second stage uses thrust vector control for attitude control and can not be restarted. Propellant quantities for each stage are listed in Table 2-3.

Table 2-3. Titan II Propellant Quantities

Stage	Propellant Type	Quantity in Pounds
Stage One	N <sub>2</sub> O <sub>4</sub> / Aerozine-50	170,015 / 89,947
Stage Two	N <sub>2</sub> O <sub>4</sub> / Aerozine-50	37,787 / 21,519
Attitude Control System	N <sub>2</sub> H <sub>4</sub> (Hydrazine)	90

Source: Adapted from [TITAN 1987]

Planetary performance is dependent on use of an upper stage on top of the two-stage Titan II. Lockheed Martin has proposed using the Star 37 or Star 48 solid propellant motors from Thiokol as upper stages on the Titan IIG version. [TITAN 1993]

Products of combustion are CO, CO<sub>2</sub>, H<sub>2</sub>, H<sub>2</sub>O, OH, O<sub>2</sub>, N<sub>2</sub>, NO<sub>x</sub>. Of these combustion products, only carbon monoxide and nitrogen oxides are identified as air pollutants. The exhaust plume that persists in the launch pad area during and after ignition is known as the ground cloud. For the Titan II space booster, this cloud consists primarily of water vapor and CO. At combustion temperatures, CO formed during ignition is further oxidized to CO<sub>2</sub> because of the abundance of oxygen in the atmosphere. Nitrogen oxides are formed much later in the trajectory (when it reaches the stratosphere) of the space vehicle. Nitrogen oxide formation downrange distance from the launch site is estimated to be about 16 miles. [TITAN 1987]

### 2.3.3 Athena Description [ATHENA 1995]

The Athena is based on a rocket motor fueled by solid propellants, the Castor 120™ (Thiokol Corporation). The Castor 120™ is a solid rocket motor, which contains 48,719 kilograms (107,408 pounds) of solid HTPB propellant.

Through February of 1992, over 1,862 Castor motors of various types have flown, with a success rate of 99.95 percent [ATHENA 1995]. The Athena 2 has three stages, two of which are the Castor 120™. Athena 1 uses a single Castor 120™. Athena launch vehicles include an upper stage, the Orbus 21D which is also a solid rocket motor using the same type of solid fuel. Primary exhaust products of the Athena launch vehicle consist of hydrogen chloride, aluminum oxide, carbon monoxide, and oxides of nitrogen. The Athena would be launched from the California Commercial Spaceport (CCS or SLC-6), VAFB or Spaceport Florida (LC-46, CCAS).

Table 2-4. Athena 2 Propellant Quantities

Stage/Motor Type	Propellant Type	Propellant Quantity	
Stage 1/Castor 120™	Solid (HTPB)	48,719 kg	107,408 lbs
Stage 2/Castor 120™	Solid (HTPB)	48,719 kg	107,408 lbs
Stage 3/Orbus 21D	Solid (HTPB)	8,890 kg	19,600 lbs

Source: Adapted from [KR 1995] and [LV 1989]

#### 2.3.4 Taurus Description

The Taurus is a four-stage, inertially guided system, designed to service small payloads in the range of 450 to 1,400 kilograms (1,000 to 3,000 pounds). The Taurus launch vehicle has a success rate of 100 percent [ELV 1995] and would be launched from Spaceport Florida (LC-46) at CCAS or mobile launch pads VAFB. The overall length of the vehicle is 20 meters (90 feet) and has a gross liftoff weight of 71,100 kilograms (156,700 pounds). A Castor 120™ engine and two Castor IVB™ SSRMs (optional) constitute Taurus' first stage; a modified Pegasus launch vehicle provides three additional stages of boost. [ATHENA 1995]

Table 2-5. Taurus Propellant Quantities

Stage/Motor Type	Propellant Type	Propellant Quantity	
Stage 0/Castor 120™	Solid (HTPB)	48,719 kg	107,408 lbs
SSRMs/2 Castor IVB™ (optional)	Solid (HTPB)	20,016 kg	44,128 lbs
Stage 1 (Pegasus)	Solid (HTPB)	12,200 kg	26,800 lbs
Stage 2 (Pegasus)	Solid (HTPB)	3,030 kg	6,678 lbs
Stage 3 (Pegasus)	Solid (HTPB)	780 kg	1,725 lbs

Source: Adapted from [KR 1995] and [PEGASUS 1989]

The Taurus utilizes the same solid rocket propellant as that used for the Pegasus. The composition (by weight) of the solid propellant is approximately 95 percent fuel, oxidizer, and solid HTPB fuel binder. The fuel and oxidizer portion is comprised of 19 percent aluminum and 69 percent ammonium perchlorate. The remaining twelve percent of the propellant mixture includes a wetting agent, a free radical initiator, plasticizers and other compounds [SELV 1992]. Taurus exhaust products consist of hydrogen chloride, aluminum oxide, carbon monoxide, and oxides of nitrogen.

#### 2.3.4.1 Taurus XL

Further performance enhancements can be realized through the replacement of the stock-length Taurus Stages 1 and 2 with the stretched Hercules Orion 50S/XL and 50/XL motors, respectively. These motors are upgrades to existing flight-proven designs. The Stage 1 motor receives a 140.7 centimeter (55.4 inch) increase in length, allowing a 24 percent increase in propellant mass to 15,051 kilograms (33,181) pounds. Similarly, Stage 2 is increased 44.9 centimeters (17.7 inches) in length for a 30 percent increase in propellant mass to 3,914 kilograms (8,629 pounds). With the exception of minor changes to nozzle throat contours and wire harness lengths, these motors are identical to those currently used on the Taurus vehicle and were designed from the onset to allow their use in both air-launched and ground-launched boosters. [TAURUS 1992a] Combustion products from the Hercules motors would consist of hydrogen chloride, aluminum oxide, carbon monoxide, and oxides of nitrogen.

#### 2.3.4.2 Taurus XL/S

A significant increase in performance is available through the addition of two Alliant GEM strap-ons to the Castor 120 Stage Zero. These units are identical to those currently flown on the Delta II vehicle. [TAURUS 1992a]

#### 2.3.5 Pegasus Description

The standard Pegasus configuration is a Small Expendable Launch Vehicle (SELV) that requires the use of an L-1011 aircraft. As a three-stage

system that relies entirely on SRMs (Table 2-6), this vehicle is designed to orbit payloads in the 180 to 400 kilogram (400 to 900 pound) weight range [SELV 1993]. Vehicle payload capacity is 1.2 meter (46 inches) in diameter and 1.8 meter (72 inches) in length, with a volume of 1.8 cubic meters (65 cubic feet) [PEGASUS 1989]. The ELV incorporates seven major elements: three solid rocket motors, a payload fairing, a lifting wing, an avionics assembly, and an aft skirt assembly (including three movable control fins). Primary exhaust products of the Pegasus launch vehicle consist of hydrogen chloride, aluminum oxide, carbon monoxide, and oxides of nitrogen. Pegasus has a success rate of 85.7 percent [ELV 1995]. Although Pegasus has a lower rate of success than desired in placing spacecraft in the planned orbit placement, there have been no catastrophic failures during the launch phase.

Table 2-6. Pegasus Propellant Quantities

Stage	Propellant Type	Propellant Quantity	
Stage 1	Solid (HTPB)	12,200 kg	26,800 lbs
Stage 2	Solid (HTPB)	3,030 kg	6,678 lbs
Stage 3	Solid (HTPB)	780 kg	1,725 lbs

Source: Adapted from [PEGASUS 1989]

Pegasus would conduct the majority of its contracted air launch operations from a drop point of 36° North Latitude, 123° West Longitude [TAURUS 1992b]. An L-1011 aircraft would deliver Pegasus to this location, approximately 185 kilometers (115 miles) off the Monterey, California, coastline. The launch system can achieve orbital inclinations between 65° and 120° from the specified drop point.

Land-based Pegasus activities would include site preparation, payload preparation and checkout, assembly and payload mating, launch vehicle mating to the L-1011 aircraft, and subsequent aircraft ground operations; takeoff, and departure. Necessary flight hardware would be delivered to a VAFB vehicle assembly building for vehicle and payload integration. Pegasus launch system integration will include the receipt of flight hardware components and the integration of the launch vehicle and payload into a complete launch system. After processing, the Pegasus launch system will be transported over existing VAFB roads to an aircraft loading area adjacent to the VAFB runway and loaded on to an L-1011 carrier aircraft.

#### 2.3.5.1 Pegasus XL

The Pegasus XL is a small design evolution from the original Pegasus ELV and is the baseline vehicle for all commercial Pegasus launches. The XL has a winged, three-stage solid rocket booster weighing roughly 22,680 kilograms (50,000 pounds), and measures 1.27 meters (50 inches) in diameter and 16.9 meters (55.4 feet) in length, six feet longer than the standard Pegasus.

The primary modification on the XL is the incorporation of stretched Stages 1 and 2 to achieve greater payload-to-orbit performance [PEGASUS 1993].

#### 2.3.5.2 Pegasus Precision Injection Kit [PEGASUS 1991]

Both Pegasus designs can be equipped with a fourth stage, called the Precision Injection Kit (PIK), that would allow greater accuracy and higher altitude in the placement of satellites into Earth orbit. The fourth stage is designed to be added to the existing three-stage solid propellant Pegasus booster, and can be fueled with up to 73 kilograms (160 pounds) of liquid hydrazine. The PIK has a 68 kilograms (150 pounds) capacity hydrazine tank, three 23 kilograms (50 pounds) force thrusters, and a new separation system that operates between the Pegasus Avionics structure and the third stage motor. Servicing of the hydrazine propellant is accomplished in the Pegasus vehicle assembly building at VAFB.

### 2.4 ALTERNATIVE LAUNCH VEHICLES

Selecting a launch vehicle for NMP projects depends upon most closely matching the payload mass and the energy required to achieve the desired orbit to the capabilities of the prospective launch system. The more massive the payload and the more energy required to achieve the desired trajectory or orbital placement, the more powerful the launch system required. The most desirable launch system would meet, but would not greatly exceed, the mission's minimum launch performance requirements. Once launch vehicle performance requirements have been delineated, tolerable launch environments (launch vehicle induced load, vibration, shock, etc.) and payload fairing volume requirements are defined. If the launch vehicle under consideration would provide adequate performance, would not produce a launch environment potentially damaging to the anticipated spacecraft design and offers a payload fairing that does not volumetrically constrain the spacecraft then the launch vehicle could be a reasonable alternative. Finally, launch vehicles are reserved years in advance (e.g., Delta II launches are accounted for through 2002), therefore, the launch vehicle must be available during the time frame being considered to be a viable option.

Other considerations which must be addressed in selection of the launch system include cost, reliability, and potential environmental impacts associated with the use of the launch system. With the exception of the Atlas (described below), the nature of environmental impacts are essentially the same, with the level of adverse impact generally increasing as launch vehicle capability increases.

#### 2.4.1 Foreign Alternative Launch Vehicles

Foreign alternative Medium Expendable Launch Vehicles (MELVs) are the Japanese M-V and Russian Start; potential Small Expendable Launch Vehicle (SELV) alternatives include the Russian Kosmos and Japanese J-1. A brief summary is presented below.

##### Foreign Alternative MELVs

- **M-V** vehicles meet NMP requirements; however, their cost exceeds that of the Delta II 7925 while providing performance equivalent to the Delta II 7326. Furthermore, the M-V uses all solid propellant and offers no environmental advantage over the Delta launch vehicle.
- **Start** meets NMP project requirements. However, payload processing information and other launch related information (reliability, etc.) is not generally available.

##### Foreign Alternative SELVs

- **Kosmos and J-1** meet or exceed NMP requirements. Unlike the Pegasus, these systems are ground launched, producing pollutants at and near the Earth's surface.

Current U.S. Government policy prohibits the launch of U.S. Government-sponsored spacecraft on foreign launch systems. Therefore, these foreign launch systems are not considered to be reasonable alternatives.

#### 2.4.2 Alternative U.S. Launch Vehicles

##### Space Shuttle

At this time, the Space Shuttle greatly exceeds NMP mission requirements and is not anticipated as a back-up launch system. Consequently, it is not considered to be a reasonable alternative launch system; however, it may be used for NMP piggy back flights in coordination with other (non-NMP) missions.

##### Alternative MELV

- **Atlas II** meets program requirements and would produce less exhaust emissions than a Delta II 7925 vehicle which uses SRMs. The Atlas II could carry more payload to orbit, but would cost an estimated \$25-35 million more than the Delta II 7925.

##### Alternative SELVs

- **Conestoga** meets NMP requirements and offers performance flexibility by utilizing two, three, four or six SSRMs. Unlike the Pegasus, this system is ground launched, producing pollutants at and near the Earth's surface.

## Summary

Of the launch vehicles examined, launch vehicles proposed for launch of NMP spacecraft; the Delta II, Titan IIG, Athena 2, Taurus, Athena 1, and Pegasus are best suited for NMP for the following reasons:

- The proposed launch vehicles most closely match NMP performance requirements and allow for variations in payload size and weight.
- The proposed launch vehicles are similar in terms of reliability when compared to the alternative launch vehicles examined.
- With the exception of the Atlas II, alternative launch vehicles examined do not provide a clear environmental advantage with respect to environmental impacts.
- The proposed launch vehicle suite is the lower cost alternative of those systems meeting NMP performance criteria.

### 2.5 NO-ACTION ALTERNATIVE

The No-Action alternative would mean the New Millennium Program would not be undertaken and the immediate local (i.e., launch site) impacts would be precluded. However, no-action would impede space technology readiness in the 21<sup>st</sup> century. NMP's plans to accelerate the development of essential technologies and capabilities required for the new types of missions to be flown in the next century is imperative in today's environment of economic austerity. Technological advances must be made quickly in order to provide a future for affordable space and Earth science missions.

The investment in the New Millennium Program now could begin to provide tangible benefits, especially in validating solar electric propulsion, before the year 2000. The infusion of flight validated technologies into the commercial infrastructure could both strengthen and stimulate the American industrial base, as well as improve the nation's competitive edge in the global market; the nation's space and Earth science program could accrue new capabilities and develop a wealth of new and diverse data.

### 3. CHAPTER THREE

## ENVIRONMENTAL CHARACTERISTICS OF CAPE CANAVERAL AIR STATION

### GENERAL

The information provided in this section is summarized from the reference documents cited in the text. Refer to those references for more complete information and maps of environmental resources.

This discussion of the existing environment is limited to those resources, or related resources, that could be affected by the implementation of the New Millennium Program. Areas proposed for use by NMP, Launch Complex 17 (LC-17) and Launch Complex 46 (LC-46) are discussed in greater detail.

Sources of potential impacts to the environment include the use of hazardous materials, creation of exhaust plumes, emissions of air pollutants and rocket motor noises.

#### 3.1 GEOGRAPHIC LOCATION

Cape Canaveral Air Station (CCAS) is located in Brevard County on the eastern coast of Florida, near the city of Cocoa Beach and 75 kilometers (45 miles) east of Orlando. The station occupies nearly 65 square kilometers (25 square miles) of the barrier island that contains Cape Canaveral, and is adjacent to the NASA Kennedy Space Center (KSC), Merritt Island, Florida. CCAS is bounded by KSC on the north, the Atlantic Ocean on the east, the city of Cape Canaveral on the south, and the Banana River and KSC/Merritt Island National Wildlife Refuge on the west.

#### 3.2 LAND USE AND DEMOGRAPHY [DELTA 1995]

Launch operations are the primary activity at CCAS and KSC. Over 3,000 launches have been conducted at CCAS and KSC since 1950.

Only about 8 percent, or 1,327 square kilometers (510 square miles), of the total region (17,000 square kilometers; 6,534 square miles) shown in Figure 3-1 is urbanized, with the largest concentrations of people occurring in three metropolitan areas:

- Orlando (approximately 80 kilometers [50 miles] from CCAS SLCs), in Orange County, expanding into the Lake Mary and Sanford areas of Seminole County to the north, and into the Kissimmee and St. Cloud areas of Osceola County to the south,

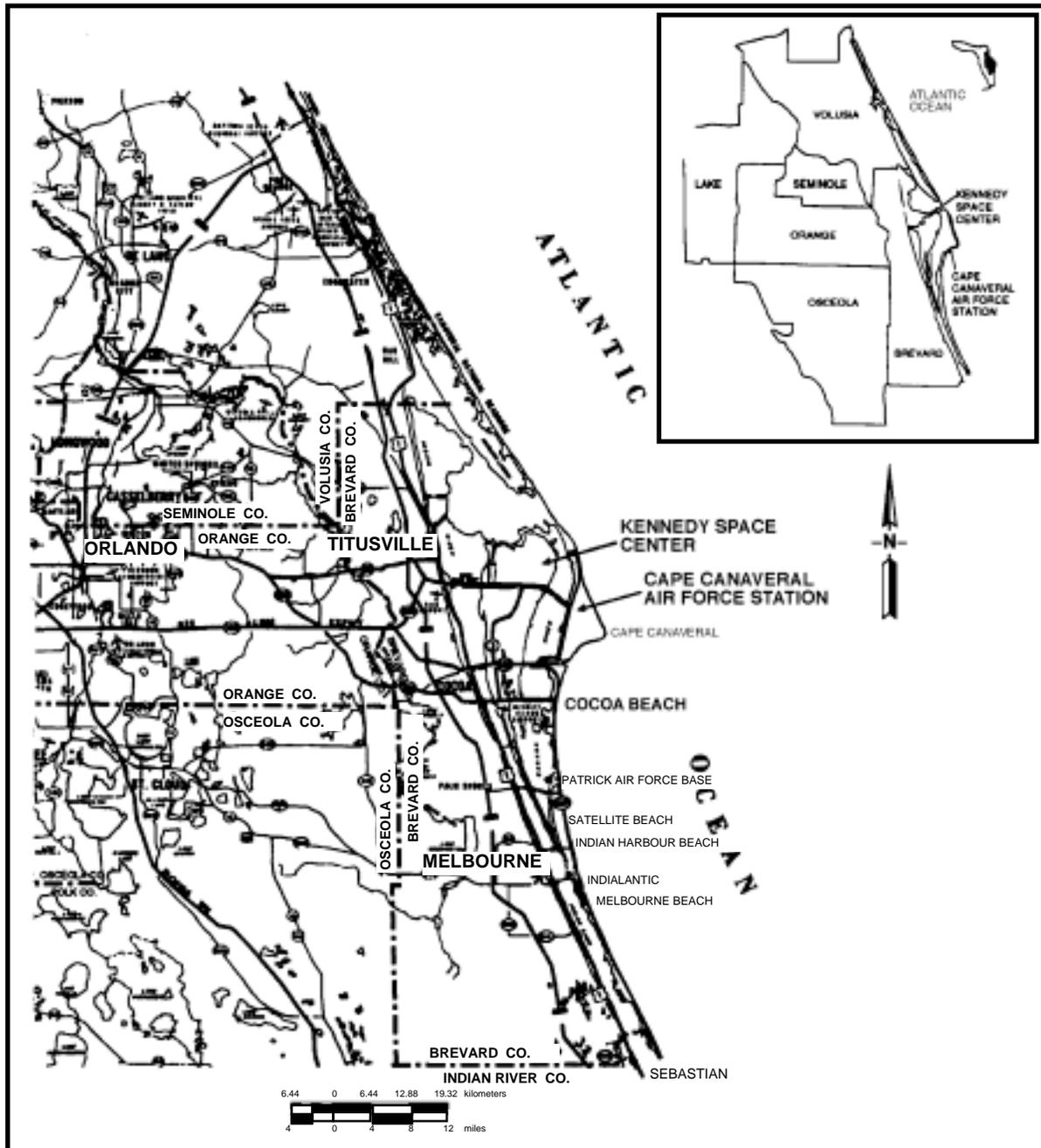
- the coastal area of Volusia County (approximately 80-100 kilometers [50-60 miles] from CCAS SLCs), including Daytona Beach, Port Orange, Ormond Beach, and New Smyrna Beach, and
- along the Indian River Lagoon and coastal areas of Brevard County (approximately 30-50 kilometers [20-30 miles] from CCAS SLCs), specifically the cities of Titusville, Melbourne, and Palm Bay.

Approximately 85 percent of the region's population live in urban areas.

The majority of the region is considered rural, which includes agricultural lands and their associated trade and service areas, conservation and recreation lands, and undeveloped areas. About 35 percent of the regional area is devoted to agriculture, including more than 5,000 farms, nurseries, and ranches. Agricultural areas include citrus groves, winter vegetable farms, pasture land and livestock, foliage nurseries, sod farms, and dairy land.

In Brevard County, approximately 68 percent of the developed land use is agricultural, 12 percent is residential, 2 percent is commercial, 1 percent is industrial, and 1 percent institutional. The remaining 16 percent is composed of various other uses. The developed land areas are clustered in three areas in a north-south pattern along the coast and the banks of the Indian and Banana Rivers.

Figure 3-1. Cape Canaveral Air Station Regional Map

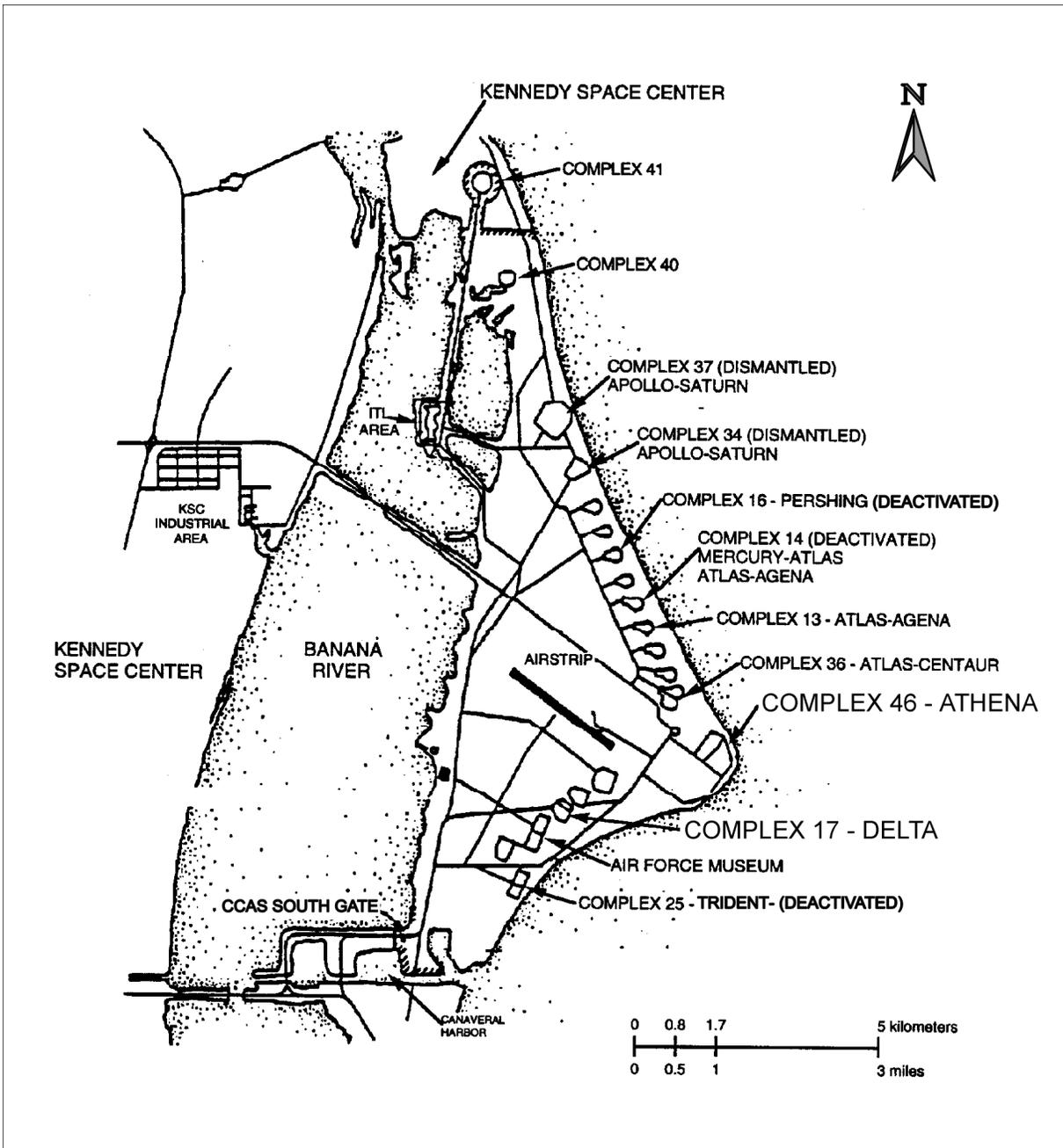


Source: [DELTA 1994]

Approximately 30 percent of CCAS (about 18.8 square kilometers; 7.3 square miles) is developed, and consists of launch complexes and support facilities (Figure 3-2). The remaining 70 percent is composed of unimproved land. CCAS also contains a small industrial area, the Air Force Space Museum, a turning basin for the docking of submarines, and an airstrip that was initially constructed for research and development in recovery operations for missile

launches. Many of the hangars located on the station are used for missile assembly and testing. Future land use patterns are expected to remain similar to current conditions. KSC occupies almost 560 square kilometers (about 216 square miles), about 5 percent of which is developed land. Nearly 40 percent of KSC consists of open water areas, such as portions of the Indian and Banana Rivers, Mosquito Lagoon, and all of Banana Creek.

Figure 3-2. Land Use at CCAS



Source: Adapted from [DELTA 1994]

LC-17 is located in the southern portion of CCAS, approximately 0.8 kilometers (0.5 miles) west of the Atlantic Ocean, 2.5 kilometers (1.5 miles) east of the Banana River, and roughly 5.7 kilometers (3.4 miles) from the station's South Gate. The complex consists of two launch pads, 17A and 17B, each with its own mobile Missile Service Tower, Fixed Umbilical Tower, cable runs, and Fuel Storage Area. LC-46 is the easternmost launch complex at CCAS located within the south central portion of CCAS approximately 3.2 kilometers (2 miles) northwest of LC-17.

### 3.3 REGIONAL ENVIRONMENTAL CHARACTERISTICS OF CCAS

#### 3.3.1 Meteorology and Air Quality [DELTA 1995]

##### 3.3.1.1 Meteorology

The climate of the region is subtropical with two distinct seasons: long, warm, humid summers and short, mild, and dry winters. Rainfall amounts vary both seasonally and yearly. Average rainfall is 128 centimeters (51 inches), with about 70 percent falling during the wet season (May to October). Temperature is less variable – prolonged cold spells and heat waves rarely occur. Tropical storms, tropical depressions, and hurricanes occasionally strike the region, generally in the period starting in August and ending in mid-November. The probability of winds reaching hurricane force in Brevard County in any given year is approximately 1 in 20. Tornadoes may occur, but are very scarce. Hail falls occasionally during thunderstorms, but hailstones are usually small and seldom cause much damage. Snow and freezing in the region are rare. Temperature inversions are infrequent, occurring approximately two percent of the time [NAVSTAR 1994].

Summer weather typically lasts about nine months of the year, starting in April. The Cape Canaveral area has the highest number of thunderstorms in the United States, and one of the highest frequencies of occurrence in the world during the summer. On average, thunderstorms occur 76 days per year at Cape Canaveral, commonly in the afternoon and usually result in lower temperatures and an ocean breeze. [NAVSTAR 1994] Occasionally cool days occur as early as November, but winter weather generally commences in January and extends through March.

The wind rose in Figure 3-3 shows the annual average frequency distribution of average wind speed and direction in the vicinity of CCAS. At CCAS, winds typically come from the north/northwest from December through February, from the southeast from March through May, and from the south from June through August. Sea breeze and land breeze phenomena occur commonly over any given 24-hour period due to unequal heating of the air over the land and ocean. Land breeze (toward the sea) occurs at night when air over land has cooled to a lower temperature than that over the sea; sea breeze (toward the

land) occurs during the day when air temperatures over the water are lower. The sea breeze and land breeze phenomena occur frequently during the summer months, less frequently during the winter.

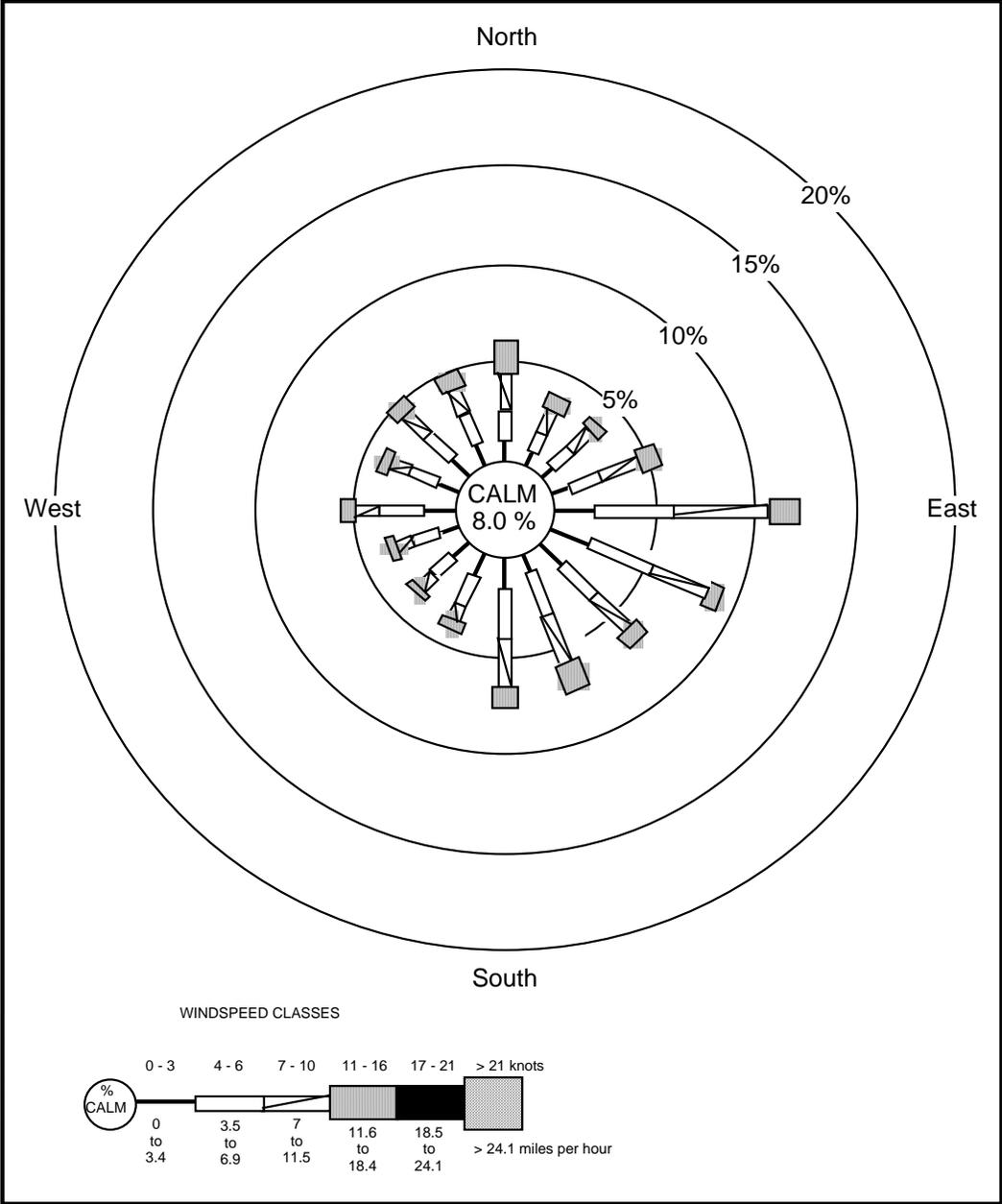
### 3.3.1.2 Air Quality [DELTA 1995]

Air quality at CCAS is good primarily due to a predominant easterly sea breeze. There are no Class I or nonattainment areas for the criteria pollutants (ozone - O<sub>3</sub>, nitrogen oxides - NO<sub>x</sub>, sulfur dioxide - SO<sub>2</sub>, lead - Pb, carbon monoxide - CO, and particulates) within about 96 kilometers (60 miles) of CCAS. Orange County was a nonattainment area for ozone until 1987, when it was redesignated as an ozone attainment maintenance area.

The station and its vicinity are considered to be “in attainment” or “unclassifiable” with respect to National Ambient Air Quality Standards (NAAQS) for criteria pollutants. The criteria pollutants and the Federal and State standards are listed in Table 3-1. NAAQS primary and secondary standards apply to continuously emitting sources, while a launch is considered to be a one-time, short-term moving source; however, the standards will be used for comparative purposes throughout this EA to provide a reference, since no other more appropriate standards exist.

The daily air quality at CCAS is chiefly influenced by a combination of vehicle traffic, maintenance activities, utilities fuel combustion, and incinerator operations. Space launches influence air quality only episodically. Two regional power plants are located within 20 kilometers (12 miles) of the station and are believed to be the primary source of occasional elevations in nitrogen dioxide and sulfur dioxide levels. Ozone has been CCAS’s most consistently elevated pollutant. However, since January 1992, the primary standard for ozone has not been exceeded.

Figure 3-3. Wind Rose Indicating Wind Speed and Direction – Lower Atmospheric Conditions: Cape Canaveral 1968 - 1978 Annual Averages



Source: [DELTA 1994]

Table 3-1. State and Federal Air Quality Standards

Pollutant	Averaging Time	State of Florida Standard	Federal Primary Standard	Federal Secondary Standard
Carbon Monoxide (CO)	8-hour *	10 mg/m <sup>3</sup> (9 ppm)	10 mg/m <sup>3</sup> (9 ppm)	none
	1-hour *	40 mg/m <sup>3</sup> (35 ppm)	40 mg/m <sup>3</sup> (35 ppm)	none
Lead (Pb)	Quarterly Arithmetic Mean	1.5 µg/m <sup>3</sup>	1.5 µg/m <sup>3</sup>	same as primary
Nitrogen Dioxide (NO <sub>2</sub> )	Annual Arithmetic Mean	100 µg/m <sup>3</sup> (0.05 ppm)	100 µg/m <sup>3</sup> (0.05 ppm)	same as primary
Ozone (O <sub>3</sub> )	8-hour	157 µg/m <sup>3</sup> (0.08 ppm)	157 µg/m <sup>3</sup> (0.08 ppm)	same as primary
	1-hour +	235 µg/m <sup>3</sup> (0.12 ppm)	235 µg/m <sup>3</sup> (0.12 ppm)	same as primary
Sulfur Dioxide (SO <sub>2</sub> )	Annual Arithmetic Mean	60 µg/m <sup>3</sup> (0.02 ppm)	80 µg/m <sup>3</sup> (0.05 ppm)	none
	24-hour *	260 µg/m <sup>3</sup> (0.1 ppm)	365 µg/m <sup>3</sup> (0.14 ppm)	none
	3-hour *	1300 µg/m <sup>3</sup> (0.5 ppm)		1300 µg/m <sup>3</sup> (0.5 ppm)
Suspended Particulates < 10 microns (PM <sub>10</sub> )	Annual Arithmetic Mean	50 µg/m <sup>3</sup>	50 µg/m <sup>3</sup>	same as primary
	24-hour *	150 µg/m <sup>3</sup>	150 µg/m <sup>3</sup>	same as primary
Suspended Particulates < 2.5 microns (PM <sub>2.5</sub> )	Annual Arithmetic Mean	15 µg/m <sup>3</sup>	15 µg/m <sup>3</sup>	same as primary
	24-hour	65 µg/m <sup>3</sup>	65 µg/m <sup>3</sup>	same as primary

Source: [DELTA 1994]

Note: mg/m<sup>3</sup> = milligrams per cubic meter  
 µg/m<sup>3</sup> = micrograms per cubic meter  
 ppm = parts per million  
 \* Not to be exceeded more than once per year

+ The ozone 1-hour standard applies only to areas that were designated nonattainment when the ozone 8-hour standard was adopted in July 1997.

### 3.3.2 Land Resources [DELTA 1995]

#### 3.3.2.1 Geology

The region is underlain by a series of limestone formations, with a total thickness of several thousand feet. The lower formations contain the Upper Floridan Aquifer, which is under artesian pressure in the vicinity of the station. At CCAS, the Upper Floridan Aquifer commences at a depth of about 80 meters (260 feet) and is about 110 meters (360 feet) thick. Beds of sandy clay, shells, and clays of the Hawthorn formation overlay the Floridan Aquifer, isolating the Floridan Aquifer from other, more shallow aquifers. The Hawthorn formation lies at a depth of about 30 meters (100 feet) at CCAS and is about 50 meters (160 feet) thick. Overlying the Hawthorn formation are upper Miocene, Pliocene, Pleistocene, and recent age deposits, which form secondary, semi-confined aquifers and a surficial aquifer, which lay at depths up to about 30 meters (100 feet).

CCAS lies on a barrier island composed of relict beach ridges formed by wind and wave action. This island, approximately 7.5 kilometers (4.5 miles) wide at the widest point, parallels the Florida shoreline and separates the Atlantic Ocean from the Indian River, Indian River Lagoon, and Banana River. The land surface elevation ranges from sea level to about 6 meters (20 feet) above sea level at its highest point. LC-17 and LC-46 are located near the southeastern shore of the station. This area is designated as above the 500-year floodplain.

### 3.3.2.2 Soils

Soils on CCAS have been mapped by the U.S. Department of Agriculture Soil Conservation Service (SCS). Soil types that have been identified by the SCS in the vicinity of proposed launch sites are Canaveral Complex, Palm Beach Sand, Urban Land, and Canaveral-Urban Land Complex. These native soils are composed of highly permeable, fine-grained sediments typical of beach and dune deposits. Based on examination of well and soil borings from CCAS, the near-surface stratigraphy is fairly uniform, consisting of Pleistocene age sand deposits that underlie the installation to depths of approximately 30 meters (100 feet).

### 3.3.3 Hydrology and Water Quality [DELTA 1995]

#### 3.3.3.1 Surface Waters

The station is located on a barrier island that separates the Banana River from the Atlantic Ocean. As is typical of barrier islands, the drainage divide is the dune line just inland from the ocean. Little runoff is naturally toward the ocean; most runoff percolates or flows westward toward the Banana River. The majority of storm drainage from CCAS is collected in manmade ditches and canals and is directed toward the Banana River.

Major inland water bodies in the CCAS area are the Indian River, Banana River, and Mosquito Lagoon. These water bodies tend to be shallow except for those areas maintained as part of the Intracoastal Waterway. The Indian and Banana Rivers are brackish water lagoons that connect adjacent to Port Canaveral by the Barge Canal, which bisects Merritt Island; they have a combined area of 600 square kilometers (232 square miles) in Brevard County and an average depth of 1.8 meters (6 feet). This area receives drainage from 2,160 square kilometers (834 square miles) of surrounding terrain.

Predominant ocean currents in the vicinity of CCAS are north of the area. From the Cape Canaveral region to 26 kilometers (16 miles) offshore, the average ocean current speed is 1.7 to 5 kilometers per hour (1 to 3 miles per hour). Beyond about 26 kilometers (16 miles), the system of currents becomes known as the Florida Current of the Gulf Stream. The central axis of the Gulf

Stream is located approximately 83 kilometers (50 miles) off the coast of Florida at Cape Canaveral.

### 3.3.3.2 Surface Water Quality

Surface water quality near CCAS and KSC is monitored at 11 long-term monitoring stations that are maintained by NASA. It is also monitored by the Air Force Bioenvironmental Engineering Services on a quarterly basis at 7 sites. Other monitoring stations in the general area are maintained by Brevard County, the U.S. Fish and Wildlife Service, and the Florida Department of Environmental Protection (FDEP). In general, the water quality of the monitored surface waters has been characterized as good. Both the northern and southern segments of the Banana River tend to be brackish to saline (15 to 36 parts per thousand) at NASA Causeway East.

The Banana River is designated a Class III surface water, as described by the Federal Clean Water Act of 1977. Class III standards are intended to maintain a level of water quality suitable for recreation and the production of fish and wildlife communities.

The Banana River is also designated an Outstanding Florida Water (OFW) by the FDEP. An OFW is provided the highest degree of protection of any Florida surface waters.

### 3.3.3.3 Ground Waters

Ground water at the station occurs under both confined (artesian) and unconfined (nonartesian) conditions. Confined ground water is located in the Floridan Aquifer, which serves as the primary ground water source in the coastal lowlands. Recharge to the Floridan Aquifer occurs primarily in northern and central Florida.

The unconfined surficial aquifer is recharged by rainfall along the coastal ridges and dunes. The unconfined aquifer formation at CCAS ranges in depth from about 15 meters (50 feet) at the coastal ridge to less than 6 meters (20 feet) in the vicinity of St. Johns River. The unconfined aquifer beneath LC-17 and LC-46 is not used as a water source.

Domestic water on CCAS is obtained from the City of Cocoa. This water is pumped from wells in east Orange County that extract water from the Floridan Aquifer. Water from the unconfined, surficial aquifer is not typically used except for residential irrigation.

### 3.3.3.4 Ground Water Quality

Although good quality water may be obtained from the Floridan Aquifer throughout much of the State, water from this formation below CCAS is highly mineralized and is not used as a domestic or commercial water source. Table 3-2 summarizes the water quality characteristics of a sample collected from the Floridan Aquifer underlying the west-central portion of the station. The sample exceeded national drinking water standards for sodium, chloride, and total dissolved solids.

Overall, water in the unconfined aquifer in the vicinity of KSC and CCAS is of good quality and meets the State of Florida Class G-II (suitable for potable water use; total dissolved solids less than 10,000 milligrams per liter) and national drinking water quality standards for all parameters, with the exception of iron, and/or total dissolved solids. There are no potable water wells located at or in the vicinity of LC-17 and LC-46.

Table 3-2. Ground Water Quality for the Floridan Aquifer at CCAS

Parameter	Average Value (mg/l)	Drinking Water Standards (mg/l)
Nitrates (as Nitrogen)	< 0.01	10 (primary standard)
Chlorides	540	250 (secondary standard)
Copper	< 0.01	1.0 (secondary standard)
Iron	0.02	0.3 (secondary standard)
Manganese	< 0.001	0.05 (secondary standard)
Sodium	1,400	160 (primary standard)
Sulfate	85	250 (secondary standard)
Total Dissolved Solids	1,425	250 (secondary standard)
pH	7.6	6.5-8.5 (secondary standard)
Zinc	< 0.01	5.0 (secondary standard)
Arsenic	< 0.01	0.05 (primary standard)
Barium	0.02	1.0 (primary standard)
Cadmium	< 0.001	0.01 (primary standard)
Chromium	0.001	0.05 (primary standard)
Lead	< 0.001	0.05 (primary standard)
Mercury	0.0005	0.002 (primary standard)
Selenium	0.006	0.01 (primary standard)

Source: Adapted from [DELTA 1995] Note: mg/l = milligrams per liter  
 Primary standard = National Interim Primary Drinking Water Regulations  
 Secondary standard = National Secondary Drinking Water Regulations

Ground water quality in five monitoring wells at LC-17 is generally good, with some detectable quantities of trace metals and organic compounds reported in one well, and detectable zinc concentrations in another. These results suggest that soil contaminants detected by earlier studies may be relatively non-mobile under the present soil conditions.

### 3.3.4 Biotic Resources [DELTA 1995]

The station is located in east-central Florida on the Cape Canaveral peninsula. Ecological resources at CCAS are influenced by the Atlantic Ocean on the east and the Banana river on the west. Vegetation communities and re-

lated wildlife habitats are representative of barrier island resources of the region. Major community types at CCAS include beach, coastal strand and dunes, coastal scrub, lagoons, brackish marsh, and freshwater swale marsh.

The restrictive nature of CCAS and KSC activities has allowed large areas of land to remain relatively undisturbed. In addition to communities found at CCAS, coastal hammocks and pine flatwoods are found on KSC to the northwest and increase the ecological diversity and richness of the area. A majority of the 65 square kilometer (25 square mile) CCAS complex consists of coastal scrub, woodland, strand, and dune vegetation. Coastal scrub and coastal woodland provide excellent cover for resident wildlife. Coastal strand occurs immediately inland of the coastal dunes and is composed of dense, woody shrubs. Coastal dune vegetation (a single layer of grass, herbs, and dwarf shrubs) exists from the high tide point to between the primary and secondary dune crest. Wetlands represent only a minor percentage (11 percent) of the total land area and include freshwater marsh, mangrove swamp, and salt swamp. Known hammocks are small, total less than 0.8 square kilometers (0.3 square miles), and are characterized by closed canopies of tree, shrub, and herb vegetation. Most of the wildlife species resident at the station can be found in each of these vegetation communities.

#### 3.3.4.1 Terrestrial Biota [DELTA 1995]

Natural upland vegetation communities found on CCAS are coastal dune, coastal strand, coastal scrub, and hammock. Wetlands found on-site include both marshes and swamps.

The coastal dune community extends from the coastal strand system to the high tide line. Dune systems develop on poorly consolidated, excessively drained sands that are exposed to constant winds and salt spray. This zone is delineated by the interior limit of sea oats (*Uniola paniculata*) growth, which has been listed as a State species of special concern. Florida Statute 370.41 prohibits the disturbance or removal of sea oats [NAVSTAR 1994].

Coastal strand vegetation surrounds LC-46 and occurs between the coastal dune and scrub communities, just east of LC-17. Coastal strand communities exist on sandy, excessively drained soils dominated by shrubs and often are nearly devoid of ground cover vegetation.

LC-17 is surrounded by coastal scrub vegetation. The coastal scrub community covers approximately 37.6 square kilometers (14.5 square miles), or about 78 percent of the undeveloped land on CCAS. This community is distributed on excessively drained, nutrient-deficient marine sands. The coastal scrub vegetation surrounding LC-17 has recently been studied by the Nature Conservancy and was re-classified as Maritime Hammock.

Coastal (hydric) hammocks found along the CCAS Banana River shoreline (in narrow bands) are characterized by closed canopies consisting primarily of cabbage palms. Inland from the hydric hammocks are maritime hammocks dominated by a live oak with red bay overstory. Hammocks are shaded from intense insolation, and therefore retain higher levels of soil moisture than the previously described habitats. No hydric hammocks occur in the immediate vicinity of LC-17 or LC-46, the nearest one being about 3 kilometers (1.8 miles) west of LC-17, adjacent to the Banana River.

Five plant communities characterize LC-46 and the surrounding area – coastal dune, coastal strand, freshwater marsh, freshwater swamp and developed areas dominated by terrestrial grasses and weeds. All of the plant communities in the general vicinity of LC-46 have been disturbed to some extent by human activities. [ATHENA 1994]

Wetlands within CCAS and surrounding station facilities are important wildlife resources. Wetland types that are found in the area include fresh water ponds and canals, brackish impoundments, tidal lagoons, bays, rivers, vegetated marshes, and mangrove swamps. The closest wetland to LC-46 is a drainage ditch approximately 212 meters (700 feet) north of the launch site [ATHENA 1994]. Aquatic and wetland habitats near LC-17 include four isolated emergent wetlands and a major east-west drainage canal. These habitats support a wide variety of aquatic plants and animals including the American alligator, a Federally threatened species. The four isolated wetlands are vegetated primarily by cattails with Carolina-plains willow, wax myrtle, and groundsel bush along the edge of the system. These systems are small and appear to have originated as borrow areas for adjacent construction sites. [NAVSTAR 1994]

CCAS beaches are nonvegetated, but provide significant wildlife resources. The tidal zone supports a large number of marine invertebrates, as well as small fish that are food for various shorebirds. CCAS and KSC beaches are also important nesting areas for several varieties of sea turtles. Sea turtles and turtle hatchlings are affected by exterior lights. To minimize impacts to sea turtles, CCAS has implemented a lighting policy for management of exterior lights at the installation. The policy requires the use of low-pressure sodium lights unless prohibited by safety or security purposes [NAVSTAR 1994].

No endangered plant species occur near LC-17 or within the pad perimeter fence of LC-46, however, the prickly pear cactus, a threatened plant species does occur near both launch complexes.

Species of plant and animal life observed or likely to occur on CCAS are listed in [ERD 1994].

#### 3.3.4.2 Aquatic Biota [DELTA 1995]

The northern Indian River lagoon ecosystem is a shallow system with limited ocean access, limited tidal flux, and generally mesohaline salinities. The aquatic environment is subject to wide fluctuations in temperature and salinity due to the shallowness of the system.

Sea grasses are present in the Indian River system, generally found in patches in shoal areas less than 1 meter (3 feet) deep and surrounded by open, sandy terrain. Benthic invertebrates found in the northern Indian and Banana Rivers include marine worms, mollusks, and crustaceans, typical of estuarine systems. Epibenthic invertebrates collected from the area included horseshoe crabs, blue crabs, and penaeid shrimp.

The area is not considered an important nursery area for commercially important shrimp species. Mosquito Lagoon, north of the complex, has been considered an important shrimp nursery area. Blue crabs were determined to spawn in the area.

Few freshwater fish species inhabit the area. Many of the area's freshwater fish species are believed to have been introduced by man. Primary reasons for the low diversity in fish species are considered to be latitude, climate, low habitat diversity, and limited ocean access.

#### 3.3.4.3 Threatened and Endangered Species [DELTA 1995]

The U.S. Fish and Wildlife Service (USFWS), the Florida Game and Fresh Water Fish Commission (FGFWFC), and the Florida Commission on Rare and Endangered Plants and Animals (FCREPA) protect a number of wildlife species listed as endangered or threatened under Federal or State of Florida law. The presence, or potential occurrence, of such species on CCAS was determined from consultations with USFWS, FGFWFC, and CCAS and KSC environmental staff, and from a literature survey. Table 3-3 lists those endangered or threatened species in Brevard County residing or seasonally occurring on CCAS and adjoining waters.

A review of the list indicates that four Federally threatened species (American alligator, Florida scrub jay, southeastern beach mice and eastern indigo snake) potentially occur in the immediate vicinity of LC-17 and LC-46 (Figure 3-4). Additionally, West Indian manatees (Federally endangered), green turtles (Federally endangered), and loggerhead turtles (Federally threatened) are known to occur in the Banana River, Mosquito Lagoon, and along Atlantic Ocean beaches.

Table 3-3. CCAS Species of Concern

SPECIES	Potential Occurrence <sup>a</sup> LC-17/46	STATUS <sup>b</sup>			
		Federal USFWS	State FGFWFC	Other <sup>c</sup> FCREPA	Cape Canaveral
<b>Threatened/Endangered Species</b>					
<b>REPTILES/AMPHIBIANS</b>					
American Alligator ( <i>Alligator mississippiensis</i> )	X/	FT (S/A)	SSC	SSC	O
Loggerhead turtle ( <i>Caretta caretta</i> )	/X	FT	T	T	O
Green turtle ( <i>Chelonia mydas</i> )	/X	FE	E	E	O
Leatherback turtle ( <i>Dermochelys coriacea</i> )	/X	FE	E	R	O
Eastern indigo snake ( <i>Drymarchon corais couperi</i> )	X/X	FT	T	SSC	O
Atlantic ridley turtle ( <i>Lepidochelys kempii</i> )	/X	FE	E		Offshore
Hawksbill sea turtle ( <i>Eretmochelys imbricata imbricata</i> )	/X	FE	E	E	Offshore
Gopher tortoise ( <i>Gopherus polyphemus</i> )	X/X	FT	SSC	T	O
<b>BIRDS</b>					
Florida scrub jay ( <i>Aphelocoma coerulescens coerulescens</i> )	X/X	FT	T	T	O
Piping plover ( <i>Charadrius melodus</i> )	/X	FE	T	SSC	O
Peregrine falcon ( <i>Falco peregrinus</i> )	/X	FE (S/A)	E	E	O
Southeastern American kestrel ( <i>Falco sparverius paulus</i> )	X/	F	T	T	O
Bald eagle ( <i>Haliaeetus leucocephalus</i> )	/X	FT	T	T	Visitor
Wood stork ( <i>Mycteria americana</i> )	/X	FE	E	E	O
Least tern ( <i>Sterna antillarum</i> )	/X		T		O
Brown pelican ( <i>Pelecanus occidentalis</i> )	/X	FE	SSC		O
<b>PLANTS</b>					
Sea Lavender ( <i>Tournefortia gnaphalodes</i> )			E		O
Curtis milkweed ( <i>Asclepias curtissii</i> )			E	E-FDA	O
Coconut palm ( <i>Coccoloba nuvifera</i> )				T-FDA	O
Mosquito fern ( <i>Azolla caroliniana</i> )				T-FDA	O
Beach creeper ( <i>Ernodea littoratis</i> )				T-FDA	O
Wild coco ( <i>Elophia alta</i> )			T	T-FDA	O
Prickly pear cactus ( <i>Opuntia compressa</i> )	X/			T-FDA	N/O
Prickly pear cactus ( <i>Opuntia stricta</i> )	X/			T-FDA	O
Beach star ( <i>Remirea maritima</i> )			E	E-FDA	O
Scaevola ( <i>Scaevola plumeria</i> )			T	T-FDA	O
Wildpine; air plant ( <i>Tillandsia simulata</i> )				T-FDA	N/O
Coastal Vervain ( <i>Glandularia maritima</i> )		F	E		O
Nodding Pinweed ( <i>Lechea cernua</i> )			E		O
Satin-leaf ( <i>Chrysopyllum oliviforme</i> )			E		O
Hand fern ( <i>Ophioglossum palmatum</i> )			E		O
<b>MAMMALS</b>					
Southeastern beach mouse ( <i>Peromyscus polionotus niveiventris</i> )	/X	FT	T		O
Manatee ( <i>Trichechus manatus</i> )		FE	E	T	O
Florida Panther ( <i>Felis concolor coryii</i> )		FE			N/O
<b>Candidate Species</b>					
<b>BIRDS</b>					
Roseate spoonbill ( <i>Ajaia ajaja</i> )	/X		SSC		O
Snowy egret ( <i>Egretta thula</i> )	/X		SSC		O
Tricolored heron ( <i>Egretta tricolor</i> )	X/X		SSC		O
Little blue heron ( <i>Florida oerules</i> )	X/X		SSC		O
American oystercatcher ( <i>Haematopus palliatus</i> )	/X		SSC		O
Osprey ( <i>Pandion haliaetus</i> )	/X		SSC		O
Reddish egret ( <i>Egretta rufescens</i> )		F	SSC	R	O

SPECIES	Potential Occurrence <sup>a</sup> LC-17/46	STATUS <sup>b</sup>			
		Federal USFWS	State FGFWFC	Other <sup>c</sup> FCREPA	Cape Canaveral
<b>PLANTS</b>					
Broad-leaved spiderlily ( <i>Hymenocallis latifolia</i> )		UR2		UR2-FNAI	O
Royal fern ( <i>Osmunda regalis</i> var. <i>spectabilis</i> )				C-FDA	N/O
Giant wildpine; giant air plant ( <i>Tillandsia utriculata</i> )				C-FDA	O
<b>MAMMALS</b>					
Florida mouse ( <i>Peromyscus floridanus</i> )	/X	F	SSC	T	O
Round-tailed muskrat ( <i>Neofiber alleni</i> )		F		SSC	N/O
<b>Other species of interest</b>					
Finback whale ( <i>Balaenoptera physalus</i> )		FE			Offshore
Humpback whale ( <i>Megaptera novaeangliae</i> )		FE			Offshore
Right whale ( <i>Eubalaena glacialis</i> )		FE			Offshore
Sperm whale ( <i>Physeter macrocephalus</i> )		FE			Offshore
Sei whale ( <i>Balaenoptera borealis</i> )		FE			Offshore

Source: Data acquired from [DELTA 1995], [NAVSTAR 1994], [ATHENA 1994] and [ERD 1994]

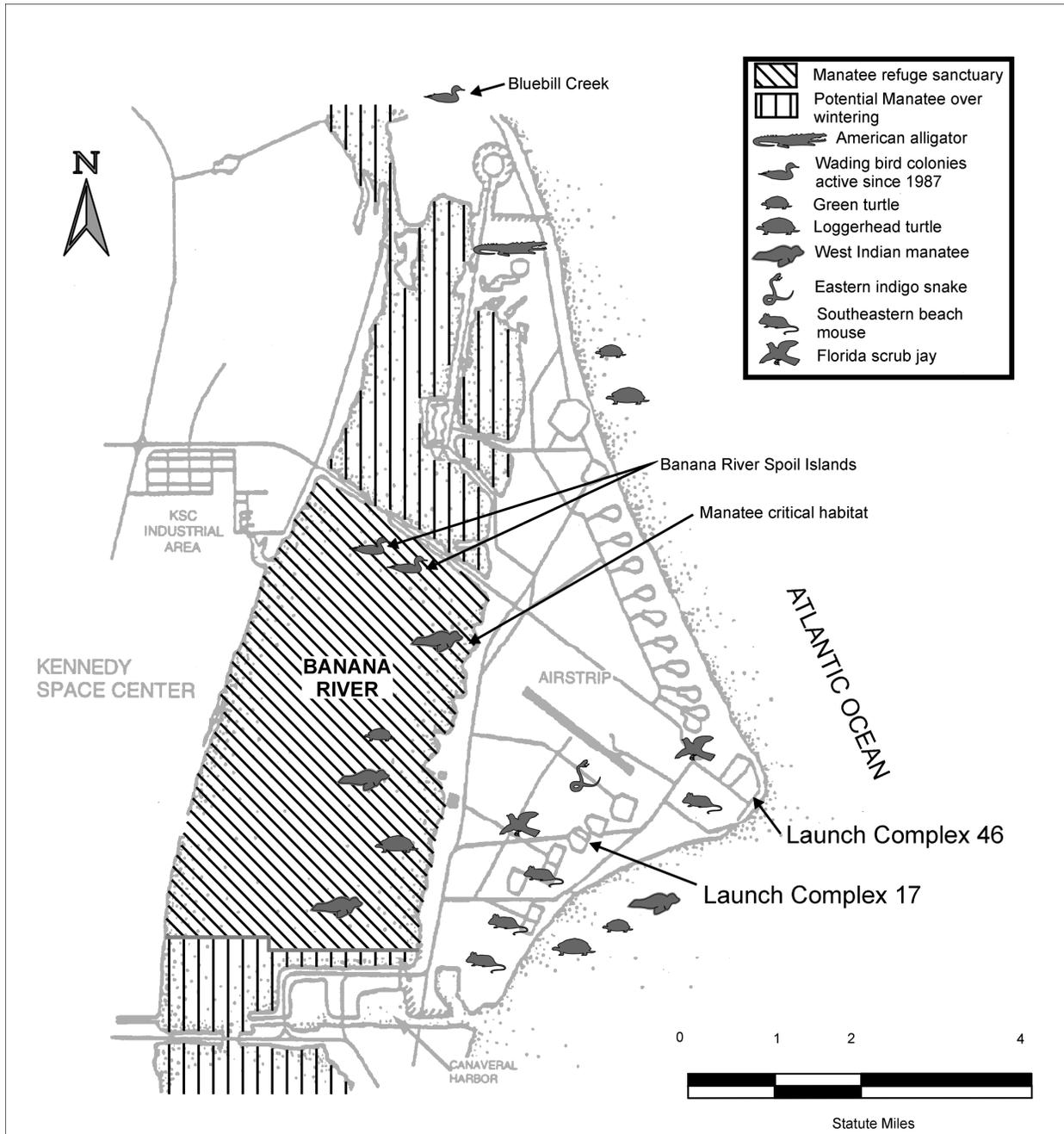
<sup>a</sup> X = potential occurrence near LC-17/LC-46

<sup>b</sup> FE = Federally listed as endangered; FT = Federally listed as threatened; S/A = similarity of appearance; UR2 = under review, but substantial evidence of biological vulnerability and or threat is lacking; F = Federal species of concern (former Category 2 Candidate species) - Such species are the pool from which future candidates for listing will be drawn [Federal register Vol. 61, No. 40, pp. 7457-7463]. E = State listed as endangered; T = State listed as threatened; R = rare; SSC = species of special concern; C = commercially exploited; O = observed; N/O = not observed

USFWS = U.S. Fish and Wildlife Service; FGFWFC = Florida Game and Fresh Water Fish Commission; FCREPA = Florida Commission on Rare and Endangered Plants and Animals; FDA = Florida Department of Agriculture and Consumer Services; FNAI = Florida Natural Areas Inventory

<sup>c</sup> listing agencies other than FCREPA are noted next to species designation

Figure 3-4. Potential Occurrence of Threatened/Endangered Species Near LC-17/LC-46



Source: Data acquired from [DELTA 1995], [NAVSTAR 1994], [LMLV1 1994] and [ERD 1994]

### 3.3.5 Economic Population and Employment Factors [DELTA 1995]

The region's economic base is tourism and manufacturing. Tourism-related employment includes most jobs in amusement parks, hotels, motels, and campgrounds, as well as many occupations in the retail trade and various types of services. Manufacturing jobs, while probably outnumbered by tourism jobs, may provide more monetary benefits to the region because of higher average wages and a larger multiplier effect.

The region's agricultural activities include citrus groves, winter vegetable farms, pastures, foliage nurseries, sod, livestock and dairy production. In the central region, 30 percent of the land is forested and supports silviculture, including harvesting of yellow pine, cypress, sweetgum, maple, and bay trees. In Osceola County, large cattle ranches occupy almost all of the rural land. Agricultural employment declined in 1986 to just 2.2 percent of the region's employment base.

Commercial fisheries in the two counties bordering the ocean (Brevard and Volusia) landed a total of approximately 9,727 metric tons (about 21.4 million pounds) of finfish, shrimp and other invertebrates in 1988. Brevard and Volusia Counties ranked third and fourth, respectively, among the East Coast counties of Florida in total 1988 finfish landings.

### 3.3.6 Noise, Sonic Boom and Vibration

The primary noise generators at CCAS prelaunch processing sites are support equipment, vehicles, and air conditioners. Occasionally, increased noise levels are experienced on a short-term basis when launches occur at one of the launch complexes. Ambient conditions in the prelaunch processing areas are typical of those for an urban commercial business or light industrial area. On the whole, day-to-day operations at CCAS would most likely approximate that of an urban industrial area, reaching levels of 60 to 80 decibels (dBA), but with a 24-hour average ambient noise level that is somewhat lower than the EPA-recommended upper level of 70 dBA.

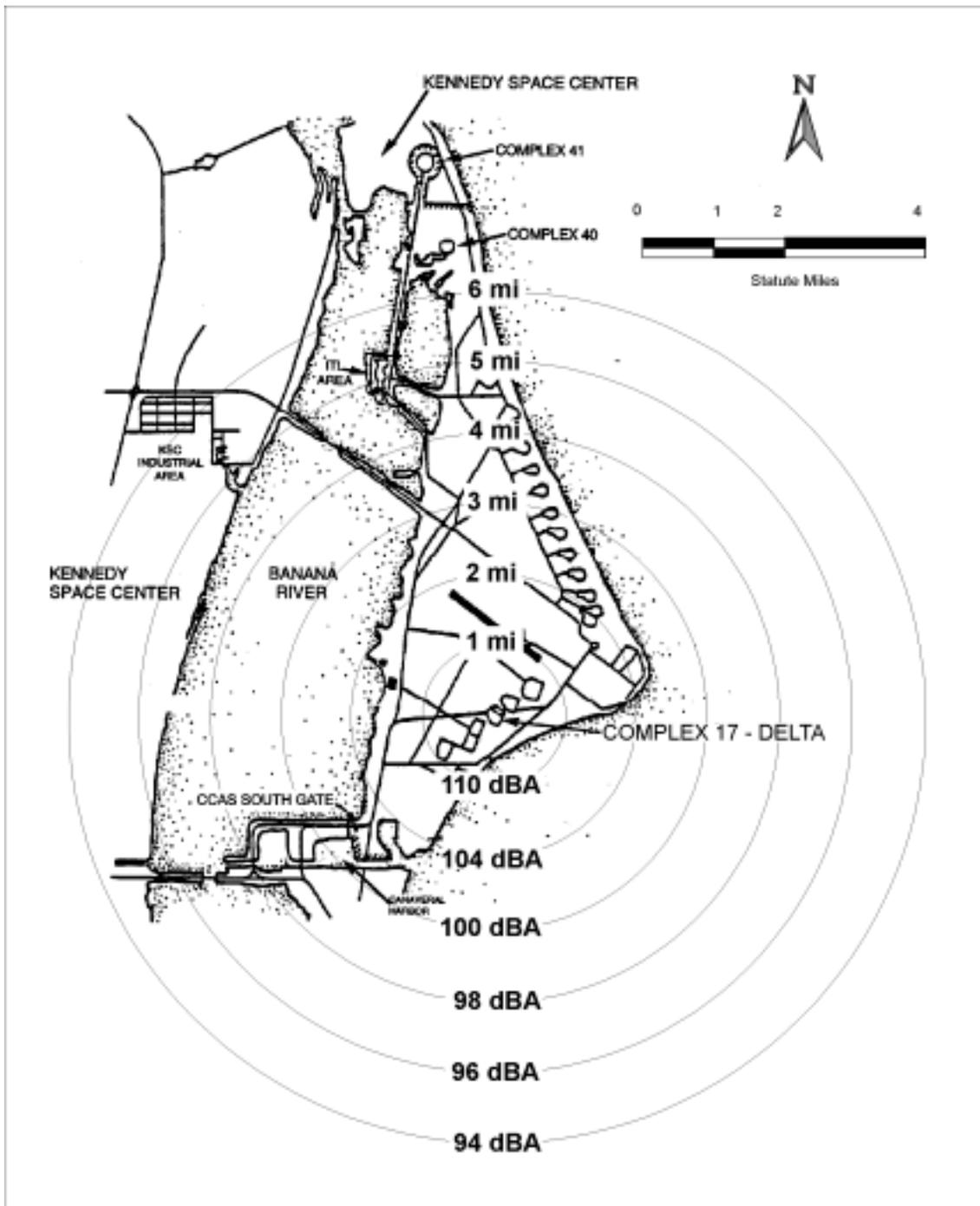
Occasionally, increased noise levels are experienced on a short-term basis when launches occur at one of the launch complexes. Noise is generated from the following sources: combustion noise emanating from the rocket chamber; jet noise generated by the interaction of the exhaust jet with the atmosphere; combustion noise resulting from the postburning of the fuel-rich combustion products in the atmosphere; and sonic booms. The major noise source in the immediate vicinity of the launch pad is the combination of these noises. The nature of the noise may be described as intense, of relatively short duration, composed predominantly of low frequencies, and occurring infrequently. This noise is usually perceived by the surrounding communities as a distant rumble. A concrete exhaust flume on each pad deflects exhaust gases

away from the pad to reduce the noise and shock wave that result from ignition of solid rockets and the first stage of the launch vehicle.

Space launches also generate sonic booms during vehicle ascent and stage reentry. Launch-generated sonic booms are directed upward and in front of the vehicle and occur over the Atlantic Ocean. Stage reentry sonic booms also occur over the open ocean and do not impact developed coastal areas.

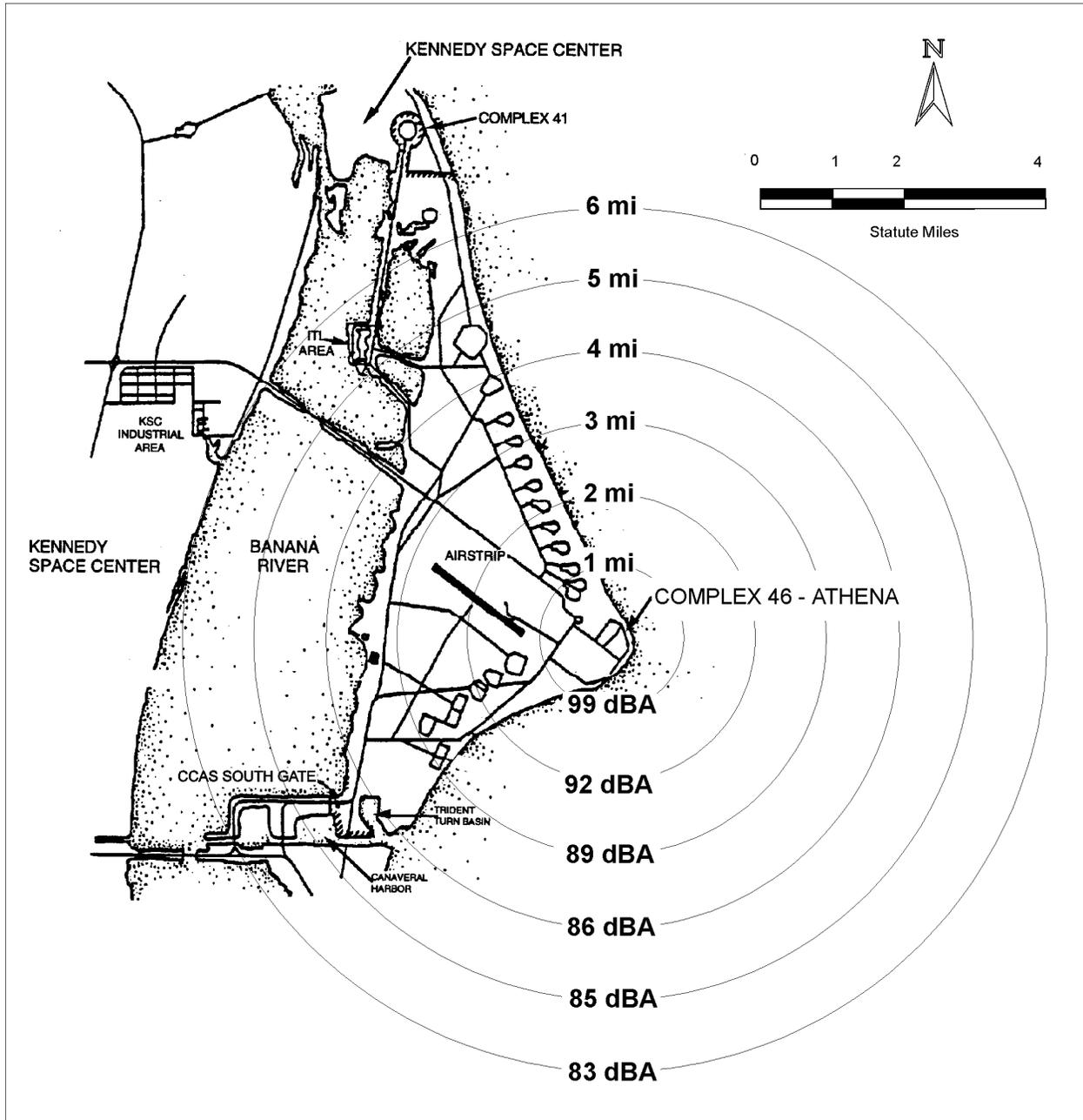
Launch noise generated by a Delta II launch from LC-17 and an Athena 1 launch from LC-46 is illustrated in Figures 3-5 and 3-6.

Figure 3-5. Noise Generated by a Delta II Launch From LC-17



Source: Adapted from [DELTA 1994] and [NAVSTAR 1994]

Figure 3-6. Noise Generated by an Athena Launch From LC-46



Source: Adapted from [DELTA 1994] and [ATHENA 1995]

### 3.3.7 Historic, Archeological, and Recreational Factors [DELTA 1995]

#### Historic Resources

CCAS is a National Historic Landmark District. A recent historical review of CCAS was conducted (45 SW Cultural Resource Management Plan). The review noted 24 historic sites. Seven of these sites are considered eligible

for listing in the National Register of Historic Places (NRHP), and seven are designated National Historic Landmarks.

Launch Complex 17 has been identified as eligible for listing in the NRHP. Launch Complex 46 is not listed as a National Historic Landmark [ATHENA 1994] nor is it eligible for listing in the NRHP.

### Archeological Resources

A recent archeological review of CCAS was conducted (45 SW Cultural Resource Management Plan). The review noted 56 archeological properties. Two of these are considered eligible and 16 are considered potentially eligible for listing in the NRHP.

### Recreation

Numerous opportunities for public recreation occur in the vicinity of CCAS/KSC. Two of these recreation areas are Merritt Island National Wildlife Refuge and the Canaveral National Seashore. Merritt Island National Wildlife Refuge is located on KSC, 6 kilometers (4 miles) east of Titusville, Florida and covers 570 square kilometers (220 square miles). Canaveral National Seashore covers 230 square kilometers (90 square miles) and is the longest stretch of undeveloped beach (39 kilometers [24 miles]) on Florida's east coast. Canaveral National Seashore and Merritt Island National Wildlife Refuge preserve and protect all cultural and natural resources within their boundaries, and provide recreational opportunities for park visitors. Canaveral Seashore and Merritt Island form a sheltered space for 5 wildlife species Federally listed as endangered or threatened, including sea turtles, West Indian manatees, southern bald eagles, wood storks, peregrine falcons, eastern indigo snakes, and Florida scrub jays. In cooperation with NASA, the U.S. Fish and Wildlife Service has managed Merritt Island National Wildlife Refuge since 1963, and the National Park Service has operated Canaveral National Seashore since 1975. The joint efforts of these agencies is protecting the Refuge and the Canaveral Seashore from development, preserving the history, the wildlife and the diverse habitats.

## **4. CHAPTER FOUR ENVIRONMENTAL CHARACTERISTICS OF VANDENBERG AIR FORCE BASE**

### GENERAL

The information provided in this section is summarized from the reference documents cited in the text. Refer to those references for more complete information and maps of environmental resources.

This discussion of the existing environment is limited to those resources, or related resources, that could be affected by the implementation of the New Millennium Program. Areas near Space Launch Complexes (SLCs) proposed for use by NMP – SLC-2, SLC-6 (Spaceport) and SLC-4 – are discussed in greater detail.

Sources of potential impacts to the environment include the use of hazardous materials, creation of exhaust plumes, emissions of air pollutants, rocket motor noises, and sonic booms.

#### 4.1 GEOGRAPHIC LOCATION

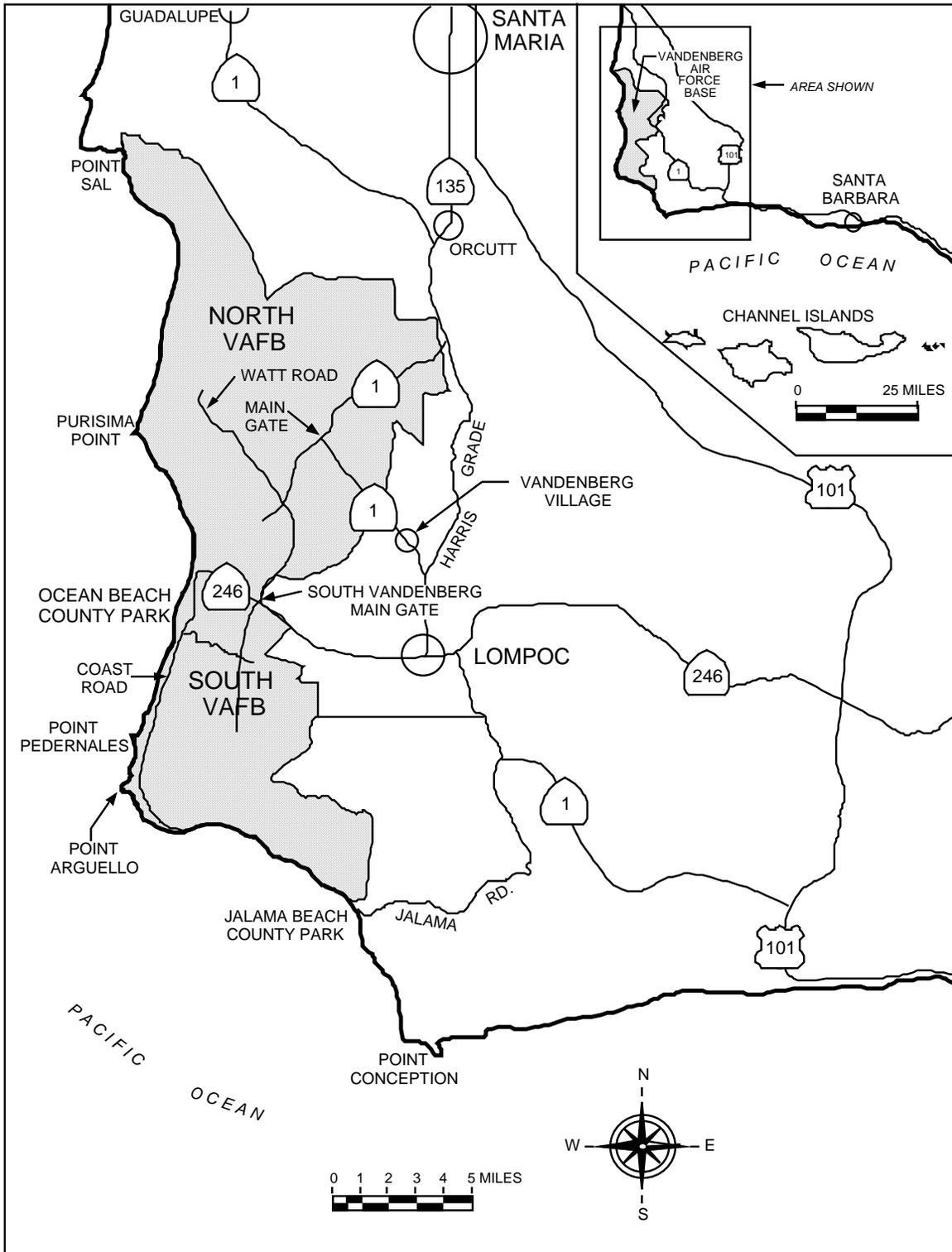
Vandenberg Air Force Base is located in Santa Barbara County, on the coast of South Central California (see Figure 4-1). It occupies approximately 400 square kilometers (150 square miles) of land and is bounded on the west by 56 kilometers (35 miles) of Pacific Ocean coastline. The nearest cities are Santa Maria, 10 kilometers (6.2 miles) to the northeast and Lompoc immediately to the east. The base is administratively divided into North Vandenberg and South Vandenberg. North Vandenberg contains SLC-2 and South Vandenberg houses SLC-4 and SLC-6, which is part of the California Commercial Spaceport.

#### 4.2 LAND USE AND DEMOGRAPHY [ATHENA 1995]

Launch operations are the primary activity at VAFB, which is the headquarters of the 30<sup>th</sup> Space Wing, Air Force Space Command. Over 1,700 launches have been conducted since 1958. Among these, space boosters of all sizes have inserted more than 500 unmanned satellites into polar and high-inclination orbits.

Vandenberg AFB occupies roughly six percent of the total land area of Santa Barbara County. Sixty percent of the base is reserved for open space and recreation. An additional 30 percent is used for grazing and other forms of agriculture. The remaining 10 percent of the land is occupied by facilities and operations associated with U.S. Air Force activities. South Vandenberg is almost entirely devoted to open space and grazing uses; only one percent is occupied by Air Force-related activities. [ATHENA 1995]

Figure 4-1. Vandenberg Air Force Base Regional Map



Source: Adapted from [ATHENA 1995]

## 4.3 REGIONAL ENVIRONMENTAL CHARACTERISTICS OF VAFB

### 4.3.1 Meteorology and Air Quality [ATHENA 1995]

#### 4.3.1.1 Meteorology

The climate in the vicinity of VAFB is Mediterranean, which is characterized by warm, dry weather from May to November and cool, wet weather from December to April. The Pacific Ocean exerts a moderating influence on local weather patterns.

At the VAFB airfield, the average annual temperature and the mean annual relative humidity are 12.8° C (55° F) and 77 percent, respectively. The average precipitation is 32.3 centimeters (12.7 inches) per year, ranging from 6.6 centimeters (2.6 inches) in February to less than 0.3 centimeters (0.1 inches) in July. More than 90 percent of annual precipitation falls between November and April. Coastal fog and low clouds are common in the morning hours, especially during the summer months, when inversion conditions intensify.

Meteorological monitoring is conducted at two sites on VAFB. The first of these is on Watt Road, near the VAFB Airfield and SLC-2. The second air monitoring station is located adjacent to the SLC-6 power plant, about 1.6 kilometers (1.0 miles) north of the Spaceport. The airfield (near SLC-2) is on a flat plateau on North Vandenberg, where the wind blows predominantly from the north-northwest (NNW). The average monthly wind speed ranges from a low of approximately 5 knots (5.8 miles per hour) in August to a high of 7.8 knots (9 miles per hour) in March (see Figure 4-2). The Spaceport, located on South Vandenberg, is nearer to the ocean and on a terrace adjacent to a ridge, where the predominant wind flow is from the north. The monthly average wind speed measured at SLC-6 ranges from a low of 7.5 knots (8.6 miles per hour) in January to 10.5 knots (12 miles per hour) in July. Unlike the data from the airfield, the SLC-6 measured wind speed is higher in the summer than in the winter. Since predominate wind flow at SLC-4 is expected to be similar to that of SLC-3 due to its proximity to SLC-3, SLC-3 data was used to create the SLC-4 wind rose. Predominate wind flow at SLC-4 is from the northwest at 5 to 8 knots (5.8 to 9 miles per hour).

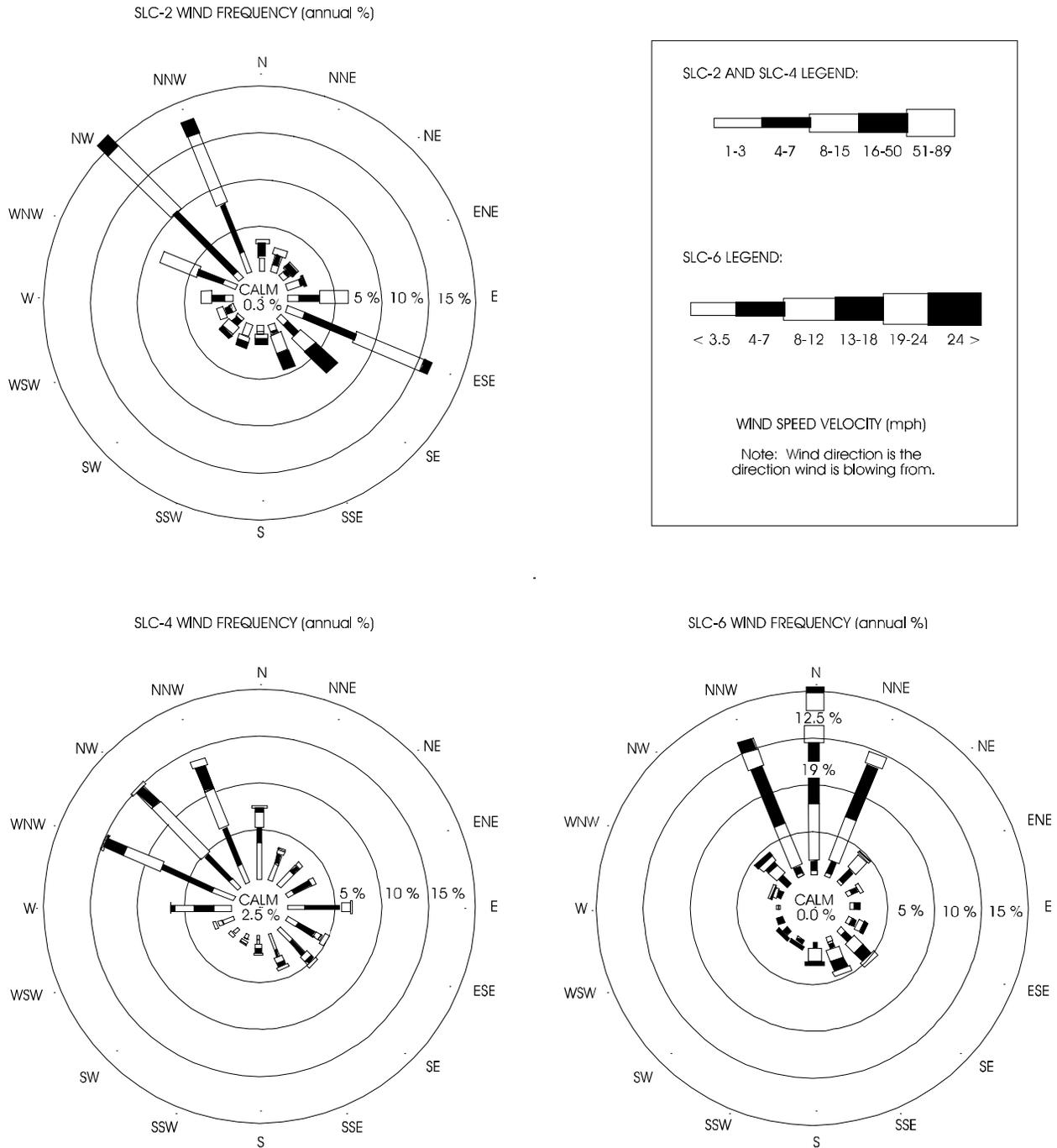
The mixing height of the atmosphere represents the upper limit of the atmospheric region where pollutants and emissions generally remain. Higher mixing heights (inversion layers) will facilitate dispersion of any trapped air pollutants. The mixing height is controlled by the location in the atmosphere of the first layer of air that is warmer than the air below. At VAFB, the average maximum height ranges from approximately 900 meters (2,950 feet) above sea level in July to 1,350 meters (4,430 feet) above sea level in November. Most frequently, the atmosphere at Vandenberg is nearly neutral in stability (Pasquill Stability Class D). [ATHENA 1995]

#### 4.3.1.2 Air Quality [ATHENA 1995]

Vandenberg Air Force Base and Santa Barbara County are located within the South Central Coast Air Basin. With respect to air quality, Santa Barbara County is divided into North County and South County. South County includes the region south of the crest of the Santa Ynez Mountains and east of Jalama Beach. VAFB is situated entirely in North County.

Monitoring of ambient air pollution concentration is conducted by the California Air Resources Board (CARB), the Santa Barbara County Air Pollution Control District (SBCAPCD), and industry. Monitoring operated by CARB and SBCAPCD are part of the State and Local Air Monitoring Systems (SLAMS). The SLAMS monitors are located to provide local and regional air quality information. Monitors operated by industry are called Prevention of Significant Deterioration (PSD) stations. PSD stations are required to ensure that new and modified sources do not interfere with the County's ability to attain and maintain air quality standards.

Figure 4-2. Wind Rose Indicating Wind Speed and Direction: SLC-2, SLC-4 and SLC-6 Annual Averages



Source: Data acquired from [ATLAS 1991], [PPF 1993] and [SELV 1992]

Five criteria pollutants, as defined by the Clean Air Act (CAA), are monitored by VAFB: ozone (O<sub>3</sub>), carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), and particulate matter under 10 microns in diameter (PM<sub>10</sub>).

In addition, the Air Force monitors for total hydrocarbons and meteorological data. Table 4-1 presents a summary of recent air quality measurements, as well as air quality standards defined by the CAA, the State of California, and Santa Barbara County. Many sections of Santa Barbara County are not in attainment of the National Ambient Air Quality (NAAQ) standards. Both the primary national and California health standards for ozone have been exceeded in recent years (1994). For all monitoring stations, Santa Barbara County experiences between 30 and 45 days per year on which the State ozone standard is violated and two to eight days per year on which the national standard is violated. Santa Barbara County is classified as a “serious” ozone nonattainment area.

Table 4-1. State and Federal Air Quality Data and Applicable Standards

Pollutant	Highest Measured Concentration		CA Ambient Air Quality Standard BNA 321:0101, Article 15	Nat'l. Ambient Air Quality Standard 40 CFR 50.6	Santa Barbara County Air Pollution Control District
	SLC 2: Watt Road VAFB Mar - Sep '93	SLCs 4/6: South VAFB Power Plant Oct '92-Nov '93			
Ozone(O <sub>3</sub> )					
1-hour average (ppm) <sup>(a)</sup>	0.085	0.087 <sup>(b)</sup>	0.09	0.12	Ozone precursor (Nox, VOC) de minimis threshold =50 tons/yr <sup>(c)</sup>
8-hour average (ppm)			0.08	0.08	
Carbon Monoxide (CO)					“cannot be classified or better than national standards”
1-hour average (ppm)	1.2	1.0	20.0	35.0	
8-hour average (ppm)	1.0	0.8	9.0	9.0	
Nitrogen Dioxide (NO <sub>2</sub> )					“cannot be classified or better than national standards”
1-hour average (ppm)	0.015	0.046	0.25	No Std	
Annual arithmetic mean (ppm)				0.053	
Sulfur Dioxide (SO <sub>2</sub> )					“cannot be classified”
1-hour average (ppm)	0.005	0.008	0.25	No Std	
3-hour average (ppm)	0.003	0.007	No Std	0.5 <sup>(d)</sup>	
24-hour average (ppm)	0.001	0.004	0.05	0.14	
Annual arithmetic mean (ppm)				0.03	
Suspended Particulates < 10 microns (PM <sub>10</sub> )					“cannot be classified”
24-hour average (µg/m <sup>3</sup> )	42.0	48.9	50.0	150.0	
Annual geometric mean (µg/m <sup>3</sup> )	NA	NA	30.0	No Std	
Annual arithmetic mean (µg/m <sup>3</sup> )	NA	NA	No Std	50.0	
Suspended Particulates < 2.5 microns (PM <sub>2.5</sub> )					“cannot be classified”
24-hour average (µg/m <sup>3</sup> )	NA	NA	65	65	
Annual geometric mean (µg/m <sup>3</sup> )	NA	NA	No Std	No Std	
Annual arithmetic mean (µg/m <sup>3</sup> )	NA	NA	15	15	

(a) The ozone 1-hour standard applies only to areas that were designated nonattainment when the ozone 8-hour standard was adopted in July 1997.  
(b) Levels violated the Federal Ozone Standard in July, 1992  
(c) Santa Barbara County is classified as “serious” nonattainment for O<sub>3</sub>. The proposed action must also be <10% of the regional baseline inventory for the priority pollutants.  
(d) National Secondary Standard

Source: Adapted from [ATHENA 1995]

The Air Force and the SBCAPCD have agreed to cooperate in the air quality program managed by Santa Barbara County. Under this agreement, changes in activities at VAFB are coordinated with and permitted through the SBCAPCD. Any new emissions on VAFB from regulated sources would have to be considered within the context of the agreement.

#### 4.3.2 Land Resources

##### 4.3.2.1 Geology [ATHENA 1995]

The recent geologic history of the Vandenberg region is characterized by alternating periods of deposition and uplift. The bedrock underlying the Cypress Ridge area consists of the Upper Monterey Formation, a diatomaceous shale. The hills to the northeast of SLC-6 are comprised of middle Miocene Tranquillon volcanics. Marine terrace deposits consisting of beds and lenses of sand, silt, and gravel underlie nearly all of VAFB.

All of the south central coast of California is considered to be a seismically active region. In Santa Barbara County, major earthquakes have been recorded as early as 1769. In 1927, an earthquake with a Richter magnitude of 7.3 occurred approximately 32 kilometers (20 miles) west of Point Arguello. Of the 90 additional earthquakes that have occurred within a 32 kilometer (20 mile) radius of VAFB since 1990, their Richter magnitudes have been 7.1 or less. The Santa Ynez fault, about 64 kilometers (40 miles) to the east of the Cypress Ridge area, is the nearest seismically active, onshore, geologic feature.

##### 4.3.2.2 Soils

The characteristics and development of soils are related to the underlying bedrock, topographic conditions, organisms, and time. The soils immediately to the southeast of SLC-6 were sampled in 1986 in anticipation of the Space Shuttle Program. Fifty soil samples were obtained and analyzed in March 1986, and ten of those sample points were resampled in September of the same year. The acidity of these soils, measured from a 1:1 soil/water mixture, typically ranged from 5.0 to 6.0 pH units (mean pH = 5.5). The cation exchange capacities ranged from about 5.0 to 35.0 milliequivalents/100 g (mean = 9.6). The mean percent organic matter and percent base saturation were 8.6 (standard deviation = 4.94) and 74.2 (standard deviation = 16.03), respectively. [ATHENA 1995] These values are expected to be similar and representative of the soils near other SLCs proposed for use by NMP.

Soils containing little or no calcium or magnesium carbonates have low buffering capacity. Acidic deposition poses a threat to ecosystems for which, because of local or regional geology (crystalline/metamorphic rock), soils and surface waters cannot neutralize acidified rain, snow, or dry-deposited materials. Vandenberg AFB soils have a high buffering capacity.

### 4.3.3 Hydrology and Water Quality

#### 4.3.3.1 Surface Waters

Surface water resources near VAFB are characterized by three major stream drainage areas or watersheds<sup>14</sup>. Shuman Creek drains the northern portion of VAFB. The southern boundary of VAFB is located near Jalama Creek and the Jalama Creek drainage system. The Santa Ynez River bisects North and South VAFB and comprises the core of the Santa Ynez drainage system. In addition, one minor drainage area, the San Antonio drainage system, is present on North VAFB and is drained by San Antonio Creek. [DELTA 1991]

Prominent drainages to the north of SLC-6 include Cañada Honda Creek, Spring Canyon, Bear Creek, and the Santa Ynez River. The Santa Ynez River is the only major drainage on South Vandenberg. Drainages nearest SLC-4 are the Santa Ynez River and Bear Creek. SLC-2 is the furthest removed from local drainages. San Antonio Creek and the Santa Ynez River are about 4.8 and 6.4 kilometers (3 and 4 miles) from SLC-2, respectively.

South VAFB has no permanent lakes, impoundments, rivers, or flood plains; however, several local drainages discharge directly into the Pacific Ocean. The flow rates associated with these drainages can be highly variable. Many of them flow only during storm events. Intense episodes would be expected to give high intermittent yields due to the relatively steep topography of the area. Some of the drainages are spring-fed, although ground percolation frequently traps the water flow before it reaches the ocean. [ATHENA 1995]

#### 4.3.3.2 Surface Water Quality

In general, the streams near SLC-6 are high in hardness, alkalinity, and specific conductance, but low in chemical oxidation demand, and total organic carbon. These streams also have high levels of certain elements such as calcium, iron, magnesium, and sodium. [ATHENA 1995]

Surface flows have been sampled near SLC-2 and other space launch complexes on both North and South Vandenberg. Dissolved oxygen and pH values of not less than 5.0 mg/l and 6.5 - 8.5 pH units, respectively, are within the EPA's criteria limits for aquatic life. High levels of total dissolved solids, chloride, lead, and zinc in the surface water have resulted in the water generally being recognized as of poor to medium quality. [DELTA 1991]

#### 4.3.3.3 Ground Waters

The Monterey shale underlying the region supports a minimal amount of ground water in fracture zones. The lower member of this formation contains

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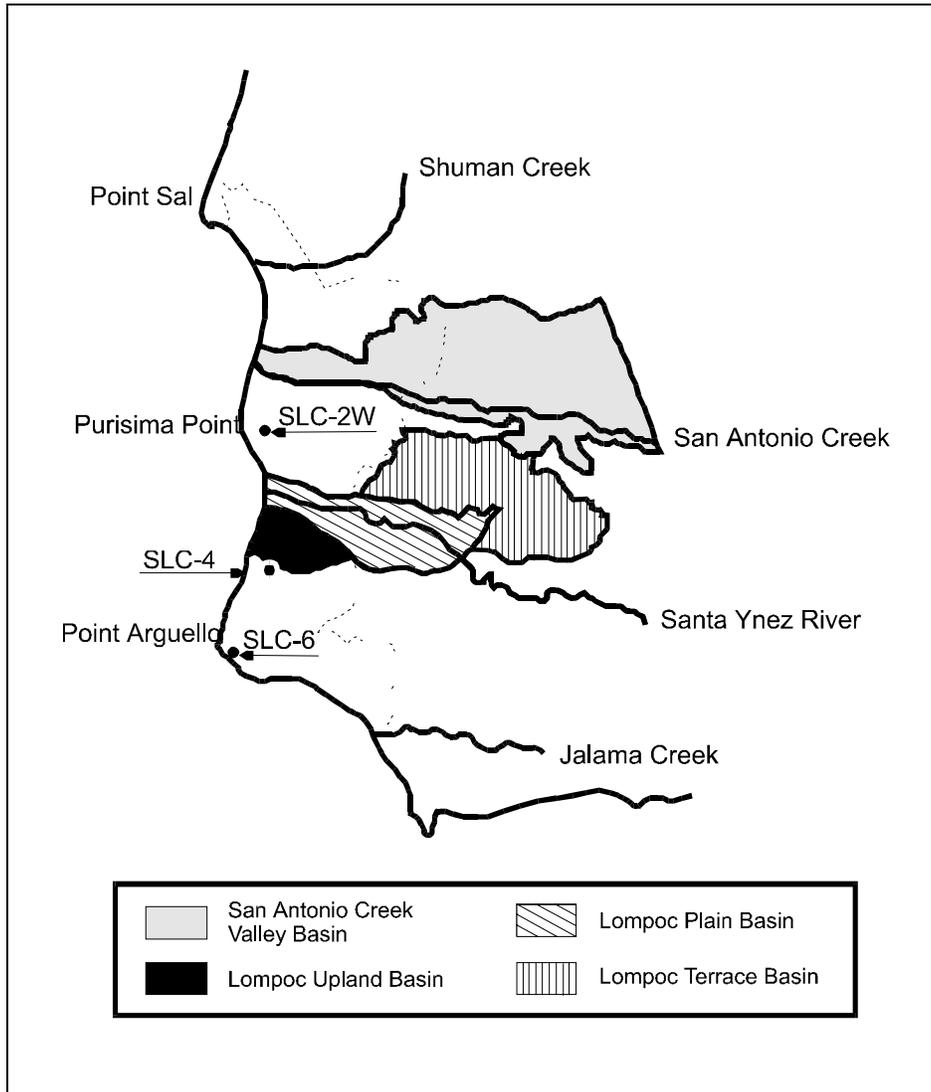
<sup>14</sup> A watershed or drainage area is defined as the region surrounding a body of water from which precipitation discharges to join that body.

greater amounts of water than the upper member. The depths to the water table vary from 42 meters (138 feet) to 40 meters (131 feet). [ATHENA 1995]

Ground water in the vicinity of VAFB is present in four ground water basins (Figure 4-3): the Lompoc Upland Basin, the Lompoc Plain Basin, the Lompoc Terrace Basin, and the San Antonio Creek Valley Basin. A ground water basin is a hydrogeologic unit containing one large aquifer or several connected and interrelated aquifers. In general, in a valley between mountain ranges, the ground water basin may occupy only the central portion of the stream drainage area. The three Lompoc basins are concentrated along the Santa Ynez River, while the San Antonio Creek Valley Basin is present along a part of the San Antonio Creek. Ground water is the sole potable water source on VAFB; ten wells are used to draw water from the first three basins for domestic and operational use. Ground water pumped by VAFB is also consumed at the adjacent U.S. Penitentiary and Federal Correctional Institute. Increased withdrawals from the area's ground water basins has created an overdraft condition that is affecting the availability and quality of water in these basins. Continued overdraft of the ground water basins could lead to a decrease in the water table levels, a compaction of the basins, and subsidence of the surface land; NMP is not expected to exacerbate the situation.

The city of Lompoc and the surrounding incorporated communities receive their water from wells drilled in the Lompoc Plain and Lompoc Upland ground water basins. North VAFB receives about 30 percent of its water from the Lompoc Plain ground water basin, and South VAFB derives all of its water from the Lompoc Terrace ground water basin. North VAFB takes approximately 70 percent, or 2,850 acre-feet per year, of its water supply from the San Antonio Creek Valley Basin, which is overdrafted by 12,000 acre-feet per year. Total VAFB ground water usage is approximately 4,300 acre-feet per year.

Figure 4-3. Ground Water and Surface Water in the Vicinity of VAFB



Source: Adapted from [DELTA 1991]

#### 4.3.3.4 Ground Water Quality

Samples taken at four of the wells near SLC-6 indicate that the quality of the ground water is low. Three parameters, dissolved solids, hardness, and chloride were measured at high levels. These averaged 1,150 mg/l, 617 mg/l, and 343 mg/l, respectively. These compare with the respective State of California and EPA standards, which are as follows: 500 mg/l, 400 mg/l, and 250 mg/l. [ATHENA 1995]

Ground water quality in the region meets all national Interim Primary Drinking Water Regulation standards. A slight decrease in water quality has occurred in the region due to the use of water for irrigation. As irrigation water

flows through the soil and back to the basin, it entrains salt which increases the salinity of the ground water. [DELTA 1991]

#### 4.3.4 Biotic Resources

Vandenberg Air Force Base is recognized as a biologically important area, occupying a transitional zone between the cool, moist conditions of northern California and the semi-desert conditions of southern California. Consequently, many plant species, as well as plant communities, reach their northern or southern limits in this area. Plant communities of particular interest include tanbark oak forest, bishop pine forest, Burton Mesa Chaparral, coastal dune scrub, and a variety of wetland types. [ATHENA 1995]

The portion of Vandenberg's coastline that lies within the NMP region of influence is occupied by several species of seabirds, marine mammals, and other species of interest (i.e., threatened and endangered species) (Table 4-2). Harbor seals, protected under the Marine Mammal Protection Act, use the beaches south of Rocky Point as haulout<sup>15</sup> and pupping (breeding activities) areas. Southern sea otters also feed in the offshore kelp beds and occasionally come onshore. Peregrine falcons nest on the rocky cliffs. Western gulls, brown pelicans, pigeon guillemots, pelagic<sup>16</sup> cormorants, rhinoceros auklets, black oystercatchers, and Brandt's cormorants use the rocky outcrops for roosting or nesting purposes. Three miles of Vandenberg's coastline are protected under agreement with the State of California as a marine ecological reserve. This area extends from Lookout Rock to Point Pedernales. [ATHENA 1995] Vandenberg AFB has a memorandum of agreement with the California Department of Fish and Game for access to these areas for military operations and scientific research only [REa 1995].

##### 4.3.4.1 Terrestrial Biota

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. The larger, contiguous, relatively undisturbed tracts of native vegetation on South VAFB provide 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 redtailed hawks, American kestrels, white-tailed kites, and numerous common land birds. Shore birds are abundant on all sandy beaches. California brown pelicans and the California least tern occur at several locations along the coast. Brown pelicans do not breed on VAFB, but are transient visitors to the coast

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<sup>15</sup> A haulout is an area where marine mammals haul themselves from oceans to congregate, breed, etc.

<sup>16</sup> marine

[SLC2W 1993]. The western snowy plover is considered a year-round resident of VAFB.

Due to the predominance of southerly and westerly exposures, the region's vegetation is primarily central coastal scrub or coastal sage scrub, grassland, and chaparral community types. The riparian vegetation of drainages in the area provide important habitat for wildlife. Plant communities of particular interest include tanbark oak forest, bishop pine forest, Burton Mesa chaparral, coastal dune scrub, and a variety of wetland types. [ATHENA 1995]

Approximately 30 vegetative assemblages, representing more than 15 distinct plant communities, have been identified within VAFB boundaries. Plant communities include coastal saltmarsh, coastal sage scrub, central dune scrub, riparian woodland, a variety of chaparral types, and diverse upland woodland communities. This diversity results from variation in topography, elevation, geology, and proximity to the coast. Approximately 85 percent of VAFB supports a "natural" vegetation; the remaining 15 percent supports a ruderal, or disturbed, vegetation or is developed for human use. [ATLAS 1991]

Table 4-2. VAFB Species of Concern

SPECIES	Potential Occurrence <sup>a</sup>			STATUS <sup>b</sup>		
	SLC-6	SLC-4	SLC-2	Federal	State	Other
<b>Threatened/Endangered Species</b>						
<b>FISH</b>						
Unarmored threespine stickleback ( <i>Gasterosteus aculeatus williamsoni</i> )	X			FE	E	
Tidewater goby ( <i>Eucyclogobius newberryi</i> )	X			FE		
<b>REPTILES/AMPHIBIANS</b>						
California red-legged frog ( <i>Rana aurora draytonii</i> )	X	X		FT	SC	
Leatherback sea turtle ( <i>Dermochelys coricea</i> )	O	O	O	FE		
Loggerhead sea turtle ( <i>Caretta caretta</i> )	O	O	O	FT		
Green sea turtle ( <i>Chelonia mydas</i> )	O	O	O	FT		
Pacific Ridley sea turtle	O	O	O	FT		
<b>BIRDS</b>						
American peregrine falcon ( <i>Falco peregrinus anatum</i> )	X	X	X	FE	E	
California brown pelican ( <i>Pelecanus occidentalis californianus</i> ) <b>(a transient species)</b> <sup>17</sup>	X	X	X	FE	E	
Western snowy plover ( <i>Charadrius alexandrinus nivosus</i> )	X	X	X	FT	SC	
California least tern ( <i>Sterna antillarum browni</i> )			X	FE	E	
Bald eagle ( <i>Haliaeetus leucocephalus</i> )				FE		
Southwestern willow flycatcher ( <i>Empidonax traillii extimus</i> )		X		FE		
<b>PLANTS</b>						
Seaside bird's beak ( <i>Cordylanthus rigidus</i> )					E	1B
Beach Layia ( <i>Layia Carnosa</i> )		X		C	E	1B
Surf thistle ( <i>Cirsium rothophilum</i> )	X		X	C	T	1B
Spectacle pod ( <i>Dithyrea maritima</i> )	X		X		T	
<b>MAMMALS</b>						
Southern sea otter ( <i>Enhydra lutris nereis</i> )	X	X	O	FT	R	
<b>Candidate Species</b>						
<b>INVERTEBRATES</b>						
White sand dune scarab beetle ( <i>Lichnanthe albopilosa</i> )			X	F		
Morro Bay blue butterfly ( <i>Icaricia icaroides moroensis</i> )			X	F		
<b>REPTILES/AMPHIBIANS</b>						
Southwestern pond turtle ( <i>Clemmys marmorata pallida</i> )	X	X		F	SC	
Two-striped garter snake ( <i>Thamnophis hammondi</i> )	X			F		
California tiger salamander ( <i>Ambystoma californiense</i> )				C	SC	
South coast garter snake ( <i>Thamnophis sirtalis ssp.</i> )				F		
Silvery legless lizard ( <i>Anniella pulchra pulchra</i> )	X	X	X	F		
California horned lizard ( <i>Phrynosoma coronatum frontale</i> )	X	X	X	F		
Arroyo chub ( <i>Gila orcutti</i> )				F		
Western spadefoot toad ( <i>Scaphiopus hammondi</i> )				F		

<sup>17</sup> California brown pelicans are a common year-round visitor to VAFB, however they frequent many diverse sites.

SPECIES	Potential Occurrence <sup>a</sup>			STATUS <sup>b</sup>		
	SLC-6	SLC-4	SLC-2	Federal	State	Other
<b>BIRDS</b>						
Bell's sage sparrow ( <i>Amphispiza belli belli</i> )	X			F		
Southern California rufous-crowned sparrow ( <i>Aimophila ruficeps canescens</i> )				F		
Western burrowing owl ( <i>Speotyto cunicularia hypugea</i> )	X	X	X	F	SC	
California black rail		X		C	SC	
White-faced ibis	O		O	F	SC	
Ferruginous hawk ( <i>Buteo regalis</i> ) ( <b>a transient species</b> )	X	X		F	SC	
Long-billed curlew	O		X	F		
White-tailed kite ( <i>Elanus leucurus</i> )	X		X		P	
Northern harrier ( <i>Circus cyaneus</i> )	X		X		SC	
Cooper's hawk	X		X		SC	
Prairie falcon	X		X		SC	
Long-eared owl					SC	
Short-eared owl	X				SC	
Belding's savannah sparrow ( <i>Passerculus sandwichensis beldingi</i> )				F		
Large-billed savannah sparrow ( <i>Passerculus sandwichensis rostratus</i> )				F		
Olive-sided flycatcher ( <i>Contopus borealis</i> )				F		
Little willow flycatcher ( <i>Empidonax traillii brewsteri</i> )		X		F		
Saltmarsh common yellowthroat ( <i>Geothlypis trichas sinuosa</i> )				F		
Elegant tern ( <i>Sterna elegans</i> )				F		
Mountain plover ( <i>Charadrius montanus</i> )				C		
Tricolored blackbird ( <i>Agelaius tricolor</i> )			X	F		
White-faced ibis ( <i>Plegadis chihi</i> )				F		
<b>PLANTS</b>						
Shagbark manzanita			X	F		1B
Lompoc Yerba Santa			X	C	R	1B
Aphanisma			X	F		3
Crisp monardella ( <i>Monardella crispera</i> )	X		X	F		1B
San Luis Obispo Monardella ( <i>Monardella frutescens</i> )	X		X	F		1B
Black flowered figwort ( <i>Scrophularia atrata</i> )	X		X	F		3
La Graciosa thistle			X	C		1B
<b>MAMMALS</b>						
Sand Diego desert woodrat ( <i>Neotoma lepida intermedia</i> )	X	X		F		
Townsend's Western big-eared bat ( <i>Plecotus townsendii townsendii</i> )	X	X	X	F	SC	
Badger ( <i>Taxidea taxus</i> )	X		X		SC	
Mountain Lion ( <i>Felis concolor</i> )	X				P	
Greater western mastiff-bat ( <i>Eumops perotis californicus</i> )				F		
Small-footed myotis ( <i>Myotis ciliolabrum</i> )				F		
Long-eared myotis ( <i>Myotis evotis</i> )				F		
Fringed myotis ( <i>Myotis thysanodes</i> )				F		
Long-legged myotis ( <i>Myotis volans</i> )				F		
Yuma myotis ( <i>Myotis yumanensis</i> )				F		

SPECIES	Potential Occurrence <sup>a</sup>			STATUS <sup>b</sup>		
	SLC-6	SLC-4	SLC-2	Federal	State	Other
<b>Other species of interest</b>						
Right whale ( <i>Eubalaena glacialis</i> )	O	O	O	FE		
Sperm whale ( <i>Physeter macrocephalus</i> )	O	O	O	FE		
Humpback whale ( <i>Megaptera novaeangliae</i> )	O	O	O	FE		
Blue whale ( <i>Balaenoptera musculus</i> )	O	O	O	FE		
Finback whale ( <i>Balaenoptera physalus</i> )	O	O	O	FE		
Sei whale ( <i>Balaenoptera borealis</i> )	O	O	O	FE		
Gray whale ( <i>Eschrichtius robustus</i> )	O	O	O	FE		
California sea lion ( <i>Zalophus californicus</i> )	O	O	O	P		
Northern fur seal ( <i>Callorhinus ursinus</i> )	O	O	O	P		
Northern elephant seal ( <i>Mirounga angustirostris</i> )	O	O	O	P		
Harbor seal ( <i>Phoca vitulina richardsi</i> )	O	O	O	P		
Guadalupe fur seal ( <i>Arctocephalus townsendii</i> )	O	O	O	FT		
Steller sea lion ( <i>Eumetopias jubata</i> )	O	O	O	FT		
Golden eagle ( <i>Aquila chrysaetos</i> )						
<b>Habitats of interest</b>						
Pinniped haulout and breeding areas						
Seabird nest and roost sites						
Wetland and riparian habitats						

Source: Data acquired from [ATHENA 1995], [ATLAS 1991], [SELV 1992] and [SLC2W 1993]

<sup>a</sup> X = Possibly suitable habitat available on site or within the NMP region of influence, O = Offshore Species in the vicinity of Boat-house Flats are noted as potentially occurring near SLC-6.

<sup>b</sup> FE = Federally listed as endangered; FT = Federally listed as threatened; C = candidate for Federal listing (USFWS has sufficient information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened species); F = Federal species of concern (former Category 2 Candidate species) - Such species are the pool from which future candidates for listing will be drawn [Federal register Vol. 61, No. 40, pp. 7457-7463]. E = State listed as endangered; T = State listed as threatened; R = rare; P = protected by State or Federal law; SC = CDFG species of special concern; 1B = candidate plants considered by the California Native Plant Society (CNPS) to be of highest priority, rare and endangered in California and elsewhere; 3 = candidate plants considered by the CNPS to be possibly appropriate for candidate listing but for which more information is needed. Correspondence with NMFS elicited concern for the threatened Guadalupe fur seal and the threatened Steller sea lion.

No other Federally listed species under the jurisdiction of the National Marine Fisheries Service (NMFS) are likely to be affected.

The flora of VAFB comprises approximately 624 species and subspecies, approximately 21 percent of which are alien to California; the remaining 79 percent are native. Local flora includes a number of sensitive plant taxa, including several species recognized as rare, threatened, or endangered by the State or Federal government. [ATLAS 1991]

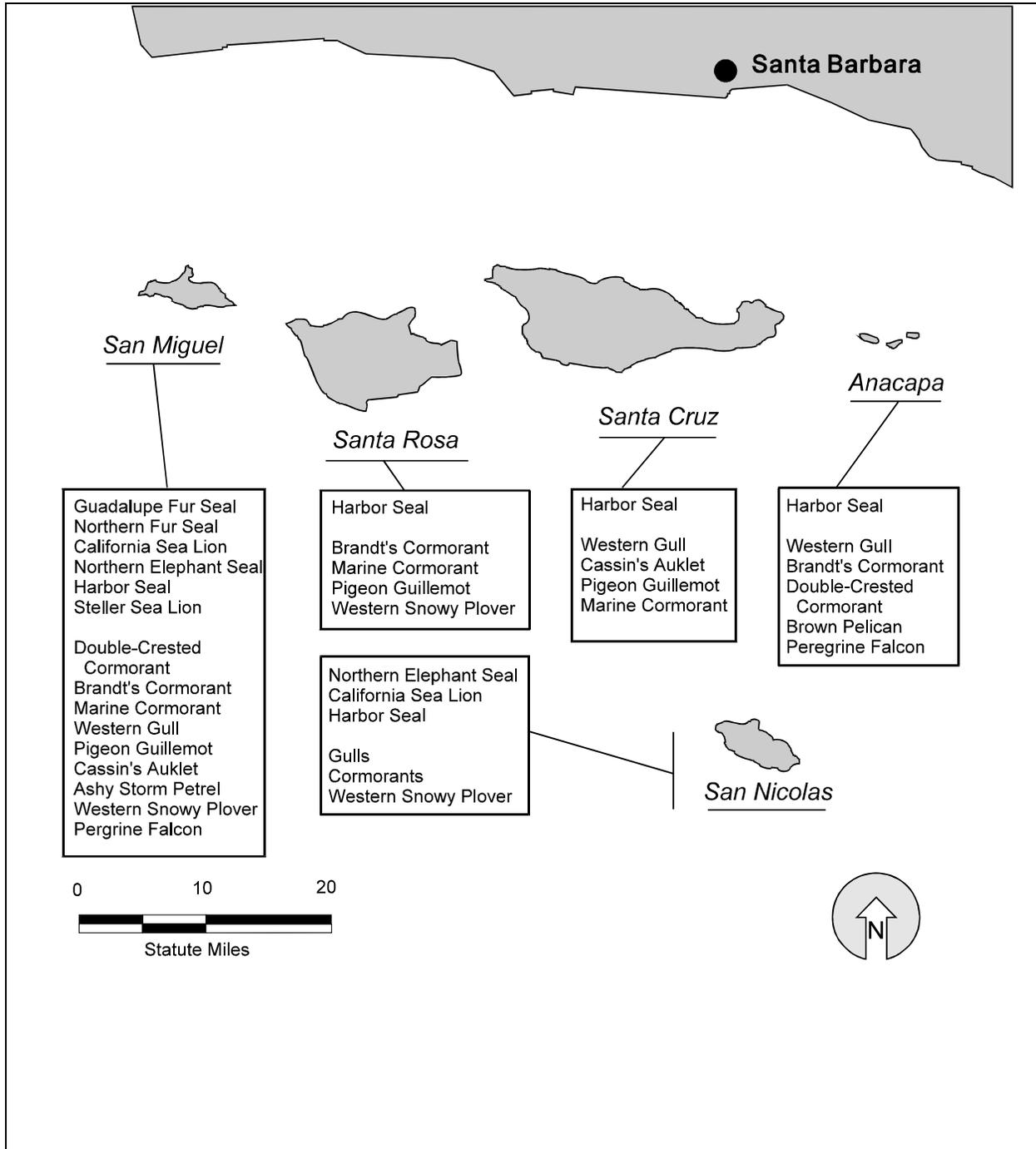
#### 4.3.4.2 Aquatic Biota

Reptiles and amphibians are represented by several snakes, the Pacific tree-frog, western toad, and the California legless lizard, among others. A harbor seal population haulout site occurs at Purisima Point, which is identified in the National Marine Fisheries Service census as a breeding rookery in their annual harbor seal census. The southern sea otter is found at various rocky areas along the VAFB coastline. A small colony of sea otters was found near Purisima Point in 1990 and was still intact in 1992.

The coastal waters encompassing south VAFB and the northern Channel Islands (Figure 4-4) support diverse marine mammal assemblages. The sea otter, six species of pinniped (seals), and more than 25 species of ce-

tacean (whales) inhabit the regions either as residents or transients. The Marine Mammal Protection Act of 1972 protects all marine mammals inhabiting the study region. The Santa Barbara County Local Coastal Plan identifies marine mammal haulout and pupping grounds as environmentally sensitive habitat and delineates policies designed to help protect these areas.

Figure 4-4. Occurrence of Breeding Populations of Marine Mammals and Sea Birds on the Northern Channel Islands



Source: Adapted from [SELV 1992]

#### 4.3.4.3 Threatened and Endangered Species

Threatened and endangered species, and their approximate location relative to SLCs proposed for use by NMP are depicted in Figures 4-5 and 4-6.

##### SLC-2

There are no threatened or endangered amphibians, reptiles, or land mammals known to occur in the vicinity of SLC-2. However, two Federally endangered bird species (the California brown pelican and California least tern) are known to occur in the SLC-2 area. One, the California brown pelican, is a transient species and does not nest or breed on VAFB. One Federally threatened mammal (the southern sea otter), one Federally threatened bird (the western snowy plover), and two State threatened plant species (the surf thistle and spectacle pod), have been reported or are expected to occur near SLC-2.

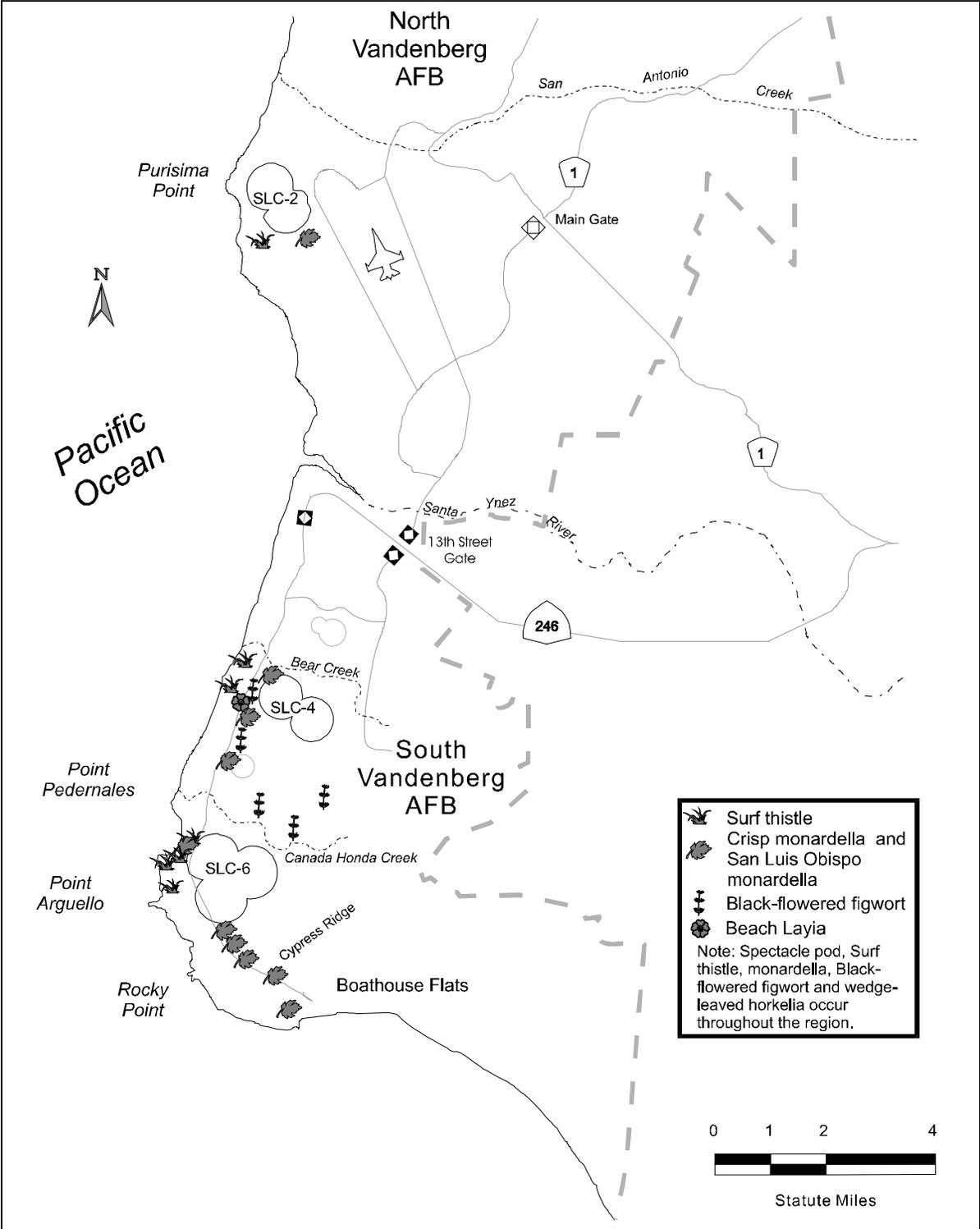
##### SLC-4

There are no threatened or endangered amphibian, reptile, or land mammals known to occur near SLC-4. Three bird (the California brown pelican, western snowy plover and American peregrine falcon) and one mammal species (the southern sea otter) that are either Federally or State listed as endangered or threatened have been reported or are expected to be seen near SLC-4. One State endangered plant species, Beach Layia, is known to occur near SLC-4.

##### SLC-6

There are no threatened or endangered reptiles, amphibians, or land mammals in the vicinity of SLC-6. Four Federally endangered bird and fish species (the unarmored three-spine stickleback, tidewater goby, American peregrine falcon and the California brown pelican) and one Federally threatened bird species (the western snowy plover) have been reported or are expected to occur at or in the immediate vicinity of SLC-6.

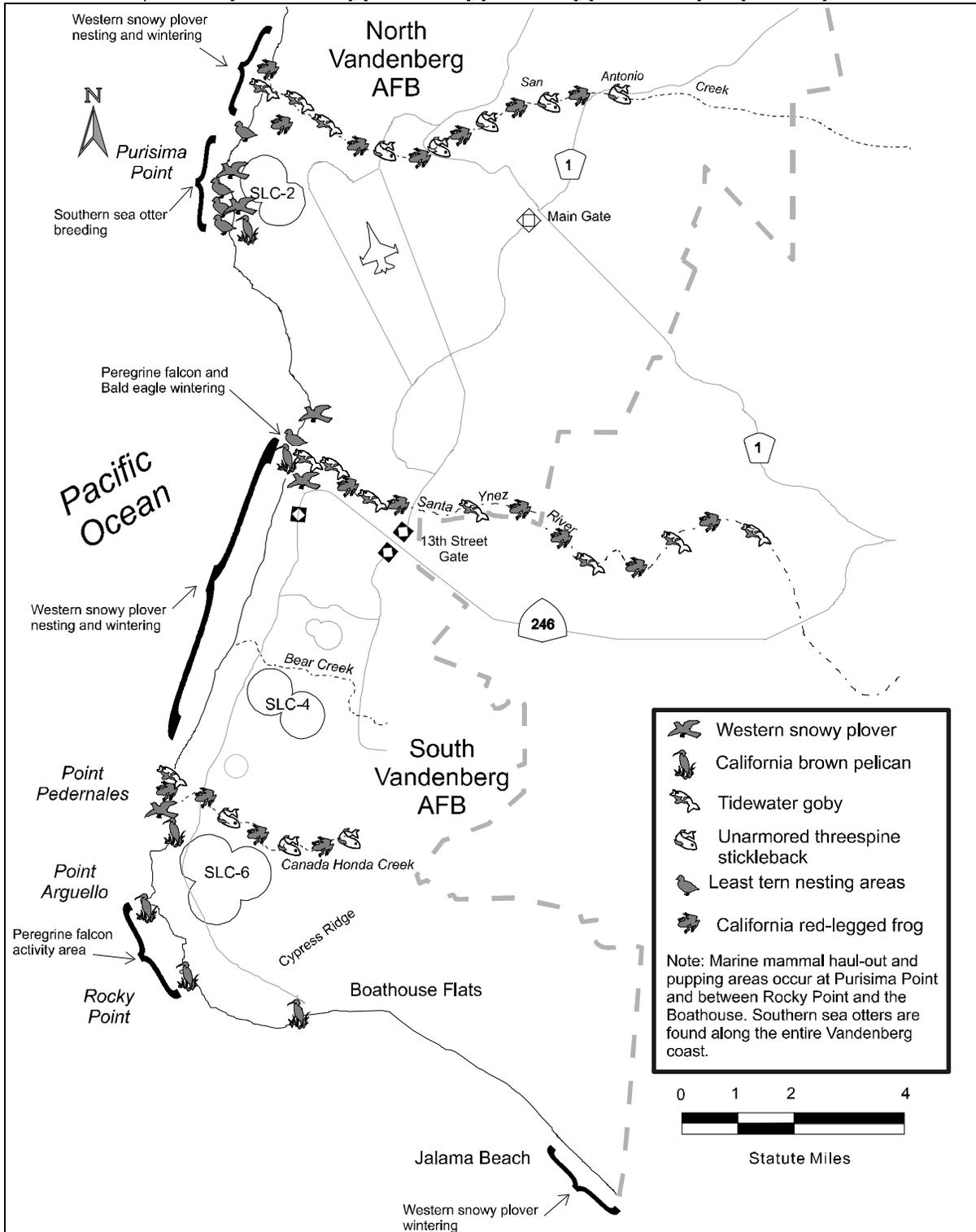
Figure 4-5. Potential Occurrence of Threatened/Endangered Flora Near SLC-2, SLC-4 and SLC-6



Source: Data acquired from [ATHENA 1995], [ATLAS 1991], [SELV 1992], [SLC2W 1993] and [REb 1995]

Figure 4-6. Potential Occurrence of Threatened/Endangered Fauna Near SLC-2, SLC-4 and SLC-6

Source: Data acquired from [ATHENA 1995], [ATLAS 1991], [SELV 1992], [SLC2W 1993] and [REb 1995]



#### 4.3.5 Economic Population and Employment Factors

Agriculture is the region's primary industry, particularly in the Santa Maria area. Surface mining for diatomaceous earth is also a major regional industry. The largest employers in the area of Santa Barbara county surrounding VAFB are services, retail trade, government, and manufacturing. In 1985, the area's employment levels was 101,600, an increase of approximately 50 percent in 10 years with most growth occurring in the manufacturing sector. Projections are for employment to increase to 145,800 by 2005, a 43 percent increase from employment levels in 1985. The unemployment rate is currently five percent and is projected to remain between five and five and one-half percent through the year 2005 [ATHENA 1995].

The number of persons employed at VAFB has declined from approximately 16,000 in 1985 to less than 10,000 currently. Of these, approximately 68 percent are civilian employees. The base generates about 4,300 jobs for the local economy, and has an overall monetary impact of more than \$500 million on the surrounding region. VAFB employs approximately 40 percent of Lompoc's labor force and nine percent of Santa Maria's [ATHENA 1995].

#### 4.3.6 Noise, Sonic Boom and Vibration

Noise levels for most of the region surrounding VAFB are normally low. Higher levels appear in industrial areas and along transportation corridors. The rural areas near Lompoc and Santa Maria are expected to have low overall community noise equivalent levels. Noise levels temporarily increase due to aircraft flyovers, railroad traffic, and missile launches. Noise monitoring conducted at VAFB and surrounding areas during 1984 and 1985 showed 24-hour average noise levels of 48 to 67 dBA<sup>18</sup>, with higher levels along transportation corridors. These levels are typical of rural areas. [ATLAS 1991]

Peak launch noises are experienced for a very brief time and are therefore not expected to exceed EPA or Occupational Safety and Health Administration (OSHA) requirements and recommendations. Comparatively, peak noise levels created by industrial and construction activities – mechanical equipment such as diesel locomotives, cranes, and rail cars – could range from about 90 to 111 dBA. Vehicular traffic noise ranges from around 85 dBA for a passenger auto to about 100 dBA for a motorcycle. [DELTA 1994]

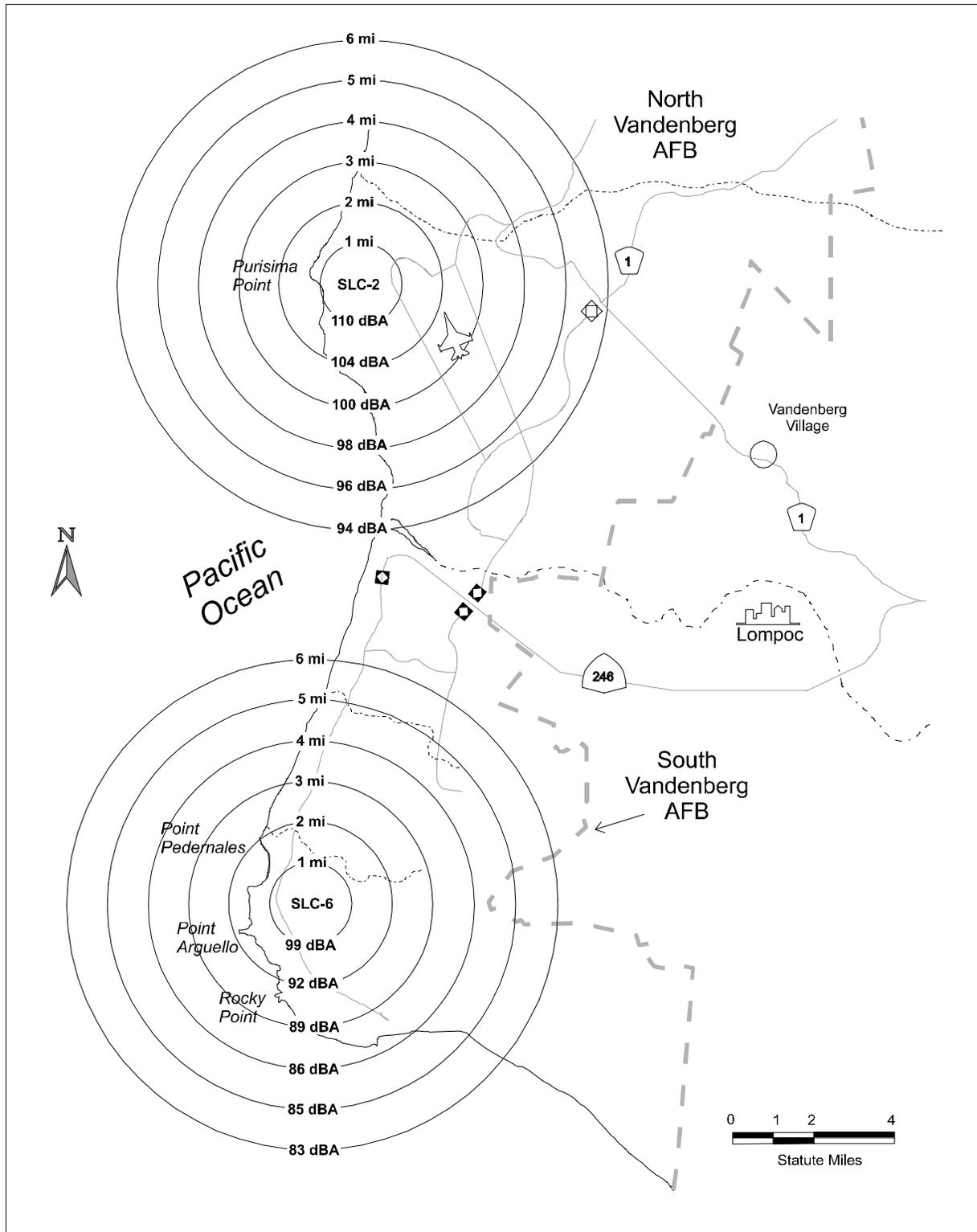
Space launches also generate sonic booms during vehicle ascent and stage reentry. Launch-generated sonic booms are directed upward and in front of the vehicle and occur over the Pacific Ocean. Stage reentry sonic booms also occur over the open ocean and do not impact developed coastal areas.

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<sup>18</sup> A-weighted decibels (dBA) are applied to emphasize the mid-range of human hearing.

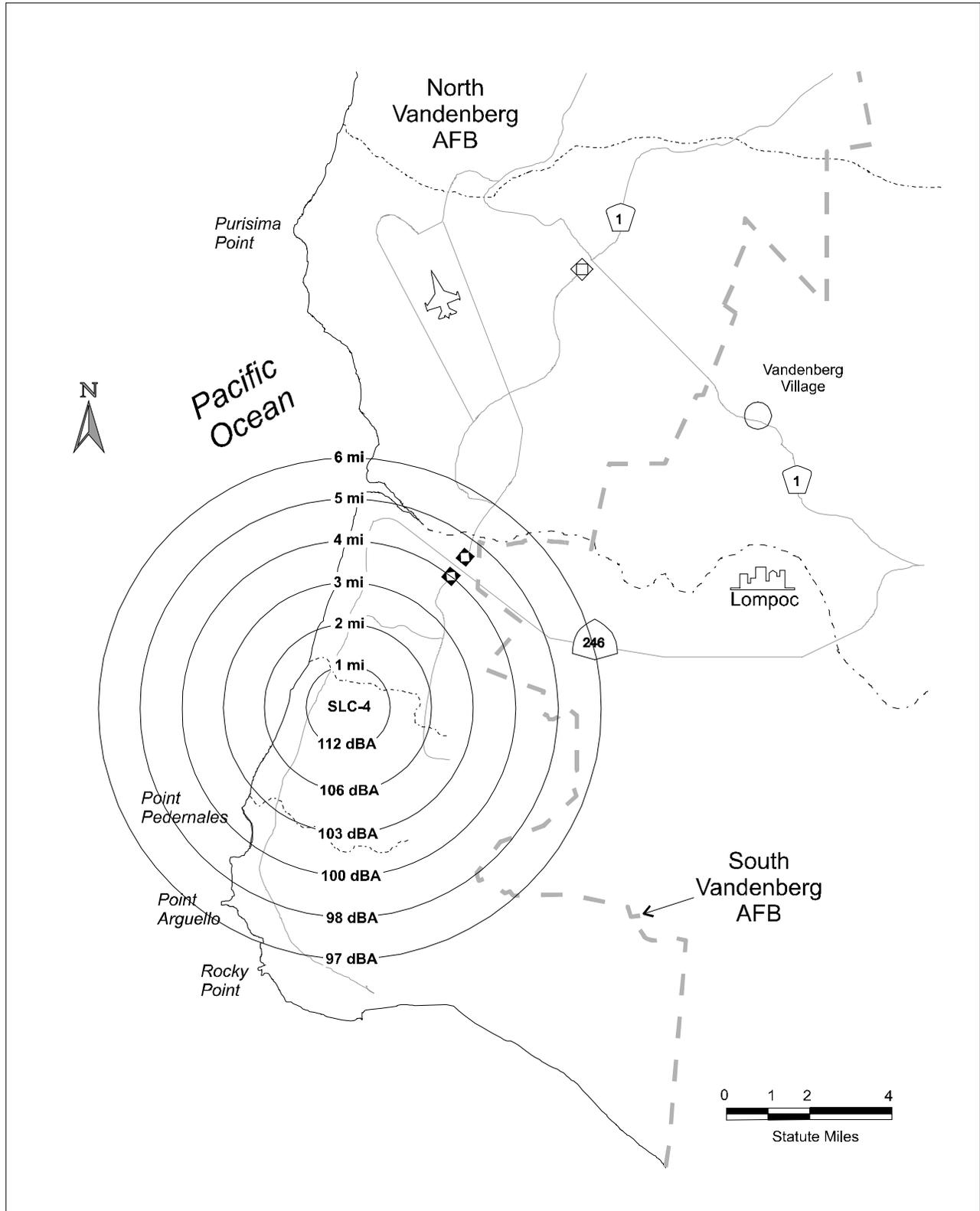
Launch noise generated by Athena or Taurus launches from SLC-6 and Delta II launches from SLC-2 are illustrated in Figure 4.7. Figure 4.8 depicts noise levels near SLC-4 produced by Titan II launches.

Figure 4-7. Noise Generated by a Delta II Launch From SLC-2 and an Athena Launch From SLC-6



Source: Data acquired from [ATHENA 1995] and [NAVSTAR 1994]

Figure 4-8. Noise Generated by a Titan II Launch From SLC-4



Source: Data acquired from [ATHENA 1995] and [TITAN 1987]

In recent years, there have been no recorded complaints concerning noise produced by missile launches, which can be attributed to the infrequency of launches and the low annoyance level of rocket motor firings. [DELTA 1991]

#### 4.3.7 Historic, Archeological, and Recreational Factors

##### Historic Resources

Two historically valuable buildings remain in the Cypress Ridge area. The first of these is a Coast Guard Rescue Station, known as the Boathouse, built at Boathouse Flats between 1936 and 1938. Although deactivated in 1952, the station retains historical value as one of the few West Coast examples of the U.S. Colonial revival style of architecture. The second historical site is a complex of Coast Guard Station buildings located at Point Arguello. [ATHENA 1995] A brief description of the cultural resources near SLCs proposed for use by NMP follows.

##### SLC-2

Cultural resources are present within and adjacent to SLC-2. Consultation with the State Historic Preservation Officer (SHPO) was conducted during the environmental assessment process for the modification of SLC-2 [DELTA 1991]. The SHPO recommended SLC-2 as a candidate for listing in the NRHP; therefore, any proposed modifications to SLC-2 must first be reviewed by the SHPO [SO 1996].

##### SLC-4

None of the Titan launch complexes at SLC-4 were nominated as historic landmarks [TITAN 1987] nor were they considered eligible for listing in the NRHP.

##### SLC-6

Space Launch Complex 6 was originally constructed in 1970 for the Titan IIIM space launch vehicle, which was designed to support the Manned Orbital Laboratory (MOL). In the 1980's, SLC-6 was modified in anticipation of Space Shuttle launches at VAFB. Neither the MOL program nor the Space Shuttle launches from VAFB were implemented. Although SLC-6 was not used for Cold War activities, it was evaluated for inclusion in the NRHP. The SLC-6 complex and the Payload Preparation Room have been evaluated and recommended as not eligible for inclusion in the NRHP [ATHENA 1995].

## Archeological Resources

Paleoindian sites characterized by the presence of chipped stone tools and grinding stones at least 9,000 years old occupy areas along the coast from Point Conception to the Santa Maria River area. One of these rare Paleo-Coastal sites is a fluted projectile point fragment. It was found on a coastal plain east of Point Conception approximately 12.9 kilometers (8.0 miles) south of SLC-6. While claims have been made for earlier occupation of the area, the earliest well-documented remains are associated with Paleoindian peoples (12,000 to 9,000 years ago). After the lands were transferred to USAF ownership, their use related primarily to construction of missile launch and support facilities.

Seven archeological sites have been recorded in the vicinity of SLC-4 as a result of archeological surveys conducted as part of the SLC-4 Restoration Program [TITAN 1987]. The site records regarding these seven archeological sites appear to be incomplete. However, all recorded archeological sites on VAFB are considered potentially eligible for inclusion in the NRHP until examination and evaluation proves otherwise. Due to limited resources these sites will most likely not be evaluated until a project impact requires such an evaluation.

## Recreation

The Pacific Coast in the vicinity of VAFB provide numerous opportunities for public recreation. Two of these recreation areas are adjacent to South Vandenberg. The first, Ocean Beach County Park, is located 12.1 kilometers (7.5 miles) to the north of the Cypress Ridge Area at the mouth of the Santa Ynez River. The second, Jalama Beach County Park, is situated at the mouth of Jalama Creek, near the eastern boundary of VAFB. [ATHENA 1995]

## 5. CHAPTER FIVE ENVIRONMENTAL IMPACTS

### GENERAL

Preparations for completing New Millennium Program flights include refining the design of flight projects, fabrication and assembly of spacecraft, testing of components, final instrument design and fabrication, launch and subsequent mission operations. While fabrication processes may generate small quantities of effluents generally associated with tooling or cleaning operations, these are well within the scope of normal activities at fabrication/testing facilities, are covered in applicable environmental permits, and would produce no substantial adverse environmental consequences. Pre-launch activities (i.e., at the launch site) would involve integration and testing of the payload with the launch vehicle and final launch preparations, such as spacecraft and launch vehicle fueling operations, and would culminate in a successful launch as an element of the NMP DS or EO flight projects. The NEPA process (for space launches from VAFB and CCAS) has been previously completed for launch activities in the range expected for NMP<sup>19</sup>. Currently no NMP-specific processing or launch activities have been identified that would require permits and/or mitigation measures beyond the baseline permits and mitigation measures already necessary.

The potential environmental impacts of both normal launches and launch failures are described in the sections below. NMP flights which are piggy backed may utilize launch vehicles other than those covered here. Environmental impacts associated with the launch of those particular missions would be covered by separate analyses done by the carrying mission.

### 5.1 MULTIPLE LAUNCH SITES

The NMP proposal is to use one to three launch pads at VAFB. These include SLC-2, for launching Delta IIs, the California Commercial Spaceport (CCS or SLC-6) for Athena, and SLC-4 for launching the Titan IIG. Two CCAS launch complexes are proposed for use by NMP. Launch Complex 17A/B and Spaceport Florida (LC-46) at CCAS may be used by NMP projects for launching Delta II and Athena, respectively. The Taurus launch vehicle would launch from LC-46 at CCAS or mobile launch pads at VAFB and the Pegasus (an air launched vehicle) would be launched from an L-1011 aircraft approximately 185 kilometers (115 miles) off the coast of California. The environmental impacts associated with any particular launch site are similar in effect with respect to noise, emissions, and payload processing. The site specific environment characteristics such as flora and fauna, endangered species, existing land use and

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<sup>19</sup> [DELTA 1991], [FONSI 1991], [ATHENA 1994], [ATHENA 1995], [FONSI 1995a], [ATHENA 1997], [FONSI 1997], [DELTA 1995], [FONSI 1995b], [PEGASUS 1989], [TAURUS 1992b], [FONSI 1993], [TITAN 1987] and [FONSI 1987]

proximity to population centers can be unique to a site. The following discussion presents the impact discussion as if it were a single location, but with specific notations of environmental impacts based on differences in the five launch sites.

## 5.2 SINGLE LAUNCH SITE ENVIRONMENTAL IMPACTS

### General

The greatest source of uncontrollable emissions to the atmosphere would be vehicle launch. Primary constituents of exhaust from solid-fueled rocket motors are hydrogen chloride (HCl), carbon dioxide (CO<sub>2</sub>), carbon monoxide (CO), and aluminum oxide (Al<sub>2</sub>O<sub>3</sub>). Primary exhaust products from liquid rocket motors are CO, CO<sub>2</sub>, and water. The portion of the exhaust plume that persists longer than a few minutes (the ground cloud) is emitted during the first few seconds of flight and is concentrated near the pad area. Prior to launch all non-essential personnel are evacuated from the launch site to areas a minimal distance outside the facility perimeter. Necessary personnel remain inside the complex until the area has been monitored and declared clear. No impacts to communities and populated areas are expected. Exhaust products are expected to dissipate before reaching sensitive human, flora or fauna receptors.

Existing NAAQS primary and secondary standards apply to continuously emitting sources, while a launch is considered to be a one-time, short-term moving source; however, the standards will be used for comparative purposes throughout this EA to provide a reference, since no other more appropriate standards exist.

For the purposes of this EA, the Delta II 7925 launch vehicle has been selected to represent an environmental case which is likely to bound the anticipated environmental impacts from launch activities. Anticipated environmental impacts from the launching of all other proposed launch vehicles are expected to be equal to or less than Delta II 7925 impacts (Table 5-1). Emissions data, performance data, and propellant information are readily available for the Delta II. The Delta II 7925 will therefore serve as the basis for analysis of environmental impacts.

Table 5-1. Pollutant Emissions in Tons (Pounds) per Launch of NMP Proposed Launch Vehicles

Pollutant	Launch Vehicles				
	Delta II 7925 <sup>1</sup>	Athena 2 <sup>2</sup>	Taurus <sup>3</sup>	Pegasus	Titan IIG
CO	71.2 (142,474)	23.8 (47,600)	19.5 (39,000)	3.7 (7,480)	0.80 (1,600)
CO <sub>2</sub>	34.2 (68,451)	2.0 (4,000)		0.4 (702)	
HCl	24.8 (49,567)	19.2 (38,400)	17.2 (34,400)	3.1 (6,290)	
H <sub>2</sub>	4.2 (8,302)			0.4 (700)	
H <sub>2</sub> O	36.7 (73,410)			1.5 (3,000)	
N <sub>2</sub>	9.7 (19,343)			1.4 (2,800)	
NO <sub>x</sub>	9.6 (19,200)	9.2 (18,400)	8.0 (16,000)	1.4 (2,850)	0.60 (1,200)
Al <sub>2</sub> O <sub>3</sub>	42.1 (84,304)	36.0 (72,000)	34.4 (68,800)	6.4 (12,700) <sup>4</sup>	

Source: Data derived from [PEGASUS 1989], [TITAN 1987], [DELTA 1994], [SELV 1992] and [ATHENA 1995]

<sup>1</sup>Delta II 7925 air pollutant emissions are for 9 GEMs and 1<sup>st</sup> stage. NO<sub>x</sub> values were estimated by comparing the total solid propellant quantity to that of the Taurus and include NO<sub>x</sub> resulting from afterburning (heated exhaust decomposing the atmosphere).

<sup>2</sup>Total emission values were extrapolated from emissions to 3,000 feet by comparing the total propellant quantity to the quantity burned up to 3,000 feet. These values represent a complete burn of two Castor 120 SRMs. NO<sub>x</sub> values were estimated by comparing the total solid propellant quantity to that of the Taurus and include NO<sub>x</sub> resulting from afterburning.

<sup>3</sup>Total emission values were extrapolated from emissions to 5,000 feet by comparing the total propellant quantity to the quantity burned up to 5,000 feet. These values include all stages and two Castor IVB strap-ons.

<sup>4</sup>Includes all aluminum species

## 5.3 LAUNCH VEHICLE IMPACTS

### 5.3.1 Air Quality Impacts

In a normal launch, exhaust products from the Delta II are distributed along the launch vehicle's path. The quantity of exhaust emitted per unit length of trajectory is greatest at ground level and decreases continuously. The portion of the exhaust plume that persists longer than a few minutes (the ground cloud) is emitted during the first few seconds of flight and is concentrated near the pad area. It consists of the rocket exhaust effluents and deluge water. Prior to launch all non-essential personnel are evacuated from the launch site to areas a minimal distance outside the facility perimeter. [DELTA 1994]

The Air Force uses the Rocket Exhaust Effluent Diffusion Model (REEDM) to determine the concentration and areal extent of launch cloud emission dispersion from launch vehicles. For this assessment, Air Force personnel from the 45<sup>th</sup> Space Wing (CCAS) ran REEDM for the Delta II 7925 nominal launch case (normal launch mode) and for two failure modes (conflagration and deflagration) using a credible<sup>20</sup> worst case weather scenario. A total of 3 runs were performed. The weather scenario involved a cold front over southern Florida. This is a case with northerly wind components and inversions which could cause an adverse toxic hazard corridor toward the closest and densest population center at Port Canaveral.

<sup>20</sup> A credible weather scenario is one in which launch would proceed.

For the nominal launch scenario the launch cloud was assumed to be 100 meters (330 feet) in diameter at ground level. The area directly impacted by flame from the rocket exhaust would be approximately 80 meters (260 feet) in diameter. [NAVSTAR 1994]

Because the cloud rises so rapidly, surface exposure to the cloud immediately after launch is assumed to occur for approximately two minutes for this analysis. Concentrations for CO, CO<sub>2</sub>, chlorine (Cl), Al<sub>2</sub>O<sub>3</sub>, and HCl were considered. The model predicted that the cloud would stabilize approximately 3.5 kilometers (2.2 miles) from LC-17. REEDM outputs predict that the 60-minute average concentrations would be less than 0.1 ppm for all gaseous species considered for a normal launch in either of the two weather scenarios (Table 5-2).

Table 5-2. Peak Concentrations and 60-Minute Mean Concentrations for a Normal Delta II 7925 Launch from CCAS During Worst Case Meteorological Conditions

Exhaust Cloud Constituent	Peak Concentration (ppm)	Maximum 60-Minute Mean (ppm)	Distance From LC-17 Peak/Mean (kilometers)
CO	1.758	0.065	13/16
CO <sub>2</sub>	0.373	0.014	13/16
Cl	0.010	No Cl Found	13/--
Al <sub>2</sub> O <sub>3</sub> *	3.071 mg/m <sup>3</sup>	0.091 mg/m <sup>3</sup>	10/12
HCl	0.792	0.029	13/16

Source: Data acquired from [USAF 1997a]

\*Al<sub>2</sub>O<sub>3</sub> concentrations are in mg/m<sup>3</sup> because the aluminum oxide is a particulate rather than a gas.

## VAFB

At the request of the 30<sup>th</sup> Space Wing Safety Office (VAFB) and JPL, ACTA<sup>21</sup> conducted an evaluation of gaseous and particulate emissions for the Delta II 7925 and Titan II<sup>22</sup> launch vehicles. For the purposes of this assessment “worst case” conditions were derived by running approximately 3,350 meteorological samples and ranking them by severity. The meteorological sample which modeled the highest peak and mean pollutant concentrations was then edited to remove wind directional shear in the vertical profile. Eliminating the wind shear factor narrows the arc over which the aluminum oxide particulates deposit and results in higher estimated ground level concentrations. Typically worst case weather conditions involve a combination of a strong low level temperature inversion coupled with light winds and uniform wind directions. Table 5-3 indicates the highest ground level concentrations predicted by REEDM for potentially hazardous normal Delta II 7925 and Titan II launch exhaust emissions. [USAF 1997b]

<sup>21</sup> ACTA holds the flight safety analysis contract at CCAS and VAFB.

<sup>22</sup> The Titan II was included in the VAFB REEDM analysis, because it is the only vehicle proposed for use by NMP with substantial quantities of liquid hypergolic propellant.

Table 5-3. Peak Concentrations and 60-Minute Mean Concentrations for Delta II 7925/Titan II Normal Launch 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-2/4 Peak-Mean (kilometers)
Delta II 7925	Delta II 7925	Delta II 7925	Delta II 7925
CO	1.76	0.62	10-14
CO <sub>2</sub>	0.37	0.13	10-14
Al <sub>2</sub> O <sub>3</sub> *	49.1 mg/m <sup>3</sup>	7.29 mg/m <sup>3</sup>	3-4
HCl	0.79	0.28	10-14
Titan II	Titan II	Titan II	Titan II
CO	1.31	0.39	8-12
CO <sub>2</sub>	0.79	0.23	8-12
NO**	0.16	0.05	8-12

Source: Data acquired from [USAF 1997b]

The gaseous concentrations predicted using this meteorological case (no wind shear) are moderately severe but may not represent the highest concentrations that might occur under other meteorological conditions.

\*Al<sub>2</sub>O<sub>3</sub> concentrations are in mg/m<sup>3</sup> because the aluminum oxide is a particulate rather than a gas.

\*\*NO is generally unstable in the atmosphere and oxidizes to NO<sub>2</sub>. NMP is not expected to violate the 1-hour California standard for

NO<sub>2</sub> of 0.25 ppm, because the 60-minute mean availability of NO (0.05 ppm) for oxidation is far less than 0.25 ppm.

The Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for HCl is 5 ppm for an 8-hour time-weighted average. Although National Ambient Air Quality Standards have not been adopted for HCl, the National Academy of Sciences (NAS) developed recommended short-term exposure limits for HCl of 20 ppm for a 60-minute exposure, 50 ppm for a 30-minute exposure and 100 ppm for a 10-minute exposure. The peak HCl concentration is predicted to be 0.792 ppm 13 kilometers (8 miles) from LC-17 (CCAS) for a normal Delta II launch during worst case meteorological conditions with a maximum 60-minute average concentration of 0.029 ppm at 16 kilometers (10 miles). The maximum HCl concentration for a normal Delta II launch from SLC-2 (VAFB) during worst case meteorological conditions is predicted to be 0.79 ppm 10 kilometers (6 miles) downwind with a maximum 60-minute average concentration of 0.28 ppm at the 14 kilometers (9 miles). Since the nearest uncontrolled area (i.e., general public) is approximately 4.8 kilometers (3 miles) from CCAS and VAFB SLCs, HCl concentrations are not expected to be high enough to be harmful to the general population. The maximum level of HCl expected to reach uncontrolled areas during preparation and launch of the Delta II would be well below the NAS recommended limits. Appropriate safety measures would also be taken to ensure that the permissible exposure limits defined by the OSHA are not exceeded for personnel in the launch area.

Peak CO concentration for a normal Delta II launch from CCAS during worst case meteorological conditions is predicted (by REEDM) to be 1.758 ppm 13 kilometers (8 miles) from LC-17. The maximum 60-minute mean for CO is predicted to be 0.065 ppm 16 kilometers (10 miles) from LC-17. The highest peak and average CO concentration predicted for a normal launch from VAFB was for that of the Delta II 7925 – a 1.76 ppm peak 10 kilometers (6 miles)

downwind of SLC-2 and a 60-minute mean concentration of 0.62 ppm at 14 kilometers (9 miles). REEDM predicted carbon monoxide concentrations for NMP launches from CCAS and VAFB do not exceed the NAAQS of 35 ppm (60-minute average). The CO is also expected to rapidly oxidize into CO<sub>2</sub> in the atmosphere.

Aluminum oxide (Al<sub>2</sub>O<sub>3</sub>) exists as a crystalline dust in solid rocket motor (SRM) exhaust clouds, but is inert chemically and is not toxic. However, since many of the dust particles are small enough to be retained by lungs, it is appropriate to abide by NAAQS for particulate matter less than 10 microns (PM<sub>10</sub>). The maximum and 60-minute mean Al<sub>2</sub>O<sub>3</sub> concentration (all particle sizes) predicted by REEDM for a normal launch from LC-17 (CCAS) during worst case meteorological conditions is 3.071 mg/m<sup>3</sup> at a distance of 10 kilometers (6 miles) and 0.091 mg/m<sup>3</sup> at 12 kilometers (7 miles), respectively. The maximum 24-hour average Al<sub>2</sub>O<sub>3</sub> concentration is predicted to be 0.004 mg/m<sup>3</sup> (4 µg/m<sup>3</sup>) 12 kilometers (7 miles) from LC-17, which is well below the 24-hour average NAAQS for PM<sub>10</sub> and PM<sub>2.5</sub> of 150 µg/m<sup>3</sup> and 65 µg/m<sup>3</sup>, respectively. The peak Al<sub>2</sub>O<sub>3</sub> ground level concentration predicted for Delta II launches from VAFB is 49.1 mg/m<sup>3</sup> 3 kilometers (2 miles) from SLC-2 with a maximum 60-minute mean concentration of 7.29 mg/m<sup>3</sup> at 4 kilometer (3 miles). This correlates to a 24-hour average of 0.303 mg/m<sup>3</sup> (303 µg/m<sup>3</sup>), which exceeds NAAQS. These predicted concentrations are conservative (protective of resources) in that they assume all particulate matter produced is less than 10 microns when in fact nearly half the Al<sub>2</sub>O<sub>3</sub> particulate mass created by Delta SRM combustion would be greater than 10 microns in size. Taking half of the predicted value of 303 µg/m<sup>3</sup> elicits approximately 150 µg/m<sup>3</sup> which is within NAAQS. Less than 1 percent of the predicted Al<sub>2</sub>O<sub>3</sub> particulate mass would be in the PM<sub>2.5</sub> range or smaller. One percent of 303 µg/m<sup>3</sup> correlates to a 24-hour average of approximately 3 µg/m<sup>3</sup>, which is well within the PM<sub>2.5</sub> 24-hour average NAAQS of 65 µg/m<sup>3</sup>.

#### 5.4 CLEAN AIR ACT CONFORMITY

The New Millennium Program would not increase approved launch rates nor utilize launch systems beyond the scope of approved programs at VAFB/CCAS. The Clean Air Act general conformity analyses have been completed for the previous licensing of the proposed sites. However, for clarity and ease of reference a brief discussion of NMP conformity is included in this document.

##### VAFB

The Air Force is required to make a formal determination as to whether VAFB operations comply with the General Conformity Rule of the Clean Air Act, as amended (42 U.S.C. 7401 et seq.). Section 176 (c) of the Clean Air Act, as amended in 1990, requires all Federal agencies or agency supported activities to comply, where applicable, with an approved or promulgated State im-

plementation plan (SIP) or Federal implementation plan (FIP). Conformity means compliance with a SIP/FIP's purpose of attaining or maintaining the national ambient air quality standards (NAAQS). Specifically, this means ensuring the activity will 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. [SLC6 1995]

For the NMP conformity analysis, emissions have been derived from scaling by one-eighth the predicted Spaceport emissions for twenty-four launches per year (Table 5-4). The original analysis included Castor 120 solid rocket boosters; gasoline and diesel fueled vehicles transporting Spaceport and customer launch support equipment; and diesel fueled standby generators for emergency backup power to maintain critical Spaceport systems, which can be assumed to be representative of NMP activities.

Table 5-4. Total Emissions (Tons/Year)

Source	NO <sub>x</sub>	VOC
NMP*	0.216	0.095
Spaceport**	1.725	0.756

\*Maximum NMP contribution assumes a maximum of three flights per year, which scales all other planned Spaceport launch and launch support activities by 3/24 or 1/8.  
 \*\*Total Spaceport contribution includes 24 launches of the Athena 3 with 6 Castor IV/XL SSRMs, gasoline vehicles (80 twenty-mile round trips/day x 260 days), diesel vehicles (110 forty-mile round trips/year, 60 two-mile tow tug trips), diesel standby generators (300 hp-hr generator x 12 hr/year), alcohol wipedown (48 gallons per year), and hydrazine transfer (99% efficiency).

Source: Adapted from [SLC6 1995]

The total direct and indirect emissions from the Proposed Action, do not exceed the Federal de minimis conformity threshold for the criteria nonattainment pollutants (ozone precursors). Additionally, total emissions for each nonattainment pollutant are less than 10 percent of SBCAPCD's 1990 Base Year Annual Emission Inventory (Table 5-5). Therefore, the Proposed Action is considered de minimis and not regionally significant. This determination is in accordance with EPA Conformity Rule 40 CFR part 93.153 (b) and (c), in accordance with Section 176 (c) of the Clean Air Act, as amended in 1990, 42 U.S.C. 7506 (c).

Table 5-5. Comparative NMP Emissions (Tons/Year)

Ozone Precursor	Total NMP Contribution	Total Spaceport Contribution	De Minimis Thresholds	Planning Emission Inventory*
VOCs	0.095	0.756	50	5,437
NO <sub>x</sub>	0.216	1.725	50	2,637

Source: Data acquired from [SBCAPCD 1994], [JA 1996] and [SLC6 1995]

\*10% of SBCAPCD's 1990 Base Year Annual Emission Inventory.

## CCAS

Since NMP launches from CCAS would occur in an area that is in attainment for NAAQS, the general conformity rules do not apply.

### 5.5 ACCIDENTS AND LAUNCH FAILURES

#### 5.5.1 Liquid Propellant Spill

The potential for an accidental release of liquid propellants would be minimized by strict adherence to applicable United States Air Force and NASA safety procedures. All spills would be managed in accordance with a Spill Response Plan. First stage propellants, RP-1 and liquid oxygen, would be stored in tanks near the launch pad within cement containment basins designed to retain 110 percent of the storage tank volumes. Post-fueling spills from the launch vehicle would be channeled into a sealed concrete catchment basin and disposed of according to the appropriate State and Federal regulations. Second stage propellants, Aerozine-50 and  $N_2O_4$ , are not stored at the SLCs and would be transported to the launch site by specialized vehicles.

At VAFB, the most severe propellant spill accident scenario would be releasing the entire Titan II launch vehicle load of nitrogen tetroxide at the launch pad while conducting propellant transfer operations. Under adverse weather conditions, it was predicted that a plume from a spill involving a Titan may reach as far as 4 kilometers (2.5 miles) before nitrogen oxide concentrations are lowered to 5 parts per million (ppm), and would travel several miles farther before being lowered to 1 ppm [USAF 1988]. If the direction of the wind and the critical distance for hazardous vapor dispersal were to include an on-base or offbase uncontrolled area, propellant loading would be postponed [TITAN 1987]. At CCAS, the most severe propellant spill accident scenario would be releasing the entire Delta II 7925 launch vehicle load of nitrogen tetroxide at the launch pad while conducting propellant transfer operations. Using the Titan predictive models and scaling for the Delta propellant loading, incremental airborne  $NO_x$  levels from this scenario should be reduced to 5 ppm within about 150 meters (500 feet) and to 1 ppm within 300 meters (about 1,000 feet) [DELTA 1994]. In both cases, activating the launch pad water deluge system would substantially reduce the evaporation rate, limiting exposure to concentrations that are above Federally established standards to the vicinity of the spill. Propellant transfer personnel would be outfitted with protective clothing and breathing equipment. Personnel not involved in transfer operations would be excluded from the area.

### 5.5.2 Launch Failures

The environmental impacts of any of the proposed launch vehicles during launch failures have been previously described in environmental assessments for each launch vehicle [DELTA 1991], [ATHENA 1994], [ATHENA 1995], [DELTA 1995], [PEGASUS 1989], [TAURUS 1992b] and [TITAN 1987]. Accidents either on the launch pads or within a few seconds of launch present the most threat to people, mainly the launch complex work force. Due to Range Safety requirements and operational requirements all personnel, including workers are sufficiently far away from the launch site so as not to be affected by debris and other direct impacts of such accidents. There are potential short term effects including: localized effects of a fireball, fragments from the explosion, and release of some propellants and combustion products.

Range Safety requirements mandate command safety destruct (CSD) systems on liquid propellant tanks and solid rocket motors. In the event of a CSD action, combustion products would include:  $\text{Al}_2\text{O}_3$  particulates, HCl, CO, oxides of nitrogen ( $\text{NO}_x$ ) from the solids and  $\text{CO}_2$  and nitrogen ( $\text{N}_2$ ) from the hypergols. The amount of dilution would be dependent on existing meteorological conditions at the time of launch. The flight of the vehicle would be monitored by Air Force personnel who have authority to destroy the launch vehicle in the event of abnormal operations or a departure from the approved limits of flight. [ATHENA 1995]

Some uncombusted propellants could enter nearby surface waters or the Pacific/Atlantic Ocean. Depending on the amount of fuel reaching the water bodies, aquatic biota could be subject to short term impacts including death to biota in the immediate area due to hydrazine or nitrogen tetroxide releases. Immediate on pad effects to terrestrial plants and animals due to the fireball are possible. These effects although severe are transient and occur only one time if there is an accident on the pad.

#### CCAS

In the event of a launch vehicle destruction, either on the pad or in-flight, the liquid propellant tanks and SRM cases of the Delta II would be ruptured. Table 5-6 illustrates the REEDM predictions for chemical species concentrations at CCAS due to a GEM SRM failure (conflagration) during worst case meteorological conditions.

Table 5-6. Peak Concentrations and 60-Minute Mean Concentrations for a GEM SRM Failure (Conflagration) of the Delta II 7925 at CCAS During Worst Case Meteorological Conditions

Exhaust Cloud Constituent	Peak Concentration (ppm)	Maximum 60-Minute Mean (ppm)	Distance From LC-17 Peak/Mean (kilometers)
CO	0.279	0.084	24/31
CO <sub>2</sub>	0.019	0.006	24/31
Cl	0.019	0.006	24/31
HCl	0.120	0.036	24/31
Al <sub>2</sub> O <sub>3</sub> *	0.613 mg/m <sup>3</sup>	0.085 mg/m <sup>3</sup>	15/23

Source: Data acquired from [USAF 1997a]

\*Al<sub>2</sub>O<sub>3</sub> concentrations are in mg/m<sup>3</sup> because the aluminum oxide is a particulate rather than a gas.

Table 5-7 illustrates the REEDM predictions for chemical species concentrations of a catastrophic launch pad failure (deflagration), wherein there is burning of the hypergolic propellants. Although much of the solid and hypergolic propellants would be burned in either failure mode, emissions would include the constituents from a normal launch and dispersed propellants, including hydrazine (N<sub>2</sub>H<sub>4</sub>), and Unsymmetrical Dimethyl Hydrazine (UDMH). For the deflagration scenario, additional species such as UDMH, NO<sub>2</sub>, ammonia (NH<sub>3</sub>), N<sub>2</sub>H<sub>4</sub>, nitrosodimethylamine (NDMA), formaldehyde (FDH), and nitric acid (HNO<sub>3</sub>) were considered by REEDM. REEDM predicted there would be no FDH and NDMA found in the ground cloud. Any nitrogen tetroxide (N<sub>2</sub>O<sub>4</sub>) which does not react with other propellants is predicted by REEDM to convert to nitrogen dioxide (NO<sub>2</sub>) in the fireball chemical reactions. This release of pollutants would have only a short-term impact on the environment near LC-17.

Table 5-7. Peak Concentrations and 60-Minute Mean Concentrations for a Catastrophic Launch Pad Failure (Deflagration) of the Delta II 7925 at CCAS During Worst Case Meteorological Conditions

Exhaust Cloud Constituent	Peak Concentration (ppm)	Maximum 60-Minute Mean (ppm)	Distance From LC-17 Peak/Mean (kilometers)
CO	8.701	0.255	10/12
UDMH	0.044	0.001	10/12
HCl	0.511	0.015	10/12
NH <sub>3</sub>	0.260	0.008	10/12
NO <sub>2</sub>	0.660	0.019	10/12
N <sub>2</sub> H <sub>4</sub>	0.016	No N <sub>2</sub> H <sub>4</sub> Found	10/--
Al <sub>2</sub> O <sub>3</sub> *	0.405 mg/m <sup>3</sup>	0.012 mg/m <sup>3</sup>	10/12
HNO <sub>3</sub>	0.002	No HNO <sub>3</sub> Found	14/--

Source: Data acquired from [USAF 1997a]

\*Al<sub>2</sub>O<sub>3</sub> concentrations are in mg/m<sup>3</sup> because the aluminum oxide is a particulate rather than a gas.

## VAFB

A Delta II vehicle abort condition can be self initiated by a failure in a solid rocket motor or the liquid main engine. If the vehicle guidance or flight control system fails the vehicle may be destroyed by initiation of destruct charges on command from the Missile Flight Control Officer. In either event the solid rocket motors are assumed to be destroyed resulting in a scatter of burning solid propellant fragments that fall back to the ground and burn for several minutes. Destruction of the core vehicle in flight is assumed to result in rupture of the RP-1 tank with incomplete consumption of RP-1. Residual burning of RP-1 on the ground in the vicinity of the scattered solid propellant fragments is assumed to occur. This kind of failure is simulated using the REEDM "conflagration" failure mode (see Table 5-8). [USAF 1997b]

Table 5-8. Peak Concentration and 60-Minute Mean Concentration Predictions for Delta II 7925 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-2 Peak-Mean (kilometers)
CO	0.78	0.30	11-14
CO <sub>2</sub>	0.05	0.02	11-14
Al <sub>2</sub> O <sub>3</sub> *	45.4 mg/m <sup>3</sup>	6.16	13-13
HCl	0.34	0.13	11-14

Source: Data acquired from [USAF 1997b]

\*Al<sub>2</sub>O<sub>3</sub> concentrations are in mg/m<sup>3</sup> because the aluminum oxide is a particulate rather than a gas.

The Titan II is a two stage core vehicle that utilizes liquid Aerozine-50 fuel (a 50/50 blend of hydrazine and unsymmetrical dimethyl hydrazine (UDMH) and nitrogen tetroxide oxidizer in both stages. Both the liquid fuel and oxidizer are toxic chemicals in their liquid and vapor states, however, under nominal engine performance the fuel and oxidizer react to produce non-toxic or low toxicity combustion products. Titan launch vehicle failures present a unique hazard due to the large quantities of hypergolic liquid propellants used on the vehicle. The failure of the Titan 34D-9 at Vandenberg in 1986 amply demonstrated the probability of incomplete mixing and reaction of the fuel and oxidizer components during vehicle breakup. By design the Titan propellant tanks are ruptured during a command destruct action, but theoretical and empirical evaluations suggest that less than 25 percent of the fuel and oxidizer react. The residual portions of the hydrazine fuel and nitrogen tetroxide oxidizer 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 NDMA (nitrosodimethylamine) and FDH (formaldehyde dimethyl hydrazone). The concentration predictions for these and other chemicals predicted to result from a Titan II abort are listed in Table 5-9. [USAF 1997b]

Table 5-9. 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 (kilometers)
CO	1.59	0.53	9-13
CO <sub>2</sub>	0.98	0.33	9-13
UDMH	1.24	0.41	9-13
NH <sub>3</sub>	7.51	2.50	9-13
NO <sub>2</sub>	19.44	6.39	9-13
N <sub>2</sub> H <sub>4</sub>	0.38	0.11	8-11
NDMA	Trace*	Trace*	No Data
FDH	0.03	0.01	13-21
HNO <sub>3</sub>	0.66	0.33	13-21

Source: Data acquired from [USAF 1997b]

\*Trace quantities are <0.01.

Under normal or catastrophic launch scenarios, concentrations would not be hazardous except in the immediate vicinity of the launch pad for approximately two minutes after launch or near the centroid of the launch cloud for a short time after the launch. The launch cloud would be several hundred meters above ground level, depending on weather conditions. These hazardous concentrations near the centroid of the launch cloud would persist for an estimated ten minutes, but could occur for shorter or longer periods depending on meteorological conditions. Prior to launch, personnel are cleared from the areas where potentially hazardous concentrations would occur, and there should be no hazard to humans associated with exhaust effluents. The health hazard quantities of these chemicals are summarized in Table 5-10.

For the propellants that would be dispersed to the air in the event of a catastrophic launch failure, hazardous concentrations would not occur except in the immediate vicinity of the launch complex. Since personnel would be cleared from the area prior to launch, there should be no hazard to humans from dispersed propellants in the event of a catastrophic launch failure.

Since Immediate Danger to Life or Health standards (IDLHs), Permissible Exposure Limits (PELs), Short Term Exposure Limits (STELs), and Threshold Limit Values (TLVs) are established considering potential exposure of workers, they should not be used for evaluating the potential health significance of accidental release which may impact the general population. They are, however, included here since personnel would be transferring and loading fuel at the pad prior to launch. The recommended guidelines used to determine safe exposure limits for the general population should instead be the Emergency Response Planning Guidelines (ERPGs), developed by the American Industrial Hygiene Association. The endpoint for a toxic substance is its Emergency Response Planning Guideline level 2 (ERPG-2) (Section 112r of the Clean Air Act). None of the concentrations predicted by REEDM for catastrophic launch aborts

of the Titan or Delta at CCAS/VAFB exceeded the ERPG-2 values except in the immediate vicinity of the launch pad.

A Delta II 7925 failure occurred on January 17, 1997 at CCAS as a result of a GEM breaking apart. The flight termination systems proved able to prevent hazard to the public. The vast bulk of the plume from the accident was out over water; maximum concentrations of HCl and NO<sub>2</sub> were both 1 to 2 ppm. A slight wisp at the surface may have blown on-shore at concentrations below detection. A large buoyant and visible plume covered much of southern Brevard County and Indian River County at high altitude. No aspect of this plume was hazardous. However, CCAS now has a Brevard County Emergency Management Center (BEMC) representative at the launch console beginning two hours before launch, as well as a direct audio and video feed to BEMC. They have installed a crash net phone to the Florida State Emergency Response Center. [BE 1997b]

Table 5-10. Health Hazard Quantities of Hazardous Launch Emissions

Compound	ERPG (ppm)			EEGL (ppm)	SPEGL (ppm)	PEL (ppm)	STEL (ppm)	TLV (ppm)	IDLH (ppm)
	1	2	3						
Unsymmetrical Dimethyl Hydrazine (UDMH)	0.03	8	80	0.24 - 1 hr 0.12 - 2 hr 0.06 - 4 hr 0.03 - 8 hr 0.015 - 16 hr 0.01 - 24 hr	24 - 1 hr 1 - 24 hr	0.5 (skin)		0.01 (skin)	15
Hydrazine (N <sub>2</sub> H <sub>4</sub> )	0.03	8	80		0.12 - 1 hr 0.06 - 2 hr 0.03 - 4 hr 0.015 - 8 hr 0.008 - 16 hr 0.005 - 24 hr	1 (skin)		0.01 (skin)	50
Hydrochloric Acid or Hydrogen Chloride (HCl)	3	20	100	100 - 10 min 20 - 1 hr 20 - 24 hr	1 (ceiling)	5 (ceiling)		5 (ceiling)	50
Nitrogen Tetroxide (N <sub>2</sub> O <sub>4</sub> ) as NO <sub>2</sub>				1 - 1 hr (ceiling) 0.04 - 24 hr (ceiling)	1 - 1 hr 0.5 - 2 hr 0.25 - 4 hr 0.12 - 8 hr 0.06 - 16 hr 0.04 - 24 hr	5 (ceiling)		5 (STEL) 3 (TWA)	20
Ammonia (NH <sub>3</sub> )	25	200	1000			50	35	25	
Nitric Acid (HNO <sub>3</sub> )	4	10	100			2	4	2	
Nitrogen Dioxide (NO <sub>2</sub> )*				1 - 1 hr (ceiling) 0.04 - 24 hr (ceiling)	1 - 1 hr 0.5 - 2 hr 0.25 - 4 hr 0.12 - 8 hr 0.06 - 16 hr 0.04 - 24 hr	5 (ceiling)		5 (STEL) 3 (TWA)	20
Aluminum Oxide (Al <sub>2</sub> O <sub>3</sub> )**	15	15	25	50 - 10 min 25 - 30 min 15 - 60 min					

Source: Data acquired from [NAVSTAR 1994], [BE 1997b] and [ERPG 1997]

**ERPG** Emergency Response Planning Guidelines - Developed by the American Industrial Hygiene Association, ERPGs are the maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour: ERPG-1 - without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor, ERPG-2 - without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action, and ERPG-3 without experiencing or developing life-threatening health effects.

**EEGL** Emergency Exposure Guidance Level - Advisory recommendations from the National Research Council (NRC) for the Department of Defense (DoD) for an unpredicted single exposure.

**SPEGL** Short-term Public Emergency Guidance Level - Advisory recommendations from the NRC for the DoD for an unpredicted single exposure by sensitive population.

**PEL** Permissible Exposure Limit - Occupational Safety and Health Administration (OSHA) standards averaged over an 8-hour period, except for ceiling values which may not be exceeded in the workplace.

**STEL** Short Term Exposure Limit - OSHA standards averaged over 15-minute period in the workplace.

**TLV** Threshold Limit Value - Recommendations of the American Conference of Governmental Industrial Hygienists. The TLV is the airborne concentration of the substance which represent conditions under which it is believed nearly all workers may be repeatedly exposed to day after day without adverse effect. There are three categories of TLVs: 1) Time Weighted Average (TWA) is the time weighted average concentration for a normal 8-hour work day or 40-hour week, 2) Short Term Exposure Limit (STEL) is the maximum concentration to which workers can be exposed to for a period of up to 15 minutes, and 3) Ceiling is the concentration that should not be exceeded even instantaneously.

**IDLH** Immediately Dangerous to Life or Health - Air concentration at which an unprotected worker can escape without debilitating injury or health effect - a 30 minute exposure

\* The National primary and secondary ambient air quality standard (NAAQS) for nitrogen dioxide is 0.053 ppm - annual arithmetic mean.

\*\* Aluminum oxide concentrations are given in milligrams per cubic meter (mg/m<sup>3</sup>).

### 5.5.3 Range Safety

A Range Safety Program [WR 1995] is implemented for each launch to ensure that the launch and flight of launch vehicles and payloads present no greater risk to the general public than that imposed by the overflight of conventional aircraft. In addition to public protection, range safety on a national range includes launch area safety, launch complex safety, and the protection of national resources.

NMP proposed launch vehicle impacts have previously been approved for launch of spacecraft from CCAS and VAFB. The NMP would not increase launch rates nor utilize launch systems beyond the scope of approved programs at VAFB/CCAS.

## 5.6 PAYLOAD PROCESSING IMPACTS

Potential payload processing impacts are anticipated to be similar for all NMP payloads. The following discussion, based on DS1, presents a representative estimate for NMP spacecraft.

In terms of payload processing, there are no anticipated releases of fluorocarbons to the atmosphere. Ozone-depleting chlorofluorocarbons (CFCs) and hydrofluorocarbons (HFCs) are commonly used for both cooling systems and fire suppression systems. Support services for payloads may require provision of a cooling system for the period immediately before launch. An electro-mechanical compressor/condenser unit would be used. Any ozone-depleting chemicals would be properly contained, reused, or disposed of in accordance with applicable Federal, State, and local laws, regulations, rules, and site specific hazardous waste management plans. There is no planned free venting of the system to the atmosphere. NASA has an active program in place to eliminate use of CFC's to the maximum extent possible consistent with flight safety.

Approximately 15.1 liters (4 gallons) of isopropyl alcohol (IPA) would be used prior to satellite processing to wipe the interior of the facility free of dust. The IPA would evaporate inside the building and it is unlikely that any amount of IPA would escape into the environment [PPF 1993]. Usage rate of IPA wipe cleaner would be well within the prescribed SBCAPCD Rules and Regulations.

NMP spacecraft utilizing ion propulsion would be loaded with approximately 75 kilograms (170 pounds) of xenon. In a confined space, overpressure and/or structural failure of the xenon tanks may allow the xenon to escape resulting in an oxygen deficient atmosphere. To prevent xenon from escaping, the low pressure side of the tank is designed to survive the maximum operating pressure of the high pressure side without venting. Xenon is an inert gas and is not toxic; therefore, normal safety handling is all that is required for its use.

Operations at the payload processing facility, would include loading of fuel propellants (hydrazine and nitrogen tetroxide) from existing loading carts. Emissions from the loading process would be controlled by a permitted air emissions control system (scrubbers or closed loop propellant transfer). Estimates of scrubber emission rates for hydrazine and nitrogen oxide vapors are estimated to be less than 0.0009 kilograms per hour (0.002 pounds per hour) and 0.026 kilograms per hour (0.057 pounds per hour), respectively. [PPF 1993]

To further investigate the potential impact on the environment as a result of propellant loading, the U.S. EPA SCREEN atmospheric dispersion model was employed. When compared to a National Academy of Sciences, Committee on Toxicology Report, OSHA Standards, and several State regulated acceptable ambient limits, the maximum predicted hydrazine concentration is below each standard or regulation (Table 5-11). When compared to the State of California standard (for nitrogen dioxide) and OSHA standard (for nitrogen dioxide and nitrogen tetroxide) the maximum predicted nitrogen oxides concentration is below each standard (Table 5-12). [PPF 1993]

Table 5-11. SCREEN Model Results for Hydrazine Compared to Acceptable Levels

Agency/SCREEN Model Results	Acceptable Ambient Level/SCREEN Model Results
National Academy of Sciences	19.6 $\mu\text{g}/\text{m}^3$ – 8hr
OSHA	130 $\mu\text{g}/\text{m}^3$ – 8hr
SCREEN Model Results	0.2 $\mu\text{g}/\text{m}^3$ – 8hr

Source: [PPF 1993]

Table 5-12. SCREEN Model Results for Nitrogen Oxides Compared to Acceptable Levels

Agency/SCREEN Model Results	Acceptable Ambient Level/SCREEN Model Results
State of California (nitrogen dioxide)	470 $\mu\text{g}/\text{m}^3$ – 8hr
OSHA	900 $\mu\text{g}/\text{m}^3$ – 8hr
ACGIH (nitrogen dioxide)	600 $\mu\text{g}/\text{m}^3$ – 8hr
SCREEN Model Results	5.1 $\mu\text{g}/\text{m}^3$ – 8hr

Source: [PPF 1993]

Ground operations would temporarily increase emissions slightly from electrical power generators and vehicle traffic. Tables 5-13 and 5-14 represent a comparative expectation for the Taurus program involving four launches per year. The anticipated increases for NMP would be within the range predicted here. These increases are not expected to have substantial adverse impacts to air quality.

Table 5-13. Emissions from Generators for Launch Vehicle Power and Lighting

Pollutant	Tons/Launch	Tons/Year
CO	0.23	0.92
HC	0.09	0.36
NOx	1.07	4.28
SOx	0.07	0.28
PM	0.08	0.32

Source: Adapted from [SELV 1992]  
 Figures are for the Taurus launch program  
 Assumes four Taurus launches per year

Table 5-14. Emissions from Support Vehicles and Equipment

Equipment	Emissions, Tons/Launch (Tons/Year)				
	CO	HC	NOx	SOx	PM
Cranes (2)	0.12 (0.48)	0.03 (0.12)	0.33 (1.32)	0.03 (0.12)	0.03 (0.12)
Trucks (15)	0.003 (0.012)	0.012 (0.048)	0.012 (0.048)	0.003 (0.012)	0.003 (0.012)
Total	0.123 (0.491)	0.042 (0.169)	0.342 (1.399)	0.033 (0.132)	0.033 (0.132)

Source: Adapted from [SELV 1992]  
 Figures are for the Taurus launch program  
 Assumes four Taurus launches per year

### 5.6.1 Exposure to Hazardous Fluids During Ground Processing and/or Launch

Inadvertent activation of the thrusters, overpressure of the feed system and/or structural failure, failure of tubing, components, tank, joints, or valve seats may cause potential for exposure to hazardous fluids during ground processing/launch.

Thruster valves are dual seated and two independent electrical inhibits (the PDE enable and thruster firing command) prevent activation of the thruster valves. The propellant tanks are inherited from the Mars Pathfinder Program and would provide a sufficient structural safety-factor margin. Materials used in the construction of propellant tanks would be compatible in accordance with MSFC-HDBK-527/JSC 09604. Monitoring of pressure and temperature would be performed while the spacecraft is powered.

The feed system would be an all welded construction - no mechanical joints. Service valves are dual seated. Functional, proof, and leak tests would be performed on the feed system.

#### 5.6.1.1 Propellant Off-Loading

A DS1 propellant off-loading plan would be prepared and detailed step-by-step test procedures would be developed to safely off-load propellant from the spacecraft in the event that an emergency situation develops. Emergency off-loading the RCS involves:

- Depressurization of the pressurant side of the tanks
- Off-loading the hydrazine propellant

Propellant leaks would be detected using dual redundant Interscan vapor detectors with a sensitivity to 0.01 parts per million (ppm). Detectors would be operational at all times when the spacecraft is fueled and personnel are present. In the event of propellant leakage:

- The area would be evacuated, exhaust systems activated, and emergency crews summoned.
- Power to the spacecraft would be inhibited.
- Leak source would be determined and the system depressurized.
- Liquid propellants would be off-loaded.

The fuel cart and flex hoses are designed to be flushed and aspirated clean. All hazardous fluids would be collected for proper disposal.

The fuel cart used for loading is also used for hydrazine (N<sub>2</sub>H<sub>4</sub>) off-loading. If necessary, the spacecraft can be off-loaded on the launch pad. All service valves would be accessible through an access door in the fairing. The RCS service valves would be connected to the existing LC-17 fuel service panels. The N<sub>2</sub>H<sub>4</sub> is routed through the panel and existing drain lines to a waste container at the base of the pad. Pressure remaining in the propellant tank would be used to prevent drawing a vacuum on the gas side of the diaphragm due to the height of the drain lines.

#### 5.6.2 Payload Processing Facility (PPF) Environmental Management

As “small quantity generators” of hazardous waste, payload processing facilities must prepare and retain a written contingency plan and emergency procedures for dealing with emergencies. Each action plan elucidates required coordination with officials, applicable regulations and specific actions to be taken during an emergency. [SPILL 1995] It is expected that all PPFs at VAFB, CCAS and KSC would have similar emergency response and environmental management plans.

Hazardous materials present at PPFs include small quantities of isopropyl alcohol, spray paint and general purpose cleaner.

Recyclable solid waste produced by NMP would be reused, or recycled through base recycling plans, or processed through the Defense Reutilization Marketing Office (DRMO) to meet Air Force solid waste reduction goals in accordance with Executive Order 12856.

Materials to be used for DS1 processing are listed in Table 5-15. These materials are assumed to be typical of the materials to be used for all NMP spacecraft processing. This list denotes the approximate quantity of material that would be used during DS1 processing. Any remaining material would be properly stored for future use or disposed of in accordance with all applicable regulations.

Table 5-15. DS1 Payload Processing Materials

Material	Quantity	Purpose
Isopropyl Alcohol	5 Gallons	Wash
Denatured Alcohol	5 Gallons	Wash
Ink, White	1 Pint	Marking
Ink, Black	1 Pint	Marking
Glue	1 Gallon	
Epoxy, Resin	1 Gallon	
Acetone	1 Gallon	
Trichlor 1.1.1	1 Pint	Solder Cleaning
Paint, Enamel	1 Gallon	
Paint, Lacquer	1 Gallon	
Mineral Spirits	1 Gallon	
Lacquer Thinner	1 Gallon	
Lubricant, Synthetic	1 Pint	
Flux, Solder, MA	1 Pint	
Flux, Solder, RA	1 Pint	
Aladyne	1 Pint	Metal Passivation

Source: [BE 1997c]

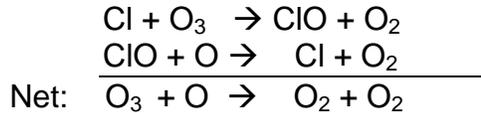
### 5.6.3 Hazardous Waste Management

Hazardous materials are controlled in accordance with Federal, State, local and VAFB, CCAS and KSC regulations, and are allocated to the person responsible for the scheduled activities on a one-day supply basis.

## 5.7 IMPACTS ON STRATOSPHERIC OZONE

During the last 20 years there has been an increased concern about human activities affecting the upper atmosphere. Substantial decreases of total ozone in the middle and high latitudes of both hemispheres have been documented [WMO 1994]. The links between ozone losses in the Antarctic spring and Arctic winter stratosphere and human-made chlorine and bromine increases have been established. Although losses of total ozone and midlatitude dynamics are difficult to simulate with atmospheric models, the observed losses are best explained by the halogen increases. Furthermore, the link between a decrease in stratospheric ozone and an increase in surface UV radiation has been measured [WMO 1994].

Space vehicles that use SRMs have been studied concerning potential contribution to ozone depletion due to exhaust products. Primary constituents of exhaust from solid-fueled rocket motors are HCl, CO<sub>2</sub>, CO, and Al<sub>2</sub>O<sub>3</sub>. To date, most attention in previous studies has focused on the chlorine emissions of rockets as the largest threat to stratospheric ozone (e.g., [HCl 1996a] and references therein). Through reaction with OH (OH + HCl → Cl + H<sub>2</sub>O), the chlorine atom from HCl is released to play a role in ozone loss. One such catalytic loss cycle is:



The Cl is not consumed in this loss process, thus one Cl atom can be responsible for the loss of many hundreds of thousands of ozone molecules before reacting with another atmospheric constituent and ending the catalytic loss cycle [HCl 1975].

### 5.7.1 NMP Launch Vehicle Impacts on Stratospheric Ozone

Since the planned NMP launch vehicles would result in emissions of exhaust products into the stratosphere, their effect on stratospheric ozone depletion was evaluated. The average global stratospheric ozone depletion rates for the types of chemicals emitted were calculated as a percent O<sub>3</sub> reduction (in a global annually averaged sense) per ton of exhaust emissions. The relevant depletion rates were 2.8 x 10<sup>-5</sup> percent reduction for each ton of HCl emitted [HCl 1998], 7.5 x 10<sup>-6</sup> percent reduction for each ton of Al<sub>2</sub>O<sub>3</sub> emitted [HCl 1998], and 1.6 x 10<sup>-6</sup> reduction for each ton of NO emitted [JA 1998], [HCl 1996c] and [HCl 1996b].

Using the depletion rates above, estimates of peak ozone depletion per launch of the Delta II 7925, Athena 2, Taurus, Pegasus and Titan II launch vehicles were calculated (Table 5-16). The tabulated values are conservative, in that they were calculated assuming all HCl, Al<sub>2</sub>O<sub>3</sub>, and NO<sub>x</sub> would migrate to the stratosphere. Also, a study of Space Shuttle launches from KSC indicates that 28 percent of the HCl produced in the first ten seconds of launch is entrained in deluge water and/or deposited on the ground, which strongly suggests that input values for stratospheric ozone calculations and ground cloud composition be reduced by at least 20 to 30 percent [HCl 1985]. No reductions of this kind were used in calculating the ozone depletion estimates below.

Table 5-16. Percent Stratospheric Ozone Reduction  
(in a global annually averaged sense) per Launch

Launch Vehicles	HCl (tons/launch)	Al <sub>2</sub> O <sub>3</sub> (tons/launch)	NO <sub>x</sub> (tons/launch)	Percent Ozone Depletion (HCl + Al <sub>2</sub> O <sub>3</sub> + NO <sub>x</sub> )
Delta II 7925	24.8	42.1	9.6	1.0 x 10 <sup>-3</sup>
Athena 2	19.2	36.0	9.2	8.2 x 10 <sup>-4</sup>
Taurus	17.2	34.4	8.0	7.5 x 10 <sup>-4</sup>
Pegasus	3.1	6.4	1.4	1.3 x 10 <sup>-4</sup>
Titan II	0	0	0.6	9.6 x 10 <sup>-7</sup>

Source: Data acquired from [PEGASUS 1989], [ATHENA 1995], [SELV 1992], [TITAN 1987] and [DELTA 1994]. NO<sub>x</sub> values for the Athena and Delta were extrapolated by comparing their total solid propellant quantity to that of the Taurus. Quantities are for the complete burn of all solids. Assumes all emissions migrate to the stratosphere.

Rockets contribute very minor amounts of HCl to the atmosphere when compared with other human-made sources. The launch scenario of nine Space Shuttles and three Titan IVs each year would release 725 metric tons (800 tons) of HCl into the atmosphere. Existing analyses show extremely small, if any, long-term impacts on stratospheric ozone from the HCl emissions due to Space Shuttle and Titan operations. A launch rate of two Delta II 7925 rockets per year would introduce a maximum of 45 metric tons (50 tons) of HCl into the atmosphere, some of which would be released at too low an altitude to have any potential impact on stratospheric ozone.

Solid rockets also emit  $\text{Al}_2\text{O}_3$ . The launch scenario of nine Space Shuttles and three Titan IVs each year would release 1,215 metric tons (1,340 tons) of  $\text{Al}_2\text{O}_3$  (alumina) into the atmosphere. It is not clear what will happen to the alumina particles once they are emitted into the atmosphere. If the alumina particles become coated by  $\text{H}_2\text{SO}_4$  (hydrogen sulfate), then they would result in a small increase in the background sulfate particle burden, a minor effect. However, if they remain uncoated, the alumina particles would have a higher potential for ozone depletion because they could promote a chlorine activation reaction ( $\text{ClONO}_2 + \text{HCl} \rightarrow \text{HNO}_3 + \text{Cl}_2$ ). A recent analysis [HCl 1998] showed extremely small, if any, long-term impacts on stratospheric ozone from the  $\text{Al}_2\text{O}_3$  emissions due to Space Shuttle and Titan operations. [JA 1998]

Extensive analyses have been performed and concluded that “the effects of rocket propulsion on stratospheric ozone depletion, acid rain, toxicity, air quality, and global warming were extremely small compared to other anthropogenic impacts, and therefore that there is no pressing need to change propellants of current launch systems.” [ELV 1991]

## 5.8 LAND RESOURCE IMPACTS

### VAFB

The likely anticipated land impacts would be to soils and vegetation from acidic deposition of launch vehicle exhaust. The HCl content of the exhaust plume from solid rocket motors would not be expected to adversely affect the local soils. The soils on VAFB 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. In contrast, soils at Cape Canaveral are more susceptible to acidic deposition than those at VAFB [ATHENA 1995]. However, despite additions of significant amounts of acidic deposition from 43 wet launches over a ten year period, the affected soils at CCAS showed no decrease in buffering capacity [ATHENA 1995]. Therefore, the HCl content of the exhaust plume from solid rocket motors would not be expected to adversely affect VAFB soils. In addition, aluminum oxide would not affect the soils because it would be deposited as a stable compound.

The observation of plant communities at VAFB launch sites, such as the Titan IV pad at SLC-4, indicate that plants are able to thrive in the extreme near-field of launch events.

## CCAS

Overall, launching of proposed NMP launch vehicles is expected to have negligible effects on the land forms surrounding LC-17 and LC-46. However, launch activities could have some small impacts near the launch pad associated with fire and acidic deposition. Minor brush fires are infrequent by-products of Delta launches, and are contained and limited to the ruderal vegetation within the launch complexes; past singeing has not permanently affected the vegetation near the pads. Wet deposition of HCl, caused by rain falling through the ground cloud or SRM exhaust, could damage or kill vegetation. Wet deposition is not expected to occur outside the pad fence perimeter, due to the small size of the ground cloud and the rapid dissipation of both the ground cloud and SRM exhaust plume. [DELTA 1995]

## 5.9 WATER QUALITY IMPACTS

### VAFB

Water usage for NMP payload processing fits within the current scope of water discharge permit definitions. Local and regional water resources would not be affected since there would be no ground water withdrawals. Water utility piping would be used to meet miscellaneous onsite needs. As a result there would be no related impacts to the ground water, surface water or wastewater processing system.

The nearest bodies of surface water are beyond the range of expected impacts. Moreover, the high acid neutralization characteristics of the local drainages would counteract any acidic deposition from rocket launches [ATHENA 1995]. In the event that rain water absorbs HCl which might then be deposited on the ground, this natural buffering capacity of the streams would result in negligible or no change in water quality [ATHENA 1995].

### CCAS

Water, supplied by municipal sources, is used at LC-17 for deluge water (for fire suppression), launch pad washdown, and potable water. Most of the deluge and launch pad washdown water is collected in a concrete catchment basin; however, minor amounts may drain directly to grade. The only potential contaminants used on the launch pad are fuel and oxidizer, and the only release of these substances would occur within sealed trenches and should not contaminate runoff. Any accidental or emergency release of propellants from the Delta vehicle after fueling would be collected in the flume located directly beneath the launch vehicle and channeled to a sealed concrete catchment basin.

If the catchment basin water meets the criteria set forth in the FDEP industrial wastewater discharge permit, it is discharged directly to grade at the launch site. If it fails to meet the criteria, it is 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 medium launch vehicle operations at LC-17. To ensure this, the groundwater in the discharge area is monitored quarterly by Air Force Bioenvironmental Engineering Services. [DELTA 1995]

The primary surface water impacts from a normal Delta II launch involve HCl and Al<sub>2</sub>O<sub>3</sub> deposition from the ground cloud. The cloud would not persist or remain over any location for more than a few minutes. Depending on wind direction, most of the exhaust may drift over the Banana River or the Atlantic Ocean, resulting in a brief acidification of surface waters from HCl. Aluminum oxide is relatively insoluble at the pH of local surface waters and is not expected to cause elevated aluminum levels or significant acidification of surface waters. The relatively large volume of the two bodies of water compared to the amount of exhaust released is a major factor working to prevent a deep pH drop and fish kills associated with such a drop. There have been no fish kills recorded in the Atlantic Ocean or Banana River as a result of HCl and Al<sub>2</sub>O<sub>3</sub> deposition during a normal launch. A normal Delta II launch would have no substantial impacts to the local water quality. [DELTA 1995]

#### 5.9.1 Ocean Environment

In a normal launch from CCAS or VAFB, the first stage and SRMs would land in the ocean. The trajectories of spent first stage and SRMs would be programmed to impact a safe distance from any U.S. coastal area or other land mass. Toxic concentrations of metals are not likely to occur due to the slow rate of corrosion in the deep ocean environment and the large quantity of water available for dilution [DELTA 1995].

Since the first stage and SRMs would be burned to depletion in-flight, there would be 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 the first stage propellant would spread rapidly to form a localized surface film that would evaporate in several hours. Second stage propellants are soluble and should also disperse rapidly.

Concentrations in excess of the maximum allowable concentration of these compounds for marine organisms would be limited to the immediate vicinity of the spent stage. No substantial impacts are expected from the reentry and ocean impact of spent stages, due to the small amount of residual propellants and the large volume of water available for dilution.

## 5.10 NOISE, SONIC BOOM AND VIBRATION

Shipping in the area likely to be affected is warned of the impending launches as a matter of routine, so that all sonic booms are expected and of no practical consequence.

Peak launch noises for all potential NMP launch vehicles are experienced for a very brief time period (approximately 5 seconds), and therefore, are not expected to exceed EPA or OSHA requirements and recommendations (Table 5-17). Moreover, any personnel at the launch site exposed to high noise levels would wear protective gear.

Table 5-17. Launch Vehicle Noise Levels at 1 Mile in A-weighted Decibels

Launch Vehicle	Noise Level	Standard
Titan II	112	<u>OSHA Requirements</u> Not to exceed 115 dBA for > 15 min.    Not to exceed 90 dBA for an 8-hr day  <u>EPA Recommendation</u> Not to exceed 70 dBA for the general public as a 24-hr average
Delta II	110	
Taurus	100	
Athena	99	

Source: Data acquired from [SELV 1992], [TITAN 1987], [NAVSTAR 1994] and [ATHENA 1995]

## VAFB

Pinniped<sup>23</sup> harassment permits are either in place or are being developed to accommodate impacts for vehicles with NMP launch capabilities. Monitoring and mitigation plans developed by Spaceport Systems International and McDonnell Douglas Aerospace (now Boeing) identify 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 service.

## CCAS

The engine noise and sonic booms from a Delta II launch are typical of routine CCAS operations. To the surrounding community, noise from launch-related activity appears, at worst, to be an infrequent nuisance rather than a health hazard. In the history of the USAF space-launch vehicle operations from CCAS, there have been no problems reported as a result of sonic booms, most probably because the ascent track of all vehicles and the planned reentry of spent suborbital stages are over open ocean, thus placing sonic booms away from land areas. [DELTA 1995]

### 5.11 BIOTIC RESOURCES/ENDANGERED SPECIES IMPACTS

Any action that may affect Federally listed species or their critical habitats requires consultation with the U.S. Fish and Wildlife Service (USFWS) and/or the National Marine Fisheries Service (NMFS) under Section 7 of the Endangered Species Act of 1973 (as amended). The USFWS and the NMFS have previously reviewed those actions which would be associated with the launch of NMP proposed launch vehicles from VAFB and CCAS. Currently no NMP-specific processing or launch activities have been identified that would require permits and/or mitigation measures beyond the baseline permits and mitigation measures already necessary or in coordination for VAFB and CCAS launches.

## VAFB

The listed endangered or threatened species are located in colonies away from the payload processing facilities and the space launch facilities under consideration at VAFB and, therefore, from the immediate influence of rocket launches and launch staging activities. The nearest colonies are in Cañada Honda Creek and along the rocky coastline.

Previous environmental analyses for the Titan IV/Centaur and the Space Shuttle indicated there would be no significant impacts to terrestrial and marine animal life as a result of the far-field deposition of the exhaust emission.

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<sup>23</sup> seals, walruses

[ESI 1990] This conclusion is supported by analyses of 43 launches of the Space Shuttle, which concluded that there were no indications that sensitive species suffered cumulative impacts from exhaust deposition or from the launch noise [ATHENA 1995]. Since the Space Shuttle is much larger than any of the rocket systems proposed for the NMP, it is expected that the cumulative impacts to flora and fauna, and to the biological environment from the NMP would not be substantial.

## CCAS

A normal Delta II launch is not expected to substantially impact CCAS terrestrial, wetland, or aquatic biota. The elevated noise levels of launch are of short duration and would not substantially affect wildlife populations. Wildlife encountering the launch-generated ground cloud may experience brief exposure to exhaust particles, but would not experience any significant impacts. Aquatic biota may experience acidified precipitation, if the launch occurs during a rain shower. This impact is expected to be insignificant due to the brevity of the ground cloud and the high buffering ability of the surrounding surface waters to rapidly neutralize excess acidity. [DELTA 1995]

Florida scrub jay and southeastern beach mice occur in the vicinity of LC-46. A small potential exists that individuals of these species would be directly impacted. Previous environmental analyses [ATHENA 1994] concluded that due to the infrequent launch schedule at LC-46 (one per month) and the short duration of vibrational and noise disruption to the area (less than thirty seconds), nesting and foraging impacts to these species are expected to be minimal. The USFWS concurred that the launching of one Athena 1 per month from LC-46 is not likely to jeopardize the continued existence of the above-listed species. [ATHENA 1994] The NMP's maximum rate of two launches per year would not be expected to substantially impact Florida scrub jay or southeastern beach mice.

### 5.12 WASTE GENERATION, TREATMENT, TRANSPORTATION, DISPOSAL AND STORAGE

The handling and use of hazardous and toxic materials would be limited. Solid rocket propellants would be contained in the launch vehicles themselves. These would be fueled at the factory and would arrive at VAFB/CCAS as completely assembled, painted, encapsulated units.

Hazardous materials used at Payload Processing Facilities during operations would normally consist of various solvents and cleaners, paints and primers, adhesives, alcohol, lubricants, and contaminated clothing and rags. It is expected that no more than a gallon of each of the listed types of materials would be used for each NMP payload.

Hazardous and solid waste management would comply with all existing Federal, applicable State and local base environmental regulations. The hazardous materials anticipated are the usual materials normally encountered in the space industry. The primary liquid rocket motor propellants include hydrazine (N<sub>2</sub>H<sub>4</sub>), nitrogen tetroxide (N<sub>2</sub>O<sub>4</sub>), kerosene (RP-1), and liquid oxygen (LOx). Liquid hydrogen (LH<sub>2</sub>), high pressure helium (GHe), gaseous nitrogen (GN<sub>2</sub>), and other materials would also be on the complex.

### VAFB

Vandenberg AFB operates as a generator of hazardous waste and as a Treatment, Storage, and Disposal Facility (TSDF). The transportation and disposal activities for NMP-generated waste can be performed by VAFB host base services. Hazardous waste routinely generated by the base include oils, paints, thinners, solvents, and other regulated materials, including radioactive wastes. A Hazardous Waste Management Plan has been developed and implemented to ensure compliance with Resource Conservation and Recovery Act (RCRA) requirements. In addition to the Hazardous Waste Management Plan, the base has also developed a Hazardous Waste Source Reduction Compliance Plan to provide information and procedures to reduce and minimize the generation of hazardous wastes on the base. [PPF 1993]

### CCAS

CCAS was issued a RCRA, Part B Hazardous Waste Operations permit in January 1986. All hazardous wastes generated at CCAS would be managed according to the 45<sup>th</sup> Space Wing Petroleum Products and Hazardous Waste Management Plan (OPlan 19-14). Hazardous wastes produced during processing and launch operations would be collected and stored in hazardous waste accumulation areas before being transferred to a hazardous storage area. These wastes would eventually be transported to an off-station licensed hazardous waste treatment/disposal facility. [DELTA 1995]

## 5.13 WETLANDS AND FLOODPLAINS

### VAFB

No wetlands or floodplains were identified in environmental assessment documents for SLCs 2W [DELTA 1991], 4 [TITAN 1987] and 6 [ATHENA 1995] [SLC6 1995].

## CCAS

Neither LC-17 nor LC-46 is located in a 500-year floodplain. However, LC-46 is adjacent to a large complex of swale marsh, willow swamp and other freshwater wetlands located immediately west and north of the LC-46 boundary. Impacts to wetlands from the launch of NMP spacecraft would not exacerbate impacts from other CCAS activities or launches.

### 5.14 IONIZING AND NONIONIZING RADIATION

Only very small amounts<sup>24</sup>, if any, of radioactive material would be used aboard NMP spacecraft, with the possible exception of Deep Space 4 (DS4).<sup>25</sup> In accordance with 14 CFR 1216.305 (c) (3), only devices with millicurie quantities or less of radioactive materials would fall within the scope of the NMP Programmatic EA. Additional NEPA documentation would be required of DS4 and any future NMP mission if it were to use radioactive material in excess of the quantities described in Chapter Six of this document. Currently, no other spacecraft designs plan to use radioactive materials. However, it is anticipated that future missions may utilize minute quantities of radioactive material associated with science instruments. As specific spacecraft and missions are fully defined, they will be reviewed in light of this Programmatic EA. If proposed radioactive material usage falls outside the scope of the Programmatic EA, further NEPA review will be conducted, as necessary and appropriate. As a checklist to be applied to future NMP projects, criteria has been established to determine this Programmatic EA's applicability to future flights (see Chapter Six).

Exemplary of NMP spacecraft, DS1 would carry two types of transmitters: an X-band transmitter for telemetry and tracking, and a Ka-band transmitter for downlink. With proper safeguard against electrical shock, there is no human health or safety hazard expected from radio frequency radiation by the launch vehicle/spacecraft.

The DS1 attitude control sensor contains a 6 mW laser. The laser is contained within the Fiber Optic Gyro (FOG) which is inside the Inertial Measurement Unit (IMU). There is an opaque enclosure in the IMU that totally contains the laser and all emissions. Furthermore, a minimum of two safety-inhibits within the IMU prevents the laser from being inadvertently operated. Because the 6 mW laser and all emissions from it are wholly contained within the opaque enclosure of the IMU, it requires no special handling and poses no hazard. [DS1 1997]

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<sup>24</sup> Quantities equal to or less than 10 times the A<sub>2</sub> limits as defined by the International Atomic Energy Agency [IAEA 1990]

<sup>25</sup> Preliminary spacecraft designs suggest DS4 may carry as many as three Radioisotope Heater Units.

The Earth Observing 2 (EO2) Project plans to use an Earth pointing laser. EO2's currently proposed laser would be eyesafe. However, in accordance with Chapter Six of this document, further risk analyses and NEPA documentation will be required of EO2 and future projects if an Earth pointing medium or high power laser (Class 3b and 4), as defined by the American National Standards Institute, is to be utilized.

#### 5.15 HISTORICAL, ARCHEOLOGICAL AND RECREATIONAL FACTORS

Since no surface or subsurface areas would be disturbed, no significant archeological, historic, or other cultural properties are expected to be affected by launching NMP spacecraft.

The NMP would not increase launch rates nor utilize launch systems beyond the scope of approved programs at VAFB/CCAS; therefore, NMP would not produce increased closure of County-owned parks, other public use areas and private properties.

#### 5.16 NMP SPACECRAFT HAZARDS<sup>26</sup>

##### General

Although specific payloads are currently being developed, DS1 has been assumed to be a "typical" payload for the purposes of the NMP EA. DS1 spacecraft hazards are presented here as a representative case and are exemplary of all future NMP payloads. DS1/NMP spacecraft hazards and mitigation measures are summarized in Table 5-18.

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<sup>26</sup> This section is summarized from [DS1 1997].

Table 5-18. NMP Spacecraft Hazards and Mitigation Measures

System/Subsystem/ Component	Hazard	Mitigation
Structure and Propulsion Module Assembly	Structural failure causing hardware to collide with launch vehicle (LV)	Stress analysis, dynamic analysis, environmental testing, and inspections
Solar Array Deployment	Inadvertent deployment resulting in injury and/or collision with LV	Actuators can be operated by the spacecraft main computer only
Reaction Control	Inadvertent activation of the thrusters	A minimum of one fault tolerant to the release of fuel or thruster firing at all times, mechanically independent valve seats, hydrazine sniffers to detect leaks, leak tests, and acceptance tests
	Over-pressure of the feed system	Contamination control procedures, unique inlet fittings and connect procedures, temperature would be controlled, inspections performed, proof tests, leak tests, and a high factor of safety
	Structural failure of the feed system	Detailed handling procedures, random vibration tests, and non-destructive evaluation and proof tests
Ion Propulsion	Inadvertent activation of the ion propulsion engine	Three mechanical seats, independent solenoid valves, and two independent electrical inhibits
	Overpressure and/or structural failure resulting in oxygen deficient atmosphere	Low pressure side designed to survive maximum operating pressure of high pressure side without venting
	Exposure to high voltages	All high voltages are contained within the power processing unit and grounded to chassis
Electrical and Electronic Subsystem	Inadvertent operation of the separation circuit	Single fault tolerant separation initiation, separation breakwire, signal shorting wire, shorting plug, internal undervoltage shutdown circuit
Cabling	Damage to electrical power circuitry leading to loss of safety circuitry and redundant power, generation of toxic products	Wire size and circuit protection analysis, bent pin analysis, pyro devices cables would have separate connectors and wire bundles
Attitude Control Sensor	Exposure to non-ionizing radiation from IMU FOG laser	Laser and all emission from it are wholly contained within the opaque enclosure of the IMU
Electrical Power and Distribution	Deployment of solar arrays and/or diagnostic sensor boom, initiation of separation sequence, generation of exposed high voltages and rapid increase in battery pressure	Shorting plug/separation connector, 91V lines insulated to withstand 600V, high voltage metal interconnects are concealed, battery pressure vessels would meet MIL-STD-1522A, spare battery subjected to qualification shock and random vibration, temperature monitoring
Telecommunication	Personnel exposure to radio frequency radiation	Radio Frequency (RF) absorbing hats, RF absorbing wall, RF monitors, prohibited access during tests, hazardous commands would be flagged, at least two inhibits
Autonomy/Flight Software	Commands which could cause the system to reach a hazardous state	A "hazardous operations test mode" would inhibit turning on power
Advanced Instruments	Exposure to MICAS high voltage	High voltage power supply fully contained inside MICAS instrument,
	Exposure to PEPE high voltage	High voltages contained within the grounded chassis of PEPE, high voltage commands are software inhibited
	Oxygen deficient atmosphere due to MICAS/PEPE purging	Normal safety handling of nitrogen gas is all that is required

## 5.17 POLLUTION PREVENTION

### 5.17.1 Emergency Planning and Community Right-To-Know Act

NASA will comply with Toxic Release Inventory requirements, Emergency Planning and Community Right-to-Know responsibilities, and State and Local Right-to-Know and Pollution Prevention requirements. NASA will support the Local Emergency Planning Committee as requested and will make available all Pollution Prevention and Community Right-to-Know information to the public upon request. [NASA 1995]

#### NASA

In compliance with Executive Order 12856, "Pollution Prevention and Community Right-to-Know," NASA has developed a comprehensive agency program to prevent adverse environmental impacts by: 1) Moving ahead of environmental compliance; 2) Emphasizing pollution source elimination and waste reduction; and, 3) Involving communities in NASA decision processes. [NASA 1995]

By December 31, 1999, NASA will have achieved a 50 percent reduction (1994 baseline) in releases of toxic chemicals to the environment and off-site transfers of such chemicals for treatment and disposal as reported on Toxic Chemical Release Inventory (TRI), Form R. NASA will have a system in place to transfer Pollution Prevention technologies both in and out of its operations. Each NASA Center submits annual Pollution Prevention progress reports to NASA Headquarters, describing the progress the Center has made in complying with Executive Order 12856. [NASA 1995]

#### USAF

By December 31, 1999, the USAF will have achieved a 50 percent reduction (1994 baseline) in total releases and off-site transfers of TRI Chemicals. Purchases of Environmental Protection Agency (EPA) 17 Industrial Toxic Pollutants<sup>27</sup> have been reduced by 50 percent as of December 31, 1996, and hazardous waste disposal will be reduced 50 percent (1992 baseline) by December 31, 1999. Environmentally preferable products will be purchased, so that one-hundred percent of all products purchased each year in each of EPA's "Guideline Item" categories shall contain recycled materials. [USAF 1995]

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<sup>27</sup> Established in 1991 as EPA's first voluntary initiative under the Pollution Prevention Act of 1990. The program (33/50 program) targets 17 priority pollutants: Benzene, Cadmium, Carbon tetrachloride, Chloroform, Chromium, Cyanide, Dichloromethane, Lead, Mercury, Methyl ethyl ketone, Methyl isobutyl ketone, Nickel, Tetrachloroethylene, Toluene, 1,1,1-Trichloroethane, Trichloroethylene and Xylene.

## 5.18 ECONOMIC, POPULATION AND EMPLOYMENT FACTORS

Launching the New Millennium Program spacecraft would have a negligible, if any, impact on local communities, since no additional permanent personnel are expected beyond the current CCAS and VAFB staff. The NMP would cause no additional adverse impacts on community facilities, services, or existing land uses.

## 5.19 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 NMP missions, analysis indicates little or no potential of substantial environmental effects on any human populations outside VAFB/CCAS boundaries.

## 5.20 ORBITAL DEBRIS

Orbital debris as a result of U.S. and foreign space activities may reenter the Earth's atmosphere. "NASA's policy is to employ design and operations practices that limit the generation of orbital debris, consistent with mission requirements and cost-effectiveness." [NPD 1997] NASA policy requires, as appropriate, that each program or project conduct a formal assessment for the potential to generate orbital debris. General methods to accomplish this policy include:

- Depleting on-board energy sources after completion of mission
- Limiting orbit lifetime after mission completion to 25 years or maneuvering to a disposal orbit
- Limiting the generation of debris associated with normal space operations
- Limiting the consequences of impact with existing orbital debris or meteoroids
- Limiting the risk from space system components surviving reentry as a result of postmission disposal

The New Millennium Program would comply with all requirements of and will complete a Debris Assessment as required by NPD 8710.3, "Policy for Limiting Orbital Debris Generation".

## 5.21 CUMULATIVE EFFECTS

The long-term, cumulative effects to the local and regional biota would be expected not to be substantial. The use of VAFB/CCAS facilities is consistent with existing uses and poses no new impacts. The total number of launches at individual launch sites proposed by the NMP per year is small when compared

to ongoing programs at VAFB/CCAS. Permits and mitigation measures exist for launching up to 10 Deltas per year from SLC-2 [SLC2W 1996], a maximum of three Titan II launches per year from SLC-4 [TITAN 1987], a total of 25 launches per year from the California Commercial Spaceport (CCS or SLC-6) [SLC6 1995], and Delta/Athena 1 launches from LC-17/LC-46 are limited by human resources only (approximately 1 per month) [BE 1997a]. Future programs such as the NMP were accounted for in determination of these launch rates. The New Millennium Program would not increase previously approved launch rates nor utilize launch systems beyond the scope of approved programs at VAFB/CCAS. When the proposed program of 12 launches is considered over the life of the program (approximately 12 years) it amounts to only one launch per year at VAFB or CCAS. The NMP plan shows a maximum of two launches in any one year. Even a conservative estimate of four (double of that proposed) launches per year at VAFB or CCAS does not pose significant adverse environmental impacts.

## 5.22 NO-ACTION ALTERNATIVE

The No-Action alternative would mean the New Millennium Program would not be undertaken and the immediate local (i.e., launch site) impacts would be precluded. However, no-action would impede technology readiness in the 21<sup>st</sup> century. NMP's plans to accelerate the development of essential technologies and capabilities required for the new types of missions to be flown in the next century is imperative in today's environment of economic austerity. Technological advances must be made quickly in order to provide a future for affordable U.S. space and Earth science missions.

The investment in the New Millennium Program now could begin to provide tangible benefits, especially in validating solar electric propulsion, before the year 2000. The infusion of flight validated technologies into the commercial infrastructure could both strengthen and stimulate the American industrial base, as well as improve the nation's competitive edge in the global market; the nation's space and Earth science program could accrue new capabilities and develop a wealth of new and diverse data.

## **6. CHAPTER SIX APPLICABILITY OF THE PROGRAMMATIC EA TO FUTURE MISSIONS**

### **GENERAL**

Though future NMP mission are not fully characterized, NMP materials, payloads and launch vehicle impacts are expected to be similar and benign. As specific spacecraft and missions are fully defined, they will be reviewed in light of this Programmatic EA. If NASA determines that future payloads have potential for substantially different environmental impacts, further NEPA review will be conducted, as necessary or appropriate.

For future missions the New Millennium Program Manager will submit a memorandum to the appropriate Enterprise Associate Administrator (Space Science or Earth Science) at NASA Headquarters making a recommendation and requesting a determination as to whether the mission in question falls within the scope of and is, thus, covered by this EA or requires further NEPA analysis. The memorandum, at a minimum, will briefly describe the mission, and provide “yes” or “no” answers to each of the questions identified in Section 6.1. Where the mission would involve radioactive materials and/or lasers the memorandum will state whether or not the International Atomic Energy Agency (IAEA) and American National Standards Institute (ANSI) standards, as applicable, have been used in answering the questions. If, after consulting with the NASA Office of the General Counsel and the NASA Headquarters Environmental Management Division, the Enterprise Associate Administrator agrees that the mission falls within the scope of this Programmatic EA, he/she will issue a Memorandum for the Record documenting the decision. For missions that the Enterprise Associate Administrator determines are not covered by this EA and require further analysis, the New Millennium Program Manager will be notified in writing. The criteria to be used in determining the Programmatic EA’s applicability to future missions follow.

### **6.1 APPLICABILITY TO THE PROGRAMMATIC EA**

To be covered by the NMP Programmatic EA and in compliance with the National Environmental Policy Act future missions must meet the specific criteria established herein. The following list of mission specific questions is offered as a checklist for future NMP missions to ensure they are covered by the Programmatic EA.

1. a) Will the mission involve any amount of radioactive material? If the answer is yes, describe the type(s) and amount of material and its use(s).

b) Would the future mission utilize radioisotopic material in excess of 10 times the A<sub>2</sub> limits [IAEA 1990] established by the International Atomic Energy Agency (i.e., contains other than very minute quantities of radioactive material, for uses such as science instruments)?

In accordance with 14 CFR 1216.305 (c) (3), only devices with millicurie quantities or less of radioactive materials would fall within the scope of the NMP Programmatic EA. For guidance in the determination of acceptable radioactive material quantities, NASA uses Safety Series No. 6 of the International Atomic Energy Agency (IAEA) [IAEA 1990]<sup>28</sup>. The quantity of radioactive material which could statistically produce negative health effects is referred to as the A<sub>2</sub> limit. IAEA Safety Series 6 contains A<sub>2</sub> limits for over 380 radionuclides. Missions containing less than 10 times the A<sub>2</sub> limit fall within the scope of the NMP Programmatic EA.

2. Would the future mission utilize an Earth pointing medium or high power laser (Class 3b and 4) as defined by the American National Standards Institute?

On orbit exposure of the general public might arise from experiments where laser energy is directed toward Earth and its atmosphere. Environmental effects of experiments involving lasers directed to Earth must be evaluated using criteria in "American National Standard for Safe Use of Lasers" [ANSI 1993] which addresses laser classifications and controls necessary to prevent biological damage to the eye or skin during intended use. Detailed calculations for establishing laser classifications and Maximum Permissible Exposure limits are provided in [ANSI 1993]<sup>29</sup>. Medium and high power lasers (Class 3b and 4) require both control measures and medical surveillance and are not included under this EA. Future missions utilizing Class 3b and 4 lasers would require specific risk analyses and additional NEPA documentation.

3. Would the future mission contain pathogenic microorganisms (e.g., bacteria, protozoa, and viruses) which can produce disease or materials extremely hazardous to human health (e.g., neurotoxins)?

Launch of pathogens or extremely hazardous materials to human health is not included under this EA. Future missions proposing the launch of pathogens would require additional NEPA documentation.

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<sup>28</sup> This document can be viewed at the Jet Propulsion Laboratory Library.

<sup>29</sup> This document can be viewed at the Jet Propulsion Laboratory Library.

4. Would the future mission utilize more than 25 percent greater quantities of hazardous materials (propellants, solvents, etc.) or substantially different types of hazardous materials?

As described in Chapter 2, Chapter 5 and/or considered to be within the scope of approved VAFB/CCAS programs.

5. Would the future mission include a sample return to Earth?

Sample returns to Earth are not included under this EA. Future missions proposing sample returns to Earth will require additional NEPA documentation, to be determined in consultation with NASA Headquarters.

6. Would the future mission (non-piggy back) utilize a launch vehicle not analyzed in the Programmatic EA?

Future non-piggy back missions proposing to use launch vehicles not routinely launched from CCAS/VAFB or producing impacts not bound by this EA may require further NEPA documentation.

7. Would the future mission utilize a new (never before launched) launch vehicle?

Further NEPA documentation will be required for first-use launch vehicles.

8. Would the future mission utilize a foreign launch vehicle?

Further documentation under NEPA or Executive Order 12114, Environmental Effects Abroad of Major Federal Actions, will be required. The nature and scope of the environmental review process and documentation will be determined in consultation with NASA Headquarters.

9. Would the future mission be launched from a site other than CCAS or VAFB?

Future missions proposing use of a launch site other than CCAS or VAFB will require further NEPA documentation, to be determined in consultation with NASA Headquarters.

10. Would the future mission increase previously approved launch rates or utilize launch systems beyond the scope of approved programs at VAFB/CCAS?

As described in Chapter 2, Chapter 5 and/or considered to be within the scope of approved VAFB/CCAS programs.

11. Would the future mission require the construction of new facilities?

New facility construction is not included under this EA. Modification to existing facilities may require further NEPA documentation.

12. Would the future mission cause significant public controversy related to environmental issues?

As determined by the responsible program office at NASA Headquarters.

13. Are there any other unique aspects of the proposed mission which suggest the potential for environmental impacts outside the scope of this Programmatic EA?

In regard to the future mission, if the answer to one or more of questions 1-12 above is yes, further NEPA and environmental analysis of the proposed future mission will be required.

## 7. LIST OF PREPARERS AND PERSONS AND AGENCIES CONSULTED

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**9. APPENDIX A  
RESPONSES TO THE NMP LETTER TO REGULATORS/ENVIRONMENTAL ASSESSMENT**

Version	Comment Submitted	Name/Organization of Respondent	Section Eliciting Comment	Section/Rationale Addressing Comment
Letter to Regulators April 1997	The County's primary concerns over potentially adverse impacts are related to public health and safety, especially fuels transportation and the direct and indirect effects of potential debris from launch mishaps. The latter includes: concerns over potential closures of County-owned parks at Ocean Beach and Jalama; closures and evacuations of other public use areas, roads, fishing grounds, and private properties; and, hazards to fixed installations such as local offshore oil and gas platforms. The subject document should address such potential impacts, particularly the cumulative effects of this and other approved and anticipated Vandenberg AFB programs.	Daniel H. Gira, Acting Deputy Director, Comprehensive Planning Division / County of Santa Barbara Planning and Development	General	Section 5.5, & 5.15 / A Range Safety Program is implemented for each launch to ensure that the launch and flight of launch vehicles and payloads present no greater risk to the general public than that imposed by the overflight of conventional aircraft. [WR 1995] NMP would not increase previously approved launch rates nor utilize launch systems beyond the scope of approved programs at VAFB. Therefore, NMP would not produce increased closure and evacuations of public use areas or increased hazards to fixed installations.
Draft February 1998	We have reviewed the draft Programmatic Environmental Assessment for NASA's New Millennium Program and find it to be legally sufficient for its intended purpose.	Charles E. Wiedie, Assistant Staff Judge Advocate / 45 SW/JA	General	Comment noted
Draft February 1998	We have reviewed the draft assessment for the NASA New Millennium Program and have no comments.	Eisley K. Witt, Chief of Plans and Programs / 45 SW/XP	General	Comment noted
Draft February 1998	Concur with draft environmental assessment as it's written. Foresee no major public affairs ramifications. We do have some concern with the finding that Florida scrub jays and beach mice near LC-46 may be directly impacted by a launch from that complex. This could draw the interests of certain community groups.	Ken Warren, Public Affairs / 45 SW/PA	General	Section 5.11 / Florida scrub jay and southeastern beach mice occur in the vicinity of LC-46. A small potential exists that individuals of these species would be directly impacted. Previous environmental analyses [ATHENA 1994] concluded that due to the infrequent launch schedule at LC-46 (one per month) and the short duration of vibrational and noise disruption to the area (less than thirty seconds), nesting and foraging impacts to these species are expected to be minimal. The USFWS concurred that the launching of one Athena 1 per month from LC-46 is not likely to jeopardize the continued existence of the above-listed species. [ATHENA 1994]
Draft February 1998	Section 2.3.3 states the Athena II vehicle will be launched from the California Commercial Spaceport. Lockheed has launched two vehicles from SLC-6 and plans to launch two additional vehicle from SLC-6. The environmental approval to launch Athena I and Athena II vehicles from another facility, the Spaceport, was approved in a prior EA, however to date, Lockheed Martin has not launched a vehicle from this facility. Another facility besides SLC-6 and the California Spaceport will require an EA.	Gregory A. Caresio, Wing Planning Manager / VAFB	Section 2.3.3	Inclusive of CCS, SLC-6 is mentioned at every occurrence of CCS in this document. An EA was written and FONSI found for the use of LC-46 at Cape Canaveral Air Station, Florida for launching Lockheed Launch Vehicles (renamed Athena) in October of 1994. [ATHENA 1994]
Draft February 1998	1) This summary appears to discuss the launch vehicles which you reference as having NEPA documentation. Please provide specific references for each proposed launch vehicle. Also this EA needs to address the spacecraft and the environmental impacts associated with it. 2) Recommend reference to the most recent Delta launch vehicle explosion. 3) Since the launches are proposed to occur at Air Force installations, Air	Ginger Crawford / 45 CES/CEVP	1) Page ix 2) Page xii 3) Page 1-2 4) Page 2-9 5) Page 2-12 6) Page 2-12 7) Page 2-13	1) Page ix / The NEPA documentation for each proposed launch vehicle is listed in a footnote on Page ix. Spacecraft descriptions and environmental impacts are discussed in Chapters 2 & 5, respectively. 2) Reference to the recent Delta launch vehicle explosion is made in Chapter 5. 3) Comment noted

Version	Comment Submitted	Name/Organization of Respondent	Section Eliciting Comment	Section/Rationale Addressing Comment
	<p>Force Instruction (AFI) 32-7061 applies. Specifically the submission of an Air Force Form 813.</p> <p>4) The Air Force needs to be involved in the EA for Mar's Surveyor '98.</p> <p>5) An air emissions control system which is part of the base Title V permit is used (for hydrazine loading). All expected air emissions, including propellants, must be identified to base personnel in advance.</p> <p>6) Small spills at CCAS are wiped up and do not go down any drains.</p> <p>7) Please check RCRA regulations regarding the status of transporting a "hot" hydrazine portable container off-site for cleaning.</p> <p>8) The water/neutralizing tank and the scrubber...Please check the accuracy of your statement.</p> <p>9) Please do not assume that CCAS/KSC or VAFB are Small Quantity Generators. They are Large Quantity Generators.</p> <p>10) Will any of the Evolved Expendable Launch Vehicles be used?</p> <p>11) Recommend adding a statement that the Banana River &amp; Indian River are actually, lagoons, brackish water, and not typical "rivers"</p> <p>12) Compliance with site specific (such as launch areas) Light Management Plans is required.</p> <p>13) How does the theoretical compare to the actual Delta Explosion?</p> <p>14) See comment #5</p> <p>15) Please note that if Air Force (AF) installations are used then the AF has some involvement in determining NEPA requirements. See comment #3. This chapter is an excellent addition to a programmatic EA.</p> <p>16) Please Reference 45 SW Cultural Resource Management Plan for historical and archeological information. Need most up to date information.</p>		<p>8) Page 2-13</p> <p>9) Page 2-13</p> <p>10) Page 2-20</p> <p>11) Page 3-8</p> <p>12) Page 3-10 &amp; 3-12</p> <p>13) Page 5-7</p> <p>14) Page 5-12</p> <p>15) Page 6-1</p> <p>16) Page 3-18</p>	<p>4) The comment has been forwarded to the developers of the Mars '98 EA. Patrick Air Force Base has provided comments on a preliminary Mars '98 EA which are being addressed.</p> <p>5) Page 2-12 / Text was added to Section 2.2.2 to reflect this comment.</p> <p>6) Page 2-12 / Last sentence of 4<sup>th</sup> paragraph of Section 2.2.2 was modified to reflect this comment</p> <p>7) Page 2-13 / This part of Section 2.2.2 has been modified to reflect this comment and has been moved to Chapter 5.</p> <p>8) Page 2-13 / The text being referred to has been modified to reflect this comment and has been moved to Chapter 5.</p> <p>9) Page 2-13 / Comment noted. This section referred to Payload Processing Facilities as Small Quantity Generators. This section now occurs in Chapter 5.</p> <p>10) The Evolved Expendable Launch Vehicles are not proposed for use by NMP.</p> <p>11) Page 3-8 / Text was added to Section 3.3.3 to reflect this comment.</p> <p>12) Section 3.3.4.1 / The light management plan is mentioned in Section 3.3.4.1.</p> <p>13) Maximum theoretical concentrations of pollutants for a GEM failure (conflagration) are estimated to be less than 1 ppm at 24 kilometers [USAF 1997a]. Maximum concentrations resulting from the Delta II failure on January 17, 1997 were 1 to 2 ppm [BE 1997b].</p> <p>14) Page 5-12 / Text was added to Section 5.6 to reflect this comment.</p> <p>15) Comment noted</p> <p>16) Page 3-18 / This section was updated to include historical and archeological information from the 45 SW Cultural Resource Management Plan</p>
Draft February 1998	<p>1) The document shows NOx emissions per launch of the Athena 2 and Taurus vehicles are 9.2 tons and 8.0 tons, respectively. The Table shows there are no NOx emissions from the Delta II 7925 launches. Please explain why this analysis does not underrepresent the air quality impacts of this project.</p> <p>2) It appears that the worst-case for this project, in terms of NOx emissions, would occur during the launch of the Athena 2 vehicle.</p> <p>3) Because NO is generally unstable in the atmosphere and oxidizes to NO<sub>2</sub>, please explain why the potential for the violation of the 1-hour California standard for NO<sub>2</sub> was not addressed.</p> <p>4) Table 5-4 lists total annual emissions from this project (assuming 3 launches/year) as 0.216 tons/year for NOx. As noted in Table 5-1 of the EA, the NOx emissions from one launch of the Athena 2 vehicle alone would be 9 tons/year.</p> <p>5) The document states that future programs as the NMP program were</p>	Vijaya Jamma-lamadaka, Air Quality Specialist / Santa Barbara County Air Pollution Control District	<p>1) Table 5-1</p> <p>2) Page 5-3</p> <p>3) Table 5-3</p> <p>4) Table 5-4</p> <p>5) Page 5-24</p>	<p>1) Table 5-1 was updated to include Delta II 7925 NOx emissions. NOx emissions from the Delta II 7925 bound NOx emissions from all other proposed launch vehicles, and therefore, adequately represents the air quality impacts of this project.</p> <p>2) Delta II 7925 NOx emissions exceed that of the Athena 2 launch vehicle.</p> <p>3) A note was added to Table 5-3: NMP is not expected to violate the 1-hour California standard for NO<sub>2</sub> of 0.25 ppm, because the 60-minute mean availability of NO for oxidation is far less than 0.25 ppm.</p> <p>4) Table 5-1 estimates total launch vehicle emissions for a complete burn of all propellants and includes thermal NOx resulting from afterburning (heated exhaust decomposing the atmosphere). Table 5-4 represents a more accurate esti-</p>

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	accounted for in launches approved for the California Commercial Spaceport and the Delta II and other programs and that the NMP would not increase previously approved launch rates nor utilize launch systems beyond the scope of approved programs at VAFB (of the EA). If this is the case, it appears that the evaluation of impacts in the EA for this project is unnecessary.			mate of the quantity of NOx emitted into the lower atmosphere. 5) It is NASA policy to provide NASA decision makers with a complete set of information upon which to base their informed decisions. NASA believes it is in managements best interest to provide all information in a single decision making document, so that mangers don't have to look up referenced EAs to assess the potential impacts. Also, the present EA is designed to document that the information in the preexisting documents is still accurate.
Draft February 1998	There is no review of the impact of this program to VAFB airspace, the small offshore preserve north of Point Arguello or impact to the offshore oil platforms.	Walter Schobel, Chief, Airspace and Offshore Mgt. Section / VAFB	General	Because NMP would not increase previously approved launch rates, the frequency by which airspace is withdrawn from the air traffic system for government use would not increase beyond what is currently anticipated, and no new impacts to offshore preserves or offshore oil platforms are anticipated.
Draft February 1998	<p>1) Define "carrying mission". What insures that NEPA documentation will be completed by the carrying mission?</p> <p>2) What Space Shuttle NEPA documentation are you referring to?</p> <p>3) Under propellant loading it is indicated that 170 pounds of Xenon would be used for the ion propulsion system. The DS1 AF Form 813 identifies 882 pounds of xenon – which is correct?</p> <p>4) It is stated that the no-action alternative would "minimize" local impacts. Wouldn't impacts be precluded?</p> <p>5) In the first sentence you refer to a 510 square mile region. Is this the area shown in Figure 3-1?</p> <p>6) It is indicated that LC-46 is "west of Cape Canaveral." This is confusing.</p> <p>7) The primary freshwater wetland community on CCAS is swale marsh. Canals and borrow pits are a minor, man-made component of wetland acreage on CCAS.</p> <p>8) The CCAS National Wetlands Inventory and the Installation Integrated Natural Resource Management Plan estimate approximately 1,300 acres of freshwater wetlands and 500 acres of estuarine wetlands which would be approximately 11% of the Installations total land area.</p> <p>9) Hydric hammocks specifically found along the CCAS Banana River shoreline (in narrow bands) are characterized by closed canopies consisting primarily of cabbage palms. Inland from the hydric hammocks are maritime hammocks dominated by a live oak with red bay overstory.</p> <p>10) No hydric hammocks are located in the vicinity of LC-17 but there are some well developed maritime hammocks in the area.</p> <p>11) This table contains incorrect or outdated information.</p> <p>12) Suggest reviewing the 45 SW Cultural Resource Management Plan to revise both historic and archeological resource descriptions.</p> <p>13) LC-46 is adjacent to a large complex of swale marsh, willow swamp and other freshwater wetlands located immediately west and north of the LC-46 boundary. The drainage canals are an insignificant component of</p>	M. Mercadante, LBS Environmental	<p>1) Page 2-1</p> <p>2) Section 2.1.3.3</p> <p>3) Section 2.2.2</p> <p>4) Section 2.5</p> <p>5) Section 3.2</p> <p>6) Page 3-4</p> <p>7) Section 3.3.4</p> <p>8) Section 3.3.4</p> <p>9) Section 3.3.4.1</p> <p>10) General</p> <p>11) Table 3-3</p> <p>12) Section 3.3.7</p> <p>13) Section 5.13</p> <p>14) Chapter 6</p>	<p>1) The "carrying mission" is defined as a United States mission and/ or program other than NMP missions. As stated on Page 2-1 piggy back flight would be launched on domestic spacecraft. All spacecraft launched from a United States Air Force installation require at least an AF 813 to comply with NEPA.</p> <p>2) Section 2.1.3.3 / EO2 would be a payload carried aboard the Space Shuttle. Environmental impacts due to launch would be covered by relevant Space Shuttle NEPA documentation at the time of launch.</p> <p>3) Section 2.2.2 / The figure (170 pounds) currently cited in this document is correct.</p> <p>4) Section 2.5 / Impacts at the launch site would still occur due to other missions and programs. Text modified to reflect comment</p> <p>5) The total region is shown in Figure 3-1. Text added for clarification.</p> <p>6) Page 3-4 / Text was added for clarification.</p> <p>7) Section 3.3.4 / This section was modified to reflect this comment.</p> <p>8) Section 3.3.4 / Comment incorporated</p> <p>9) Section 3.3.4.1 / The text in this section was modified to include this information.</p> <p>10) Section 3.3.4.1 / Comment noted</p> <p>11) Table 3-3 / New data was incorporated into the species table.</p> <p>12) Section 3.3.7 / This section was revised based on the 45 SW Cultural Resource Management Plan</p> <p>13) Section 5.13 / This new data was incorporated into this section.</p> <p>14) Chapter 6 / Comment noted</p>

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	the wetlands in the vicinity of LC-46. 14) Should specify in this chapter that an AF Form 813 will be prepared by the proponent for each mission and submitted to the appropriate host installation (launch site) for review/approval to satisfy AF NEPA requirements. The installation environmental management office will also review the applicability of the Programmatic EA to each mission and assign the applicable CATEX If appropriate.			
Draft February 1998	1) While the EA does analyze potential environmental impacts of the payloads, much of the analysis is of the launches. It is not necessary to analyze launch vehicles which have already been analyzed. Only the environmental impacts of the payloads must be analyzed in the subject EA. 2) Santa Barbara county has been redesignated as serious nonattainment for ozone. The information in this section is outdated and must be revised to reflect the current situation. However, see comment 1. 3) Please attach a copy of the signed FONSI to the AF Form 813 for the VAFB launches when it is submitted.	Denise R. Caron, Chief, Env Compliance & Restoration / VAFB	1) General 2) Pages 4-5 & 5-5 3) General	1) It is NASA policy to provide NASA decision makers with a complete set of information upon which to base their informed decisions. NASA believes it is in managements best interest to provide all information in a single decision making document, so that mangers don't have to look up referenced EAs to assess the potential impacts. Also, the present EA is designed to document that the information in the preexisting documents is still accurate. 2) Pages 4-5 & 5-5 were updated to reflect the redesignation 3) A copy of the signed FONSI will be attached to the AF Form 813 when it is submitted.
Final March 1998	1) In regards to public exposures, operations must adhere to USAF Surgeon General and Local Emergency Planning Commission requirements, as appropriate, for planned, unplanned, and credible releases. Recommend HCl exposures for workers and public be compared to a relevant standard. 2) Many credible launch failure modes do not involve command destruct scenarios. Most launch failure scenarios should produce significantly higher HCl concentrations than from a nominal launch. No CSD scenario or otherwise will extinguish SRMs once they are lit. Most oxidizers would not be consumed in the deflagration and will be released to disperse. 3) Section 5.5.2 presents worker and public emergency exposure standards that have either been rescinded or replaced. Should be rewritten to reflect current toxic risk practice on both Eastern/Western Ranges. 4) Needs to be replaced with actual worker and public exposures in accordance with Range Toxic Hazard Control Policy driven by USAF Surgeon General and Local Emergency Planning Commission requirements.	John W. Bridge, Chief, Systems Safety Section / 45 SW/SES	1) Page 5-4 2) Section 5.5.2 3) Page 5-9 4) Table 5-10	1) Emission standards presented here are conservative and bounding when compared to USAF Surgeon General and Local Emergency Planning Commission requirements. Also, the National Academy of Science is currently reviewing USAF Surgeon General and Local Emergency Planning Commission requirements. As of this writing no final document has been issued and no official determination has been made. Therefore, this section was left unchanged. 2) Section 5.5.2 was modified to reflect this comment. 3) Please see response number one above. 4) Please see response number one above.
Final March 1998	1) The document now shows NOx emission per launch of the Delta II 7925 vehicle are 9.6 tons. Please state what proportion of the pollutants are released in the lower atmosphere as opposed to the stratosphere. 2) Your response (to our comments on the Draft document) states that Table 5-4 represents a more accurate estimate of the quantity of NOx emitted into the lower atmosphere. As noted in the document the estimate is 1/8 <sup>th</sup> of the predicted Spaceport emissions. The Spaceport emissions were based on Castor 120 solid rocket boosters which do not appear to be representative of NMP activities. 3) To be more accurate, the lower atmosphere portion of emissions from the Delta II 7925 should be added to estimated indirect emissions associated with this project to obtain the total emissions per year for use in the Clean Air Act conformity determination.	Vijaya Jamma-lamadaka, Air Quality Specialist / Santa Barbara County Air Pollution Control District	1) Page 9-2 2) Table 5-4 3) General	1) During a normal launch, approximately 31 lbs of NO are emitted from a Delta II 7925 launch vehicle in the first 3,000 feet of ascent. 2) Pollutant emissions from the launch vehicle analyzed in the Spaceport Clean Air Act Conformity determination bound pollutant emissions for the Delta II 7925. Furthermore, the Castor 120 is the same booster used by the Athena 1, Athena 2 and Taurus launch vehicles proposed for use by NMP. 3) The LLV-3(6) was used for the Spaceport Clean Air Act conformity determination upon which this analysis is based. The LLV-3(6) uses 158,224 kilograms of solid propellant whereas the Delta II 7925 uses 105,318 kilograms of solid

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				propellant. Furthermore, NMP would not increase previously approved launch rates nor utilize launch systems beyond the scope of approved programs at VAFB and is included as part of previous Clean Air Act determinations. Therefore, NMP impacts to air are encompassed by the Spaceport determination.
Final March 1998	<p>1) The National Executable Mission Model for government space launches replaces the current Atlas II, Delta II, and Titan IVB launch vehicles with the Evolved Expendable Launch Vehicle (EELV). A full schedule of payloads should be provided in the Proposed Action sections of the Executive Summary and the main document.</p> <p>2) The Record of Decision for the Final EELV Program EIS is scheduled to be signed in early Summer 1998. The EELV EIS contains analyses of the projected launch vehicles, including medium vehicles on which the government would launch the New Millennium spacecraft.</p> <p>3) We suggest incorporating by reference or summary in your New Millennium document, the analysis for the viable medium class of EELV to supplement your Delta II analysis.</p>	John R. Edwards, Chief, Environmental Branch Acquisition Civil Engineer Division / SMC/AXFV	<p>1) Page 2-2</p> <p>2) General</p> <p>3) General</p>	<p>1) Because future NMP missions are not fully defined a full schedule of NMP payloads is not available.</p> <p>2) Comment noted</p> <p>3) The EELV Environmental Impact Statement (EIS) has not been finalized but a Record of Decision been made on the EIS. Therefore, data on the EELV has not been included in this Environmental Assessment. Provisions have been made to accommodate future missions on launch vehicles other than those proposed herein (see Chapter Six).</p>
Final March 1998	The Florida State Clearinghouse, pursuant to Presidential Executive Order 12372, Gubernatorial Executive Order 95-359, the Coastal Zone Management Act, as amended, and the National Environmental Policy Act, as amended, has coordinated a review of the above-referenced project. Based on the information contained in the application and the enclosed comments provided by our reviewing agencies, the state has determined that the allocation of federal funds for the above-referenced project is consistent with the Florida Coastal Management Program.	Ralph Cantral, Executive Director / Florida Coastal Management Program	General	Comment noted