Environmental Impact Statement for the Kennedy Space Center

FINAL
October 1979

National Aeronautics and
Space Administration

NASA

John F. Kennedy Space Center

SUMMARY

ENVIRONMENTAL IMPACT STATEMENT

FOR THE

JOHN F. KENNEDY SPACE CENTER

(1978-1979 REVISION)

( ) Draft (X) Final Environmental Impact Statement

RESPONSIBLE FEDERAL AGENCY:

National Aeronautics and Space Administration
Washington, D.C. 20546

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1. TYPE OF ACTION: (X) Administrative ( ) Legislative

2. BRIEF DESCRIPTION OF ACTION AND PURPOSE: This Environmental Impact Statement (EIS) supersedes and updates the original Institutional EIS for Kennedy Space Center (KSC) dated August 1971 and Amendment 1 to the KSC Institutional EIS dated August 1973. Prepared under the Guidelines of the Council on Environmental Quality (CEQ), as amended August 7, 1973, this EIS describes the ongoing operation of KSC for expendable launch vehicles and automated spacecraft, continued development of facility capabilities, and the approved follow-on operations of the Space Transportation System (STS) and associated payloads. This EIS is based on the Expendable Launch Vehicle and Space Shuttle traffic projected as of January, 1979. Recent schedule changes have altered the mission model and the number of launches from KSC will change as schedules become better defined. However, since this statement addresses the maximum potential effect on the environment, changes to the launch phasing in the mission model will not alter the conclusions in this document. The purpose of this revision is to summarize extensive new information on the environmental effects discussed in the predecessor documents and provide that information for public review and comment.

3. SUMMARY OF SITE SPECIFIC ENVIRONMENTAL EFFECTS. The continuing modification of existing facilities and construction of new facilities for STS operations at KSC will impact land use and will temporarily disturb air and water quality in the vicinity of the work, presenting minor, localized

effects. Operational environmental impacts involve potential effects on air quality and water quality, weather, and noise effects associated with preparation, launch, and landing of NASA systems. The additional information accumulated in the nearly 6 years since the previous (August 1973) EIS on Space Shuttle development and operation at KSC indicates that all potential impacts foreseen will be localized, of short duration, controllable, and of minimum severity. Studies of alternatives and research to define more fully those areas where effects are not yet known are continuing.

Refer to the topical index (appendix E) for specific location of each discussion area.

4. ALTERNATIVES CONSIDERED. The alternatives considered are: discontinuance or postponement of programs, recovery of Freon 113, alternate methods of chemical waste disposal, solid rocket motor storage, Orbiter landing approaches to mitigate sonic boom effects, hypergolic fuel storage, alternate sources of energy, and alternate modes of transportation of supplies and consumables.

5. COMMENTS REQUESTED FROM:

Advisory Council on Historic Preservation
Advisory Council on Intergovernmental Relations
Agency for International Development
Council on Environmental Quality
Department of Agriculture
Department of the Air Force
Department of the Army
Department of Commerce
Department of Defense
Department of Energy
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of the Navy
Department of State
Department of Transportation
Department of Treasury
Environmental Protection Agency
Federal Aviation Administration
Federal Communications Commission
Federal Maritime Commission
Federal Power Commission
General Services Administration

National Academy of Sciences
National Oceanic and Atmospheric Administration
National Science Foundation
Office of Management and Budget
Smithsonian Institution
U.S. Fish and Wildlife Service

Brevard County Board of County Commissioners
Brevard County Mosquito Control District
Brevard County Planning and Zoning Department
Brevard County Public Works Department
Brevard County Utilities Administrative Office
Brevard Economic Development Council
Canaveral Port Authority
Cape Canaveral, City of
Cocoa, City of
Cocoa Beach, City of
Indialantic, Town of
Indian Harbour Beach, City of
Malabar, Town of
Melbourne, City of
Melbourne Beach, Town of
Melbourne Village, Town of
Palm Bay, City of
Palm Shores,Town of
Rockledge, City of
Satellite Beach, City of
Titusville, City of
West Melbourne, City of
Cocoa Beach Area Chamber of Commerce
Cocoa Chamber of Commerce
Florida Areawide Clearinghouse
Florida Chamber of Commerce
Florida State Clearinghouse
Melbourne Area Chamber of Commerce
North Brevard Development Commission
Palm Bay Area Chamber of Commerce
Titusville Chamber of Commerce

Air Pollution Control Association
American Association for the Advancement of Science
American Conservation Association, Inc.
American Farm Bureau Federation
American Forestry Association
American Geophysical Union
Bureau of National Affairs
Center for Law and Social Policy
Chamber of Commerce of the U.S.A.
Citizens' Committee on Natural Resources
Concern, Inc.
Conservation Foundation

Consumer Environmental News Service
Council on Economic Priorities
Ecological Society of America
Environmental Action Foundation
Environmental Action, Inc.
Environmental Defense Fund
Environmental Law Institute
Environmental Policy Center
Federation of American Scientists
Florida Audubon Society
Florida Chapter Sierra Club
Florida Defenders of the Environment
Florida Wildlife Federation
Ford Foundation
Friends of the Earth
Halifax Audubon Society
Indian River Audubon Society
International Ozone Institute
Izaak Walton League of America
League of Conservation Voters
League of Women Voters of the U.S.
National Association of Conservation Districts
National Audubon Society
National Commission on Supplies and Shortages
National Geographic Society
National Parks and Conservation Association
National Trust for Historic Preservation
National Wildlife Federation
Natural Resources Defense Council, Inc.
Rockefeller Foundation
Sierra Club
Wilderness Society
Wildlife Society, Inc.

6. PLACED FOR REFERENCE AT:

Bethune-Cookman College Library
Brevard Community College Library
Canaveral National Seashore
Cape Canaveral Public Library
Cocoa Beach Public Library
Cocoa Public Library
Eau Gallie Public Library
Florida A & M University Library
Florida Atlantic University Library
Florida Institute of Technology Library
Florida International University Library
Florida State Archives

Florida State University Library
Jones College Library
Kennedy Space Center Library
Library of Congress
Meadowlane Community Library
Melbourne Public Library
Merritt Island National Wildlife Refuge
Merritt Island Public Library
National Park Service, Southeast Archaeological Center Library
North Brevard Public Library
Nova University Library
Patrick Air Force Base Library
Rollins College Library
Satellite Beach Public Library
State Library of Florida
Stetson University Library
University of Central Florida Library
University of Florida Library
University of Miami Library
University of North Florida Library
University of South Florida Library
University of West Florida Library
Florida Senator Clark Maxwell, Jr.
Florida Senator John Vogt
Florida Representative David L. Barrett
Florida Representative Tim Deratany
Florida Representative Marilyn Evans
Florida Representative Winston S. Gardner
Florida Representative R. Dale Patchett
U.S. Senator Lawton M. Chiles, Jr.
U.S. Senator Richard Stone
U.S. Representative C. William Nelson (Florida Ninth District)

7. COMMENTS RECEIVED FROM:

Department of the Air Force
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of State/Agency for International Development
Department of State/Bureau of Oceans and International Environmental and Scientific Affairs
Federal Energy Regulatory Commission
National Oceanic and Atmospheric Administration/Environmental Research Laboratories
National Oceanic and Atmospheric Administration/National Marine Fisheries Service
National Science Foundation
United States Department of Agriculture
United States Department of Commerce
United States Environmental Protection Agency

United States Department of the Interior
United States Department of Transportation
United States Department of the Treasury

Brevard County Board of County Commissioners/County Development Division
East Central Florida Regional Planning Council (Regional Clearing House)
Florida Department of Agriculture and Consumer Service
State of Florida Department of Administration (State Clearing House)
State of Florida Department of Community Affairs
State of Florida Department of Commerce
State of Florida Department of Transportation
State of Florida Department of Natural Resources
State of Florida Game and Fresh Water Fish Commission

8. SUBMITTAL DATE: The draft environmental impact statement was submitted to the Environmental Protection Agency and made available to the public on April 12, 1979. This final environmental impact statement is being submitted to the Environmental Protection Agency and forwarded for notice to the public on MAR 14 1980

ADDENDUM

In order for NASA to pursue its role in space programs as established by Federal legislation while ensuring public safety and security for NASA facilities, it has been necessary for NASA to establish zones where, and times when, portions of the Kennedy Space Center are closed to public access. Security and safety zones for expendable launch vehicles lie within restricted areas of the Kennedy Space Center and the Cape Canaveral Air Force Station; however, before, during, and after a Space Transportation System (STS) launch, safety and security measures will require closure of certain additional areas (including certain lands managed by the DOI under Public Law 93-626, Canaveral National Seashore, and in accordance with the NASA/DOI Agreement, April 2, 1975).

Subsequent to the completion and printing of this Final Environmental Impact Statement, NASA and the Department of Defense identified additional STS requirements that will mandate closure of State Road (SR) 402 (Beach Road) for longer periods than were initially predicted (Sections 4.4, 5.7.2.3, and 7.7). There will be minor changes through 1984, but starting in mid-1986, it will be necessary to close SR 402 100 percent of the time. This may restrict public access to Playalinda Beach and certain surrounding wildlife viewing areas.

Due to this change, NASA responses to the Brevard County Board of Commissioners (p. 11-30, comment f) and the East Central Florida Regional Planning Council (p. 11-35, comment d), which referred to vehicle access to Playalinda Beach, are no longer, appropriate. Alternatives such as the use of alternate routes are still being evaluated, but at the present time closure of SR 402 whenever flight hardware is emplaced on either Launch Complex 39A or Launch Complex 39B (as was done during the Apollo era) will best serve the national interest by affording the Space Transportation System a more secure environment.

OVERVIEW

POTENTIAL ENVIRONMENTAL EFFECTS

The potential environmental effects resulting from Kennedy Space Center (KSC) institutional operations and Space Transportation System (STS) development operations were discussed in the initial Environmental Impact Statement (EIS) published in August 1971 and amended in August 1973. Since that time, the National Aeronautics and Space Administration (NASA), in cooperation with outside experts and other Government agencies, has pursued an aggressive and comprehensive environmental program. A reassessment of the potential environmental impacts has recently been completed and the results are summarized as follows:

AIR QUALITY: The possible environmental effects on air quality imposed by KSC operations can be attributed to six sources: (1) automotive vehicle emissions, (2) waste products of fuel combustion by utilities, (3) waste products of incineration, (4) exhaust effluents from space vehicle launches, (5) aircraft exhaust emissions, and (6) chemical releases by venting and evaporation.

A ground cloud will be formed by the Space Shuttle during launch, similar to those produced in the past by Delta and Titan expendable launch vehicles but larger in size. The Space Shuttle ground cloud will consist of (1) the exhaust products from the Solid Rocket Boosters (SRB) and from the liquid rocket main engines which ignite at launch, (2) the products of afterburning in the exhaust plume, and (3) the water, air, and ground debris mixed with exhaust gases at the launch area. The potential effects of the ground cloud depend upon its movement, local meteorological conditions, and concentrations of chemical constituents in the cloud.

Hydrogen chloride and aluminum oxide are the chemical constituents of primary concern in the ground cloud. In order to gain the most comprehensive understanding of the characteristics and predictable impact of the ground cloud, the following studies have been made and are continually being updated as new information is collected:

a. Mathematical modeling of the ground cloud movement and diffusion

b. Extensive in situ measurements of similar but smaller clouds produced by expendable launch vehicles

c. A long-term scientific laboratory and field study to detect impacts on local flora and fauna

d. Establishment of sophisticated air monitoring stations to provide a comparison between normal and post-launch air quality

These ongoing efforts are being conducted to test predictions that the Space Shuttle will not have a long-term impact on air quality and that short-term exposures will have no significant long-term effect on plants and animals or on the human environment.

WATER QUALITY. The possible environmental effects on water quality imposed by KSC operations can be attributed to five sources: (1) water use, (2) discharge from sewer plants, (3) rainwater runoff, (4) dredging, and (5) runoff from washdown of components and equipment and other operations. Increased future use of water is not expected to be significant and none of the operations which produce waste water is expected to exceed State or Federal standards. No measurable long-term effects are expected.

The water used for acoustic damping and facility cooling during launch of the Space Shuttle will be sampled following the first launch to determine if partial impoundment and ground runoff are environmentally acceptable.

LAND QUALITY. The probable environmental effects on land quality imposed by KSC operations can be attributed to five sources: (1) facility construction, (2) landfill for solid waste disposal, (3) material storage areas, (4) receiving lands for effluent discharge, and (5) tenant leases. All uses of land are consistent with past practices and current dedication for KSC operations, and a master planning group at KSC assures continuing compatibility with local and State of Florida land-use plans.

NOISE. Noise generated by day-to-day operations and by launching and landing operations can be attributed to five general sources: (1) Orbiter reentry sonic boom, (2) noises at launch, (3) aircraft operations, (4) industrial operations, and (5) traffic noises. Of these, only the reentry trajectory will produce sonic boom over populated areas. Extensive studies of sonic boom dynamics indicate that the maximum overpressures will be in the range of nuisance or annoyance. A program is planned for monitoring sonic boom generated by the first landing at KSC.

RADIATION IMPACTS. The sources of potential radiation impacts include both ionizing and nonionizing radiation. The use of research and flight sources has been a part of the KSC program for many years, and strict local and Federal controls apply to this area of activity. No adverse effects are expected.

SOCIOECONOMIC IMPACTS. In the period following termination of the Apollo program, high levels of unemployment and sharply curtailed economic gains were common in Brevard County, Florida. Area changes included a drastic reduction in the grade school population and an influx of retired persons. The decision to implement the STS at KSC has had, and will continue to have, a stabilizing, even mildly stimulating effect on the local economy. The necessary services now exist in sufficient capacity to meet all projected needs of the area. Beneficial impacts from the STS program have provided the needed confidence to establish a pattern of long-term, gradual growth.

WEATHER. Two areas of potential weather impact have been identified with Space Transportation System (STS) operations at KSC: (1) acidic rain, and (2) inadvertent weather modification.

a. Acidic Rain. The hydrogen chloride present in a Space Shuttle exhaust cloud may, under recognized local meteorological conditions, produce an acidic rainfall. NASA has established and is continuing a research program to model the potential for acid rain. Studies have been conducted to assess the potential effects of acid rain on the local environment. An extensive rain collection network and an associated analysis laboratory have been established at KSC to collect, analyze, and monitor current and future rain composition. Initial results of this work indicate that acidic rain which might occur would be localized, probably not having measurable effects beyond the boundaries of KSC. Observed effects of an acidic rain having a very low pH (0.5 to 2.0) include abscission of leaves, flowers, and fruits at the lowest pH, and slight spotting of these sensitive plant parts at the higher pH. To date, no permanent impairment has been identified. A laboratory evaluation of leaching effects of hydrogen chloride washout from the Solid Rocket Motor exhaust indicated that the neutralizing capability of the soil at KSC is substantial. No long-term effects on soil or water due to acidic rain are expected.

b. Inadvertent Weather Modification. The Space Shuttle exhaust cloud might initiate rainfall if it encounters active precipitation cells, or might suppress rainfall if it encounters a shallow, warm cloud. Results of such weather modification are difficult to assess and its occurrence is unlikely. The program of rainfall monitoring and collection, already underway at KSC (July 1977 to present) to establish a baseline for analyses of acidic rain, may provide meaningful ground-based observation for weather modification studies. In the event that conclusive evidence cannot be obtained, it may be possible to choose launch times which coincide with favorable meteorological conditions and so eliminate the possibility of weather modification.

ECOLOGY. Based on the results of analyses performed for the preceding impact areas, no long-term or cumulative effects are predicted for the abiotic, biotic, or human health and welfare elements. Assessments have been made of the potential impact on threatened and endangered species and critical habitat at KSC and no significant effects are expected. Consultations with the appropriate agencies have been initiated.

UNPLANNED EVENTS. Adverse environmental consequences of potential mishaps for both the operations and worst-case events have been assessed. No unacceptable risks to the environment have been identified.

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SECTION I

INTRODUCTION

1.1 PURPOSE

The purpose of this Environmental Impact Statement (EIS) is to consolidate and bring up to date the evaluations of environmental effects associated with current and future activities at the National Aeronautics and Space Administration (NASA) John F. Kennedy Space Center (KSC) in Florida. This document supersedes two previous environmental impact statements for the Kennedy Space Center: (1) the original EIS of 1971 (reference 1-1), which was descriptive of the then-current activities, and (2) the Amendment No. 1 of 1973 (reference 1-2), which assessed the expected environmental effects of Space Shuttle development and operations. Because this EIS is principally an update of information pertaining to an ongoing program, it does not describe potential effects of program alternatives on which decisions have been made. Some alternative approaches to specific program operations at KSC remain under consideration and are discussed herein.

1.2 SCOPE

As a fully revised institutional and programmatic EIS for KSC, this statement includes consideration of the site specific environmental effects of all development and operations activities at this installation. Specifically included are facility development, industrial operations (those carried out on a day-to-day basis independent of particular launch and landing operations), system support operations (those carried out in support of a particular launch or landing event), and space vehicle launches and landings (which are characterized by their own unique environmental signatures). Systems support and launch and landing activities include those associated with the Space Shuttle itself, Spacelab, and Space Shuttle Upper Stages, all of which comprise the Space Transportation System (STS). Coverage is also provided in this EIS for expendable launch vehicle operations and activities associated with payloads as presently identified both for the STS and for the expendables. Also, other activities not related to space flight programs, such as the Merritt Island National Wildlife Refuge and the Canaveral National Seashore, are included.

Global concerns and impacts due to manufacturing, test, transportation, or flight outside the immediate locality of the John F. Kennedy Space Center are the subject of program-oriented statements issued by NASA Headquarters, Washington, D.C. or the NASA Field Center responsible for program development and so are beyond the scope of this document.

1.3 BACKGROUND

KSC is the principal site for launch of space systems by NASA. With the advent of the Space Shuttle, KSC will become the principal launch and landing site for the Space Transportation System as well. The environmental effects of activities at KSC have been the subject of a series of evaluations, and NASA has previously prepared two EIS's describing these effects.

The first of these, the Institutional EIS (reference 1-1), was issued in 1971 and included a description of the environmental effects associated with the facilities and operations then in being or approved for construction and operation. This included the remaining launch operations in the Apollo program, the four Skylab launches, and a group of launches of unmanned spacecraft conducted by KSC utilizing the Air Force Eastern Test Range (AFETR), Cape Canaveral, Florida and the Air Force Western Test Range (AFWTR), Vandenberg Air Force Base, California. That institutional statement was intended as a document descriptive of environmental effects of ongoing activities and did not give consideration to any specific proposed actions; it was intended as a baseline document, against which any subsequent actions could be assessed.

The second KSC EIS, Amendment Number 1 to the Institutional EIS (Space Shuttle Development and Operation), was published as a draft in October 1972 and as a final EIS in August 1973 (reference 1-2). This amendment was prepared to describe the predicted environmental effects at KSC and its environs that would result from construction and operations activities associated with the Space Shuttle Program. The 1973 Amendment 1 to the KSC Institutional EIS (reference 1-2) provided for new facilities, six of which have since undergone changes in concept, location, or both, during program development, as depicted in figure 1-1:

a. Two facilities, a Landing, Deservicing, and Safing Facility (location 1) and a Maintenance and Checkout Facility (location 2), were originally conceived as separate entities. As a result of costs and needs for improved scheduling efficiency, the Orbiter Processing Facility (OPF) (location 2) was created to fulfill the functions of both of the proposed facilities. Because the OPF was constructed in a previously disturbed area, northwest of the Vehicle Assembly Building (VAB), adverse environmental impact in the region of the proposed site near the Shuttle Landing Facility was avoided. Moreover, handling of toxic substances and of servicing fluids has been consolidated into a single industrialized area adjacent to the Space Shuttle assembly area.

b. Modifications to the Crawler Transporter parking area (location 3) to provide service pits and equipment for maintenance and refurbishment are under consideration but have not been funded. Construction of this facility, if approved and funded, will take place in a previously disturbed area. Alternate locations and solutions for current operations were studied and eliminated from further consideration because they would not meet the increased maintenance requirements during the Space Transportation System program.

c. New construction at the VAB turn basin (location 4) was originally planned to accommodate the entire Solid Rocket Booster (SRB) handling sequence of receiving, buildup, recovery, disassembly, and cleaning.

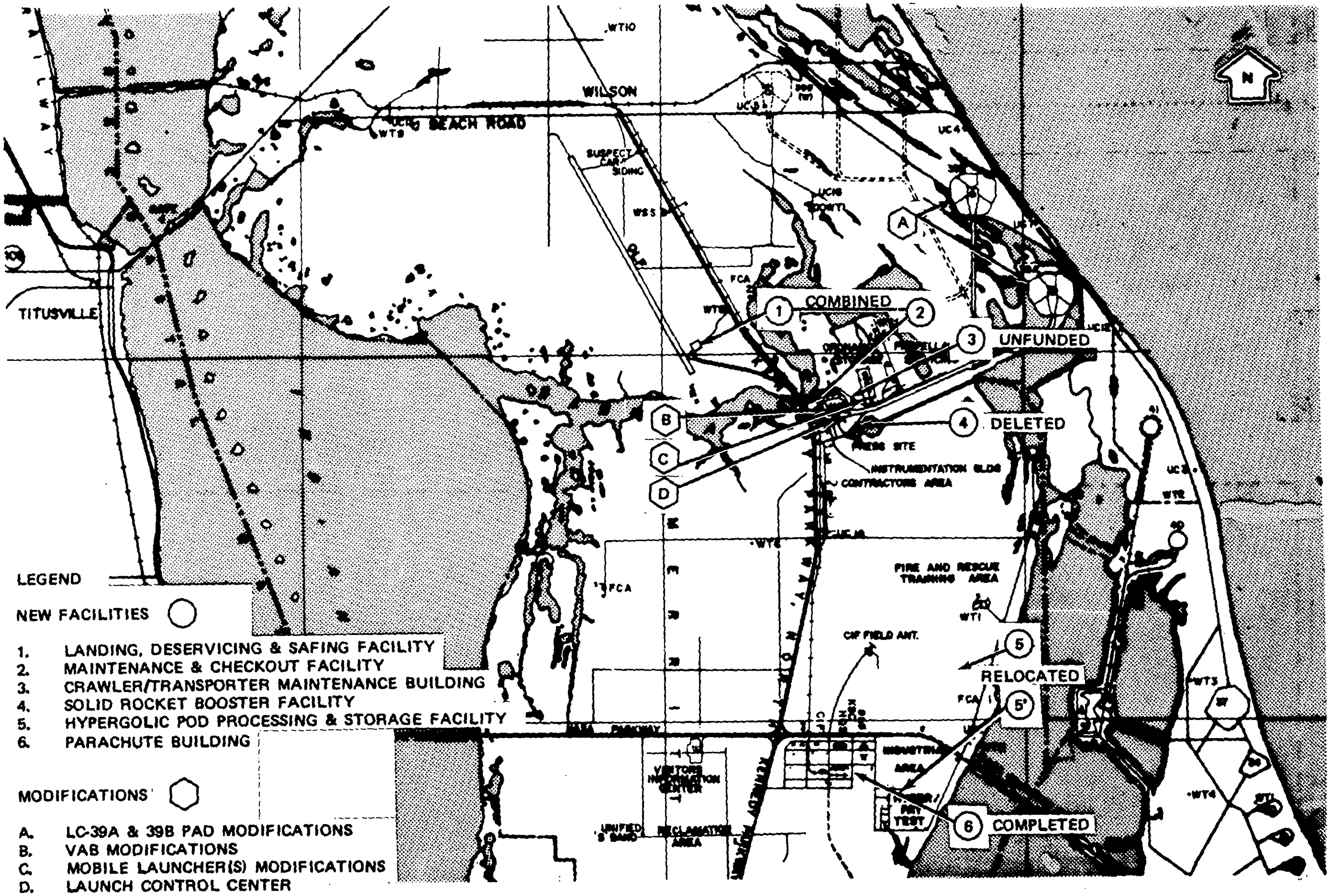


Figure 1-1. Proposed Siting for Space Shuttle Facilities, 1973, Versus Current Status

The size and complexity of this facility and the required utilities and rail services made this option very costly. Environmental considerations included use of an existing navigable waterway and availability of previously disturbed land, but construction of a new facility would have required some fill operations, bulkheading, and major site work. Although an optimum choice operationally, this alternative was abandoned in favor of using existing facilities and a more decentralized approach. Costs were appreciably lower and environmental impact from new construction was avoided. The current facility baseline includes three areas for SRB work: (1) VAB Low Bay for SRB component refurbishment and subassembly (location B); (2) VAB High Bay for receiving and buildup (location B); and (3) modification to Hangar AF to provide an SRB Recovery and Disassembly Facility (RDF) for receiving, disassembling, and cleaning retrieved SRB casings in preparation for vendor reloading. (See section II for details.)

d. The facility originally envisioned for refurbishment and testing of Orbiter hypergol modules was to be new construction in an area between the KSC Industrial Area and the VAB (location 5). To accommodate the hazardous operations inherent in the handling of hypergolic fuel and oxidizer, the facility design incorporated safety and environmental features which contributed to prohibitive costs. The need to locate the facility at a safe distance from other operations removed the operational advantage of geographic proximity. Therefore, existing Apollo facilities previously used for similar operations and located 10 kilometers (6 miles) to the south of the VAB were selected (location 5'). In addition to effecting considerable cost savings, use of the Apollo facilities avoided the environmental impact resulting from new construction while providing a degree of isolation for hazardous operations.

e. The Parachute Refurbishment Facility (location 6) is essentially the same as originally proposed except for modifications to improve the flow of materials through the sequence of receiving, defouling, washing, rinsing, drying, refurbishment, and repacking. Two new building segments have been added, requiring the grubbing, clearing, grading, and filling of about 405 square meters (0.1 acre) of land and a new 38-centimeter (15-inch) drainage line.

Since the preparation of Amendment No. 1 (reference 1-2), NASA has implemented the construction and modification activities required to prepare for Space Shuttle operations at KSC and has moved far along towards the commencement of Space Shuttle flight operations (scheduled to begin in 1979). During this period, as design and construction activities progressed, changes in design or location of certain facilities and resulting environmental effects were assessed. The remaining work in progress and planned construction for the future are described in section II.

During these same years, continued research on the expected environmental effects of the Space Shuttle test and flight operations has yielded considerable new information; also, a number of design changes have altered somewhat the previous estimates of environmental effect. As a result of these continuing assessments, NASA released, in May 1978, a revised final EIS for the Space Shuttle Program (reference 1-3) incorporating the new information and superseding the original 1972 program statement (reference 1-4). The new program statement describes in detail the probable effects of Space Shuttle-related activities that are global or otherwise not specific to a particular location and summarizes those effects that are peculiar to a particular locale. Other site specific Environmental Impact Statements in the Space Shuttle group are references 1-5 through 1-10, the last being that of the United States Air Force for Space Shuttle-related activites at the Vandenberg Air Force Base, California. Expendable launch vehicle environmental effects are described in reference 1-11, and Air Force operations at the Cape Canaveral Air Force Station (CCAFS) are discussed in reference 1-12. All references are identified in appendix B.

1.4 SECTION CONTENT

The sections into which this EIS is divided are interrelated. While the topical index, appendix E, will direct the reader to a chosen area of interest, unlisted portions of this document may be pertinent to a comprehensive understanding.

Section II provides a brief history of the Space Program at KSC and describes past, present, and proposed Space Program activities.

Section III describes the existing environment at KSC as experienced by the human population as well as the animal and plant life, including endangered and threatened species.

Section IV defines the land-use plans and policies, and explains why certain controls and restrictions must be imposed.

Section V details the individual and collective expected environmental impacts of the proposed action under normal, planned operations and the mitigating measures proposed to maintain the effects at an acceptable level. Certain unplanned events are analyzed in recognition of the fact that, though highly improbable, they cannot be ignored.

Section VI discusses, in addition to the "No-Action" alternative, seven alternatives to various actions which are presently under investigation.

Section VII discloses potential unavoidable adverse environmental effects and methods to avoid or mitigate unacceptable impacts.

Section VIII explains the multiple long-term advantages of the Space Program which will clearly compensate for the short-term use of the environment.

Section IX itemizes the expected consumption of irretrievable resources by the proposed action as compared to the present demands of KSC operations.

Section X lists the present and future benefits to mankind resulting from the proposed action.

Section XI presents the letters received on the draft environmental impact statement and NASA's reponses to specific comments.

The five appendices contain the following information:

Appendix A defines the abbreviations and acronyms used herein and provides conversion factors for values used in the text, figures, and tables.

Appendix B provides the sources of referenced documents.

Appendix C expands on the nature and habitat of endangered and threatened species of fauna found at KSC.

Appendix D contains detailed background material for sections II and V.

Appendix E lists and cross-references the topics discussed in sections I through X.

A vegetation map of the area is included in a pocket on the rear cover.

SECTION II

SPACE PROGRAM ACTIVITIES

2.1 INTRODUCTION

This section describes space program activities at KSC and related operations at Cape Canaveral Air Force Station (CCAFS) for which NASA has a responsibility. Subsections describe the history of KSC development, Space Transportation System activities, expendable launch vehicle operations, support facilities for space vehicles, and KSC facilities operations which are required on a daily basis, regardless of launch schedules.

2.2 HISTORY

The primary mission of the John F. Kennedy Space Center involves the launching of space vehicles into Earth orbit and beyond, using chemically fueled rockets. NASA began the KSC acquisition process in 1962, taking title to 33,952 hectares (approximately 84,000 acres) by outright purchase, and negotiating with the State of Florida for use of an additional 22,600 hectares (about 56,000 acres) of submerged lands, most of which lie within the Mosquito Lagoon (also known as the Indian River Lagoon). Thus, the total area of KSC is slightly more than 56,500 hectares (140,000 acres). The southern boundary of KSC runs east-west along the Barge Canal which connects Port Canaveral with the Banana and Indian Rivers and parallels the southern tip of Cape Canaveral. From that point, the tract extends northward about 48 kilometers (30 miles) and is bounded on the east by the Atlantic Ocean and the CCAFS, and on the west by the Indian River (figure 2-1). Under a 1972 agreement with the U.S. Fish and Wildlife Service (FWS), and a 1975 agreement with the Department of the Interior, the Merritt Island National Wildlife Refuge and most of the Canaveral National Seashore (CNS) fall within the boundaries of KSC. By creation of the CNS (Public Law 93-626), 16,605 hectares (41,000 acres) of the CNS fell within the KSC boundaries. Today, almost 2,700 hectares (6,655 acres) are administered by the National Park Service (NPS) and 13,909 hectares (34,345 acres) are under Merritt Island National Wildlife Refuge management. By agreement, such use authorization and administration does not extend to property related to the space program.

Since the space program began in the late 1950's, U.S. space missions have been performed using a family of expendable launch vehicles. The Saturn vehicles provided the launch capability for the manned lunar exploration program (Apollo), the manned space station missions (Skylab), and the joint U.S.-U.S.S.R. Apollo-Soyuz Test Project. The smaller Atlas and Delta launch vehicles are currently used to launch a variety of automated spacecraft (e.g., communications satellites, weather satellites, Earth-orbiting scientific satellites, and interplanetary exploratory spacecraft). Atlas and Titan vehicles were also used for the early Mercury and Gemini manned flight programs.

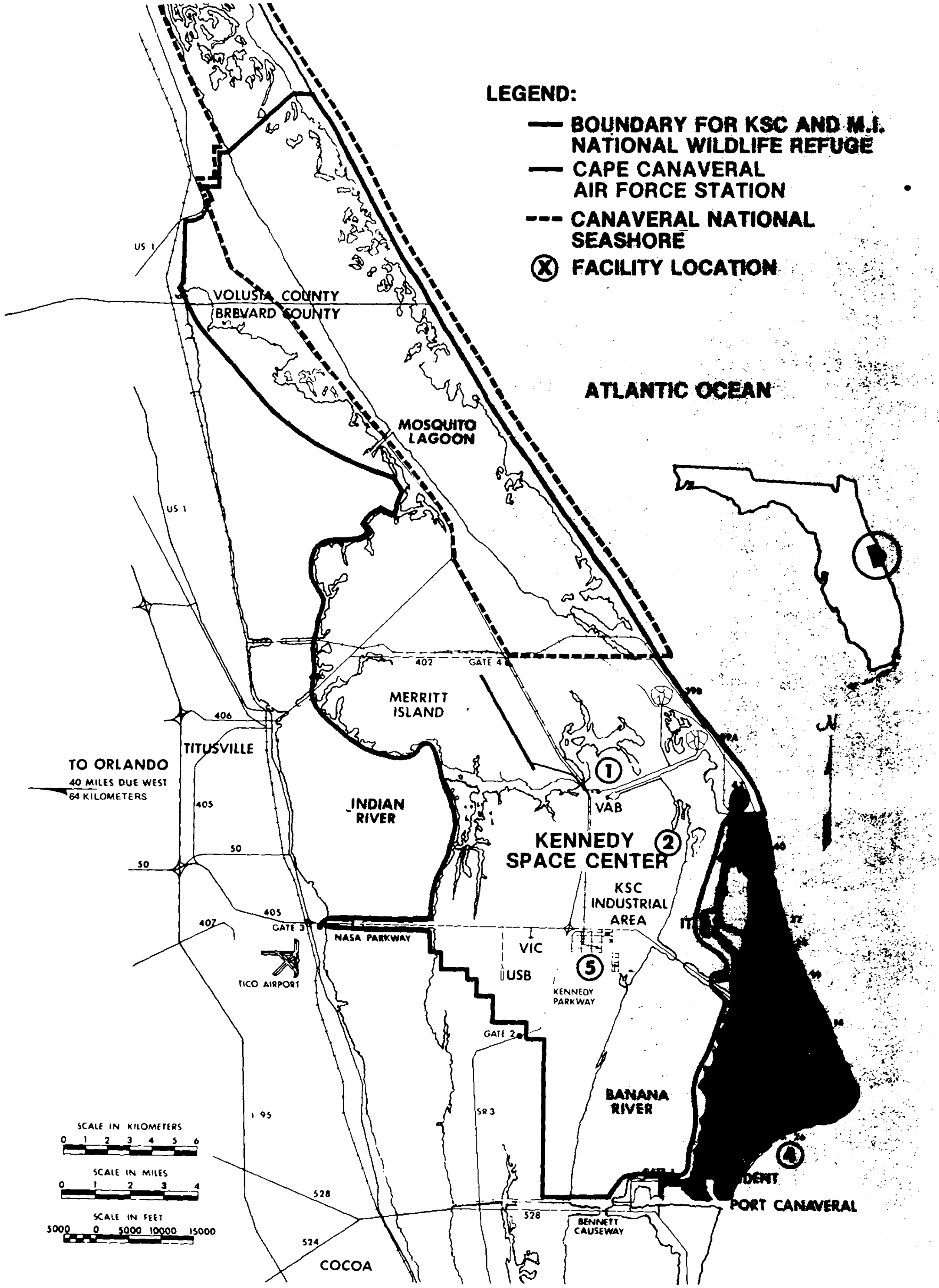


Figure 2-1. Kennedy Space Center/Merritt Island National Wildlife Refuge and Vicinity

These expendable launch vehicles served the nation's space program well; however, their use is limited because of the cost incurred in constructing a new vehicle for each mission. In the late 1960's and early 1970's, the need was recognized for replacing (by the early 1980's) the current expendable launch vehicles with low-cost reusable vehicles. The Space Shuttle has been designed to fill that need.

The Space Shuttle will make routine space operations possible. As shown in table 2-1, Space Shuttle flights will replace all NASA expendable launch vehicle missions at KSC. Payloads carried to and from Earth orbit will include crew-operated, personnel-tended, or fully automated scientific or applications satellites. Payloads will be used for applications in Earth resources, environmental monitoring, communications, meteorology, and geodesy. The Space Shuttle will provide space transportation for operational and developmental payloads for NASA, the U.S. Department of Defense (DOD), the National Oceanic and Atmospheric Administration (NOAA), and other U.S. Government users. It will also accommodate the space transportation needs of future commercial and international organizations on a reimbursable basis.

The launch programs at KSC can be divided into two broad classes, based on the types of launch vehicles used: (1) Space Transportation System (STS) vehicles, which will fly numerous missions on a reusable basis, and (2) Expendable Launch Vehicles, which fly for only one mission, during which they are consumed.

A third program area, which does not involve launches but does relate directly to environmental management, includes scientific applications using capabilities and hardware developed by NASA. Science applications projects at KSC utilize optical equipment and computers for image enhancement and analysis to enable interpretation of remote sensing data; computer models which are used to develop tools for pollution monitoring; laser applications which develop advanced communication techniques; and a variety of laboratory projects which contribute to state-of-the-art advances in technology. These projects contribute to the new applied science and engineering which will be needed for future space program operations as well as in the transfer of space-derived technology to terrestrial applications.

2.3 SPACE TRANSPORTATION SYSTEM OPERATIONS

The STS is an integrated system consisting of the Space Shuttle Vehicle, Spacelab(s), and Upper Stages. The STS will replace all current NASA expendable rocket boosters except the smaller Scout vehicle currently launched from Wallops Island, Virginia and Vandenberg Air Force Base, California. This section describes each STS element in relation to KSC operations.

2.3.1 SPACE SHUTTLE VEHICLE. The Space Shuttle flight system (figure 2-2) consists of an Orbiter, two Solid Rocket Boosters (SRB's), and an External Tank (ET). The Orbiter and SRB's are reusable elements; an ET will be expended on each launch. The following descriptions of the individual elements

Table 2-1. KSC Predicted Mission Model by Fiscal Year

Fiscal Year[1]/	79	80	81	82	83	84	85	86	87	88	89	90	91	92	Total
Space Transportation System Flights															
Spacelab	-	-	1	4	8	7	9	13	12	14	13	13	16	12	122
Upper Stages	-	-	6	9	8	14	18	17	13	21	17	21	15	13	172
Free-Flyers	-	-	-	2	1	2	1	2	5	1	4	3	3	2	26
Other	-	4*	2	1	1	2	2	4	4	4	4	4	4	3	39
Total (STS)	-	4*	9	16	18	25	30	36	34	40	38	41	38	30	359
Expendable Launch Vehicles															
Delta	4	3	4	-	-	-	-	-	-	-	-	-	-	-	11
Atlas-Centaur	2	5	3	-	-	-	-	-	-	-	-	-	-	-	10
Total (ELV)	6	8	7	-	-	-	-	-	-	-	-	-	-	-	21
Total KSC Flights	6	12	16	16	18	25	30	36	34	40	38	41	38	30	380

1/Fiscal Year is Government Fiscal Year: 1 October through 30 September. These data are valid as of January 1979 and may change as schedules become better defined. Slippages may cause lower flight rates during the initial years, so this table may reflect more traffic than will occur.

*The September 1979 projection for FY 1980 is one STS launch.

Figure 2-2. Space Shuttle Vehicle

passing through the facilities illustrated in figures 2-3 and 2-4 are presented to provide a comprehensive view of the Space Shuttle ground processing routine.

a. Space Shuttle Orbiter Operations. The Space Shuttle Orbiter (figure 2-5) will contain the crew and payload for the Space Shuttle system. The Orbiter can deliver to orbit payloads of 29,500 kilograms (65,000 pounds) with lengths to 18 meters (60 feet) and diameters of 5 meters (15 feet). The Orbiter is comparable in size and weight to modern transport aircraft; it has a dry weight of approximately 68,000 kilograms (150,000 pounds), a length of 37 meters (122 feet), and a wingspan of 24 meters (78 feet).

The crew compartment can accommodate 7 crewmembers and passengers (4 is the baseline) for some missions but will hold as many as 10 persons in emergency operations.

The three main propulsion rocket engines used during launch are contained in the aft fuselage. The main engine propellants are contained in the ET, which will be jettisoned before initial orbit insertion. The orbital maneuvering subsystem (OMS) is contained in two external pods on the aft fuselage. These units will provide thrust for orbit insertion, orbit change, rendezvous, and return to Earth. The reaction control subsystem (RCS) is contained in the two OMS pods and in a module in the nose section of the forward fuselage. These units will provide attitude control in space and precision velocity changes for the final phases of rendezvous and docking or orbit modification. In addition, the RCS, in conjunction with the Orbiter aerodynamic control surfaces, will provide attitude control during reentry. Once de-orbit is initiated, the Orbiter glides to the landing site without further powered flight. The aerodynamic control surfaces will provide control of the Orbiter at speeds of less than Mach 5. The Orbiter is designed to land at a speed of 95 m/sec (185 knots), similar to current high-performance aircraft.

The turnaround flow for the Orbiter element initiates processing in one of two ways. Either an Orbiter in dormant stage will be ferried to KSC or an Orbiter will land at the KSC landing facility. In each case, the Orbiter will be towed to the Orbiter Processing Facility (OPF) and all Orbiter systems will be deactivated. When access has been provided, the hypergol modules will be removed and sent to the Hypergol Maintenance Facility (HMF) for maintenance. Access to all areas of the Orbiter will be provided to permit inspection and to begin specific maintenance. Part of this phase will include "power-on fault isolation" to detect failures in redundant circuits not apparent from flight data. A significant part of this maintenance effort will be the evaluation and replacement of damaged tiles of the Orbiter Thermal Protection Subsystem (TPS).

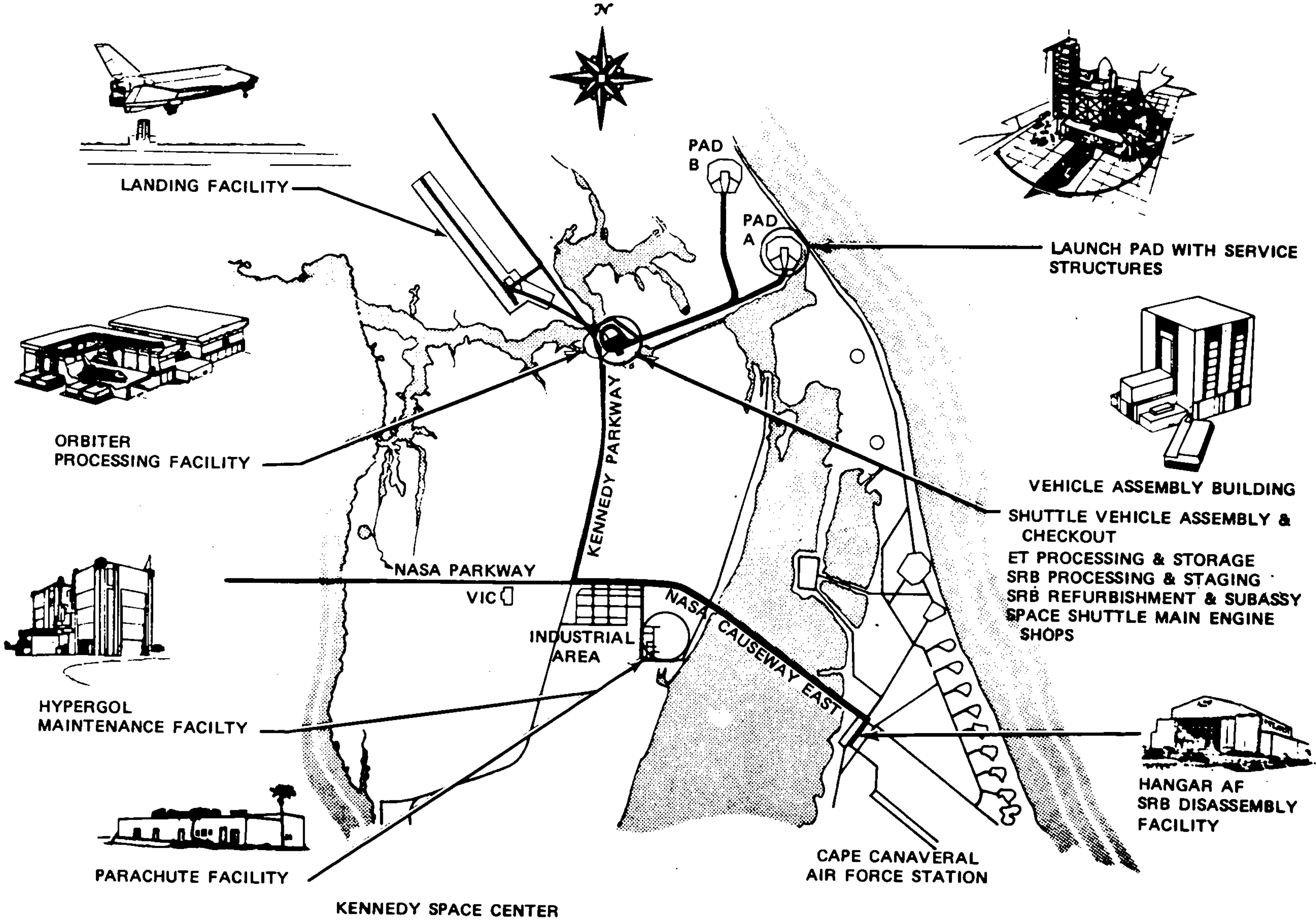


Figure 2-3. KSC Major Shuttle Facilities - Pictorial Baseline

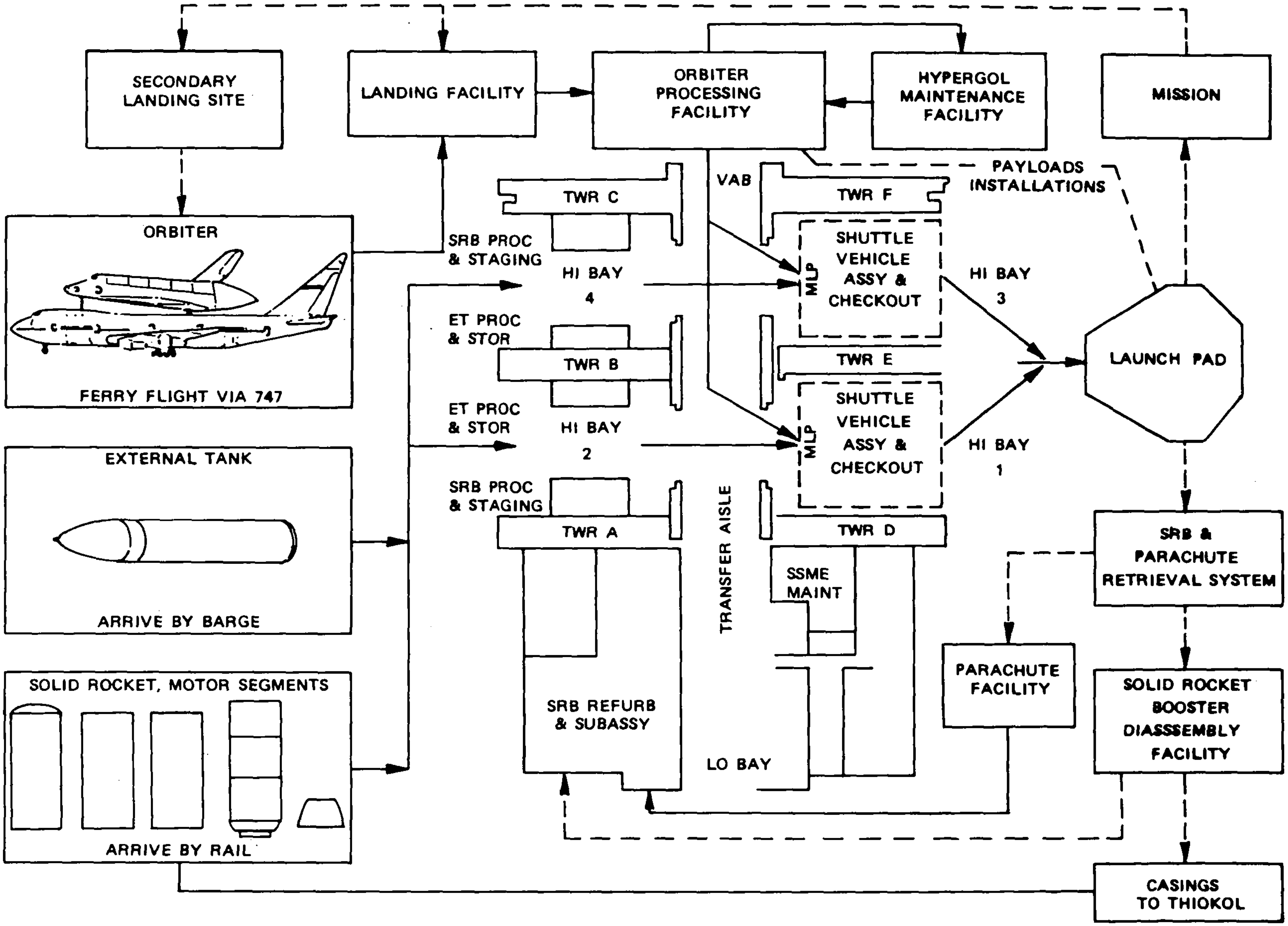


Figure 2-4. KSC Major Shuttle Facilities - Flow Logic

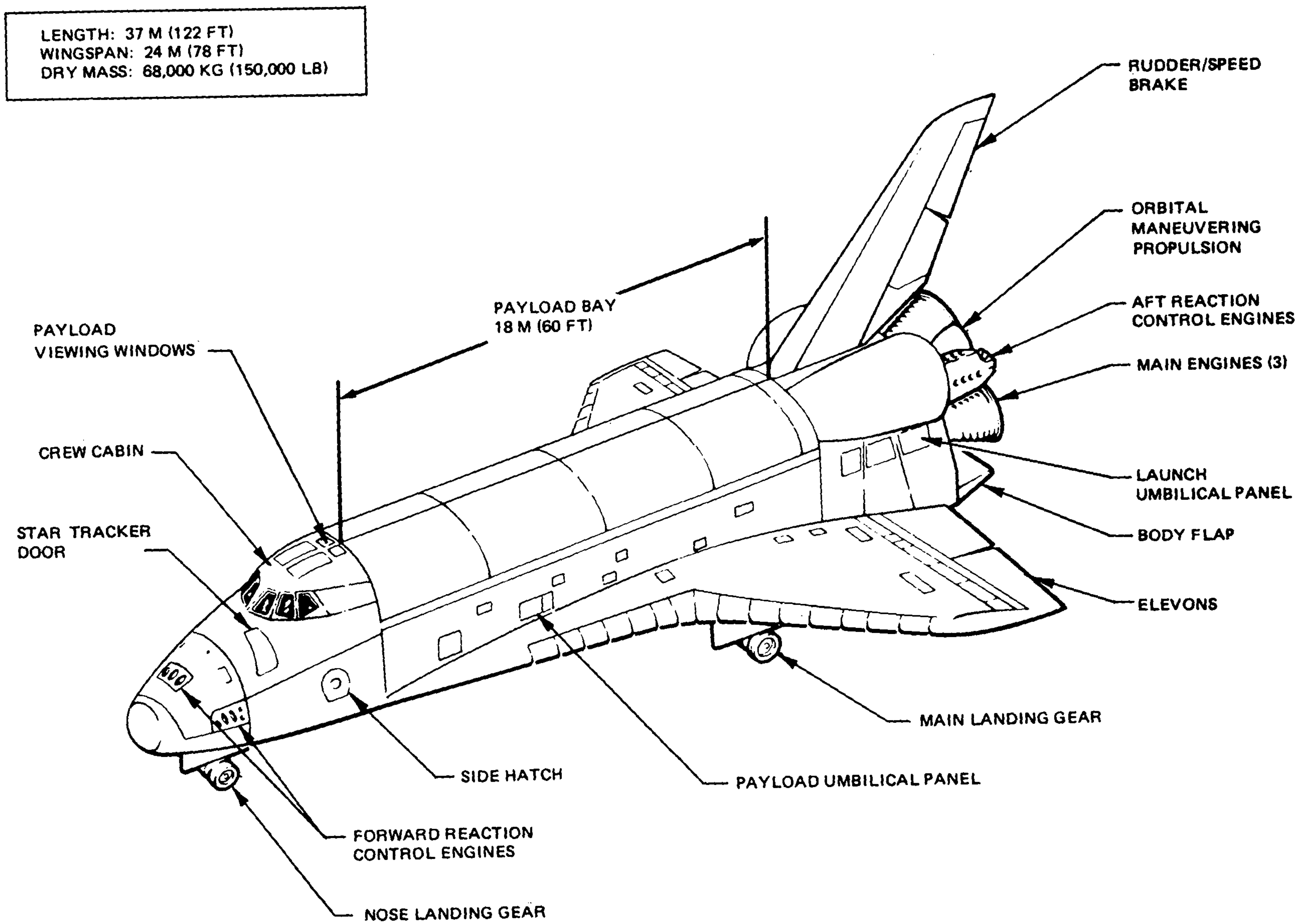


Figure 2-5. Space Shuttle Orbiter

Phased with the maintenance and modification period will be the servicing of the hypergolic system modules, which will be checked out in the HMF "off-line" facility. Upon arrival from the OPF, each module will be placed in the appropriate test cell and connected to electrical cables (for command and monitoring functions), servicing/deservicing lines, and pneumatic lines. The modules will go through detailed pneumatic, electrical, instrumentation, and leak checks.

At the OPF, the payload will be installed in the Orbiter, which will then be prepared for final integrated power-on testing (including Orbiter/payload interface tests). A cabin leak test will be performed to verify cabin integrity. Servicing operations in the OPF will include those performed on the ammonia coolant system. The Orbiter integrated test will include requalification of Orbiter/payload interfaces with the flight control center at Johnson Space Center by performing the Mission Control Center - Houston (MCC-H) interface test.

The remaining Orbiter element testing will include closeout of the payload areas, installation and connection of Orbiter ordnance, stowage of the crew compartment, and installation of fixtures for mating the element to the ET/SRB. A vertical weight and X-axis center of gravity will be established prior to moving the Orbiter from the OPF to the Vehicle Assembly Building (VAB). Towing to the VAB will be performed with the Orbiter landing gear down.

b. Solid Rocket Booster Operations. Two SRB's (figure 2-6) burn in parallel with the main propulsion system of the Orbiter to provide initial ascent thrust. Primary elements of the booster are the motor, including case, propellant, igniter, and nozzle; forward and aft structures; separation and recovery systems; and thrust vector control subsystems. Each SRB weighs approximately 584,000 kilograms (1,286,600 pounds) and produces 11,800,000 Newtons (2,650,000 pounds) of thrust at sea level. The propellant grain is shaped to reduce thrust by approximately one-third 55 seconds after lift-off to prevent overstressing the vehicle during the period of maximum dynamic pressure. The hydrazine-driven thrust vector control (TVC) subsystem operates in conjunction with the Orbiter main engines to provide flight control during the Shuttle boost phase. Eight separation rockets on each SRB (four aft and four forward) separate the SRB from the Orbiter and the ET. The forward section provides space for the SRB electronics and recovery gear and for the forward separation rockets.

Solid Rocket Motor (SRM) segments will be shipped by rail from the contractor facility to KSC. The segments will be covered with transportation covers and will be shipped in a horizontal position. End rings will provide segment handling points, environmental protection, protection of the solid grain propellant, and protection of the

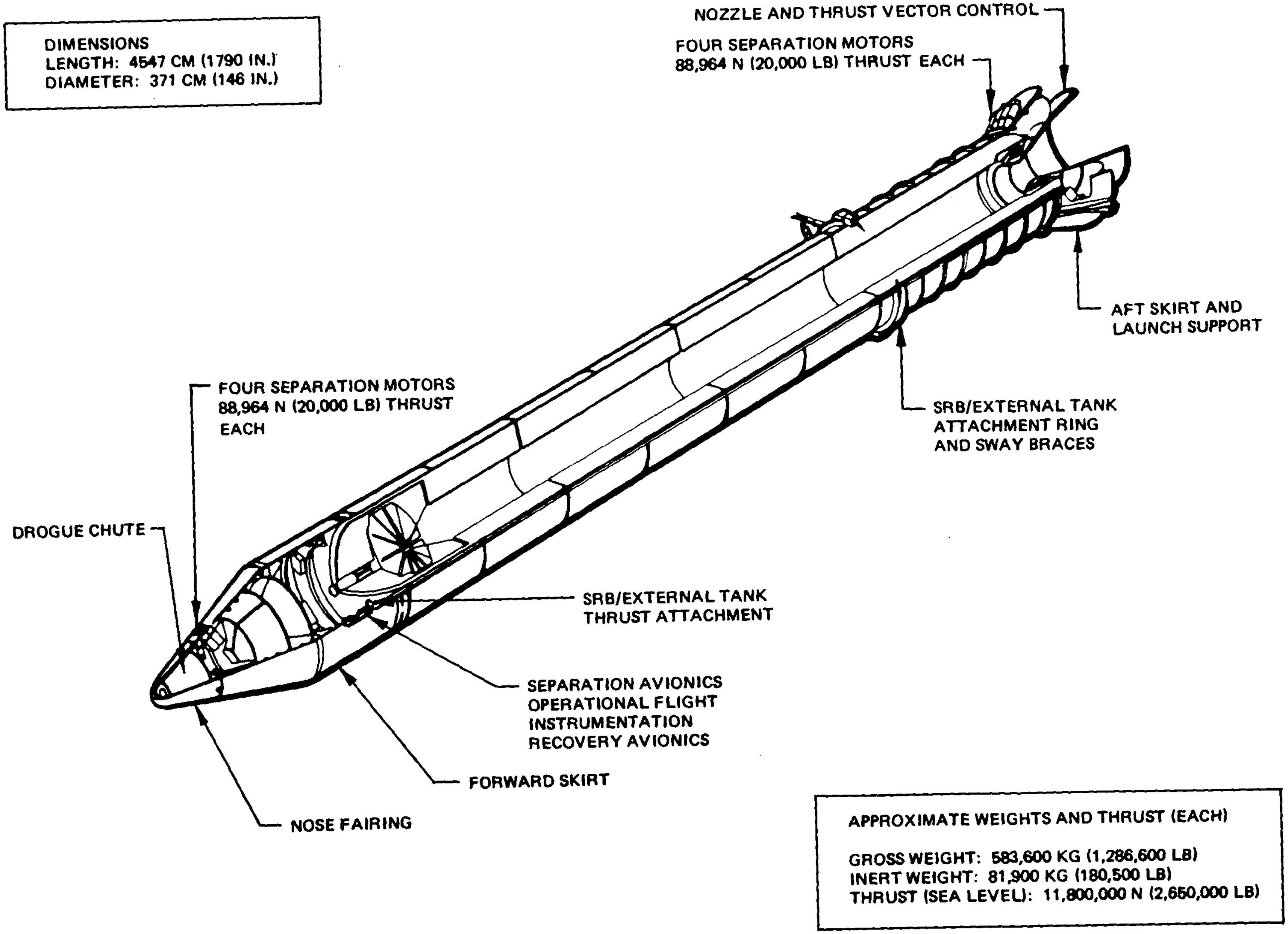


Figure 2-6. Solid Rocket Booster

circumferential interface edge of each segment from potential impact damage.

Upon arrival of the SRM segments at KSC, four segments for each SRB will be off-loaded in High Bay 4 of the VAB with the 227-metric ton (250-ton) bridge crane and a 113-metric ton (125-ton) hoist, rotated, and placed vertically into buildup workstands or inprocess areas. The receiving inspection will consist of an overall visual inspection of the external case and a general overall examination of each segment for possible shipping damage. The forward and aft closures, nozzle assemblies, nozzle extensions, and loose hardware will be inspected in a like manner.

The inert elements such as the forward skirt, frustums, nose caps, recovery systems, electronics and instrumentation (E&I) components, aft skirts, system tunnels, system cables, and elements of the TVC subsystem will be received in the Refurbishment and Subassembly Facility (RSF), located in the west Low Bay of the VAB, where receiving inspection will be performed. All small ordnance items (e.g., separation motors, linear-shaped charges, etc.) will be sent to the ordnance storage area where the receiving and inspection functions will be performed. The aft skirt will be received from the RSF and will be mated to the assembled aft segment in the buildup stand. The aft segment assembly, the forward segment, and the two center segments will be transferred by the 227-metric ton (250-ton) crane to High Bay 3 for stacking on the Mobile Launcher Platform (MLP).

As required by the launch rate, SRM receiving and checkout capabilities similar to those of High Bay 4 will be provided in High Bay 2.

c. External Tank Operations. The ET (figure 2-7) will contain the propellants for the Orbiter main engines: liquid hydrogen fuel and liquid oxygen oxidizer. All fluid controls and valves (except the vent valves) for operation of the main propulsion system are located in the Orbiter to minimize throwaway costs. At lift-off, the ET will contain 703,000 kilograms (1,550,000 pounds) of usable propellant. The liquid hydrogen tank volume is 1,523 cubic meters (53,800 cubic feet) and the liquid oxygen tank volume is 552 cubic meters (19,500 cubic feet). These volumes include a 3-percent ullage space. The liquid hydrogen tank will be pressurized in the range of 220,600 to 234,400 Newtons per square meter (N/m^2), equivalent to 32 to 34 pounds per square inch, absolute (psia), and the liquid oxygen tank will be pressurized to the range of 137,900 to 151,700 N/m^2 (20 to 22 psia).

The ET will arrive at the LC-39 Barge Terminal Facility via barge and will be moved on a transporter to the VAB transfer aisle in front of High Bay 4. The high bay and transfer aisle cranes will be used to pick up the ET, rotate it to vertical position, and place it in one

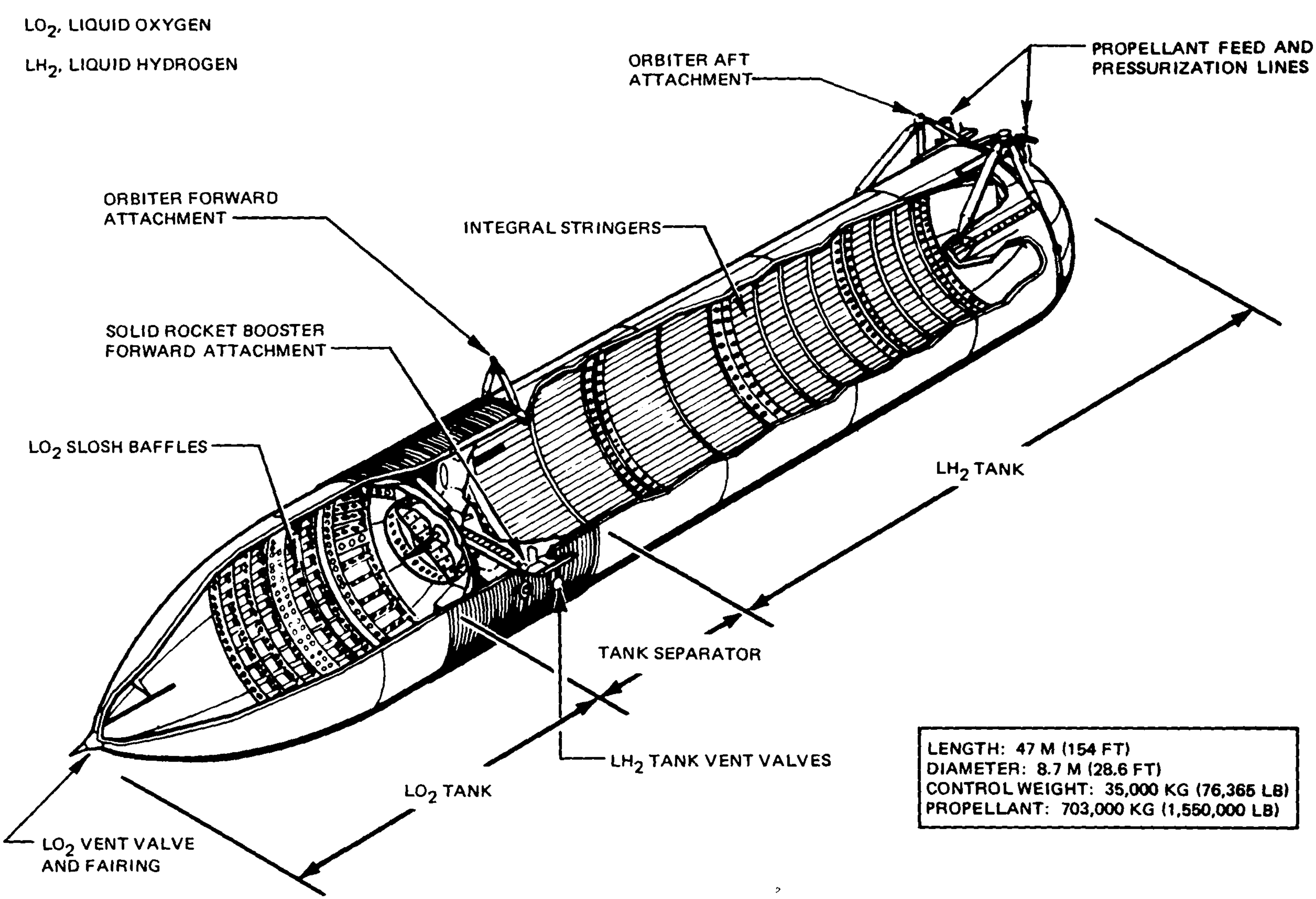


Figure 2-7. External Tank

of two storage/checkout cells in High Bay 4. Optical alignment measurements and inspection for possible in-transit damage will be performed, and the exterior insulation will be inspected. Following these inspections, the ET can be committed to controlled storage or transferred to High Bay 3 for mating operations. The storage configuration will include desiccant breathers to protect the tanks and components from moisture and foreign materials.

As required by the launch rate, ET receiving and checkout capabilities similar to those of High Bay 4 will be provided in High Bay 2.

2.3.2 CARGO OPERATIONS. Payloads for each Shuttle will be combined into a complete Shuttle cargo consisting of one or more Spacelab modules, Upper Stages, and Automated Payloads.

a. Spacelab Modules. Spacelab modules (figure 2-8) being developed by the European Space Agency can conduct on-orbit research as an extension of the Orbiter to enhance STS capabilities. Several Spacelab system configurations will be flown, one of which is shown in figure 2-9. This configuration is a pressurized module where man can work in a shirtsleeve environment (connected by an access tunnel to the cabin area of the Orbiter). Other configurations include those without a pressurized module in which a large number of instruments are installed on a pallet and are controlled from the payload specialist station in the Orbiter. Spacelab is an international program and, in addition to the European manufacture of Spacelab, payloads and crews will be international in origin.

b. Upper Stages. The Inertial Upper Stage (IUS) and the Spinning Solid Upper Stage (SSUS) are solid-propellant propulsive stages to be carried in the Orbiter cargo bay for use in obtaining higher apogee orbits for selected payloads than is possible with the Shuttle vehicle alone. The IUS and SSUS are presently in the design phase and subject to changes as the designs mature.

   As shown in figure 2-10, the IUS flight hardware consists primarily of a forward stage with a smaller solid-propellant motor, an interstage, a larger solid-propellant aft motor, and an aft skirt structure. This two-stage configuration is the baseline from which three- and four-stage configurations can be derived. For the Spinning Solid Upper Stages, two configurations are being considered. Both use electrically driven spin tables as part of the guidance system. The SSUS-Delta (SSUS-D) flight hardware consists primarily of a solid rocket propulsion subsystem, a structural/mechanical subsystem, and a telemetry system. As many as four SSUS-D/spacecraft combinations can be flown on a single Shuttle launch. As shown in figure 2-11, the SSUS-Atlas (SSUS-A) flight hardware consists primarily of a solid rocket propulsion subsystem, a structural/mechanical subsystem, and a telemetry system. Two SSUS-A/spacecraft combinations can be flown on a single Shuttle launch.

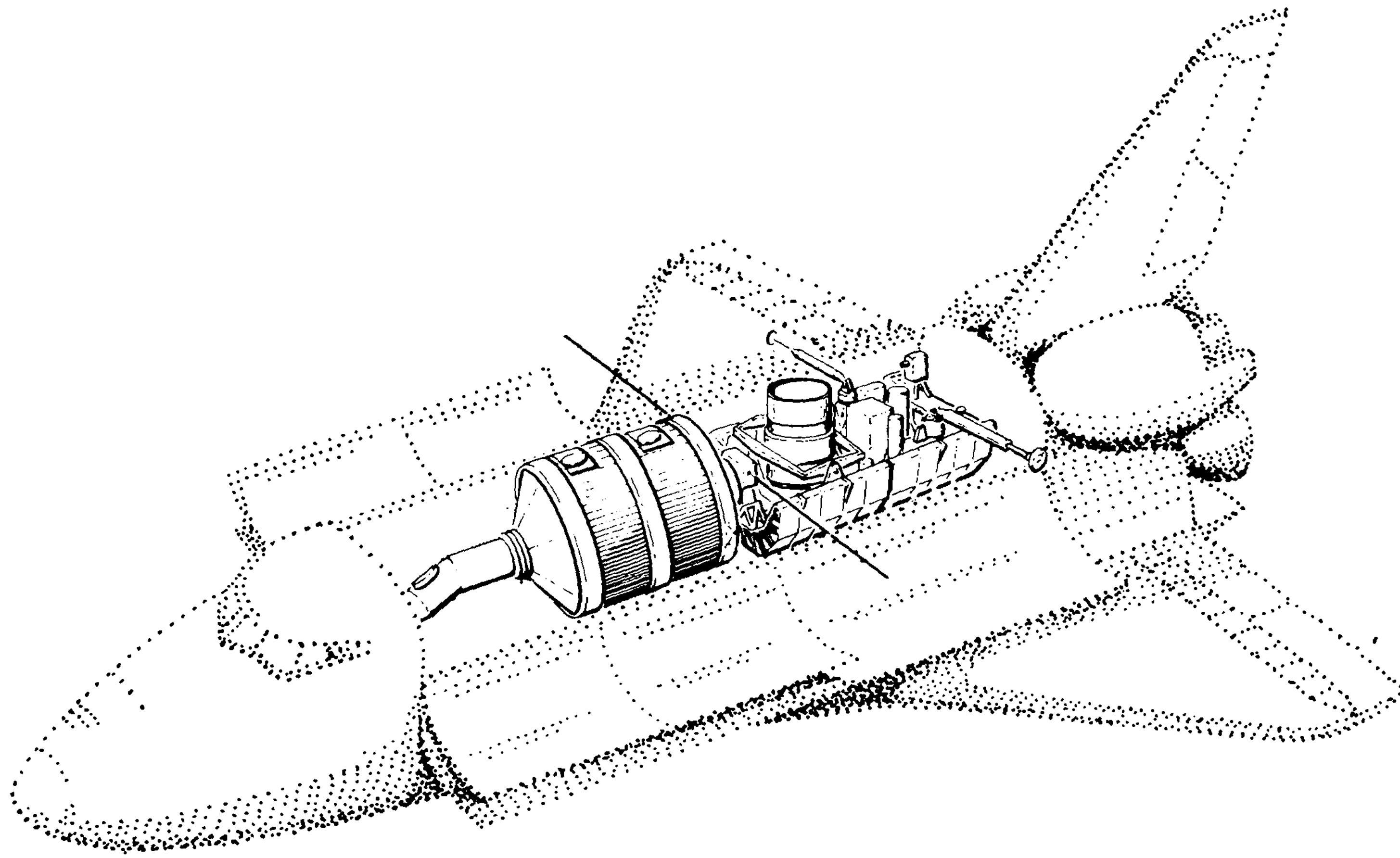


Figure 2-8. Typical Spacelab/Shuttle Configuration

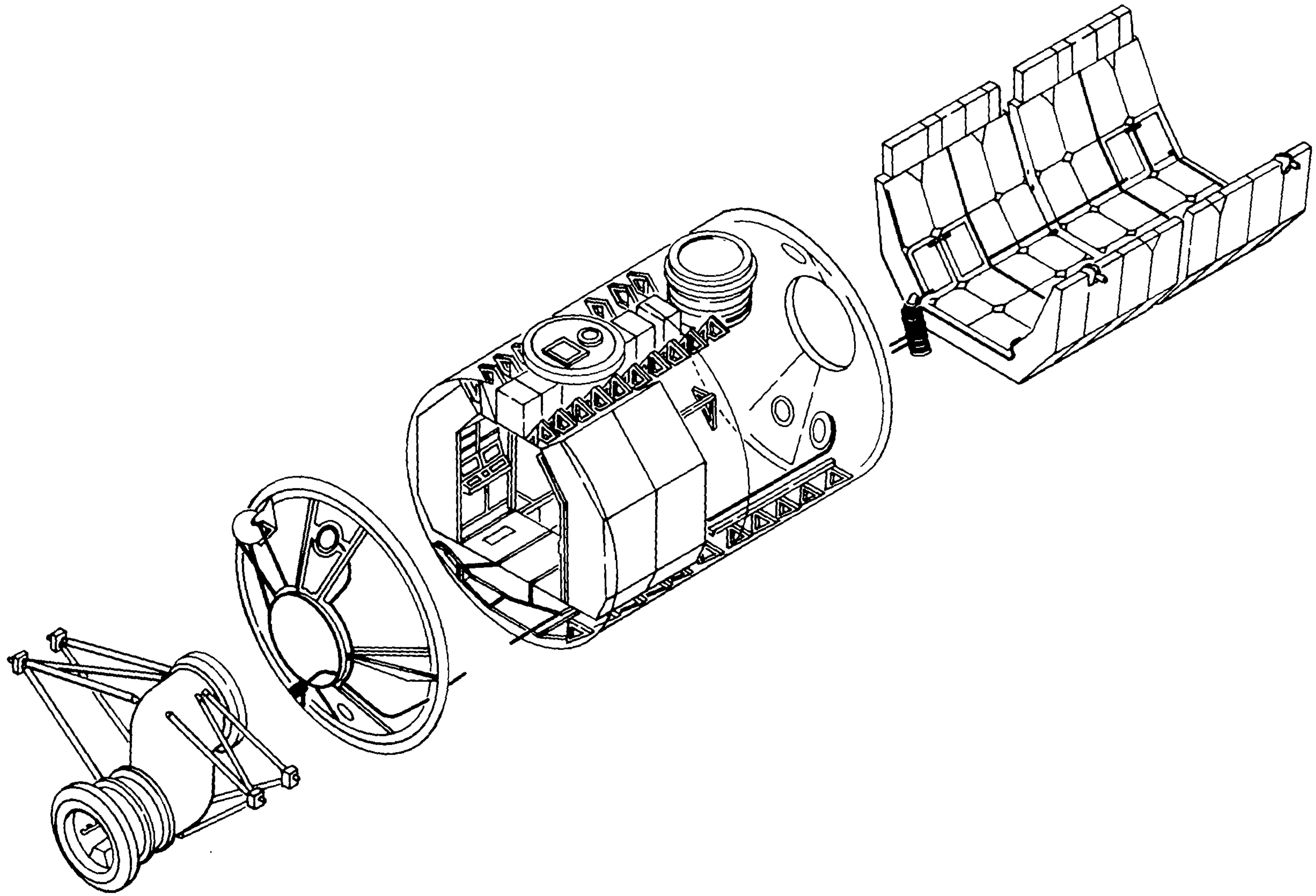
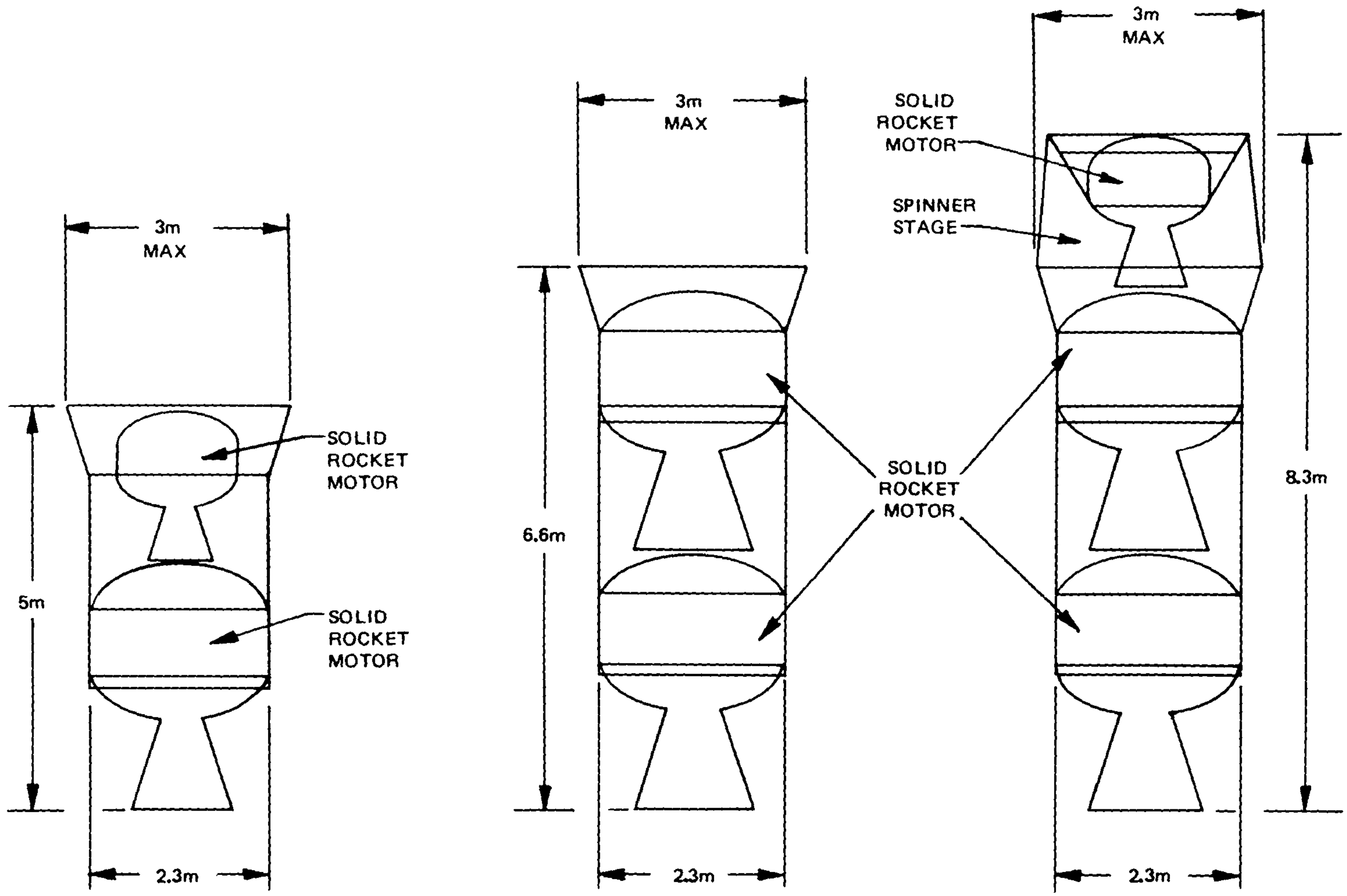


Figure 2-9. Typical Spacelab Configuration



	TWO-STAGE	TWIN-STAGE	THREE-STAGE SPINNER
VEHICLE	14,650kg	21,230kg	25,000kg
ASE WEIGHT	2,180kg	3,000kg	2,810kg
MAX S/C WEIGHT	2,270kg	5,000kg	1,680kg

Figure 2-10. Typical IUS Vehicle Configurations

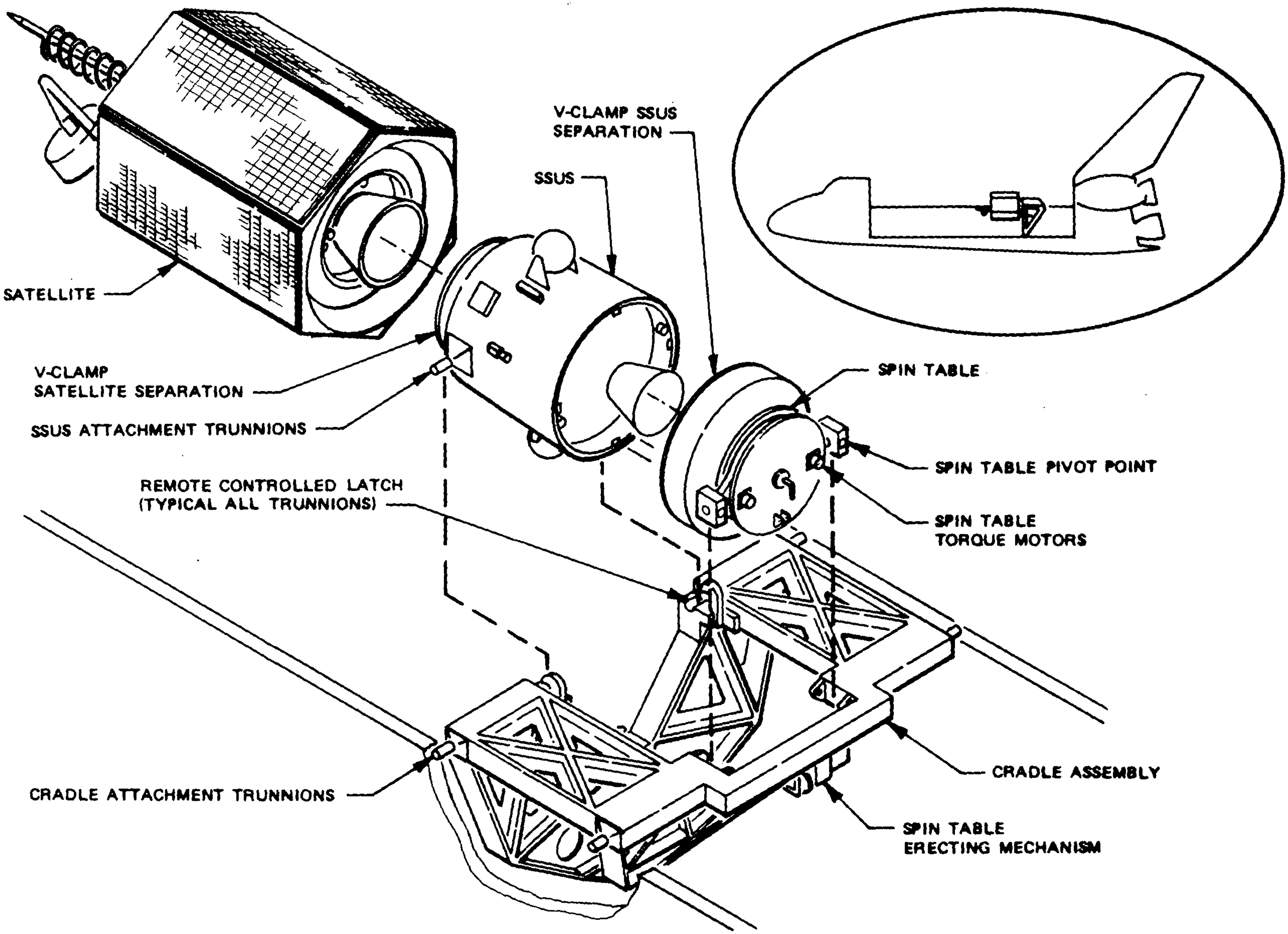


Figure 2-11. Typical SSUS-A/Spacecraft Configuration

c. Automated Payloads. Automated payloads include a wide class of self-contained spacecraft which will fly in the Orbiter payload bay. Examples are the Long Duration Exposure Facility, the Large Space Telescope, deep space probes, and many types of commercial communications spacecraft. Depending on the type of automated payload, integration may be required with an Upper Stage.

2.3.2.1 Cargo Integration. A part of the integration performed by KSC will be to determine whether the payload will be installed in the Orbiter at the OPF or at the launch pad. Certain hazardous operations cannot be performed in the OPF; consequently, some payloads must be installed at the launch pad. The type of hazardous operations to be performed is the most important criterion in deciding whether a payload will be installed in the OPF or at the launch pad.

In order to obtain the shortest possible Shuttle turnaround flow, KSC will perform simulated Orbiter to cargo interface checks of the entire cargo prior to installation into the Orbiter. This test, using cargo integration test equipment (CITE), will be conducted in one of two facilities, the Assembly and Test Area in the O&C Building or the Vertical Cargo Integration Test Facility in the Vertical Processing Facility (VPF). Figures 2-12 and 2-13 show the locations and flow of both horizontally and vertically integrated payloads at KSC.

Payloads which are integrated horizontally in the O&C Building will normally be installed horizontally in the OPF. Payloads which are integrated vertically in the VPF will normally be installed vertically at the launch pad.

a. Horizontally Integrated Payloads. Horizontally integrated payloads will be received, assembled, and checked in the O&C Building prior to mating with the Orbiter at the OPF. Both automated payloads and spacelabs may be included. For automated payloads, receiving inspections and subsystem tests will be completed. After mechanical buildup of the payload train, the payload elements will be transferred to the Spacelab integration workstand for integration with the Spacelab module/igloo, when applicable.

Spacelab modules will have been undergoing refurbishment and buildup in parallel with payload buildup. After buildup of the total Spacelab and payload configuration in the workstand, the module aft end cone will be installed, pallets will be positioned and utilities connected between pallets and modules, and servicing will be performed as necessary.

If the complete Shuttle cargo for a flight consists of a Spacelab module and/or pallets, all testing will be accomplished in the Spacelab horizontal workstands. This includes CITE testing. If the Shuttle cargo consists of Spacelab pallets and an automated spacecraft, the Spacelab pallets will be moved from the Spacelab horizontal integration workstand to the horizontal CITE stand to meet the

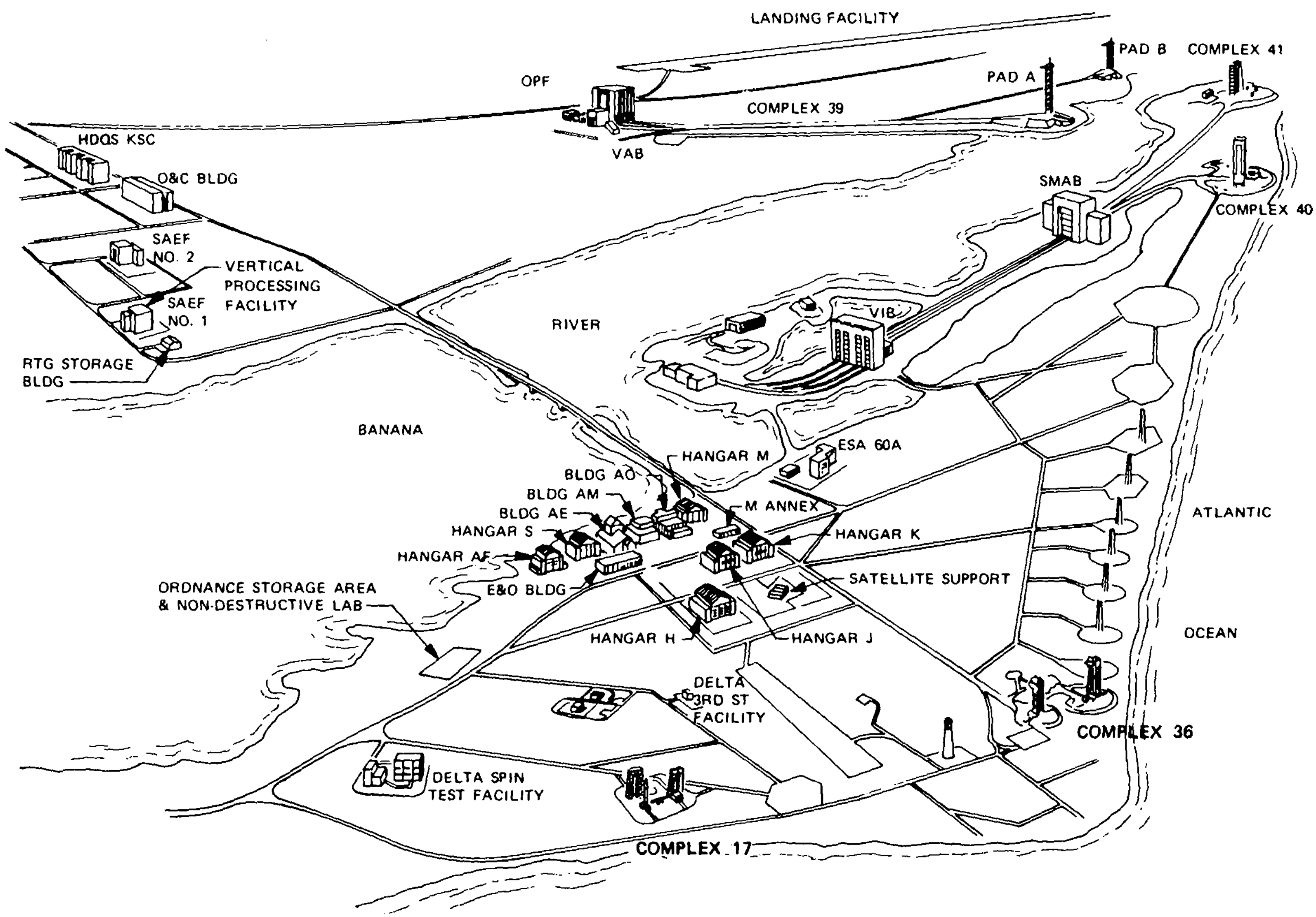


Figure 2-12. Payload Processing Facilities.

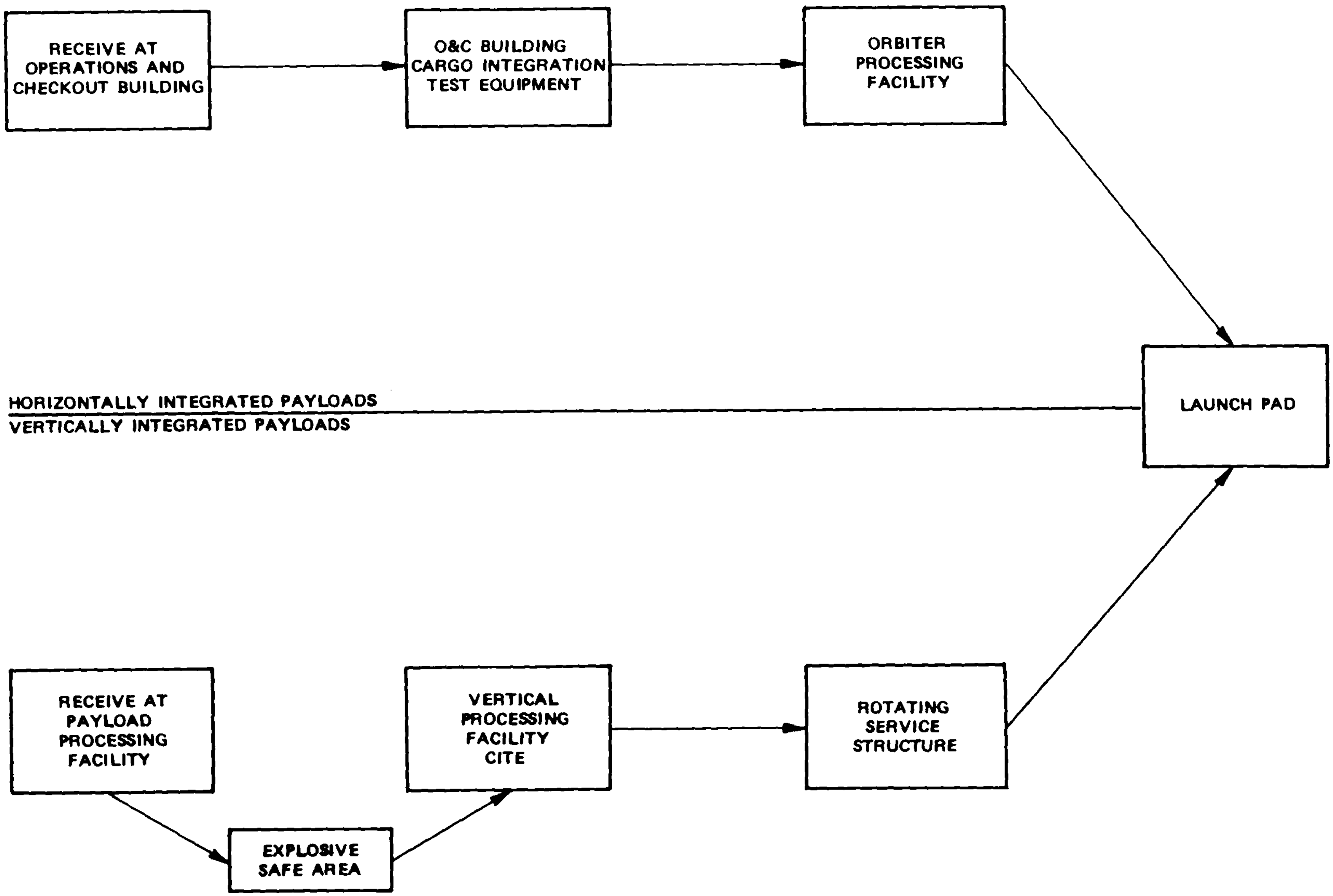


Figure 2-13. Standard Payload Processing Flows

rest of the Shuttle cargo. The CITE test will then be conducted in the horizontal CITE stand.

The Spacelab, along with any other payload(s), will be hoisted by bridge cranes and strongback, installed into the payload canister, and moved to the OPF by the canister transporter. Environmental conditioning, via air purge and system monitoring, will be provided during transport to the OPF where payload removal from the canister and installation into the Orbiter will be accomplished.

Upon completion of testing, the inspection access platforms will be removed. Final closeout of the payload will include removal of any remaining environmental enclosure/covers and closing/latching of the payload bay doors. At this point, the Orbiter will be powered down for move to the VAB and mating operations. (No power or purge will be provided from this point until completion of the Shuttle vehicle assembly in the VAB.)

b. Vertically Integrated Payloads. Vertically integrated payloads will normally be received in one of the following Payload Processing Facilities: Buildings AE, AO, AM, SAEF 2, or Hangar S (see figures 2-12 and 2-13). Following receiving operations, the spacecraft will be built up to its launch configuration. This buildup will include assembly of such things as solar panels, antennas, and other items which were shipped separately but will not include operations involving ordnance, cryogens, or hypergols. Following the buildup operations, the spacecraft testing (off line) will be conducted as requested (and planned) by the STS user.

After functional tests have been completed, the spacecraft will be moved to an Explosive Safe Area (ESA) where any hazardous operations will be conducted. Upon arrival at the ESA, the spacecraft will be removed from its transporter or container and installed in test or assembly stands provided by the STS user. The Delta Spin Test Facility or ESA 60, both located on CCAFS, is normally used for these hazardous operations. Activity in the ESA will include installation of solid-propellant apogee motors, hydrazine loading, ordnance separation devices, and any other items which are potentially explosive or hazardous. When testing has been completed, the spacecraft will be ready for movement to the Vertical Processing Facility (VPF) for integration.

Receipt and processing of Upper Stages is similar to, and is integrated with, launch site processing of spacecraft. Processing of spacecraft within the VPF will vary, depending upon the type of Upper Stage involved.

SSUS-D. The SSUS-D will be received at the Delta Spin Test Facility where it will undergo receiving, assembly, and test. Spacecraft which are scheduled to fly on an SSUS-D will be mated with the SSUS-D in this facility.

SSUS-A. The SSUS-A also will be received at the Delta Spin Test Facility where it will undergo receiving, assembly, and test. When these operations have been completed, the SSUS-A will be moved by the SSUS contractor to the VPF for mating with its spacecraft.

IUS. The IUS will be received at the Solid Motor Assembly Building (SMAB) located on CCAFS where it will undergo receiving, assembly, and test. Operations in the SMAB are under the management of the USAF. When operations in the SMAB have been completed, the IUS will be moved by the IUS integration contractor, under USAF management, to the VPF for mating with its spacecraft.

The last major test in the VPF will be the CITE test. Upon completion of the CITE test, the payload canister will be moved vertically up to the workstand and positioned such that a vertical payload handling device in the workstand can transfer the entire Shuttle cargo into the canister for movement to the launch pad. Environmental conditioning via air purge and system monitoring will be provided during transport.

2.3.2.2 Payload Processing Variations. Many variations for payload processing are available at KSC due to the flexibility which is built into KSC's PPF's. Two specific variations of processing are:

a. KSC Processing of Get-Away-Special (GAS) Payloads. GAS payloads are small autonomous units prepaid by individual experimenters. Since these payloads have limited interfaces with the Orbiter and since they are not installed in the Orbiter on trunnions, they cannot be processed as standard payloads. At present the location for receiving and buildup for GAS payloads is undecided. The GAS payloads will, however, be installed in the Orbiter at the OPF. Each GAS payload will be evaluated to determine the necessity of processing through the horizontal CITE facility in the O&C Building. Most GAS payloads will not require a CITE test; therefore, they will be built up, attached to a special bridge beam, and installed in the Orbiter much like operations using any other bridge beam. Flight assignments for GAS payloads will be determined by Johnson Space Center (JSC).

b. KSC Processing of Life Sciences Payloads. The flight hardware associated with life sciences payloads would normally follow the flow outlined for horizontally integrated payloads. However, live specimens for these payloads will be received at Hangar L located on CCAFS. KSC will have complete operations and maintenance responsibility for Hangar L.

   Life sciences specimens, or live specimens already in their flight containers, will be installed at the launch pad by opening the payload bay door and installing the specimens from a special access platform mounted on the Payload Ground Handling Mechanism, or through the crew ingress hatch for launch. The live specimens in their container(s) will then be mounted in the Orbiter middeck area of the crew cabin.

2.3.3 INTEGRATED LAUNCH OPERATIONS. The primary elements of the Space Shuttle Vehicle (Orbiter, SRB's, and ET) will be mated in the VAB, and all processing thereafter will be an integrated operation. Depending on the mission, cargo may already have been installed in the Orbiter at this point (via the OPF) or may be integrated later at the launch pad.

High Bay 3 is the location where the SRB's, ET, and Orbiter will be transferred after receiving and checkout operations have been completed. The Shuttle elements will then be mated on the Mobile Launcher Platform (MLP), and final electrical and mechanical verifications will be performed. Space Shuttle Vehicle (SSV) checkout will be limited to that required to verify interface compatibility. After mechanical and electrical verifications have been completed, ordnance will be installed and the SSV will be ready for transfer to the pad.

The Crawler Transporter will jack the integrated MLP/SSV from VAB mounts and transport the assembly to the launch pad. After the integrated MLP/SSV is in place on the pad support columns, the Crawler Transporter will return to the VAB area. The Rotating Service Structure (RSS) will be extended, the MLP and SSV will be electrically mated with the supporting facilities, and all interfaces will be verified.

For horizontally integrated payloads, normal operations at the launch pad will not include access to the Orbiter payload bay. For missions requiring access to the Spacelab or payload at the launch pad, access capability will be provided via the Orbiter payload bay doors and the payload access platforms on the Payload Ground Handling Mechanism part of the RSS. Spacelab activity at the launch pad will be limited to fulfilling the STS verification required and final servicing.

For vertically integrated payloads the cargo will be transferred from the Multiuse Mission Support Equipment canister to the RSS and vertically mated with the Orbiter. Operational checks of all electrical data and fluid interfaces will be performed.

Time-critical items and limited servicing will conclude the IUS/SSUS/payload checkout activities.

In preparation for launch, power will be applied to the SSV, the Launch Readiness Test will be completed, and hypergolic and helium load preparations will be performed. Cabin closeout will be accomplished as a part of the non-hazardous countdown preparations, followed by pad clearance and hazardous servicing operations; hypergolics, high-pressure gases, fuel cell cryogenics, and payload fluid servicing (if required). Completion of the hazardous servicing and RSS retraction places the vehicle in a standby status, at approximately T-2 hours in the countdown. The SSV will have the capability either to remain at this point for up to 24 hours or to proceed with the terminal countdown following a clearance to launch.

Figure 2-14 summarizes the preceding discussion, showing interrelationship of the elements during ground processing.

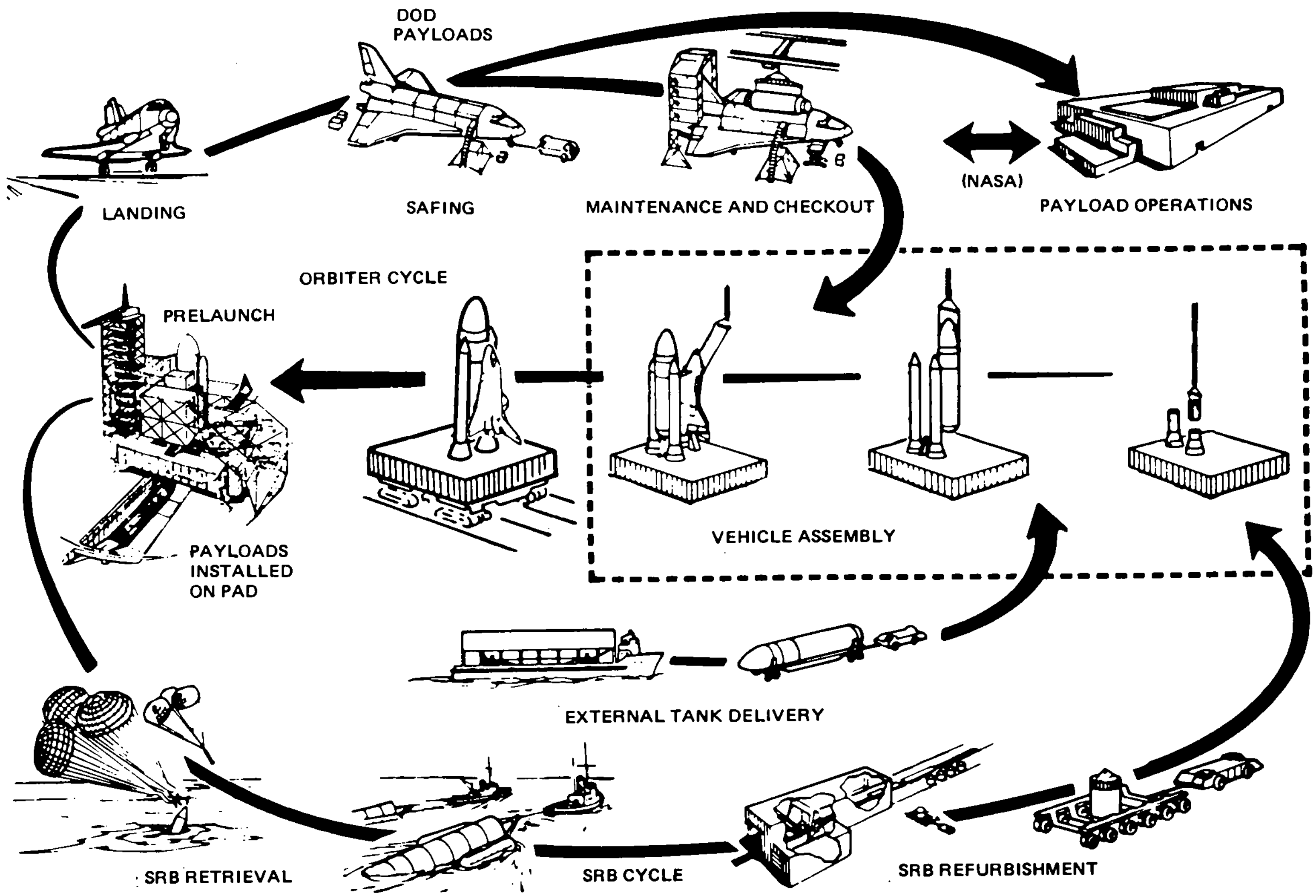


Figure 2-14. KSC Shuttle Systems Ground Flow

2.3.4 MISSION OPERATIONS. The Shuttle developmental launches will be used to test vehicle recovery/retrieval systems and to determine the final system configurations and operating techniques. Figure 2-15 depicts the typical mission profile for a launch from KSC.

The SRB's, which burn in parallel with the Orbiter main propulsion system, will be separated from the Orbiter/ET at an altitude of approximately 43 kilometers (150,000 feet). The SRB's will descend on parachutes and land in the ocean about 280 kilometers (150 nautical miles) from the launch site. Retrieval vessels, dispatched prior to launch, will proceed to the impact area to locate the SRB's. When located, the SRB will be inspected and verified safe. The SRB nozzle will then be plugged, and water will be pumped from the booster by pressurizing the case with air. This will reorient the booster from a vertical (spar buoy) mode to a horizontal (log) mode suitable for towing. Parachutes will also be recovered; these have flotation devices at the apex that will permit attachment of a line to pull the parachutes onto a palletized reel. Frustums will be brought on board and secured to the deck of the retrieval vessels. The empty SRB is effectively inert. It will contain a small amount of residual hydrazine in tanks designed to withstand the splashdown loads and the salt water environment without leakage. Early SRB's will carry a linear shaped charge as part of the flight termination system for range safety; however, this ordnance will be both mechanically and electrically "safed" (made inert) prior to SRB separation. Upon completion of SRB dewatering and retrieval of the parachutes and frustums, a tow line will be attached to the SRB, and it will be towed through Port Canaveral to the SRB Recovery and Disassembly Facility at Hangar AF.

At this facility, the SRB will be positioned in a slip for removal from the water and the nose cone frustums and parachutes will be off-loaded. The SRB will be removed from the water and placed on cradles for handling and disassembly. Immediately after removal from the water, the SRB thrust vector control (TVC) and ordnance systems will be removed, and SRB structures will be washed to remove the bulk of the salt deposits and marine growth. After washing, the structures will be moved into the disassembly area for disassembly to the level of major assemblies consisting of four SRM segments, the aft skirt assembly, and the forward skirt assembly. Motor segments will be thoroughly washed, dried, and preserved in preparation for shipment to the vendor for refurbishment and reprocessing. The aft skirt, nose cone frustum, and forward skirt will be stripped of insulation, washed, dried, and transferred to the RSF for testing, further disassembly, refurbishment, and buildup.

Retrieved parachutes will be sent to the Parachute Refurbishment Facility to be washed, dried, inspected, refurbished, and packaged in deployment bags for reuse.

After SRB separation, the Orbiter main propulsion system will continue to burn until the Orbiter has been injected into the required ascent trajectory. The ET will then separate and fall ballistically into the Indian Ocean. The Orbiter Maneuvering Subsystem (OMS) will complete insertion of the Orbiter into the desired orbit. Following operations in orbit, the Orbiter will move to

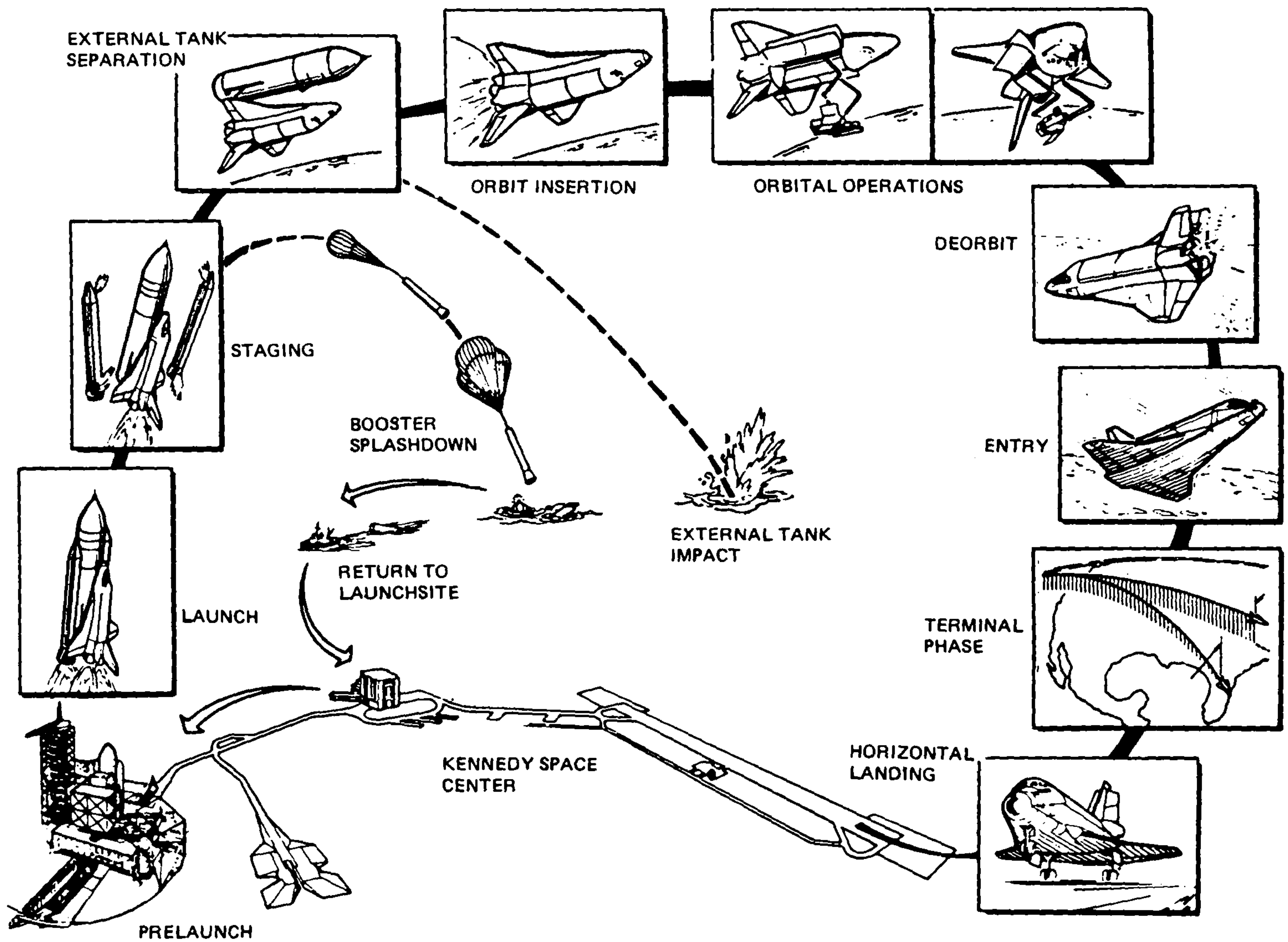


Figure 2-15. Space Shuttle Mission Profile

a retrograde attitude, and a deorbit burn will be performed using the OMS. The Orbiter will then transition to a nose-on attitude for final unpowered atmospheric entry, descent, and landing at a predetermined runway.

Landing of the Orbiter is planned at the Dryden Flight Research Center (DFRC) for the first four Space Shuttle flights during 1979 and 1980. Landings of the Space Shuttle at KSC are planned to commence in 1980. See table 2-1.

The initial phase of the landing approach, known as the Terminal Area Energy Management (TAEM), will start at an altitude of approximately 25,338 meters (83,130 feet) and 96 kilometers (60 miles) from the landing site. This is the final decision point for choosing the direction of landing (north-to-south or south-to-north) at KSC. The objective of TAEM is to place the Orbiter in a favorable position to intercept the final landing approach plane at the correct altitude and speed. This point, approximately 4,073 meters (13,365 feet) high and 12 kilometers (7.5 miles) from touchdown is where the ground-based Orbiter Autoland System interface takes control of the Orbiter trajectory and altitude through landing, braking, and wheelstop. The Orbiter Autoland System will maintain the correct energy management profile to guide the Orbiter down to a nominal 24-degree glideslope. At approximately 526 meters (1,725 feet) in altitude and 3.2 kilometers (2 miles) from touchdown, the Orbiter will start the preflare maneuver that will place it on a 3-degree glideslope. Touchdown will occur a few seconds after final flare and the Orbiter will be controlled to a normal stop approximately midway down the 4,572-meter (15,000-foot) runway (see figure 2-16).

The Orbiter will be towed to the OPF at a maximum speed of 8 kilometers (5 miles) per hour. Payload ground operations will begin after touchdown and rollout of the vehicle on the runway. Payload bay purge from mobile Ground Support Equipment (GSE) will be established within 15 minutes after landing and will continue until switchover to a facility system in the OPF. If removal of time-critical carry-off payload items has been scheduled, access will be provided via the cabin through the payload bay bulkhead hatch to the payload while the Orbiter is still on the runway. At the OPF, the cargo will be removed, using the overhead cranes and strongback, and transferred to the appropriate refurbishment area. Here it will be serviced and reverified or stored pending mission scheduling. This will complete the cargo cycle at KSC.

2.4 EXPENDABLE LAUNCH VEHICLE OPERATIONS

Depending upon the mission, the launch of unmanned scientific and technology applications spacecraft at KSC involves one of two basic expendable launch vehicles operating from Air Force-owned facilities at Complex 17 and Complex 36 for which NASA has property accountability. The two launch vehicles (figure 2-17) are Atlas-Centaur and Delta. Table 2-2 lists the characteristics of these vehicles compared with the STS.

Base support services are provided largely by Air Force contractors under NASA-Air Force agreements. Launch support services are provided by the contractors who build the launch vehicles. Spacecraft are normally handled and

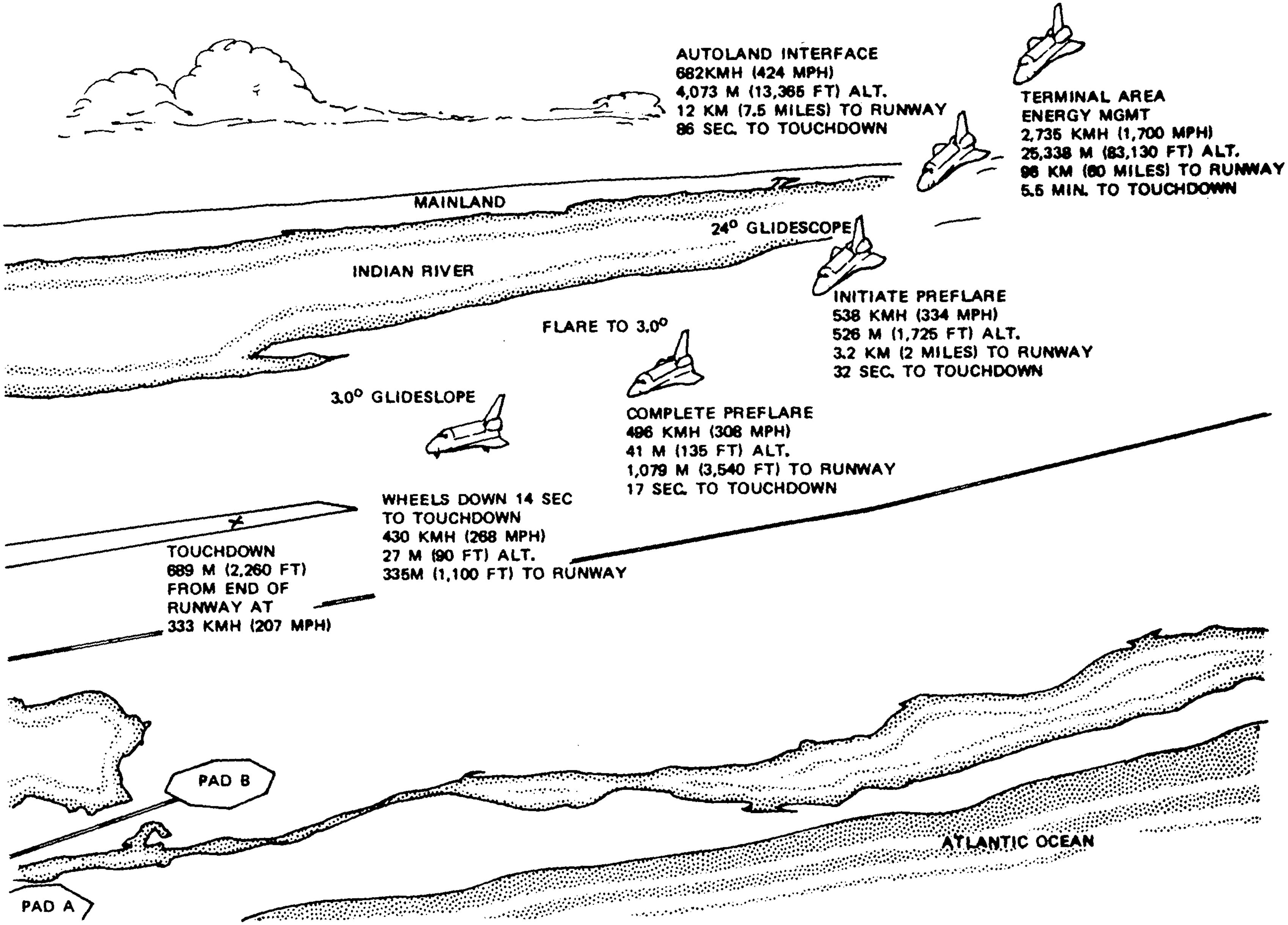
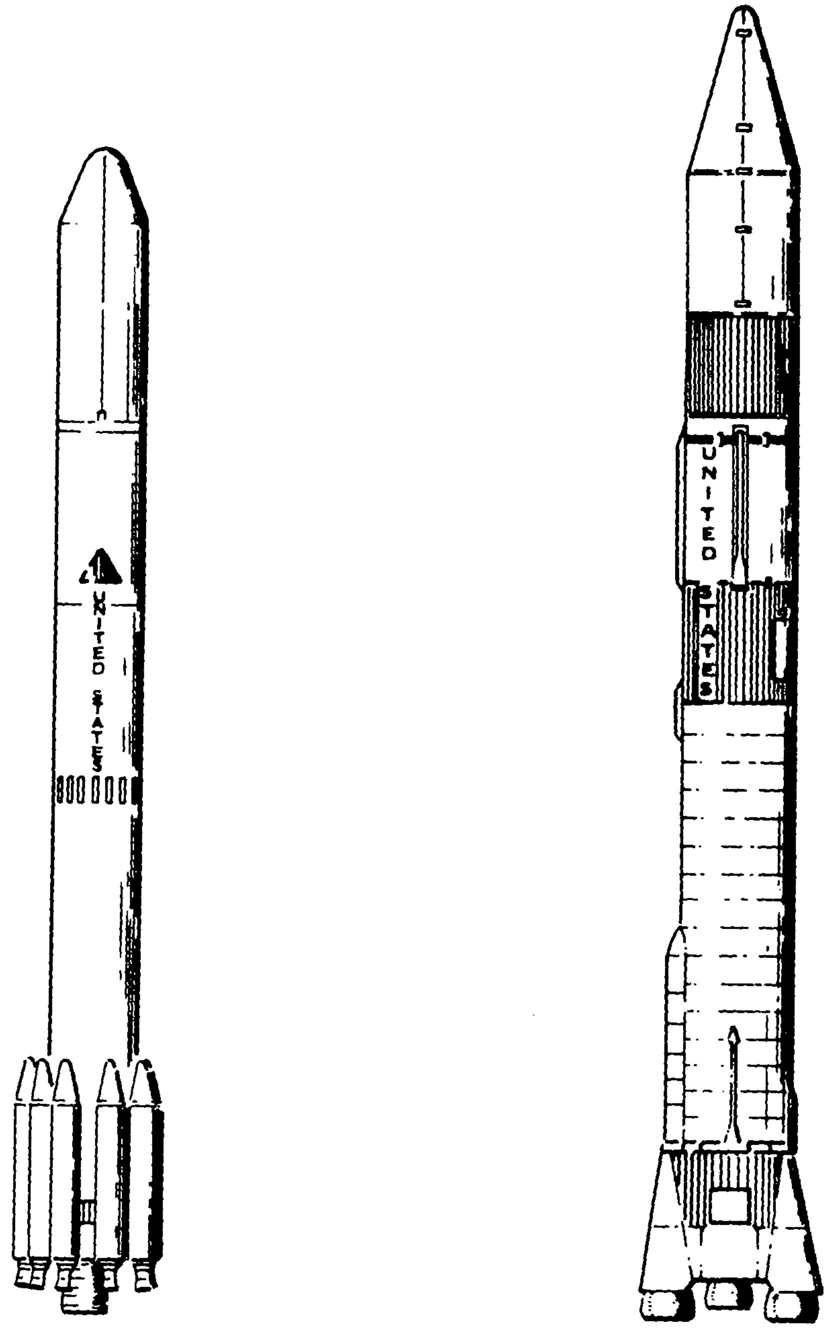


Figure 2-16. Orbiter Approach and Landing Trajectory



DELTA (2900 SERIES)

ATLAS-CENTAUR

Figure 2-17. Launch Vehicles

Table 2-2. Launch Vehicles - Propellant Data

Vehicle	Type of Propellant	Quantity of Propellant (kg)
Atlas-Centaur		
SLV3D	Liquid oxygen and RP-1 (kerosene)	121,600
Centaur	Liquid oxygen and liquid hydrogen	13,950
Delta (2900 Series)		
1st Stage	Liquid oxygen and RP-1 (kerosene)	80,200
2nd Stage	Nitrogen tetroxide and Aerozine 50	4,260
3rd Stage (TE-364-4)	Solid rocket	1,040
Augmentation (Castor II)	Solid rocket (9 motors)	33,500
Delta (3900 Series)		
1st Stage	Liquid oxygen and RP-1 (kerosene)	80,200
2nd Stage	Nitrogen tetroxide and Aerozine 50	4,260
3rd Stage (TE-364-4)	Solid rocket	1,040
Augmentation (Castor IV)	Solid rocket (9 motors)	84,800
Space Shuttle		
Orbiter Main Engines	Liquid oxygen and liquid hydrogen	712,100
Orbiter OMS and RCS	Nitrogen tetroxide and monomethyl-hydrazine	13,240
Solid Rocket Motor	Solid rocket (2 motors per launch)	1,007,923
Hydraulic Power Unit	Hydrazine	675
Upper Stages		
IUS	Solid rocket (3 units) Hydrazine	21,572 38
SSUS-A	Solid Rocket Hydrazine	3,465 5
SSUS-D	Solid rocket	1,700

checked out by the payload supplier or a designated mission manager using crews from the responsible agency and the manufacturer(s). The following paragraphs describe the operations for each of the launch vehicles and representative spacecraft. Refer to the map in figure 2-12 for locations.

2.4.1 ATLAS-CENTAUR VEHICLE. The Atlas-Centaur vehicle consists of an Atlas booster, an interstage adapter, a Centaur Upper Stage, a split barrel, and a nose fairing. Both the Atlas and Centaur are pressure stabilized stages, where structural rigidity is provided by internal gas pressure. An integrated electronics system mounted on the Centaur stage is used to provide all guidance, navigation, control, and sequencing functions on both the Atlas and Centaur stages. The vehicle is launched from Launch Complex 36, Pad 36A or 36B.

The 21.3-meter (70-foot) long first stage is an uprated version of the flight-proven Atlas vehicle used in the National Space Program since 1959. The engine system burns RP-1 (a highly refined kerosene) and liquid oxygen. The system utilizes two main engines: a 1,646,000-Newton (370,000-pound) thrust booster engine with two thrust chambers, and a smaller sustainer with a single thrust chamber that produces 266,900 Newtons (60,000 pounds) of thrust. The sustainer nozzle is located between the two larger ones of the booster engine. Two smaller vernier engines which help control the vehicle in flight are also burning at lift-off for a total thrust of 1,917,000 Newtons (431,000 pounds). Total weight at lift-off is about 150,000 kilograms (328,600 pounds).

The only radio frequency system on the Atlas is a range safety command system, consisting of two receivers, a power control unit, and a destruct unit. The Atlas can be destroyed in flight by ground control if necessary but otherwise receives all its control directions from the Centaur stage.

The Centaur stage sits above the Atlas, on a barrel-shaped interstage adapter. The Atlas and Centaur separate 2 seconds after the Atlas burns out, just over 4 minutes after lift-off. Eight small retrorockets near the bottom of the Atlas fuel tank then back this stage away from the Centaur.

The Centaur stage is 9 meters (30 feet) in length. Exclusive of payload, it weighs about 16,330 kilograms (36,000 pounds) when loaded with propellants. The main propulsion system consists of two engines burning liquid oxygen and liquid hydrogen, producing 133,400 Newtons (30,000 pounds) of thrust in the vacuum of space in which they are designed to operate. These engines can be stopped and restarted, allowing the Centaur to coast to the best point from which to achieve its final trajectory before igniting for another burn. Engine burn time can total 7-1/2 minutes. While coasting, the stage is controlled by 12 small thrust engines, powered by hydrogen peroxide. These hold the stage steady and provide a small constant thrust to keep the propellants settled in the bottoms of their tanks, a necessity for a second or third burn. The Centaur also has a ground-controlled destruct system similar to that on the Atlas, in case the vehicle must be destroyed in flight.

2.4.2 ATLAS-CENTAUR OPERATIONS. The Atlas and Centaur arrive by C5-A aircraft landing at the CCAFS Skid Strip. The Atlas and Centaur are transferred from their aircraft travel trailers to road trailers and taken to Hangar J. Both trailer configurations are designed for air transportation and are equipped to monitor and maintain the positive pressure inside both stages which ensures their structural integrity.

The Atlas remains in Hangar J about 1 day for an initial inspection and, at the appropriate time, is taken to Launch Complex 36 for erection at the launch pad. The interstage adapter is brought out on the same day and mated with the Atlas.

The Centaur stage is brought out on the second day, hoisted, and then lowered to mate with the interstage adapter. The short section called the split barrel is brought out from Hangar J and installed atop the Centaur. The insulation panels which protect the hydrogen tanks on the Centaur are installed in the ensuing weeks. The nose fairing is trucked to the Cape with the interstage and insulation panels, and is received and inspected in Hangar J. It then goes to ESA 60A or SAEF 2 where it is inspected for delaminations through a unique "cointap" procedure. When the spacecraft has completed its checks and is brought to ESA 60A or SAEF 2, it is encapsulated in the nose fairing.

The encapsulated spacecraft is taken to the the pad, lifted by means of the small hoist, with the weight borne by the torus ring, and moved into position over the Centaur. The spacecraft adapter and Centaur are then mated and the torus ring removed. The fairing is lowered and bolted to the Centaur. This completes the assembly of the Atlas-Centaur vehicle and spacecraft.

2.4.3 DELTA VEHICLE. The Delta vehicle consists of two liquid-fueled stages with augmentation (nine SRB's), an interstage adapter, an optional solid-propellant third stage, and a nose fairing. Delta vehicles are launched from Complex 17, Pads 17A and 17B.

The first stage of the Delta is 22.6 meters (74 feet) in length and 2.4 meters (8 feet) in diameter. The main engine burns RP-1 (a highly refined kerosene) and liquid oxygen. It produces 912,000 Newtons (205,000 pounds) of thrust at sea level and burns for about 228 seconds.

Nine strap-on SRB's greatly increase the power of the Delta first stage. Two configurations of this booster are available, the Castor II and the larger Castor IV. In the Castor II configuration, each SRB produces 146,784 Newtons (33,000 pounds) of thrust at lift-off. This increases to 275,776 Newtons (62,000 pounds) at maximum; the average thrust for the 38-second burn time is 240,190 Newtons (54,000 pounds). Six of these Castor II SRB's ignite at lift-off, and three ignite after the first six burn out. The average first stage thrust while the six SRB's, the main engine, and two small verniers are burning is 2,357,440 Newtons (530,000 pounds). Gross vehicle weight will be about 132,900 kilograms (294,000 pounds) at lift-off.

In the Castor IV configuration, each SRB produces an average of 329,298 Newtons (85,270 pounds) of thrust for 57 seconds. Five ignite at lift-off and four ignite after the first five burn. In this configuration first stage thrust averages 2,824,607 Newtons (635,350 pounds) from lift-off to burnout of the five solids. Gross vehicle weight is about 190,735 kilograms (420,500 pounds) at lift-off.

The second stage is approximately 6.4 meters (21 feet) long and 140 centimeters (55 inches) in diameter. The main structure consists of two propellant tanks, one containing the Aerozine 50 fuel and the other the nitrogen tetroxide oxidizer. These tanks are separated by a common bulkhead. The TR-201 main engine produces 43,590 Newtons (9,800 pounds) of thrust and can burn for over 300 seconds. This engine can be restarted in space. The Delta Inertial Guidance System which controls the flight of the first and second stages is mounted in this stage.

A spin-stabilized solid-propellant motor which produces an average of 67,000 Newtons (15,000 pounds) of thrust for 44 seconds serves as the Delta third stage. It is supported by a spin table, which sits on top of the second stage. The spacecraft is mounted atop this third stage, extending into the fairing. A miniskirt supports the weight of the second stage to which it is attached, as well as the third stage and the payload.

Prior to second and third stage separation, a spin table assembly spins the third stage and spacecraft up to about 90 revolutions per minute. This spin stabilizes the third stage throughout its burn, ensuring an accurate trajectory. The third stage does not require a separate guidance system.

2.4.4 DELTA OPERATIONS. The Delta first stage is delivered by van, cross-country from California. Inside Hangar M it is removed from the van and shifted to a special handling trailer. Following mechanical buildup, the first stage is transferred to Complex 17.

The SRB's are delivered two to a truck encased in protective containers. They are taken to the Pan American Solid Rocket Storage Area or directly to the Delta Solid Motor Facility. At the latter the engine nozzles and nose cones are installed, an inspection is made of the solid propellants, and the casings are pressure-checked. A special trailer then takes the solids to the launch pad, where they are installed on the first stage.

The second stage, nose fairing, and interstage adapter arrive at Hangar M in a single van. The interstage adapter is checked and taken to the launch pad on a special trailer. It is hoisted by the tower crane, lowered, and attached to the top of the first stage.

The second stage receives a series of leak checks in a smaller building behind Hangar M. As with the interstage, the second stage moves to the pad in a special trailer, is hoisted by a lifting device, and mated with an interstage adapter. A structural assembly called the miniskirt, attached to the stage, sits atop the interstage. The interstage thus supports the weight of the second stage, as well as the spin table, third stage, and spacecraft when they are later placed atop the second stage.

When a solid motor third stage is required, it also arrives at KSC by truck. It is taken either to the Solid Rocket Storage Area or directly to the Delta Spin Test Facility. Only one motor is allowed in the Spin Test Building at a time. In most cases after completing most of its checkout, the spacecraft is taken to the Spin Test Facility and mated to the third stage. A spin table is always used with the third stage in the Spin Test Facility. The three components (third stage, spin table, and spacecraft) are taken to the pad in a trailer. They are then hoisted and installed on top of the second stage.

The Delta nose fairing is handled like the second stage. After inspection and preparatory work in Hangar M, it is taken to the pad in a special trailer and installed atop the miniskirt, enclosing the spacecraft, third stage and spin table, and part of the second stage. This completes the assembly of the major components of the Delta vehicle. A Delta vehicle can be assembled, checked out, and launched in 4 to 6 weeks.

2.4.5 SPACECRAFT OPERATIONS. Spacecraft launched at KSC can be generally divided into two types: Technological Applications and Scientific Exploration. The number of applications is far larger than exploration, but the latter are often very complex and require more time in checkout and preparation for launch.

NASA-KSC provides technical support, laboratories, and mission control facilities for all types of spacecraft, but the actual checkout work is performed by transient crews sent to KSC for that purpose. Usually these personnel are from the manufacturer who built the particular spacecraft, accompanied by managerial and engineering personnel from the responsible or funding agency.

2.4.5.1 Technological Applications. The major applications satellites operate in the fields of communications and weather observation. The average applications spacecraft arrive at KSC 6 weeks before launch. The buildings used primarily for the checkout of these spacecraft are AE and AM. Most spacecraft require 4 weeks in the checkout building for preparation and setup, subsystem checkout, and assembly operations; a week in an ESA for pyrotechnic maneuvering system servicing, and solid motor installation and checkout; and a week on the pad after vehicle mate, undergoing final checks.

2.4.5.2 Scientific Exploration. The scientific spacecraft launched by KSC can be divided into two categories: Earth orbit research and interplanetary (including lunar-oriented spacecraft, sun observation, and deep space). Most scientific spacecraft are checked out in buildings AO and AE and Hangar S. A large number of scientific programs and types of spacecraft exist, but launch rates for each program may be low, averaging one or two a year in most cases. Many of these spacecraft have complex subsystems which must be checked out one at a time, in sequence. A scientific spacecraft may remain in the checkout building for more than a month and may require 10 days on the pad after mating. As with technological spacecraft, 1 week in the ESA is usually sufficient.

2.5 OPERATION OF THE PHYSICAL PLANT

Within the KSC boundaries, some 278 buildings, facilities, and support areas, and 80 trailers provide approximately 378,300 square meters (4,067,800 square feet) of gross building area, plus 118,600 square meters (1,275,210 square feet) of mechanical, custodial, and public service space in all buidlings.

The major facilities and their capabilities and current use are located by figure 2-1 and are described in table 2-3. For additional information, see references 2-1, 2-2, and appendix D.

Over 195 hectares (481 acres) of roadways and 64 hectares (159 acres) of railroad rights-of-way provide access to facilities. Key areas used for launch processing are shown in figure 2-18.

Facility operation is concerned with the daily tasks that are required to support the Center. The normal day-to-day operations and the occasional one-time institutional operations that occur at KSC are fully controlled, i.e., all facility operations are governed by published schedules and written procedures incorporating standard industrial "good practice" methods. Support operations, as distinguished from launch and landing operations, include:

a. Maintenance of Facilities

b. Utilities

c. Shops (including Laboratories and the Motor Pool)

d. Roads and Grounds (including Sanitary Landfill)

e. Waste Management

f. Logistics (Liquid Fuels and Fluids)

g. Emergency Services

h. Visitor Services

2.5.1 MAINTENANCE. Maintenance is primarily concerned with the architectural aspects of the facilities; e.g., walls, floors, roofs, lighting, plumbing, carpentry, and services. Special emphasis is placed on procedural techniques for those facilities and systems closely associated with launch and test schedules. Maintenance operations, which preserve the initial investment in facilities and ensure their continued availability, are performed on a regular schedule throughout the year.

Table 2-3. Major Facilities - Their Current Use and Capabilities

Facility Number	Facility Name	Use	Size (sq meters)	Unique Features	Location On Figure 2-1
K7-468	Converter/ Compressor Facility	Compression, monitoring, and distribution of gaseous helium. Nitrogen system inactive	850	Helium and nitrogen compressors	1
39A J8-1708 39B J7-337	Complex 39 Launch Pads	Launch of STS	656,700 (each pad)	Large storage spheres (Dewars) for liquid hydrogen and oxygen. Flame trench with deflector. Rotating Service Structure	1
J6-2313	Shuttle Landing Facility	Landing of Orbiter, ferrying aircraft, and support aircraft	518,000	Microwave Scanning Beam Landing System for control of Orbiter landings. Mate/Demate Device	1
K6-894	Orbiter Processing Facility	Safing, maintenance, and checkout of Orbiter. Installation of horizontal payloads	7,000	Large high bays - Class 100,000 clean rooms	1
K6-793	Crawler Transporter Maint. Building	Maintenance of Crawler Transporter	233	Special shop and office space for Crawler Transporter Maintenance	1
K7-1005	Barge Terminal Facility	Docking and unloading of barges transporting the External Tank		Large turn basin	1

Table 2-3. Major Facilities - Their Current Use and Capabilities (cont)

Facility Number	Facility Name	Use	Size (sq meters)	Unique Features	Location On Figure 2-1
K6-848	Vehicle Assembly Building	Assembly and integrated checkout of STS elements	170,137	Large and high open areas; bridge cranes	1
K6-900	Launch Control Center	Launch processing and control	21,000	Equipment to monitor and control STS elements from the OPF through launch	1
K6-1091	Emergency Power Generating Plant	Supply power for Shuttle processing in event of commercial power failure		5 diesel-driven generators. Total installed capacity of 4700 kilowatts	1
K6-1141	VAB Area Power Substation	Distribution of electrical power	162	Automatic switchover capability	1
K6-792	VAB Area Sewage Treatment Plant	Treatment of sewage to meet environmental standards	39	410 kiloliters per day capacity	1
J8-1705	LC-39A Sewage Treatment Plant	Treatment of sewage to meet environmental standards	26	216 kiloliters per day capacity	1
None	Locomotive Maintenance Area	Servicing of diesel locomotives		Service pit	1
None	Sanitary Landfill	Disposal of solid wastes	202,345	Minimum of 1.5 meters above water table	2

Table 2-3. Major Facilities - Their Current Use and Capabilities (cont)

Facility Number	Facility Name	Use	Size (sq meters)	Unique Features	Location On Figure 2-1
L7-888	Fire and Rescue Training Area	Training for propellant mechanics and astronaut rescue teams in hypergolic and hydrocarbon fire fighting and rescue	11,800	Large area with burn pan for ignition of hypergols and hydrocarbons	2
5443 5444 5445 5446	Unmanned Launch Operations (ESA 60)	Installation of solid-propellant apogee motors and ordnance separation devices. Loading of hydrazine and other potentially explosive or hazardous items into spacecraft	829	2 high bays and an airlock	3
None	Fuel Storage Area No. 1	Storage and transfer of hypergol propellants		Tankage: 650 kiloliters	3
60680	Hangar AE	Checkout unmanned spacecraft	3,600	Special test equipment	3
6625	Hangar AF (SRB Recovery and Disassembly Fac)	SRB post-recovery disassembly and processing	6,000	Dock space, high pressure stream of water to clean SRB casings	3
60550	Hangar AM	Checkout of Technological Applications Spacecraft	2,500	Special test equipment	3
60530	Hangar AO	Checkout of Scientific Exploration Spacecraft	4,000	Special test equipment	3
1721	Hangar J	Inspection of Atlas and Centaur stages	4,000	Special inspection equipment	3

Table 2-3. Major Facilities - Their Current Use and Capabilities (cont)

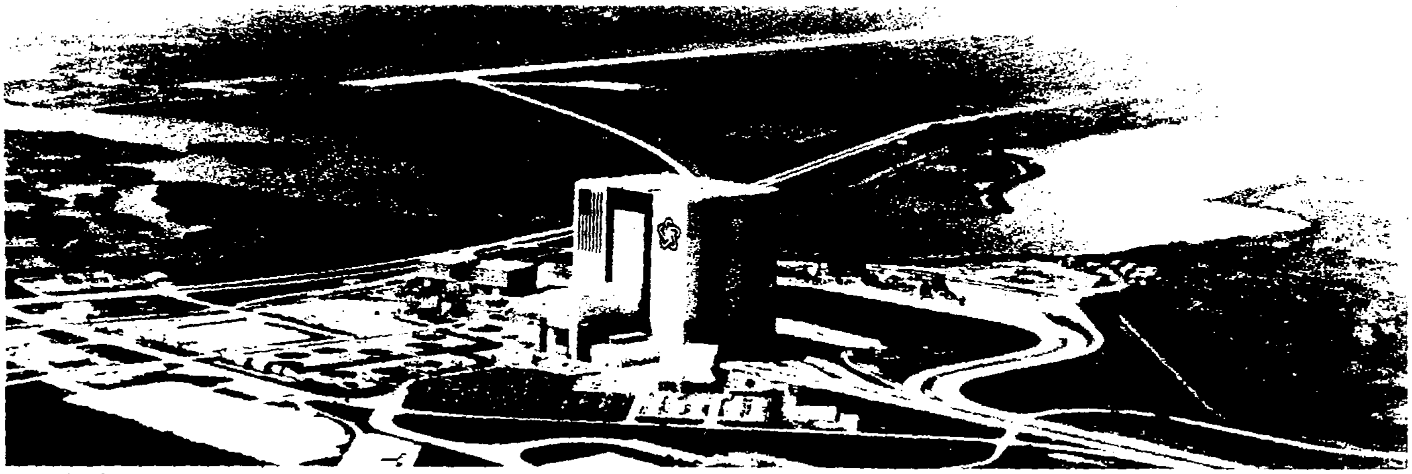
Facility Number	Facility Name	Use	Size (sq meters)	Unique Features	Location On Figure 2-1
1732	Hangar L	Life Sciences Laboratory (Planned)	4,000	Facilities to prepare specimens for space flight and ground control during flight	3
1731	Hangar M	Processing Delta elements	4,000	Special handling equipment	3
1726	Hangar S	Support unmanned spacecraft	5,600	Two Class 100,000 clean rooms	3
1270	Complex 17	Delta Launch Pads	202,340	Large mobile service structures, blockhouse	4
5500	Complex 36	Atlas-Centaur Launch Pads	255,000	Large mobile service structures, blockhouse	4
M7-505A	Launch Equipment Test Fac.	Testing of access arms and tail service mast		Large random motion simulators	5
M6-409	Visitors Information Center	Depot for bus tours, space exhibits	6,500	Actual missiles and space equipment on display. Large transparent scale model of Apollo Saturn	5
M5-1395 M5-1444 M5-1494 M5-1544	Unified "S" Band	Data and audio reception and retransmission	2,307	Large antenna	5
M6-495	Dispensary	Medical care for workforce	1,058	Hospital-type laboratory equipment	5

Table 2-3. Major Facilities - Their Current Use and Capabilities (cont)

Facility Number	Facility Name	Use	Size (sq meters)	Unique Features	Location On Figure 2-1
M6-595	Central Heating Plant	Supply heat to buildings in KSC Industrial Area	548	Two 42,190,000 kilojoule per hour boilers and one 16,877,000 kilojoule per hour boiler	5
M6-895	Industrial Area Sewage Treatment Plant	Treatment of sewage to meet environmental standards	134	1,401 kiloliters per day capacity	5
M7-355	Operations and Checkout Building	Refurbishment, assembly and checkout of STS horizontal payloads	56,189	Large Class 100,000 clean rooms and altitude chambers	5
M6-399	KSC Headquarters Building	Administrative and engineering offices for NASA and contractor personnel	40,189	Technical library, reproduction and film processing facilities, Post Office, and cafeteria	5
M7-657	Parachute Refurbishment Facility	Refurbishment of parachutes used for SRB retrieval	770	Large washers and dryers	5
M7-961 M7-1061 M7-1212 M7-1412	Hypergol Maintenance Facility Complex	Checkout and test, drain, flush, and repair of STS hypergol modules	2,614	Scrubbers to treat toxic vapors	5
M7-1469	Vertical Processing Facility	Refurbishment, assembly and checkout of STS vertical payloads	1,673	Large Class 100,000 clean rooms	5

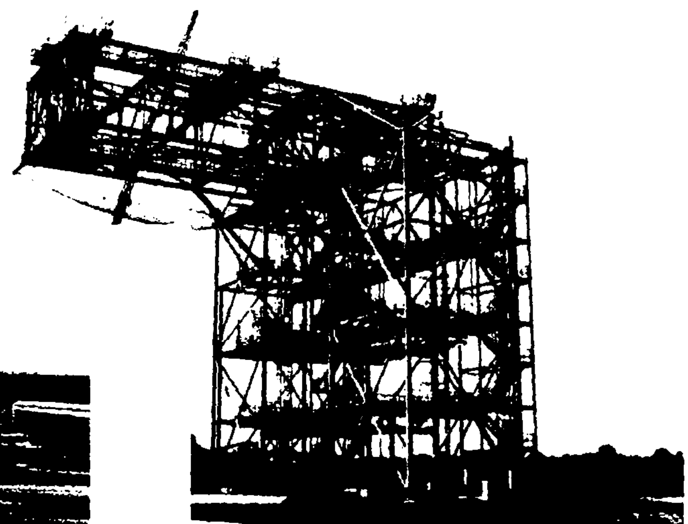
Table 2-3. Major Facilities - Their Current Use and Capabilities (cont)

Facility Number	Facility Name	Use	Size (sq meters)	Unique Features	Location On Figure 2-1
M6-342	Central Instrumentation Facility	Ground instrumentation systems for telemetry, timing correlation and data processing	12,635	Computer complexes	5
M6-744	Central Supply Facility	Receiving, storage, and issuance of supplies	8,633	Rail siding	5
M6-138	Communications Distribution and Switching Center	Central distribution and switching for all KSC communications	2,932	Distribution and switching equipment	5

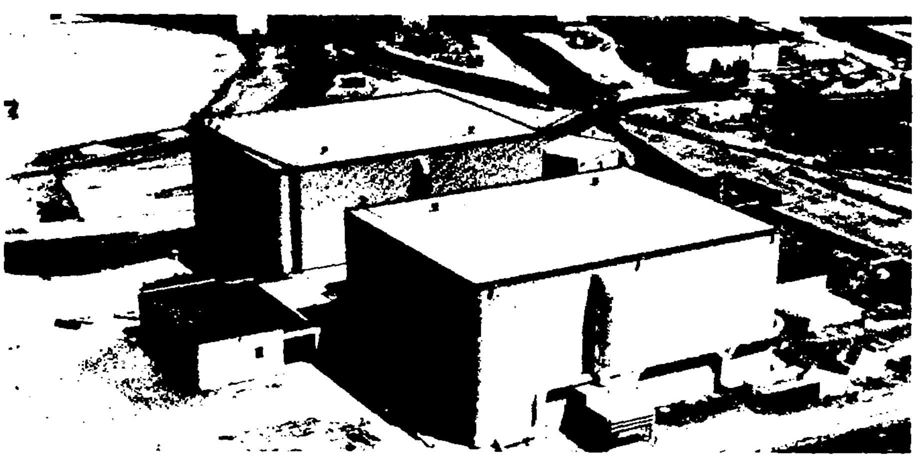


THE VEHICLE ASSEMBLY BUILDING (VAB) with the Orbiter Landing Facility (OLF) runway in the background are the beginning and end points, respectively, for a Space Shuttle mission. The Space Shuttle will be assembled in the VAB. Upon completion of the space mission, the Orbiter will glide to earth at the OLF.

THE CRAWLER TRANSPORTER, supporting a Mobile Launcher Platform (MLP), will transport the Space Shuttle mounted on the MLP from the VAB to the launch pad.

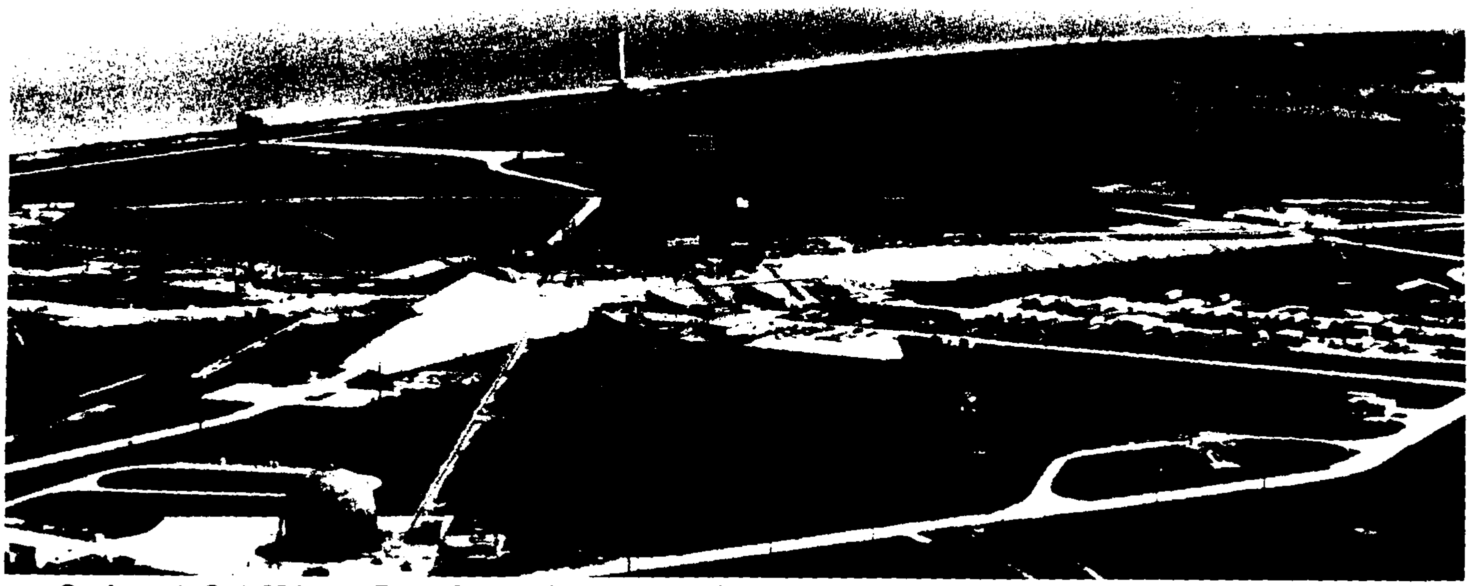


THE MATE/DEMATE DEVICE (MDD) is used to raise and lower the Orbiter when it is ferried on a 747 carrier aircraft.



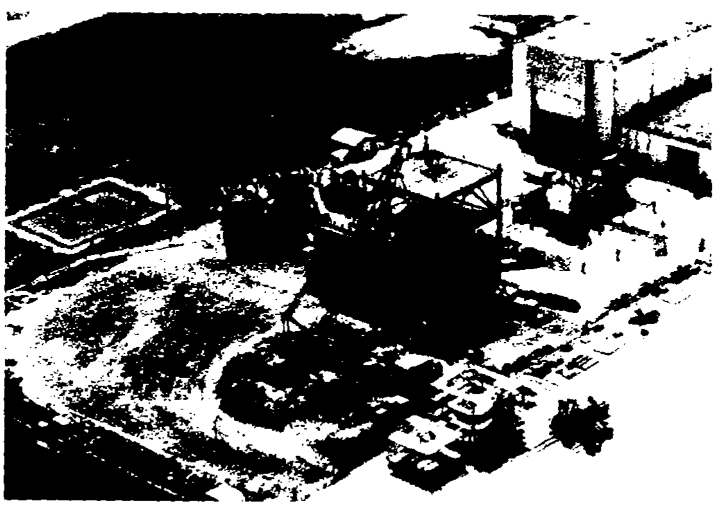
THE ORBITER PROCESSING FACILITY (OPF) is where a returned Orbiter is readied for the next flight.

Figure 2-18. Key Launch Processing Area (Sheet 1 of 3)

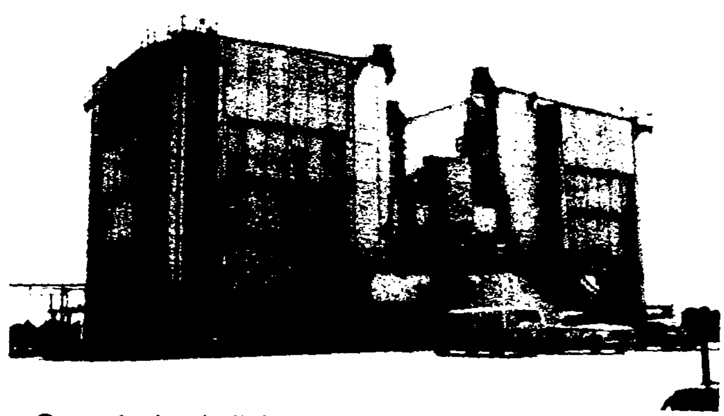


On Launch Pad 39A, the Fixed Service Structure (FSS) and the Rotating Service Structure (RSS) are prominent. To the left is the 300,000-gallon deluge water tank.

The checkout workstands in the high bay of the O&C Building will be used for work on the Spacelab.

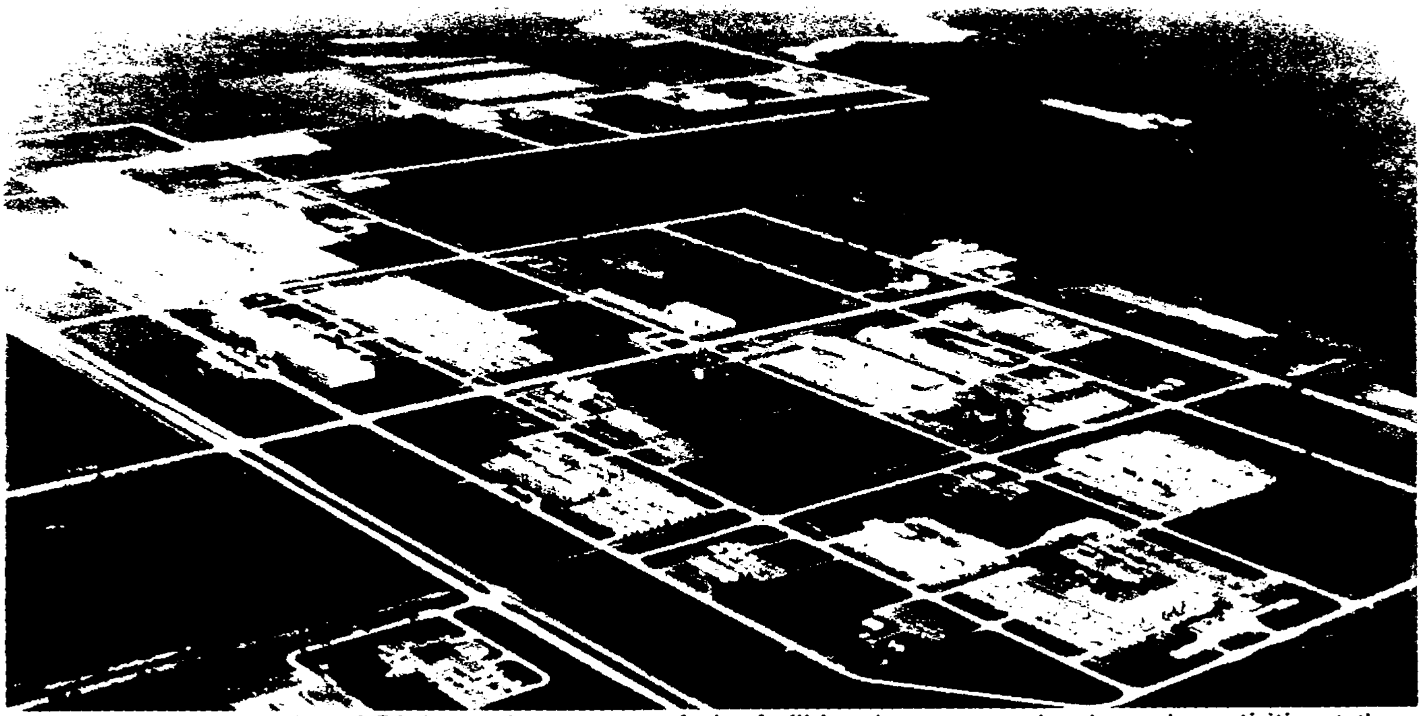


THE LAUNCH EQUIPMENT TEST FACILITY (LETF) verifies the integrity of the ground support equipment.



One of the buildings of the Hypergol Maintenance Facility Complex where maneuvering and propulsion modules will be processed.

Figure 2-18. Key Launch Processing Area (Sheet 2 of 3)



THE KSC INDUSTRIAL AREA is the site of many of the facilities that support the day-to-day activities at the Kennedy Space Center. The Hypergol Maintenance Facility area is in the upper center of the view.

THE VISITORS INFORMATION CENTER (VIC) maintains exhibits, a food and restroom facility, and parking areas for visitors boarding the KSC/Cape Canaveral tour buses.

THE CAPE CANAVERAL AIR FORCE STATION (CCAFS) Industrial Area is the location of several facilities which NASA operates, including the SRB Recovery and Disassembly Facility (Hangar AF) with a dock and turn basin, visible in the foreground.

Figure 2-18. Key Launch Processing Area (Sheet 3 of 3)

2.5.2 UTILITIES. The major utilities at KSC include the facilities which provide for heating, air-conditioning, electrical power and lighting, water, and sewage management. These installations, using standard industrial equipment, are operated and monitored to comply with Federal energy regulations and the rules of the Florida Department of Environmental Regulation. Consistent with the Nation's efforts to reduce energy consumption, portions of these facilities have undergone, or are scheduled for, selective modification to improve energy posture. Other than the new utilities for the Shuttle Landing Facility and the Orbiter Processing Facility, the utility systems remain configured essentially as they have been since 1965.

2.5.2.1 Heating. Two central heating plants, one in the KSC Industrial Area (M6-595) and the other identified as the VAB Utility Annex (K6-947), are operated continuously. The M6-595 plant contains two 42,190,000 kilojoule per hour (kj/hr), equivalent to 40,000,000 British thermal unit per hour (Btu/hr), boilers and one 16,877,000 kj/hr (16,000,000 Btu/hr) boiler. The K6-947 plant contains three 16,877,000 kj/hr (16,000,000 Btu/hr) boilers. These two plants presently consume approximately 7,570 kiloliters (kl), equivalent to 2,000,000 gallons, of low sulfur (1 percent) fuel oil per year. In addition to these plants, 8 package boiler plants are installed at outlying facilities located throughout the Industrial and LC-39 areas. These plants vary in output from 143,000 kj/hr (136,000 Btu/hr) to 2,827,000 kj/hr (2,680,000 Btu/hr) and collectively consume about 852 kl (225,000 gallons) of low sulfur oil per year. The total heat-generating capacity at KSC is approximately 40,744,300 kilogram-calories (161,696,650 Btu) per hour. Fuel consumption, which is expected to remain fairly constant during the years to come, represents an irreversible and irretrievable use of fossil fuel (see section IX).

2.5.2.2 Air-Conditioning. Approximately 22,700 metric tons (25,000 tons) of air-conditioning refrigeration is installed throughout KSC. A 9,100-metric ton (10,000-ton) central chilled water installation at the LC-39 Utility Annex supplies the immediately adjacent OPF, VAB, and LCC. In the Industrial Area, individual installations ranging from 1,633 to 5,080 metric tons (1,800 to 5,600 tons) are provided in the O&C, CIF, and Headquarters buildings. All large installations utilize centrifugal refrigeration compressors and are chilled-water systems. Smaller systems are both centrifugal [91 metric tons (100 tons) minimum] and reciprocating. Small centrifugals total 907 metric tons (1,000 tons). The reciprocating systems total approximately 6,730 metric tons (7,420 tons) and utilize either chilled water or direct expansion refrigerant for the space cooling medium. Water treatment for cooling tower systems is closely controlled and utilizes a biocide for control of algae.

To avoid a buildup of sludge, an automatic monitoring system measures suspended solids and periodically discharges cooling tower water to adjacent drainage ditches. Makeup water is supplied from the Cocoa potable water supply at approximately 68 liters (18 gallons) per minute. There are no cooling tower sludges to be disposed of at KSC.

While much of the air conditioning is provided as an aid to human comfort and efficiency, a large portion is required for support equipment (e.g., computer rooms, laboratories, clean rooms, test cells) and for temperature/humidity control for experimental specimen maintenance. The production of conditioned air consumes a portion of the energy specified in 2.5.2.3.

2.5.2.3 Electricity - Purchased and Generated. As described in the following subparagraphs, KSC purchases the electricity required for daily operation of the Center. In addition, emergency power can be generated by facilities within the Center.

2.5.2.3.1 Purchased Power. Electric power is generated offsite by the Florida Power and Light Company. The Air Force administers the contract with the power company and KSC reimburses the Air Force for the power used. The power company supplies power at 115 kV to KSC-owned transformers which are connected to the KSC underground and overhead 138 kV distribution systems. Electrical components of the distribution network are made up of standard industrial-type equipment. KSC presently consumes approximately 190×10^6 kilowatt-hours (kWh) of electrical energy per year. Consistent with Presidential Executive Order 12003, "Energy Policy and Conservation" and NASA Energy Management Action Plan, Revision 2, dated February 10, 1977, KSC maintains a continuing energy conservation and reporting program. Projected use of offsite generated power is as follows:

Year	kWh X 10^6	Year	kWh X 10^6
1978	190	1982	212
1979	200	1983	210
1980	208	1984	205
1981	215		

2.5.2.3.2 Generated (Emergency) Power. A permanent emergency power generating plant (K6-1091) containing 5 diesel-driven generators with a total installed capacity of 5,000 kilovolt-amperes is equipped for automatic start and load pickup to support STS processing in the event of commercial power failure, brownout, or scheduled shutdown for maintenance. Supporting equipment and facilities include an underground diesel fuel tank, a pad for fueling by tanker truck, and sanitary facilities for operators and maintenance personnel.

The Government Furnished Equipment (GFE) diesel-driven generators have been modified to meet relevant air and noise pollution limitation requirements. The diesel engines use approximately 53 kiloliters (14,000 gallons) per year of number 2 diesel fuel having a low sulfur content. An oil interceptor sump is provided to prevent water pollution. Silencing equipment is provided to muffle the noise from the generators, heat rejection is directly to atmosphere, and no water cooling system is required. Pad construction impounds leaks and drips from fueling operations.

At other strategic locations, permanently installed diesel-powered generators supply power for emergency circuits in the event of commercial power failure. These 20 installations vary in output from 5 kW to 1,200 kW and are similar to those used in hospitals, telephone exchanges, and law enforcement agencies. Approximately 49 kiloliters (13,000 gallons) of diesel fuel per year are consumed by operation of these generators. Mobile diesel generator units also are available for one-time emergency use or during planned outages of individual facilities.

2.5.2.4 Potable Water. Potable water is purchased from the City of Cocoa, Florida, under a contract administered by the U.S. Air Force. KSC currently is using about 1,540 kiloliters (405,000 gallons) of potable water daily which is distributed through 77 kilometers (48 miles) of underground utility piping network varying in size from 53 centimeters (21 inches) to 15 cm (6 inches) in diameter. Elevated and ground tanks provide storage for about 9,463 kiloliters (2,500,000 gallons) of water. There are two chlorination stations on the system which are operated under strictly observed written procedures. System water pressure is maintained at a nominal 3,515 g/cm^2 (50 psig). Projected increases in annual consumption of potable water due to planned launch rates are:

Year	Kiloliters	(Gallons)	Year	Kiloliters	(Gallons)
1978	560,180	(148,800,000)	1982	926,568	(244,800,000)
1979	749,430	(198,000,000)	1983	1,065,856	(281,600,000)
1980	832,700	(220,000,000)	1984	1,308,096	(345,600,000)
1981	870,550	(230,000,000)			

2.5.2.5 Sewage Management. The domestic waste collection and treatment facilities at KSC consist of two major installations, the main plant at the Industrial Area and the main plant at the VAB. In addition, 15 package plants are distributed throughout the Center (see table 2-4). The Industrial and VAB plants have maximum capacities of 1,420 kiloliters (375,000 gallons) per day and 409 kiloliters (108,000 gallons) per day, respectively. The package plants, ranging from 3,785 liters (1,000 gallons) per day to 190,000 liters (50,000 gallons) per day, have a total capacity of 1,088,270 liters (287,500 gallons) per day. Thus, the facilities have the capacity to treat approximately 3,110,000 liters (821,500 gallons) per day. Operation and maintenance of these facilities comply with State and Federal Water Quality Standards, Federal Guidelines for Design, Operation, and Maintenance of Waste Water Treatment Facilities, and E.0 11507, "Prevention, Control, and Abatement of Air and Water Pollution at Federal Facilities." Only two plants produce outfall, and both are National Pollution Discharge Elimination System (NPDES) permitted. See table 2-4.

Table 2-4. Sewage Treatment Plants

Plant No.	Building No.	Name	Capacity (liters/day)	Location On Figure 2-1
* 1	M6-895B	Main Plant	1,420,000	5
2	M7-1162	Fluid Test Area	26,500	5
3	N6-2296A	Central Telemetry	37,900	5
* 4	K6-792	Main Plant - VAB	408,800	1
5	J8-1705	Launch Pad 39A	190,000	1
6	J7-384	Launch Pad 39B	190,000	1
7	K7-1205D	Press Site LC-39	37,900	1
8	J8-2010	Launch Pad 39A	3,785	1
9	K7-464	Propellant Facilities	53,000	1
10	M6-409A (East)	Visitors Info. Center	190,000	5
	M6-409A (West)	Visitors Info. Center	190,000	5
11	M5-1494A	S-Band	57,000	USB
12	K7-520	Propellant Facilities	42,000	1
13	M7-1469A	SAEF 1 (VPF)	7,600	5
14	M6-1671A	Ransom Road	19,000	5
15	K6-1996E	Contractor's Road	30,000	1
16	M3-7	Pass and Identification	11,000	Gate 3
17	J6-2263	Landing Aids Control Bldg	5,700	1

* NPDES permitted outfall

In addition to these plants, there are 10 domestic treatment plants ranging in capacity from 2 to 6 kiloliters (500 to 1500 gallons) per day (see table 2-5). There are also 13 septic tanks in areas so remote that hookup to the sewer system is impractical in terms of volume, expense, and construction impact on the environment (see table 2-6). Maximum flow through any one of these systems is estimated to be less than 2 kiloliters (500 gallons) per day. Varying numbers of portable toilets are located and relocated to meet temporary requirements.

Table 2-5. Domestic Treatment Plants

Plant No.	Building No.	Name	Capacity (liters/day)	Location On Figure 2-1
1	J8-15003	Operation Support LO_2 Launch Pad 39A	1900	1
2	J8-1614	Operation Support RP-1 Launch Pad 39A	1900	1
3	K6-1141	C-5 Substation	1900	1
4	K6-1193	VAB Repeater Station	1900	1
5	K6-1446	Tanker Overhaul	5700	1
6	J7-132	Operation Support LO_2 Launch Pad 39B	1900	1
7	J7-243	Operation Support RP-1 Launch Pad 39B	1900	1
8	L7-1557	CIF Antenna Site	1900	1
9	K6-2196A	Roads and Grounds	1900	1
10	J7-1388	Water Pump Station	1900	1

Table 2-6. Septic Tanks

Septic Tank No.	Building No.	Name	Location On Figure 2-1
1	K7-188	MSS Park Site	1
2	K7-1557	Instrumentation Building	1
3	L5-683	Frequency Control and Analysis	1
4	J6-553	Weather Substation B	1
5	N6-1009	Pass and Identification Building	Gate 2
6	M7-531	Banana River Repeater Station	5
7	M7-867	Radar Range Boresight Control Site	5
8	Q6-82	Radar Station	SR 528
9	M7-1410	Hypergol Module Storage West	5
10	M7-1412	Hypergol Module Storage East	5
11	M7-1417	Ordnance Laboratory No. 2	5
12	K7-557	Gate House	1
13	K7-506	Ordnance Laboratory No. 1	1

These sewage treatment plants are supported by Domestic Waste System Mechanical Facilities shops which provide services for planning, management, supervision, inspection, operations, maintenance, preparation of reports, systems engineering, and operational readiness of the domestic waste collection and treatment facilities. The sludge from these facilities is land-spread over 2 hectares (5 acres) of grassed areas at KSC at a rate of about 15,140 liters (4,000 gallons) per day. Using the present methods of treatment, no sludge cakes or semi-solids remain for disposal.

In addition to these plants, there are 10 domestic treatment plants ranging in capacity from 2 to 6 kiloliters (500 to 1500 gallons) per day (see table 2-5). There are also 13 septic tanks in areas so remote that hookup to the sewer system is impractical in terms of volume, expense, and construction impact on the environment (see table 2-6). Maximum flow through any one of these systems is estimated to be less than 2 kiloliters (500 gallons) per day. Varying numbers of portable toilets are located and relocated to meet temporary requirements.

2.5.3 SHOPS AND LABORATORIES. Throughout the KSC and CCAFS areas, shops and laboratories are provided and equipped to support every aspect of institutional and programmatic activity.

2.5.3.1 <u>Shops</u>. Approximately 56 shops, occupying more than 34,100 square meters (367,000 square feet) of floorspace, are used to furnish services for maintenance, repair, and cleaning; machining, sheet metal working, and welding; printing and reproduction; photography and microfilming; calibration of tools and machinery; gases and fluids handling; model-making; hypergolic training; locksmith; and GSA motor pool. Table D-1 of appendix D shows the locations and sizes of selected shops, together with their major functions.

2.5.3.2 <u>Laboratories</u>. Approximately 77 laboratories occupying more than 16,350 square meters (176,000 square feet) of floorspace furnish capabilities for communications equipment design, development, assembly, and testing; calibration; receiving inspection; nondestructive testing of materials; chemical and microchemical analysis; meteorological prediction; biomedical (crew and cargo) support; flight crew clothing and equipment standards; maintenance of measurement standards; and maintenance of exhibits (VIC). Table D-2 of appendix D shows the locations and sizes of selected laboratories, together with their major functions.

2.5.4 ROADS AND GROUNDS. This function provides services which include roadway, shoulders, parking lot, and grounds maintenance and mowing; bridge lift span equipment maintenance and operations; bridge and trestle maintenance; crawlerway maintenance; minor construction; flood and erosion control; utilities trenching; quay walls maintenance and repair; overall land management including grass cutting, fertilizing, mulching, sodding and planting; pest and weed control; insect, rodent and reptile control; dead animal disposal; placing barricades and roped stanchions; refuse removal; survey and maintenance of waterways, barge canal, and turning basin; and firebreak clearing.

A nursery with shade house is provided for plant cultivation and preparation for replanting. Occasionally, maintenance and operational requirements dictate removal of various plants and small trees from certain areas. These plants are transplanted to the nursery as stock to satisfy future minor landscaping requirements.

An important feature of the Roads and Grounds operation is the use of chemical compounds for the destruction or control of unwanted vegetation, rodents, and insects. All of these chemicals are herein collectively termed pesticides. A listing of materials, purpose, application, and restrictions is shown in table 2-7 for all pesticides used during 1977-1978. However, quantities and types of pesticides used can change as dictated by specific pests to be controlled, pesticide effectivity, toxicity, registration restrictions, and other factors.

Control of pests and vermin cannot be accomplished by any one tool. KSC has a program of sanitation which effectively reduces the need for excessive use of pesticides. To further this reduction in the random use of pesticides, no work of this type is performed on a regular, scheduled basis. All use of pesticides is restricted to a demand basis. As alternatives to pesticides (e.g., biological methods) are identified, NASA will evaluate and apply acceptable techniques which will reduce or eliminate pesticide use to the extent practicable.

2.5.5 WASTE MANAGEMENT. Operations at KSC produce or result in large quantities of waste products. Solid wastes are almost entirely nontoxic and can be disposed of in an environmentally acceptable manner at the KSC Sanitary Landfill. The small amount of chemically active solid waste requiring controlled disposal includes Thermal Protection Subsystem (TPS) residues, discarded toxic substance containers (e.g., pesticides), and accumulated salt deposits. These types of solid waste are collected, identified, and staged for offsite disposal. Radioactive wastes are considered a special category and are shipped offsite to a Federal repository.

Chemical wastes must be disposed of by methods which are environmentally acceptable and economically practical. These wastes are identified, segregated, and, as applicable, directed to the KSC Sanitary Sewage System, biologically treated, incinerated, reclaimed, or delivered to offsite contractors for disposal in accordance with environmental requirements. Facilities at KSC include the Sanitary Sewage System, the Sanitary Landfill, Freon recovery system, hydrocarbon recovery system, mercury and silver recovery laboratories, incinerators, and staging areas for those materials to be picked up by offsite contractors. Chemical wastes in the staging areas are sent off site for EPA-approved disposal, treatment, or processing by a vendor under contract to KSC.

Table 2-8 shows types and annual quantities of waste and the disposal method dictated by the characteristics of the waste.

Table 2-7. Purpose and Use of Pesticides in KSC Area 1/

Pest	Reason	Common Name 2/	Formulation	Method of Application	Restrictions	Qty Per Year 3/
(a) Vegetation, cattails Johnson grass, Bermuda grass	Weed abatement	Dalapon	1.8 kg/liter of water	Power sprayer	Avoid drainage and outfall ditches near orange groves	227 kg
(b) Vegetation, perennial weeds	Bare ground weed control	Diuron	4.5 grams/m^2 in 379 liters water (2.3 grams for retreatment)	Power sprayer	High voltage substations. Wind 13 km/h max	272 kg
(c) All vegetation	Bare ground weed control	Prometryn	454 to 908 grams per m^2	Hand application	Avoid trees and ornamental shrubs. Wind 13 km/h, max.	2,722 kg
(d) Ragweed thistles, mallow, docks, wild morning glory, water hyacinth	Broadleaf weed control, maintain free drainage ditches	2,4-D Dimethyl Amine Salt	908 grams per m^2 (479 grams per liter water)	Power sprayer	St. Augustine grass lawns-drainage and outfall ditches near citrus groves	379 liters
(e) Woody Plants-cedar, elm gum, maple oak, pine, willow	To maintain power lines and road rights-of-way	Ammonium Sulfamate	6,725 g/m^2 per m^2 (6,725 g per 379 liters water)	Power sprayer	Orange groves, streams, ditches. Wind 13 km/h, max.	91 kg

Table 2-7. Purpose and Use of Pesticides in KSC Area[1] (cont)

Pest	Reason	Common Name [2]	Formulation	Method of Application	Restrictions	Qty Per Year [3]
(f) Aphids, scale insects	Ornamental plant protection	Malathion	907 grams of 57% emulsion per 379 liters water	Power sprayer	Wind 13 km/h max. (No area restrictions)	76 liters
(g) Mosquitos	Health and welfare	Malathion	225 grams/hectare - apply undiluted	Nonthermal fog ULV	LOX storage areas. Wind 13 km/h max.	568 liters
(h) Roaches, silverfish, ants	Health and welfare	Diazinon	3.8 liters/93m^2	Hand pressure sprayer	After closing-cover food and utensils	114 liters
(i) Roaches, silverfish, ants	Health and welfare	Propoxur	229 g/3.8 liters per liter of water per 93 m^2	Hand-compressed air	Same as (h) plastic, asphalt, rubber tile	114 liters
(j) Flies	Health and welfare	Pyrethrin	7 sec. spray per 28 m^3	Hand-aerosol	Spray when unoccupied	20 cases
(k) Black Norway rats	Health and equipment protection	Warfarin	227 grams bait per station	Hand placed	Keep bait boxes locked	2.3 kg
(l) Sod web worms, caterpillars, army worms	Protection of grass	Carbaryl	397 ml to 76 liters	Power sprayer	Drainage and outfall ditches. Lakes and streams. Wind 13 km/h max.	57 liters

Table 2-7. Purpose and Use of Pesticides in KSC Area 1/ (cont)

Pest	Reason	Common Name 2/	Formulation	Method of Application	Restrictions	Qty Per Year 3/
(m) Ants - all stages	Health and morale	Carbaryl	227 g/9.3 m^2	Hand duster	Wind 13 km/h, max. (No area restrictions)	91 kg
(n) Termites	Control	Chlordane	3.8 liters emulsion per 360 liters water	Power sprayer	Wind 13 km/h, max. (No area restrictions)	57 liters

1/ All pesticides are applied by trained personnel supervised by a graduate entomologist; reviewed by NASA Agronomist.

2/ The chemical names of ingredients may be found in FWGPM-1 through -15. See pages 94 through 112 of reference 2-3.

3/ Approximate amounts.

Table 2-8. Wastes - KSC/CCAFS

Waste Category	Types of Chemicals Included in Category	Present or Interim Treatment Methods	Proposed Long-Term Treatment Methods	1978 Waste Volume	Projected Annual Volume
1. Recoverable Freon 113	Trichlorotrifluoroethane contaminated with oxidizer, less than 1% isopropyl alcohol, or other contaminants	a. Recovery by existing onsite facilities b. Offsite reprocessing c. Staging until long-term facility is operational	Onsite recovery by KSC facility	0	2,490 kiloliters (kl)
2. Hypergolic Fuel, Water/Alcohol	Water or isopropyl alcohol contaminated with hypergolic fuel. Waste hypergolic fuel	Incineration	Same as present	303 kl	2,623 kl
3. Group 1 Hydrocarbons	Petroleum base, water insoluble compounds only, gasoline, motor oil, paint thinner, lubrication oil, hydrocarbon solvents	Reclamation at LC-34 facility, discharge of aqueous waste, and utilization of recovered hydrocarbons as fuel	Same as present with installation of ground water monitoring wells	284 kl	2,926 kl
4. Bilge Water	Bilge water and other water contaminated with traces of oil	Gravity separation of wastes at LC-15 with recovery of oil phase at LC-34. Aqueous phase discharged to biological treatment pond	Same as present with installation of four monitoring wells	1,514 kl	12,498 kl

Table 2-8. Wastes - KSC/CCAFS (cont)

Waste Category	Types of Chemicals Included in Category	Present or Interim Treatment Methods	Proposed Long-Term Treatment Methods	1978 Waste Volume	Projected Annual Volume
5. Group 2 Hydro-carbons	Unrecoverable trichlorotrifluoroethane, trichloroethylene, methylene chloride, other halogenated hydrocarbons, solvents, strippers, paints, oils, glycols, lab wastes, and transformer oils [polychlorinated biphenyls (PCB)]	Storage at LC-34 for disposal by offsite contractor, PCB transformer oils require special handling and offsite disposal along with clothing contaminated with PCB	Same as present with possible revision of storage logistics	76 kl	3,293 kl
6. Recoverable Silver	Wastes from photographic processes	Silver recovery at onsite facilities with effluents collected and treated as Category 8 waste	Same as present	5 kl	314 kl
7. Recoverable Mercury	Contaminated mercury	Recovery at special lab (Hangar L) with effluents collected and treated as Category 5 and 8 wastes	Same as present	45 kilograms (kg)	544 kg
8. Metal-contaminated Wastes	Acids, bases, and neutral solutions containing toxic levels of ionic contamination, chiefly etchants and metal-cleaning solutions	Storage at LC-20 for disposal by offsite contractor	Disposal at proposed onsite metal wastes treatment facility	106 kl	5,265 kl

Table 2-8. Wastes - KSC/CCAFS (cont)

Waste Category	Types of Chemicals Included in Category	Present or Interim Treatment Methods	Proposed Long-Term Treatment Methods	1978 Waste Volume	Projected Annual Volume
9. SRB Refurbishment Wastes	No Category 9 wastes generated at present. Chemistry uncertain	Collection and evaluation for appropriate treatment	Definition will be provided after first recovery of SRB	0	79,708 kl
10. Acids and Bases	Acids and bases which contain acceptable levels of ionic contaminants, photo developer neutralized oxidizer	Storage at LC-20 for disposal by offsite contractor	Neutralization at proposed onsite metals treatment facility	15 kl	337 kl
11. Fuel Scrubber Liquors	Reaction products of hypergolic fuel vapors and 14% citric acid solution	Incineration	Same as present	0	833 kl
12. Oxidizer Scrubber Liquors and Waste Oxidizer	Reaction products of hypergolic oxidizer vapors and 18% sodium sulfite and 5% sodium hydroxide solution	Disposal by offsite contractor	Neutralization/precipitation of toxic salts. Effluent to land spray.	0	3,989 kl
	Waste nitrogen tetroxide	Used for fire training with excess disposed by offsite contractor. Very diluted mixtures are discharged to percolation/evaporation pond.	Mix with oxidizer scrubber liquor		

Table 2-8. Wastes - KSC/CCAFS (cont)

Waste Category	Types of Chemicals Included in Category	Present or Interim Treatment Methods	Proposed Long-Term Treatment Methods	1978 Waste Volume	Projected Annual Volume
13. Radioactive Wastes	Any source on the registry. (Most contained in devices which are sealed, plated, or on foils.)	Storage at LC-19 for offsite shipment to Federal repository	Same as present	208 to 416 liters	2.9 kl
14. Inert Solid Wastes	Paper, office wastes, and similar	Authorized for disposal at Sanitary Landfill	Same as present	13.6 metric tons (m.t.)	13.6 m.t.
15. Special Wastes	Wastes not covered by preceding categories, except for hazardous solid wastes (Category 16)	Treatment determined on an individual basis	Interim methods will be studied and improved where feasible	Variable	Variable
16. Hazardous Solid Wastes	Hazardous solid chemicals, ablative materials, solid propellants, etc.	Storage for offsite disposal	Same as present	1.4 cubic meters	312 cubic meters

2.5.6 LOGISTICS. Institutional and programmatic operations at KSC require the continual receipt, off-loading, storage, and dispensing of large quantities of equipment and supplies. A Central Receiving and Warehouse Facility is used to stage much of the material. More than 22 different fluids and gases are used in support of the Space Transportation System (some elements are needed in both the liquid and the gaseous state, e.g., nitrogen). In addition, NASA-sponsored launches of expendable launch vehicles require the same capabilities for 9 different fuels and fluids.

Tables 2-9 and 2-10 itemize these commodities for the STS and ELV's, respectively, and list the quantities of each required for different aspects of operations. Quantities listed in table 2-10 are developed figures and do not represent actual quantities for a specific flight. Actual quantities required for an individual launch are dictated by weight of payload, trajectory required, and desired apogee.

For the transportation of personnel and materials within the confines of KSC, NASA maintains a fleet of approximately 275 passenger vehicles (cars, vans, and small buses) and about 550 light duty trucks. The older vehicles are periodically sold at public auction to maintain the quality of the fleet.

2.5.7 EMERGENCY SERVICES. Personnel and equipment are provided for security, fire protection, medical services, and all emergency response on a 24-hour-a-day basis. See figure 2-1 for facility locations.

2.5.7.1 Security. KSC maintains a continuous program to provide personnel identification and entry authorization, clearance of hazardous areas during launch and landing operations, vehicular traffic control, control of secured areas, classified document storage responsibility, and surveillance to prevent theft and destruction of Government property. The Security Operations Building (K6-1146) with an area of 453 square meters (4,875 square feet) contains an administrative center and a central dispatching point. The building also houses security records and provides for interrogation and temporary detention. Pass and Identification Buildings N6-1009, occupying 110 square meters (1,182 square feet), and M3-2, occupying 136 square meters (1,462 square feet), are located at Gates 2 and 3, respectively. Security gate houses occupying 13 square meters (140 square feet) are also located at Gates 2 and 3. The other entrances to KSC, except the entrance from CCAFS, are provided with part-time security gate houses. Security gate houses are located at eight sites on LC-39. Temporary entrance passes are issued at both Gate 2 and Gate 3 Pass and Identification Buildings. Permanent badges are issued only at Gate 3. Badge or pass checks are made at security gate posts upon entrance to the closed area.

The KSC installation is secured from trespass by land by a 3-strand barbed wire fence along the south boundary, a stretch of approximately 18.5 kilometers (11.5 miles), except at the Gate 2 site, where a 2-meter (6-foot) chain link fence is used in the immediate vicinity of the gate. There is a 3-strand barbed wire fence from water to water, a distance of 244 meters (800 feet), at a narrow point 0.8 kilometer (1/2 mile) south of Haulover Canal.

Table 2-9. Space Transportation System Fuels and Fluids

Fluid	Use	1/ OBQ	2/ BLD	3/ BA	Unit
Liquid Hydrogen (LH_2)	Propellant for ET; reactant for fuel cell	102,513			kg
	Vehicle boiloff; loading losses; conversion to GH_2		44,588		kg
	Quiescent boiloff			137,894	kg
Liquid Oxygen, High Purity (LO_2) (LAir = Liquid Air)	Propellant for ET	609,638			kg
	Vehicle boiloff; loading losses; and LAir		417,312		kg
	LAir for SCAPE; quiescent boil-off of Dewars			3,447,360	kg
Liquid Oxygen, Fuel Cell Grade (LO_2)	Fuel cell (reactant and ECLSS)	1,361			kg
	Conversion to GO_2 for fuel cell purge; FSS servicing; transfer/loading losses		11,340		kg
Gaseous Helium (GHe)	ET, RCS, APU, OMS pressurant; APU pressurant for each SRB	510			m^3
	Purging, leak checking, and inerting		20,957		m^3
	General support (purging, leak checking, inerting)			77,880	m^3
Gaseous Nitrogen (GN_2)	ECLSS atmosphere diluent, hydraulic system accumulator pressurant; SRB hydraulic system accumulator pressurant	85			m^3
	Purging, leak check, inerting, and drying agent		104,784		m^3
	General support (purging, leak check, inerting, etc.)			2,180,640	m^3

Table 2-9. Space Transportation System Fuels and Fluids (con't)

Fluid	Use	1/ OBQ	2/ BLD	3/ BA	Unit
Liquid Nitrogen (LN_2)	Standby for GN_2 pipeline; SCAPE support		73,483		kg
	Conversion to GN_2; SCAPE; quiescent boiloff			1,587,600	kg
Monomethylhydrazine (MMH)	Orbiter OMS and RCS fuel	5,366			kg
	Hypergol Training Facility			3,629	kg
Nitrogen Tetroxide (N_2O_4)	Orbiter OMS and RCS	7,873			kg
	Hypergol Training Facility			5,443	kg
Hydrazine (N_2H_4)	Orbiter and SRB APU fuel	327			kg
Mixed oxides of nitrogen (MON-10)	Enrichment of NO content of N_2O_4	907			kg
Freon 113	Pad Hypergol oxidizer system flush; SCAPE flush		23,950		kg
	General cleaning			498,960	kg
Isopropyl Alcohol	Pad hypergol fuel system flush		45,420		liter
	General cleaning support			7,570	liter
Ammonia	Orbiter coolant loop	68			liter
FC-40	Orbiter fuel cell coolant (scheduled maintenance)	45			kg
	Scheduled maintenance (twice yearly per Orbiter)			272	kg

Table 2-9. Space Transportation System Fuels and Fluids (cont)

Fluid	Use	1/ OBQ	2/ BLD	3/ BA	Unit
Freon 21	Orbiter radiator coolant loop	227			kg
	Sample		5		kg
	Scheduled maintenance (once a year per Orbiter)			680	kg
Demineralized Water (DM)	SRB flush		75,700		liter
	Cleaning solvent (component cleaning lab)			7,570,000	liter
Hydrochloric Acid (HCl)	Regenerant to produce DM		151		liter
	Regenerant to produce DM			13,248	liter
Sodium Hydroxide (NaOH)	Neutralizing agent (Freon); regenerant (DM)		1,098		liter
	Regenerant to produce DM			11,734	liter
Potable Water (Crew)	Purchased drinking water for crew	45			liter
Coolant Water	ECLSS and APU (scheduled maintenance)	314			liter
	Scheduled maintenance (twice yearly per Orbiter)			681	liter
Carbon Dioxide (CO_2)	For charging annulus ET GH_2 vent line		TBD		
Diesel Fuel	For operating five Paul rechargers			45,420	liter
Hydraulic Fluid	Hydraulic systems	450			liter
	Scheduled maintenance			2,725	liter

Table 2-9. Space Transportation System Fuels and Fluids (cont)

Fluid	Use	1/ OBQ	2/ BLD	3/ BA	Unit
Halon 1301	Fire extinguishing agent	45			liter
	Fire extinguishing agent			5,443	kg
Argon	Welding and brazing			4,361	m^3
Propane	Firing GH_2		1,135		liter
	Various shops			45,420	liter

NOTES

1/ OBQ = Onboard quantity. This column lists the quantities of fluids required onboard the Space Shuttle at launch.

2/ BLD = Base launch dependent. This column lists the quantities of fluids required at the various Space Shuttle ground facilities to prepare the vehicle for launch.

3/ BA = Base annual. This column lists the total annual quantities of fluids required to support ground activities on a day-to-day basis, regardless of launch schedules.

Table 2-10. Expendable Launch Vehicle Fuels and Fluids

Substance	Unit	Delta		Atlas-Centaur	
		Base/Month 1/	Amt/Launch 2/	Base/Month 1/	Amt/Launch 2/
Aerozine -50	kg		1,814		
Gaseous Nitrogen	m^3	1,416	2,832	235,031	566,340
Gaseous Helium	m^3	1,416	4,248	16,990	33,980
Liquid Hydrogen	kg			4,436	7,257
Liquid Nitrogen	metric tons	45	73	14	82
Liquid Oxygen	metric tons	18	91	45	272
RP-1 (Highly Refined Kerosene)	kl		32		57
Nitrogen Tetroxide	kl		2,858		
Hydrogen Peroxide	kg			408	

1/ Base/month. This column lists the total monthly quantities of fluids required to support ground activities on a day-to-day basis, regardless of launch schedules.

2/ Amt/launch. This column lists the quantities of fluids required to accomplish the launch of the specified ELV.

The KSC Secure Area of 30,741 hectares (75,960 acres) is the area between Beach Road (Titusville to Playalinda Beach) and the KSC south boundary. Security in this area is accomplished by contractor personnel using patrol cars and boats. The KSC area north of the secured area is patrolled by the Brevard and Volusia County Sheriff Departments. KSC is also under surveillance by officers of the U.S. Fish and Wildlife Service, Merritt Island National Wildlife Refuge, and the National Park Service, Canaveral National Seashore. The Secure Area can be expanded or reduced to match the existing launch or Orbiter landing preparations clearances.

2.5.7.2 Fire Protection. KSC fire protection is provided by mobile firefighting equipment operating from the fire station at LC-39 and from the fire station in the KSC Industrial Area. The KSC water distribution system provides water at all facilities for firefighting. KSC facilities are equipped with automatic fire detector alarm systems, and manual alarm systems, both of which are connected to a central dispatching system. Automatic fire suppression systems, including water sprinklers and Halon 1301 dispensers, are installed in high-risk and mission-essential sites. Manual spray systems are provided at many flight hardware operational sites where hazardous operations are performed and fire-fighting equipment and personnel are stationed at strategic field locations during hazardous operations to provide immediate service as required.

The LC-39 Fire Station (K6-1198), near the VAB, is a three-stall one-floor metal structure of 692 square meters (7,445 square feet) including fireman's quarters. The Industrial Fire Station (M6-695) is located near the KSC Headquarters Building and serves all of the KSC Industrial Area. It is a standard five-stall station for crash and structural fire trucks, firefighting equipment, offices, and quarters for operating personnel, all contained in a one-floor concrete block structure having 937 square meters (10,088 square feet) of floorspace. The Fire and Rescue Training Area (L7-999), located between the Industrial Area and LC-39, is a 305-meter (1,000-foot) square facility located in a 9-hectare (23-acre) area improved with specialized installations for training firemen and technicians in the use of equipment and procedures, particularly with respect to hypergolic chemicals. The Fire and Rescue Drill Tower (L7-889) is a 77-square meter (833-square foot) structure located in the Fire and Rescue Training Area and is used for training firemen in interior rescue work. A buffer zone is provided for blast and toxic clearances.

2.5.7.3 Medical Services. KSC maintains a Medical and Environmental Health Program that covers a wide variety of health protection services for KSC work forces as well as medical support for launches, tests, and simulation activities. The Medical Program includes, among other items: emergency diagnosis and first aid treatment for injuries or illness of anyone at KSC; emergency transportation; health examinations; immunizations; and treatment, therapy, and medication to varying degrees, as provided by regulations, for job and non-job related ailments. The Environmental Health Program includes industrial hygiene, radiological health, and environmental sanitation.

The Industrial Dispensary provides medical examination and emergency treatment for persons working near the KSC Industrial Area. It also supports the outlying first aid and medical treatment stations. The building is equipped for employment physicals, innoculations, and emergency treatment. The Dispensary is a one-floor concrete block structure of 1350 square meters (14,534 square feet) located at C Avenue and Second Street in the KSC Industrial Area. Major items of equipment available at the Dispensary are a large X-ray unit, fluoroscope and camera, complete fixed electrocardiograph equipment and walkaround sets, many minor items for first aid and therapy, and all types of laboratory and test equipment for complete physical examinations.

The VAB has a dispensary and first aid station occupying 203 square meters (2,184 square feet). An area of 173 square meters (1,862 square feet) in the O&C Building (M7-355) is dedicated to medical purposes for the astronauts.

2.5.8 VISITORS SERVICES. NASA provides for (1) the local, national, and overseas visitors who daily enter the Kennedy Space Center, (2) the periodic public viewing of space vehicle launches and (near future) Orbiter landings, and (3) members of the news media. Moreover, the well-attended Merritt Island National Wildlife Refuge and most of the Canaveral National Seashore lie within the boundaries of KSC.

2.5.8.1 Visitors Information Center. The Visitors Information Center (VIC) is located about 10 kilometers (6 miles) east of U.S. Highway 1. Facilities include a main building with exhibits, lecture and audiovisual theaters, public bus tour accommodations, and a booth staffed by the Space Coast Tourism Committee to answer inquiries about food, lodging, travel routes, and distances and to provide other traveler assistance. Restroom accommodations and a Pet Kennel for temporary care of visitors' pets also are provided. Nearby are an Exhibit Building (Hall of History), a souvenir store, and a Food Services Facility. The entire VIC area, including visitor parking lots, bus parking and maintenance, and a sewage plant, occupies about 26 hectares (65 acres); occupied floorspace exceeds 6,500 square meters (70,000 square feet).

The guided Bus Tours, operating daily until 2 hours before sundown, provide viewing and opportunity for picture-taking of KSC and Cape Canaveral Air Force Station (CCAFS) installations. Short stops are made at the Vehicle Assembly Building (VAB), the Launch Control Center (LCC), launch pads at Complex 39 (from which the Space Shuttle will be launched), the Flight Crew Support Building in the KSC Industrial Area, the Space Museum, and several historical launch pads at CCAFS. Patronage of the Bus Tours reached a peak in 1972, the final year of the Apollo lunar landing program, and is expected to surpass that mark by 1980, during the Space Transportation System era. Combined VIC and Bus Tour patronage and projections through 1984 provide the following figures:

Actual			Projected	
Year	Attendance		Year	Attendance
1966	219,537		1979	1,690,000
1967	644,069		1980	1,780,000
1968	823,909		1981	2,040,000
1969	1,424,069		1982	2,350,000
1970	1,260,601		1983	2,590,000
1971	1,296,744		1984	2,840,000
1972	1,736,303			
1973	1,580,401			
1974	1,098,433			
1975	1,460,263			
1976	1,421,708			
1977	1,397,003			
1978	1,612,066			

2.5.8.2 Public Viewing Areas. During the Space Transportation System era, the greatest concentrations of viewers within KSC to witness Space Shuttle launches and Orbiter landings will probably occur along the Kennedy Parkway and on the NASA Causeway. These two locations offer excellent unobstructed observation of activities. Therefore, portable sanitary facilities will be scheduled and located in the same manner that proved to be satisfactory during the Apollo program. Also, the feasibility of installing public address systems for traffic control by segments is being studied. This plan might forestall mass exodus traffic jams.

2.5.8.3 Press Sites. Press activities are presently operated from the KSC News Center located in the Headquarters Building. During NASA launches of expendable launch vehicles from CCAFS facilities, press operations are centered about Press Site 1, midway down the geographical cape to the east of Cape Road.

During the manned Apollo, Skylab, and Apollo-Soyuz Test Project launches from Complex 39, onsite news operations were centered about a press site on the west side of the Barge Terminal Facility adjacent to the VAB. Sited atop a mound overlooking the Barge Terminal is a grandstand capable of seating 300. The mound facilities provide excellent views of both Complex 39 launch pads. During a manned Apollo launch, the press site accommodated up to 3,500 news media representatives. Nearby is a parking area capable of handling up to 500 cars and 15 buses.

Near-term projects proposed include a permanently active press operation at the Complex 39 mound facility and viewing site on the east side of the SLF. A new 557-square meter (6,000-square foot) press facility will be constructed within the existing Complex 39A press area which is located just southwest of the Barge Terminal Facility. Sanitary facilities will be provided for press representatives and guests. Additional portable comfort stations will be located throughout the Barge Terminal area and the VAB parking lots to accommodate the expected visitors arriving at the sites by chartered buses and private cars. These contractor-provided facilities are similar to those furnished during the Apollo launches and have proved to be adequate, efficient, and economical.

Starting with the fifth launch of the Space Shuttle, it is expected that the returning Orbiter will land at the KSC 4,572-meter (15,000-foot) Shuttle Landing Facility (SLF). Construction of limited press facilities will include erection of viewing bleachers just north of 32nd St. N.W. and approximately 380 meters (1,250 feet) from the east side of the SLF at the 2,286-meter (7,500-foot) location, together with parking areas for the expected buses and automobiles.

2.5.8.4 Merritt Island National Wildlife Refuge. The Merritt Island National Wildlife Refuge (NWR) coincides with the boundaries of KSC. The area is administered by the U.S. Fish and Wildlife Service. Under FWS supervision, the public is invited to enjoy freshwater and saltwater fishing, controlled waterfowl hunting, wildlife observation, and nature photography. In 1977 over 2,800,000 visits were made to the Refuge.

2.5.8.5 Canaveral National Seashore. Canaveral National Seashore was established in 1975 under the provisions of Public Law 93-626. As a result, about 16,600 hectares (41,000 acres) of the CNS are within KSC boundaries. Of that area, the National Park Service (NPS) administers 2,693 hectares (6,655 acres) and the Merritt Island National Wildlife Refuge (NWR) manages the remaining 13,909 hectares (34,345 acres). Conveniences are provided at the beach for the public and include a parking area for approximately 750 vehicles, portable toilets, identified trash containers, and dune-protecting crossovers and boardwalks. In 1977, nearly 600,000 visitors experienced the benefits of the CNS and Playalinda Beach.

2.6 CONSTRUCTION OPERATIONS

The following paragraphs discuss construction in progress on new facilities, modifications to existing facilities, and proposed new construction. Figure 2-1, in combination with table 2-3, indicates the locations for these activities.

2.6.1 CONSTRUCTION IN PROGRESS.

2.6.1.1 Modifications to the Operations and Checkout (O&C) Building. Modifications to the high and low bay areas of the O&C Building are being performed to install Spacelab flow processing testing equipment, to provide clean room conditions for payload handling equipment (cranes, dollies, racks, and pallets), and to furnish mobile service units (vacuum systems, hydraulic servicing carts, and glycol environmental cooling carts).

2.6.1.2 Vertical Processing Facility. Modifications to this facility, also known as SAEF No. 1, include enlargement of an existing parking area, modification of the south access door and roof to accommodate passage of the transporter and the vertical payload canister, and erection of a 2.5-meter (8-foot) chain link security fence around the entire property.

2.6.1.3 SRB Recovery and Disassembly Facility. Construction of this facility entails excavation for, and fabrication of, the SRB slip and bulkheads, facility construction, and development of a land spray area to treat effluents from planned operational activities. Modifications to permit berthing of the retrieval vessels also are planned for this site.

2.6.1.4 Mobile Launcher Platform. Three Mobile Launcher Platforms are located within the KSC area. One is receiving machinery and equipment to ready it for the first Shuttle launch from Pad 39A. A second MLP, located outside of the VAB, is being reconfigured to Shuttle requirements. The third MLP, presently in the Apollo Launch Umbilical Tower configuration, is available for modification at a later date.

2.6.1.5 Launch Pad 39B. Extensive modifications to Launch Pad 39B are being conducted to ready this facility for the launch of the Space Shuttle. All activities are of the type associated with the construction, modification, and installation of launch support equipment similar to what has been done on Pad 39A.

2.6.2 PROPOSED CONSTRUCTION.

2.6.2.1 Modification for STS Payload Support. An existing building in the HMF Complex, M7-1210, has been reserved for modifications to support STS automated payloads. As plans mature, an Environmental Assessment will be performed for this project.

2.6.2.2 Occupational Health/Dispensary. Plans are being reviewed to remodel an existing building, M5-495, to add a four- to five-bed emergency facility. An alternate plan under study is to provide facilities for helicopter transport for patients to a nearby hospital for immediate attention. An Environmental Assessement will be performed as part of the decisionmaking process.

2.6.2.3 Modifications to Hangar L. Plans are being formulated to provide modifications to Hangar L for a research laboratory equipped for biological analyses of flight and control specimens of animals and plants, plus standard laboratory equipment; facilities for the receipt, examination, quarantine, and maintenance of specimens also are proposed. These facilities must include provisions for environmental control, sanitation, furnace for cremation, storage space for routine and sterile supplies, and office space. An Environmental Assessment has been made (reference 2-4).

2.6.2.4 Crawler Transporter Maintenance Facility. Modification of the Crawler Transporter maintenance area is planned to provide a building for gear train servicing, mechanical servicing, and hydraulic components and system testing. Outside the new building, but within the fenced parking area, two slit trenches will be constructed, each housing a hoist platform. The hoists, each having a capacity of 4,536 kilograms (10,000 pounds), will be on dollies that move manually on steel rails from a point below the track to an open access area outside the Crawler Transporter area perimeter. The two slit trenches will each have a floor drain to a sump and sump pump.

Construction of this facility, if approved and funded, will take place in a previously disturbed area. Alternate locations and solutions for current operations were studied and discarded because they would not meet the increased maintenance requirements during the Space Transportation System program. An Environmental Assessment of Crawler Transporter maintenance operations was performed (reference 2-5).

2.6.2.5 Press Facility. During the Space Transportation System era, press accommodations will be provided just southwest of the Barge Terminal Facility. A 174-square meter (6,000-square foot) news facility will be built which will have the capability of being expanded to 290 square meters (10,000 square feet). This facility will include the necessary working quarters and conference areas. An existing parking area will handle up to 500 cars and 15 buses. An Environmental Assessment will be made as plans mature.

2.6.2.6 Orbiter Landing Viewing Site. Beginning with Space Shuttle Flight 5 (SS-5), the Orbiter will land at the KSC Landing Facility. Plans are under way to provide a viewing site to accommodate the press and invited guests on the east side of the landing strip near the 2,286-meter (7,500-foot) mark. This site will accommodate approximately 4,250 guests and 750 news media representatives traveling in 50 buses and 250 cars. An Environmental Assessment will be performed.

2.7 TENANT OPERATIONS

Leases of property within the KSC boundaries which are not related to space activities are administered by the Department of the Interior. Under this arrangement, the National Park Service administers all National Seashore leases; the U.S. Fish and Wildlife Service administers all others. For details, see 4.4 and 4.5.

Land acquisition to establish KSC included 1,016 hectares (2,511 acres) of citrus groves having an appraised value of $7.2 million. The ideal location of these groves on Merritt Island offers growing conditions rarely subjected to frost. The Indian River area is recognized as the source of some of the highest quality citrus in the United States. In order to conserve a valuable Government asset and to continue an operation important to the stability of the local economy, the decision was made to out-lease the existing citrus groves. The lessees and the Government receive maximum revenue with a minimum of administrative costs by grouping these groves into nine leasing units. This has provided an incentive for the lessee to practice needed topping, hedging, cleaning ditches, planting new trees in skips, or removing unprofitable trees and replacing them with new trees. The best interests of NASA are served because the groves improve with age. These arrangements also encourage more growers to participate in the bidding. By the terms of their contracts, the lessees of citrus groves within the KSC confines must purchase, apply, and report the application and quantities of fungicides, insecticides, herbicides, and nutritional chemicals necessary for grove protection and productivity. The citrus grove lessees apply the minimum amounts of chemicals necessary to accomplish the intended purpose. Table 2-11 provides a listing of materials, purpose, and quantities used during 1977-1978.

In addition to these operations, KSC has established a 96-hectare (238-acre) recreational area known as Complex 99, which is administered by the Kennedy Athletic, Recreation, and Social Organization (KARS). Approximately 40 hectares (100 acres) is maintained with facilities for family picnics, sports, swimming, and club activites. This area is located on the Banana River at Hall Road and is open to all NASA and contractor personnel and their families. Outleasing of facilities is provided for approved activities to organizations outside of KSC.

Table 2-11. Purpose and Use of Pesticides 1/ in KSC Citrus Groves

Pest or Condition	Purpose of Chemical	Common Name	Yearly Rate (Active Ingredients)		Application Rate 2/	
			kg	(lb)	g/hectare	(lb/acre)
Nutritional disorders	Nutritional	Manganese	656	1,447	67	6
		Zinc	755	1,655	90	8
Greasy Spot, Melanose, Lemon Scab, Fungus diseases	Fungicide	Copper 3/	3,182	7,014	90	8
		Benlate	80	177	34	3
Scale insects, Rust mites, Spider mites	Insecticide	Spray Oil	54,272	119,648	482	43
		Sulfur 4/	19,043	41,981	560	50
		Chlorobenzilate	2,528	5,574	11	1
		Ethion	1,052	2,320	34	3
Weeds	Herbicide	2,4-D	27	60	22	2
		2,4-STP	54	120	22	2
		Dowpon C	47	103	112	10
		Sodium-TCA	23	51	56	5
		Diuron	287	633	56	5
		Bromacil	409	902	56	5

1/ Including nutritional chemicals, fungicides, insecticides, and herbicides.

2/ Most chemicals are applied in a water solution at approximately 31 liters per hectare (500 gallons per acre) [1016 hectares (2511 acres)]. A tractor-drawn 1.9-kiloliter (500-gallon) tank with an air-blast sprayer is used. Some small amounts are dispensed by aircraft and some sulfur is dry-dusted.

3/ Copper sulfate or oxide is both a nutritional and fungicide on citrus.

4/ Sulfur furnishes nutrition, is an insecticide, and helps to buffer alkaline soil.

SECTION III

DESCRIPTION OF EXISTING ENVIRONMENT

3.1 INTRODUCTION

In this section, the reader is provided with a thorough description of the past and present factors which have shaped and are now affecting the environment in Brevard County in general and the Kennedy Space Center (KSC) in particular. Topics discussed include topography, geology, climatology, hydrology, air quality, water quality, land quality, noise, sonic boom, ecological resources, and social and economic resources. Numerous maps, charts, and tables are provided to condense the data presented.

3.2 REGIONAL PHYSIOGRAPHY

3.2.1 TOPOGRAPHY. The general topography of the KSC area and Brevard County is characterized by a marine terrace system formed during the Pleistocene epoch. As the ocean receded, a series of north-to-south barrier beach and dune systems were formed. The plain or flatland between a previous dune system and a more easterly newly forming system emerged as a terrace. When the ocean receded further, new dunes built up and older ones eroded. Cape Canaveral and Merritt Island are recently formed dune systems and the Banana and Indian Rivers are submerged terraces inundated by brackish water. The physical influences which have shaped the present topography of Cape Canaveral and Merritt Island include the longshore current, the onshore/offshore breezes, and natural land building processes. The project area is part of a barrier beach system which is bordered by the Silver Bluff marine terrace on the northeast and the Pamlico marine terrace on the west. The Pamlico and Silver Bluff terraces stand at 8 to 11 meters (25 to 35 feet) and 0.9 to 2.4 meters (3 to 8 feet) above mean sea level (msl), respectively. Cape Canaveral and Merritt Island have numerous strands of north-to-south dune ridges which are approximately 3 meters (10 feet) above msl. In figure 3-1, the topographic characteristics for KSC and the surrounding area are illustrated (reference 2-1).

3.2.2 GEOLOGY. During the Eocene epoch, the Florida peninsula was inundated repeatedly by the sea. Between inundations, limestone formations in Brevard County were exposed to erosion. Erosion is thought to have reduced the thickness of the limestone formations and is responsible for several missing layers of Oligocene and Lower Miocene Age deposits. The existing Oligocene and Lower Miocene deposits consist of a thick series of sands, silts, and clays of varying thickness. Generally, the first 12 to 18 meters (40 to 60 feet) consist of loose to fairly compact fine sands and shelly sands. The silts and clays range from soft to moderately stiff. These deposits overlie the Hawthorn Formation which consists of calcareous clays and silts, sandy phosphatic limestone, and phosphatic clay. Local sand and shell beds also occur within the Hawthorn Formation. In certain areas a thin, hard limestone or siltstone occurs about 9 to 11 meters (30 to 35 feet) above the top of the Ocala Group. The Hawthorn Formation is generally recognizable by its phosphatic content and its olive-green coloration.

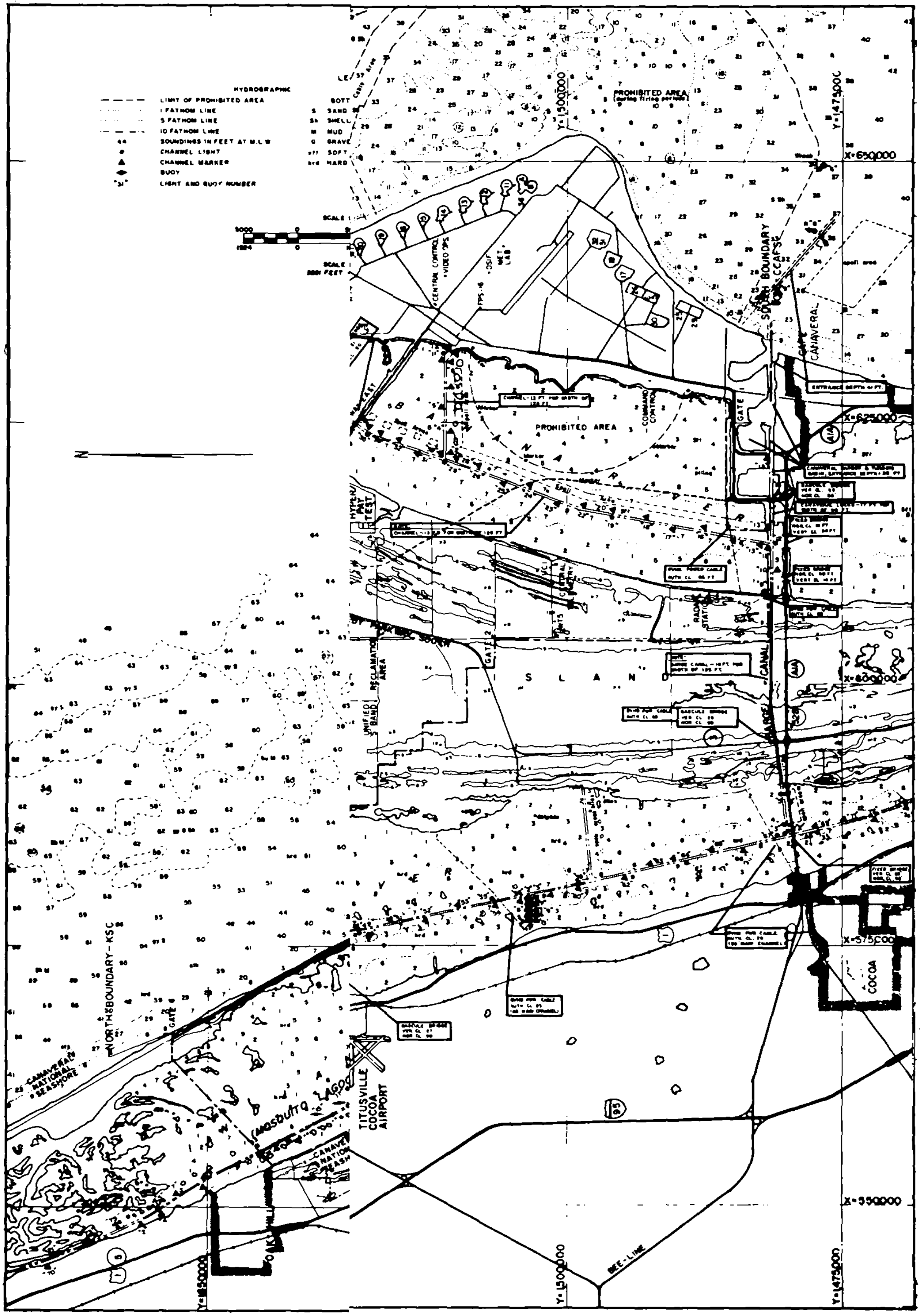
The Ocala Group contains the Crystal River, Williston, and Inglis Formations. These formations are abundant with cavities and consist of Eocene limestone which is creamy white in color. The Ocala Group overlies the Avon Park Formation which ranges in color from light brown to white and is chalky in texture. In some places, the Avon Park Formation has been changed largely to dolomite. The lower portion of the Avon Park Formation is relatively impermeable and is believed to retard the vertical movement of water. The upper part of the Avon Park Formation is the principal source of deep artesian wells in Brevard County. In figure 3-2, a generalized geologic column for Brevard County is illustrated.

Conglomerates of shell, limestone, and sand deposited in the Pleistocene and recent eras make up the five general soil associations found at KSC and Cape Canaveral Air Force Station (CCAFS). The distribution of these general associations is presented in figure 3-3 (reference 3-1) and is discussed in the following text.

a. Paola-Pomello-Astatula Associations are nearly level to strongly sloping, excessively to moderately drained soils and sandy throughout the profile. In the KSC area, these soils are found on long, narrow ridges usually less than 3 kilometers (2 miles) wide between the Indian River and the Banana River and along the Kennedy Parkway.

   Paola soils are nearly level to strongly sloping, excessively drained sandy soils on ridges. Vegetation includes sand pine, scrub live oak, turkey oak, scattered saw palmetto, runner oak, rosemary, and grasses. These soils formed in thick beds of eolian sands. Permeability is very rapid throughout the profile. Organic matter is low. These soils are very strongly to medium acid (4.5 to 6.0). The water table is usually below a depth of 305 centimeters (10 feet).

   Pomello soils are nearly level, moderately well-drained, sandy soils on broad, low ridges and knolls throughout the flatwoods. Vegetation is scattered long needle pine, scrub live oak, saw palmetto, and native grasses. These soils formed in thick beds of marine sands. The water table is within 75 to 100 centimeters (30 to 40 inches) of the surface during the rainy season. Permeability is very rapid in the upper 125 centimeters (50 inches) of soil. Organic matter is low. These soils are strongly to very strongly acid (4.5 to 5.5) throughout the profile.



rographic and Topographic Map

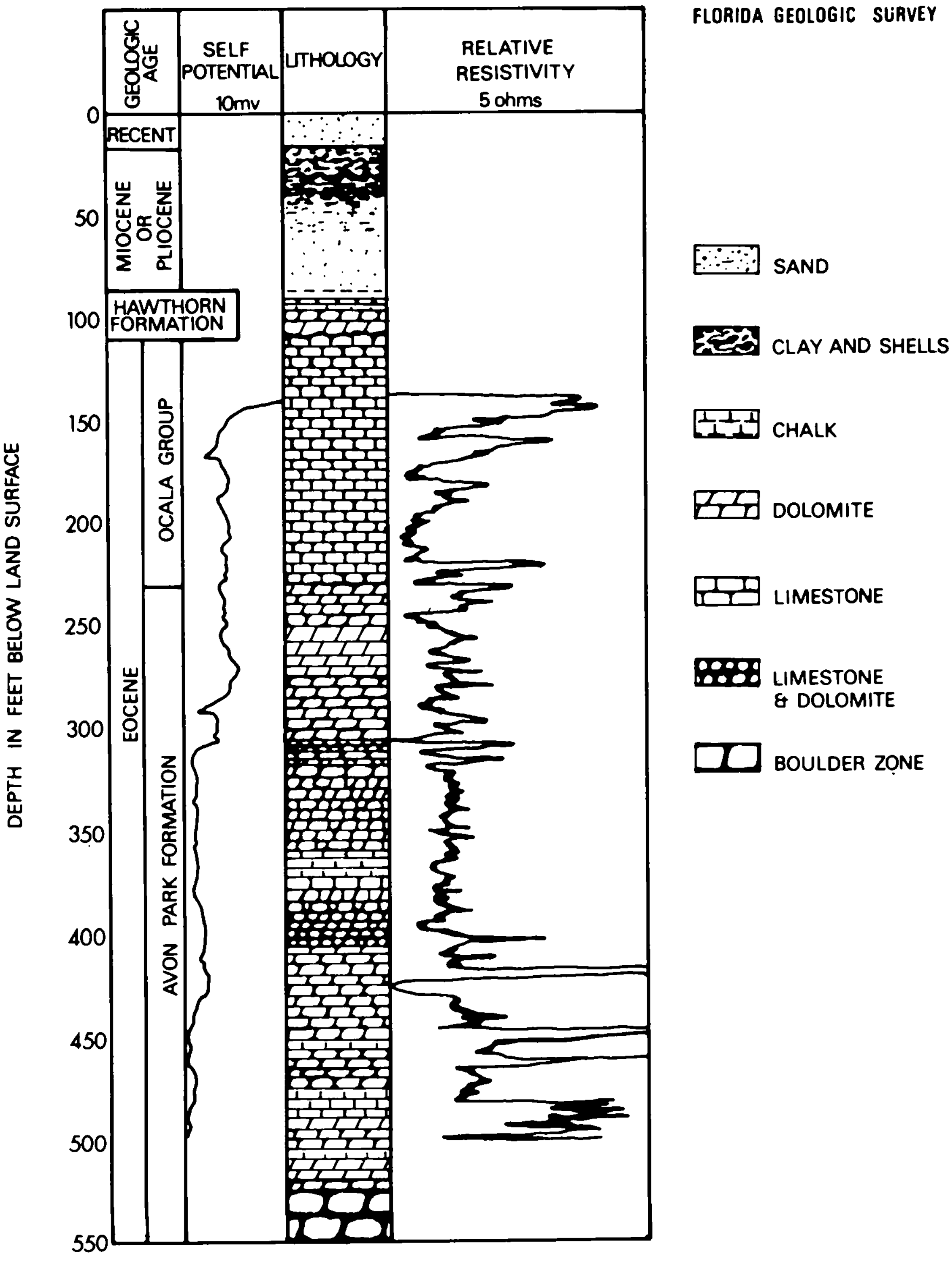


Figure 3-2. Generalized Geologic Column: Brevard County

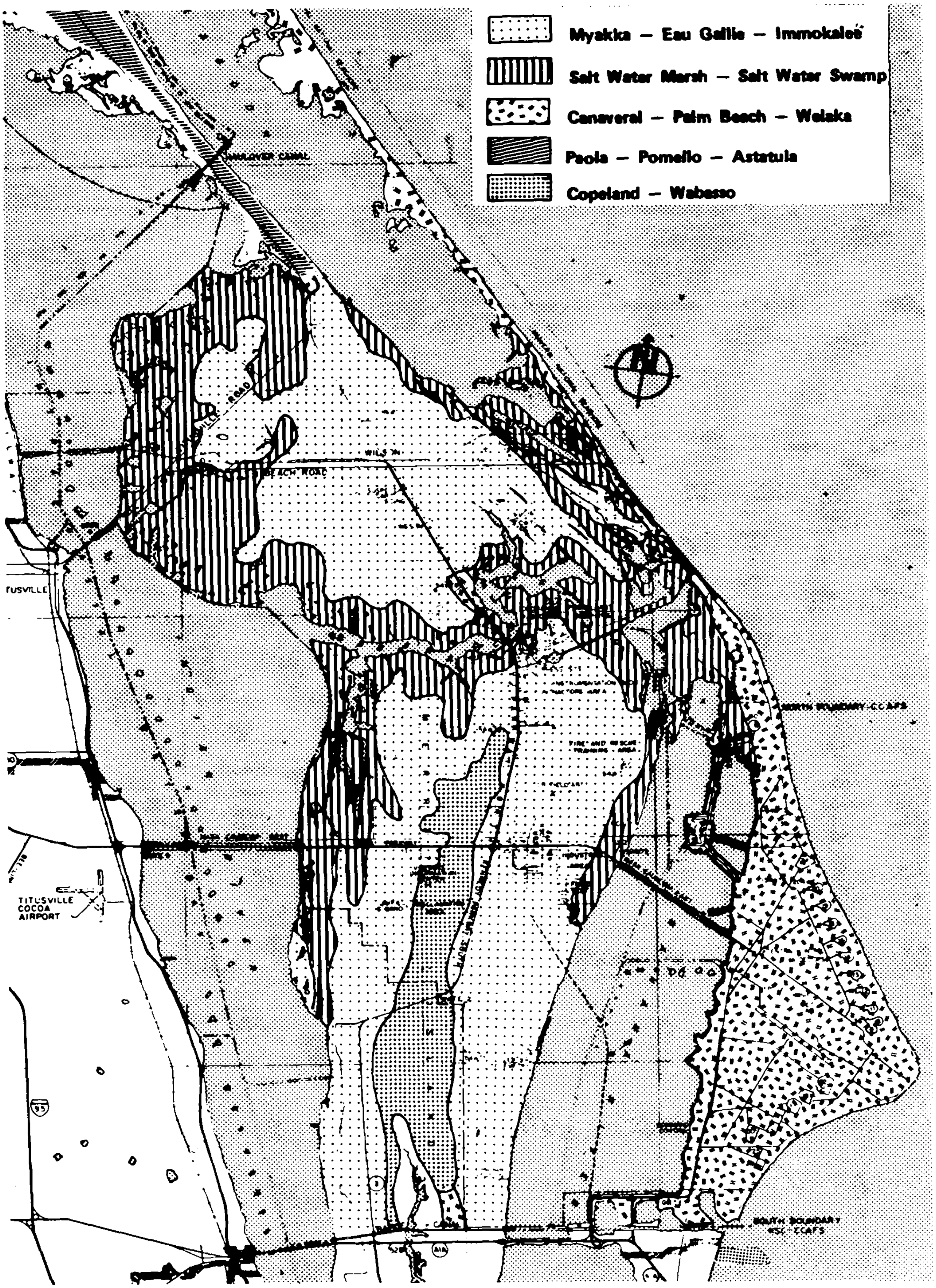


Figure 3-3. Generalized Soil Associations: Cape Canaveral - Merritt Island Land Mass

Astatula soils are nearly level to gently sloping, excessively drained, sandy soils on ridges. These soils formed in sandy marine or eolian sediments and are more than 95-percent quartz. Organic matter is low. Permeability is very rapid throughout the profile. The water table is usually below a depth of 305 centimeters (10 feet). These soils are very strongly to slightly acid (4.5 to 6.5). The natural vegetation is long needla uteaW scattered scrub oak, and scrub hickory.

b. Canaveral-Palm Beach-Welaka Associations are nearly level to gently sloping with moderately well-drained to excessively drained soils and are sandy throughout.

Canaveral soils are excessively drained and appear on narrow ridges and sloughs parallel to the Atlantic Ocean. The natural vegetation supported by these soils is saw palmetto, scrub oak, and cactus on the ridge, and various salt-tolerant grasses in the slough where this soil is poorly drained. The water table varies between 25 and 101 centimeters (10 and 40 inches) in the wet season and below 152 centimeters (60 inches) in the dry season. This soil is not suited for ornamental or agricultural crop cultivation.

Palm Beach soils are excessively drained and appear on dunelike ridges parallel to the Atlantic Ocean. Permeability is very high throughout, and water table depths average 3 meters (10 feet). The natural vegetation associated with this soil includes prickly pear cactus, scrub live oak, sea oats, and sea grapes. This soil is not suited for ornamental or agricultural crop cultivation.

Welaka soils are nearly level and well drained, on moderately broad ridges interspersed with long narrow sloughs. Water table depths are generally below 152 centimeters (60 inches). The natural vegetation is dominated by pine and saw palmetto. The soil is not suited for agricultural or domestic plant cultivation.

c. Myakka-Eau Gallie-Immokalee Associations are nearly level, poorly drained soils, sandy throughout to a depth of 101 centimeters (40 inches) and loamy below.

Myakka sands are nearly level, poorly drained soils on broad flatwoods and areas between ridges. Water table depths vary from 25 to 101 centimeters (10 to 40 inches) during the dry season and less than 25 centimeters (10 inches) during the wet season. Flooding may occur for 2 to 7 days once in 1 to 5 years. Natural vegetation is characterized by slash pine with an understory of saw palmetto and wiregrass. This soil association is suitable for pasture and lawn grass if adequately drained.

Eau Gallie sands are nearly level, poorly drained soils on broad and low ridges. Water table depths vary from 25 to 101 centimeters (10 to 40 inches) during the dry season and less than 25 centimeters (10 inches) in the wet season. The natural vegetation is dominated by the flatwoods community.

Immokalee sands are nearly level and poorly drained. They occur in sloughs and narrow areas between dune ridges. Water table depths vary between 25 and 101 centimeters (10 and 40 inches) in the dry season and less than 25 centimeters (10 inches) in the wet season. Flooding may occur for 2 to 7 days once in 1 to 5 years. Natural vegetation is characterized by slash pine, wiregrass, and saw palmetto. If adequately drained, this soil is suitable for vegetable crop, pasture grass, and lawn grass cultivation.

d. Copeland-Wabasso Associations are nearly level, very poorly drained to poorly drained, sandy to depths of 101 centimeters (40 inches), and loamy below.

Copeland soils are nearly level, poorly drained soils on low flats. Water table depths vary between 25 and 76 centimeters (10 and 30 inches) during the dry season, and less than 25 centimeters (10 inches) doing the wet season. Flooding occurs for approximately 7 to 30 days once in 5 to 20 years. Limestone or coquina rock may underlie this soil. Natural vegetation includes cabbage palms, live oaks, bay, and magnolia. If drainage is adequate, these soils are suitable for ornamental plants, clover, and pasture grass cultivation.

Wabasso soils are nearly level, poorly drained soils on low ridges and floodplains. These soils were formed in sandy marine sediments over loamy materials. Water table depths vary from 25 to 76 centimeters (10 to 30 inches) during the dry season and less than 25 centimeters (10 inches) during the wet season. Flooding occurs 2 to 3 days once in 1 to 5 years. Natural vegetation is characterized by slash pine, runner oak, and saw palmetto on low ridges, and cabbage palm and live oak in the floodplain.

e. Salt Water Marsh-Salt Water Swamp Associations are nearly level, very poorly drained, saline to brackish soils of variable textures. Marsh soils may be shallow sands over marl or limestone, irregularly stratified mixed sand and shell fragments, silty clays over sand and shell, or deep organic material. Natural vegetation is the salt marsh community. Swamp soils consist of mixed sand and organic material. Neither soil is suited for cultivation; however, they do provide substrata for marsh and swamp plants which support migratory and wading birds. The coastal marshes and swamplands play an important role in marine and terrestrial ecosystems.

3.2.3 CLIMATOLOGY. KSC experiences both tropical and temperate meteorological influences. The Florida peninsula is insulated by the warm Florida Current which flows south along the Florida west coast and northward along the Florida east coast to Vero Beach. The influences of this current are noticeable as far north as Cape Canaveral where the Florida peninsula's contour moves northwest away from the current.

The dominant weather pattern (May to October) is characterized by southeast winds which travel around the Bermuda Anticyclone. With the wind comes moisture and warm air which helps create almost daily thundershowers (reference 3-2). Approximately 70 percent of the average annual rainfall occurs during this period. The monthly precipitation average is 10 centimeters (4 inches), with the greatest amount of rain occurring in September. Although tropical depressions and hurricanes occur throughout the wet season, only 24 hurricanes have passed within 185 kilometers (100 nautical miles) of KSC and CCAFS since 1887. None has ever centered the Cape Canaveral area.

Temperatures during the wet season average 26 degrees Celsius (79 degrees Fahrenheit) and rarely exceed 32 degrees Celsius (90 degrees Fahrenheit). Relative humidity averages 90 percent in the early morning hours and declines to approximately 70 percent by early afternoon. Weather patterns in the dry season (November to April) are influenced by cold continental air masses. Rains occur when these masses move over the Florida peninsula and meet warmer air. In contrast to localized, heavy thundershowers in the wet season, rains are light and tend to be uniform in distribution in the dry season. In the dry season, total rainfall averages 38 centimeters (15 inches).

Dry season temperatures average 18 degrees Celsius (64 degrees Fahrenheit), but have sharp gradients when the cold air masses move over the project area. Although the extreme low temperatures have usually not gone below 0 degree Celsius (32 degrees Fahrenheit) in the past decade, the recent winters have had longer cold periods. Relative humidity during the dry season averages 55 percent. In table 3-1, the KSC and CCAFS meteorological data for the past 14/15 years are summarized.

The quality and characteristics of the atmosphere determine the loading capacity of the air and its ability to disperse gases and particulates. The atmosphere for the purposes of this assessment is discussed in terms of two meteorological systems and the interrelationship of these two systems with wind speed, wind persistence, and atmospheric stability (reference 3-3)

a. Surface Atmosphere. The surface atmosphere extends from ground level to 1,000 meters (3,281 feet). Wind directions are influenced by seasonal meteorological conditions and by the thermal differences between the Atlantic Ocean and the Cape Canaveral-Merritt Island land mass.

Table 3-1. Climatological Data for the Cape Canaveral - Merritt Island Land Mass

	J	F	M	A	M	J	J	A	S	O	N	D	Ann	Yr Rcd
Temperature (°C)														
Highest	28	30	31	35	35	37	35	35	35	33	30	29	37	15
Mean daily max	21	21	23	25	28	30	31	31	30	27	24	21	26	14
Mean daily min	11	12	14	17	19	22	23	23	23	21	16	12	18	14
Lowest	-2	-2	-1	7	8	14	17	18	17	8	0	-4	-4	15
Mean no. of days														
Max temp ≥32°C	0	0	0	0	*	4	6	6	1	*	0	0	17	14
Min temp ≤0°C	*	*	*	0	0	0	0	0	0	0	*	*	1	14
Precipitation (no snowfall)														
Mean (cm)	7.49	8.64	10.49	5.11	4.57	10.74	14.48	15.16	22.48	12.95	8.76	4.01	125	14
Mean no. of days >1.27 cm	1.9	2.4	2.6	1.2	1.1	2.8	3.6	3.6	4.9	2.7	2.2	1.1	29.9	14
Relative humidity (%)														
Mean	80	80	78	75	77	81	83	84	82	79	79	79	80	14

Maximum 24-hour precipitation 17.42 centimeters (6.86 inches) (records kept for 15 years)

Flying weather - annual percentages for various categories

A. Ceiling ≥305 meters and visibility ≥5 kilometers — 97.6%
B. Ceiling 152 to 274 meters and visibility ≥1.6 kilometers or visibility >1.6 kilometers but <5 kilometers and ceiling ≥152 meters — 1.5%
C. Ceiling <152 meters and/or visibility <1.6 kilometers — 0.9%

Source: National Oceanographic and Atmospheric Administration

Note: Asterisk denotes less than 1 day.

Heat is gained and lost more rapidly from land than water. During a 24-hour period, water may be warmer and again cooler than adjacent land. Cool air replaces rising warm air creating offshore (from land to ocean) breezes in the night and onshore (from ocean to land) breezes in the day. These sea breezes have been recorded at altitudes of 1,000 meters (3,281 feet) and higher, and reach further inland during the wet season. Figure 3-4 illustrates day and night mean wind direction patterns. Seasonal wind directions are influenced primarily by continental temperature changes. In general, the fall winds occur predominantly from the east to northeast. Winter winds occur from the north to northwest shifting to the southeast in the spring and then to the south in the summer months. Figure 3-5 presents seasonal wind direction distributions.

Atmospheric stability is inversely related to the dispersion of gases and particulates. Stable conditions can result in poor dispersion and are most likely to occur during the evening hours. Figure 3-6 illustrates the frequency distribution of the classes by hours of the day. Table 3-2 presents seasonal distribution of atmospheric stability. In general, atmospheric conditions are most stable in the winter months (reference 3-2).

Table 3-2. Atmospheric Stability at 18-Meter Altitude

Atmospheric Turbulence	Stability Classification	Summer June - Aug		Winter Dec - Feb		Annual Average	
		1/	2/	1/	2/	1/	2/
	Extremely Unstable	1.8	2.8	0.6	2.2	1.1	2.9
High	Unstable	4.4	3.7	1.9	4.1	2.8	4.1
	Slightly Unstable	19.4	4.6	12.9	5.1	15.2	5.0
Moderate	Neutral	44.9	4.3	40.4	5.1	44.9	4.9
	Slightly Stable	21.4	3.1	28.9	4.3	24.6	3.8
Low	Stable	7.3	2.1	12.9	3.0	9.8	2.7
	Extremely Stable	0.8	1.6	2.6	2.6	1.6	2.3

1/ Percent of the time

2/ Meters per second (windspeed)

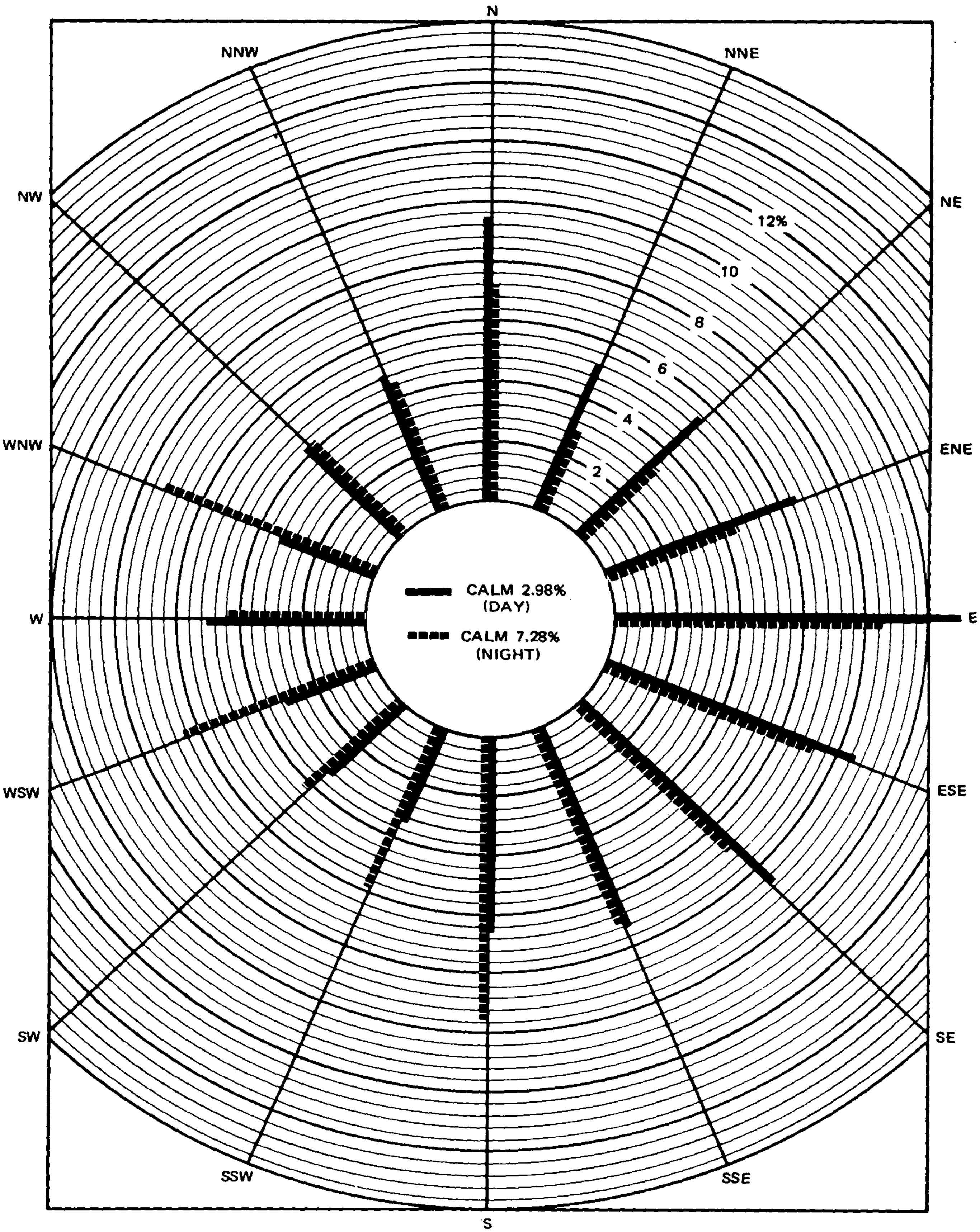


Figure 3-4. Wind Directions - Day and Night 8-Year Distributions: Cape Canaveral - Merritt Island Land Mass

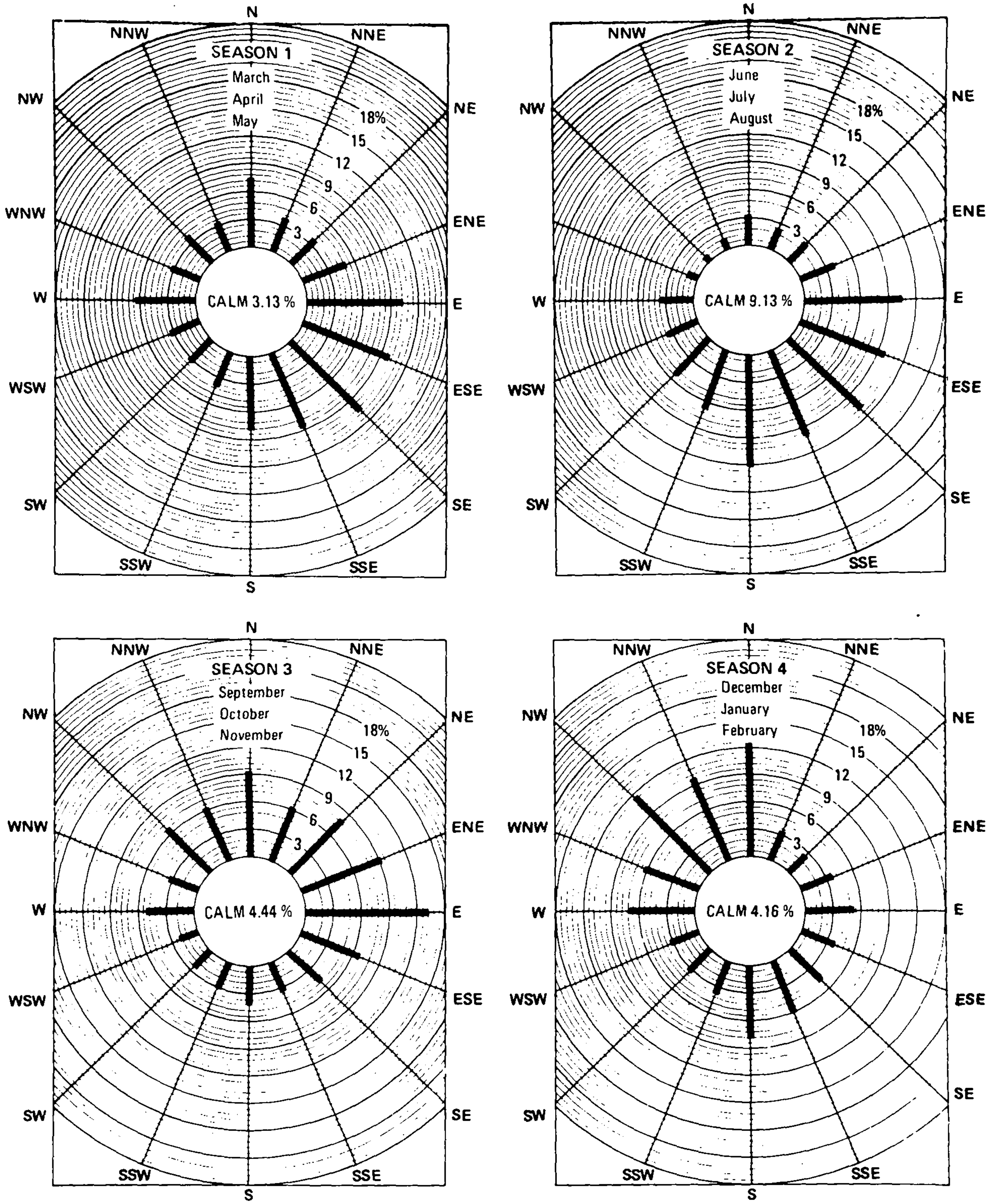


Figure 3-5. Seasonal Wind Directions - Lower Atmospheric Conditions: Cape Canaveral - Merritt Island Land Mass

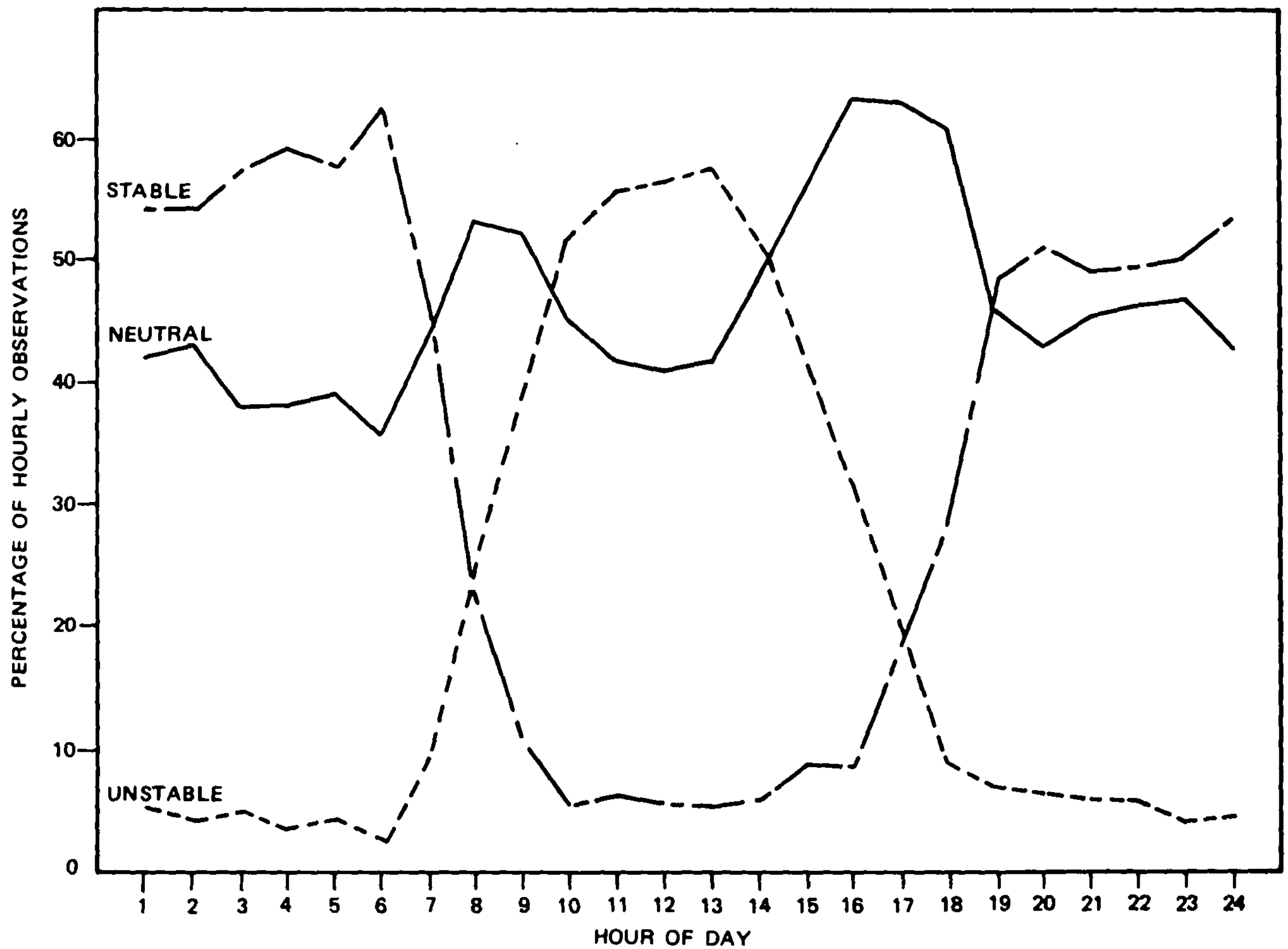


Figure 3-6. Frequency Distribution of Atmospheric Stability Classes by Hours of the Day: Cape Canaveral - Merritt Island Land Mass

b. Upper Atmosphere. The upper atmosphere extends from 1,000 meters (3,281 feet) to 5,000 meters (16,404 feet). Above 2,000 meters (6,562 feet), the wind direction is primarily from the west. Between 1,000 and 2,000 meters (3,281 and 6,562 feet), wind direction is influenced slightly by the thermal differences between the land and water. Figure 3-7 summarizes upper atmosphere wind direction distributions, and table 3-3 summarizes the dispersion characteristics for different atmospheric layers.

c. Air Pollution Potential. The KSC area can be characterized as one offering a low potential for accumulation of air pollutants. This derives from good ventilation, absence of topographic barriers, and generally favorable climate. Figure 3-8 presents a map summarizing the number of "episode" days in 5 years, expressed as isopleths across the United States. Episode days are defined as conditions of mixing heights $\leq$ 1500 meters (about 5000 feet), wind $\leq$ 4 meters per second (about 9 miles per hour), and no significant precipitation for episodes lasting at least 2 days. The season with the greatest number of episode days is indicated as winter (W), spring (SP), summer (SU), or autumn (A). These conditions of air stagnation would be conducive to accumulation of materials released to the atmosphere and the buildup of pollutants. As indicated by the dots on figure 3-8, the data for Florida were gathered at Tampa and Miami; it can thus be seen that central Florida shows one of the lowest incidences of air stagnation of any area of the contiguous 48 states.

Analyses of the foregoing climatological data indicate that prevailing winds will generally contribute to dispersion and enervation of the concentrations of atmospheric pollutants. The data also show that atmospheric inversion, a meteorological condition that could cause an effluent to retain its coherency rather than to disperse readily, occurs rarely over the KSC area, and even then, under predictable conditions. Therefore, air quality impacts are most likely to be of short duration and pollutants will be rapidly dispersed.

3.2.4 HYDROLOGY.

3.2.4.1 Surface Water. As shown in figure 3-9, the surface waters which drain Cape Canaveral and Merritt Island are the Mosquito Lagoon (also known as the Indian River Lagoon), Indian River, Banana River, Banana Creek, and numerous canals throughout the area. The Banana and Indian Rivers are lagoons which drain approximately 2,170 square kilometers (838 square miles) of land. The Banana River is directly connected to the Atlantic Ocean by an artificial inlet and locks at Port Canaveral. The Indian River is indirectly connected to the Atlantic Ocean on the north by Haulover Canal, Mosquito Lagoon, and the Ponce de Leon Inlet, and on the south by Sebastian Inlet.

The Banana River is a northeast extension of the Indian River Basin and is separated from the Indian River by Merritt Island. Banana Creek connected the Banana River to the Indian River before the Complex 39 Crawlerway was constructed. The creek still drains the area north of the Crawlerway into the Indian River. South of the Crawlerway the ground waters drain to the Banana River.

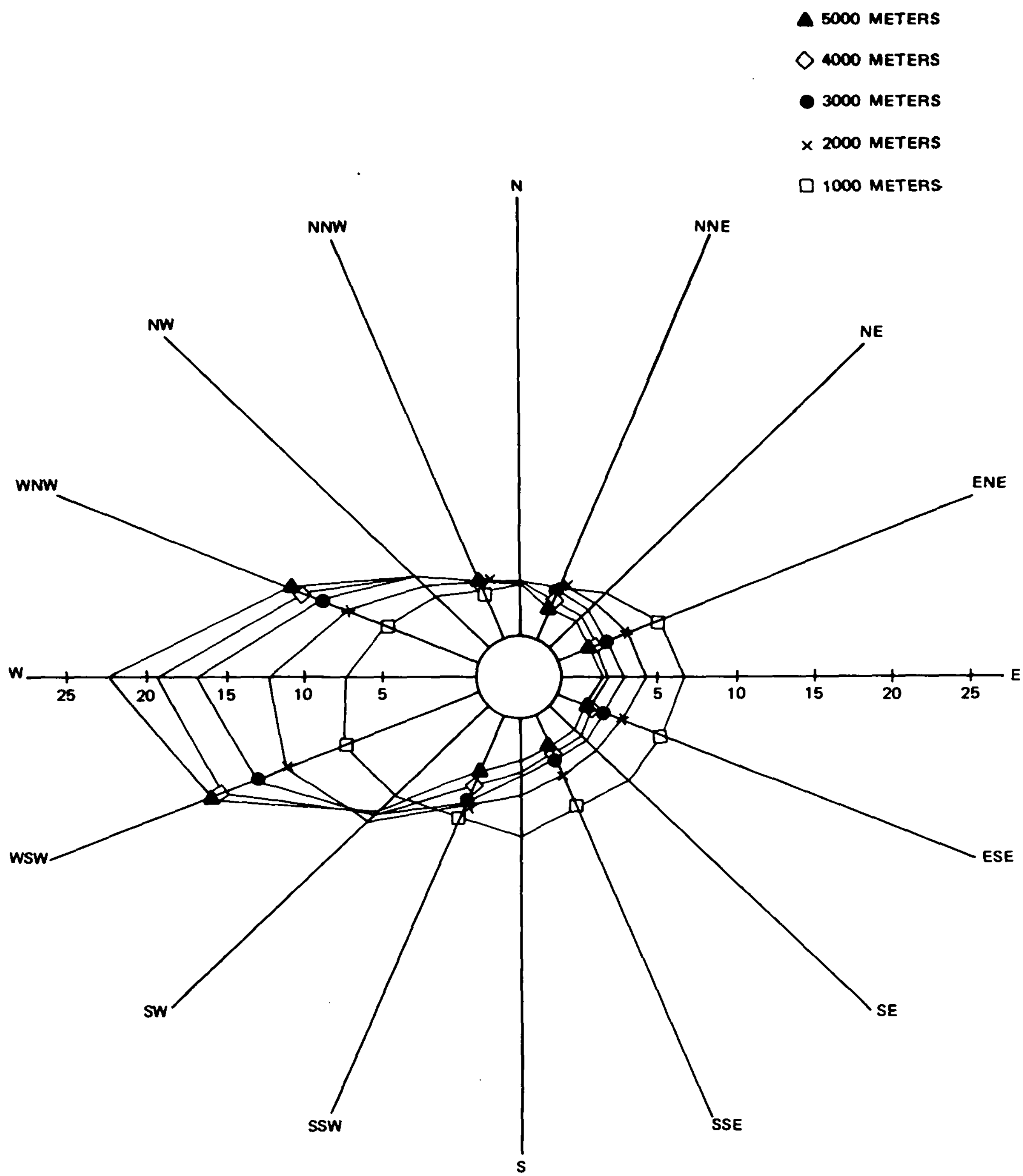


Figure 3-7. Upper Air Wind Rose at Kennedy Space Center (From 7 AM and 7 PM Rawinsonde Data, 1957-1967)

Table 3-3. Atmospheric Dispersion Characteristics: Cape Canaveral - Merritt Island Land Mass

Atmospheric Layers; Altitude Range	Temperature Structure	Wind Structure	Characteristic Mixing Rate
Below nocturnal inversion 0 to 500 m	Increase with height	Very light or calm	Very poor
Below subsidence inversion 0 to 1,500 m	Decrease with height	Variable	Generally fair to inversion base
Troposphere (above boundary layer) 0.5 to 10 km	Decrease with height	Variable; increase with height	Generally very good

SOURCE:
STERN, A. C. ED, AIR POLLUTION VOL I, PAGE 668, THIRD EDITION, ACADEMIC PRESS INC., 1976.

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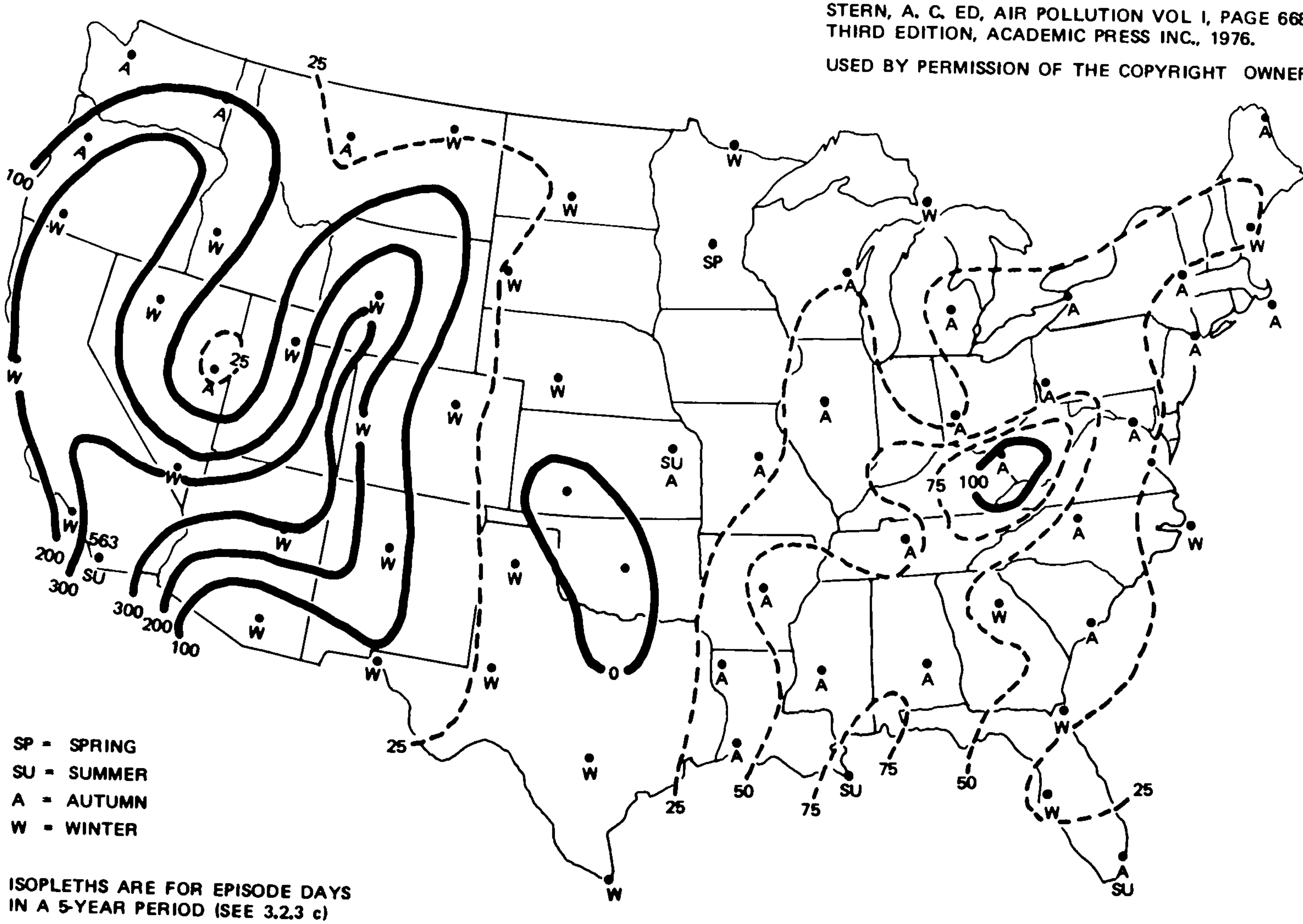

Figure 3-8. Frequency and Location of Air Stagnation: Continental U.S. Isopleths

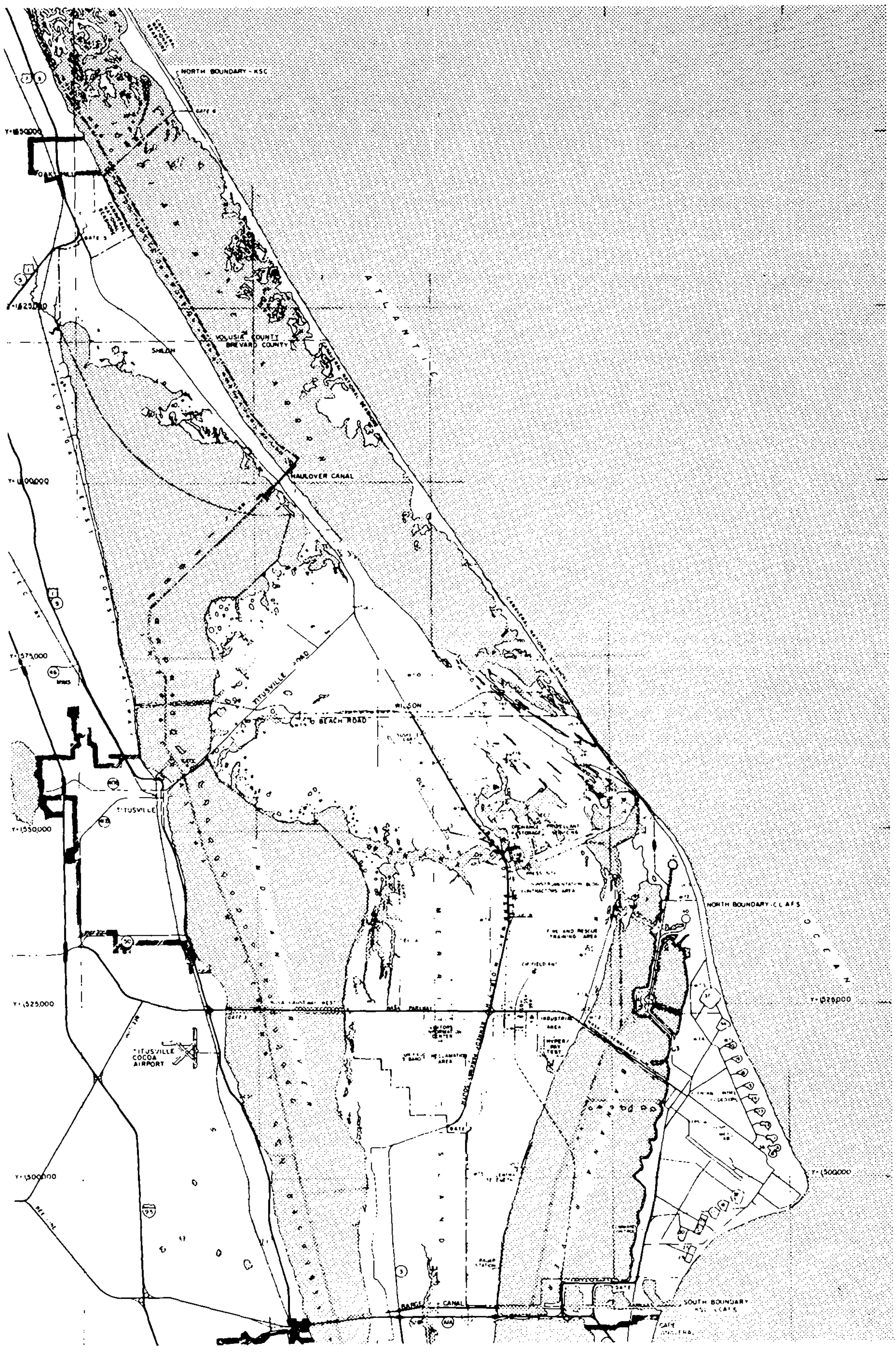

Figure 3-9. Location of Surface Waters: Cape Canaveral - Merritt Island Land Mass

Neither lagoon system is influenced by tides in the KSC area because of the distance and the effect of natural and manmade constrictions between these systems and the ocean. Winds are primarily responsible for water movement; however, fresh water surges during the wet season have a slight influence on those movements. Dike and drainage systems in the project area discharge to both the Indian and the Banana Rivers. The Indian and Banana Rivers and Mosquito Lagoon are estuaries representing nurseries which provide habitats for wading and migratory birds and for commercially important fish, shellfish, and sportfish. Several sections of the rivers are used for commercial and sport fishing, and the Intracoastal Waterway lies in the Indian River.

Mosquito control canals and impoundments are maintained throughout the Indian and Banana River basins. Mosquito control is accomplished by flooding marshlands where the mosquito breeds. The impoundments and canals have extensively altered the productivity and stability of many coastal marshes and have shifted the fauna and flora composition of the basins from the previous natural state.

Portions of Cape Canaveral and Merritt Island are characterized by high ground-water conditions. Excessive rainfall in these areas which cannot be entirely absorbed by the nonartesian aquifer remains on the surface until it flows off or evaporates. Complete saturation could occasionally occur during the wet season if a network of drainage canals did not exist. Figure 3-10 illustrates the locations of flood-prone areas in the project area. These areas now receive special evaluation as required by Presidential Executive Order 11988 and the regulations of 14CFR, paragraph 1216.204.

3.2.4.2 Ground Water. Ground water underlying the project area occurs under both confined (artesian) and unconfined (nonartesian) conditions. The nonartesian aquifer is composed of the Pleistocene and recent deposits. This aquifer is exposed to the land surface and will absorb water until it is filled by rain. After the saturation point has been reached, additional water will remain on the ground surface until it flows off or evaporates. Water percolating through the sandy soils of the project area quickly moves to the zone of saturation, the upper surface of which is the ground water table. Permeable areas above the water table hold some water due to the molecular action between the sand grains. The nonartesian aquifer is recharged by local rainfall.

The Floridan Aquifer, an artesian aquifer, underlies the project area. The Ocala Group and the Avon Park Formation comprise the Floridan Aquifer in Brevard County. Rain falling to the west of Brevard County recharges the Floridan Aquifer. Recharge also occurs in certain areas between the Silver Bluff and Pamlico Terraces. The coefficient of storage in the upper part of the Floridan Aquifer in Brevard County is 0.0008 and transmissibility is 3,725 kiloliters per day per meter (300,000 gallons per day per foot). In figure 3-11, the hydrologic conditions of Brevard County are diagrammatically illustrated.

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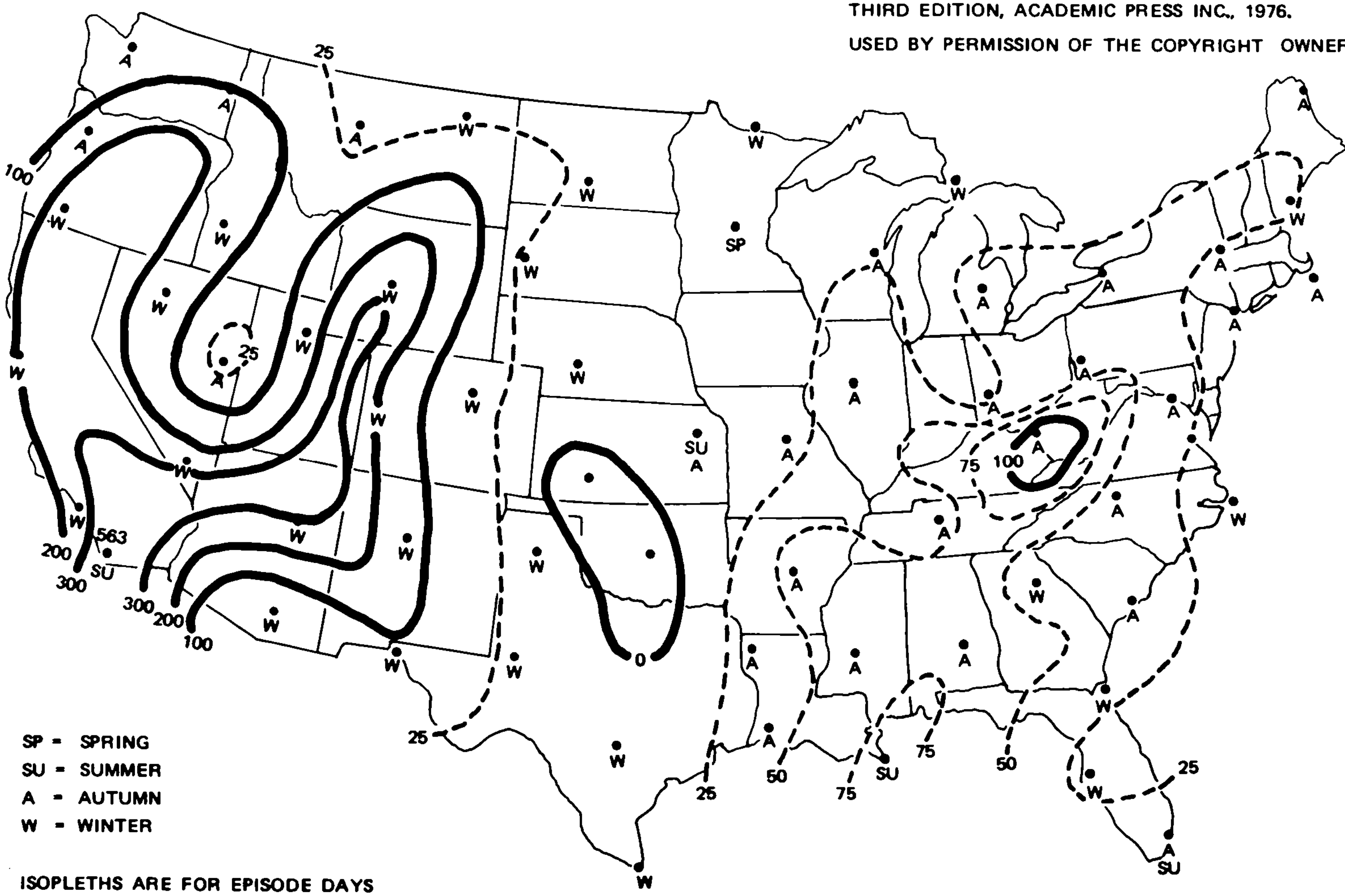
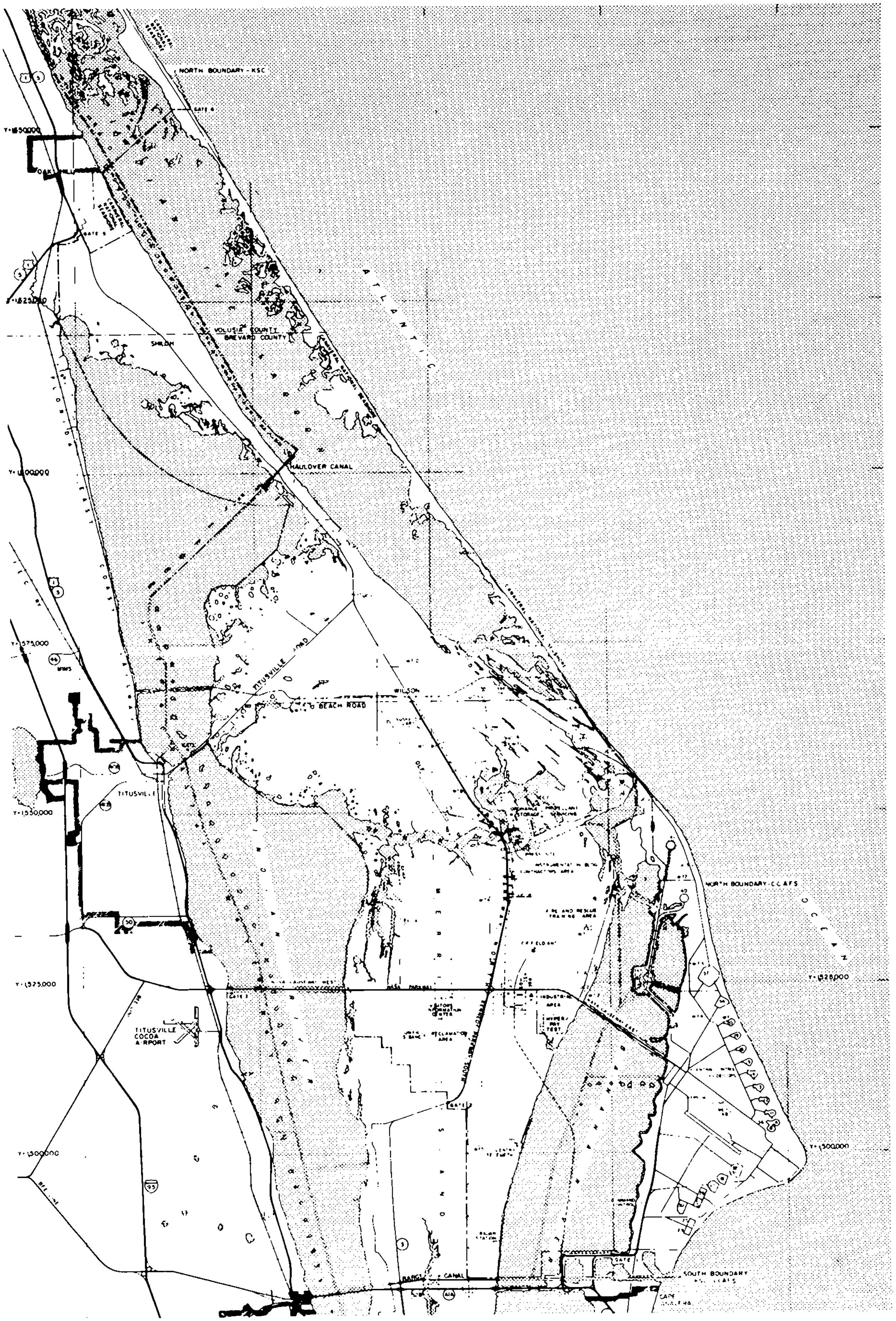


SP - SPRING
SU - SUMMER
A - AUTUMN
W - WINTER

ISOPLETHS ARE FOR EPISODE DAYS IN A 5-YEAR PERIOD (SEE 3.2.3 c)

Figure 3-8. Frequency and Location of Air Stagnation: Continental U.S. Isopleths



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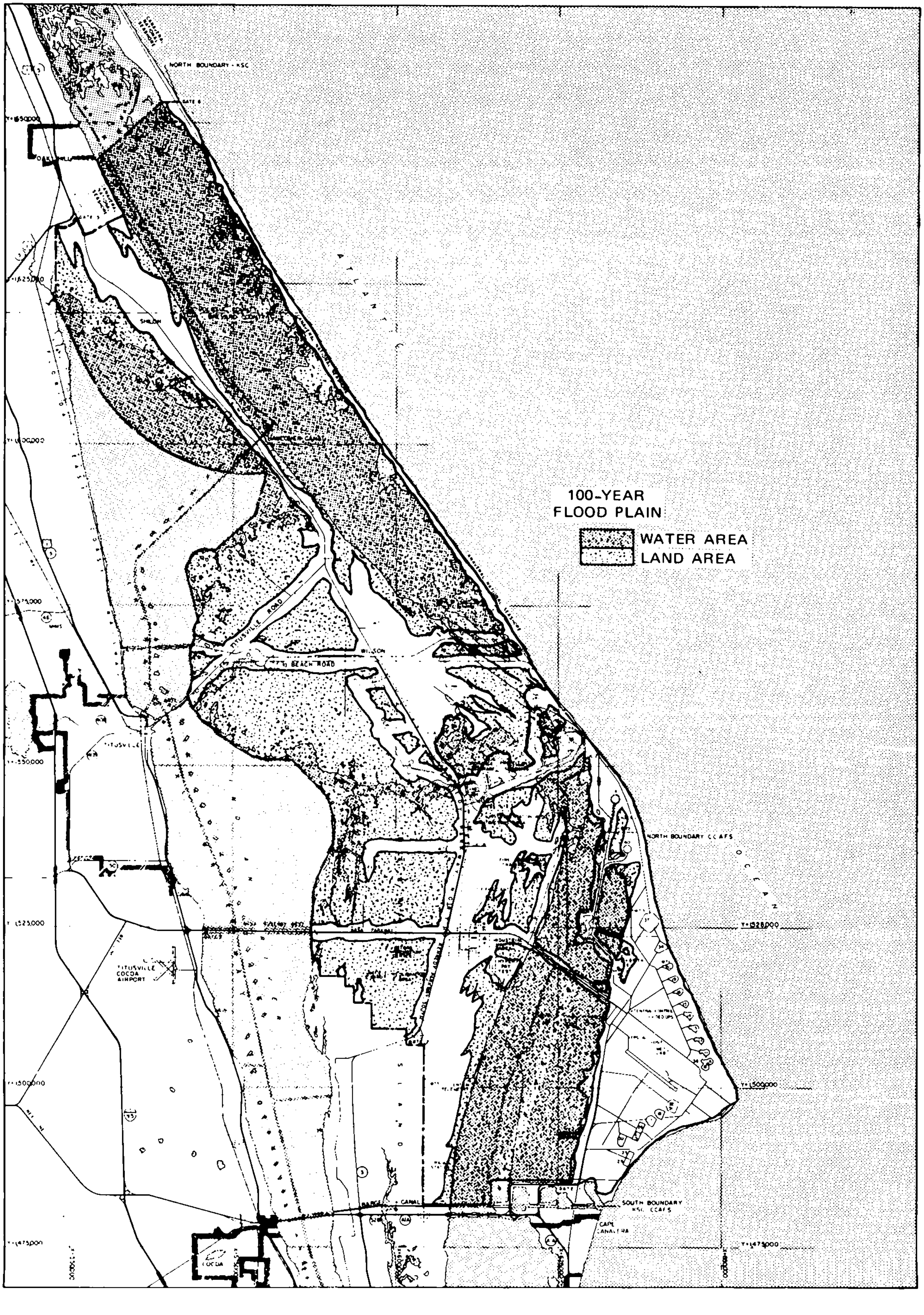
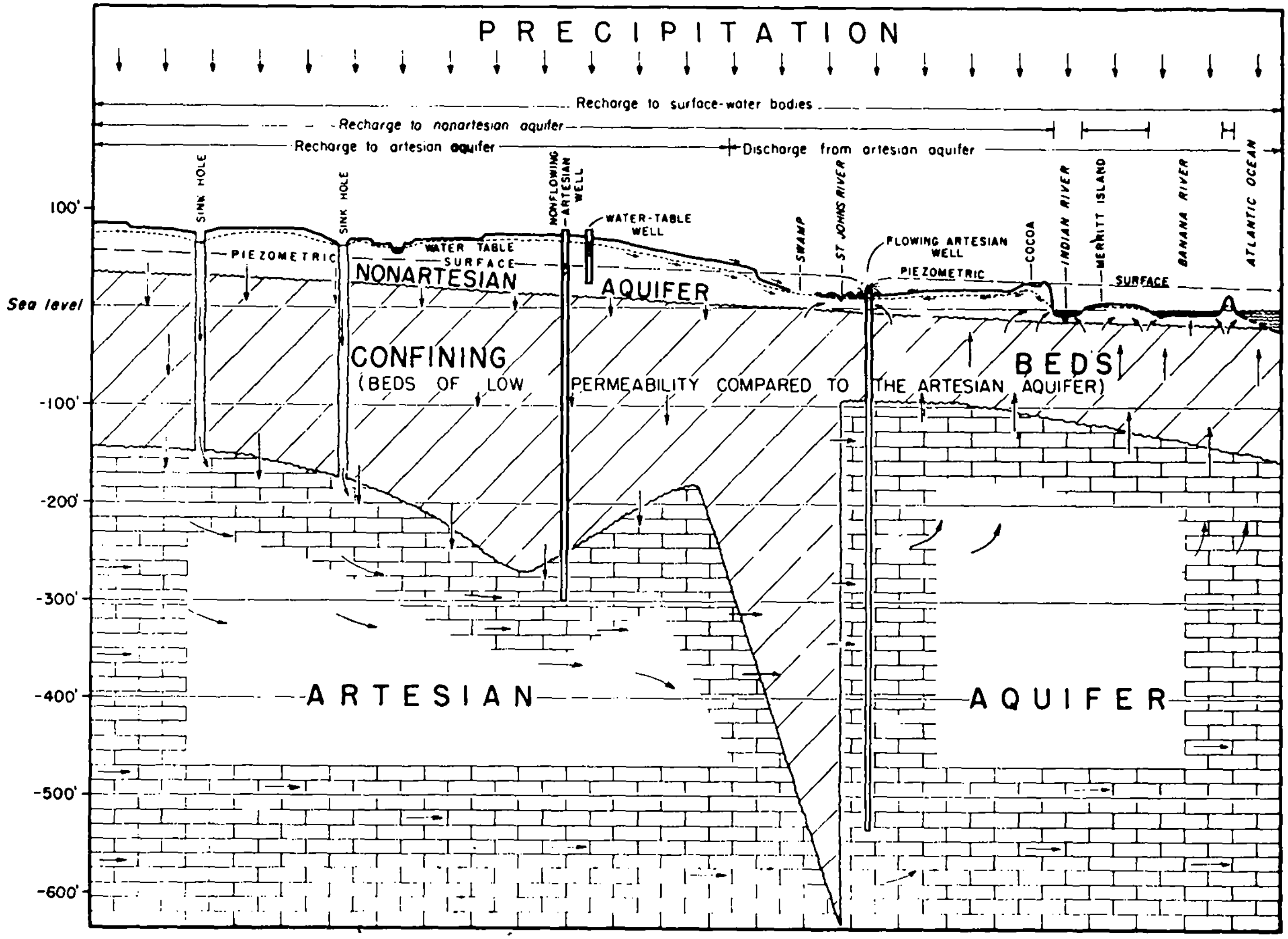


Figure 3-10. 100-Year Floodplain Within KSC Boundaries



FLORIDA GEOLOGIC SURVEY

Figure 3-11. Generalized Hydrologic Column: Brevard County

Residual salt water entered the Floridan Aquifer during the Pleistocene era. It is slowly being flushed as fresh water recharges the aquifer. Flushing has proceeded less rapidly in the western portions of Brevard County where the chloride levels are highest along a fault. The piezometric surface of the Floridan Aquifer is slightly above mean sea level in north coastal Brevard County where increased pumping has resulted in saltwater intrusion from the Atlantic Ocean and the Indian and Banana Rivers. Figure 3-12 shows the potentiometric characteristics of the ground water at KSC.

3.2.4.3 Oceanography. The Atlantic Ocean borders CCAFS on the east. Out to depths of about 18 meters (60 feet), sandy shoals dominate the underwater topography. The bottom continues seaward at about the same slope out to about 48 kilometers (30 miles) where it drops downward to the 731- to 914-meter (2,400- to 3,000-foot) depths of the Blake Plateau. The Blake Plateau extends out about 370 kilometers (200 nautical miles) to the Blake Escarpment.

Water movements in the area have been investigated by oceanographers of the Woods Hole Oceanographic Institute (WHOI) and the Chesapeake Bay Institute (CBI) of Johns Hopkins University working in support of Space Nuclear Systems Division, U.S. Atomic Energy Commission (AEC). The results of a study (reference 3-2) carried out during March and April of 1962 by WHOI indicate a shoreward direction of the current at speeds of several kilometers per day for the entire depth, surface to bottom, in the region out to depths of 18 meters (60 feet). Wind-driven currents generally determine the current flow at the surface. In the region out to the sloping bank (Blake Plateau), the flow is slightly to the north with an eastward reversal when the winds blow to the south. Water over the Blake Plateau flows to the north most of the time [the Florida Current of the Gulf Stream which begins at the Straits of Florida and runs northward to Cape Hatteras at a mean speed of about 6.4 kilometers (4 miles) per hour]. Longshore currents continually deposit sand on the beach during the summer months (April through September). During the winter months, beach sands are removed and redeposited in offshore sandbars. These currents are separate from offshore currents and are dependent on wind for direction.

3.3 ENVIRONMENTAL QUALITY

3.3.1 AIR QUALITY. The quality of the atmosphere at KSC is considered to be quite good, due primarily to its remoteness from major sources of pollution.

Regional air quality is primarily influenced by industrial and private sources rather than by sources within KSC. The major sources of air pollution in the KSC vicinity and their estimated discharge rates of pollutants are tabulated in table 3-4. During only 4 to 6 percent of the year (see figure 3-4) does the wind blowing across the utility power plants listed in table 3-4 impinge directly on KSC. The atmospheric dispersion of pollutants from the power plants, due to the 18- to 29-kilometer (11- to 18-mile) transport, is good, resulting in low ambient readings determined by KSC instrumentation.

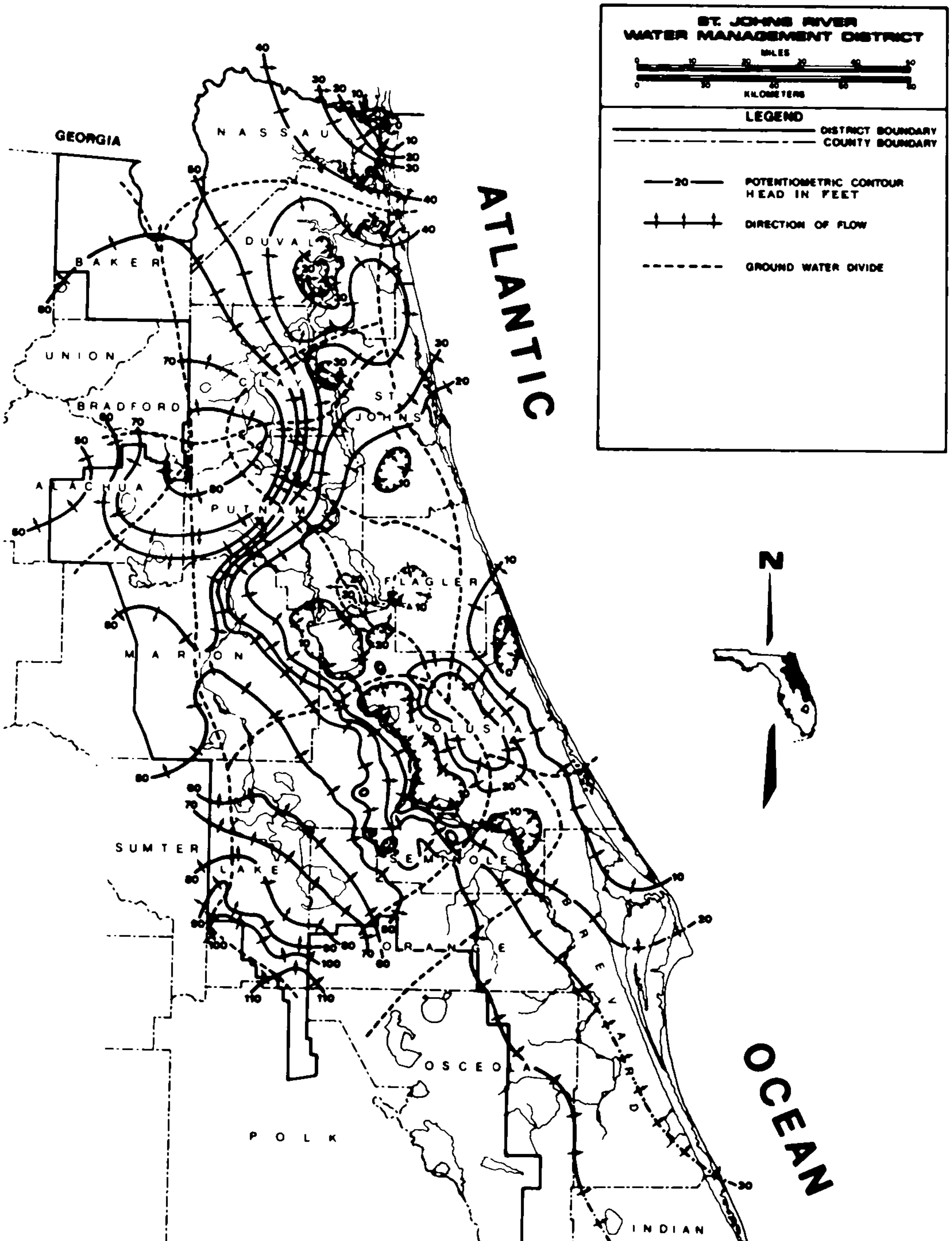


Figure 3-12. Floridan Aquifer Characteristics: Potentiometric Surface, General Ground Water Divides, and Direction of Flow

Table 3-4. 1975 Emission Estimates for Brevard County[1]
(metric tons/year)

Company	Location	Part.	SO_2	NO_2	HC	CO
Belcher Oil Co.	Port Canaveral	1.8	25.4	8.2	0	0
Melbourne Water	Melbourne	11.8	3.6	7.3	0	0
Florida P & L	Frontenac	396	9,730	10,313	512	5
General Development	---	7.3	28	15.4	0.9	1
Harris Corporation	Palm Bay	24.5	6.4	0	69.9	0
Macasphalt	Malabar	10	122	28.1	1.8	0
Orlando Utilities	Bellwood	2,152	29,023	9,730	219	305
Weekly Lumber Co.	Rockledge	21.8	6.4	0	0	0

1/ From National Emission Data System via Florida Department of Environmental Regulation, Tallahassee, Florida

The only real exception to this situation occurs during periods when an inversion overlay is in effect. Then the laminar flow characteristics of a low-velocity wind combine with the creation of a meteorological ceiling to inhibit normal diffusion and dispersion functions, resulting in a visible trail of pollutants directly from the source to the downwind section of the countryside.

Recently acquired air quality monitoring equipment at KSC (including the capability to measure toxic gases generated during launches) and State air quality measurements since 1973 have provided data confirming the absence of major pollutants in the KSC vicinity (references 3-4 and 3-5). During 1978, for example, the range of pollutant concentrations was (in micrograms per cubic meter): (1) sulfur dioxide: 0 to 176; (2) nitrogen dioxide: 0 to 100; (3) particulates: 12.76 to 94.36; and (4) ozone: 4 to 382. Data on hydrocarbons and oxides of carbon are not available at this time. Table 3-5 lists the current national ambient air quality standards.

Ozone measurements made using new EPA calibration standards (ultraviolet source) and new national ambient air quality standards (240 vs. 160 micrograms/cu. meter) currently show only isolated, seasonal (spring, fall) high levels of ozone which appear to correspond with certain weather patterns and may involve long-range transport phenomena. KSC limitations on mechanical activity and proscribed burning restrict the amount of pollutants entering the atmosphere. Thus the major sources of air pollutants generated within KSC are private motor vehicles and launches of space vehicles.

Table 3-5. Ambient Air Quality Standards

Pollutant	National		Florida
	Primary	Secondary	
Particulate matter (micrograms/cu. meter)			
Annual 2/	75	60	60
4-hour	260	150	150
Sulfur dioxide (micrograms/cu. meter)			
Annual 3/	80 (0.03) 1/		60 (0.02)
24-hour	365 (0.14)		260 (0.1)
3-hour		1300 (0.5)	300 (0.5)
Carbon monoxide (milligrams/cu. meter)			
8-hour 4/	10 (9)	10 (9)	10 (9)
3-hour	40 (35)	40 (35)	40 (35)
Photochemical oxidants (as ozone) (micrograms/cu. meter)			
1-hour	240 (0.12) 5/	240 (0.12) 5/	160 (0.08)
Nonmethane hydrocarbons (as methane) (micrograms/cu. meter)			
6-9 A.M.,	160 (0.24)	160 (0.24)	160 (0.24)
Nitrogen dioxide (micrograms/cu. meter)			
Annual 3/	100 (0.05)	100 (0.05)	100 (0.05)

1/ Concentrations in parentheses are in parts per million.
2/ Calculated as the geometric mean.
3/ Calculated as the arithmetic mean.
4/ Concentrations specified for averaging times of 24 hours or less are not to be exceeded more than once per year.
5/ Reflects current 1979 EPA standards. "Photochemical oxidants" has been changed to "ozone".

Source: Florida Sulfur - Oxides Study Inc. (reference 3-6, page 3-13)

3.3.2 WATER QUALITY. The surface waters surrounding KSC are brackish lagoons. Those waters north of KSC are class II (suitable for shellfish harvesting and the propagation of marine life). Waters to the south, west, and within KSC are considered class III (suitable for fish and shellfish propagation and water contact sports) pursuant to Chapter 17.3 of the Florida Administrative Code. Mosquito Lagoon and the portion of the Banana River that is adjacent to KSC and CCAFS are classified as aquatic preserves pursuant to the Florida statutes. KSC is part of the St. Johns River Water Management District.

As required by section 106 of the Federal Water Pollution Control Act (FWPCA) as amended, Public Law 92-500 (33 U.S.C., paragraph 1256), the Florida Department of Environmental Regulation (DER) completed a statewide revision of stream segment delineation, classification, and ranking which now provides the basis of priority for all DER water program activities. In this endeavor, the 13 major river basins in the state were divided into 115 segments. The segment delineations generally include those surface waters which have common hydrological characteristics, common natural, physical, chemical, and biological processes, and common reactions to external stresses.

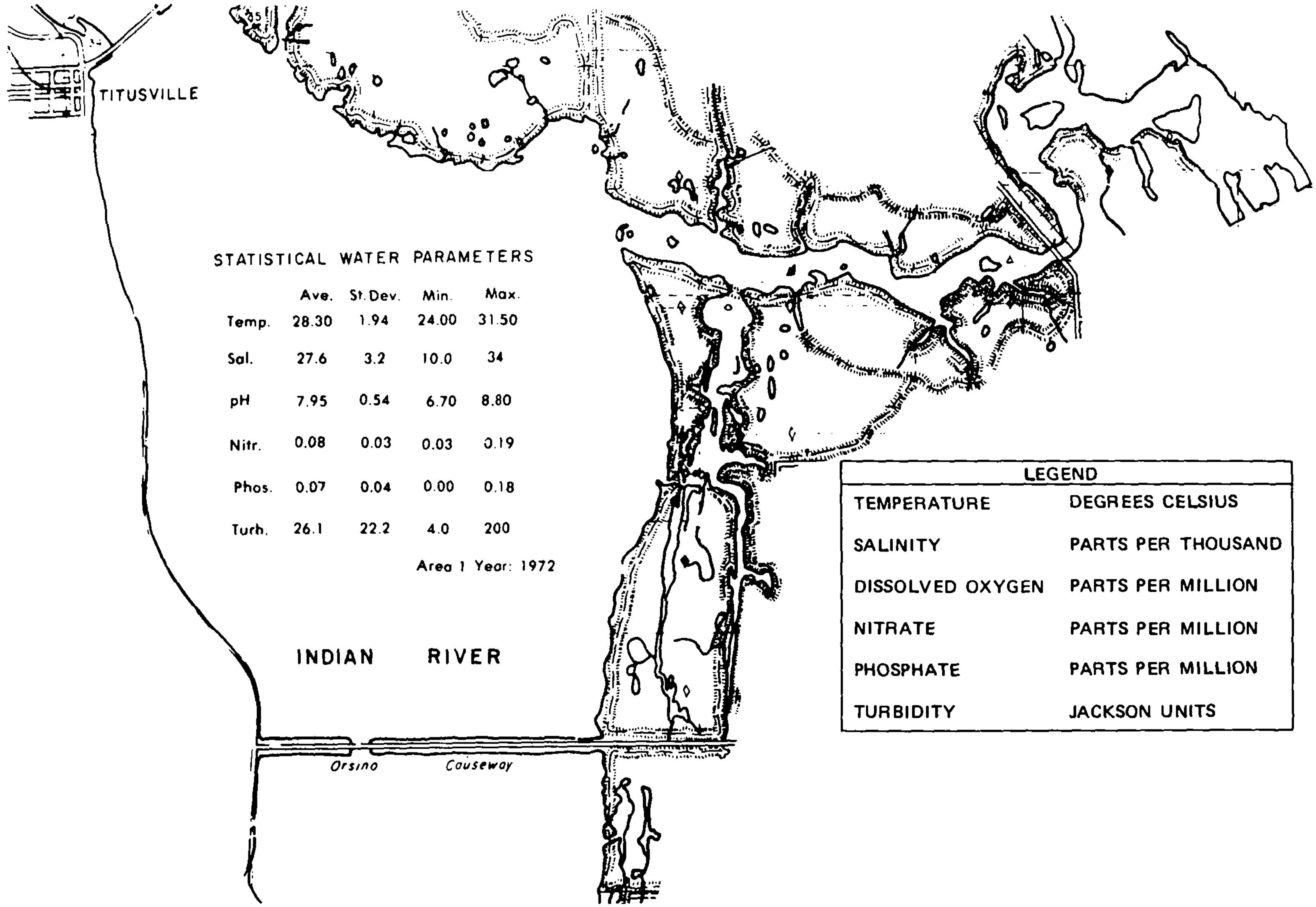
KSC and CCAFS lie, for the most part, in stream delineation segments 27.1GA and 27.1EA. Of the 115 stream segments in the State, segments, 27.1GA and 27.1EA rank 83rd and 72nd, respectively. Relative to those nine stream segments that are contained in the Florida East Coast Basin, segments 27.1GA and 27.1EA rank 5th and 3rd, respectively.

In general, lagoonal water quality is considered good, but variable with regard to turbidity. Winds affect the lagoonal systems significantly. Figure 3-13 depicts lagoonal water quality at four general locations around KSC (reference 3-7). Ground water quality at KSC is poor, as shown in figure 3-14 (reference 3-8). An ongoing water quality program at KSC monitors outfalls; table 3-6 and figure 3-15 provide the most recent information.

3.3.3 LAND QUALITY. Figure 3-16 shows the general land use at KSC. Table 3-7 shows the total land area at KSC categorized by basic land quality types. See 3.2.1 and 3.2.2 for details of topography and soil types.

It can be fairly stated that the quality of land within the boundaries of KSC has been protected during the planning, construction, and operation of facilities directly involved in launch operations and facilities used for support functions. The presence of KSC has isolated this large and environmentally important segment of the Florida East Coast from the type of extensive commercial development that has occurred to the north and south of its boundaries. This protective philosophy will be continued.

Approximately 80 percent of the undeveloped land within the KSC boundaries falls within the definition of floodplains and wetlands; controls have been established in consonance with Presidential Executive Orders 11988 and 11990.



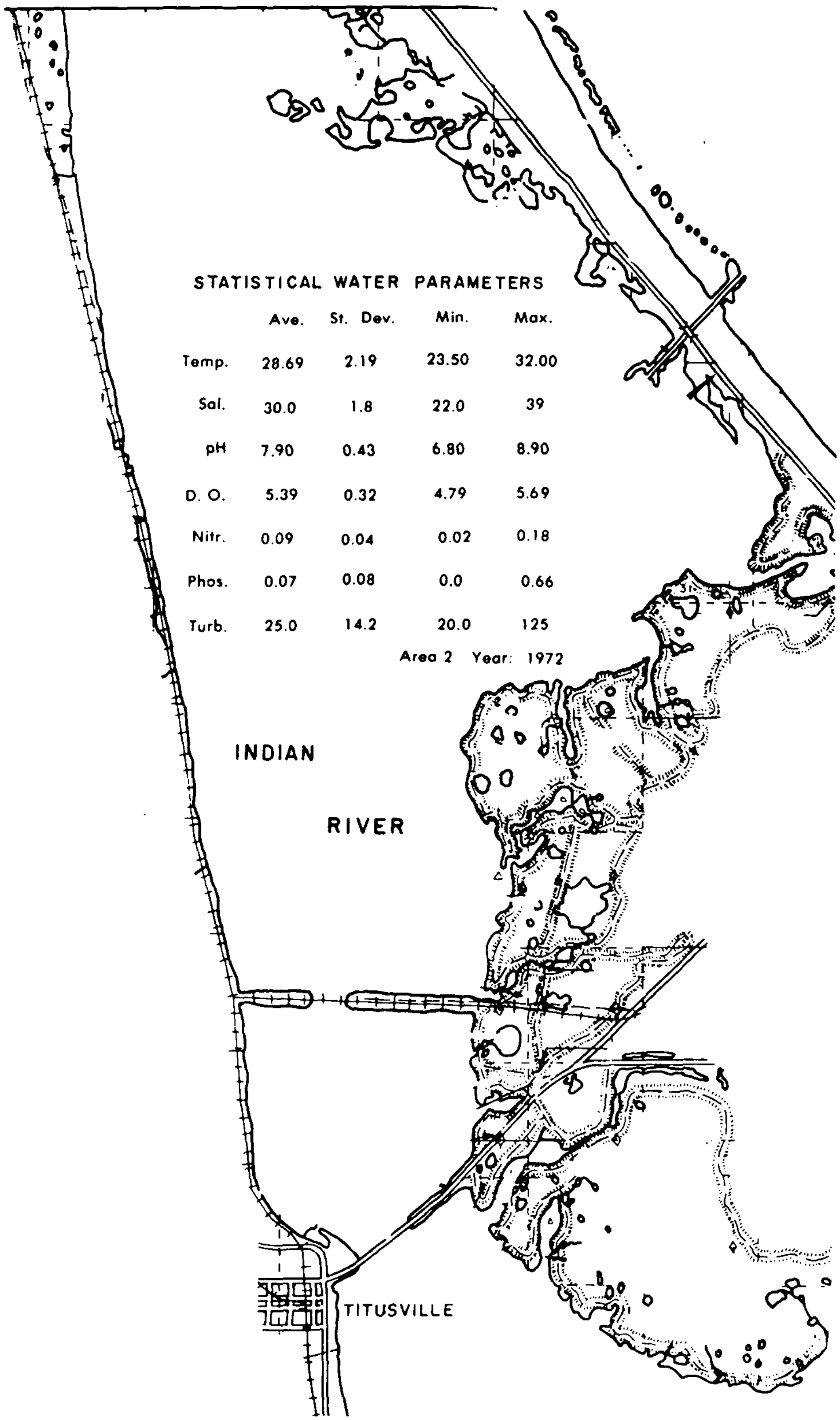
STATISTICAL WATER PARAMETERS

	Ave.	St.Dev.	Min.	Max.
Temp.	28.30	1.94	24.00	31.50
Sal.	27.6	3.2	10.0	34
pH	7.95	0.54	6.70	8.80
Nitr.	0.08	0.03	0.03	0.19
Phos.	0.07	0.04	0.00	0.18
Turb.	26.1	22.2	4.0	200

Area 1 Year: 1972

LEGEND	
TEMPERATURE	DEGREES CELSIUS
SALINITY	PARTS PER THOUSAND
DISSOLVED OXYGEN	PARTS PER MILLION
NITRATE	PARTS PER MILLION
PHOSPHATE	PARTS PER MILLION
TURBIDITY	JACKSON UNITS

Figure 3-13. Lagoonal Water Quality at Kennedy Space Center (Sheet 1 of 4)

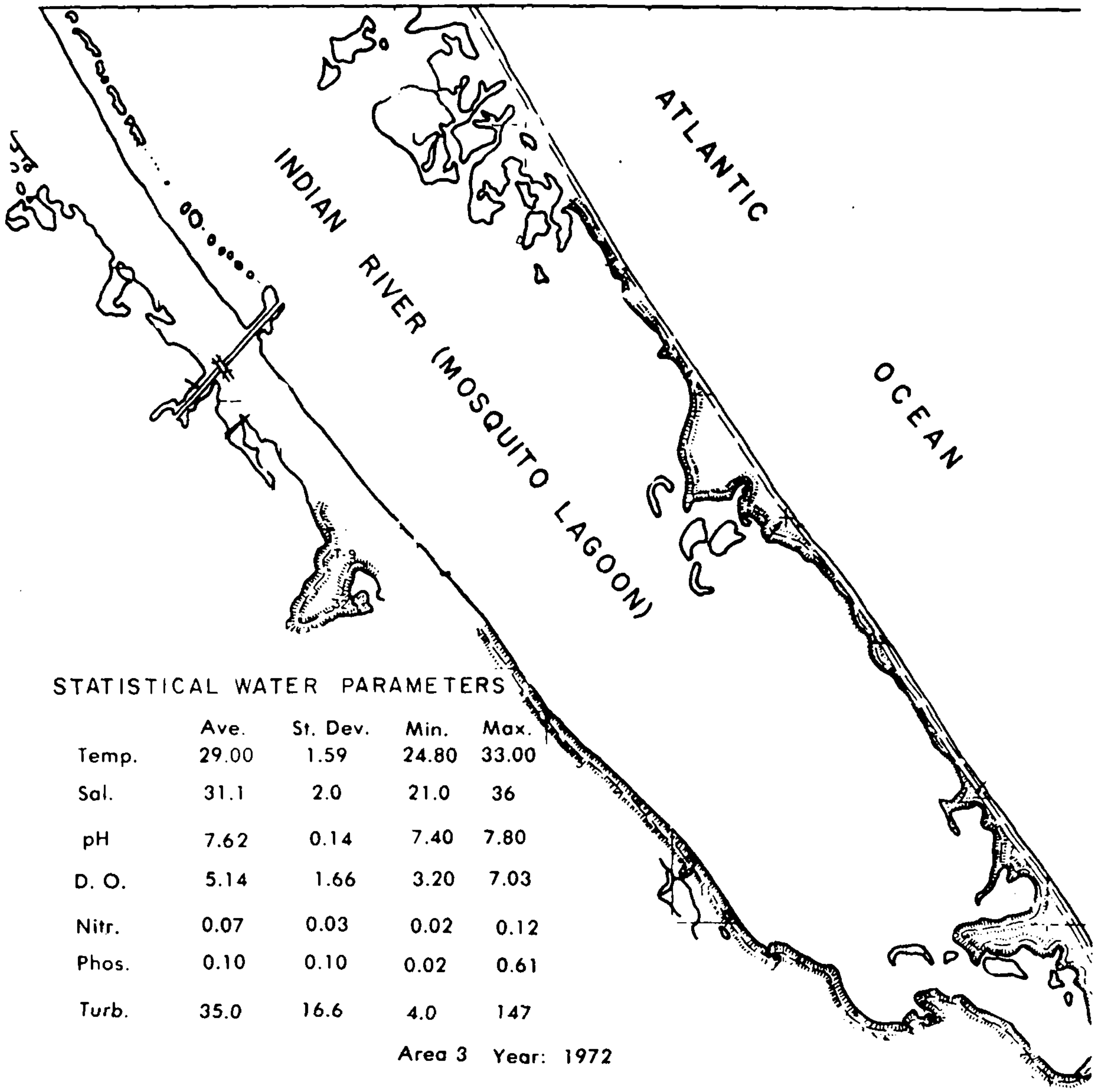


STATISTICAL WATER PARAMETERS

	Ave.	St. Dev.	Min.	Max.
Temp.	28.69	2.19	23.50	32.00
Sal.	30.0	1.8	22.0	39
pH	7.90	0.43	6.80	8.90
D. O.	5.39	0.32	4.79	5.69
Nitr.	0.09	0.04	0.02	0.18
Phos.	0.07	0.08	0.0	0.66
Turb.	25.0	14.2	20.0	125

Area 2 Year: 1972

Figure 3-13. Lagoonal Water Quality at Kennedy Space Center (Sheet 2 of 4)



STATISTICAL WATER PARAMETERS

	Ave.	St. Dev.	Min.	Max.
Temp.	29.00	1.59	24.80	33.00
Sal.	31.1	2.0	21.0	36
pH	7.62	0.14	7.40	7.80
D. O.	5.14	1.66	3.20	7.03
Nitr.	0.07	0.03	0.02	0.12
Phos.	0.10	0.10	0.02	0.61
Turb.	35.0	16.6	4.0	147

Area 3 Year: 1972

Figure 3-13. Lagoonal Water Quality at Kennedy Space Center (Sheet 3 of 4)

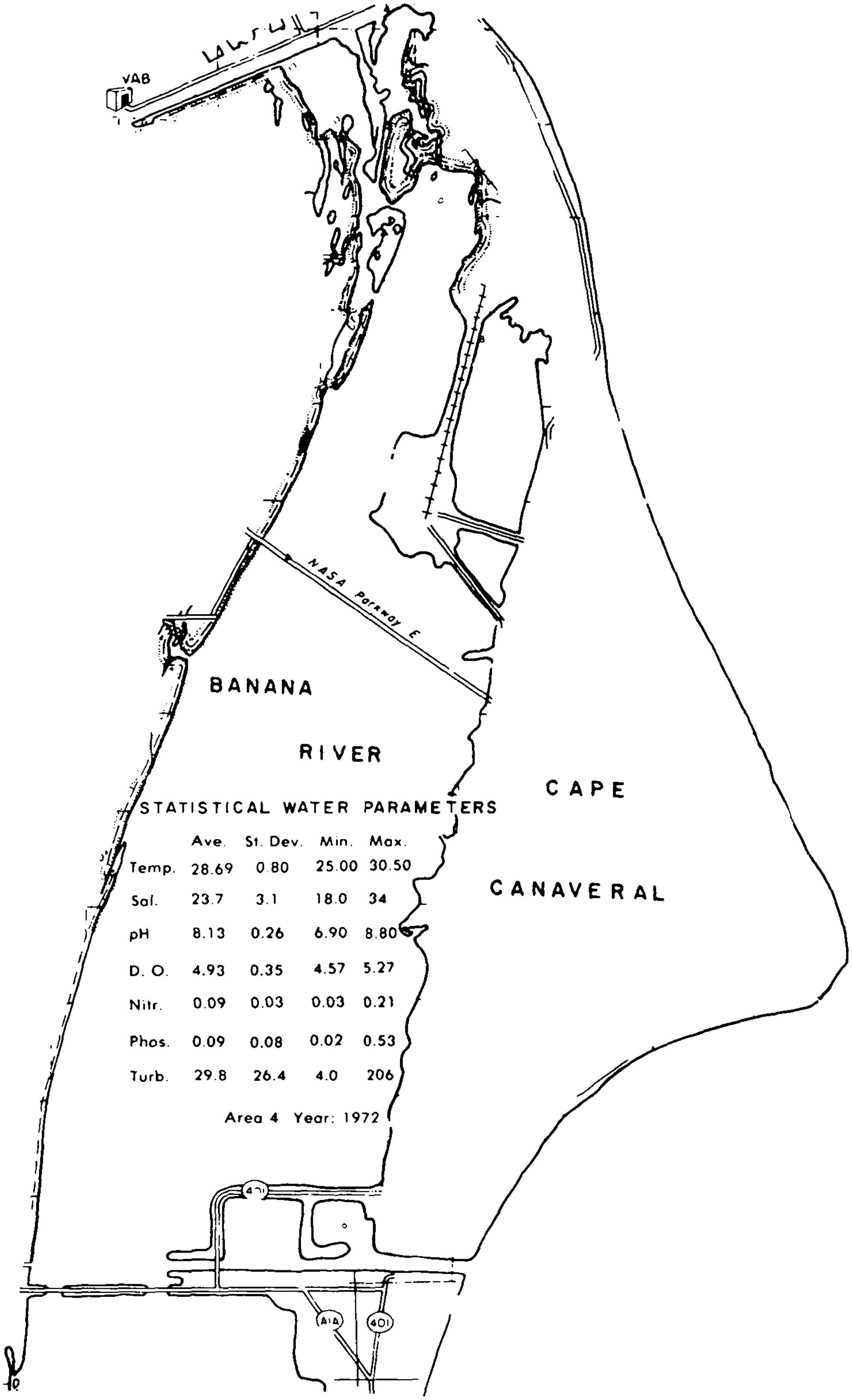


Figure 3-13. Lagoonal Water Quality at Kennedy Space Center (Sheet 4 of 4)

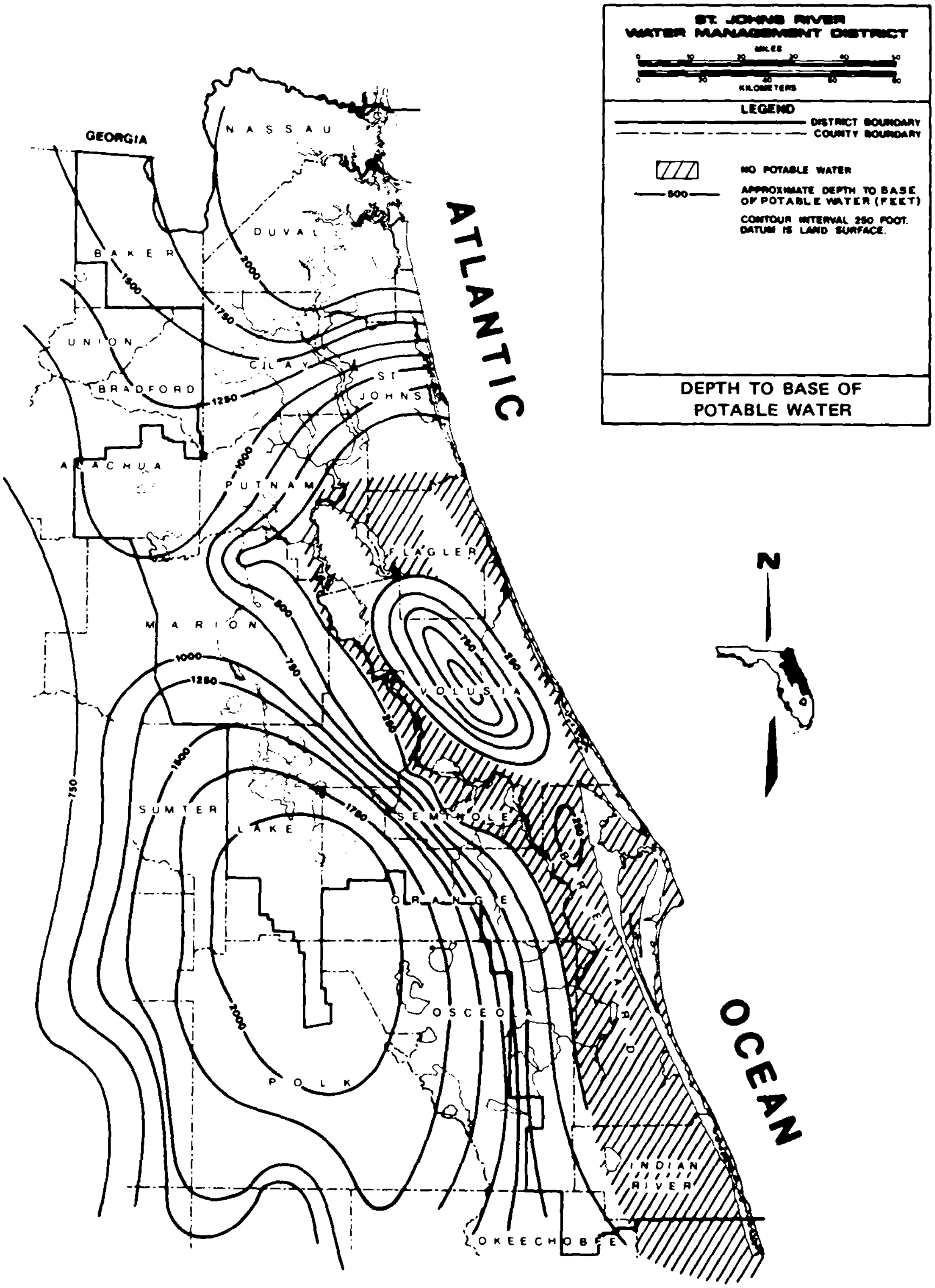


Figure 3-14. Ground Water Quality at Kennedy Space Center (Sheet 1 of 4)

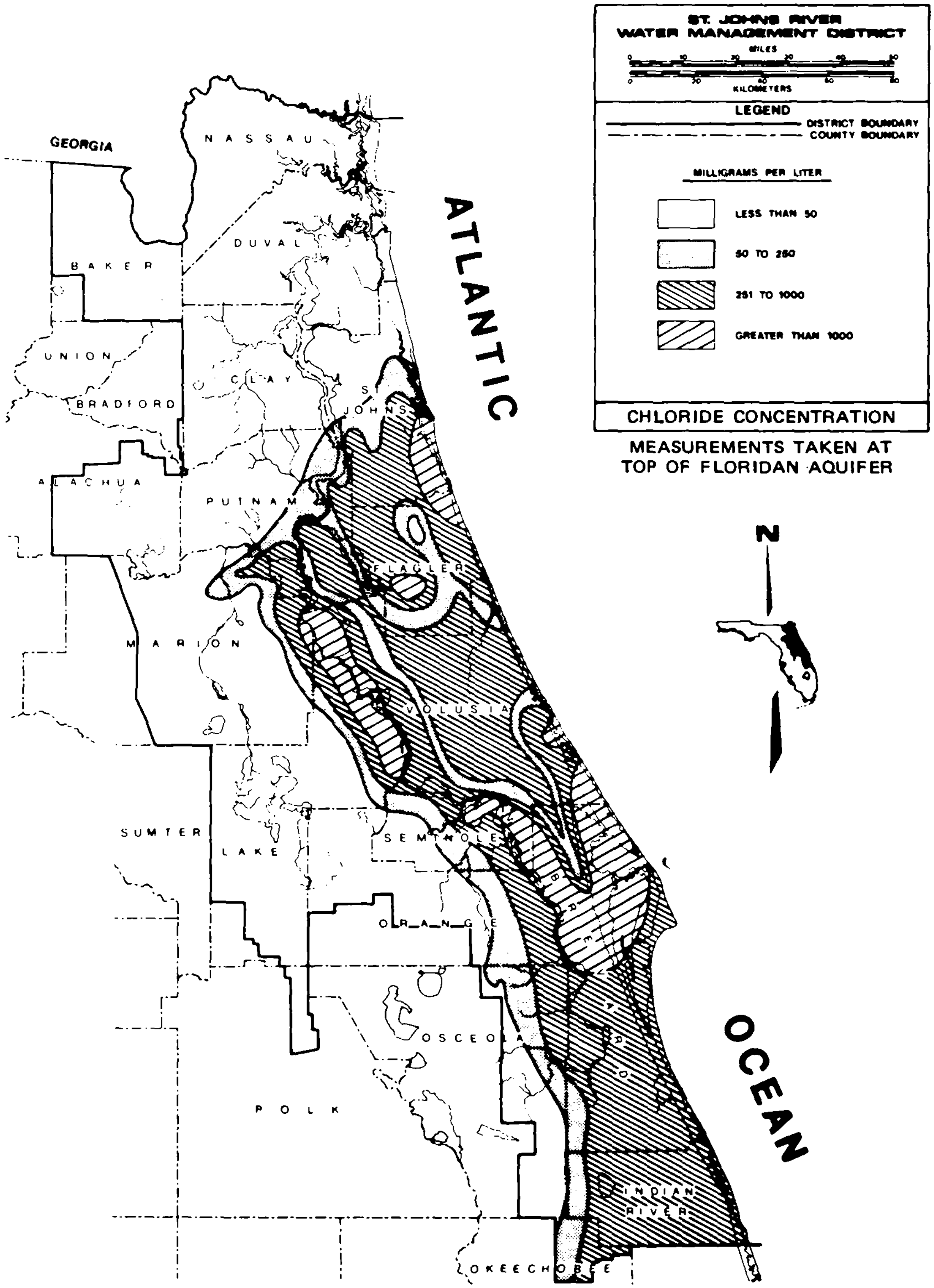


Figure 3-14. Ground Water Quality at Kennedy Space Center (Sheet 2 of 4)

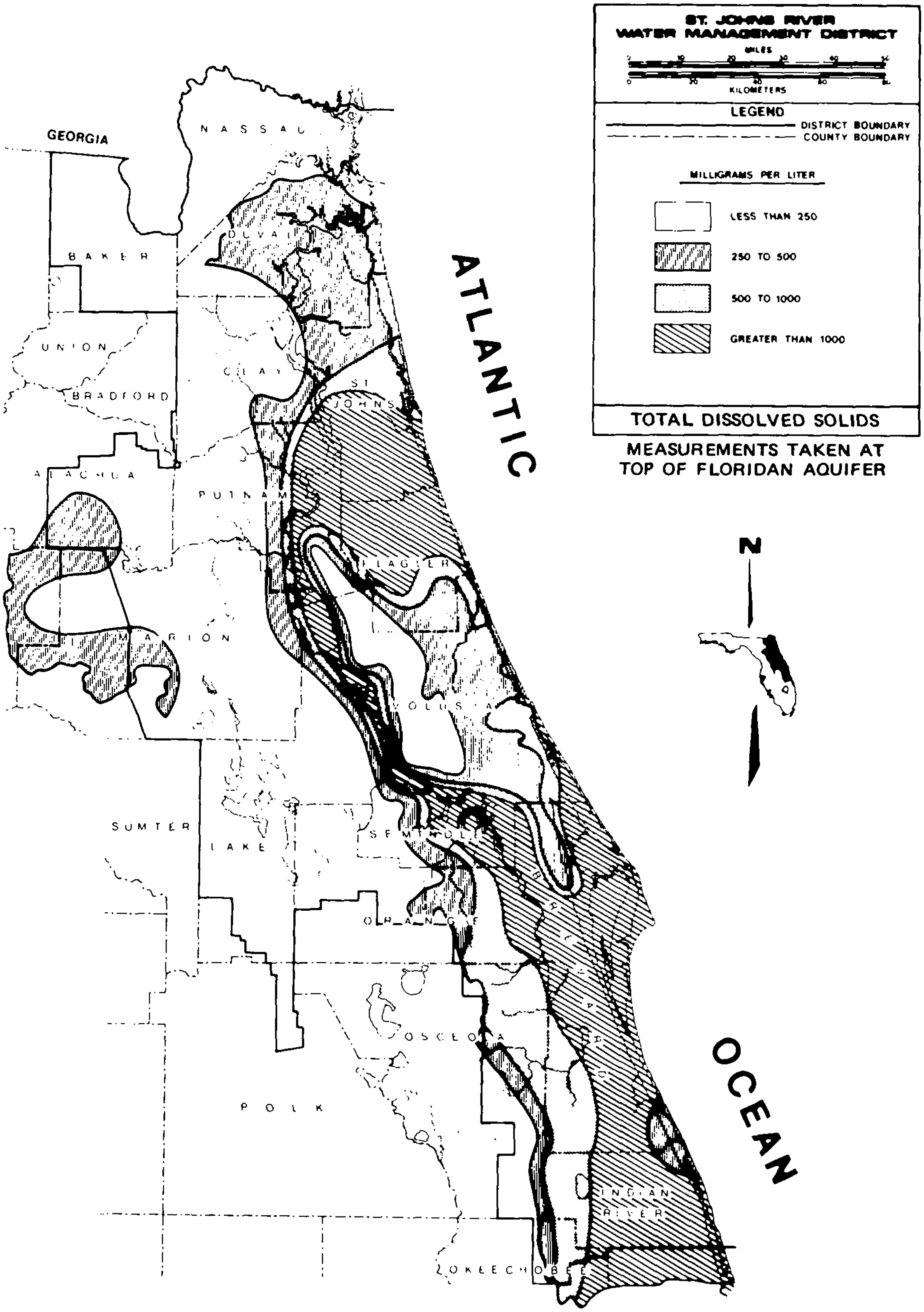


Figure 3-14. Ground Water Quality at Kennedy Space Center (Sheet 3 of 4)

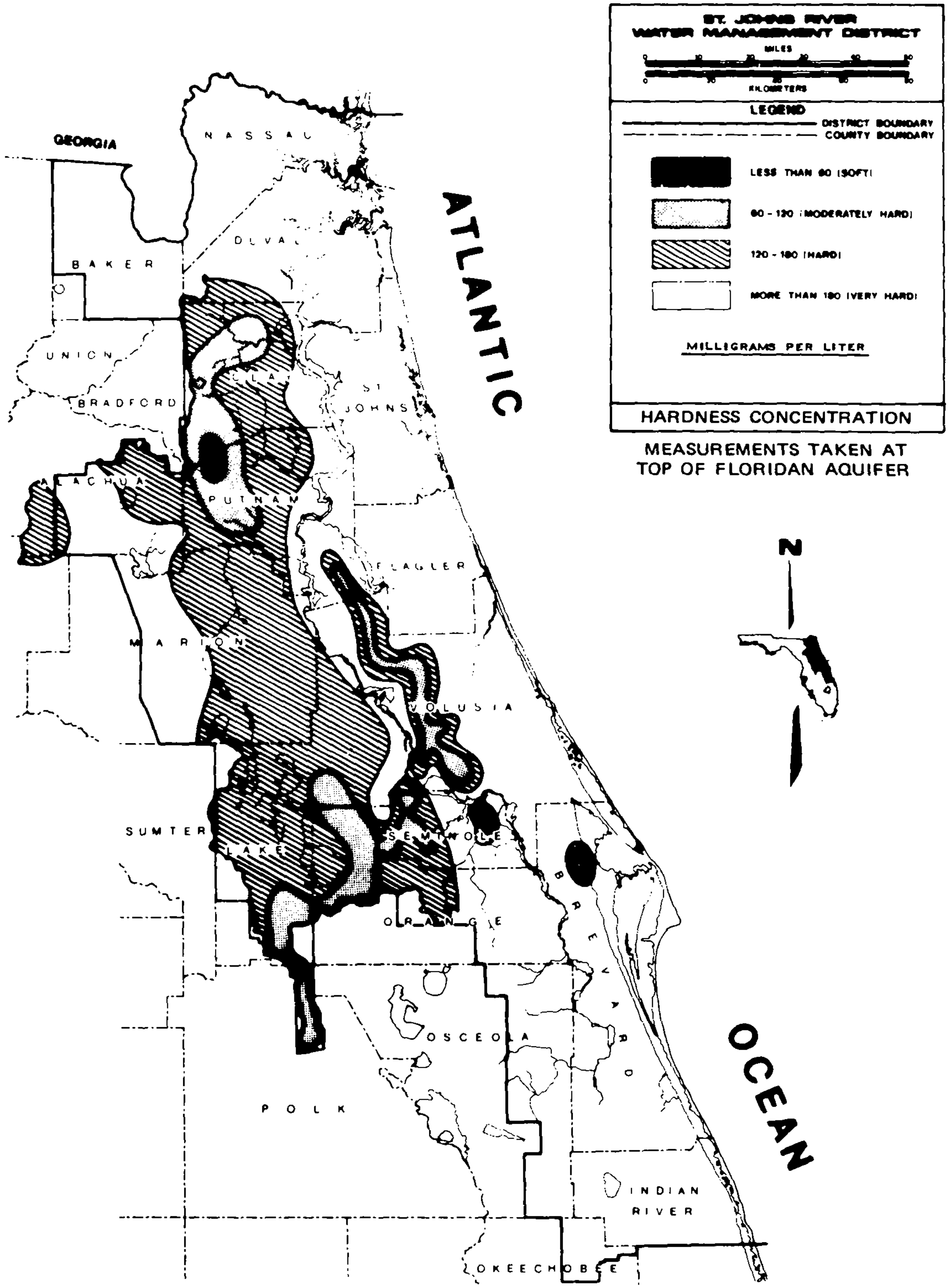


Figure 3-14. Ground Water Quality at Kennedy Space Center (Sheet 4 of 4)

Table 3-6. Typical Water Quality at 12 Selected Sites
(10 March 1978)

	Dissolved Oxygen (mg/l)	B.O.D.1/ (mg/l)	Salinity (ppt)2/	pH	Dissolved Solids (mg/l)	Fecal Coliform Bacteria (no. /100 ml)
1.3/ Banana River	9.1	1.2	30.5	7.9	33,500	0
2. Main Canal - Ind. Area	6.5	5.2	5.3	7.0	22,100	100
3. Ransom Road	4.3	5.2	2.1	7.2	2,430	900
4. Indian River	8.4	3.0	16.5	7.7	4,560	1
5. Tour Bus Maint.	1.2	5.4	2.0	7.1	8,070	25
6. VIC Polishing Pond	13.64/	10.6	1.4	8.7	6,920	42
7. Banana Creek	7.3	3.6	10.5	7.9	29,700	24
8. Barge Canal	8.5	3.2	35.0	7.6	33,533	23
9. Complex 39A Culvert	6.1	2.4	26.5	7.5	29,620	2
10. Towway S. Side	7.1	3.0	3.3	7.3	6,760	70
11. Towway N. Side	9.1	11.7	2.0	7.4	2,328	35
12. Runway S. Side	7.6	4.8	4.6	7.9	5,280	70

1/ Biochemical Oxygen Demand
2/ ppt = Parts per thousand
3/ Numbers refer to locations on map shown in figure 2-1.
4/ Abnormally high dissolved oxygen reading due to unknown interference.

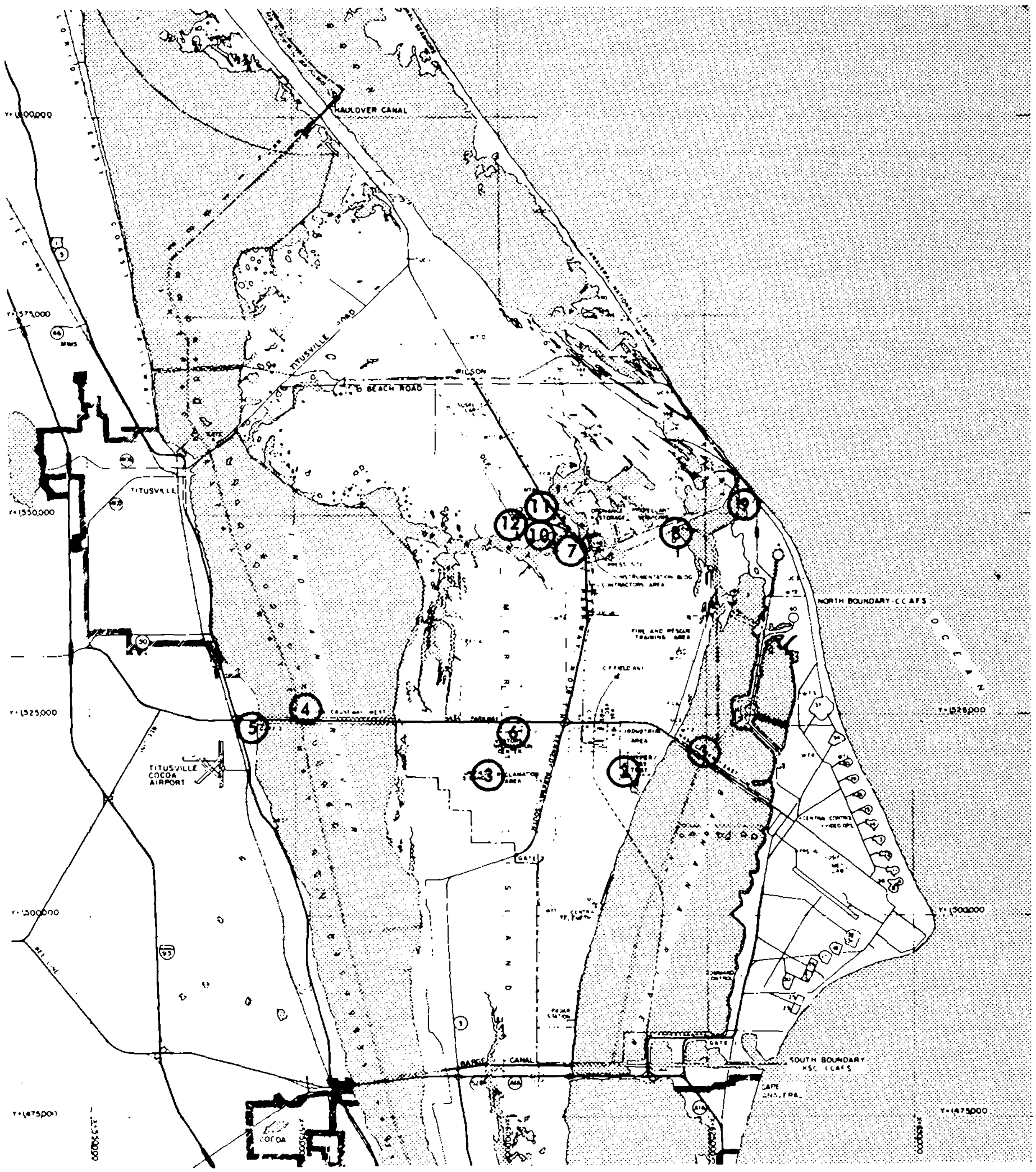


Figure 3-15. Location of Ground Water Monitoring Wells at Kennedy Space Center

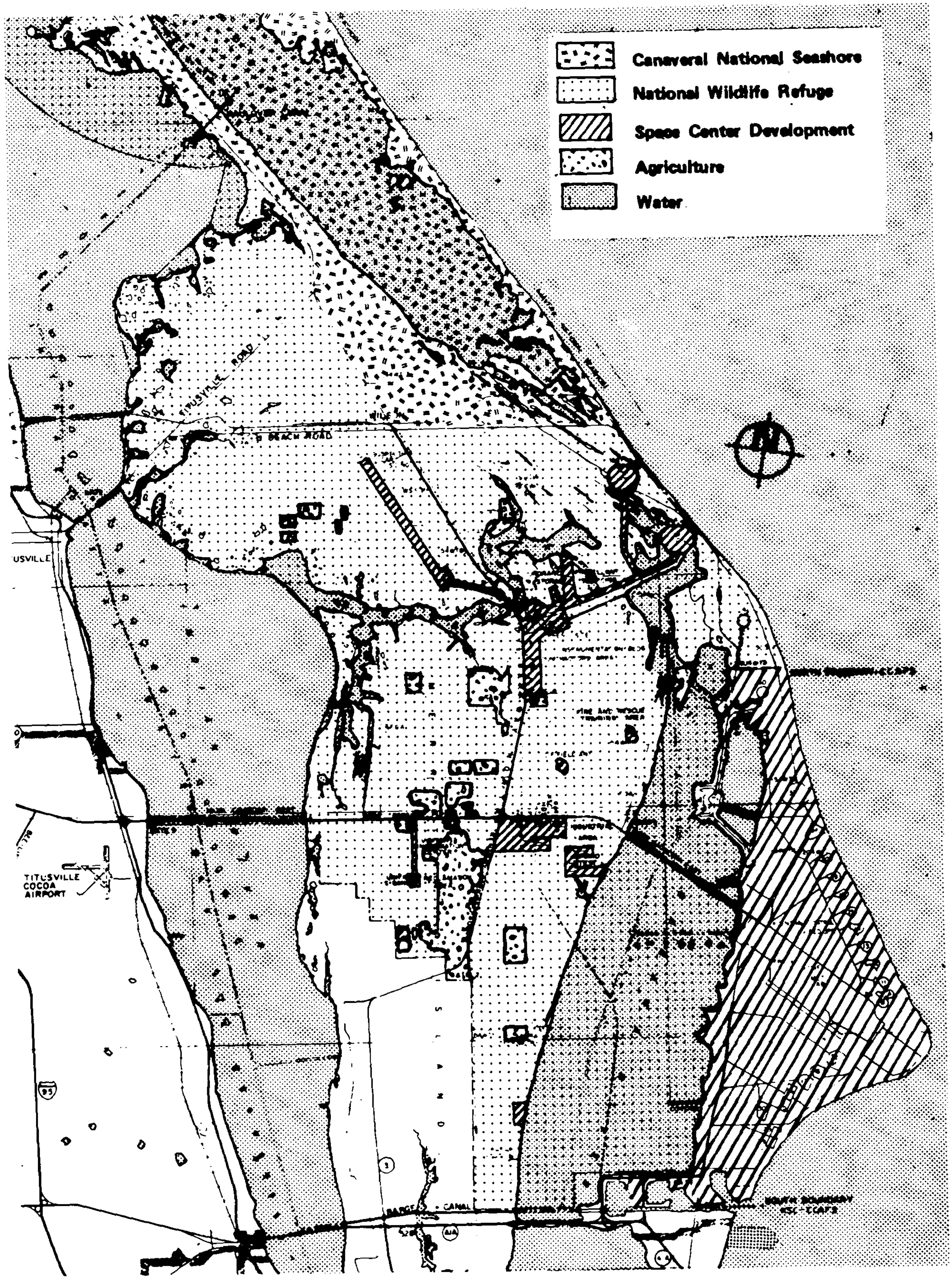


Figure 3-16. Categories of Land Use: Cape Canaveral - Merritt Island Land Mass

Table 3-7. Land Quality Inventory - KSC

Association	General Description	Approx. %/Total Area	Potential Uses	Flood Hazard (water table)	pH Tendency
Paola-Pomello-Astatula	Sandy ridges	7.5	Best for construction soil, citrus	None	Low - Acidic
Canaveral-Palm Beach-Welaka	Dunes and ridges	10	Wildlife, native plants, recreation	None	High - Basic
Myakka-Eau Gallie-Immokalee	Flat-woods	60	Citrus, pastureland, construction, upland wildlife	Infrequent	Low - Acidic
Copeland-Wabasso	Hammocks	7.5	Citrus, pastureland, construction, upland wildlife	Frequent	Neutral
Salt Water Marsh-Salt Water Swamp	Marshes & Swamps	15	Wetland, wildlife, recreation	Continuous	High - Basic

3.3.4 NOISE. The 24-hour average ambient noise level on the KSC is appreciably lower than the EPA recommended upper level of 70 dBA (reference 3-9). This is on a scale ranging from approximately 10 dBA for the rustling of grass or leaves to 115 dBA, the unprotected hearing upper limit for exposure on a missile or space launch.

The backwoods and National Wildlife Refuge areas of KSC are exposed to relatively low ambient noise levels, in the range of 35 to 40 dBA. In these sections, it is possible to identify bird calls from distances of several hundred meters. The traffic access routes during periods of heavy flow are rated at about 65 to 70 dBA, measured at 30 meters (100 feet) from the traffic artery. During past periods of construction, the use of heavy equipment such as dump trucks, bulldozers, draglines, and earthmovers produced noise levels as high as 95 to 100 dBA.

The active NASA expendable launch vehicle program using Atlas-Centaur, Delta, and Titan-Centaur vehicles has produced the highest launch pad noise levels during the past year. The Atlas-Centaur and Delta vehicles have lower launch noise levels [114 to 118 dBA at distances of 1,524 to 1,829 meters (5000 to 6000 feet) from the pad] than the previous Apollo Saturn program and the future Shuttle program. Observer areas and security zones are located on a basis of 115 dBA maximum for visitor protection.

3.3.5 SONIC BOOM. The term sonic boom actually describes the reception of bow shock waves generated by a vehicle traveling at supersonic speeds. The dynamic characteristics include the rise time, overpressure, time of duration, and impulse under a wave. All of these characteristics are a function of the size and velocity of the generating vehicle. All missiles and space vehicles that are successfully launched from the KSC and CCAFS produce a sonic boom; however, these booms are produced well out over the ocean, away from the populated coast and do not affect land masses at all. Ships and aircraft in the area likely to be affected are warned prior to each launch.

3.4 ECOLOGICAL RESOURCES - FLORA AND FAUNA

Merritt Island supports large and diverse communities of flora and fauna. Much of the island has been maintained in an undeveloped state as a result of protection within the Merritt Island National Wildlife Refuge and the Canaveral National Seashore. The area is a mosaic of natural and developed coastal communities typical of east-central Florida and includes citrus groves, shoreline and standing water vegetation in impoundments and construction ditches, vegetation in abandoned pastures and around old homesites, plantings of Australian pine, eucalyptus, and Florida holly, and cultivated vegetation (grasses and ornamentals) along roads and around KSC and CCAFS facilities. The diversity of flora and fauna in this area is made even greater by the fact that Merritt Island is the northernmost area in the United States with both tropical and subtropical species. Figure 3-17 presents a map of key environmental features in the north Merritt Island area and a map of selected vegetation types is enclosed in a pocket on the rear cover of this EIS.

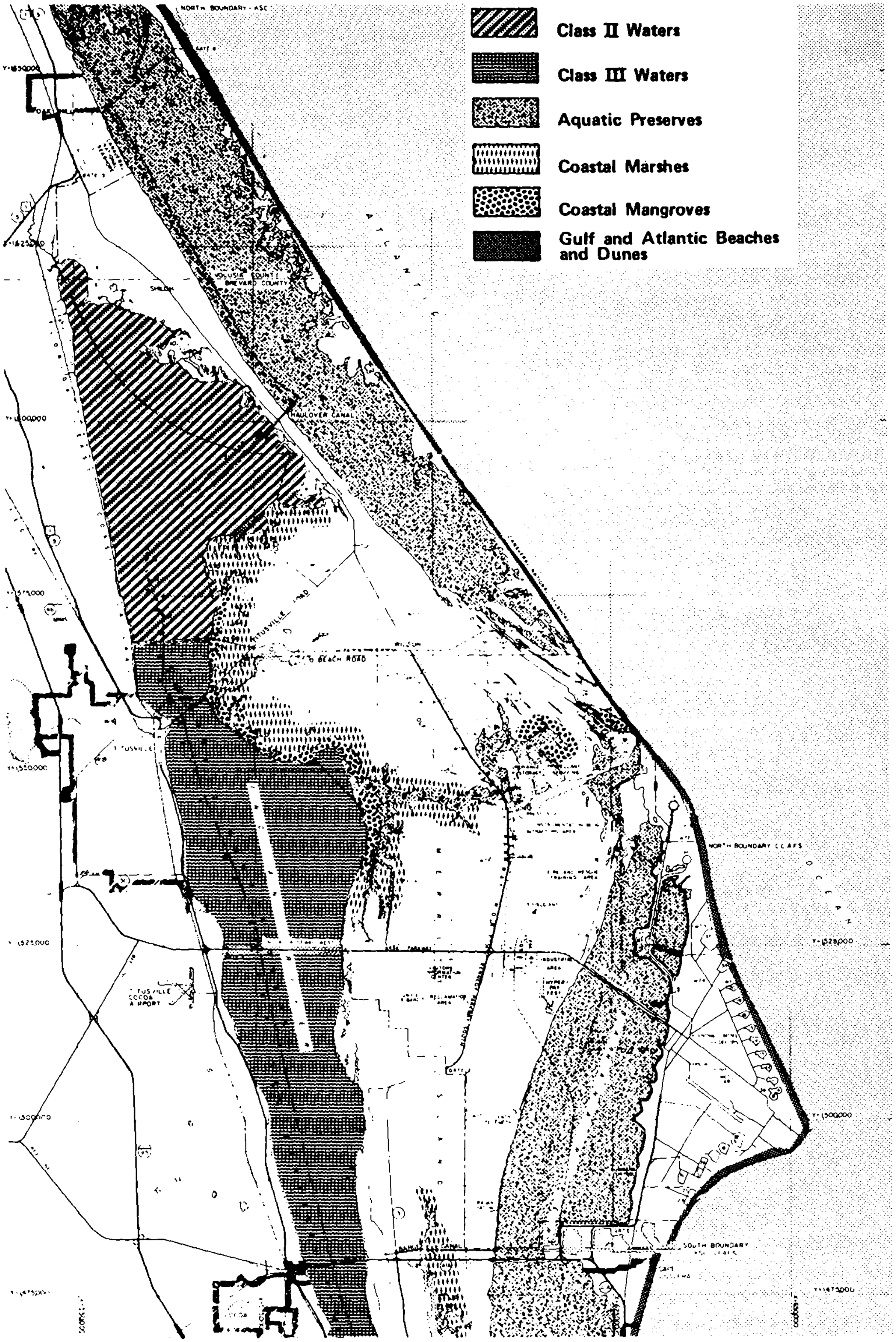


Figure 3-17. Key Environmental Features: Cape Canaveral - Merritt Island Land Mass

3.4.1 METHODS OF CLASSIFICATION. Detailed floral and faunal surveys of Merritt Island were conducted by Sweet, Ehrhart, and Stout (references 3-10 and 3-11). They identified 34 different types of communities and classified them primarily by height of vegetation (grass, low shrubs, and trees), and secondarily by substrate moisture and salinity. They grouped these communities under the following major headings: strand, dune, flatwoods, hammock, marsh, mangrove, and submerged marine. Many of the conventional community designations were not directly applicable to the vegetation of Merritt Island, so new or modified old designations were used. In addition, one must realize that variation among communities on the island is continuous; thus, all community designations and groupings are largely arbitrary, simply to facilitate description. The information and designations used in the following discussions of the flora and fauna of Merritt Island are taken from the sources referenced above.

3.4.2 COMMUNITIES.

3.4.2.1 Strand, Dune, and Scrub. Most of the eastern portion of Merritt Island is characterized by communities which are common to the sand dunes on the east coast of Central Florida.

a. Strand. The strand communities (the front of the primary dunes) are stabilized by sea oats and beach grasses along with other representative plants such as pennywort, croton, and railroad vine.

b. Dune. Behind the strand communities exist dune communities which occupy varying degrees of the crests and back sides of the primary dunes. Dune communities are characterized by saw palmetto, tough buckthorn, beach grass, and sea grape.

c. Scrub. Coastal scrub communities exist behind the primary dunes and on the alternating ridges and depressions of the multiple secondary dune system which is extensive in this area. The ridges are characterized by saw palmetto, coral bean, saltwort, prickly pear cactus, broomsedge, Spanish dagger, lantana, sand live oak, tallow-wood, wax myrtle, runner oak, and Chapman's oak. The depressions are dominated by cabbage palm, wax myrtle, southern cedar, and moonvine.

Fauna commonly found in this coastal portion of the island are beach mouse, spotted skunk, eastern kingbird, gopher tortoise, and peregrine falcon.

3.4.2.2 Flatwoods. The central part of Merritt Island is covered by flatwoods. In general, the flatwoods are dominated by saw palmetto, fetterbush, oaks, dwarf wax myrtle, huckleberry, blueberry, and wire grass. They are typically dominated by woody plants which, except for occasional trees, are 0.6 to 3 meters (2 to 10 feet) tall. When trees do occur, they are usually stands of slash pine. Scattered throughout the flatwoods are extensive areas called grassy swales. The vegetation on these small (less than an acre), circular to elongated land areas is predominately grasses and herbs, with an outer margin of either dwarf live oak or runner oak. The grasses include such species as broomsedge and wire grass.

The fauna of the flatwoods include: cotton rats, cotton mice, golden mice, rabbits, skinks, armadillos, tortoises, turtles, black racers, rattlesnakes, lizards, towhees, mockingbirds, warblers, and hawks.

3.4.2.3 Hammocks. Clumps of tall, closed forest communities (hammocks) are scattered throughout Merritt Island. The two most frequently occurring types are hardwood hammocks and palm hammocks. The hardwood hammocks include such species as live oak, palms, marlberry, lancewood, bays, red mulberry, wild coffee, and hackberry. In very wet areas (swamps) elms, red maples, sweet gums, and laurel oaks dominate. Palm hammocks are almost entirely cabbage palm with occasional ferns or grass. Light intensity is so reduced beneath the palm canopy that little else is able to grow.

The fauna of the hammocks include: treefrogs, toads, frogs, skinks, cotton mice, squirrels, armadillos, raccoons, and opossums.

3.4.2.4 Marsh. Marsh communities located on low wetlands are scattered thoughout the central regions of Merritt Island and are also found around the fringes. These marsh areas differ in the composition of their vegetations depending on the salinity of the water. Marsh areas in which the water is saline or brackish are characterized by cord grass, saw grass, salt grass, black needle rush, and sea oxeye. Extensive stands of willow are often present around these types of marshes. In the freshwater marshes are found such species as sun dews, red root, groundsel, leather fern, cattails, heartweed, hemp weed, persimmon, red maple, and willows. Standing water in these freshwater marshes is characterized by water lily, spatterdock, arrowhead, duckweed, and water ferns.

The fauna of the marsh include: cotton rat, raccoon, rails, heron, ibis, and egrets.

3.4.2.5 Mangroves. Mangrove communities are located around the fringe of the island, in some impoundments, and in a few areas near Mosquito Lagoon. The communities are composed primarily of red and black mangroves but have other species such as saltwort, leather fern, sea oxeye, white mangrove, and buttonwood.

The fauna of the mangroves include: brown pelicans, ibis, egrets, herons, and red-winged blackbirds.

3.4.2.6 Submerged Marine. Saline aquatic communities in the shallow waters of the Indian and Banana Rivers and Banana Creek are composed of submerged beds of manatee grass, shoal grass, sea grass, and turtle grass.

Fauna in these communities include: crustaceans, mollusks, manatees, and various transient fish, birds, and snakes.

See tables 3-8 and 3-9 for listings of representative floral and faunal species found on Merritt Island.

3.4.3 CRITICAL ECOLOGICAL AREAS. Certain communities on Merritt Island are considered to be more fragile or of more ecological importance than others. Pursuant to the Coastal Zone Management Act of 1972 (Public Law 92-583), the Florida Bureau of Coastal Zone Planning identified certain areas on the island as of critical importance which should be preserved or conserved. These areas include class II waters, marine grass beds, aquatic preserves, coastal mangrove communities, and dune communities.

Extreme care should be taken to protect these and other areas from undue disturbance or perturbation for several reasons. The marsh communities are important feeding areas for waterfowl and wading birds. The Spartina marsh is the only habitat of the endangered dusky seaside sparrow. Dune communities are very fragile and their destruction would eliminate a protection for inland areas from the Atlantic Ocean. The mangrove communities also are very fragile and could be easily altered by dredging, flooding, impounding, and clearing. They are important detritus sources within a complex marine food chain and are protected by Florida Statute 861.02. The marine grasses provide food and habitat for many marine animals, including the endangered Florida Manatee. Hammocks can act as fire breaks and are a refuge for wildlife during extended droughts. An opening in their canopy may ultimately destroy the hammock as will changes in the water level or drainage flow in or near them. Hammocks and flatwoods appear to recover very slowly from even slight perturbation. Palm savannas cannot be developed without extensive filling which would prohibit the reestablishment of the original community.

Merritt Island is in general a fragile ecosystem and effects of land use on the biota must be closely monitored.

3.4.4 ENDANGERED AND THREATENED SPECIES. The U.S. Department of the Interior maintains and issues the official list of endangered or threatened species of fauna and flora on a worldwide basis. The listings of flora and fauna are subject to continual revision as the status of certain species is changed and new species are proposed. As an example, the classification of the local alligator (Alligator mississippiensis) was changed from endangered to threatened in 1978. In addition, the Florida Committee on Rare and Endangered Plants and Animals has identified species as endangered, threatened, rare, or of special concern. Tables 3-10 and 3-11 identify fauna and flora, respectively, which are found in the KSC environs. Further information on fauna is contained in appendix C.

Table 3-8. Selected Plant Species Found on Merritt Island

Scientific Name	Common Name	Coastal Dune & Strand	Scrub	Flatwood	Hammock	Marsh	Mangrove	Submerged Marine
Trees and Treelike Plants								
Sabal palmetto	Cabbage palm	x			x	x		
Coccoloba uvifera	Sea grape	x	x					
Quercus chapmanii	Scrub oak		x	x				
Quercus pumila	Runner oak		x	x				
Quercus virginiana	Live oak		x	x				
Serenoa repens	Saw palmetto			x				
Juniperous silicola	Southern red cedar			x				
Pinus clausa	Sand pine			x				
Pinus elliottii	Slash pine			x				
Quercus minima	Dwarf live oak			x		x		
Diospyros virginiana	Persimmon			x	x			
Morus rubra	Red mulberry			x	x			
Magnolia virginiana	Sweet bay			x	x			
Acer rubrum	Red maple			x	x			
Liquidambar styraciflua	Sweet gum				x	x		
Ulmus americana	American elm				x	x		
Salix caroliniana	Swamp willow					x		
Shrubs and Vines								
Conocarpus erecta	Buttonwood	x					x	
Borrichia frutescens	Sea oxeye	x	x			x	x	
Asimina obovata	Gopher apple	x	x					
Opuntia species (spp.)	Prickly pear cactus	x	x	x				
Yucca spp.	Spanish bayonet	x	x	x				
Iles spp.	Holly	x	x	x	x	x		
Batis maritima	Batis		x			x		
Vitis rotundifolia	Muscadine		x		x			
Baccharis halimifolia	Groundsel		x		x	x		
Lyonia lucida	Fetterbush		x	x				
Smilax spp.	Greenbrier		x	x				
Vaccinium stanineum	Squaw huckleberry		x	x				
Myrica cerifera	Wax myrtle		x	x				
Erythrina herbacea	Coral beans		x	x	x			
Vaccinium myrsinites	Blueberry			x				
Ilex glabra	Gallberry			x				
Ximenia americana	Tallowweed			x	x			
Persea borbonia	Red bay			x	x			
Bumelia tenax	Tough buckthorn			x	x	x	x	
Nectrandra coriacea	Lancewood				x			
Persea palustris	Swamp bay				x			
Avicennia germinans	Black mangrove						x	
Laguncularia racemosa	White mangrove						x	
Forbs								
Puspalum spp.	Puspalum	x						
Salsola kali	Saltwort	x						
Croton spp.	Croton	x	x					
Iva spp.	Marsh elder	x	x					
Ipomoea pes-caprae	Railroad vine	x	x					
Heterotheca subaxillaris	Camphorweed	x	x	x				
Hydrocotyle spp.	Pennywort	x	x	x				
Acrostichum spp.	Leather fern		x					
Lantana spp.	Lantana		x	x				
Befaria racemosa	Tar flower		x	x				
Droseran spp.	Sundew			x				
Nephrolepsis spp.	Boston fern			x				
Lachnanthes caroliniana	Redroot			x	x			
Aster spp.	Aster			x	x	x		
Utricularia spp.	Bladderwort				x	x		
Mikania spp.	Hempweed				x	x		
Ipomoea spp.	Morning-glory				x	x		
~~Polygonum persiearia~~	~~Heartweed~~					x		
Typha latifolia	Common cattail					x	x	
Saggitarian lancifolia	Arrowhead					x	x	
Liatris spp.	Blazing star					x	x	
Nymphaea elegans	Blue water lily					x		
Nuphar luteum	Spatterdock					x		
Salvinia rotundifolia	Water fern					x		
Lemna minor	Duckweed					x		
Grasses and Grasslike Plants								
Uniola paniculata	Sea oats	x						
Panicum amarum	Beach grass	x	x			x		
Aristida spp.	Wire grass		x	x		x		
Andropogon spp.	Beard grass			x		x		
Andropogon virginicus	Broomsedge			x		x		
Spartina bakeri	Bunch grass			x		x	x	
Distichlis spicata	Salt grass					x	x	
Cladium jamaicensis	Saw grass					x	x	
Juncus roemerianus	Black needle rush					x	x	
Syringodium filiformis	Sea grass							x
Halophilia spp.	Sea grass							x
Najas spp.	Shoal grass							x
Thalassia testudinum	Turtle grass							x

Table 3-9. Selected Animal Species Found on Merritt Island

Scientific Name	Common Name	Coastal Dune & Strand	Scrub	Flatwood	Hammock	Marsh	Mangrove
		Location					
	Crustaceans						
Ocypode albicans	Ghost crab	x					
	Ichthyofauna						
Lepisosteus platyrhincus	Gar					x	x
Fundulus spp.	Killifish					x	x
Gambusia affinis	Mosquitofish					x	x
Fundulus chrysotus	Top minnow					x	x
Poecilia latipinna	Sailfin molly						x
	Amphibians						
Dasypus novemcinctus	Armadillo	x	x	x			
Hyla cinerea	Green treefrog		x	x			
Bufo quercus	Oak toad		x	x			
Bufo terrestris	Southern toad		x	x			
Rana pipiens	Leopard frog					x	

Caretta caretta	Loggerhead turtle	x					x
Terrapene carolina	Box turtle	x	x	x		x	
Crotalus adamanteus	Eastern diamondback rattlesnake	x	x	x		x	
Elaphe obsoleta	Rat snake	x	x	x		x	
Eumeces inexpectatus	Florida skink	x	x	x			
Coluber constrictor	Black racer		x	x			
Elaphe guttata	Corn snake		x	x			
Natrix fasciata	Banded water snake					x	
Farancia abocura	Mud snake					x	
Kinosternon subrubrum	Mud turtle					x	
Alligator mississippiensis	Alligator					x	
Chelonia mydas	Green turtle						x
Agkistrodon piscivorus	Water moccasin						x
	Aves						
Laurus atricilla	Laughing gull	x					
Aphelocoma coerulescens	Scrub jay	x	x				
Mimus polyglottos	Mockingbird		x	x			
Pipilo erythrophthalmus	Rufous-sided towhee		x	x			
Buteo jamaicensis	Red-tailed hawk		x	x		x	
Haliaeetus leucocephalus	Bald eagle			x		x	
Ammospiza maritima	Dusky seaside sparrow				x	x	
Pandion haliaetus	Osprey				x	x	
Leucophoyx thula	Snowy egret				x	x	x
Ardea spp.	Heron				x	x	x
Anas fulvigula	Mottled duck				x	x	x
Eudocimus albus	White ibis				x	x	x
Gallinula chloropus	Gallinule					x	
Megaceryle alcyon	Kingfisher					x	
Mycteria americana	Wood stork					x	x
	Mammals						
Peromyscus polionotus	Oldfield mouse	x					
Spilogale putoris	Eastern spotted skunk	x	x	x			
Sigmodon hispidus	Cotton rat	x	x	x		x	
Procyon lotor	Raccoon	x	x	x		x	
Peromyscus floridanus	Florida mouse		x				
Sylvilagus floridanus	Eastern cottontail		x	x			
Didelphis virginiana	Opossum		x	x			
Peromyscus gossypinus	Cotton mouse		x	x		x	
Ochrotomys nuttalli	Golden mouse		x			x	
Sciurus carolinensis	Squirrel			x			
Sylvilagus palustris	Marsh rabbit					x	
Oryzomys palustris	Rice rat					x	
Lutra canadensis	River otter					x	
Neofiber alleni	Roundtailed muskrat					x	
Trichechus manatus	Manatee						x

Table 3-10. Endangered and Threatened Fauna

Common Name	Taxonomic Classification	Status U.S. DOI List	Status-Florida List
Eastern Brown Pelican	Pelecanus occidentalis carolinensis	Endangered	Threatened
Southern Bald Eagle	Haliaeetus leucocephalus leucocephalus	Endangered	Threatened
Arctic Peregrine Falcon	Falco peregrinus tundrius	Endangered	Endangered
Dusky Seaside Sparrow	Ammospiza maritima nigrescens	Endangered	Endangered
Wood Stork	Mycteria americana	-	Endangered
Florida Scrub Jay	Aphelocoma coerulescens coerulescens	-	Threatened
Least Tern	Sterna albifrons	-	Threatened
Roseate Tern	Sterna dougallii	-	Threatened
American Oystercatcher	Haematopus palliatus	-	Threatened
Southeastern American Kestrel	Falcon sparverius paulus	-	Threatened
Osprey	Pandion haliaetus carolinensis	-	Threatened
Magnificent Frigatebird	Fregata magnificens rothschildi	-	Threatened
Florida Manatee	Trichechus manatus	Endangered	Endangered
Florida Mouse	Peromyscus floridanus	-	Threatened
Atlantic Ridley Turtle	Lepidochelys kempii	Endangered	Endangered
Atlantic Green Turtle	Chelonia mydas mydas	Endangered	Endangered
Atlantic Loggerhead Turtle	Caretta caretta caretta	Threatened	Endangered
Gopher Tortoise	Gopherus polyphemus	-	Threatened
American Alligator	Alligator mississippiensis	Threatened	Threatened
Atlantic Salt Marsh Snake	Nerodia fasciata taeniata	Threatened	Endangered
Eastern Indigo Snake	Drymarchon corais couperi	Threatened	Threatened

Table 3-11. Endangered and Threatened Flora

Common Name	Taxonomic Classification	Status - Florida List
Sea Lavender	*Tournefortia gnaphalode*	Endangered
Coontie	*Zamia integrifolia*	Threatened
Hand Fern	*Ophioglossum palmatum*	Endangered
Pond Apple	*Annona glabra*	Endangered
Satin Leaf	*Chrysophyllum oliviforme*	Endangered
Curtis Milkweed	*Asclepias curtissii*	Threatened
Golden Leather Fern	*Acrostichum aureum*	Rare
Water Sundew	*Drosera intermedia*	Rare
Florida Peperomia	*Peperomia obtusifolia*	Rare
Red Mangrove	*Rhizophora mangle*	Special concern
Black Mangrove	*Avicennia germinans*	Special concern

The KSC area encompasses the natural habitats of 11 species of fauna which are considered endangered or threatened by the U.S. Department of the Interior - U.S. Fish and Wildlife Service. Two of the 11 species are found in areas designated critical habitats, as follows:

a. Florida Manatee. The Florida Manatee critical habitat includes the entire inland section of water known as the Indian River, from its northernmost point immediately south of the intersection of U.S. Highway 1 and Florida State Road 3, the entire inland section of water known as the Banana River, and all waterways between the Indian and Banana Rivers (exclusive of those existing manmade structures or settlements which are not necessary to the normal needs or survival of the species).

b. Dusky Seaside Sparrow. The Dusky Seaside Sparrow critical habitat includes the marshes and associated airspace within the mosquito control impoundments designated by the Brevard County Mosquito Control District as T-10-J and T-10-K, northwest of Florida State Road 406 on the Merritt Island National Wildlife Refuge.

In recognition of the extent and diversity of endangered and threatened species at KSC, and the importance of understanding the effect of NASA operations on their continued existence, extensive work has been carried out by the University of Central Florida under contract to KSC and by the U.S. Fish and Wildlife Service at the Merritt Island National Wildlife Refuge. Appendix C contains narrative descriptions and maps to provide further information on the fauna identified on the Federal list. Surveys, now under way by the U.S. Fish and Wildlife Service and scheduled for completion by October 1979, will identify and locate endangered and threatened flora within the boundaries of the Merritt Island National Wildlife Refuge.

3.5 SOCIAL AND ECONOMIC RESOURCES

This paragraph describes the existing socioeconomic environment of Brevard County, Florida, with emphasis on the area immediately surrounding KSC (see figure 3-18). This area has been significantly impacted over the years by space program operations at KSC and earlier military launch activities on Cape Canaveral. Operations at KSC will continue to have measurable social and economic effects on Brevard County and to a lesser degree on outlying counties. The following subparagraphs provide baseline data, trend analyses, and general information on population demography, economy, housing, public services, recreation, history and archaeology, and aesthetics.

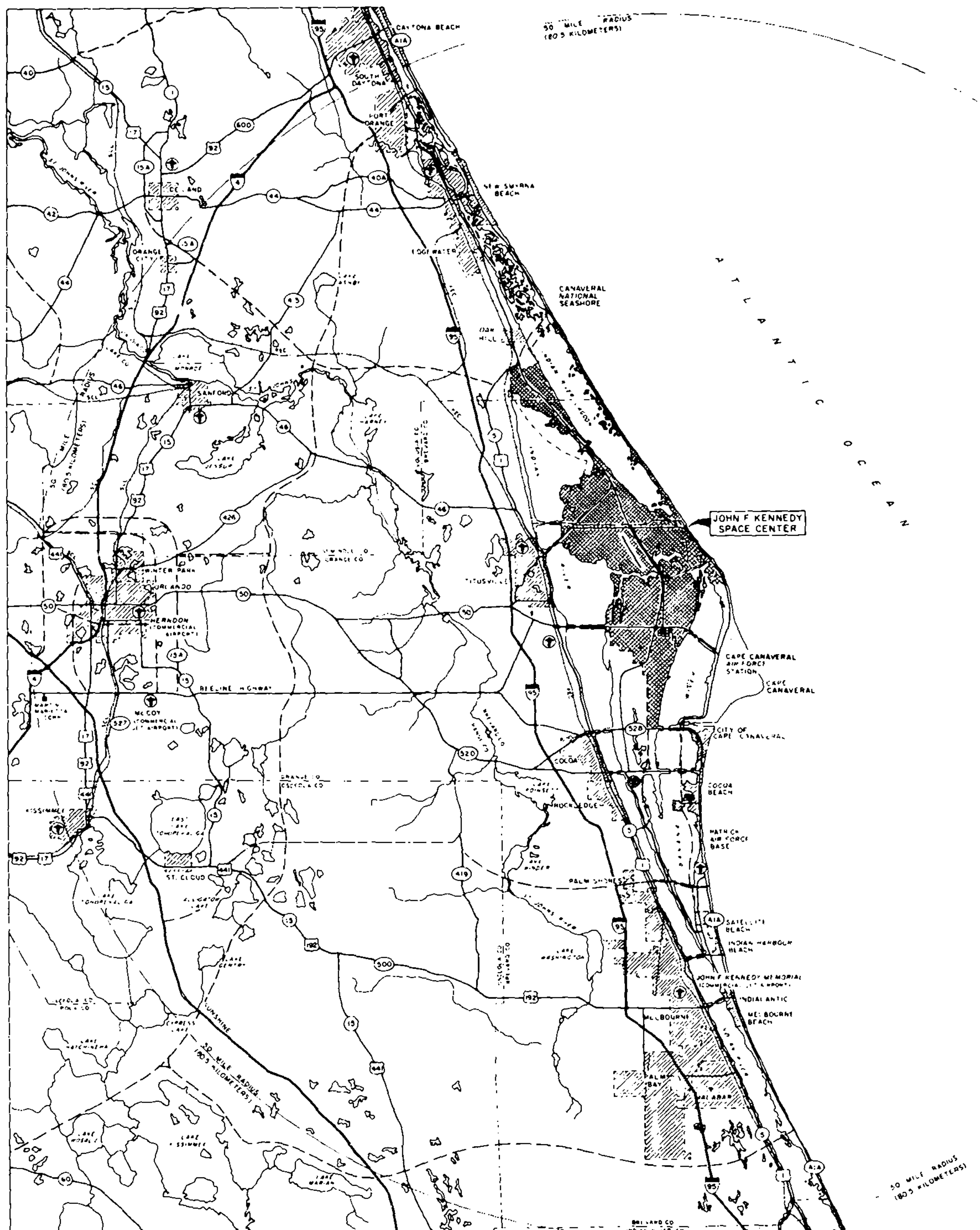


Figure 3-18. Area Surrounding Kennedy Space Center

3.5.1 POPULATION.

3.5.1.1 Geography and Population Density. The Kennedy Space Center is located in Brevard County, Florida. This county, with a width of about 29 kilometers (18 miles) east and west and a length of 109 kilometers (68 miles) north and south, is situated near the middle of the state along the Atlantic Ocean. The western boundary of the county is formed by the St. Johns River and Osceola County. It is bordered on the north and northeast by Orange, Seminole, and Volusia Counties, and on the south by Indian River County. The county comprises 339,549 hectares (839,040 acres) and ranks eighth in physical size among the state's 67 counties. It ranks ninth in population. The county seat, Titusville, is 64 kilometers (40 miles) east of Orlando. Brevard County had the following comparative population density in 1976:

Area	Persons Per Sq. Kilometer	Persons Per Sq. Mile
U.S.	24	62
Florida	61	158
Brevard County	92	239
Dade County (Miami)	274	710
New York City	10,000	26,000

A survey conducted in August of 1976 showed the county of residence for the KSC work force. At that time, over 90 percent of the work force resided in Brevard County, while 6 percent and 2.5 percent resided in Orange and Volusia Counties, respectively. The remaining 1.5 percent resided in five outlying counties some distance from KSC.

3.5.1.2 Population Composition. Between 1950 and 1960 the county population was made up of largely rural and military families. By 1960, the county was changing to a more urban civilian population. The median age of 26.5 years and the 3.4 population per household reflected the young characteristics of the population; i.e., younger families with more children. During the 1960's the county became increasingly more urban and additional young and middle-aged families entered into Brevard. In 1970, the median age had risen slightly to 27.5 years. A drop in the population per household to 3.31 reflected the national trend towards smaller families.

Since 1971, however, there has occurred a distinct change in the composition of the population. The county population has been aging, due to an increasing number of retirees and the decreasing number of young families. As a result, the population per household has decreased to about 3.0. The median age is estimated to have increased to 34.5 years. Table 3-12 and figure 3-19 reflect the population trends and age distribution of the county.

Table 3-12. Age Distribution (Percentage) of Brevard County

Age Group	1930	1940	1950	1960	1970	1975	1976
0 through 5	11.3	9.3	12.2	15.7	10.9	6.6	6.6
6 through 17	22.4	20.1	23.4	21.8	27.8	22.4	18.1
18 through 59	56.1	57.2	48.2	53.1	53.0	60.5	64.3
60 and over	10.2	13.4	16.2	9.4	8.3	10.5	11.0

Data Source: Brevard County, Florida - Division of Health and Social Services

3.5.2 ECONOMY. The barometers used in assessing the economic base and expectations of the impact area (Brevard County) include: employment (labor market sources, employment levels, and occupational characteristics), income levels, construction activity (including building permits), retail sales, and the natural resources of the area.

3.5.2.1 Past Impact and Trends. Beginning in the early 1950's Brevard County began a transformation and restructuring of both the population and economic base of the county. What had previously been a mostly rural agricultural area was transformed within the space of 10 years into a growing urban/industrial oriented county. Between 1950 and 1960, the county population increased 371 percent from 23,653 persons in 1950 to 111,435 in 1960, making Brevard the fastest growing county in the nation.

The impetus for this rapid growth was the development of the Air Force Eastern Test Range (AFETR) and the establishment of NASA. As the space program gained momentum, so did the economy of the county. The new space effort meant large-scale construction of space-related facilities and an accompanying housing construction boom to provide for the thousands of new residents entering each year. The total Brevard County civilian labor force, which had stood at 41,900 persons in 1960, rose to a peak of 100,800 persons by 1968.

During this period of development, schools, utilities, roads, and public services also expanded at a rapid pace in order to house and provide services for the incoming residents. Employment in the retail and wholesale sectors of the economy increased almost 2-1/2 times over that of 1960. All sectors of the economy were affected. The boom years, however, soon came to an abrupt end. In 1968, employment cutbacks began. Between 1968 and 1970 over 10,000 jobs were lost. With such huge employment losses, economic growth abruptly stopped and then plunged downward.

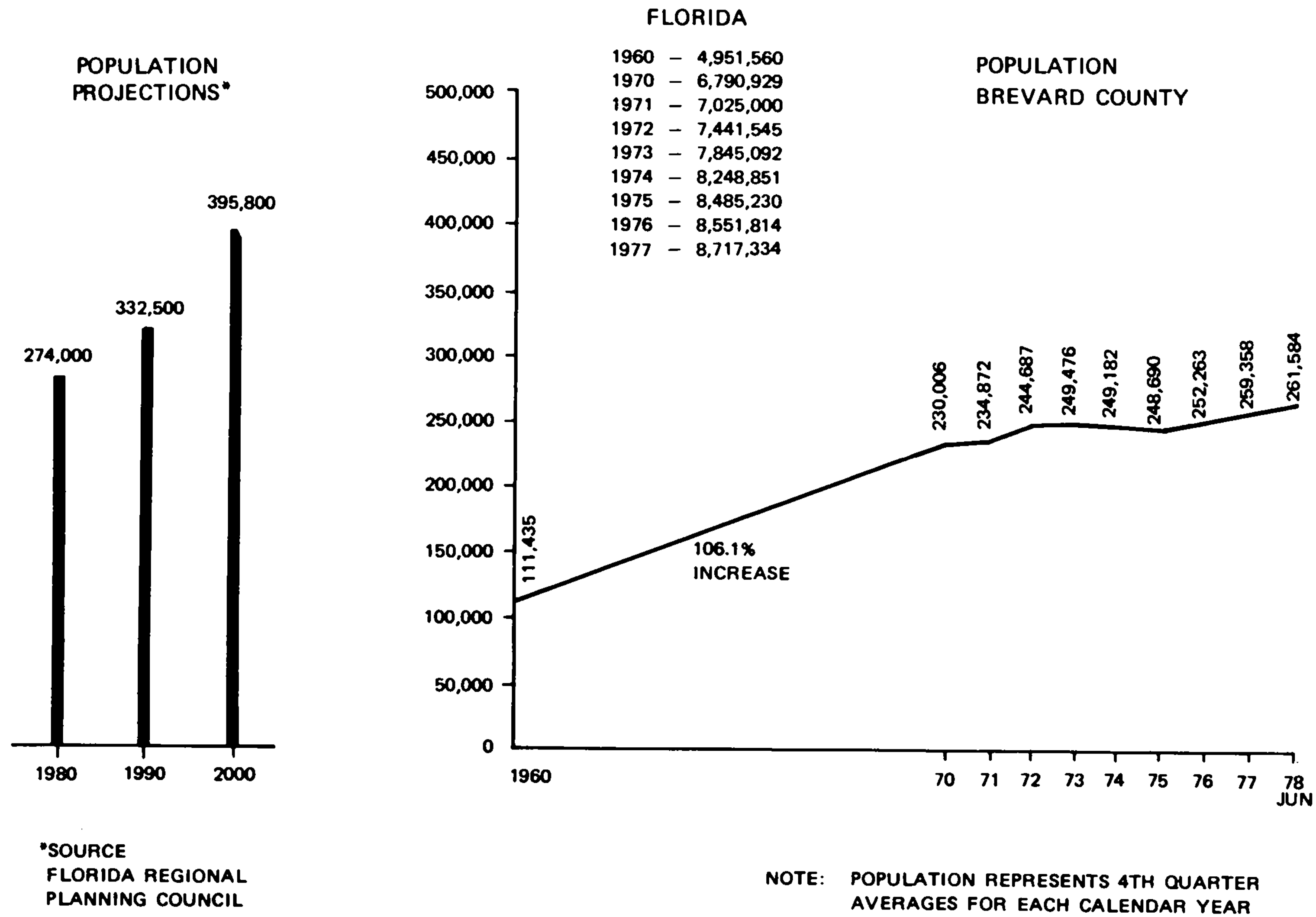


Figure 3-19. Population Trends: Brevard County

During 1970 and 1971, the county was still experiencing the effects of the NASA/Department of Defense employment cutbacks. Many aerospace workers, unable to find alternate forms of employment, were forced to leave the county. Businesses also found conditions unprofitable and many were forced to close down. Even harder hit were the housing market and the construction industry. Previously a seller's market, housing quickly turned into a buyer's market. Federal Housing Administration (FHA)-repossessed houses increased from around 300 in 1968 to a peak of almost 1000 by March 1971.

If not for retirees, brought to Brevard County by comparatively low-priced housing and the economic stability of South Brevard, the economy might have declined even more substantially. During 1972 and 1973 Brevard County emerged from a 3-year economic slump and the population rose by over 10,000 persons. Surplus housing, increased multifamily construction, and a sharp increase in the number of tourists due to the opening of Disney World set into motion economic recovery which was soon blunted by economic forces on the local, national, and international scene. NASA employment cutbacks caused by completion of the Skylab project sent Brevard County unemployment from a 1973 level of 7.0 percent to 10.2 percent in 1974. The Arab oil boycott and the national recession combined to drive the unemployment rate to 13.4 percent in 1975. Population growth, because of the economic uncertainties of this period, slowed considerably.

The year 1976 saw the beginning of improved economic conditions. There was a drop in unemployment to 11.2 percent by year's end. A continued increase in manufacture of ordnance and electrical machinery and increase in retail trade accounted for most of the gain. In 1976 there were over 1,300 new single-family units constructed in the county, 300 new multifamily units, and 126 new commercial buildings (reference 3-12).

3.5.2.2 Current Status. The economy showed continued growth in most areas during 1977. Unemployment rates declined, reflecting the state and national trend. The civilian labor force rose to 93,206, an increase of 2,845 over 1976 and the unemployment rate dropped to 9.3 percent. This trend continued in the first quarter of 1978 when the rate dropped to a level of 7.9 percent. Manufacturing and construction jobs accounted for most of the increase in employment and were concentrated primarily in the private sector. Trade jobs continue to advance and are showing signs of strong growth. The rate of growth in service jobs is higher than in 1976. Construction employment is on the rise and reflects the improvement in the economy of the area. The county activities in 1977 reached their highest level since the energy crises of 1973 and 1974. The expansion is in the private sector and occurs when public construction is at the lowest level since the boom of the 1960's. Over $158 million worth of building permits were purchased in 1977. This was approximately $64 million over the 1976 annual figure. (Public construction projects are not required to purchase building permits.)

Gross retail sales are an important indicator of the economic activity of an area. The trend of gross retail sales has been steadily rising since the late 1960's. Gross retail sales rose from $39 million in December 1970 to $116 million in December 1977.

Tourism is a growing industry in Brevard, though not yet competitive with the State's primary tourist attraction centers. The county's foremost tourist attraction is the tour of the NASA and Air Force facilities. NASA tours attracted 1,117,603 visitors during 1977.

A number of industrial firms have recently located or expanded their operations in Brevard. Total firms have grown from 175 in 1967 to nearly 300 today. The 12,100 manufacturing jobs serving national and international markets today are expected to double by 1985.

Port Canaveral has undergone a multimillion dollar expansion including dredging the turning basin and construction of new wharves. The Port has good potential for tour ships, for offshore oil storage, and for expansion of imports and exports. A new base to handle Trident nuclear missile submarines is nearing completion and the Coast Guard has completed a new permanent facility. The Solar Energy Center near the Port is also expanding its operations.

Some indications of the yearly resources capability of the area can be discerned from the following:

Agriculture	Hectares (Acres)	Value (Dollars)
Pasturelands	88,414 (218,470)	3,800,000
Citrus	7,487 (18,500)	18,500,000
Nurseries	405 (1,000)	2,200,000
Marine	**Kilograms (Pounds)**	**Value (Dollars)**
Fish	1,033,765 (2,279,038)	426,288
Shellfish	1,287,200 (2,837,759)	885,385
Timber	**Cubic Meters (Board Feet)**	**Value (Dollars)**
Softwood	323,000 (136,900,000)	Not Available
Hardwood	165,200 (70,000,000)	Not Available

Data Source: Florida Department of Commerce, Division of Economic Development

Table 3-13 shows per capita income adjusted for inflation, where the 1967 dollar is considered the standard dollar.

Tables 3-14, 3-15, and 3-16 display data on employment and income. Table 3-17 presents some economic indicators.

Table 3-13. Per Capita Income in Brevard County, Florida, and the U.S. Adjusted for Inflation

Year	Brevard	Florida	U.S.
1965	3,356	2,545	2,947
1966	3,836	2,660	3,087
1967	3,889	2,817	3,188
1968	4,053	2,994	3,318
1969	3,580	3,155	3,400
1970	3,056	3,215	3,410
1971	3,274	3,326	3,458
1972	3,321	3,551	3,630
1973	3,352	3,666	3,787
1974	3,254	3,664	3,679
1975	3,218	3,499	3,662
1976	---	3,582	3,778

Data Source: Brevard County, Florida - Division of Health and Social Services

Table 3-14. Labor Force Estimates: Melbourne-Titusville-Cocoa (Brevard County)

Year/Category	Quarter Ending				Annual Average
	Mar.	June	Sept.	Dec.	
1974					
Employment	80,092	81,038	80,839	76,838	80,355
Unemployment	9,518	9,350	10,140	10,294	9,160
Unemployment Rate %	10.6	10.3	11.1	11.8	10.2
1975					
Employment	77,489	81,623	79,351	77,678	79,091
Unemployment	10,490	13,583	13,258	10,755	12,200
Unemployment Rate %	11.9	14.3	14.3	12.2	13.4
1976					
Employment	77,196	80,834	82,307	79,529	80,220
Unemployment	10,712	10,966	9,982	8,832	10,141
Unemployment Rate %	12.2	11.9	10.8	10.0	11.2
1977					
Employment	79,338	82,825	88,741	88,438	84,569
Unemployment	8,569	9,877	8,221	8,168	8,637
Unemployment Rate %	9.7	10.7	8.5	8.5	9.3

Data Source: State of Florida, Department of Commerce, Division of Employment Security, Research and Statistics. Released May 1978.

Table 3-15. Brevard County/KSC/AFETR Labor Force Relationships

Calendar Year	Brevard County Labor Force	KSC Labor Force	AFETR Labor Force	KSC and AFETR Labor Force as a % of Brevard County Labor Force
1960	41,900	---	21,108	50.4
1961	45,300	---	24,319	53.7
1962	50,200	---	25,826	51.5
1963	62,600	---	27,376	43.7
1964	76,200	6,280	27,447	44.3
1965	83,700	9,781	27,150	44.1
1966	93,400	17,574	27,240	48.0
1967	98,800	21,482	24,869	46.9
1968	100,800	21,283	22,145	43.1
1969	98,700	22,100	19,968	42.6
1970	86,600	15,378	16,084	36.3
1971	82,500	12,859	14,927	33.7
1972	85,000	13,146	13,446	31.3
1973	89,300	11,211	13,365	27.5
1974	89,515	9,246	13,906	25.8
1975	91,291	10,368	13,356	26.0
1976	90,361	8,441	13,388	24.2
1977	93,206	9,430	12,748	23.8

Data Source: Brevard County, Florida - Division of Health and Social Services

Table 3-16. Unemployment Rates

Year	U.S.	Florida	Brevard
1960	5.5	5.0	3.6
1965	4.5	3.1	2.0
1966	3.8	2.7	1.9
1967	3.8	2.8	2.1
1968	3.6	2.8	2.4
1969	3.5	2.5	3.1
1970	4.9	4.3	8.2
1971	5.9	4.9	8.8
1972	5.6	5.1	7.3
1973	4.9	4.3	7.0
1974	5.6	6.2	10.2
1975	8.5	10.7	13.4
1976	7.7	9.0	11.2
1977	7.0	8.2	9.3

Data Source: Florida Department of Commerce, Division of Labor

Table 3-17. Economic Indicators

District	Feb 1978	Feb 1977	Percent Change
Sales and use tax for 12 months collection-Brevard County1/	$32,481.5	$27,295.7	+19.0
Sales and use tax for 12 months collection-Florida1/	$1,543,394.6	$1,345,459.5	+14.7
Valuation of building permits issued for 12 months-Melbourne, Titusville, Cocoa1/	$186,014.0	$105,404.0	+76.5
Consumer price index2/	188.4	177.1	+6.4

1/ In thousands of dollars

2/ 1967 = 100

Data Source: Florida Department of Commerce, Division of Labor

3.5.3 HOUSING. Brevard County housing facilities range from mobile homes to residences valued at more than $100,000. In the county there are some 89,000 dwelling units, including about 64,000 single-unit homes, 17,000 apartments, and 8,000 mobile homes. Prices, which have risen in recent months, remain quite reasonable compared with other areas of Florida and many parts of the nation (reference 3-12).

Building construction activities during the fourth quarter of 1977 amounted to $45,226,488, an increase of 78.6 percent over fourth quarter 1976. Building permits for 1977 totalled 4,735 compared with 2,148 in 1976 and 1,287 in 1975. Figure 3-20 exhibits the boom-bust behavior of the Brevard housing industry.

Another important housing market indicator is residential electric meter hookups. The number of new household connections for the fourth quarter 1977 shows a 5.0-percent increase over the same period in 1976. The following provides a trend analysis of electric meter hookups in Brevard County:

1970: 68,414

1971: 72,089

1972: 77,050

1973: 79,996

1974: 81,597

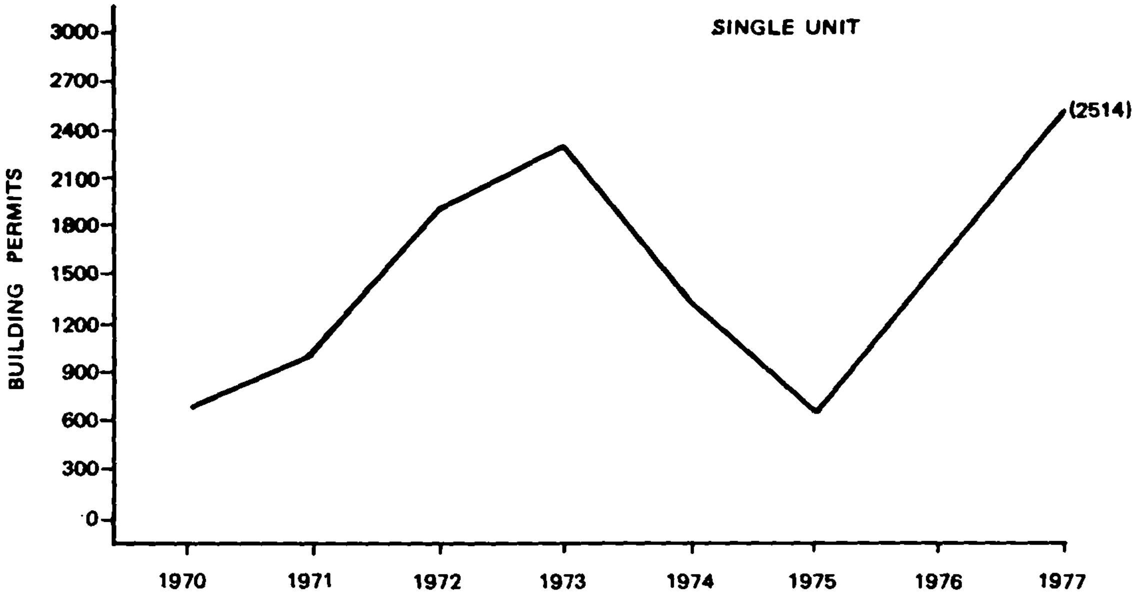
1975: 83,000

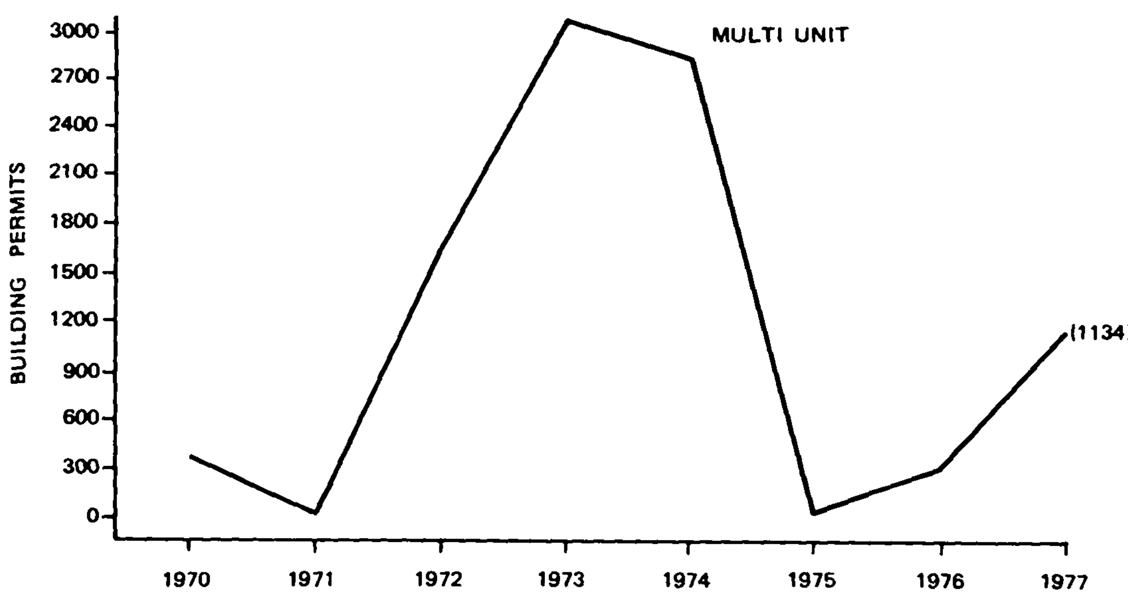
1976: 86,012

1977: 90,385

The reduced level of FHA repossessions and increased resale activity also indicates the population's ability to meet mortgage payments and shows the state of the house-buying market.

3.5.4 PUBLIC SERVICES. An essential ingredient in an area's social and economic stability is its ability to provide its inhabitants the necessary services such as a governing body, police and fire protection, utilities, transportation, schools and colleges, hospitals and physician care, churches, libraries, and news coverage. Space activities during the late 1950's created for Brevard's various cities and townships a critical problem with respect to public services. Local government was not prepared to provide the services being called for by such a rapidly increasing population. However, expansion during the 1960's and changes in the 1970's have resulted in adequate services for the demands of the populace. Today Brevard County, except for public transportation, has excellent public facilities, systems, and services.





DATA SOURCE: BREVARD COUNTY, FLORIDA – PLANNING AND ZONING DEPARTMENT

Figure 3-20. Housing Trends: Brevard County

3.5.4.1 Government. Brevard County has 15 incorporated municipalities, each having its own distinct characteristics and governmental structures. The county has a commission-type government with five members elected at large. The chairman is elected by the members of the commission. The commissioners are elected for 4-year terms. The following are real and personal property tax millage rates for the year 1977:

	City	County	Total
Cocoa	7.583	19.025	26.608
Melbourne	9.058	17.434	26.492
Titusville	6.402	19.710	26.112

3.5.4.2 Law Enforcement. Police protection is provided by the Sheriff's Department and the police forces of the various municipalities. The Sheriff's Department maintains three stations in the county including the county jail located in the courthouse complex in Titusville. The cities maintain their own stations.

3.5.4.3 Fire Protection. Fire protection is provided by the fire departments of the municipalities and several fire districts. A listing of the major fire departments follows.

Agency and Rating	Stations	Equipment
Cocoa NB-6	2	3 2839-liter (750-gallon) pumpers 1 3785-liter (1000-gallon) pumper 1 23-meter (75-foot) aerial rescue truck
Melbourne NB-7 (south) NB-5 (north)	6	10 pumpers 1 27-meter (90-foot) aerial platform 1 6.4-meter (21-foot) fireboat (rescue) 3 6 X 6 tankers 1 0.906-metric ton (1-ton) pickup (skid mount) 1 27-meter (90-foot) pumper and ladder 2 rescue units
Titusville NB-7	3	3 2839-liter (750-gallon) pumpers 1 3785-liter (1,000-gallon) pumper 1 fire rescue van 2 brush trucks 2 booster trucks 3 automobiles

3.5.4.4 Utilities. Water and sewage service is provided to city and county users by a number of systems. The major systems are listed below.

City	Water Capacity Kiloliters/Day	Gallons/Day	Utilization (Percent)
Cocoa	121,120	32,000,000	50
Melbourne	79,485	21,000,000	48
Titusville	60,560	16,000,000	23

City	Sewage Capacity Kiloliters/Day	Gallons/Day	Utilization (Percent)
Cocoa	7,570	2,000,000	87.5
Melbourne	25,511	6,740,000	77.2
Titusville	13,428	3,500,000	71.4

Electricity is distributed by the Florida Power and Light Company with service areas in Cocoa, Melbourne, and Titusville.

3.5.4.5 Transportation. Rail service is provided in Brevard County by the Florida East Coast Railway, which has scheduled daily freights. The main Jacksonville/Miami line has two spurs; one servicing the Cape Canaveral area to the east, the other servicing Orlando to the west.

Port Canaveral is one of the most accessible seaports in Florida. Entrance from the sea is by a straight channel 152 meters (500 feet) wide, 14 meters (45 feet) deep, and 1.6 kilometers (1 mile) long and is protected by jetties. Entrance from the Intracoastal Waterway (Indian River) on the west is by a canal 38 meters (125 feet) wide and 3.7 meters (12 feet) deep that runs due east through Merritt Island for about 8 kilometers (5 miles) to the turning basin.

The major north-south arteries are U.S. Highway 1, Interstate Highway 95, State Road A1A, and State Road 3. The east-west routes are provided by State Roads 50, 46, 404, 520, 528, and U.S. 192.

Thirteen trucking firms are presently serving the county. Additionally, the United Parcel Service provides daily pickup and delivery service with a terminal in Rockledge.

There is currently no public bus system linking the various parts of the county. However, the Greyhound Bus Lines have depots in Cocoa, Melbourne, and Titusville. Additionally, the Consolidated Agencies Transportation System is a government-sponsored busing system dedicated to transporting elderly and low-income persons. Taxi companies also operate in the municipalities. Brevard County is currently considering a "Dial A Ride" system aimed at providing a form of municipal transportation for Brevard residents.

The following illustrates airport service for the area:

Airport	Type	Paved Runways	Lighted Runways	Longest Runways1/	Air Freight	Service2/
Arthur Dunn	General	1	1	884	No	G/U/M/T/R
Melbourne Regional3/	General	3	2	2,890	Yes	G/JP/U/M/T/R
Merritt Island	General	1	1	1,097	No	G/U/M/T/R
Ti-Co	General	3	2	1,829	No	G/JP/U/M/T/R
Valkaria	General	0	0	914	No	T

1/ Lengths are in meters.

2/ G=gasoline, JP=jet fuel, U=UNICOM, M=maintenance and repair, T=tiedown, R=rental car

3/ Formerly known as John F. Kennedy Memorial Airport

Orlando International Airport is located approximately 80 kilometers (50 miles) west of KSC.

3.5.4.6 Public Schools and Colleges. More than 2,432 teachers staff the 65 schools in the county, including 36 elementary, 13 junior high and middle, and 10 senior high schools. Although public school enrollment dropped by 1147 students between 1976 and 1977, the annual change of -2.4 percent represents a rate of decline half that of the previous annual percent change of -5.1 percent. This can be attributed to increased employment and economic stability. Put in a historical perspective, the county school enrollment figures reveal a 15.5-percent decline from October 1968 peak enrollment of 60,408 students. School enrollment in Brevard at the end of 1977 was 51,016.

There are four colleges serving the advanced educational needs of the community. Brevard Community College, with campuses in Titusville, Cocoa, and Melbourne, has an enrollment, including part-time and noncredit attendees, of 7,297. It offers a 2-year associate degree plus vocational training. The Florida Institute of Technology is a 4-year institution located in Melbourne. Current enrollment, including part-time students, is 2,508. Rollins College, Winter Park, with facilities at Patrick Air Force Base, offers both undergraduate and graduate courses. The University of Central Florida, located 32 kilometers (20 miles) west of Titusville, offers undergraduate and graduate courses to an enrollment of 11,100 students.

3.5.4.7 Hospital Facilities and Physicians. Though the county's hospital bed rate (361 per 100,000 population) is less than the state as a whole (624) and the U.S. rate (657), expanding facilities should improve the rate in the near future. There are 5 hospitals and 6 nursing/convalescent homes serving the county. There are currently 252 physicians and 99 dentists in the county. Currently, the hospitals are operating at 80 percent of a capacity of 90 percent (10 percent is always reserved for public emergencies).

3.5.4.8 Media. The following are the local newspapers and radio stations, and the available television channels in the area:

Local Newspapers

Publication Name	Frequency	Circulation
Star Advocate	Weekly	18,500
TODAY	Daily	64,600
The Sentinel Star and Brevard Sentinel	Daily	9,700
Melbourne Times	Weekly	44,000

Local Radio Stations

Community	AM	FM
Cocoa	4	1
Titusville	1	1
Melbourne	3	2

Available Television Channels

Community	Antenna Only	Cable
Cocoa	3	11
Titusville	3	11
Melbourne	3	11

Controlled proximity to the launch pad and structural protection will shield personnel and visitors from noise levels exceeding EPA limits, viz., 20-minute exposure to a maximum of 135 dB between 20 and 100 hertz (Hz) not more than once in 24 hours. All public exposure levels are below those requiring protective devices for such a short exposure; consequently, Space Shuttle launch acoustic impacts are expected to be well within acceptable limits. Damage risk criteria are as follows:

Damage Risk Criteria for Controlled Areas 1/
(Physiological Damage - No Protection-Single Daily Exposure)

Frequency Range (Hz)	Duration (Minutes)	SPL, dB Re: 0.00002 N/m^2
1 to 20	-	- 2/
20 to 100	20	135
100 to 6300	8	125 dBA 3/

1/ Level and duration not to be exceeded or damage will result.

2/ No sound-pressure level (SPL) criteria have been developed for this area. Refer to reference 5-8, paragraph 7-3.1.2, page 7-41, for physiological effects of high-intensity, low-frequency acoustic energy.

3/ dBA: measured with an "A-weighted" frequency network.

As far as is now known, sonic booms from launch vehicle ascent and SRB and ET reentry are unavoidable; however, the KSC launchsite assures that the phenomena will occur over little-used areas of the ocean. Based on known trajectory and existing wind conditions, the location of the focused ascent sonic boom will be predictable. If necessary, it is possible to deploy vessels with acoustic detection equipment to the zone of predicted maximum overpressure to measure actual results for comparison with predictions. This same technique was used for Apollo flights, and good agreement between modeled data and actual measurements was obtained (reference 1-3). As in the past, range safety officers will designate a launch danger zone which includes portions of KSC and a sea area and airspace measured from the launch point and extending downrange along the intended flight azimuth. The size of the danger zone is based on the potential hazard to ships and aircraft. Helicopter and aircraft surveillance of the zone commences an hour before launch. In accordance with current practice, ships and aircraft in the area will be warned of impending launches. Focused sonic booms have occurred during previous space vehicle launches from KSC and have caused no problems. No difficulties are expected for Space Shuttle launches from KSC.

The effects of launch sonic boom will involve only overwater locations where environmental effects are minimal. Human exposure to high overpressures is prevented by area control at the launchsite and along the groundtrack downrange. In remote areas where ET reentry occurs, inadvertent exposure to the reentry sonic boom should not exceed 192 N/m^2 (4 psf), a level insignificant compared to the threshold for physiological damage [720 N/m^2 (15 psf)]. For these reasons, no significant effects from sonic booms are anticipated.

Beyond the boundaries of KSC, the public will be exposed to infrequent launch noise comparable to traffic noise on a busy highway, which poses no danger of physiological damage. The short duration and relatively infrequent occurrence, even at the highest predicted launch rate (one flight every 10 days), make any human reaction beyond momentary orientation/awareness unlikely. Since launch acoustic noise has been a part of the normal environment for this area over the past 25 years, no adverse effects are expected.

5.5.2.2 Reentry Sonic Boom Impacts. The sonic boom generated over populated areas by the returning Orbiter will constitute one of the few noises caused by KSC operations which will be heard beyond the KSC boundaries. At the greatest predicted intensity, 101 N/m^2 (2.1 psf), no primary structural damage will occur. As shown in table 5-19, reaction will be of a "startle/movement" nature.

Table 5-19. Physiological Effects From Sonic Booms

Sonic Boom Overpressures, N/m^2	Behavioral Effects
16	Orienting, but no startle response Eyeblink response in 10% of subjects No arm/hand movement
30 to 111	Mixed pattern of orienting and startle responses Eyeblink in about half of subjects Arm/hand movements in about a fourth of subjects No violent physical reaction
130 to 310	Predominant pattern of startle response Eyeblink response in 90% of subjects Arm/hand movements in more than half of subjects Gross body flexion in about a fourth of subjects
340 to 640	Arm/hand movements in more than 90% of subjects

The frequency of occurrence of the reentry boom of one every 10 days, maximum, at the peak flight rate of 40 per year, makes it difficult to correlate with existing data compiled by the International Civil Aviation Organization in their comprehensive Oklahoma City study of sonic boom effects in 1964 (reference 5-9) because up to 15 booms per day were experienced in that exercise.

In reviewing the effects of sonic boom produced by supersonic aircraft during normal flight operations, the International Civil Aviation Organization found that:

a. The probability of immediate direct injury to persons exposed to sonic boom is essentially zero.

b. The percentage of persons queried who rated sonic booms occurring 10 to 15 times daily as annoying increased with increasing overpressures. For overpressures of less than about 24 N/m^2 (0.5 psf), no one rated the boom as annoying; about 10 percent considered 48 N/m^2 (1 psf) sonic booms annoying; nearly all considered 144 N/m^2 (3 psf) booms annoying.

c. Primary (loadbearing) structures meeting acceptable construction standards or being in good repair showed no sign of damage up to overpressures of about 960 N/m^2 (20 psf). Nonprimary structures such as plaster, windows, and bric-a-brac sustained some damage at overpressures ranging from 48 to 144 N/m^2 (1 to 3 psf).

The effect of a single boom estimated from the multiple boom data was that the peak overpressures of a single sonic boom should not exceed 36 N/m^2 (0.75 psf) if the populace is not to be annoyed. It is significant to note that the International Civil Aviation Organization reported (reference 5-9): "Experience from Concorde test flights over water and many years of military flying over the sea, in particular near land where many ships and small boats are found, has not yielded any evidence of human disturbance by sonic booms at sea."

The effects of sonic boom on the Eastern Wild Turkey have been studied (reference 5-17). The reactions of nesting turkey hens and foraging adult turkeys and poults was miminal, with no panic and only momentary cessation of feeding. The reaction of captive minks to sonic booms has been observed (reference 5-10). In this study, using 288-N/m^2 (6-psf) overpressure sonic booms, it was found that the mink were affected only to the point of sticking their heads out of the cages. There were no frantic reactions or panic and the mink shortly resumed their normal activities. Specific examples may exist, however, for which the startle associated with sonic boom and other impulsive noises has a deleterious effect.

It should be noted that the landing configuration of the STS can produce a sonic boom over the St. Johns River basin, a portion of which is critical habitat for the endangered Dusky Seaside Sparrow. Although no adverse effects are expected, consultation with the Department of the Interior will be requested under Section 7 of the Endangered Species Act. To ensure that no adverse impacts are imposed, KSC is planning a program for monitoring selected species of wildlife for their reactions in various zones of sonic boom overpressures during an actual landing. In situ observation can provide added information on this aspect of the Shuttle's impact on the environment.

Sonic booms tend to be unexpected. Impulsive noises which are novel, unheralded, or unexpectedly loud can startle people and animals. Even very mild impulsive noises can awaken sleepers. Because startle and alerting response depend largely upon individual circumstances and psychological factors unrelated to the intensity of the sound, it is difficult to make any generalization about accepted values in this connection. To mitigate the effects of the reentry sonic boom, NASA plans to announce landing operations in advance of their occurrence whenever possible. An interested and informed public will be far less likely to have any significant concern for an understood and expected noise. NASA also plans to deploy monitoring equipment at Dryden Flight Research Center, California, to measure the actual sonic boom overpressures from the first Orbiter landing. This equipment will be used at KSC, following the fourth Orbiter landing, to provide similar information on the KSC landings.

5.6 RADIATION LEVELS

5.6.1 RADIATION SOURCES. The sources of radiation at KSC produce both ionizing and nonionizing radiation. Major radiation sources are few in number. Minor sources are widely dispersed throughout KSC. Both are well controlled.

5.6.1.1 Ionizing Radiation. Materials and machinery which produce radiated energy of high enough potential to ionize air (33 electron-volts and up) are termed ionizing radiation sources. They present the greatest potential radiation hazard to the environment because of their ability to cause physiological damage to living organisms and, for radioactive materials, the potential for long-term contamination to irradiated zones. At KSC, ionizing radiation devices can be categorized as industrial/operational, medical/diagnostic, research/development, and launch related. Within these categories, sources are termed major or minor, depending on their energy potential. Minor material sources range from micro- and millicuries to a few curies in size. Major sources can range up to 250,000 curies and more.

Typical sources of ionizing radiation at KSC include:

a. Minor sources: Cobalt 60, Krypton 85, Nickel 63, Tritium (^3H), Iron 55, Americium 241

Uses: Smoke detectors
Laboratory instruments
Medical instruments

Test/tracer fluids
Static elimination devices
Calibration reference sources

b. Major sources: Californium 252, Iridium 192, Cobalt 60, Plutonium 238, numerous machine sources

<u>Uses</u>: Large material sources for radiography
X-ray producing units
Medical and industrial radiography units
Analytical radiography units
Radioisotope Thermoelectric Generators (RTG's)

Industrial/operational sources are the largest in number and the most frequently used. They are generally employed in industrial institutional support (e.g., industrial radiography, smoke detectors) and therefore include both major and minor sources ranging from microcurie to curie levels.

Medical/diagnostic sources are limited to operation within the medical facilities at KSC, under the direct control of licensed practitioners. The largest machines produce radiation at about 200 kilovolts potential, maximum, and are used daily.

Research and Development (R&D) sources at KSC are very limited, and usually are connected with specific, program-related applications of a specialized type. Current planning for STS envisions the use of limited amounts of laboratory tracer fluids and calibration sources at the Hangar L Life Sciences Facility for experimental plant and animal work with radiation levels not greater than millicurie quantities. No other R&D uses are projected at this time.

Launch-related uses of ionizing radiation sources typically involve the use of low-energy calibration sources for flight experiments. Perhaps 50 to 60 percent of all satellite launches employ such sources, since reliable calibration is essential to the mission. Typically, micro- and millicurie quantities are utilized.

Deep-space probes and interplanetary missions from KSC may employ RTG's for the high power demands of long-term space flights. RTG's can be of significant size (75,000 curies or more) and require substantial protection to avoid impact to the environment. Experiences at KSC with these sources include the Apollo Program, Pioneer, Viking, and Voyager launches. Although no RTG's are present at this time, future deep-space missions such as the Jupiter Orbiter Probe (Galileo) will require RTG's. Detailed EIS's for each of these missions are prepared by NASA Headquarters or the appropriate development center.

5.6.1.2 <u>Nonionizing Radiation</u>. Nonionizing radiation sources at KSC include visible and near visible infrared sources (e.g., lasers), electromagnetic radiation [e.g., microwave and radio frequency (rf) transmitters], and ultraviolet radiation (e.g., arc welders). Controls for these sources include technical evaluation of every source and, in some cases, baseline surveys to check for proper operational controls, perform leak checks, and assure that correct procedures exist.

The largest class IV (highest power class) laser at KSC is the Precision Laser Tracking System used to calibrate and test the Space Shuttle Microwave Scanning Beam Landing System. This laser is emplaced at the Shuttle Landing Facility where it is being used to test the operation of part of the landing control system for the Space Shuttle Orbiter. The system has a power output of approximately 50 millijoules per pulse, 100 pulses per second, and can cause physiological damage to humans.

Electromagnetic radiation sources include the S-Band systems for tracking flight vehicles and numerous communicating rf devices. The first sources are at fixed locations having 10-kW transmitters and operating at a maximum of 200 watts. The rf transmitters are distributed throughout KSC and range in operation from milliwatts to 100 watts, maximum.

Ultraviolet radiation sources include xenon searchlights and arc-welding equipment in various locations at KSC.

5.6.2 RADIATION IMPACTS AND MITIGATING MEASURES.

5.6.2.1 Ionizing Radiation. All ionizing radiation sources, regardless of size, are licensed or registered, inventoried, and strictly controlled. Possession and operation of ionizing sources require very stringent registration of machine sources and both state and Federal licensing of material sources. In addition, offsite contractors who operate properly licensed or registered sources at KSC must be certified by the KSC Radiation Protection Officer to do so. Federal regulations involve a number of agencies, including the Nuclear Regulatory Commission and the Department of Energy (reference 5-11).

Except for RTG's, which are maintained in secure storage equipped with air handling systems, security monitors, and personnel access controls at Building M7-1472, ionizing sources of radiation at KSC are placed in buildings throughout the center in proximity to the laboratories and operational areas they serve. For major sources (e.g., RTG's), air handling, security, personnel controls, and other systems for storage are also extended to the use areas, laboratories, launchsites, or wherever the source is located, to preclude any adverse effects. Operations involving launch-related sources which vary from microcurie quantities to large RTG's may utilize controls ranging from a Radiation Control Center for central communications to airborne equipment to detect and track any airborne contamination, a Department of Energy computer program for prediction of any downwind dispersion of airborne particles, and field decontamination and radiation monitoring teams for emergency operation in the event of catastrophic failure of a launch vehicle. These same measures have been employed for every RTG launched from KSC in the past. There have been no incidents involving RTG's at KSC.

Fire department authorities are notified of the existence of radiation material so that safety of firefighting personnel is not endangered by vaporized radioisotopes. Waste material contaminated with ionizing radiation is stored in a designated area at Complex 19 prior to shipment to a Government-designated or approved commercial repository. No onsite disposal of any waste from ionizing sources is permitted. Waste loads are small and shipments are infrequent. A recent shipment of waste which accumulated at KSC over a period of 7 years amounted to fifteen 208-liter (55-gallon) containers. No increase in this rate is expected.

The environmental impacts associated with ionizing radiation sources at KSC could include land, air, and water contamination and subsequent impairment or death of plants and animal life through contact with contaminated substances. The majority of materials are so small that, even in the event of accidental spills or breakage, no significant threat to the environment would be imposed. Nevertheless, all sources are surveyed and approved by the Radiation Protection Officer and are subject to inspection by the Radiation Protection Committee and the Occupational Medicine Environmental Health Services contractor (reference 5-11). Quarterly inventories are made of every onsite source and operators/users are required to undergo training and experience reviews. A dosimetry service (e.g., film badges) is provided on a case-basis for those sources providing enough potential for exposure to require such precautions.

5.6.2.2 Nonionizing Radiation. For nonionizing radiation, electromagnetic emissions at all sites are limited to those required for communication between sites or with the vehicle under test. Intersite communications follow established procedures and regulations as defined by the Federal Communications Commission and other Federal, state and local regulating agencies. Communications with the vehicle under test will conform to current regulations and practices as implemented in the Space Ground Link System and the Space Tracking Data Network. All such transmissions from ground stations are carefully controlled and directed upward toward the vehicle under test by high-gain, directional antennas. Control procedures preclude exposure to rf in excess of 10 mW/cm^2. Due to the low power levels and careful control of assigned frequencies, electromagnetic emissions from rf sources will not affect the environment in an adverse manner.

For the class IV laser, eye hazard is the greatest concern, as in any laser operation. Operational restrictions include minimum eye-safe distance [1,600 meters (5,250 feet)], trained personnel, buddy systems, filtration devices, and controlled procedures to mitigate this impact. Personnel required to work inside the safety perimeter are issued safety goggles for mandatory use.

The American Conference of Governmental Industrial Hygienists Threshold Limit Value 8-hour-per-day exposure of the work force to visible and near-visible ultraviolet radiation (eye hazard) is 1.0 mW/cm^2 for periods greater than 16 minutes (reference 5-12).

To preclude personnel exposure, all xenon searchlight work is done under procedural controls. Arc welders at KSC are certified and standard industrial controls are enforced to preclude physiological damage. Also, OSHA standards are enforced during all arc-welding operations and only certified personnel are permitted to use the equipment. No adverse impacts are expected.

Both ionizing and nonionizing sources have been part of the KSC environment for many years. No change to normal operations is forecast and no effects on the environment are expected.

5.7 SOCIOECONOMICS

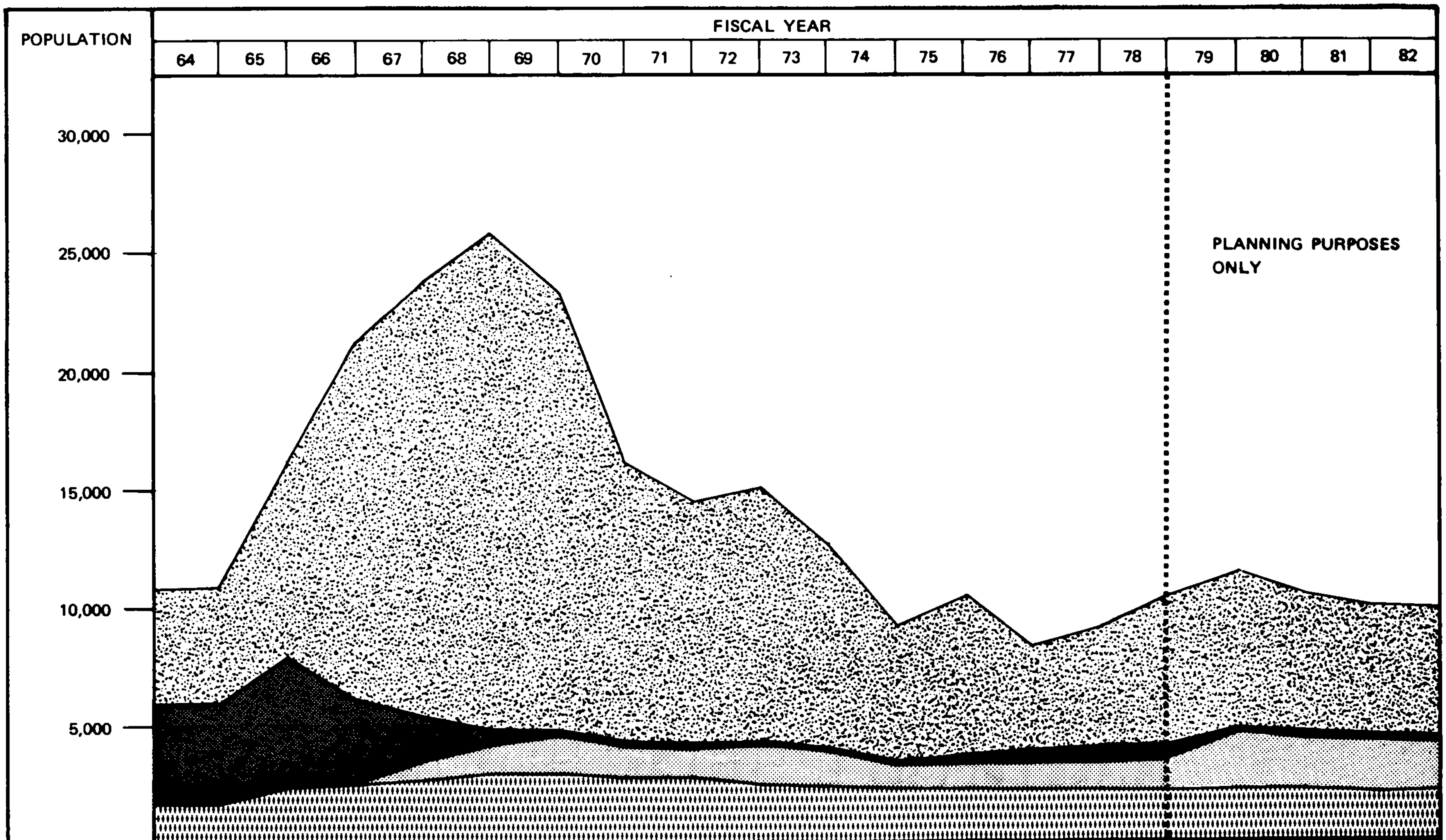
5.7.1 SOURCES OF SOCIOECONOMIC CHANGE. The possible effects of KSC on local socioeconomics can be attributed to three general sources: (1) changes in the work force, (2) changes in wages or type of work, and (3) changes in institutional requirements which reflect on the surrounding communities. All other socioeconomic impacts can be traced to these primary sources.

As stated in 3.5.1, the Brevard County area has experienced a significant amount of cyclical growth and decline due to the influence of space program activities over the past 25 years. Currently, the county is experiencing recovery and growth based on more diversified industry and a broader population base. KSC actions are not expected to introduce significant change to the current socioeconomic status but will continue to provide a mild stimulus as indicated by review of the following specific areas.

5.7.1.1 Work Force Changes. The KSC work force will develop a different skill mix in the coming years, moving from construction and facility activation to launch- and mission-related operations requiring capabilities in advanced technical disciplines. However, the KSC work force is expected to remain relatively stable in number throughout the duration of the STS program. Figure 5-6 depicts recent employment history and current projections for KSC. This figure indicates a stable work force at KSC of about 10,000 employees, of which about 20 percent are civil service and 80 percent are contractor personnel.

5.7.1.2 Changes in Wages or Type of Work. The wages of personnel working at KSC are generally higher than those paid for like skills in the surrounding communities. This is partly due to the orientation of the KSC mission and the requirement for a high degree of specialization within a particular skills classification. Thus, the higher wage scale at KSC provides a potentially greater buying power from the KSC source with the resulting positive economic impact on the surrounding communities. The Department of Labor/Bureau of Labor Statistics has recently completed a detailed survey of wage rates in Brevard County; a sample of the results is shown in table 5-20.

Although construction efforts will decline in the near future, operations contracts will be phasing up for launch and mission activities. Overall effects on contracted work and wages will probably be positive in direction.



	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
TOTAL	10,778	16,071	21,720	23,640	25,767	23,519	16,235	14,470	15,016	12,760	9,271	10,368	8,441	9,376	10,352	12,474	10,450	9,981	9,751
CONTRACTOR	4,743	7,933	15,470	18,164	20,934	18,771	11,920	10,259	10,679	8,647	5,811	6,655	4,534	5,372	6,250	7,459	6,060	5,732	5,582
CONSTRUCTION	4,525	5,870	3,795	1,906	600	312	200	170	200	212	200	243	501	755	532	380	275	200	200
TENANT	TENANT MANPOWER NOT REPORTED			876	1,312	1,515	1,371	1,441	1,670	1,498	951	1,211	1,147	1,034	1,388	2,442	1,908	1,870	1,790
CIVIL SERVICE	1,510	2,268	2,455	2,694	2,921	2,921	2,744	2,600	2,467	2,403	2,309	2,259	2,259	2,215	2,182	2,193	2,187	2,179	2,179

Figure 5-6. KSC Manpower Trends

Table 5-20. Hourly Earnings of Office and Plant Workers in Melbourne-Titusville-Cocoa, Florida, February 1978 1/

Occupation	Number of Workers	Hourly Earnings 2/	
		Mean	Median
Secretaries	111	$ 6.13	$5.88
Stenographers	83	5.27	5.21
Typists	112	4.99	5.09
File Clerks	36	5.28	5.27
Accounting Clerks	13	5.92	6.22
Key Entry Operators	26	5.68	5.55
Computer Systems Analysts	51	9.39	9.41
Computer Programmers	66	6.48	6.23
Computer Operators	70	6.81	7.01
Drafters	157	6.62	6.52
Electronics Technicians	353	8.27	8.36
Engineers	1,315	10.04	9.76
Registered Industry Nurses	14	7.18	7.24
Maintenance Electricians	143	8.16	8.00
Maintenance Machinists	147	8.04	8.02
Truck Drivers	49	6.54	6.46
Warehousemen	218	6.76	6.88
Guards	251	6.27	6.18
Janitors, Porters, Cleaners	149	5.06	5.14

1/ This table extracts data from the Kennedy Space Complex Contractors Wages Survey, Melbourne - Titusville - Cocoa, Florida, dated February 1978. This survey was conducted by the U.S. Department of Labor, Bureau of Labor Statistics. These data are based on a study of establishments with 50 or more workers whose major business is providing goods or services to KSC, AFETR, or PAFB. Occupational classification was based on a uniform review of job descriptions designed to take into account the interestablishment variations in duties within similar jobs. For details of the complete survey and descriptions of the classifications used in this table, contact the Bureau of Labor Statistics, Washington, D.C.

2/ The mean is derived by totaling the earnings of all workers and dividing by the number of workers. The median designates position: half of the workers receive the same or more and half receive the same or less.

5.7.1.3 Changes in Institutional Requirements. Except for a predicted expansion in requirements for utilities and supplies of certain materials as described in section II, no added requirements which would impact surrounding communities are known.

5.7.2 SOCIOECONOMIC IMPACTS.

5.7.2.1 Population and Work Force. While further decline in the population per household is expected due to a declining birthrate and an expanding retiree population, there are indications that the rising age level may slow as economic conditions continue to improve. This will bring the county age makeup in line with the state as a whole. The decision to implement the Space Shuttle program at KSC will continue to affect the population and work force of Brevard County. Present and future employees of the KSC, both civil service and contractor, are expected to establish homes in the area and the work force should stabilize at about the present level. It is also expected that the influx of retirees will continue. Therefore, the ratio of KSC employees to total population will decline and KSC impact will diminish.

5.7.2.2 Wages, Contracts, and the Economy. A review of past and current economic indicators clearly discloses that KSC activities have been significant in the economics of the area since the late 1950's. Though the KSC employment level has stablized in the last few years, the impact of the Space Shuttle and other KSC activities will continue to dominate the area economy. The KSC percentage of total work force is less, but the buying power of this element is still very significant. Even the influx of manufacturing companies into the area can be partially traced to the KSC influence. This is especially true of the recent relocation of electronic firms (some manufacturing space satellite mechanisms) to Brevard County. As major Space Shuttle facilities construction nears completion, there will be construction employment reductions, although there will be some demand for these skills during the operational phase for minor facilities and modification. However, the reduction in construction employment is expected to be offset by increased requirements for operational skills.

The full extent of Space Shuttle payload developers and users cannot be exactly determined. It is expected that numerous research investigators/experimenters will be transients of the area while their respective payloads are being prepared for launch. Their parent companies, universities, or research institutions may decide to establish laboratories in the area. Based on past experience and the relationship between the salary levels of aerospace workers and other employees in Brevard County, KSC activities are expected to produce a mildly stimulating effect on the local economy.

5.7.2.3 Requirements on the Surrounding Community. Although changes at KSC are not expected to place further demands on the surrounding infrastructure, housing, public services and recreational facilities will continue to be utilized and influenced by KSC employees. Analyses of these areas follow.

a. Housing. Construction data indicate that the Brevard County area is experiencing a housing boom. Whether this trend will continue at the current rate is questionable, although there are definite indications of a continuation of current building levels in the immediate future based on an increase in county rezoning and site plan activity. Most of the condominium construction is taking place along the Atlantic Ocean beach front, but areas providing access to the Indian and Banana Rivers and to manmade canals are also being developed. The occupants of condominiums are not necessarily the owners. Many absentee owners purchase them specifically for income property and for future retirement occupancy. Some condominiums are already occupied by professional, scientific, and technical people on temporary assignments in the area and this situation is expected to continue throughout all phases of the Space Shuttle program.

   Well-planned housing developments are being occupied shortly after completion by recent arrivals and by longtime residents wishing to improve their living quarters. Much private dwelling construction is taking place in the more remote areas of the county and is expected to continue.

b. Public Services. Basic capabilities developed during the Apollo era to meet public needs still exist, but some shifting of demand areas is taking place. For example, falling student enrollment has resulted in the closing of some schools, although this decline appears to have stabilized. Use/demand for hospital beds is cyclical, responding to outbreaks of influenza and other viruses. One public service area requiring attention is public transportation. Presently there are only limited systems in the county or municipalities, and the need for such a service will increase, although not in direct response to KSC needs.

c. Recreation. As with public services, the operation of KSC with its accompanying population places a demand on the local government to provide recreational facilities in addition to the the area's natural recreational resources (i.e., beaches, woodlands, rivers, and lakes).

   KSC has established an employee recreational area to meet the requirements of the work force for outdoor recreational activities, as outlined in 3.5.5, and cooperative agreements with the U.S. Fish and Wildlife Service and the National Park Service have made large areas of KSC available to the public.

KSC will impact the Canaveral National Seashore and the Merritt Island National Wildlife Refuge in the future, as has been the case for the past. The public is restricted from access to the Playalinda Beach and certain surrounding wildlife viewing areas, plus duck hunting and fishing sites, during launch activities (see table 4-1), and some areas of the Space Center are closed to the public at all times. This practice will continue to be necessary for the protection of the public and the security of NASA installations. No significant impact has been experienced in the past and none is anticipated for the future. Furthermore, as experience is gained on the operational STS, these restrictions will be relaxed to the maximum extent practicable.

5.8 WEATHER

5.8.1 SOURCES OF WEATHER CHANGE. As a result of studies to determine possible environmental effects of the STS launch activity, two potential effects on climate have been identified with the ground cloud which results from an STS launch. Acidic rain and inadvertent weather modification, while only remote possibilities not yet fully understood, present potential effect areas requiring more analysis.

5.8.1.1 Acidic Rain. Recent measurements of rain at KSC show that values are averaging a pH 4.7, thought to be in the neighborhood of one full point lower than rains of 10 years ago. A liquid having a pH value of 7.0 is neutral, being neither acidic nor basic. As the acidity increases, the pH value lowers and each full digit on the scale is 10 times more acidic. A raindrop containing no impurities but in equilibrium with atmospheric carbon dioxide will attain a pH of 5.7, so KSC measurements show 10 times more acidity than a "natural" raindrop. The mechanism by which rains are becoming progressively more acidic in the eastern half of the United States is not known but is generally assumed to be due to increased output of sulfur dioxide and nitrogen oxides from manmade sources such as burning fossil fuels and effluents of automobiles. This trend is important to the continued health and welfare of flora and fauna in the area, so investigations have been undertaken to ascertain the possible effects which the Space Shuttle might introduce.

According to models of the exhaust cloud and the meteorology of the KSC area, the Space Shuttle exhaust cloud can lead to a special type of acidic rain. Depending on atmospheric conditions, the exhaust cloud could (1) entrain enough water to generate a light rain or mist, (2) encounter rain from a higher stratum cloud, or spray-blown rain or mist, or (3) be convected into a rain-generating cloud. The rain or mist precipitated from any of these occurrences would be acidic. Modeling of acidic rain potential has resulted in conclusions that rain acidities of pH less than 1.0 are possible at distances of up to 20 km (12 miles) from the launchsite under certain meteorological conditions (see figure 5-7 and table 5-21). This is a worst-case condition where volumetric average maximum acidity levels for initial rainfall are centered through the ground cloud. The final acidity is a function of progressive washout of the ground cloud, the diluting effect of subsequent rainfall, and, for rainwater contacting the ground, the buffering capacity of the soil.

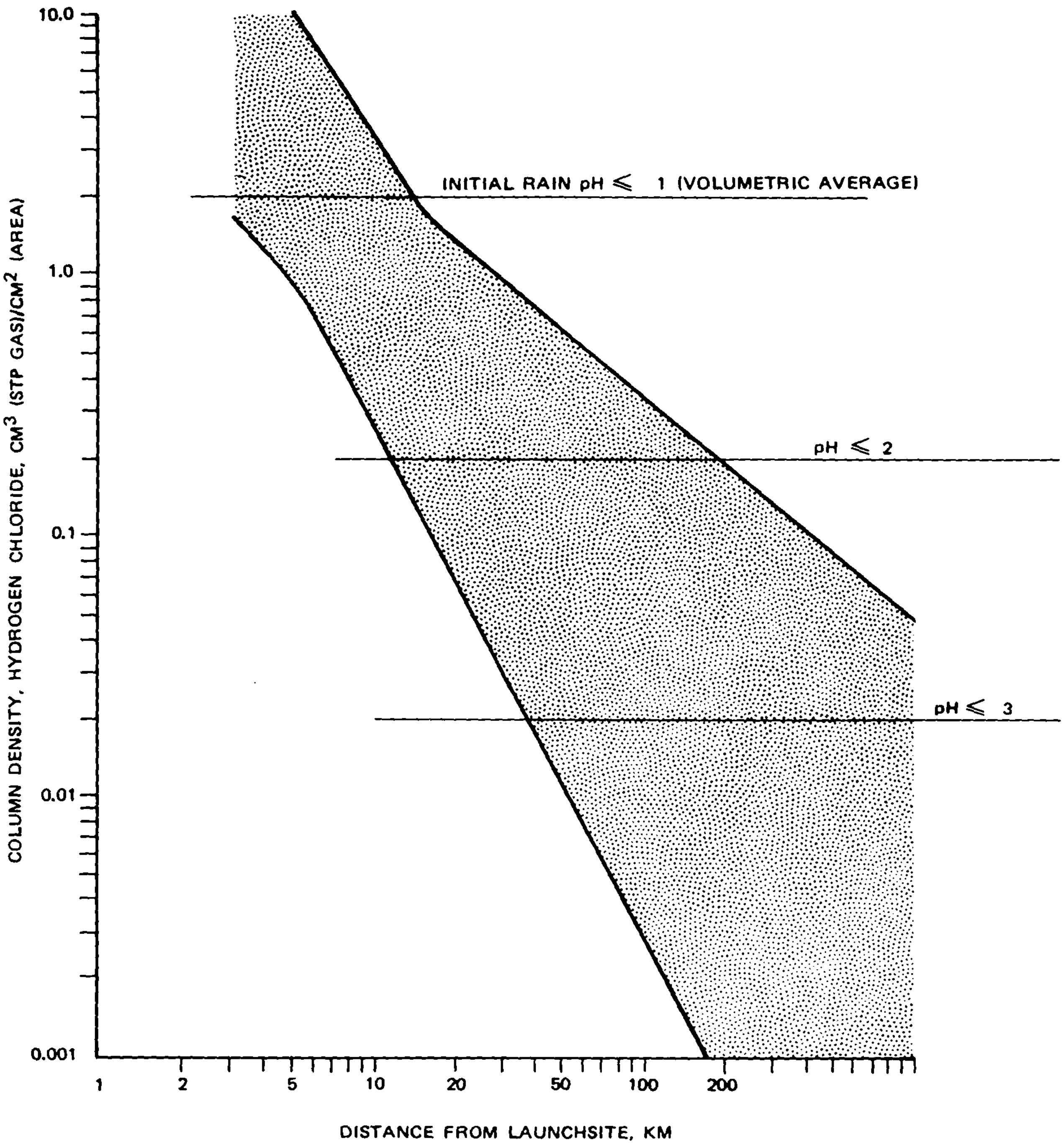


Figure 5-7. Envelope of Potential Acidic Rainfall

Table 5-21. Model Estimates of Minimum pH (Maximum Acidity) of Surface Rainwater 1/

Distance (kilometers)	Rainfall Rate (centimeters per hour)									
	0.508 cm		1.27 cm		2.54 cm		3.81 cm		5.08 cm	
	T	S	T	S	T	S	T	S	T	S
1	2.937	0.515	3.113	0.691	2.137	0.825	2.349	0.905	1.683	1.711
2	0.600	0.232	0.776	0.416	0.900	0.561	0.985	0.649	1.031	0.713
3	0.496	0.268	0.680	0.454	0.823	0.600	0.910	0.689	0.971	0.754
4	0.584	0.358	0.768	0.544	0.912	0.691	0.999	0.780	1.063	0.845
5	0.656	0.429	0.840	0.615	0.984	0.762	1.072	0.852	1.135	0.917
6	0.716	0.488	0.900	0.674	1.045	0.822	1.132	0.911	1.196	0.977
7	0.769	0.539	0.953	0.726	1.098	0.873	1.185	0.963	1.249	1.029
8	0.815	0.584	1.000	0.771	1.144	0.919	1.232	1.008	1.296	1.074
9	0.857	0.625	1.042	0.812	1.187	0.959	1.274	1.050	1.338	1.115
10	0.895	0.662	1.080	0.849	1.225	0.997	1.313	1.087	1.377	1.153
12	0.963	0.728	1.148	0.915	1.293	1.063	1.381	1.153	1.445	1.219
14	1.022	0.785	1.207	0.972	1.352	1.120	1.440	1.210	1.504	1.277
16	1.074	0.835	1.259	1.023	1.404	1.171	1.493	1.261	1.557	1.327
18	1.121	0.881	1.306	1.068	1.452	1.216	1.540	1.307	1.604	1.373
20	1.164	0.922	1.349	1.110	1.495	1.258	1.583	1.349	1.647	1.415
30	1.338	1.089	1.523	1.277	1.669	1.426	1.758	1.517	1.822	1.583
40	1.469	1.215	1.655	1.403	1.801	1.552	1.890	1.644	1.955	1.711
50	1.576	1.317	1.762	1.506	1.909	1.655	1.999	1.747	2.064	1.814

1/ Due to precipitation scavenging of HCl from Titan III (T) and Space Shuttle (S) ground clouds. Meteorological inputs were obtained from the 1824Z Rawinsonde on 9 Sept 1975 (Viking B launch).

5.8.1.2 Inadvertent Weather Modification. The potential for weather modification as a result of individual Space Shuttle launches and the cumulative effects of up to 40 launches per year have been the subject of recent studies by NASA in cooperation with the National Oceanic and Atmospheric Administration (NOAA), the Naval Weapons Center Laboratory at China Lake, State University of New York, University of Michigan, University of Washington, and Colorado State University.

Assessments to date have been oriented towards theoretical aspects of the topic, involving cloud physics, nucleation mechanics, and cloud chemistry about which confirmed data are sparse. Instrumentation has been employed in laboratory work, cloud chamber analysis, and airborne in situ data gathering on Titan launches at KSC since mid-1977. Attempts have been made to determine the activity and time duration of ice nuclei and cloud condensation nuclei resulting from solid rocket exhaust. To date, the results of this work have been inconclusive. Estimates have been made using currently available sources in this field which suggest that Space Shuttle ground clouds have the potential to modify local weather patterns for up to 48 hours after lift-off. Other data indicate that the number and relative activity of the cloud nuclei decline significantly within 3 to 5 hours after launch (reference 1-3). Such modification could include initiation, intensification, or suppression of rainfall, depending on local meteorological conditions.

In either case, no large-scale or long-range weather modification is foreseen, but studies are continuing to define this potential impact source more fully.

5.8.2 WEATHER IMPACTS AND MITIGATING MEASURES.

5.8.2.1 Acidic Rain. The effects of acidic rain are determined by many factors, known and unknown, involving the receiving environment. In order to assess potential effects from acidic rain, KSC has initiated studies of worst-case conditions. The possible effects of acidic rain on a producing citrus grove are being studied by the U.S. Department of Agriculture at North Carolina State University. A good producing, uniformly mature grove of citrus was selected on Merritt Island. This test area was subjected to 4 levels of simulated acidic rain to determine the immediate and long-term effects on fruit set, productivity, and abscission of flowers, leaves, and fruit. Initial examinations indicate that while some permanent damage may occur where the pH of rain is 0.5 or less, citrus appears relatively tolerant of pH equal to or greater than 1.0 and is essentially undisturbed by pH equal to or greater than 2.0. Table 5-22 presents preliminary data gathered in April and May of 1978.

Trees were initially sprayed (S-1 treatment) in early April when fruit was mature and the trees were in full flower with young foliage. A second set of trees was sprayed (S-2 treatment) in mid-May, after fruit set, and when many young leaves had begun to mature. In both treatments (S-1 and S-2), there was a complete loss of flowers and young fruit at a pH of 0.5. At a pH of 1.0, fruit set was about 50 percent of that of the control plants for both the S-1 and S-2 treatments. Fruit production in 1979 reflected those 1978 fruit set data.

Table 5-22. Effect of HCl Solutions on Leaf Drop and Yield of Valencia Orange Trees 1/

HCl Solution	Leaf Drop (%)		Yield (Boxes) 2/	
pH	S-1	S-2	S-1	S-2
7.8	9.2	8.0	4.26	4.57
2.0	12.9	21.0	4.23	4.57
1.0	28.3	42.9	4.32	4.04 (0.16)
0.5	85.4	50.9	0.48 (0.00)	3.96 (0.34)
(LSD P=0.05)	6.3	9.1	0.42	0.49

1/ Plants were treated in early April at flowering (S-1) and after fruit set (S-2), just prior to harvesting the mature fruit.

2/ Mature fruit which dropped from the S-1 (April) spray was not marketable at the May 10-15 harvest and was not harvested. Mature fruit which dropped from the S-2 (May) spray was marketable and is shown in parentheses. Fruit sustaining the 0.5 and 1.0 pH solution was suitable only for juice processing in both the S-1 and S-2 treatments.

A program to monitor rainfall and provide chemical analyses of cations and anions (positively and negatively charged ions) of major interest has been initiated at KSC. Data collected since July 1977 are being compiled, analyzed, and computer-logged to provide a baseline of existing rainfall conditions for as long as can be obtained prior to the first Shuttle launch (references 3-5 and 5-13). During the initial flight phase of the program, a multiple station network will be used to monitor rainfall in the KSC area to ascertain any effects attributable to the Space Shuttle launches. Onsite observation of identified reference stands of vegetation will also be monitored to observe changes and attempt to identify causes.

Other very localized but possibly longer range effects of acidic rain can be conjectured. Some impact on soil chemistry from low pH water percolating through soil is a possibility. Acid might leach certain elements, including nutrients, from the soil. Acid conditions might also change the chelating capacity of the soil. Both of these effects, if they occurred, could alter the ability of the soil to support plant growth. Although these effects are expected to be minimal and would certainly be highly localized, they deserve investigation and have been the object of soil chemistry studies conducted by the University of Central Florida under contract to KSC.

An evaluation of the effect of repeated HCl washouts from SRM exhaust clouds on five KSC soils was made. Assuming worst-case conditions (including the case where the washout from all 40 launches in a year fell on the same square meter of soil), investigators conclude that zinc, sodium, calcium, and magnesium could be leached from the soil. Aluminum, iron, cobalt and lead would not be mobilized appreciably. Furthermore, moderate acid concentrations (10^{-3} molar) significantly reduce the leaching of all elements tested (references 5-13 and 5-14). The neutralizing capability of the soils is substantial.

Since the soils are derived from marine deposits, acidic rains should initially have little effect on the soils because the hydrogen ion will be rapidly neutralized. Over a period of time and continued application of a quantity of acidic rain the soils could be expected to change character, and this could have an effect on the terrestrial ecosystems described in 3.4.2. However, deposition of HCl is dependent on meteorological influences, so it would not be anticipated that all of the HCl will be received repeatedly on a single area. The addition of the chloride ion to soils of the KSC area will probably not be as evident as the hydrogen ion addition, since the soils are fairly saline to begin with. The ecosystems are populated with salt-tolerant plant species and the further addition of the chloride ion will probably not substantially influence their existence. Ground water in the KSC area is characterized by a high water table, but water quality is initially poor (see 3.3.2) so that further degradation due to the chloride ion addition will be insignificant. It would be expected that the hydrogen ion entering the ground water would be rapidly neutralized as the water moves through calcareous (acid-consuming) deposits.

An artesian aquifer, the Floridan Aquifer, underlies the KSC area. Recharge of this aquifer occurs only at specific sites, so the acidic rain would have to occur in these areas before any effect on the aquifer could be noted. It is unlikely that the acid rain would influence water quality of the aquifer since it is at a depth of several hundred feet and is overlaid by calcareous material. This particular aquifer does have localized high chloride ion levels because of salt water intrusion along a fault, so further addition of the chloride ion would not unduly degrade the water quality of this aquifer.

An acidic rain of pH less than 1.0 from the Space Shuttle exhaust cloud will almost certainly be highly localized and temporary in duration. It is expected that the effect of acidic rain having such a low pH would be damage to vegetation, with long-term effects to the soil resulting only after prolonged exposure to repeated highly acidic rainfall. The variation in meteorologic conditions at KSC and the number of Shuttle flights make this possibility very unlikely. Evidence acquired during measurements of Titan exhaust clouds indicates that the hydrogen chloride in the ground cloud will be neutralized by atmospheric ammonia within a few days. Control of acidic rain in the general region of the launchsite can be achieved by the proper consideration of meteorological conditions at launch. Constraints could be imposed on launch schedules if warranted. Studies to define and understand this effect area further are continuing.

Concern over the potential effects of acid rain is an issue on which extensive research has been conducted, including the following typical citations for acid rain literature:

USDA Forest Service, "Proceedings of the First International Symposium on Acid Precipitation and the Forest Ecosystem", General Technical Report NE-23, Upper Darby, PA, 1079 pp., 1976.

Braekke, F. H., "Impact of Acid Precipitation on Forest and Freshwater Ecosystems in Norway," Research Report No. 6, Acid Precipitation - Effects on Forests and Fish, Aas, Norway, 111 pp., 1976.

Likens, G. E., "Acid Precipitation: Our Understanding of the Phenomenon," Proceedings of the Conference on Emerging Environmental Problems: Acid Precipitation, EP-1 Cornell University, EPA 902/9-75-001, 1976.

Galloway, J. N. and E. B. Cowling, "Effects of Acid Precipitation on Vegetation, Soils, and Water - A Proposed Precipitation Network," Air Pollution Control Association Journal (In press), 1979.

Although most work on acid precipitation to date has been done using H_2SO_4, comparable studies using HCl indicate that similar pH levels of H_2SO_4 and HCl cause about the same injury to plants, and results from H_2SO_4 work may be used to indicate what HCl would do.

Analyses of local soil buffering capability, coupled with the testing conducted on producing citrus groves at KSC, have provided indications that acid rains, if they occur, are unlikely to cause measurable effects on the growth or productivity of vegetation in the area. The pH of rainfall would have to be less than 1.0, on a repeated basis, involving the same area of land for noticeable impacts to be generated. The meteorology of the Merritt Island area and the very low likelihood of an acid rain event caused by the Space Shuttle make the probability of repeated doses of acid rain on the same vegetated area extremely small.

Furthermore, discussions with principal investigators from the U.S. Department of Agriculture at North Carolina State University and consultations with the American Institute of Biological Sciences indicate that the studies of the effects of HCl gas on plants (see tables 5-11, 5-12, and 5-13) and the high chloride content naturally occurring in the KSC environment provide further evidence that effects of acid rain generated by the Space Shuttle will probably be negligible, especially on native species.

NASA has established an extensive, in-depth monitoring program to detect and evaluate any impacts associated with acidic rain when and if it occurs. If it is determined that levels of acidic rains are significantly increased as a result of KSC operations, launch schedules can be altered to avoid incompatible weather patterns.

5.8.2.2 Inadvertent Weather Modification. A program to perform additional in situ ground cloud sampling is now underway to resolve conflicting data taken on previous experiments and to draw conclusions about the nucleating capabilities of the Shuttle ground cloud. Until these data are interpreted, no final determination of the potential for weather modification can be made. However, some planning can be accomplished and, if weather modification becomes a concern, mitigating methods can be employed.

The program of rainfall monitoring and collection, already underway at KSC (July 1977 to present) to establish a baseline for analyses of acidic rain, may provide meaningful ground-based observation for weather modification studies. In the event that conclusive evidence cannot be obtained, it may be possible to choose launch times which coincide with favorable meteorological conditions and so eliminate the possibility of weather modification. Because there are no firm data on which to make decisions, no mitigating actions are planned at this time.

5.9 ECOLOGY

To enable a comprehensive assessment of the collective effects of the potential environmental impacts on the abiotic and biotic elements and on the health and welfare of the human population of KSC and its environs, conclusions based on past experience, computer models, and ongoing studies are presented here for the known and predicted environmental impacts from present and future scheduled KSC operations.

The assessment can be most readily and realistically accomplished by evaluating individual activities and drawing conclusions on the basis of activity-oriented impacts. Except for Space Shuttle launches, this approach is valid for three reasons: (1) many activities occur which are entirely independent of other operations, (2) facilities are widely separated and dispersed over 56,650 hectares (140,000 acres) of land and water, and (3) many of the major activities occur at infrequent intervals (the maximum rate of 40 STS launches per year is not expected until 1984 at the earliest).

Since a preponderance of potential impact-producing events occur at or near launch time, analysis is focused on this event and, where predictable, potential long-term and cumulative effects are identified and assessed.

5.9.1 ABIOTIC EFFECTS. The abiotic elements of the environment are those nonliving elements such as air, water, land, chemical elements, weather, and other physical attributes. The major potential impacts imposed by an STS launch are expected to affect air quality, and possibly, precipitation; specifically, exhaust effluent impact from the Space Shuttle launch ground cloud and acidic rain occurring as a result of uncommon meteorologic conditions. The potential for inadvertent weather modification has not been shown to be substantial enough to measure and no cumulative effects are expected.

Two factors operate to reduce the cumulative and long-term abiotic effects which might occur as a result of the pollutants introduced into the environment during the periodic STS launches. First, the meteorology of the KSC area is extremely variable, which improves the capacity for atmospheric dispersion;

and second, KSC contributes less than 10 percent of the overall pollutant loading of Brevard County (see 3.1.3, 3.2.1, and table 5-7). Considering the meteorology of the area and the periodicity of STS flights, and thus, the infrequency with which any one area could be repeatedly impacted by the ground cloud, there is no reason to believe that there will be any long-term or cumulative effects from either exhaust effluents or acidic rain.

If cumulative effects were to occur from the exhaust effluent or, indirectly, through repeated exposure to acidic rain, abiotic elements would be expected to exhibit measurable changes which would increase in magnitude over time. Baseline data which are being accumulated prior to the initiation of STS activities (see section III) could then be used for comparisons and analyses with the current information. For this reason, the field monitoring of air quality, water quality, and precipitation will be continued into the operational period.

5.9.2 BIOTIC EFFECTS. A realistic view of launch operations must be assumed with respect to the biota (plants and animals) and their habitat in the immediate vicinity of any launch complex. Ecological damage is to be expected within a 1,000-meter (3,300-foot) radius of the launch pad. The level of damage expected for STS launches is consistent with that experienced over the past 12 years of launch activities; searing of vegetation and probable injury or death to fauna at 200 to 300 meters (656 to 984 feet) within the path of the flames and interruption of faunal activities within the 1,000-meter radius for 2 to 10 minutes during launch.

Except for the launch pad vicinity, and those portions of land designated for development and construction (see section II), no significant effects on biota are expected as a result of KSC activities.

5.9.2.1 Special Precautions to Protect the Biota. NASA has instituted many procedures, and others are planned, to protect the KSC biota. To ensure that biotic elements of the current environment will not be significantly disturbed by future activities, NASA has contracted with the University of Central Florida for a comprehensive description of the ecology of the KSC area. Ten permanent reference stands, four animal trapping grids, and periodic fish trawls of the waters are providing an extensive data base (reference 5-13). Follow-on monitoring will be performed to determine what changes take place over a given time period. Correlation with the field monitoring for abiotic elements may enable investigators to assess cause-effects relationships; changes will be detected and appropriate action will be taken if adverse impacts are determined to have been induced by KSC activities.

In addition to these actions, executive orders governing construction in floodplains and wetlands are fully implemented at KSC. Each project is individually assessed and appropriate procedures in accordance with Office of Management and Budget circular A-95 for notification to state agencies are exercised for any proposed floodplain or wetlands construction.

5.9.2.2 Endangered and Threatened Species. Largely because of the protection of habitat afforded by Federal control of lands and waters within the KSC area, 11 species of fauna on the U.S. Department of the Interior list of

Endangered and Threatened Species are found at KSC. Maintaining industrial and research/development activities in harmony with these elements of the environment is a constant challenge. Contributing significantly to a better understanding of the impacts imposed by KSC operations are the baseline studies performed by the University of Central Florida, and surveys by the U.S. Fish and Wildlife Service, Merritt Island National Wildlife Refuge; and the National Park Service, Canaveral National Seashore.

In accordance with the provisions of the National Environmental Policy Act and the Endangered Species Act, KSC assesses each project for potential impact on the environment, with special emphasis on endangered and threatened species. These assessments determine whether consultation with the Department of the Interior, U.S. Fish and Wildlife Service, is required. Due in part to the location of critical habitat at KSC and because the potential for impacts exists for the Florida Manatee and the Dusky Seaside Sparrow, these species have been the subject of consultations with the Department of the Interior to ensure that no KSC operation jeopardizes the continued existence or adversely modifies the habitat of either.

a. Particular care is given to KSC operations which take place adjacent to or within waters which provide habitat for the Florida Manatee (see appendix C). Barge and marine support operations will operate at restricted speeds and shallow water operations will be prohibited. This type of traffic is expected to be about the same volume as was experienced during the Apollo program. Retrieval vessels designed for SRB and parachute recovery will be equipped with propellor guards and recessed steering units to avoid inflicting the cuts which are the major cause of Florida Manatee deaths.

b. The Dusky Seaside Sparrow (see appendix C), with its critical habitat located in the St. Johns River basin, will be subjected to the low-level sonic boom generated by Orbiter reentry and landing. The sonic boom in that area is expected to resemble the thunderclap which accompanies a lightning strike, a natural phenomenon very common in this region. For this reason, no adverse reactions are expected. However, field monitoring will be attempted in coordination with the U.S. Fish and Wildlife Service to ensure that no adverse impacts occur.

c. All executive orders with respect to restrictions on construction in floodplains and wetlands will be complied with at KSC.

Based on experience over many years with similar operations in the KSC area, along with a very low probability of any new impact from STS activities which could introduce effects of cumulative or long-term consequence in the abiotic areas, no new or significant long-term or cumulative impacts are forecast for the biota of the region. Automobile traffic is responsible for occasional road kill of local fauna. Infrequent episodes of ground-level exhaust effluent deposition or acidic rainfall might cause minor effects to flora (abscission of leaf and blossom) but are not expected to affect adversely the fauna of the impacted area. The low-level boom produced by Orbiter reentry should be indistinguishable from natural weather phenomena in the area. There are no indications that endangered or threatened species will be subjected to stresses which could result in adverse reactions.

5.9.3 HUMAN HEALTH AND WELFARE. Work for the space program at KSC entails operations using toxic substances, explosives, massive machinery and equipment, flammables, corrosives and caustics, and a variety of special processes, as detailed in appendix D. While many of the activities involve standard industrial practices, some are highly specialized and represent new or unique applications or approaches. All operations classified as "hazardous" and which represent a potential threat to human health and welfare undergo rigorous scrutiny and control by two organizations at KSC; the Safety, Reliability and Quality Assurance, and Protective Service Office and the Biomedical Office. Equipment design, procedural controls, training, certification, and operational safety practices serve to reduce the risks to the work force; the KSC safety record is justifiably a matter of pride.

The potential impacts predicted from KSC operations for the future are similar to those which have existed for prior programs, with the exception of thermal protection materials used in the SRB refurbishment and subassembly operation and an increase in the quantities of some substances already being used. Controlled access, positive badge-exchange systems, and real-time predictions for airborne pollutants are tools used to minimize the potential for impact to human health and welfare. Results from plant exposures to solid rocket fuel exhaust (see reference 5-3) indicate that no substantial decrease in agricultural plant productivity in the area is expected from atmospheric pollutants generated by Space Shuttle launches. Nothing in the exhaust is known to be a potential contaminant to food crops. In view of the geographic isolation of hazardous operations coupled with predictions showing that exposure limits established for the specific impacts of concern are not expected to be exceeded (see 5.2 and 5.5), no significant adverse effects on human health and welfare are expected. The reentry sonic boom will be experienced by the general public and advance announcements will help to reduce the startle effect which might otherwise occur.

In order to assure that no adverse impacts are imposed on the population surrounding KSC, a monitoring program has been established to deploy stations into areas outside KSC boundaries to perform environmental measurements. Ambient air quality (with specific emphasis on hydrogen chloride and particulate detection), precipitation chemistry, and sonic boom levels will all be monitored and compared with baseline data now being collected to determine whether any change attributable to KSC operations is occurring. Based on the information presented in earlier paragraphs of this section, no significant impacts to human health or welfare are expected.

5.10 UNPLANNED EVENTS

The discussion thus far has focused on impacts from events which occur as a normal, planned part of KSC operations. An unplanned event, for the purposes of this document, is defined as any mishap within KSC which has a negative impact on the environment, disrupts mission scheduling, or imperils human health or welfare. An unplanned event at KSC would probably result from human error or equipment failure. Recognizing these sources, NASA has instituted measures to forestall such occurrences to the maximum possible extent. It is also recognized that despite the regulations and procedures described herein, unplanned events can occur. The mitigating measures that are available in specific facilities are described in detail in appendix D and are not repeated here. Furthermore, the diversity of activities at KSC makes a discussion of all imaginable unplanned events an impossible task. To provide an understanding of the nature of potential mishaps and the actions which would be taken, two categories of unplanned events are described, along with examples of specific actions which might be taken.

5.10.1 POTENTIAL MISHAPS IN DAILY OPERATIONS. The following unplanned events, although not as serious as "worst-case" occurrences, have a higher probability of happening because of the statistical frequency of performance of daily operations.

a. Traffic accidents

b. Facility fires

c. Human contact with, or inhalation of, a toxic or caustic substance

d. Rupture of a high-pressure line

e. Facility damage or personal injury from heavy lifting and moving operations

f. Falling objects, elevated workstand hazards

The effects of these events could range from minor, local disruption of activities to the death of local flora and fauna, destruction of habitat areas, and the possible loss of human life. No effects are expected to reach beyond KSC boundaries.

To preclude problems and avoid accidents, KSC provides extensive work force training and operator certification programs, comprehensive procedural coverage for all planned activities, safety and quality control inspections, spill prevention, control and countermeasure plans, contingency plans, and active operations monitoring.

5.10.1.1 <u>Safety Precautions</u>. KSC maintains a Safety Office which constantly monitors the area for safety violations. This group periodically issues bulletins describing hitherto unrecognized hazards or observed unsafe practices. Medical and firefighting personnel and equipment are available on base for emergency response. The substances involved in a personal injury or a fire are made known so that proper action can be taken. In the case of a major release of toxic vapors, the services of meteorologists are immediately available to predict the movement of the effluent so that the affected area can be cleared. All facilities where an employee could be injured by accidental contact with chemical substances are equipped with emergency showers and eyewash fountains. Facilities where an explosion or fire could occur are equipped with automatic deluge systems in addition to the standard fire hoses and fire extinguishers. Facilities which could experience the release of colorless, odorless gases are equipped with detectors which sense the dangerous condition and alert the area with visible and audible signals. Whenever hazardous operations are required, a safety zone is established in advance and noninvolved persons are dismissed from the area. Such operations are scheduled for periods when casual traffic is at its lowest. Finally, all persons whose duties could require them to encounter a hazardous situation are required to attend classes and lectures to acquaint them with the use of safety equipment and the escape routes and procedures for a particular area.

5.10.1.2 Hazardous Operations Controls. Specific task-related actions which are closely monitored and controlled are:

a. Lifting Equipment. To lessen the probability of lifting equipment failure, all cranes, derricks, hoists, forklifts, and elevators are periodically inspected and certified.

b. High-Pressure Lines. Lines used to transfer high-pressure gases and liquids are inspected and certified to ensure meeting the applicable burst, proof, and operating pressure. In addition, most substances are delivered through panels which measure and indicate the pressures within the lines and containers and permit isolation of malfunctioning portions of the system.

c. Flight Hardware. All flight hardware components which provide critical functions are inspected, tested, and monitored by sensing devices from installation to lift-off.

d. Movement of Equipment. Many operations in several locations at KSC require the lifting, transporting, and emplacing of equipment. Each such activity is governed by written procedures and safety requirements which are monitored and enforced by supervisory and safety personnel.

e. Liquid Propellant Handling. The handling of liquid propellants receives particularly close supervision. Not only are the technicians constantly observed, but safety perimeters are installed to exclude unauthorized persons from the danger zone. In the case of hypergolic fuels, all facilities and operations are designed to isolate the fuel handling from the oxidizer handling. Possession of flammable materials (matches or lighters) is forbidden in restricted areas. Inadvertent small spills are immediately removed by equipment assigned to the area for that purpose. All propellant storage areas are prominently identified and the appropriate restrictions are posted. Wherever incorrect substances could be delivered into a connection, mechanical design is used to make such an occurrence impossible.

f. Toxic Fumes. Mixing and loading operations can generate or release toxic fumes. All chemical mixing areas are equipped with air handlers, fans, and vents to collect, remove, and treat toxic fumes. Protective clothing and equipment are issued to all operators. Loading operations take place in the open air so that the leakage that can occur when lines are connected and disconnected will dissipate harmlessly.

g. Falling Objects. Hardhat areas are clearly identified and monitored. Personnel working on elevated platforms are required to tether handtools and are forbidden to carry small objects (lunchboxes, vacuum bottles, etc.) aloft. All open areas and pits are identified by warning signs and where possible protected by barriers.

During the 20 years of operations at KSC, there have been minor unplanned events. These occurrences were thoroughly investigated and measures were instituted to prevent the repetition of a similar mishap.

5.10.2 WORST-CASE UNPLANNED EVENTS. The following unplanned events have been categorized as "worst-case" possible occurrences:

a. Launch pad abort, with explosion and fire

b. Accidental ignition of SRM propellant segments

c. Propellant spills or storage tank rupture

d. Ignition of uncontrolled amounts of hypergolic fuel and oxidizer

e. Orbiter crash in the KSC vicinity

Each of the foregoing events is described and results are analyzed in the following paragraphs. For additional data on flight-related failures, see reference 1-3.

5.10.2.1 Launch Pad Abort, With Explosion and Fire. The most serious consequence of an on-pad fire involving the entire Space Shuttle vehicle would be the release of toxic combustion products from the SRB's. The large heat release associated with the burning of the main engines' propellants will assist the cloud of combustion products in rising to a high altitude. Although the quantity of SRB combustion products released at ground level will exceed that released at or near ground level in a normal launch, the additional heat and cloud rise contributed by the main engines' propellants will compensate in terms of ground-level concentrations of hydrogen chloride and chlorine. Analyses of on-pad solid propellant fires have shown that even in the absence of an associated liquid propellant fire, the public emergency exposure limits are not exceeded at ground level. The "worst-case" result of an analysis for an SRB fire at the KSC launchsite, using weather data for 1969, was performed by Marshall Space Flight Center and is given in table 5-23 (reference 1-3).

Table 5-23. Model Predictions of HCl Concentration for an STS Slow Burn 1/

Range (m)	Azimuth Bearing (deg)	Time of Cloud Passage (sec)	Approx 10-Min Time - Mean Concentration (ppm)	Maximum Peak 2/ Concentration (ppm)	Maximum Dosage (ppm-sec)
2,000	145.7	210.035	0.000	0.000	0.000
3,000	144.7	214.781	0.002	0.010	1.296
4,000	144.8	223.426	0.054	0.249	32.402
5,000	145.4	235.616	0.182	0.794	109.062
6,000	146.0	250.873	0.312	1.281	187.006
7,000	146.7	268.679	0.404	1.544	242.289
8,000	147.2	288.540	0.451	1.607	270.350
9,000	147.6	310.066	0.464	1.541	278.383
10,000	148.0	332.942	0.455	1.411	273.128
11,000	148.4	356.923	0.440	1.258	264.134
12,000	148.8	381.799	0.411	1.107	246.810
13,000	149.1	407.409	0.383	0.970	230.440
14,000	149.4	433.618	0.357	0.850	214.744
15,000	149.7	460.329	0.331	0.747	199.853
16,000	150.1	487.465	0.310	0.660	187.538
17,000	150.3	514.938	0.289	0.586	175.831
18,000	150.6	542.698	0.271	0.523	165.404
20,000	151.0	598.931	0.239	0.424	148.082
22,000	151.4	655.886	0.212	0.350	133.806
24,000	151.7	713.385	0.189	0.294	121.980
26,000	152.0	771.323	0.170	0.250	112.376

1/ NASA/MSFC Multilayer Diffusion Model, using meteorology from 7:00 p.m., 5 Mar 1969

2/ The largest value of hydrogen chloride (HCl) found for any of the cases was 1.6 parts per million (ppm).

Explosions on the launch pad might achieve significant blast effects under special circumstances. Such circumstances would be those that lead to sudden rupture of the ET. Toppling of the Space Shuttle or some gross structural failure of the ET or its supports might represent such events. In such a worst-case situation, the maximum explosive yield involving the ET and the SRB's would be approximately the equivalent of 453,600 kg (1,000,000 lb) of trinitrotoluene. The distances to which various adverse effects could be expected are as follows.

Effect	Threshold Blast Wave Pressure, N/cm^2 (psi)	Distance From Launch Pad, m (ft)
Glass breakage	0.34 (0.5)	2,100 (7,000)
Penetrating missiles	1.4 (2)	820 (2,700)
Eardrum rupture	3.4 (5)	500 (1,600)
Lung injury	6.9 (10)	300 (1,000)
Lethal	21 (30)	160 (540)

Immediately prior to launch, all support personnel are evacuated from the launch pad. Consequently, no injuries other than to the occupants of the Orbiter are anticipated, even for this worst-case event.

5.10.2.2 Accidental Ignition of SRM Propellant Segments. It is extremely unlikely that a Space Shuttle SRM casting segment would be accidentally ignited during SRM processing, handling, or transportation operations. However, emissions from the occurrence of such an event have been predicted (reference 1-8). The total emissions are as follows.

	Segment Amount, kg		
Species	Forward	Center	Aft
Aluminium oxide	38,700	35,300	34,600
Carbon monoxide	33,400	30,500	29,900
Hydrogen chloride	23,100	21,000	20,700
Water	12,200	11,100	10,900
Nitrogen	11,800	10,800	10,600
Chlorine	4,900	4,500	4,400
Carbon dioxide	3,800	3,500	3,400
Hydrogen	2,600	2,400	2,300

Afterburning effects would significantly reduce the carbon monoxide concentration and modify the partitioning of hydrogen chloride and chlorine to some extent. Nitrogen oxides could be formed, but the total amount would be small compared to other constituents.

The following table presents, for the most unfavorable meteorological condition investigated, the predicted peak ground-level concentrations and dosages of hydrogen chloride, chlorine, and aluminum oxide resulting from ignition and burning of a single SRM segment (reference 1-8).

Peak concentration:

Hydrogen chloride	14.0 ppm
Chlorine	1.6 ppm
Aluminum oxide	31.0 mg/m^3

Maximum integrated dose:

Hydrogen chloride	2040 ppm-sec
Chlorine	228 ppm-sec
Aluminum oxide	75 mg/m^3-min

When compared with the criteria listed in table 5-8, the predicted value for hydrogen chloride does not exceed the criterion for emergency or accidental exposures. Also, the maximum 24-hour average aluminum oxide concentration expected is 0.052 mg/m^3 and does not exceed the 24-hour average particulate concentration criteria of 0.26 mg/m^3 (primary standard) or 0.15 mg/m^3 (secondary standard).

The extent of damage to the environment would depend on where or when ignition occurred. A worst-case example would be ignition of a three-segment stack, nozzle unplugged, on the Mobile Launcher Platform in the Vehicle Assembly Building (VAB). Although this event is extremely unlikely (probability less than 1 in 10^6 as stated in reference 5-15), an analysis of the consequences has been performed (reference 5-16) and the following impacts could be expected.

The three-segment stack would burn for a total of 765 seconds. A hostile environment would exist in the entire VAB within 5 to 10 seconds after full ignition. Survival of personnel closer than 30 meters (100 feet) is doubtful. The ground-reflected plume from the burning SRM segments would exit through the open high bay doors and travel into the surrounding areas. If the burning segments remained in a vertical attitude, the VAB primary structure would survive. If the segments fell or became propulsive, structural damage could be severe. The flora and fauna in areas close to the VAB [100 to 150 meters (350 to 500 feet)] could be subjected to extreme thermal and chemical impacts and would probably be destroyed.

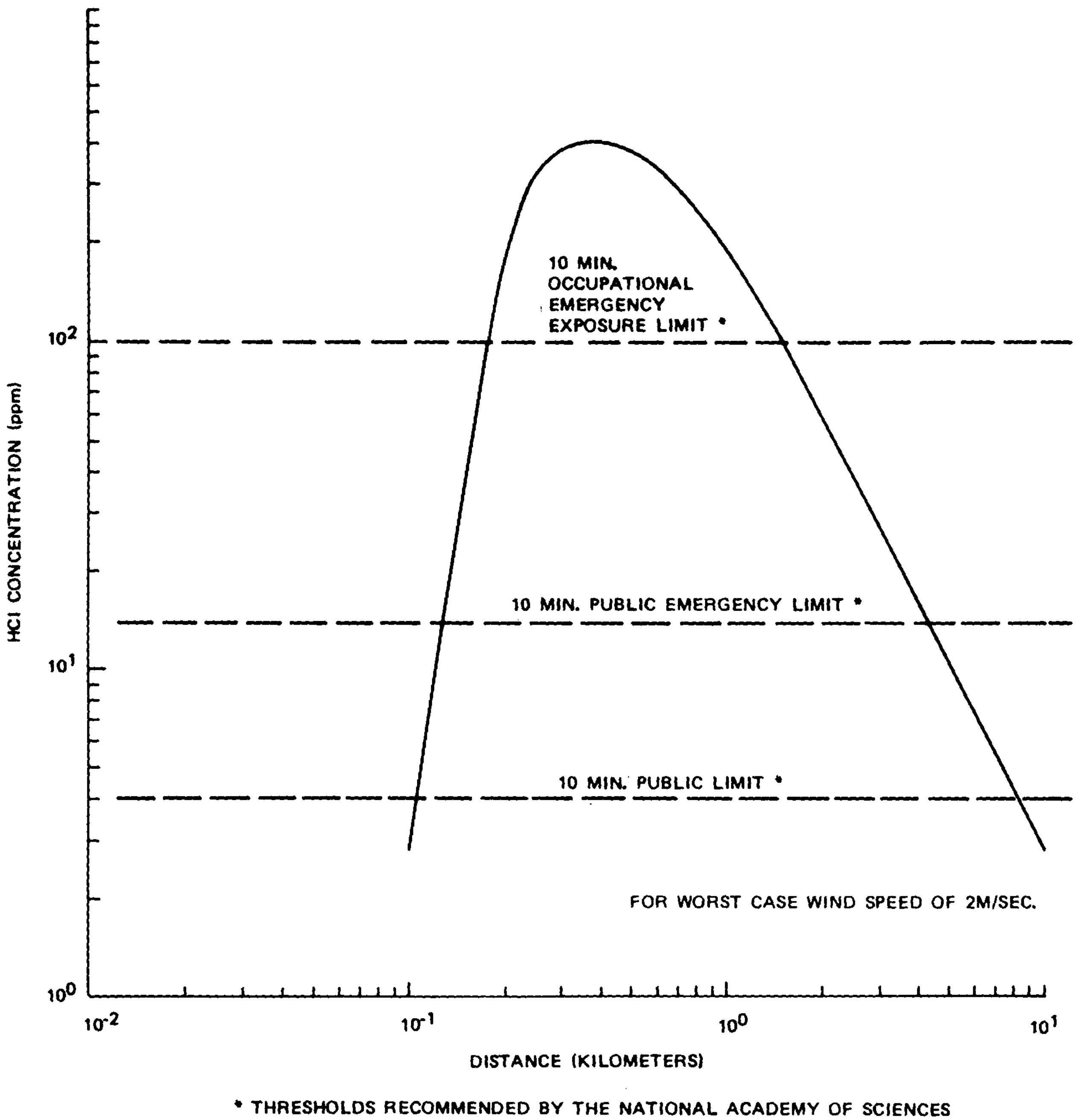


Figure 5-8. Estimate of Hydrogen Chloride Concentrations Downwind From a Three-Segment SRM Ignition in the VAB

The cloud produced by the exhaust from the burning three-segment stack would be expected to rise due to thermal bouyancy and remain at the top levels of the VAB. Calculations indicate that, for this case, the cloud would not descend below 116 meters (380 feet) above the floor but would exit through the open high bay doors and roof vents and disperse into the atmosphere. Using worst-case meteorologic parameters, the cloud could result in the maximum ground-level concentrations and down-range distances shown in figure 5-8.

These levels could exceed the emergency public exposure limits and action would be required to ensure that, in the event of such an accident, roadblocks were established and personnel evacuated along the path of the cloud. Real-time meteorologic data and recourse to the MSFC REED computer model would enable KSC safety, security, and medical personnel to be immediately dispatched to initiate appropriate measures. No effect beyond KSC boundaries is expected, even for this worst-case condition.

Extensive precautions have been taken at KSC to avoid accidental ignition of an SRM segment. The three-segment worst-case example analyzed above is an extremely remote possiblity and does not pose a realistically credible potential. No accidental ignition of SRM's has ever occurred at KSC.

5.10.2.3 Propellant Spills or Storage Tank Rupture. Potentially hazardous fluids handled in connection with the space program are: liquid hydrogen, liquid oxygen, liquid nitrogen, monomethylhydrazine, hydrazine, and nitrogen tetroxide. Other fluids such as hydraulic fluids and conventional hydrocarbon fuels used in the Space Shuttle carrier aircraft either present a much lower hazard or are handled in quantities too small to be of major consequence.

Liquid hydrogen is extremely flammable; hydrazine and monomethylhydrazine are flammable and toxic; nitrogen tetroxide is toxic and, under certain conditions, can cause spontaneous ignition of combustibles; and liquid oxygen and liquid nitrogen are cryogens.

a. Liquid Oxygen and Liquid Nitrogen Spills. Liquid oxygen is used both on ELV's and on the STS as one of the engine propellants. Liquid nitrogen is used as a refrigerant and as a source of gaseous nitrogen for pressurization and control. The largest launchsite storage capacity at KSC is 3,406 kiloliters (900,000 gallons) of liquid oxygen and 1,892 kiloliters (500,000 gallons) of liquid nitrogen.

   If spilled in large quantities, either liquid oxygen or liquid nitrogen could cause local damage because of the intense cold, 90 and 77 Kelvin (-297 and -320 degrees Fahrenheit), respectively. Liquid oxygen, if mixed with finely divided combustible material, forms explosive mixtures. The gaseous oxygen evaporating from the liquid oxygen will also intensify any pre-existing fire. The gaseous nitrogen evaporating from a liquid nitrogen spill is inert, but in high concentrations it is an asphyxiant. Industrial standards prohibit asphyxiant concentrations that reduce the oxygen concentration below 18 percent. This would correspond to the 17-percent addition of nitrogen to air.

Both liquid oxygen and liquid nitrogen are commercial materials handled in vast quantities but spills are not frequent. There have been no reports of lasting environmental damage caused by such spills or of damage beyond the small localized areas involved in the spills. There is no indication that even the largest possible spill at the launchsite would endanger the public or the ecology of any area except in the immediate vicinity of the spill.

b. Monomethylhydrazine, Hydrazine, and Nitrogen Tetroxide Spills. Handling of monomethylhydrazine (MMH), hydrazine, and nitrogen tetroxide is recognized as a hazardous operation because of their toxicity and spontaneous flammability when mixed. For a workroom environment, the 1978 American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values for MMH, hydrazine, and nitrogen tetroxide as nitrogen dioxide are 0.2, 0.1, and 5.0 ppm, respectively. Extreme precautions are taken, and quarterly personnel qualification/certification training on the handling of spills and pertinent safety practices are stressed. The actual fluids are used in these training classes.

The maximum stored quantities of nitrogen tetroxide and MMH at the Space Shuttle launch pad are about 32,550 liters (8,600 gallons) each, which is substantially less (by almost one-half) than the quantity used in a single Titan III launch. Only small quantities of hydrazine are used; less than 675 kg (1,500 pounds) per launch.

The potential consequences of spills of MMH or hydrazine and nitrogen tetroxide have been described in other environmental statements (e.g., references 1-2, 1-3, 1-4, 1-10, and 1-11). Spills at the launchsite have been shown to offer no significant hazard beyond the site boundaries. Within the site boundaries, provisions have been made to contain the spilled liquids and dispose of them in an environmentally acceptable manner: by incineration, applicable treatment, or controlled dilution and release.

c. Liquid Hydrogen Spills. The liquid hydrogen storage tank at the KSC Space Shuttle launch pad has a capacity of 3,217 kiloliters (850,000 gallons). A total of 1,450 kiloliters (383,000 gallons) will be loaded into the ET for each Space Shuttle launch.

Spills of liquid hydrogen present an extreme fire hazard and under certain circumstances may also present an explosion hazard. In these respects, liquid hydrogen differs in degree but not in kind from the hazards associated with common commercial products such as propane. On a volumetric basis, the heat released by liquid hydrogen is less than that released, for example, by propane or gasoline. Liquid hydrogen spills could ignite either immediately or at some later time. Ignition immediately following the spill will cause a flash as the inventory of gaseous hydrogen is burned, followed by burning above the pool of evaporating liquid. As in any large fire of a volatile liquid, destruction in the involved area will be considerable. In terms of environmental effects, the major feature of such a large fire would be the thermal radiation. With normal atmospheric humidity, the thermal radiation from the flash (which could last for 30 seconds) is estimated to be about 2 calories per square centimeter at a distance of about 300 meters (950 feet) for a 3,200-kiloliter (850,000-gallon) spill. The approximate threshold limit value to cause first-degree burns to exposed skin is 2 calories per square centimeter; it is also the approximate threshold value for ignition of paper and other light combustibles. The radiation from the burning pool is estimated to be less by a factor of about 5 than the flash radiation.

If the spilled liquid hydrogen evaporates without burning, the cloud of gaseous hydrogen may be carried downwind and ignited at some downwind position. The greatest distance at which ignition can occur will depend on meteorological conditions which govern the dispersion of the cloud. The high molecular diffusivity of hydrogen will augment the meteorological dispersion. Once the highest concentration of hydrogen in the cloud reaches the lower flammable limit (the lowest concentration which is flammable), ignition and burning can no longer occur. Any process that is sufficiently violent to cause accidental rapid release of large quantities of liquid hydrogen would be expected to cause some spark, hot spot, or damage to nearby power devices which would ignite the hydrogen immediately. Gaseous hydrogen has the lowest ignition energy requirement of any fuel which does not ignite spontaneously.

Mixtures of hydrogen and air near the chemically correct proportions can explode or detonate. However, for unconfined hydrogen and air mixtures, ordinary ignition sources do not cause detonation. Because immediate ignition is expected for a large, rapid spill and because detonation may not be caused by ignition by ordinary sources, detonation of the hydrogen/air cloud is not considered a credible event.

In summary, if a large hydrogen spill should ignite, extensive damage to a localized area would result, including death or serious injury to persons within that area. However, environmental damage outside that area would be negligible. The rapid spilling of large quantities of liquid hydrogen without immediate ignition is improbable because an extremely violent event would be required to initiate the process. Although spontaneous catastrophic failures of large tanks have occurred (e.g., the molasses tank in Boston and the liquefied natural gas tank in Cleveland), the causes of these failures are now understood and avoided through improvements in design, inspection techniques, and metallurgy.

5.10.2.4 <u>Ignition of Uncontrolled Amounts of Hypergolic Fuel and Oxidizer.</u> Accidental ignition of hypergolic fuel and oxidizer would probably have its most severe effect in the Hypergol Maintenance Facility (HMF) for the Space Shuttle because of the amounts of these substances that will periodically be present there. When the hypergol modules arrive at the HMF for processing, residual fuel (monomethylhydrazine) and oxidizer (nitrogen tetroxide) could be present in the following maximum amounts:

	Fuel		Oxidizer	
Component	Kilograms	Pounds	Kilograms	Pounds
OMS (each pod)	222	490	369	813
ARCS	209	460	347	765
FRCS	376	830	626	1,380
PBK	667	1,470	1,106	2,439

A worst-case event would be the release, from any cause, of uncontrolled amounts of fuel and oxidizer at the same time. The ensuing flame and effluent could damage or destroy the facility, cause environmental damage to a surrounding area (as governed by prevailing wind direction, velocity, etc.), and cause loss of life to involved personnel. Reaction to such an event would include immediate activation of the deluge system, together with firefighting personnel and rescue operations by Self-Contained Atmospheric Protective Ensemble (SCAPE)-suited personnel either present or summoned to the scene. The deluge system will direct large quantities of water to all parts of the cell to dilute the fuels and extinguish the flames. Two factors make the occurrence of such a catastrophe very unlikely: (1) regulations which prohibit more than one hazardous operation at a time in any one cell (thus reducing the chance for human error), and (2) KSC/NASA regulations which mandate periodic inspection and recertification of all lifting devices and of all installation and access structures (making equipment failure unlikely). Damage would be confined to the immediate vicinity of the event.

If, during the transportation of a module to or from the HMF, an accident occurred causing the rupture of one or both tanks containing fuel and oxidizer, release of toxic fumes and fire could take place in an open-air, uncontrolled environment. Fire, rescue, and safety personnel accompanying the convoy would take immediate action to flood the area with water and to obtain real-time predictions of downwind concentrations and transport direction of the pollutants. Personnel within the predicted hazardous zones would be evacuated until a sweep of the area, using detectors for hazardous substances, confirmed acceptable levels have been reached. Such an event could cause damage or death to local flora and fauna within the path of the resultant cloud, depending on its concentration and the speed of its passage. However, because transportation operations take place well within the confines of KSC [the nearest population area is 12 kilometers (7.5 miles) to the south], all pollutants are expected to be sufficiently diffused to prevent any hazard beyond the boundaries of KSC. The occurrence of an accident of this kind is extremely unlikely and has never been experienced at KSC.

5.10.2.5 Orbiter Crash in the KSC Vicinity. The worst-case unplanned event at landing would be an Orbiter crash or runway overshoot resulting in a crash landing. Should the Orbiter crash, the consequences would be similar to those of any large aircraft crash, except that the explosive fire which frequently follows the crash of conventional aircraft would not occur.

Because the Orbiter will contain only minimal quantities of propellants, any postcrash fire will be more confined, less intense, and of shorter duration than fire accompanying the crash of conventional aircraft.

The maximum estimated onboard quantities for a normal landing sequence are as follows:

Material	Maximum Onboard Residual	
	Kilograms	Pounds
Nitrogen tetroxide	2,816.8	6,210.0
Monomethylhydrazine	1,696.5	3,740.0
Liquid oxygen	147.2	324.5
Ammonia	30.2	66.6
Liquid hydrogen	12.3	27.2

In conventional aircraft operations, which should closely resemble Orbiter atmospheric flight operations, the most probable location of a crash on landing is near or on the runway. The initial Orbiter landings will be made at Edwards Air Force Base in California. Following the fourth flight, landings will be made at the Shuttle Landing Facility (SLF), which is well within KSC boundaries. At both locations, trained crews and fire/rescue equipment will be on standby at the runway for emergency operations, if required. Personnel in SCAPE suits with portable detection equipment can evaluate any downwind hazards due to ruptured tanks containing residual toxic propellants. Damage to the environment would be localized and minimal, with no threat whatsoever expected beyond the confines of KSC. Operational meteorological information will be used for visitor/observer controls to assure that no downwind areas at the runway are occupied during landing operations. No significant environmental impact is expected to result from normal landings.

SECTION VI

ALTERNATIVES

6.1 INTRODUCTION

The Kennedy Space Center has been evolving since late 1962 when NASA began acquiring title to lands which now comprise the Merritt Island Launch Area. During the period from conception to the present, compromises among technology, performance, reliability, time, cost, and environmental consequences have been made. While the institutional base is essentially complete and programmatic decisions for major aspects of the Space Transportation System (STS) and expendable launch vehicles have been reached, environmental issues continue to be evaluated. As a result, modifications are being made to improve designs and operations as new data and technology dictate. An evaluation of the use of STS versus the continued use of expendable launch vehicles is contained in reference 1-3 and is not repeated in this document. However, within the framework of these programs at KSC, decisions remain to be made; the major alternatives for these remaining decisions are presented herein.

6.2 THE "NO-ACTION" ALTERNATIVE

Continued use of KSC for launch operations represents a cost-effective and flexible method of conducting space activities which will benefit people and the environment. NASA is committed to continue to develop and operate the STS. In view of the extensive facility investment and program commitment at the national level, consideration of a "No-Action" alternative at KSC is not appropriate.

6.3 ALTERNATIVES AWAITING FINAL DECISION

The following subparagraphs outline alternatives for projects which are currently being considered at KSC. Decision criteria for these projects include operational and mission goals, cost, technical difficulty, environmental impact, schedule, and availability of existing facilities and equipment.

6.3.1 RECOVERY OF FREON 113. Recovery of Freon 113 is a proven concept contributing to the reduction of emissions to the atmosphere and suspected ozone depletion. Significant reductions in the loss rate of Freon 113 during cleaning operations at the launchsite are achieved by using closed-loop systems and recovery techniques to purify and reuse contaminated Freon 113. The launchsite cleaning laboratory uses Freon 113 to clean components removed from propellant handling systems at the launch pad. A system which can reclaim up to approximately 296 kg (653 lb) per hour of the Freon 113 used in cleaning operations is presently in use. Laboratory studies indicate that nitrogen may be an acceptable substitute for Freon 113 for cleaning propulsion system components. If the use of nitrogen under actual operational conditions proves to be unacceptable, plans have been made to increase the recovery of Freon 113 vapor. A new facility will be equipped to recover up to 592 kilograms (1306 pounds) per hour of Freon 113 vapors.

6.3.2 CHEMICAL WASTE DISPOSAL. As discussed in 2.5.5, the various chemical wastes generated at KSC require various methods of disposal to meet environmental regulations. One alternative would be construction of a reverse osmosis facility wherein all contaminated waste would be processed to remove 90 percent of the contaminants. A follow-on process could then result in removal of all but 1 percent of the contaminants. The contaminated sludge would then be identified, containerized, and removed by an offsite contractor for ultimate disposal. Another alternative envisions the use of a biological waste system (hyacinth ponds) to extract selected wastes for subsequent removal to standard sanitary landfill. All of these options are being considered, and a full environmental assessment will be completed prior to selection of the preferred modes for future chemical waste disposal.

6.3.3 SOLID ROCKET MOTOR STORAGE. Under certain circumstances of temporary halt to Space Shuttle flight schedules, it could become necessary to store up to 40 solid rocket motors until flights were resumed. One alternative would be construction of a long-term storage area within KSC for storage of the SRM's. Another alternative would entail negotiations with the vendor for such storage under the vendor's jurisdiction. A full environmental assessment will be completed prior to selection of a preferred alternative.

6.3.4 ORBITER LANDING APPROACHES. Present plans for Orbiter landings at KSC call for a west-to-east approach terminating with a north-to-south or south--to-north landing pattern. Sonic boom effects will occur over popu- lated areas under these conditions. Although expected overpressures will be low, feasibility of other landing patterns which would direct the highest overpressures of the reentry sonic boom to overwater (ocean) areas is being studied and may provide an alternative. Navigational computer software and flight regime limits would require significant change to make this alternative possible. Consequently, an early decision to change the current baseline is not expected. Instrumentation will be emplaced at Dryden Flight Research Center, California, to monitor the first two landings of the Space Shuttle, and a decision will be made based on the findings from those flights.

6.3.5 HYPERGOLIC FUEL STORAGE AT KSC. In order to avoid flight schedule delays, it may become necessary to provide storage facilities for up to one million pounds of hypergolic fuel (MMH) within the confines of KSC. Two alternatives are being considered: (1) long-term storage of approximately 124,740 kilograms (275,000 pounds) in five railroad tank cars, 34,000 kilograms (75,000 pounds) in two mobile tankers, and 204,100 kilograms (450,000 pounds) in three former fuel tanks at CCAFS and (2) use of alternative (1) on a temporary basis until an unused liquid oxygen tank at LC-37 can be refurbished to accommodate the MMH expected to be present in late 1979 [total capacity of the refurbished tank will be 506,600 kilograms (1,116,900 pounds)].

An environmental assessment is now being prepared for these options. Either alternative will employ safeguards and environmentally compatible practices consistent with past and current experiences. The best state-of-the-art technology will be used to minimize hazards to personnel and the environment.

6.3.6 SOURCES OF ENERGY. As detailed in 2.5.2.3, electrical energy for KSC is generated off-site by the Florida Power and Light Company. This electrical power is supplemented and backed up by on-site diesel-fueled generators. Alternative sources of power such as coal, solar energy, self-sufficient diesel-fueled power plants, and nuclear generators have been investigated. Limited use of solar power for heating water is now being implemented, and other promising areas will be investigated as new technology becomes available.

6.3.7 OFF-SITE TRANSPORTATION MODES. Materials and consumables are delivered to KSC by air, rail, highway, water, and pipelines. Investigations are being made on a continuing basis to evaluate the best mode of transportation for specific substances in terms of safety, environmental protection, and cost. Because transportation of goods is expected to be substantial over the 12-year projected life of the STS program, trade studies will continue to be made and alternatives will be selected to make maximum use of best available transportation technology within the limits of interstate commerce laws.

SECTION VII

POTENTIAL UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

7.1 INTRODUCTION

This section identifies six phenomena associated with KSC operations. Each of these reactions has the potential for a degree of adverse environmental impact. The causes and possible effects are discussed in the areas of the launch ground cloud, acid rain, inadvertent weather modification, launch noise, reentry sonic boom, and land use.

7.2 LAUNCH GROUND CLOUD

The exhaust products from the SRB for the Space Shuttle include hydrogen chloride, nitrogen oxides, chlorine, carbon monoxide, and aluminum oxide. The hot exhaust cloud will rise quickly to altitudes ranging from 0.7 to 3 km (0.4 to 1.8 miles) and then drift and disperse with the prevailing wind at that altitude. The result is expected to be a temporary and localized degradation of air quality at altitudes through which the cloud passes. Surface concentrations of the exhaust products are not expected to exceed the allowable limits for human beings, wildlife, or plants. Under unusual atmospheric conditions, the cloud might be trapped in an inversion layer, which could prevent it from dispersing rapidly.

Meteorological conditions for the launch will be selected to mitigate the potential surface effects, consistent with mission requirements and astronaut safety. In addition, a long-term monitoring program of the launch areas will be maintained to verify the expected absence of ecological effects.

As in the past, airspace near the launch operations area will be controlled for appropriate periods before and after a launch to exclude aircraft flying at low altitudes.

7.3 ACID RAIN

Although it is unlikely that a launch will occur during a rainstorm, raindrops which fall through the exhaust cloud could absorb hydrogen chloride and produce acidic rain. The acidity is highest at the beginning of rainfall through the cloud and less as hydrogen chloride is washed out of the cloud.

Near the launch area, the initial rain acidity can correspond to pH values near 1.0, which might damage vegetation. Outside the launch area, the initial rain is less acidic and damage to vegetation is less likely. In any case, the effect is expected to be highly localized and temporary. Meteorological conditions can be monitored and constraints may be imposed on the launch to minimize acidic rain effects.

7.4 WEATHER MODIFICATIONS

It is not possible to predict what effects, if any, the Shuttle exhaust cloud might have on the weather. Insufficient information is available to evaluate completely this potential effect, but any effect which does occur is expected to be limited in size and duration. Monitoring equipment will be used on the first few launches to learn more about STS effects, and research is continuing in this area. Appropriate meteorological conditions for launch would be selected should further studies indicate the possibility of any significant effects.

7.5 LAUNCH NOISE

A Space Shuttle launch will subject large areas to moderate sound levels of predominantly low frequencies for 1 to 2 minutes. At launch, the peak A-weighted sound pressure level at the nearest-to-pad boundary at KSC is expected to be about 80 dBA. The peak level at the KSC viewing stand will be about 95 dBA.

During Shuttle main engine tests, the peak A-weighted sound pressure levels to which the public might be exposed are about 85 dBA. Only one such test, the Flight Readiness Firing for the first Shuttle Orbiter, is planned for KSC.

The 24-hour sound levels to which the public would be exposed for launches are all less than the EPA daytime guideline value of 70 dBA. Consequently, no effects on the health of human beings are expected from this noise. Similarly, only temporary and localized effects on wildlife are expected. The low frequency sound may briefly rattle windows in structures near the launch area.

7.6 SONIC BOOM

Sonic boom will be produced during both launch and reentry. The launch boom will be about 300 Newtons per square meter (N/m^2), equivalent to 6 pounds per square foot (psf), over a wide area of the ocean, with a narrow region a few hundred meters wide where the boom will be focused to levels that may reach 1500 N/m^2 (30 psf). The reentry boom from the Orbiter could reach a maximum predicted value of 101 N/m^2 (2.1 psf) within 44 kilometers (24 nautical miles) of the launch site.

The launch boom will be larger than the Orbiter's reentry boom partly because the launch vehicle and its exhaust plume will be physically larger than the Orbiter. The launch boom will occur entirely over the Atlantic Ocean for launches at KSC and will not produce any significant environmental impact.

Reentry sonic boom is expected to occur over populated areas of Central Florida including portions of the following counties: Citrus, Hernando, Highland, Pasco, Pinellas, Hillsborough, Manatee, Sarasota, Hardee, Polk, Sumter, Lake, Orange, Seminole, Osceola, Volusia, and Brevard as shown in figure 5-2. The low intensity of these booms, a predicted maximum of 101 N/m^2

(2.1 psf), is not expected to produce any effect other than a slight startle reaction in about half of the people who hear the boom. The relatively long duration of the pressure wave associated with sonic booms may rattle windows. Announcement of expected occurrence of the boom should mitigate much of the "surprise" reaction for the general public. Sonic boom may occur over the habitat of the Dusky Seaside Sparrow, an endangered species, but due to the low level and infrequent occurrence, no adverse impact is expected. Formal consultation has been completed with the Department of the Interior under the provisions of section 7 of the Endangered Species Act.

7.7 LAND USE

As a result of existing and proposed new construction, 390 hectares (962 acres) of land will be permanently removed from other uses at KSC. This is consistent with present KSC, local, and State land-use plans and presents no new or unusual use classification. In addition, the periodic closing of Playalinda Beach will be required for public safety and operational security. NASA and the National Park Service will cooperate to reduce restrictions to the extent possible as experience indicates the suitability of such action.

SECTION VIII

RELATIONSHIPS BETWEEN THE SHORT-TERM USES AND THE LONG-TERM MAINTENANCE AND ENHANCEMENT OF THE ENVIRONMENT

8.1 INTRODUCTION

This section describes the short-term effects on the environment induced by KSC operations and enumerates the long-term advantages which will accrue as a result.

8.2 RELATIONSHIPS

Commensurate with provisions of the National Aeronautics and Space Act of 1958, the construction and operation of KSC facilities have brought about a long-term commitment of the KSC site for the launch and recovery of space vehicles. Although only a few thousand hectares are directly involved in active operational use, the large land and water areas comprising the Center are needed as a buffer to ensure the safety of citizens in population centers around KSC, as well as to provide security zones and physical separation of hazardous activities requiring distance between them to prevent mishaps.

As experience has been gained with the fuels and oxidizers used for space exploration, and as reliability has improved over the years, a significant portion of the KSC site has been made available to the National Park Service (NPS) and the U.S. Fish and Wildlife Service (FWS) for the long-term maintenance and enhancement of the environmental resources in the area. The NPS manages a portion of the Canaveral National Seashore (CNS) properties and the FWS manages the remainder of the CNS and the Merritt Island National Wildlife Refuge for various wildlife programs.

8.3 SHORT-TERM USES

Since the beginning of the space program in the late 1950's, all U.S. space missions have been performed using a family of expendable launch vehicles (e.g., Saturn, Titan, Atlas, Delta, and Scout). By the early 1980's, however, nearly all expendable launch vehicle missions will be replaced by Space Transportation System (STS) missions. The short-term effects on the environment of the Space Shuttle launches, as with the expendable launch vehicles, will be localized and will produce a relatively short duration of air and noise pollution. There are no substantive changes in land use, and no significant differences in operations at KSC beyond those encountered with expendable vehicles, with the exception of the Orbiter landing after deorbit. This additional activity will result in a low-intensity sonic boom of very short duration, and no adverse effects are expected. On the other hand, the STS will provide a great potential for maintaining and enhancing man's and nature's environment on Earth. The following paragraphs discuss direct and indirect environmental benfits that will result from STS operations at KSC.

8.4 LONG-TERM MAINTENANCE AND ENHANCEMENT OF THE ENVIRONMENT

The STS will provide for the delivery to space and subsequent use of three classes of payloads: (1) Earth observation equipment positioned in the cargo bay of the Space Shuttle Orbiter, (2) autonomous satellites, and (3) space laboratories (e.g., Spacelab). These payloads, expected to be launched in the 1980's, will provide capabilities that will allow monitoring, management, and enhancement of the Earth's environment. Approximately 15 percent of all STS payloads are expected to offer direct environmental benefits. Examples of these benefits are discussed below.

8.4.1 LAND USE AND LAND MAPPING. Benefits in this area include the preparation of current maps prepared in a matter of days compared to the months or even years previously required, a supply of data for comprehensive regional land-utilization planning, and development of thematic maps (e.g., previously unknown features in Antarctica have been identified, including a group of mountains in Southern Victoria Land and at the heart of Lambert Glacier).

8.4.2 BIOLOGICAL RESOURCE MANAGEMENT. Earth observation satellites will also aid in the management of biological resources. Accurate surveys of timberland have been difficult, if not impossible, to achieve because most forests are located in remote areas. Observation from space allows instantaneous identification of timber types, disease, yield, and the existence of forest fires. Agricultural crop data around the world can be unreliable and sometimes nonexistent. Space crews, working with remote sensing equipment, can identify crops and acreage, discern the vigor of the crop, identify diseases or pests, and estimate the yield per acre. Many diseases can be spotted before the farmer even knows that he has a problem. In a world where hunger and malnutrition continue to be problems, such information becomes extremely vital. Earth observations from space may allow improved management of fishing resources. By observing favorable habitat locations, fishing experts may be able to predict fish movement throughout the Earth's waters.

8.4.3 MINERAL RESOURCE MANAGEMENT. Geologists studing photographs of the Earth from space have found clues to the locations of new oil fields. From a space vantage point, promising sites for new petroleum, geothermal, and mineral deposits may be identified and on-site exploration guided.

8.4.4 WATER RESOURCE MANAGEMENT. Earth observation satellites will allow the management of water resources in areas ecologically sensitive to water levels. From space, water patterns can be identified, the development of watersheds can be predicted, floods can be forecast, and crops and property can be protected.

8.4.5 POLLUTION MONITORING. Earth observation satellites launched by the Space Shuttle can survey strip mining activities, track air, water, and thermal pollution and identify its source, monitor air quality, monitor the stratospheric ozone layer, and locate oil slicks on the ocean's surface. A pollution-mapping satellite can cover the entire United States in about 400 photographs; cameras carried in high-altitude aircraft would use about 500,000 frames to cover the same area. It would take years to monitor by aircraft what can be monitored from space in a few days. In congested urban areas, pollution levels can be accurately predicted from space by monitoring local weather patterns and pollution sources.

8.4.6 WEATHER OBSERVATIONS AND FORECASTS. Weather affects the welfare of every person on Earth, e.g., food supplies, travel, and recreation. Weather satellites currently allow advance planning and improve one's understanding of the weather environment. In the 1980's, advanced weather satellites launched by the Space Shuttle will improve the quality of weather forecasts. Improved disaster warning systems will also monitor hurricane, typhoon, tornado, and iceberg activity. These satellite systems will continue to provide the cornerstone of severe storm warnings. Warnings will allow ample time for the populace to prepare for emergencies or to evacuate the area. Satellites will also continue to assess damage caused by severe weather and will help determine the need for disaster relief.

8.4.7 EARTHQUAKE PREDICTION. Spaceborne systems carried aloft by the STS may be able to use lasers to measure minute shifts in the Earth's crust as a possible method of predicting earthquakes. It is possible that in the future a significant number of lives may be saved as a result of earthquake prediction. Methods could also be developed to relieve stress in the Earth's crust and thus prevent earthquakes.

SECTION IX

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

9.1 INTRODUCTION

This section summarizes the commitment of natural and cultural resources which will be required in order to realize the benefits offered by a continuing space program.

9.2 COMMITMENTS OF RESOURCES

Operations at KSC require the commitment of both natural and cultural resources. The commitment of natural resources includes the consumption of mineral and biological (other than human) resources. The commitment of cultural resources includes restrictions on the use of some historical and recreational areas. These basic commitments are no different from those necessary for space program activities over the past 20 years.

9.3 NATURAL RESOURCES

Activities at KSC will utilize and consume various quantities of materials and energy. This section describes those natural resources which will be committed as a result of KSC activities.

9.3.1 MATERIALS RESOURCES. The modification or construction of facilities expends building materials such as steel, aluminum, wood, and wire. Most of the construction activities are nearing completion. The operation and maintenance of the facilities requires materials such as oil, gasoline, diesel fuel, paper, water, paint, cleaning agents, pesticides, and fertilizers. Tables 2-7 and 2-11 list the kinds and amounts of pesticides and fertilizers used. Paragraph 2.5.2 gives the projected amounts of offsite generated electrical power, low sulfur fuel oil, and potable water used by KSC.

Both expendable and Space Transportation System (STS) ground support hardware is designed and built at KSC. The hardware consists of launch towers, vehicle supports, service arms, flame deflectors, valve panels, pneumatic servicing units, computer control equipment, and a wide selection of ground support equipment. Materials include aluminum, steel, copper, iron, plastics, elastomers, glass, and other substances. Although a majority of the required equipment and systems have already been obtained for expendable launch vehicles and initial STS launches, expanded capabilities required to support the higher launch rates expected for the operational period of the STS remain to be acquired.

In the support of launches from KSC, solid and liquid propellants and other consumable fluids will be expended. Tables 2-9 and 2-10 indicate the requirements for fuels and fluids. The major substances consumed are liquid oxygen, liquid hydrogen, gaseous and liquid nitrogen, gaseous helium, monomethylhydrazine, nitrogen tetroxide, Freon 113, and isopropyl alcohol. Major solid propellant ingredients are ammonium perchlorate, aluminum powder, and PBAN binder. Table 2-2 indicates the requirements for solid propellants. In addition to these substances, a total of 1,200 cubic meters (300,000 gallons) of water is used at each launch for sound suppression and cooling of the launch pad area for STS.

9.3.2 ENERGY RESOURCES. The peak annual energy required to perform space program operations at KSC is expected to be 91 X 10^{10} kilojoules (kj): 77 X 10^{10} kj will be needed for electricity; 11 X 10^{10} kj will be consumed as fuel oil; and 3 X 10^{10} kj will be required for transportation activities. Fossil fuels include oil, diesel fuel, and gasoline. The required electricity will be supplied by plants generating electricity from fuel oil.

Based on economic and energy comparisons, the STS is not considered to be an energy-intensive activity. Hence, the STS program is not expected to impose significant energy impacts on the nation as a whole. Future increases in electric or fossil fuel consumption are not expected at KSC, since STS program operations (NASA, DOD, and contractor) will be replacing existing activities related to expendable launch vehicle operations, and an extensive energy reduction program is underway. Current consumption of energy is estimated to be 54 percent of that consumed in 1973.

For a complete discussion of the energy requirements for the entire Space Shuttle program, refer to the Space Shuttle Program EIS (reference 1-3).

9.3.3 BIOLOGICAL RESOURCES. Small areas of wildlife habitat will be converted to buildings and other facilities associated with the STS program. Under cooperative agreements with the Department of Interior, launch and support facilities at KSC coexist with a National Wildlife Refuge and a National Seashore which are managed for wildlife and utilized for recreation as well as for space launch support functions. No significant irretrievable commitment of land is expected in the future (see 2.6) and present land-use patterns should continue at least until 1990.

9.4 CULTURAL RESOURCES

Changes to cultural resources, such as employment and recreational and historical resources, are addressed below. A detailed discussion of cultural resource impacts may be found in 5.7.

9.4.1 EMPLOYMENT. The work of NASA, the DOD, and contractor employees on the space program will represent a commitment of manpower. Other than construction activities, the program will employ skilled, highly skilled, and professional workers. In view of the current and long-term demand for these skill levels and the benefits to society that will result from the space program, this commitment of manpower resources is considered a benefit of the program.

Construction programs have been minimized through the use of existing facilities. Construction workers will be required in some numbers at KSC for modification of facilities and construction of others. The demand will not be great and is well within the community support developed during earlier programs. Ideally, much of the labor force can be drawn from local or nearby labor markets since planned activities are not of sufficient magnitude or duration to attract workers from remote labor markets.

9.4.2 RECREATIONAL AND HISTORICAL RESOURCES. No significant additional irretrievable commitment of recreational or historical resources is expected to result from the STS or expendable launch vehicle programs. Historical preservation agreements and restrictions will be followed by users of KSC property for the duration of the STS program. Recreational facilities, operated under current or future agreements, will not be permanently affected by the STS program. The temporary restrictions on public access to such facilities prior to launches and landings do not irretrievably commit the resource, and every effort will be made to minimize the time during which these facilities are removed from public use.

SECTION X

OTHER CONSIDERATIONS THAT OFFSET POTENTIAL ADVERSE EFFECTS

10.1 INTRODUCTION

This section provides a preview of the wealth of scientific knowledge and the corresponding benefits to all mankind and the environment which can be made possible by the capabilities of the Space Program.

10.2 NEAR-TERM BENEFITS FROM SPACE

Kennedy Space Center (KSC), as a NASA field installation, contributes significantly to the Nation's space program in the field of Space Transportation and Applications. Since the late 1950's, NASA has developed launch complexes, launch operations and checkout facilities, and test facilities of superior merit and has attained technical excellence in the areas of flight systems testing, facility/equipment development and operations, and launch operations. Over the years, KSC has consistently demonstrated its worth by the successful launching of more than 300 spacecraft into Earth orbit or into deep space trajectories. In addition to launching spacecraft that have landed on the Moon and Mars, KSC has launched spacecraft that have flown by Mercury, Venus and Jupiter, returning data to provide greater understanding of these planets. KSC has also launched spacecraft that have mapped the highly complex magnetosphere, studied the sun and the solar winds, and looked far into space, acquiring information on ultraviolet, infrared, X-ray, and gamma radiation to tell us more about the stars and galaxies. Still other spacecraft have been launched that have helped enhance the quality of life on Earth by enabling improved monitoring and managing of resources and global communications.

The wealth of scientific information gained from these launches is the primary benefit of the space program. KSC's continued success in the field of Space Transportation and Applications is a prerequisite to future revelations about the universe; and with the advent of the STS in the 1980's with its ability to reduce the cost of space operations, an even greater opportunity exists to increase the Nation's accumulation of scientific information. In the short run, the funds spent to obtain this information, and the jobs created, contribute importantly to the health of the Nation. As indicated in section 9 of reference 1-3, each dollar of NASA spending increases the real gross national product and the national average productivity and is thus counterinflationary. In the long run, the R&D expenditures contribute greatly to the advance of technology, which is a prime factor in enabling per capita economic growth and thus a rising national standard of living.

In summary, scientific investigation of other worlds made possible by the activities at KSC can tell us more about Earth, but not without some environmental impact (see section V). It is clear, however, that the potential effects identified in section V, when taken in light of existing mitigation measures, are dwarfed by the many benefits produced from operations at the Kennedy Space Center.

10.3 CONTRIBUTION TO THE LOCAL AREA

In the late 1950's, the decision by NASA to center the Nation's space activities in Brevard County, Florida, resulted in the creation of a great number of jobs and the attraction of numerous support industries into the area. To accommodate the influx of new residents, the development of homes, utilities, schools, and public services had to be significantly expanded, resulting in a boom environment. From 1968 to 1970, however, NASA employment cutbacks resulted in the loss of over 10,000 jobs; again in 1972 and 1973, as a result of the completion of the Skylab project, further employment cutbacks resulted in an unemployment increase from 7.0 percent in 1973 to 10.2 percent in 1974. Many aerospace workers were forced to leave the county, and many businesses were forced to close down. It appears that KSC's employment and spending levels have stabilized in recent years; however, the impact of the STS program and other KSC activities will continue to be a major factor in the local economy. With the operation of the STS through the 1980's, KSC employment and spending levels should remain stable for many years to come. NASA and Department of Defense installations are still the primary sources of employment in the county, directly and indirectly providing about one-third of the jobs.

The strength of Brevard County, while largely dependent upon military and aerospace expenditures, is also dependent upon increases in the number of new citizens and the rising level of tourism in the county. Tourism is a growing industry in Brevard County and NASA and Air Force facilities are the county's foremost attractions. In 1968, when KSC opened a Visitors Information Center and began bus tours of selected facilities, the space center was visited by more than 800,000 people. With the advent of frequent STS flights in the 1980's, projections indicate that NASA tours will attract more than 2,000,000 visitors each year, an unknown percentage of whom will become permanent residents of Brevard County. The Kennedy Space Center makes a significant positive contribution to the strength of Brevard County.

10.4 RELATIONSHIP TO OTHER FEDERAL PROGRAMS

10.4.1 U.S. FISH AND WILDLIFE SERVICE (FWS). As detailed in 4.3, FWS administers those portions of KSC not directly dedicated to operational uses.

10.4.2 NATIONAL PARK SERVICE (NPS). As detailed in 4.3, NPS administers 2,693 hectares (6,655 acres) of KSC as a portion of the 16,592 hectares (41,000 acres) comprising the Canaveral National Seashore.

10.4.3 DEPARTMENT OF DEFENSE. The launch of unmanned scientific and technology applications spacecraft by expendable launch vehicles involves operations from NASA and Air Force owned facilities at the Cape Canaveral Air Force Station. Base support services are provided by Air Force contractors under NASA-Air Force agreements. DOD and NASA will share responsibilities for the STS program, with NASA launching DOD payloads on STS vehicles from KSC, and DOD (Air Force) launching NASA payloads on STS vehicles at Vandenberg Air Force Base, California.

SECTION XI

COMMENTS RECEIVED AND NASA RESPONSES

11.1 INTRODUCTION

Comments on the draft Environmental Impact Statement for the Kennedy Space Center (released April 12, 1979) were requested from Federal and state agencies and from interest groups. Of the 19 letters received, nine elicited NASA response.

11.2 COMMENTS RECEIVED REQUIRING NASA RESPONSE

Copies of all letters received on the draft environmental impact statement that elicited a response from NASA are included in this section. The following agencies sent letters of this category:

Agency	Page
Brevard County Board of County Commissioners County Development Division 2575 N. Courtenay Parkway Merritt Island, FL 32952	11-24
East Central Florida Regional Planning Council 1011 Wymore Road Winter Park, FL 32789	11-32
Florida Department of Agriculture and Consumer Services The Capitol - Assistant Commissioner Tallahassee, FL 32304	11-36

DEPARTMENT OF THE AIR FORCE
WASHINGTON 20330

OFFICE OF THE ASSISTANT SECRETARY

June 20, 1979

Arnold W. Frutkin
Associate Administrator
External Relations
NASA
Washington, D.C. 20546

Dear Mr. Frutkin:

We appreciate the opportunity to review your Draft Environmental Impact Statement for the Kennedy Space Center, dated March 1979.

Our comments are:

1. Page 3-25, para 2. Recommend this section be expanded to discuss the expected frequency and effects that measured ambient levels for particulates and ozone may exceed the standards in Table 3-5.

2. Page 3-40, para 5. It seems inappropriate to classify citrus groves, construction ditches, impoundments, plantings, etc., as part of the natural coastal community.

3. Page 5-12, Table 5-8. Suggest sources of the recommended air quality guidelines for short-term exposure to rocket exhaust effluents, other than the earlier EIS, be indicated.

4. Pages 5-18 to 5-20. Suggest the human health implications of rocket engine exhaust products in the atmosphere and on food plants around KSC be discussed.

Sincerely,

CARLOS STERN, Ph.D.
Deputy for
Environment & Safety

Department of the Air Force, Deputy for Environment and Safety, Washington, DC

a. Comment: Page 3-25, para 2. Recommend this section be expanded to discuss the expected frequency and effects that measured ambient levels for particulates and ozone may exceed the standards in table 3-5.

Response: Data on expected pollutant loading are contained in paragraphs 5.2 through 5.2.2.4, pages 5-1 through 5-22.

It is generally accepted that the ozone precursors in photochemical oxidant air pollutant are hydrocarbons and nitrogen oxides. The data in table 5-7, page 5-10, indicate KSC emissions of these primary pollutants to be approximately 1% of the Brevard total and hence a distinctly minimal source of whatever problem may exist.

Paragraph 3.3.1, last 2 paragraphs on page 3-25, have been changed to read as follows:

"Recently acquired air quality monitoring equipment at KSC (including the capability to measure toxic gases generated during launches) and state air quality measurements since 1973 have provided data confirming the absence of major pollutants in the KSC vicinity (references 3-4 and 3-5). During 1978, for example, the range of pollutant concentrations was (in micrograms per cubic meter): (1) sulfur dioxide: 0 to 176; (2) nitrogen dioxide: 0 to 100; (3) particulates: 12.76 to 94.36; and (4) ozone: 4 to 382. Data on hydrocarbons and oxides of carbon are not available at this time. Table 3-5 lists the current national ambient air quality standards.

"Ozone measurements made using new EPA calibration standards (ultraviolet source) and new national ambient air quality standards (240 vs 160 micrograms/cu. meter) currently show only isolated, seasonal (spring, fall) high levels of ozone which appear to correspond with certain weather patterns and may involve long-range transport phenomena. KSC limitations on mechanical activity and proscribed burning restrict the amount of pollutants entering the atmosphere. Thus, the major sources of air pollutants generated within KSC are private motor vehicles and launches of space vehicles."

b. Comment: Page 3-40, para 5. It seems inappropriate to classify citrus groves, construction ditches, impoundments, plantings, etc., as part of the natural coastal community.

Response: Paragraph 3.4, page 3-40 (second sentence only) has been changed to read: "The area is a mosaic of natural and developed coastal communities typical of east-central Florida and includes citrus groves, shoreline and standing water vegetation in impoundments and construction ditches, vegetation in abandoned pastures and around old homesites, plantings of Australian pine, eucalyptus, and Florida holly, and cultivated vegetation (grasses and ornamentals) along roads and around KSC and CCAFS facilities." The last sentence has been expanded to add: "...and a map of selected vegetation types is enclosed in a pocket on the rear cover of this EIS."

c. Comment: Page 5-12, table 5-8. Suggest sources of the recommended air quality guidelines for short-term exposure to rocket exhaust effluents, other than the earlier EIS, be indicated.

Response: Table 5-8, page 5-12, has been changed to reflect specific sources, as follows:

"Notes: 1/ Source: Committee on Toxicology, National Academy of Sciences

2/ Source: Environmental Protection Agency (see reference 1-3)

3/ Maximum 24-hour concentration, not to be exceeded more than once a year.

Abbreviations: TWA = Time Weighted Average
CL = Ceiling Limits
STPL = Short-Term Public Limits
PEL = Public Emergency Limits
EEL = Emergency Exposure Limits (occupational)"

d. Comment Pages 5-18 to 5-20. Suggest the human health implications of rocket engine exhaust products in the atmosphere and on food plants around KSC be discussed.

Response: Paragraphs 5.9 through 5.9.3, pages 5-56 through 5-59, discuss the impacts of KSC operations on the ecology of the area, emphasizing the human health and welfare effects.

The second paragraph of 5.9.3, page 5-60 has been changed to read as follows: "The potential impacts predicted from KSC operations for the future are similar to those which have existed for prior programs, with the exception of thermal protection materials used in the SRB refurbishment and subassembly operation and an increase in the quantities of some substances already being used. Controlled access, positive badge-exchange systems, and real-time predictions for airborne pollutants are tools used to minimize the potential for impact to human health and welfare. Results from plant exposures to solid rocket fuel exhaust (see reference 5-3) indicate that no substantial decrease in agricultural plant productivity in the area is expected from atmospheric pollutants generated by Space Shuttle launches. Nothing in the exhaust is known to be a potential contaminant to food crops. In view of the geographic isolation of hazardous operations coupled with predictions showing that exposure limits established for the specific impacts of concern are not expected to be exceeded (see 5.2 and 5.5), no significant adverse effects on human health and welfare are expected. The reentry sonic boom will be experienced by the general public and advance announcements will help to reduce the startle effect which might otherwise occur."

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
ATLANTA, GEORGIA 30333
TELEPHONE: (404) 633-3311

June 8, 1979

Dr. Albert M. Koller, Jr.
Chief, Environmental Management Staff
Code DF
National Aeronautics and Space Administration
Kennedy Space Center, Florida 32899

Dear Dr. Koller:

We have reviewed the draft environmental impact statement for the Kennedy Space Center, Brevard County, Florida. We are responding on behalf of the Public Health Service.

Sonic Boom

The reentry of each Shuttle Orbiter will result in a low-level sonic boom during its descent for landing at Kennedy Space Center (KSC). The information provided in the EIS reveals that overpressures (101 N/m^2 or 2.1 csf) produced by each boom are not expected to produce any effect other than a slight startle in people who hear the boom and possibly some window rattling. Since findings of the International Civil Aviation Organization indicate that the "peak overpressures of a single sonic boom should not exceed 35 N/m^2 (0.75 psf) if the populace is not to be annoyed," it is important that each Florida county to be affected by the expected average of one reentry boom every 10 days be given the opportunity to comment on this impact and explain how they wish to be notified to mitigate much of the "surprise" reaction for the general public.

Solid Wastes

According to page 2-57 in the EIS, metal-contaminated wastes are presently stored at LC-20 for disposal by an offsite contractor. While disposal of these wastes will eventually be handled at a proposed onsite facility, the past and present disposal practices of the contractor and acceptability of the present disposal site should still be addressed in the EIS.

Hazardous solid wastes (page 2-59) are also now temporarily stored for offsite disposal. Future practices for hazardous waste disposal are indicated to be the "same as present." With a 300-fold increase in the "projected annual volume," it is important that an accounting be made of the offsite disposal site and its long-term environmental acceptability.

Page 2 - Dr. Albert M. Koller, Jr.

Pesticides

Many pests in the KSC area are controlled by a variety of different pesticides. Consideration should be given in the EIS to alternative control measures that would result in desirable benefits.

Thank your for the opportunity of reviewing this document. We would appreciate receiving two copies of the final statement when it is issued.

Sincerely yours,

Frank S. Lisella, Ph.D.
Chief, Environmental Affairs Group
Environmental Health Services Division
Bureau of State Services

Department of Health, Education, and Welfare, Public Health Service, Atlanta, GA

a. Comment: Sonic Boom. The reentry of each Shuttle Orbiter will result in a low-level sonic boom during its descent for landing at John F. Kennedy Space Center (KSC). The information provided in the EIS reveals that overpressures (101 N/m^2 or 2.1 csf) produced by each boom are not expected to produce any effect other than a slight startle in people who hear the boom and possibly some window rattling. Since findings of the International Civil Aviation Organization indicate that the "peak overpressures of a single sonic boom should not exceed 35 N/m^2 (0.75 psf) if the populace is not to be annoyed", it is important that each Florida county to be affected by the expected average of one reentry boom every 10 days be given the opportunity to comment on this impact and explain how they wish to be notified to mitigate much of the "surprise" reaction for the general public.

   Response: NASA plans a program designed to reach the majority of residents of each county in Florida that may or will experience sonic boom during Orbiter reentry. The public in these areas will be informed of the anticipated day and hour of the incidents and, more especially, public services (e.g., hospitals) will be notified well in advance. It is not expected that any problems or damage will result from the low levels of overpressures predicted.

   Using the A-95 Clearinghouse process, NASA has coordinated with the State of Florida and received no adverse comment on this approach.

   No change to the EIS text has been made as a result of this comment.

b. Comment: Solid Wastes According to page 2-57 in the EIS, metal-contaminated wastes are presently stored at LC-20 for disposal by an off-site contractor. While disposal of these wastes will eventually be handled at a proposed onsite facilty, the past and present disposal practices of the contractor and acceptability of the present disposal site should still be addressed in the EIS.

   Hazardous solid wastes (page 2-59) are also now temporarily stored for offsite disposal. Future practices for hazardous waste disposal are indicated to be the "same as present." With a 300-fold increase in the "projected annual volume," it is important that an accounting be made of the offsite disposal site and its long-term environmental acceptability.

   Response: The majority of solid waste materials at KSC are nonhazardous substances which are disposed of in the on-site sanitary landfill. Conversely, the majority of hazardous wastes are in liquid form and are currently shipped off-site for disposal. On May 11, 1979 a one-year contract was awarded to Frontier Chemical Waste Process, Inc., Niagara, N.Y. for pickup and disposal of an estimated 304,000 kilograms (670,000 pounds) of chemical wastes at KSC.

Included are: halogenated hydrocarbons and hydrocarbons which are unreclaimable at KSC; acidic, basic, and neutral aqueous solutions; and miscellaneous solid or liquid toxic, corrosive, and flammable materials.

Paragraph 2.5.5, second paragraph on page 2-52, has been expanded to add:

"Chemical wastes in the staging areas are sent offsite for EPA-approved disposal, treatment, or processing by a vendor under contract to KSC."

c. Comment: Pesticides. Many pests in the KSC area are controlled by a variety of different pesticides. Consideration should be given in the EIS to alternative control measures that would result in desirable benefits.

Response: Paragraph 2.5.4; a final paragraph has been added to page 2-52, as follows: "Control of pests and vermin cannot be accomplished by any one tool. KSC has a program of sanitation which effectively reduces the need for excessive use of pesticides. To further this reduction in the random use of pesticides, no work of this type is performed on a regular, scheduled basis. All use of pesticides is restricted to a demand basis. As alternatives to pesticides (e.g., biological methods) are identified, NASA will evaluate and apply acceptable techniques which will reduce or eliminate pesticide use to the extent practicable."

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230
(202) 377-XXX 4335

June 15, 1979

Mr. Arnold W. Frutkin
Associate Administrator for
External Relations
National Aeronautics and
Space Administration
Washington, D.C. 20546

Dear Mr. Frutkin:

This is in reference to your draft environmental impact statement entitled, "Kennedy Space Center, Florida." The enclosed comments from the National Oceanic and Atmospheric Administration are forwarded for your consideration.

Thank you for giving us an opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving seven copies of the final statement.

Sincerely,

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

Enclosures: Memos from:
NOAA - National Marine Fisheries Service
NOAA - Environmental Research Laboratories

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL RESEARCH LABORATORIES
Silver Spring, Maryland 20910 R32

May 23, 1979

TO: PP/EC - R. Lehman

FROM: RD/R32 - I. Van der Hoven

SUBJECT: Comments on DEIS #7904.26
Kennedy Space Center

It is not possible to assess the validity of the model predictions of HCl concentrations for an STS Launch as shown in Table 5-10. No references or descriptions of the Rocket Exhaust Effluent Diffusion (REED) computer program mentioned on page 5-11 and the Multi-layer Diffusion model footnoted in table 5-10 are given in the report. Are these models the same? What is the basis for the model? What dispersion parameters and what source configuration was assumed? We recognize that computers perform wondrous feats, but listing the time of cloud passage as 699.869 seconds, for example, is going too far!

National Oceanic and Atmospheric Administration/Environmental Research Laboratories, Silver Spring, MD

Comment: It is not possible to assess the validity of the model predictions of HCl concentrations for an STS Launch as shown in table 5-10. No references or descriptions of the Rocket Exhaust Effluent Diffusion (REED) computer program mentioned on page 5-11 and the Multi-layer Diffusion model footnoted in table 5-10 are given in the report. Are these models the same? What dispersion parameters and what source configuration was assumed? We recognize that computers perform wondrous feats, but listing the time of cloud passage as 699.869 seconds, for example, is going too far!

Response: The descriptions and references are contained in the Programmatic EIS for the Space Shuttle EIS, reference 1-3. On page 5-11, paragraph 5.2.2.1 a, last line of first paragraph has been expanded to add: "...and is described in detail in Appendix C of reference 1-3."

Table 5-10, note 1/, page 5-16, has been modified to read: "1/ NASA/MSFC Multilayer Diffusion Model, using meteorology from 7:00 p.m., 18 March 1969 (reference 1-3). Note: The significant digits shown on the computer printout should not be construed as implying that degree of accuracy."

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Duval Building
9450 Koger Boulevard
St. Petersburg, FL 33702

May 31, 1979

FSE61RJH
893-3503

TO: Director, Office of Ecology and Conservation, EC

FROM: FSE - William H. Stevenson

SUBJECT: Comments on Draft Environmental Impact Statement - Kennedy Space Center, National Aeronautics and Space Administration (NASA) (DEIS #7904.26).

The draft environmental impact statement for the Kennedy Space Center that accompanied your memorandum of April 24, 1979, has been received by the National Marine Fisheries Service for review and comment.

The statement has been reviewed and the following comments are offered for your consideration.

Specific Comments

3.4.2 Communities

Page 3-43, paragraph 6. In regard to "...related fishes and gar.," a more detailed description of "related" fishes would enhance the content of the statement.

Page 3-43, paragraph 7. This section should contain a more detailed faunal description including scientific and common names where appropriate. Present terminology is much too general.

Page 3-44, paragraph 8. A description is not given for ichthyofauna inhabiting grass beds described. As written, this paragraph leads the reader to assume an absence of marine organisms within these areas.

Page 3-44, Section 3.4.3. We suggest incorporating a more descriptive narrative of individual critical habitat types, particularly in regard to wetlands areas.

Page 5-23, paragraph 4. We suggest that future dredge and spoil disposal sites be identified and maps delineating these areas be incorporated into the final EIS.

Clearance | Signature and Date
F7 - K. Roberts Yates M. Barber, Jr. for KRR 6/6/79

National Oceanic and Atmospheric Administration/National Marine Fisheries Service, St. Petersburg, FL

a. Comment: 3.4.2 Communities Page 3-43, paragraph 6. In regard to "...related fishes and gar.," a more detailed description of "related" fishes would enhance the content of the statement.

Response: In compliance with the intent of the new Council on Environmental Quality regulations, the EIS was kept as concise and direct as possible. Representative fauna are listed in table 3-9 on pages 3-46/3-47.

No change has been made to the EIS text as a result of this comment.

b. Comment: Page 3-43, paragraph 7. This section should contain a more detailed faunal description including scientific and common names where appropriate. Present terminology is much too general.

Response: In compliance with the intent of the new Council on Environmental Quality regulations, the EIS was kept as concise and direct as possible. Representative fauna are listed in table 3-9 on pages 3-46/3-47.

No change has been made to the EIS text as a result of this comment.

c. Comment: Page 3-44, paragraph 8. A description is not given for ichthyofauna inhabiting grass beds described. As written, this paragraph leads the reader to assume an absence of marine organisms within these areas.

Response: In compliance with the intent of the new Council on Environmental Quality regulations, the EIS was kept as concise and direct as possible. A vegetation map of the area has been included in a pocket on the rear cover of this EIS.

d. Comment: Page 3-44, Section 3.4.3. We suggest incorporating a more descriptive narrative of individual critical habitat types, particularly in regard to wetlands areas.

Response: Figures 3-9 (page 3-19), 3-10 (page 3-21), 3-16 (page 3-38), 3-17 (page 3-41) and sections C.2 (page C-5) and C.6 (page C-23) provide more detail of the nature suggested by this comment. In addition, the detailed descriptions of these areas (beyond those noted above) are contained in references 3-7, 3-10, 3-11, and 5-13. A vegetation map of the area has been included in a pocket on the rear cover of this EIS.

e. Comment: Page 5-23, paragraph 4. We suggest that future dredge and spoil disposal sites be identified and maps delineating these areas be incorporated into the final EIS.

Response: Dredging operations recently completed at KSC are expected to provide unimpeded operations in the Banana River for the next 10 to 12 years. No further dredging is planned until maintenance dredging of the channel is required. At that time, an environmental assessment will be performed to assist in decisions on spoil sites.

No change has been made to the EIS text as a result of this comment.

NATIONAL SCIENCE FOUNDATION

WASHINGTON, D.C. 20550

OFFICE OF THE
ASSISTANT DIRECTOR
FOR ASTRONOMICAL,
ATMOSPHERIC, EARTH,
AND OCEAN SCIENCES

June 22, 1979

Mr. Arnold W. Frutkin
Associate Administrator for
External Relations
NASA
400 Maryland Avenue, S.W.
Washington, D.C. 20546

Dear Mr. Frutkin:

Several individuals in the Foundation have reviewed the draft "EIS for the Kennedy Space Center". Their comments are attached. If you wish to discuss our input, please contact Ms. Adair Montgomery on 632-7360.

Sincerely yours,

Albert Bridgewater
for Daniel Hunt
Deputy Assistant Director

Attachment

Comments on draft of "Environmental Impact Statement for Kennedy Space Center"

1. A review of the various sections pertaining to acid rain and inadvertent weather modification indicates all of the potential effects in the troposphere have been included, although their examination is not very quantitative. Also, there is no discussion of the stratospheric effects of the chemical releases.

2. The recognition by NASA that "Merritt Island is in general a fragile ecosystem and effects of land use on the biota must be closely monitored" (Sec. III, 3.4.3, p.3-44) is to be commended. It is obvious that extensive care has been considered both from planning and contruction points of view in this DEIS. It is essential for a thorough environmental impact analysis to account for the various fragile components of the biotic community, particularly the geographic distribution and ecological habitats of endangered fauna on the island (Appendix C). However, a similar appendix of rare and endangered flora is lacking and it should be realized that the fauna are intimately linked to, and dependent upon, the flora of the area. It is our recommendation that the results of the "surveys now under way by the U.S. Fish and Wildlife Service and scheduled for completion by October 1979 (to) locate endangered and threatened flora" (Sec. III, 3.4.4., p. 3-51) be included in this EIS and analysis of potential impact to the flora be included.

3. NASA's efforts to reclaim or rennovate previously existing structures where possible rather than develop new sites as stated in Sec. IV, 4.2.a, p.4-1. is also commendable. The overall effect of this consideration is, of course, to minimize ecological/environmental impacts upon an already fragile ecosystem.

National Science Foundation, Washington, DC

a. Comment: A review of the various sections pertaining to acid rain and inadvertent weather modification indicates all of the potential effects of the troposphere have been included, although their examination is not very quantitative. Also, there is no discussion of the stratospheric effects of the chemical releases.

Response: NASA has established an extensive in-depth monitoring program to detect and evaluate any impacts associated with acidic rain, if and when it occurs. If it is determined that levels of acidic rains are significantly increased as a result of KSC operations, launch schedules can be altered to avoid incompatible weather patterns.

The conclusions drawn for inadvertent weather modification are based on the evidence available to date and are as quantitative as the data can support. Stratospheric effects of Space Shuttle launches are discussed in the Space Shuttle Programmatic EIS of April 1978 (reference 1-3), specifically in 4.2.2 and 6.2 of that document. As noted in 1.2, page 1-1, global concerns are beyond the scope of this document. NASA activities pertaining to acid rain are continuing, and additional data soon will be available in a final report from the U.S. Department of Agriculture at North Carolina State University. This report will contain the results of a study which employed a producing citrus grove at the Kennedy Space Center. Paragraph 5.8.2.1, has been expanded, starting on page 5-55, as follows:

"Concern over the potential effects of acid rain is an issue on which extensive research has been conducted, including the following typical citations for acid rain literature:

USDA Forest Service, "Proceedings of the First International Symposium on Acid Precipitation and the Forest Ecosystem," General Technical Report NE-23, Upper Darby, PA, 1079 pp., 1976.

Braekke, F. H., "Impact of Acid Precipitation on Forest and Freshwater Ecosystems in Norway," Research Report No. 6, Acid Precipitation - Effects on Forests and Fish, Aas, Norway, 111 pp., 1976.

Likens, G. E., "Acid Precipitation: Our Understanding of the Phenomenon," Proceedings of the Conference on Emerging Environmental Problems: Acid Precipitation, EP-1 Cornell University, EPA 902/9-75-001, 1976.

Galloway, J. N. and E. B. Cowling, "Effects of Acid Precipitation on Vegetation, Soils, and Water - A Proposed Precipitation Network," Air Pollution Control Association Journal (In press), 1979.

Although most work on acid precipitation to date has been done using H_2SO_4, comparable studies using HCl indicate that similar pH levels of H_2SO_4 and HCl cause about the same injury to plants, and results from H_2SO_4 work may be used to indicate what HCl would do.

Analyses of local soil buffering capability, coupled with the testing conducted on producing citrus groves at KSC, have provided indications that acid rains, if they occur, are unlikely to cause measurable effects on the growth or productivity of vegetation in the area. The pH of rainfall would have to be less than 1.0, on a repeated basis, involving the same area of land for noticeable impacts to be generated. The meteorology of the Merritt Island area and the very low likelihood of an acid rain event caused by the Space Shuttle make the probability of repeated doses of acid rain on the same vegetated area extremely small.

Furthermore, discussions with principal investigators from the U.S. Department of Agriculture at North Carolina University and consultations with the American Institute of Biological Sciences indicate that the studies of the effects of HCl gas on plants (see tables 5-11, 5-12, and 5-13) and the high chloride content naturally occurring in the KSC environment provide further evidence that effects of acid rain generated by the Space Shuttle will probably be negligible, especially on native species.

NASA has established an extensive, in-depth monitoring program to detect and evaluate any impacts associated with acidic rain when and if it occurs. It it is determined that levels of acidic rains are significantly increased as a result of KSC operations, launch schedules can be altered to avoid incompatible weather patterns."

b. Comment: The recognition by NASA that "Merritt Island is in general a fragile ecosystem and effects of land use on the biota must be closely monitored" (Sec. III, 3.4.3. p.3-44) is to be commended. It is obvious that extensive care has been considered both from planning and construction points of view in this DEIS. It is essential for a thorough environmental impact analysis to account for the various fragile components of the biotic community, particularly the geographic distribution and ecological habitats of endangered fauna on the island (appendix C). However, a similar appendix of rare and endangered flora is lacking and it should be realized that the fauna are intimately linked to, and dependent upon, the flora of the area. It is our recommendation that the results of the "Surveys now under way by the U.S. Fish and Wildlife Service and scheduled for completion by October 1979 (to) locate endangered and threatened flora" (See sec. III, 3.4.4., p. 3-51) be included in this EIS and analysis of potential impact to the flora be included.

Response: Paragraph 3.4.4, page 3-51, states that surveys now under way by the U.S. Fish and Wildlife Service at the Merritt Island National Wildlife Refuge will not be completed until October 1979, and data are not yet available for inclusion in this EIS. It should be noted that no threatened or endangered species of flora are currently identified on the Federal list, but State-listed species are noted in table 3-11, page 3-50.

A vegetation map of the area is included in a pocket on the rear cover of this EIS.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET
ATLANTA, GEORGIA 30308

June 22, 1979

4SA-EIS

Mr. Arnold W. Frutkin
Associate Administrator
for External Affairs
National Aeronautics and Space Adm.
Washington, D. C. 20546

Dear Mr. Frutkin:

We have reviewed the Draft Environmental Impact Statement on the Kennedy Space Center and are concerned over potential effects of acid rains, especially cumulative impacts of these events. The effects of recurrent acid rains on the growth and productivity of species of marsh plants including Spartina, Juncus and mangroves, need to be investigated. In fact, we suggest that effects of repeated acid rains on all associations listed as Critical Ecological Areas (3.4.3) be discussed. Protection of a sensitive area from construction impacts may be a vacant gesture if ecosystem function is severely impaired by facility operation.

On the basis of our review a rating of LO-2 was assigned, i.e., we have no significant environmental objections to the facility per se; however, some additional data are needed.

If we can be of further assistance, feel free to call on us.

Sincerely yours,

John E. Hagan III
Chief, EIS Branch

Environmental Protection Agency, Region IV, Atlanta, GA

Comment: We have reviewed the Draft Environmental Impact Statement on the Kennedy Space Center and are concerned over potential effects of acid rains, especially cumulative impacts of these events. The effects of recurrent acid rains on the growth and productivity of species of marsh plants including Spartina, Juncus and mangroves, need to be investigated. In fact, we suggest that effects of repeated acid rains on all associations listed as Critical Ecological Areas (3.4.3) be discussed. Protection of a sensitive area from construction impacts may be a vacant gesture if ecosystem function is severely impaired by facility operation.

Response: Paragraph 5.8.2.1, has been expanded, starting on page 5-55, as follows: "Concern over the potential effects of acid rain is an issue on which extensive research has been conducted, including the following typical citations for acid rain literature:

USDA Forest Service, "Proceedings of the First International Symposium on Acid Precipitation and the Forest Ecosystem," General Technical Report NE-23, Upper Darby, PA, 1079 pp., 1976.

Braekke, F. H., "Impact of Acid Precipitation on Forest and Freshwater Ecosystems in Norway", Research Report No. 6, Acid Precipitation - Effects on Forests and Fish, Aas, Norway, 111 pp., 1976.

Likens, G. E., "Acid Precipitation: Our Understanding of the Phenomenon," Proceedings of the Conference on Emerging Environmental Problems: Acid Precipitation, EP-1 Cornell University, EPA 902/9-75-001, 1976.

Galloway, J. N. and E. B. Cowling, "Effects of Acid Precipitation on Vegetation, Soils, and Water - A Proposed Precipitation Network," Air Pollution Control Association Journal (In press), 1979.

Although most work on acid precipitation to date has been done using H_2SO_4, comparable studies using HCl indicate that similar pH levels of H_2SO_4 and HCl cause about the same injury to plants, and results from H_2SO_4 work may be used to indicate what HCl would do.

Analyses of local soil buffering capability, coupled with the testing conducted on producing citrus groves at KSC, have provided indications that acid rains, if they occur, are unlikely to cause measurable effects on the growth or productivity of vegetation in the area. The pH of rainfall would have to be less than 1.0, on a repeated basis, involving the same area of land for noticeable impacts to be generated. The meteorology of the Merritt Island area and the very low likelihood of an acid rain event caused by the Space Shuttle make the probability of repeated doses of acid rain on the same vegetated area extremely small.

Furthermore, discussions with principal investigators from the U.S. Department of Agriculture at North Carolina University and consultations with the American Institute of Biological Sciences indicate that the studies of the effects of HCl gas on plants (see tables 5-11, 5-12, and 5-13) and the high chloride content naturally occurring in the KSC environment provide further evidence that effects of acid rain generated by the Space Shuttle will probably be negligible, especially on native species.

NASA has established an extensive, in-depth monitoring program to detect and evaluate any impacts associated with acidic rain when and if it occurs. If it is determined that levels of acidic rains are significantly increased as a result of KSC operations, launch schedules can be altered to avoid incompatible weather patterns."

BREVARD County
BOARD OF COUNTY COMMISSIONERS

COUNTY DEVELOPMENT DIVISION, 2575 N. Courtenay Parkway, Merritt Island, Florida 32952

SEAL OF BREVARD COUNTY FLORIDA

June 11,1979

Mr. Arnold W. Frutkin
Associate Administrator for
External Relations
National Aeronautics and
Space Administration
Washington, D.C. 20546

Dear Mr. Frutkin:

Thank you for the opportunity to review the Draft Environmental Impact Statement for the Kennedy Space Center. Overall, we find that the Document is complete and well done. We have a few questions or comments which we feel will improve the overall quality of the statement.

1) 2.3.4 - The mission operations discussion indicated that the SRB will be recovered and towed through Port Canaveral before the SRB thrust vector control (TVC) and ordinance systems are safed and remaining fuel removed. What are the possible effects of fuel leakage or ordinance detonation to the operations of the Port or Jetty Park, two important county facilities?

2) 2.5.2.4 - Potable water supply is of particular concern in Brevard County. The City of Titusville has recently declared a water shortage and by 1983, the water supply for the City of Melbourne is expected to be insufficient in drought conditions. The 345.6 million gallon demand in 1984 is a 142% increase over 1978. What methods are available to reduce this demand on the local supplier as well as the resource itself? In addition, this section disagrees with the figures given in section 5.3.1.1.

3) 2.5.8.2 - As experienced with the Apollo program and to a lesser extent recently with the arrival of the Shuttle Enterprise and Columbia, public view in the areas around the Space Center places significant demand on local services and facilities such as police, highways and water front viewing areas. What methods are available to reduce that impact on local governments?

. . . continued

4) 3.2.2 - The description of the Avon Park formation is accurate, that is, a relatively impermeable formation. However, the boulder zone is a highly fractured strata with high transmissivity and not as described. This section should be clarified.

5) Section IV - CEQ guidelines clearly spell out that regional, state and local land use plans, policies and controls shall be considered. Only the State Coastal Zone Management Program and the Local Mosquito Control District are briefly mentioned in this section. Numerous other land use plans, policies and controls are developed or are being developed for the Kennedy Space Center Area. Brevard County has completed the Areawide Waste Treatment Management Plan under section 208 of PL 92-500; essentially completed the Wastewater Facilities Plan under section 201 of PL 92-500; has an adopted land use plan; and is developing a new comprehensive plan under the State of Florida's Local Government Comprehensive Planning Act of which several draft elements are complete; has contracted with a private consultant and U.S.G.S. to conduct a water supply study for the entire Brevard County area, just to name a few. While some coordination has occurred in the past, close coordination is essential now to assure consistency between local government plans and essential NASA operations.

6) Table 4-1 - January 19, 1978, the Brevard County Board of County Commissioners adopted a resolution recommending a local alternative for the development of the Canaveral National Seashore. This alternative recognized the necessity of specific security operations, but stressed the importance of Playalinda Beach as an intensive recreation facility. What methods are available to decrease the number of days State Road 402 is closed?

7) 5.3.1.3 - The Brevard County 208/201 planning effort has investigated the impact of runoff and sewage discharge on the surface waters of the County. These studies have indicated that surface runoff or non point source is the primary source of nutrient loadings in the surface water surrounding KSC. Phosphorus, nitrogen, and suspended solids are all contributed by runoff, as well as the hydrocarbons, pesticides, herbicides, or fungicides mentioned.

8) 5.3.1.4 - The studies for the 208 areawide waste treatment management plan also points out the need to control dredging. The anaerobic layer of sediments act as a nutrient sink, that is, the permanent loss of nutrients from the water column. In most cases this anaerobic layer is less than one centimeter below the water/substrate interface. If these sediments are disturbed causing the remixing and resuspension of the nutrients in the anaerobic portion of the water column the formally trapped nutrients are released resulting in higher, possibly damaging concentrations. This is also true for other trapped pollutants in the sediment.

. . . Continued

In summary, we generally find this document to be complete and accurate and look forward to working with NASA on future projects.

If you have any questions on the points raised, please feel free to call me.

Sincerely,

PLANNING & ZONING DEPARTMENT OF
BREVARD COUNTY, FLORIDA

Robert J. Massarelli
Environmental Planner

RJM/dtb

Brevard County Board of County Commissioners, County Development Division, Merritt Island, FL

a. Comment: 2.3.4 - The mission operations discussion indicated that the SRB will be recovered and towed through Port Canaveral before the SRB thrust vector control (TVC) and ordnance systems are safed and remaining fuel removed. What are the possible effects of fuel leakage or ordnance detonation to the operations of the Port or Jetty Park, two important county facilities?

Response: The Environmental Impact Statement released in April 1978 for the Space Shuttle Program (reference 1-3, pages 97, 98, and 122) addressed the effects of potential unplanned events which might occur during SRB retrieval operations. Portions of the discussions are excerpted, as follows:

"The spent SRB is retrieved at the impact point in the ocean and towed back to the haulout areas or harbors at both the KSC and the VAFB launchsites. Some seawater may mix with or dissolve the unburnt propellant and residue inside the casing (charred insulation and ammonium perchlorate) and may be released during the haulout operations. A worst-case event could involve the spillage of about 79 kg (175 lb) of this material. The maximum allowable concentration (MAC) for fish in water is 50 mg/liter for ammonium perchlorate; see table 4-9 (taken from ref. 4-38). Since both harbors are subject to flushing by tidal action, any contamination is expected to be local and to dissipate rapidly.

"The empty SRB is effectively inert. It will contain a small amount of residual hydrazine in tanks designed to withstand the splashdown loads and the salt water environment without leakage. Early SRB's will carry a linear shaped charge as part of the flight termination system for range safety; however, this ordnance will be both mechanically and electrically "safed" (made inert) prior to SRB separation. If the SRB should sink in deep water, no hazard would be presented to shipping or to the marine environment. If the SRB should sink in shallow water, it would be recovered because of its value. Mishaps to the retrieval vessel will not result in any environmental consequences different from those associated with any shipping mishap (excluding oil tankers). The retrieval vessel is powered by ordinary petroleum-based fuels. Normal safety precautions will be observed in handling these fuels."

Close coordination between NASA and the Port Authority, the Department of Defense, and the Coast Guard will ensure that all safety precautions are exercised and that no conflicts in facility use arise.

Paragraph 2.3.4, second paragraph on page 2-26, has been changed to insert the following at line 13: "The empty SRB is effectively inert. It will contain a small amount of residual hydrazine in tanks designed to withstand the splashdown loads and the saltwater environment without leakage.

Early SRB's will carry a linear shaped charge as part of the flight termination system for range safety; however, the ordnance will be both mechanically and electrically safed (made inert) prior to SRB separation."

b. Comment: 2.5.2.4 - Potable water supply is of particular concern in Brevard County. The City of Titusville has recently declared a water shortage and by 1983, the water supply for the City of Melbourne is expected to be insufficient in drought conditions. The 345.6 million gallon demand in 1984 is a 142% increase over 1978. What methods are available to reduce this demand on the local supplier as well as the resource itself? In addition, this section disagrees with the figures given in section 5.3.1.1.

Response: A more recent assessment of actual and predicted annual potable water consumption than was available when the draft EIS was being prepared has resulted in the following adjustments to the indicated paragraphs (see page 2-48):

2.5.2.4 was:

"Year	Kiloliters	Gallons
1978	540,541	142,800,000
1979	559,846	147,900,000
1980	622,587	164,475,000
1981	666,024	175,950,000
1982	926,568	244,800,000
1983	1,065,856	281,600,000
1984	1,038,096	345,600,000"

now:

"Year	Kiloliters	Gallons
1978	560,180	148,800,000
1979	749,430	198,000,000
1980	832,700	220,000,000
1981	870,550	230,000,000
1982	926,568	244,800,000
1983	1,065,856	281,600,000
1984	1,308,096	345,600,000"

It should be noted that the water used at KSC comes entirely from Orange County through the City of Cocoa. The projected use of water is related directly to the STS flight schedule (see table 2-1 on page 2-4) and represents maximum amounts based on predicted mission use. Water consumption during the Apollo era (1968-1969) was 1,480,000 kiloliters (391,010,000 gallons), about 170,000 kiloliters (45,000,000 gallons) more than the expected peak annual use for the Space Shuttle.

NASA has reduced water consumption significantly at KSC by curtailing air-conditioning wherever used solely for human comfort, by instituting reuse of wash and rinse water to the fullest extent, and by constant surveillance for sources of losses which on an annual basis could be a concern. As operational processes evolve, every opportunity to reduce consumption of potable water will be evaluated. The use of pumped ground water is an alternative which has been assessed and which can be adopted if needed, but high salinity and maintenance of ground water pumping systems present problems which should be avoided if possible.

Paragraph 5.3.1.1, page 5-23, has been changed to read: "Average use during the STS era is estimated not to exceed 2,481 kiloliters (653,000 gallons) per day."

Table 5-15, page 5-22 has been changed to read: "1. Consumption of water (Est. 1979) 749,430 kiloliters/year (198,000,000 gallons/yr)"

c. Comment: 2.5.8.2 - As experienced with the Apollo program and to a lesser extent recently with the arrival of the Shuttle Enterprise and Columbia, public view in the areas around the Space Center places significant demand on local services and facilities such as police, highways and waterfront viewing areas. What methods are available to reduce that impact on local governments?

Response: In the areas of public viewing over which NASA has control, portable comfort stations will be temporarily emplaced for viewers' use and public address systems will be used to assist in an orderly dispersal of vehicles as in the past.

For those areas not under NASA jurisdiction, it is expected that local businesses will cooperate with county and municipal governments to accommodate tourists and visitors to their mutual benefit. As has always been NASA policy, public information activities will be coordinated with local groups to ensure maximum knowledge and involvement regarding mission plans and operations.

No change has been made to the EIS text as a result of this comment.

• d. Comment: 3.2.2 -The description of the Avon Park formation is accurate, that is, a relatively impermeable formation. However, the boulder zone is a highly fractured strata with high transmissivity and not as described. This section should be clarified.

Response: 3.2.2, page 3-2. The following two sentences in the second paragraph have been deleted:

"This area is generally referred to as the boulder zone. The depth and exact characteristics of the boulder zone vary throughout the county."

e. Comment: Section IV - CEQ guidelines clearly spell out that regional, state and local land use plans, policies and controls shall be considered. Only the State Coastal Zone Management Program and the Local Mosquito Control District are briefly mentioned in this section. Numerous other land use plans, policies and controls are developed or are being developed for the John F. Kennedy Space Center Area. Brevard County has completed the Areawide Waste Treatment Management Plan under section 208 or PL 92-500; essentially completed the Wastewater Facilities Plan under section 201 of PL 92-500; has an adopted land use plan; and is developing a new comprehensive plan under the State of Florida's Local Government Comprehensive Planning Act of which several draft elements are complete; has contracted with a private consultant and U.S.G.S. to conduct a water supply study for the entire Brevard County area, just to name a few. While some coordination has occurred in the past, close coordination is essential now to assure consistency between local government plans and essential NASA operations.

Response: NASA recognizes the need for continuing coordination in these areas and representatives have been designated to work with the appropriate local and state planning groups.

No change has been made to the EIS text as a result of this comment.

f. Comment: Table 4-1 - January 19, 1978, the Brevard County Board of County Commissioners adopted a resolution recommending a local alternative for the development of the Canaveral National Seashore. This alternative recognized the necessity of specific security operations, but stressed the importance of Playalinda Beach as an intensive recreation facility. What methods are available to decrease the number of days State Road 402 is closed?

Response: As experience is gained with new STS systems, it is to be expected that restrictions imposed for reasons of public safety and operational security can be relaxed. Current plans are for NASA and the National Park Service to cooperate to permit vehicle access during all but the final days of launch preparations. Alternatives, such as supervised busing through the restricted zone, or use of alternate access routes are being evaluated.

Paragraph 7.7 on page 7-3 has been expanded by the addition of the following sentences: "In addition, the periodic closing of Playalinda Beach will be required for public safety and operational security. NASA and the National Park Service will cooperate to reduce restrictions to the extent possible as experience indicates the suitability of such action."

g. Comment: 5.3.1.3 - The Brevard County 208/201 planning effort has investigated the impact of runoff and sewage discharge on the surface waters of the county. These studies have indicated that surface runoff or non point source is the primary source of nutrient loadings in the surface water surrounding KSC. Phosphorus, nitrogen, and suspended solids are all contributed by runoff, as well as the hydrocarbons, pesticides, herbicides, or fungicides mentioned.

Response: Paragraph 5.3.1.3 on page 5-23, first paragraph, last sentence, has been revised as follows: "Runoff from unpaved areas can contain residues from the application of pesticides for citrus groves and grounds maintenance, as well as a contribution of phosphorus, nitrogen, and suspended solids."

h. Comment: 5.3.1.4 - The studies for the 208 areawide waste treatment management plan also points out the need to control dredging. The anaerobic layer of sediments act as a nutrient sink, that is, the permanent loss of nutrients from the water column. In most cases this anaerobic layer is less than one centimeter below the water/substrate interface. If these sediments are disturbed causing the remixing and resuspension of the nutrients in the anaerobic portion of the water column the formerly trapped nutrients are released resulting in higher, possibly damaging concentrations. This is also true for other trapped pollutants in the sediment.

Response: Dredging operations recently completed at KSC are expected to provide unimpeded operations in the Banana River for the next 10 to 12 years. No further dredging is planned until maintenance dredging of the channel is required. At that time, an environmental assessment will be performed to assist in decisions on spoil sites.

No change has been made to the EIS text as a result of this comment.

THE East Central Florida REGIONAL PLANNING COUNCIL
1011 WYMORE ROAD · WINTER PARK, FLORIDA 32789
TELEPHONE: (305) 645-3339

June 13, 1979

Mr. A. M. Koller, Jr., Chief
Environmental Management Staff
NASA, John F. Kennedy Space Center
Kennedy Space Center, FL 32789

Subject: Environmental Impact Statement
for Kennedy Space Center
ECFRPC No. BR-79-72

Dear Mr. Koller:

Thank you for the opportunity of reviewing the above referenced document. Following a staff review of the E.I.S., it is suggested that:

1. Since operations related to the Space Shuttle program will add to the hydrocarbon emissions in Brevard County (ref. Tables 5-1, 5-2), and since violations of ozone standards have been recorded at KSC (ref. 3-25), the agency should show records of all ozone monitoring which KSC has undertaken. It appears possible that a violation of federal ozone standards may take place and that mitigative measures may have to be implemented.

2. Figure 2-1 should display the 15 sewage treatment package plants, as stated on Page 2-48, Paragraph 2.5.2.5.

3. On Page 3-44, Paragraph 3.4.3., the name "Florida Zone Coordination Council" be changed to Florida Bureau of Coastal Zone Planning.

4. NASA should work closely with the National Park Service to mitigate as much as possible the adverse impacts associated with the closure of Playalinda Beach for Space Shuttle operations.

Should you feel that the East Central Florida Regional Planning Council could be of further assistance to you, please do not hesitate to call.

Sincerely,

Cliff Guillet
Executive Director

CG/JI/eb

cc: Hon. John F. Hurdle
Mrs. Wilma Whippo
Mr. W. Lansing Gleason

East Central Florida Regional Planning Council, Winter Park, FL

a. Comment: Since operations related to the Space Shuttle program will add to the hydrocarbon emissions in Brevard County (ref. Tables 5-1, 5-2), and since violations of ozone standards have been recorded at KSC (ref. 3-25), the agency should show records of all ozone monitoring which KSC has undertaken. It appears possible that a violation of federal ozone standards may take place and that mitigative measures may have to be implemented.

Response: On February 13, 1979, records of agency monitoring results for ozone and hydrocarbons at the Kennedy Space Center were provided to the State of Florida Department of Environmental Regulation (DER) in Orlando. Since that time, relaxation of national ambient air quality standards and changes in calibration techniques for ozone monitoring instruments have been instituted and few subsequent measurements above federal standards have been recorded.

It is generally accepted that the ozone precursors in photochemical oxidant air pollutant are hydrocarbons and nitrogen oxides. The data in table 5-7, page 5-10, indicate KSC emissions of these primary pollutants to be approximately 1% of the Brevard total and hence a distinctly minimal source of whatever problem may exist.

Paragraph 3.3.1, last 2 paragraphs on page 3-25, have been changed to read as follows:

"Recently acquired air quality monitoring equipment at KSC (including the capability to measure toxic gases generated during launches) and state air quality measurements since 1973 have provided data confirming the absence of major pollutants in the KSC vicinity (references 3-4 and 3-5). During 1978, for example, the range of pollutant concentrations was (in micrograms per cubic meter): (1) sulfur dioxide: 0 to 176; (2) nitrogen dioxide: 0 to 100; (3) particulates: 12.76 to 94.36; and (4) ozone: 4 to 382. Data on hydrocarbons and oxides of carbon are not available at this time. Table 3-5 lists the current national ambient air quality standards.

"Ozone measurements made using new EPA calibration standards (ultraviolet source) and new national ambient air quality standards (240 vs 160 micrograms/cu. meter) currently show only isolated, seasonal (spring, fall) high levels of ozone which appear to correspond with certain weather patterns and may involve long-range transport phenomena. KSC limitations on mechanical activity and proscribed burning restrict the amount of pollutants entering the atmosphere. Thus, the major sources of air pollutants generated within KSC are private motor vehicles and launches of space vehicles."

b. Comment: Figure 2-1 should display the 15 sewage treatment package plants, as stated on page 2-48, paragraph 2.5.2.5.

Response: Table 2-4 locates the sewage treatment plants by area on figure 2-1 as indicated by numbered references. Paragraph 2.5.2.5, line 4 on page 2-48 has been changed from "(see figure 2-1)" to "(see table 2-4)".

c. Comment: On page 3-48, paragraph 3.4.3., the name "Florida Zone Coordination Council" should be changed to Florida Bureau of Coastal Zone Planning.

Response: The text of the EIS has been changed as requested.

d. Comment: NASA should work closely with the National Park Service to mitigate as much as possible the adverse impacts associated with the closure of Playalinda Beach for Space Shuttle operations.

Response: As experience is gained with new STS systems, it is to be expected that restrictions imposed for reasons of public safety and operational security can be relaxed. Current plans are for NASA and the National Park Service to cooperate to permit vehicle access during all but the final days of launch preparations. Alternatives, such as supervised busing through the restricted zone, or use of alternate access routes are being evaluated.

Paragraph 7.7, page 7-3 has been expanded by the addition of the following sentences: "In addition, the periodic closing of Playalinda Beach will be required for public safety and operation security. NASA and the National Park Service will cooperate to reduce restrictions to the extent possible as experience indicates the suitability of such action."

STATE OF FLORIDA

FLORIDA DEPARTMENT OF AGRICULTURE & CONSUMER SERVICES

DOYLE CONNER, COMMISSIONER * THE CAPITOL / TALLAHASSEE 32304

June 13, 1979

Mr. Loring Lovell, Chief
Bureau of Intergovernmental Relations
Division of State Planning
Department of Administration
Carlton Building
Tallahassee, Florida 32301

Dear Mr. Lovell:

Our Division of Forestry has reviewed the Summary of The Kennedy Space Center Environmental Impact Statement presented recently at the A-95 Clearinghouse Meeting. We feel that an excellent and very thorough job has been done with preparation of this document. Our only question concerns the treatment of vegetation, and the tests which have been run concerning the effects of solid fuel by-products on the plant communities. We understand that hydrogen chloride absorbed by rain is the substance of major concern. Our question is, in addition to the mostly agricultural or horticultural plants listed on pages 5-18 of the summary document, have tests been conducted on native plants in the areas affected by rocket blast gases? If so, what are the effects?

One other concern with reference to the vegetative communities surrounding the Space Center has been noted. We saw, on the last page of the summary document, a reference to the "KSC Operational Monitoring Program" with a reference to biotic monitoring of threatened/endangered flora and fauna. However, although Table C-1 in the summary document addressed the endangered/threatened fauna, we did not see this kind of reference to the floral component. Is there a similar monitoring program for the vegetative community of the area?

If the Division of Forestry can be of service beyond the above, do not hesitate to contact us.

Sincerely,

Harold H. Hoffman

Harold H. Hoffman
Assistant Commissioner

HHH/bs

Florida Department of Agriculture and Consumer Services, Tallahassee, FL

a. Comment: Our Division of Forestry has reviewed the Summary of The Kennedy Space Center Environmental Impact Statement presented recently at the A-95 Clearinghouse Meeting. We feel that an excellent and very thorough job has been done with preparation of this document. Our only question concerns the treatment of vegetation, and the tests which have been run concerning the effects of solid fuel by-products on the plant communities.

We understand that hydrogen chloride absorbed by rain is the substance of major concern. Our question is, in addition to the mostly agricultural or horticultural plants listed on pages 5-18 of the summary document, have tests been conducted on native plants in the areas affected by rocket blast gases? If so, what are the effects?

Response: The plant exposure studies conducted at North Carolina State University included 23 species of native vegetation taken from Merritt Island. These studies generally indicated that native species were more resistant to HCl and solid rocket fuel exhaust than were the horticultural and agronomic species. It appears from the NCSU studies, and work conducted at the University of California at Riverside, that these plants will be even more resistant to exposures to solid rocket fuel exhaust in the field situation. No pronounced effects on even the most sensitive native species from solid rocket fuel exhaust are expected, based on all research work to date.

No change to the text of the EIS has been made as a result of this comment.

b. Comment: One other concern with reference to the vegetative communities surrounding the Space Center has been noted. We saw, on the last page of the summary document, a reference to the "KSC Operational Monitoring Program" with a reference to biotic monitoring of threatened/endangered flora and fauna. However, although Table C-1 in the summary document addressed the endangered/threatened fauna, we did not see this kind of reference to the floral component. Is there a similar monitoring program for the vegetative community of the area?

Response: A final paragraph has been added to 5.2.2.1 d, on page 5-20, as follows: "Extensive work has been performed over the past 6 years by the University of Central Florida (formerly known as Florida Technological University) under contract to NASA/KSC and with specific guidance by tne American Institute of Biological Sciences. This project established 10 reference sites and used permanent transects to determine standard parameters for biological assay. For initial Space Shuttle flights, these sites will be used for monitoring effects on vegetation communities in the area. Surveys, now under way by the U.S. Fish and Wildlife Service and scheduled for completion by October 1979, will identify and locate endangered and threatened flora within the boundaries of the Merritt Island National Wildlife Refuge.

A vegetation map of the area is included in a pocket on the rear cover of this EIS."

11.3 COMMENTS RECEIVED NOT REQUIRING NASA RESPONSE

All letters from the following agencies which did not elicit response from NASA are included in this section:

Agency	Page
Department of the Treasury Assistant Director (Environmental Programs) Washington, DC 20220	11-53
Federal Energy Regulatory Commission Advisor on Environmental Quality Washington, DC 20426	11-54

STATE OF FLORIDA

Department of Administration

Division of State Planning

Room 530 Carlton Building
TALLAHASSEE
32304
(904) 488-1115

R. G. Whittle, Jr.
STATE PLANNING DIRECTOR

Bob Graham
GOVERNOR

Jim Tait
SECRETARY OF ADMINISTRATION

June 27, 1979

JUL 3 1979

Mr. A.M. Koller, Jr., Chief
Environmental Management Staff
National Aeronautics and Space Administration
Kennedy Space Center, Florida 32899

Dear Mr. Koller:

Functioning as the state planning and development clearinghouse contemplated in U.S. Office of Management and Budget Circular A-95, we have reviewed the following draft environmental impact statement for the Kennedy Space Center, SAI 79-1989E.

During our review we referred the environmental impact statement to the following agencies, which we identified as interested: Departments of Agriculture and Consumer Services, Commerce, Community Affairs, Environmental Regulation, Natural Resources, State, Transportation, and Game and Fresh Water Fish Commission.

Agencies were requested to review the statement and comment on possible effects that actions contemplated could have on matters of their concern. Letters of comment on the statement are enclosed from: Departments of Agriculture and Consumer Services, Community Affairs. Commerce, Natural Resources, Transportation and the Game and Fresh Water Fish Commission have submitted letters of no comment.

We have reviewed this document and the state agency comments thereon. Based upon this review, we find that this document very adequately summarizes the environmental effects of the Kennedy Space Center (KSC) ongoing operations and future operations and facilites required for the Space Transportation program. We commend the KSC staff for its past coordination activities with state agencies and look forward to a continuing cooperative effort. The attached review comments and questions submitted by the Department of Agriculture and Consumer Services should be addressed in the final statement for this project and we particularly request that the Center cooperate closely with the Departments of Environmental Regulation and Natural Resources regarding project permits and other activities that may affect the areas natural resources.

We request that you forward us copies of the final environmental impact statement prepared on this project.

Sincerely,

R.G. Whittle, Jr., Director

RGWjr:WKy

Enclosures

cc: Mr. John Bethea
Mr. Charles Blair
Mr. James Cullison
Ms. Joan Heggen
Mr. Joseph W. Landers, Jr.
Mr. W.N. Lofroos
Mr. H.E. Wallace
Mr. Robert Williams

STATE OF FLORIDA

DEPARTMENT OF COMMUNITY AFFAIRS

BOB GRAHAM, GOVERNOR

JOAN M. HEGGEN, SECRETARY

DIVISION OF TECHNICAL ASSISTANCE

M-E-M-O-R-A-N-D-U-M

DATE: May 21, 1979

TO: Joseph Gerry

FROM: John H. Haslam

SUBJECT: A-95 Review Comment, SAI:79-1989E

Staff review has been made of the Environmental Impact Statement submitted by the National Aeronautics and Space Administration (SAI:79-1989E). We feel the stabilizing effect the planned space activities will have on the local economy will, in turn, be of benefit to all of the State of Florida.

JHH/lr

rector ... Local Government ... Housing Assistance ... Planning & Research ... Community Development
8-2356 488-7956 488-1536 488-2356 488-1536

2571 Executive Center Circle, East, Tallahassee, Florida 32301

Division of State Planning

Room 530 Carlton Building

TALLAHASSEE

32304

(904) 488-2371

tle, Jr.
NNING DIRECTOR

Reubin O'D. Askew
GOVERNOR

Wallace W. Henderson
SECRETARY OF ADMINISTRATION

): SECRETARY
Department of Commerce
510 Collins Building
Tallahassee, Florida 32304

DATE: 5-10-79

DUE DATE: 5-24-79

SUBJECT SAI: 79-1989E

ATT: ______________________

OM: Bureau of Intergovernmental Relations

The attached "424 Preapplication" serving as notification of intent to ply for federal assistance is being referred to your agency for review and mment. Your review and comments should address themselves to the extent to rify that the project(s) is/are consistent with or contributed to the fulfill-nt of your agency's plans or the achievement of your projects, programs and jectives.

If further information is required, you are urged to telephone the contact rson named on the preapplication form. If a conference seems necessary, or if u wish to review the entire application, contact this office by telephone as on as possible. Please check the appropriate box, attach any comments on your ency's stationery and return to BIGR or telephone by the above due date. If we not receive a response by the due date, we will assume your agency has no adverse mments. In both telephone conversation and written correspondence, please refer the SAI Number.

Sincerely,

Loring Lovell, Chief
Bureau of Intergovernmental Relations

losure

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Bureau of Intergovernmental Relations

M: Department of Commerce

JECT SAI: 79-1989E

No Comment [✓] Comments Attached [ ]

ision/Bureau of Economic Analysis

iewer ______________________ Date 5/15/79

STATE OF FLORIDA

Department of Administration

Division of State Planning

660 Apalachee Parkway · IBM Building

TALLAHASSEE

32304

(904) 488-2371

DIVISION OF STATE PLANNING,
Bureau Of
Intergovernmental Relations
JUN 1 1979
RECEIVED
SAI NO. ____

G. Whittle, Jr.
STATE PLANNING DIRECTOR

Reubin O'D. Askew
GOVERNOR

Lt. Gov. J. H. "Jim" Williams
SECRETARY OF ADMINISTRATION

TO: Mr. Harmon Shields
Department of Natural Resources
202 Blount Street, Crown Building
Tallahassee, Florida 32304

DATE: 5-10-79

RECEIVED ~~DUE DATE~~ 5-24-79

MAY 11 1979

DEPARTMENT OF NATURAL RESOURCES

FROM: Bureau of Intergovernmental Relations

SUBJECT: SAI: 79-1989E

The attached "Advance Notification" of intent to apply for federal assistance is being referred to your agency for review and comments. Your review and comments should address themselves to the extent to which the project is consistent with or contributes to the fulfillment of your agency's plans or the achievement of your projects, programs and objectives.

If further information is required, you are urged to telephone the contact person named on the notification form. If a conference seems necessary, or if you wish to review the entire application, contact this office by telephone as soon as possible. If you have no adverse comments, you may wish to report such by telephone. Please check the appropriate box, attach any comments on your agency's stationery, and return to this office or telephone by the above due date. If we do not receive a response by the due date, we will assume your agency has no adverse comments. In both telephone conversation and written correspondence, please refer to the SAI number.

Sincerely,

Loring Lovell, Chief
Bureau of Intergovernmental Relations

Enclosure

****

TO: Bureau of Intergovernmental Relations
FROM: Department of Natural Resources
SUBJECT: Project Review and Comments, SAI: 79-1989E

[X] No adverse Comments   [ ] Comments Attached

Signature: James B. Smith   Date: May 29, 1979

Title: Administrative Assistant

STATE OF FLORIDA

Department of Administration

Division of State Planning

660 Apalachee Parkway · IBM Building

TALLAHASSEE

32304

(904) 488-2371

OFFICE OF STATE PLANNING
Bureau Of
Intergovernmental Relations

JUN 1 1979

RECEIVED

SAI NO. ______

RECEIVED
MAY 11

R. G. Whittle, Jr.
STATE PLANNING DIRECTOR

Reubin O'D. Askew
GOVERNOR

Lt. Gov. J. H. "Jim" Williams
SECRETARY OF ADMINISTRATION

TO: Mr. W. N. Lofroos, Chief
Bureau of Planning
Department of Transportation
605 Suwannee Street
Tallahassee, Florida 32304

DATE: 5-10-79

DUE DATE: 5-24-79

FROM: Bureau of Intergovernmental Relations

SUBJECT: SAI: 79-1989E

The attached "Advance Notification" of intent to apply for federal assistance is being referred to your agency for review and comments. Your review and comments should address themselves to the extent to which the project is consistent with or contributes to the fulfillment of your agency's plans or the achievement of your projects, programs, and objectives.

If further information is required, you are urged to telephone the contact person named on the notification form. If a conference seems necessary or if you wish to review the entire application, contact this office by telephone as soon as possible. If you have no adverse comments, you may wish to report such by telephone. Please check the appropriate box, attach any comments on your agency's stationery, and return to BIGR or telephone by the above due date. If we do not receive a response by the due date, we will assume your agency has no adverse comments. In both telephone conversation and written correspondence, please refer to the SAI.

Sincerely,

[signature]

Loring Lovell, Chief
Bureau of Intergovernmental Relations

Enclosure

****

TO: Bureau of Intergovernmental Relations
FROM: W. N. Lofroos, Department of Transportation
SUBJECT: Project Review and Comments, SAI: 79-1989E

[X] No Comments [ ] Comments Attached

Signature: E. McNeely

Date: 5-23-79

Title: A-95 Coordinator

11-45

Department of Administration

Division of State Planning

660 Apalachee Parkway • IBM Building

TALLAHASSEE

32304

(904) 488-2371

Reubin O'D. Askew
GOVERNOR

Lt. Gov. J. H. "Jim" Williams
SECRETARY OF ADMINISTRATION

RECEIVED MAY 11 1979
Whittle...

TO: Mr. H. E. Wallace
Game & Fresh Water Fish Commission
Bryant Building
Tallahassee, Florida 32304

DATE: 5-10-79

DUE DATE: 5-24-79

FROM: Bureau of Intergovernmental Relations

SUBJECT: SAI: 79-1989E

The attached "Advance Notification" of intent to apply for federal assistance is being referred to your agency for review and comments. Your review and comments should address themselves to the extent to which the project is consistent with or contributes to the fulfillment of your agency's plans or the achievement of your projects, programs, and objectives.

If further information is required, you are urged to telephone the contact person named on the notification form. If a conference seems necessary, or if you wish to review the entire application, contact this office by telephone as soon as possible. If you have no adverse comments, you may wish to report such by telephone. Please check the appropriate box, attach any comments on your agency's stationery, and return to BIGR or telephone by the above due date. If we do not receive a response by the due date, we will assume your agency has no adverse comments. In both telephone conversation and written correspondence, please refer to the SAI.

Sincerely,

Loring Lovell, Chief
Bureau of Intergovernmental Relations

Enclosures

****

TO: Bureau of Intergovernmental Relations
FROM: Game & Fresh Water Fish Commission
SUBJECT: Project Review and Comments, SAI: 79-1989E

[XX] No Comments

[ ] Comments Attached

Reviewing Agency:
Signature: Bradley J. Hartman

Date: May 18, 1979

Title: Director, Office of Environmental Services

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

State Office, P. O. Box 1208, Gainesville, FL 32602

June 28, 1979

Arnold W. Frutkin
Associate Administrator for
External Relations
National Aeronautics and
Space Administration
Washington, D.C. 20546

Dear Mr. Frutkin:

RE: Draft Environmental Impact Statement for the
National Aeronautics and Space Administration (NASA)
Kennedy Space Center

We have reviewed the subject draft environmental impact statement and we have no constructive comments to offer.

We appreciate the opportunity to review and comment.

Sincerely,

[signature] Acting

William E. Austin
State Conservationist

REGION IV
Pershing Point Plaza
1371 Peachtree Street, N.E.
Atlanta, Georgia 30309

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
AREA OFFICE
PENINSULAR PLAZA
661 RIVERSIDE AVENUE
JACKSONVILLE, FLORIDA 32204

MAY 22 1979

IN REPLY REFER TO:
4.6SS
(RLC)

Mr. Arnold W. Fratkin
Associate Administrator for
External Relations
National Aeronautics and
Space Administration
Washington, D. C. 20546

Dear Mr. Fratkin:

The Draft Environmental Impact Statement for the John F. Kennedy Space Center has been received by this office.

We have reviewed the statement with regard to the environmental aspects related to proposed or ongoing Department of Housing and Urban Development programs in the immediate area, and have no comment to offer.

The opportunity to review this Environmental Impact Statement is appreciated.

Sincerely,

for Everett H. Rothschild
Area Manager

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

In Reply Refer To:
ER 79/396

JUN 20 1979

Mr. Arnold W. Frutkin
Associate Administrator for
External Relations
National Aeronautics and
Space Administration
Washington, DC 20546

Dear Mr. Frutkin:

The Department of the Interior has reviewed the draft environmental impact statement for the Kennedy Space Center, as requested by your letter of April 12, 1979.

We find the document to be generally adequate in addressing the areas of our interest and expertise, and we have no comments to offer.

We appreciate the opportunity to review this document.

Sincerely,

Larry E. Meierotto
Assistant SECRETARY

DEPARTMENT OF STATE

Washington, D.C. 20520

BUREAU OF OCEANS AND INTERNATIONAL
ENVIRONMENTAL AND SCIENTIFIC AFFAIRS

June 8, 1979

Dr. Albert M. Koller, Jr.
Chief, Environmental Management
Staff
Code DF
National Aeronautics and
Space Administration
Kennedy Space Center, Florida 32899

Dear Dr. Koller:

Officers of the Department of State have appreciated the opportunity to review the Administration's Draft Environmental Impact Statement for the Kennedy Space Center. The Department of State has no comments to make on the statement.

Sincerely yours,

Donald R. King
Director, Office of
Environmental Affairs

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

April 26, 1979

Mr. Arnold W. Frutkin
Associate Administrator for
External Relations
National Aeronautics and
Space Administration
Washington, D. C. 20546

Dear Mr. Frutkin:

We appreciate the opportunity to review the draft EIS prepared for the operation of the Kennedy Space Center. It is most complete and in far more detail than we would ever expect to prepare for some of our development assistance activities. Our evaluations are only carried out when we determine that there is a likely significant impact on the environment. Your study, however, describes no such impact.

We have no comments or suggestions to make that would help in finalizing this draft.

Sincerely yours,

Albert C. Printz, Jr.
Environmental Affairs Coordinator

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

Region Four
P. O. Box 1079
Tallahassee, Florida 32302

June 13, 1979

In Reply Refer To: HEC-FL

Dr. Albert M. Koller, Jr., Chief
Environmental Management Staff
Code DF
National Aeronautics and Space
Administration
Kennedy Space Center, Florida 32899

Dear Dr. Koller:

Subject: Florida - Kennedy Space Center

We received a copy of the draft environmental statement for the environmental effects of activities at the Kennedy Space Center.

We have reviewed your environmental document and have considered the proposed project in relation to responsibilities of this office in administering the Federal-aid highway program in Florida. Since the proposed work should not have any effect on highway transportation facilities, we have no comments concerning the proposed project.

The above finding does not in any way commit our cooperating State agency, the Florida Department of Transportation (FDOT). We assume that comments will be solicited from FDOT through Clearinghouse procedures required by Bureau of the Budget Circular A-95.

Sincerely yours,

P. E. Carpenter

P. E. Carpenter
Division Administrator

DEPARTMENT OF THE TREASURY

WASHINGTON, D.C. 20220

June 11, 1979

Dear Mr. Frutkin:

Thank you for forwarding a copy of the Draft Environmental Impact Statement for the Kennedy Space Center. This Department has no comment on the draft.

Sincerely,

/s/ A. V. DiSilvestre

Anthony V. DiSilvestre
Assistant Director (Environmental Programs)
Office of Administrative Programs

Mr. Arnold W. Frutkin
Associate Administrator for
External Relations
National Aeronautics and
Space Administration
Washington, D.C. 20546

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426

IN REPLY REFER TO:

April 25, 1979

Mr. Arnold W. Frutkin
National Aeronautics and Space
Administration
Washington, D. C. 20546

Dear Mr. Frutkin:

I am replying to your request of April 12, 1979 to the Federal Energy Regulatory Commission for comments on the Draft Environmental Impact Statement for the National Aeronautics and Space Administration (NASA) Kennedy Space Center. This Draft EIS has been reviewed by appropriate FERC staff components upon whose evaluation this response is based.

The staff concentrates its review of other agencies' environmental impact statements basically on those areas of the electric power, natural gas, and oil pipeline industries for which the Commission has jurisdiction by law, or where staff has special expertise in evaluating environmental impacts involved with the proposed action. It does not appear that there would be any significant impacts in these areas of concern nor serious conflicts with this agency's responsibilities should this action be undertaken.

Thank you for the opportunity to review this statement.

Sincerely,

Jack M. Heinemann
Advisor on Environmental Quality

APPENDIX A

ABBREVIATIONS, ACRONYMS, AND CONVERSION FACTORS

APPENDIX A

ABBREVIATIONS, ACRONYMS, AND CONVERSION FACTORS

abbrev	abbreviation
ACGIH	American Conference of Governmental Industrial Hygienists
A/C	aircraft
AEC	Atomic Energy Commission
AFB	Air Force Base
AFETR	Air Force Eastern Test Range
AFWTR	Air Force Western Test Range
alt	altitude
a.m.	ante meridiem
amt	amount
ann	annual
APS	Aft Propulsion System
APU	Auxiliary Power Unit
ARCS	Aft Reaction Control Subsystem
ASE	Airborne Support Equipment
assy	assembly
avg	average
BA	Base Annual
BC	before Christ
BEST	Booster Exhaust Study Test
BLD	Base Launch Dependent
bldg	building
BOD	biochemical oxygen demand
Btu	British thermal unit
Btu/hr	British thermal units per hour
C	Celsius (Centigrade)
CBI	Chesapeake Bay Institute
CCAFS	Cape Canaveral Air Force Station
CCF	Converter/Compressor Facility
CEQ	Council on Environmental Quality
CIF	Central Instrumentation Facility
CITE	Cargo Integration Test Equipment
cm	centimeter
cm^2	square centimeter
cm^3	cubic centimeter
CNS	Canaveral National Seashore
cu	cubic
CY	calendar year
dB	decibel
dBA	decibel (measured with an "A weighted" frequency network)
DE	Design Engineering Directorate (KSC)
deg	degree
DER	Department of Environmental Regulation (Florida)
DM	demineralized (water)
DO	dissolved oxygen

ABBREVIATIONS AND ACRONYMS (cont)

DOD	Department of Defense
DOI	Department of the Interior
ECLSS	Environmental Control and Life Support Subsystem
ECS	Environmental Control System
E&I	Electronics and Instrumentation
e.g.	for example
EIS	Environmental Impact Statement
ELV	Expendable Launch Vehicle
E.O.	Executive Order
E&O	Engineering and Operations (Building)
EPA	Environmental Protection Agency
eqmt	equipment
ESA	Explosive Safe Area, European Space Agency
ET	External Tank
etc.	and so forth
et seqq	and the following (ones)
F	Fahrenheit
Fac	Facility
FCSB	Flight Crew Support Building
FHA	Federal Housing Administration
FRCS	Forward Reaction Control Subsystem
FSS	Fixed Service Structure
ft	foot
ft^3	cubic foot
FTS	Federal Telecommunications System
FWGPM	Federal Working Group on Pest Management
FWPCA	Florida Water Pollution Control Act
FWS	Fish and Wildlife Service
FY	fiscal year
g	gram
GAS	Get-Away-Special
GFE	Government-furnished equipment
g/cm^2, gm/cm^2	grams per square centimeter
gm/km	grams per kilometer
GSA	General Services Administration
GSE	ground support equipment
HDQS	headquarters
HIM	Hardware Interface Module
HMF	Hypergol Maintenance Facility
HPU	Hydraulic Power Unit
hr	hour
Hz	hertz
i.e.	that is
in	inch
IUS	Inertial Upper Stage

ABBREVIATIONS AND ACRONYMS (cont)

JSC	Johnson Space Center
K	Kelvin
KARS	Kennedy Athletic, Recreation, and Social Organization
kg	kilogram
kg/m^2	kilograms per square meter
kj	kilojoule
kj/hr	kilojoules per hour
kl	kiloliter
km	kilometer
kmh, km/h	kilometers per hour
KSC	Kennedy Space Center
kV	kilovolt
kW	kilowatt
kWh	kilowatthour
LAir	liquid air
lb	pound
LC	Launch Complex
LCC	Launch Control Center
LETF	Launch Equipment Test Facility
LPS	Launch Processing System
LV	Launch Vehicle
m	meter
m^2	square meter
m^3	cubic meter
max	maximum
mg/l	milligrams per liter
mg/m^3	milligrams per cubic meter
MCC-H	Mission Control Center - Houston
MDD	Mate/Demate Device
M.I.	Merritt Island
min	minimum, minute
ml	milliliter
MLP	Mobile Launcher Platform
MMH	monomethylhydrazine
mph	miles per hour
MSA	Marshall Sprayable Ablator
MSBLS	Microwave Scanning Beam Landing System
MSFC	Marshall Space Flight Center
MTA	Marshall Trowelable Ablator
m/sec	meters per second
msl	mean sea level
m.t.	metric ton
mV	millivolt
mW/cm^2	milliwatts per square centimeter
N	Newton
NASA	National Aeronautics and Space Administration
N/m^2	Newtons per square meter

nitr.	nitrate
nmi, n.mi.	nautical mile
no.	number
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NWR	National Wildlife Refuge
O&C	Operations and Checkout (Building)
OBQ	Onboard Quantity
OLF	Orbiter Landing Facility (now SLF)
OMS	Orbiter Maneuvering Subsystem
OPF	Orbiter Processing Facility
OSHA	Occupational Safety and Health Administration
PAMS	Permanent Air Monitoring System
part	particulate
PBAN	polybutadiene acrylonitrile (propellant binder)
PBK	Payload Bay Kit
PCB	polychlorinated biphenyls
phos.	phosphate
p.m.	post meridiem
POL	petroleum, oil, and lubricants
ppb	parts per billion
PPF	Payload Processing Facility
ppm	parts per million
ppt	parts per thousand
PRF	Parachute Refurbishment Facility
proc	processing
PRSD	Power Reactant Supply and Distribution
psf	pounds per square foot
psi	pounds per square inch
psia	pounds per square inch, absolute
psig	pounds per square inch, gage
rcd	recorded
RCS	Reaction Control Subsystem
R&D	research and development
RDF	Recovery and Disassembly Facility
REED	Rocket Exhaust Effluent Diffusion (computer program)
refurb	refurbish(ment)
rf	radio frequency
RP-1	Rocket Propellant No. 1 (kerosene)
RSF	Refurbishment and Subassembly Facility
RSS	Rotating Service Structure
RTG	Radioisotope Thermoelectric Generator
SAEF	Spacecraft Assembly and Encapsulation Facility
sal	salinity
SAMS	Surface Air Monitoring Station

SCAPE	Self-Contained Atmospheric Protective Ensemble
sec or s	second
SLF	Shuttle Landing Facility (formerly OLF)
SMAB	Solid Motor Assembly Building
SPL	sound pressure level
spp	species
sq	square
SRB	Solid Rocket Booster
SRM	Solid Rocket Motor
SSME	Space Shuttle Main Engine
SSUS	Spinning Solid Upper Stage
SSUS-A	SSUS-Atlas
SSUS-D	SSUS-Delta
SSV	Space Shuttle Vehicle
st dev	standard deviation
STP	standard temperature and pressure
STS	Space Transportation System
subassy	subassembly
TAEM	Terminal Area Energy Management
temp	temperature
TLV	threshold limit value
TPS	Thermal Protection Subsystem
TRS	Teleoperator Retrieval System
turb.	turbidity
TV	television
TVC	Thrust Vector Control
TWR	tower
UCS	Utility Control System
UDMH	unsymmetrical dimethylhydrazine
ULV	ultra low volume
U.S.	United States
USAF	United States Air Force
USB	Unified S-Band
U.S.C.	United States Code
USCGS	United States Coast Guard Station
U.S.S.R.	Union of Soviet Socialist Republics
VAB	Vehicle Assembly Building
VIB	Vertical Integration Building
VIC	Visitors Information Center
VOC	Volatile Organic Compounds
VPF	Vertical Processing Facility
WHOI	Woods Hole Oceanographic Institute
yr	year
ΔP	differential pressure

CHEMICAL SYMBOLS

Al_2O_3	aluminum oxide
Cl, Cl_2	chlorine
CO	carbon monoxide
CO_2	carbon dioxide
GH_2	gaseous hydrogen
GN_2	gaseous nitrogen
GO_2	gaseous oxygen
He	helium
H_2	hydrogen
HC	hydrocarbons
HCl	hydrogen chloride
LH_2	liquid hydrogen
LN_2	liquid nitrogen
LO_2	liquid oxygen
N_2	nitrogen
N_2O_4	nitrogen tetroxide
NO_x	oxides of nitrogen
O_2	oxygen
SO_2	sulfur dioxide
SO_x	oxides of sulfur

CONVERSION FACTORS

Linear

1 centimeter	=	0.3937 inch	1 in	=	2.54 cm
1 centimeter	=	0.0328 foot	1 ft	=	30.48 cm
1 meter	=	3.2808 feet	1 ft	=	0.3048 m
1 meter	=	0.0006 mile	1 mi	=	1609.3440 m
1 kilometer	=	0.6214 mile	1 mi	=	1.6093 km
1 kilometer	=	0.5396 nautical mile	1 nmi	=	1.8520 km

Area

1 square centimeter	=	0.1550 square inch	1 in^2	=	6.4516 cm^2
1 square meter	=	10.7527 square feet	1 ft^2	=	0.0930 m^2
1 square kilometer	=	0.3861 square mile	1 mi^2	=	2.5900 km^2
1 hectare	=	2.4710 acres	1 acre	=	0.4047 ha

Volume

1 cubic centimeter	=	0.0610 cubic inch	1 in^3	=	16.3934 cm^3
1 cubic meter	=	35.3357 cubic feet	1 ft^3	=	0.0283 m^3

CONVERSION FACTORS (cont)

liter	= 1.0567 quarts	1 qt	=	0.9463 l
liter	= 0.2642 gallon	1 gal	=	3.7844 l
kiloliter	= 264.2 gallons	1 gal	=	0.0038 kl

Weight

gram	= 0.0353 ounce	1 oz	=	28.3286 g
kilogram	= 2.2046 pounds	1 lb	=	0.4536 kg
metric ton	= 1.1023 tons	1 ton	=	0.9072 m.t.

Energy

joule	= 0.0009 British thermal unit	1 Btu	=	1060.4 j
joule	= 0.2392 gram-calorie	1 g-cal	=	4.181 j

Pressure

Newton/square meter	= 0.0208 pound/square foot	1 psf	=	48 N/m^2

Thrust

pound (of thrust)	= 4.4 Newtons	1 N (of thrust)	=	0.2273 lb

APPENDIX B

LIST OF REFERENCES

APPENDIX B

LIST OF REFERENCES

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APPENDIX C

ENDANGERED AND THREATENED SPECIES OF FAUNA

FOUND AT THE JOHN F. KENNEDY SPACE CENTER

MERRITT ISLAND NATIONAL WILDLIFE REFUGE

FLORIDA

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C.1 INTRODUCTION

In recognition of the extent and diversity of endangered and threatened species at the Kennedy Space Center (KSC) and the importance of understanding the effect of KSC operations on their continued existence, extensive work has been carried out by the University of Central Florida under contract to KSC and by the Fish and Wildlife Service at the Merritt Island National Wildlife Refuge. This document contains maps showing the KSC range of 11 endangered and threatened fauna on the Federal list.

The endangered and threatened species on the Federal and State lists, together with a census, are listed in table C-1. Species which breed in the Merritt Island National Wildlife Refuge are indicated on the table. The breeding and population data were supplied by the Merritt Island National Wildlife Refuge. The Wildlife Refuge boundaries coincide with those of the Kennedy Space Center (see figure C-1). The Florida Committee on Rare and Endangered Plants and Animals, under the sponsorship of the Florida Audubon Society and Florida Defenders of the Environment, has prepared a report entitled "Inventory of Rare and Endangered Biota of Florida," dated July 1976. That report was used extensively in the preparation of this document, including the contributors and their referenced articles as credited herein. Bibliographic data have been omitted from this document, but can be obtained from the report.

Table C-1. KSC Area Endangered and Threatened Species - 1978

	Status			Population - M.I. National Wildlife Refuge			
	Fed.	State	Breed	Spring	Summer	Fall	Winter
Florida Manatee	E	T	Yes	30-50	30-80	50-80	0-50
Eastern Brown Pelican	E	T	Yes	1000-1400	1000-1400	800-1100	800-1100
Southern Bald Eagle	E	T	Yes	12-15	4-6	10-12	10-12
Arctic Peregrine Falcon	E	E	No	4-12	0	12-20	4-8
Dusky Seaside Sparrow	E	E	Yes	2	2	2	2
Atlantic Ridley Turtle	E	E	No	5-10	5-10	5-10	5-10
American Alligator	T	T	Yes	5000	5000	5000	5000
Atlantic Salt Marsh Snake	T	E	Yes	*	*	*	*
Eastern Indigo Snake	T	T	Yes	*	*	*	*
Atlantic Loggerhead Turtle	T	T	Yes	400-600	1000-1200	400-600	400-600
Atlantic Green Turtle	E	E	Yes	100-150	110-160	110-150	100-150
Gopher Turtle		T	Yes	13,800	13,800	13,000	13,000
Wood Stork		T	Yes	250-350	50-300	200-500	200-500
Osprey		T	Yes	10-20	20-40	20-30	10-20
Southeastern Kestrel		T	No	0-10	0	20-50	30-50
Least Tern		T	Yes	100-300	300-400	50-100	0
Roseate Tern		T	No	*	*	*	*
Florida Scrub Jay		T	Yes	*	*	*	*
American Oystercatcher		T	No	*	*	*	*
Magnificent Frigatebird		T	No	0	10-15	5-10	0
Florida Mouse		T	Yes	*	*	*	*

*Census inventory or inferential data now being collected for these species.

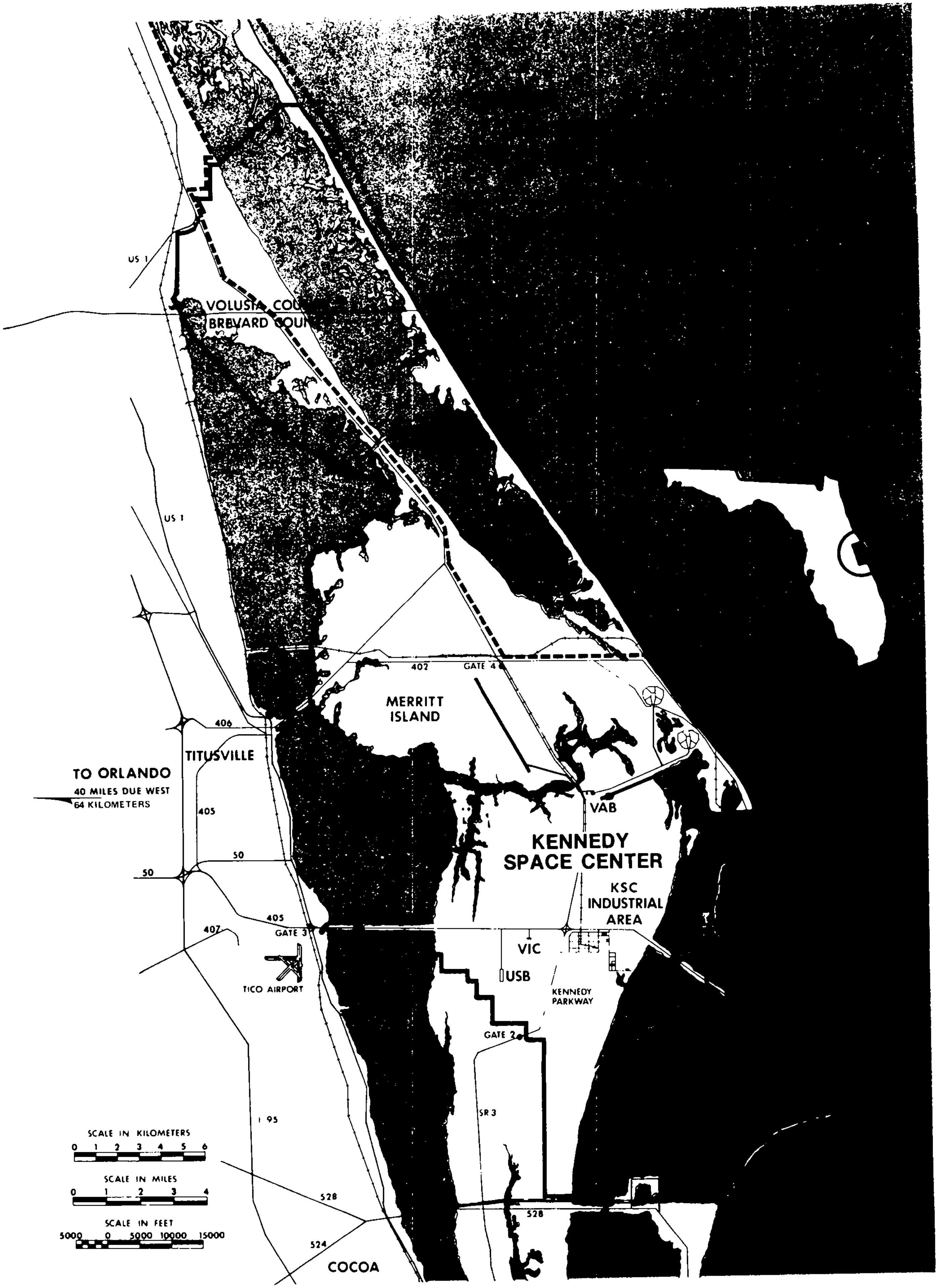


Figure C-1. Kennedy Space Center/Merritt Island National Wildlife Refuge and Vicinity

C.2 FLORIDA MANATEE <u>Trichechus manatus</u>; Order: Sirenia; Family: Trichechidae; Other Name: Sea Cow

C.2.1 DESCRIPTION. This is a massive, fusiform, thick-skinned, nearly hairless aquatic mammal. The forelimbs are paddlelike, the hind limbs lacking, and the tail horizontally flattened. Its color is grey to grey-brown. The upper lip is cleft, lobed, fleshy, and set with bristles. Sexes are similar except for the position of the genital aperture. Maximum recorded weight is 680 kilograms and average weight is between 360 and 540 kilograms. Maximum recorded length is 4.6 meters and average length is 3.0 meters.

C.2.2 RANGE. The range of the Manatee includes the Atlantic and Gulf coasts of the Florida peninsula, Gulf, Caribbean, and Atlantic shores of Central and South America from Mexico to northern Brazil. The range in the West Indies is uncertain. There have been recent sightings from Cuba and Puerto Rico.

The Manatee's distribution in the United States has changed little in historical times. Peninsular Florida is the focus of the species' range. The appearance of Manatees in Georgia is seasonal and relatively uncommon, in South Carolina exceptional. Manatees were formerly seen in Texas, probably migrants from Mexico; last Texas sighting was in 1937. On the Gulf coast of Florida the distribution of Manatees is continuous from Whitewater Bay to Charlotte Harbor. North of Charlotte Harbor, Manatees are found in semi-isolated populations in Hillsborough, Citrus, and Levy Counties. On the Atlantic coast the Manatee's range is uninterrupted from the Upper Keys to the St. Marys River and includes the lower St. Johns watershed from Lake Monroe north. The focus of abundance on the Atlantic Coast appears to be between New Smyrna Beach (Volusia County) and the St. Lucie River (Martin County). The focus of abundance on the Gulf Coast is apparently from Charlotte Harbor (Charlotte County) through the Ten Thousand Islands (Collier County).

C.2.3 HABITAT. Manatees inhabit sluggish rivers, shallow estuaries, and saltwater bays. Populations tend to be concentrated in select estuarine and riverine habitats, notably the spring-fed rivers of Citrus County, the Little Manatee River, the Myakka and Peace Rivers, the Caloosahatchee River, the Fakha Union Canal, the Miami River, the St. Lucie River, the Indian River, the Banana River, and the St. Johns River. Factors that appear to affect choice of habitat include (1) availability of vascular aquatic vegetation, (2) proximity to channels of at least 2 meters in depth, (3) recourse to warm water during winter cold snaps, and (4) a source of fresh water. Twenty-five warm-water refugia, 6 natural and 19 manmade, have been located in Florida. The sites of these refugia strongly influence the movements of Manatees from October to April.

C.2.4 LIFE HISTORY AND ECOLOGY. Manatees are weakly social, essentially solitary animals. Cohesive associations are formed only when males pursue an estrous female. Estrous females are polyandrous. Gestation is believed to last 385 to 400 days. The species is primarily uniparous; twins are rare. Calves are born and nursed in water. The family unit consists of mother and offspring. The reproductive rate is probably one calf per adult female every 2 to 2-1/2 years. There is no well-defined breeding season. Estimated age at reproductive maturity is 4 to 6 years. Longevity is unknown, although captives have lived over 25 years.

The diet is strictly herbivorous but highly diverse, ranging from algae to terrestrial plants. Submerged vascular vegetation such as Hydrilla, Elodea, Ceratophyllum, Myriophyllum, Vallisneria, Ruppia, Diplanthera, Syringodium, and Thalassia is preferred. Manatees also feed extensively on water hyacinth, Eichornia.

Manatees migrate between favored habitats and in response to cold. During the winter, cold-induced congregations form at springs and the discharges from power plants. Evidence suggests that some Manatees are nomadic and migrate hundreds of kilometers along the coast while others are more sedentary.

There are no known predators except man. Pleurisy and bronchial pneumonia from cold exposure are held responsible for deaths of animals in captivity.

C.2.5 SPECIALIZED OR UNIQUE CHARACTERISTICS. Pachyostosis increases the Manatee's specific gravity and may function in maintaining neutral buoyancy. The Manatee's cheek teeth, subject to constant wear from sand and silt in its food, are replaced consecutively from the rear.

Manatees have been used as agents of aquatic weed control and have been suggested as a potential source of protein in developing countries. The slow reproductive rate and failure to breed in captivity have discouraged large-scale efforts at husbandry.

C.2.6 BASIS FOR STATUS CLASSIFICATION. The total number of Manatees in the United States is estimated between 750 and 850, with 1,000 the conceivable maximum and 600 the conceivable minimum. The populations on the Atlantic and Gulf coasts of Florida are believed to be isolated. The estimated number of animals on the Gulf Coast is 350 to 400, compared with 400 to 450 on the Atlantic Coast and St. Johns River. Exploitation in the 17th, 18th, and 19th centuries is thought to have reduced the number of Manatees from several thousand to their current population level. The present level of abundance may reflect a gradual increase in numbers since the Depression and World War II when Manatees were heavily poached.

A slow decrease in Manatee numbers is foreseen in the years to come. The principal threats to the survival of Manatees in Florida are, in order of magnitude: (1) the propellers of power boats, (2) vandalism, (3) poaching, and (4) habitat destruction. As the human population grows, so will the incidence of propeller kills and vandal attacks. There is reason to believe the Manatee population in southeast Florida has already declined as a result of increased boat traffic. Dredging and water pollution destroy the Manatee's food resources, but dredging also opens channels, providing Manatees with routes of access to new habitat. The recent increase in the number of power plants has reduced the danger of Manatees succumbing to cold.

C.2.7 SPECIES STATUS. The marine waters of Merritt Island National Wildlife Refuge provide feeding and breeding habitat for the Manatee. Approximately 80 animals can be found in these waters. There are a number of favorite areas in and around the Refuge where the Manatee can be located. These include the barge canal depot of Cape Canaveral Air Force Station and the warm water discharge of the electric power plants into the Indian River. The warm water discharge areas are a favorite cold weather resting area.

The Refuge is cooperating with the U.S. Fish and Wildlife Laboratory in Gainesville, Florida, in conducting extensive Manatee research. This research includes tagging and radio telemetry work to determine migration and movement patterns. The Refuge is also engaged in an education program to inform the public about the harmful effects of high-speed pleasure boat operation in waters containing Manatee population. Two areas of the Refuge, the Haulover Canal and the Hangar AF Turning Basin, have been designated "Slow Speed-No Wake" zones to reduce the possibility of injury to Manatees from propeller blades.

Particular care is given to KSC operations which take place adjacent to or within waters which provide habitat for the Florida Manatee. Barge and marine support activities will operate at restricted speeds and shallow water operations will be prohibited. This type of traffic is expected to be about the same in volume as was experienced during the Apollo program. Retrieval vessels designed for SRB and parachute recovery will be equipped with propellor guards and recessed steering units to avoid inflicting the cuts which are the major cause of Florida Manatee deaths. Formal consultation has been requested from the Department of the Interior, U.S. Fish and Wildlife Service, but no operations are expected to jeopardize the continued existence of the Manatee or adversely modify critical habitat.

The range of the Florida Manatee at KSC is shown in figure C-2 which follows.

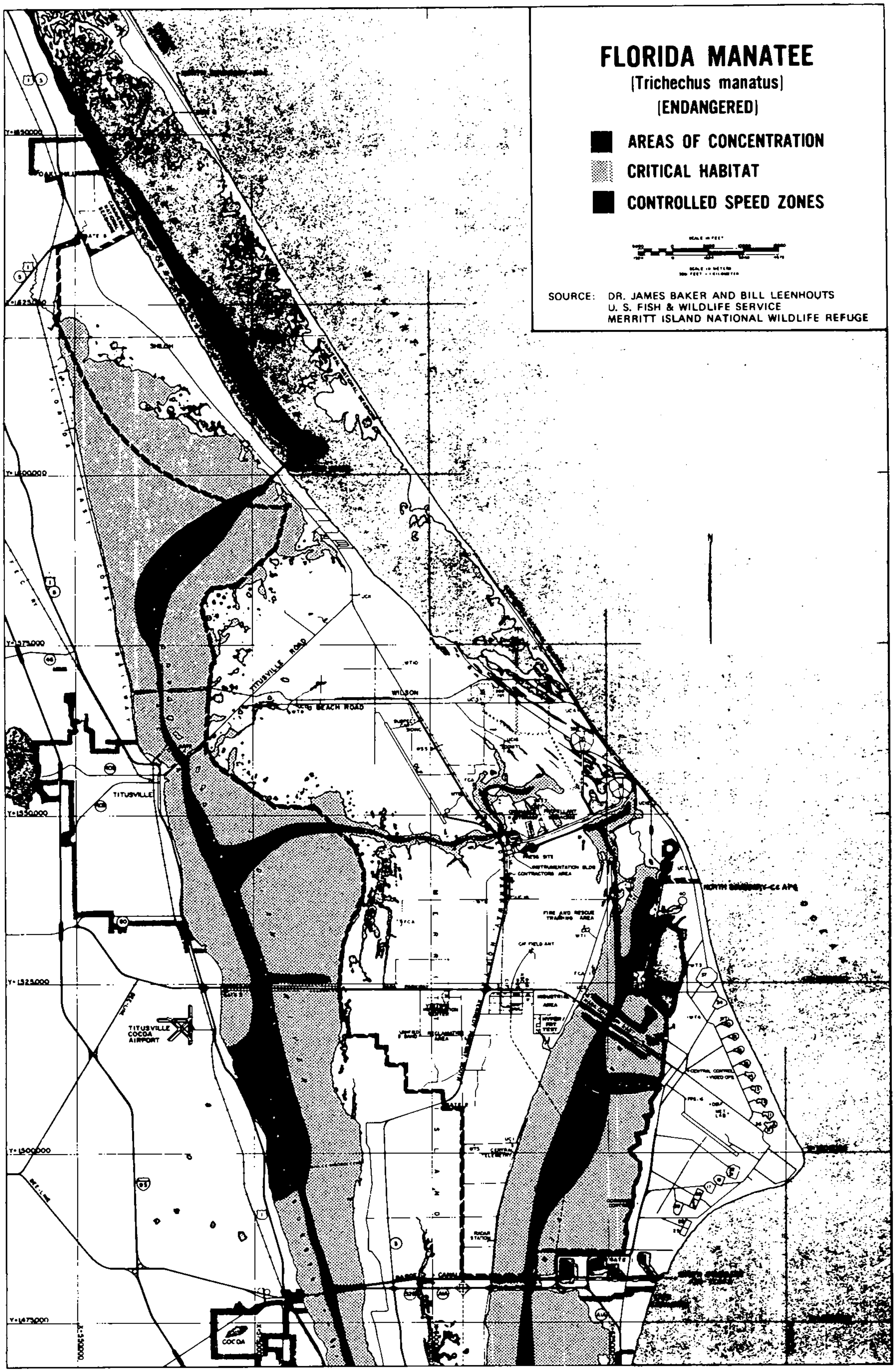


Figure C-2. KSC Range of the Florida Manatee

C.3 EASTERN BROWN PELICAN *Pelecanus occidentalis carolinensis*; Order: Pelecaniformes; Family: Pelecanidae

C.3.1 DESCRIPTION. The Brown Pelican is the familiar year-round resident pelican of the Florida coast. The long bill and dangling gular pouch are characteristic. The sexes are similar in plumage. Males average slightly larger than females. Adults have a black belly and grey wings and back. The head and neck undergo complicated plumage changes on an annual cycle. The head is yellow from early fall through the winter. White feathers replace the yellow ones after pair formation, usually in February to April. The neck is white in the fall and winter and molts rapidly to dark brown-black just as breeding begins. During the spring and summer these feathers wear and are replaced with white in August to October. The coloration of the bill, eye, and facial skin also undergoes an annual cycle. Brown Pelicans with white necks do breed, and the timing of the annual cycle differs throughout the state and is irregular in many locations. Immature birds have a white belly and brown back, wings, head, and neck. This plumage changes gradually to the adult colors during a 3- to 5-year period, with females generally assuming adult plumage at a younger age than males.

C.3.2 RANGE. On the Pacific coast, the Brown Pelican ranges from British Columbia to southern Chile and breeds from California through northern Chile. On the eastern seaboard they breed from North Carolina through the Gulf States, Mexico, the West Indies, on many islands in the Caribbean, and to Guyana in South America. *Pelecanus occidentalis carolinensis* breeds in North Carolina, South Carolina, Florida, Texas, Louisiana, Cuba, and Panama. However, the Texas and Louisiana populations declined drastically in the 1950's, and fewer than 500 pelicans exist in those states today. The last year of known nesting by native pelicans in Louisiana was 1966. Nestlings from eastern Florida were introduced in the late 1960's and early 1970's and these birds are now breeding in Louisiana in small numbers, although Endrin poisoning in the spring of 1975 killed several hundred birds. The California population declined drastically in the late 1960's. That population and the birds in Baja California are currently under close scrutiny. Aerial surveys of Florida indicate a stable adult breeding population of 6,000 to 8,000 pairs during the past 6 years with an estimated total population of fewer than 30,000 birds. The status of the species elsewhere in its range is unknown or poorly understood.

C.3.3 HABITAT. In Florida, Brown Pelicans nest primarily in mangrove trees from 0.6 to 11 meters above high tide line. Nesting is confined to coastal islands, sometimes near human habitation and fewer than 50 islands are used as colonies in the state. Colonies may contain from 10 to 1,500 pairs, with a hundred pairs occurring most commonly. Feeding occurs primarily in shallow estuarine waters but birds are seen as far as 32 to 64 kilometers offshore, rarely farther. Sand spits and offshore sand bars are used extensively as daily idling and nocturnal roost areas. Pelicans, especially newly fledged young, frequent fishing piers and are a common sight at fish cleaning stations where scraps are available.

C.3.4 LIFE HISTORY AND ECOLOGY. Brown Pelicans plunge dive for food, exclusively fish, with Brevoortia, Mugil, Sardinella, and Lagodon forming the bulk of the diet in Florida. Nests are bulky structures with green leafy material lining the cup. Three eggs constitute the maximum clutch size. Larger clutches are probably laid by more than one female and are rare. Incubation requires 30 days. Nestlings hatch naked, are downy white by 2 weeks of age, and fledge at 11 to 12 weeks. Fledging success is dependent on food availability. First-year mortality is 70 percent, mostly a result of starvation because the young are less efficient at fishing than are adults. All courtship activity is confined to the nest site. Males carry nesting material to the female and she builds the nest. The male and female both share incubation and chick-raising duties. Molt of the major flight feathers and coverts occurs during the nonbreeding season. Florida's pelicans are separated into east and west coast populations. The species is highly gregarious. They fly vigorously and also soar and glide readily.

C.3.5 SPECIALIZED OR UNIQUE CHARACTERISTICS. To Florida residents and tourists alike, the Brown Pelican standing on a piling or gliding over the waves is a familiar sight. Other than the winter resident White Pelican, the Brown Pelican is the sole representative of its family in Florida. It is the only pelican species that dives for its food. As a top carnivore known to be sensitive to some forms of pollution, the Brown Pelican serves as an excellent indicator species for the quality of the marine-estuarine environment.

C.3.6 BASIS FOR STATUS CLASSIFICATION. The Brown Pelican was essentially extirpated as a breeding species in Louisiana and Texas before anyone was aware of a problem. The reason why over 40,000 pelicans disappeared in less than a decade remains unexplained. The California breeding population has recently declined in numbers. In California, DDT contamination caused the females to lay thin-shelled eggs, with an attendant decline in reproductive success. The Florida adult population is presently stable, but many factors are operating that could change this status: approximately 3 percent of all eggs checked on Florida's west coast in the past 5 years have been thin shelled and crushed, attributable to DDT. Human disturbance in nesting colonies causes significantly decreased hatching and fledging success. Increased human activity on sand spits and beaches where birds idle during the day and roost for the night causes considerable disturbance. Productivity and survival are intricately related to fish availability and any factor or combination of factors affecting fish population could drastically affect the pelican population. A significant number of pelicans (500 or more) are killed each year after being caught on fish hooks and ensnared in monofilament line with ensuing entanglement in mangrove trees. Shooting and other malicious killing and maiming also occur.

C.3.7 SPECIES STATUS. The Merritt Island National Wildlife Refuge will have peak populations of up to 1,400 Brown Pelicans in the Spring and Summer. The increase in population is caused by breeding activities in and around the Refuge. The Refuge contains one breeding colony of Brown Pelicans located at Bird Island in Mosquito Lagoon. This colony averages 300 nesting pairs of pelicans. Pelican/fisherman conflicts have developed with an occasional Brown

Pelican being killed by monofilament fishing line entanglement. Although this molesting of the birds is illegal, it is difficult to control because of the number of potential pelican/fisherman encounters. The Refuge annually surveys the population and investigates the status, condition, population, and productivity of the Bird Island colony.

Assessments of construction and operations activities at KSC have not identified any impacts which might be expected to jeopardize the existence of this species.

The range of the Eastern Brown Pelican at KSC is shown in figure C-3 which follows.

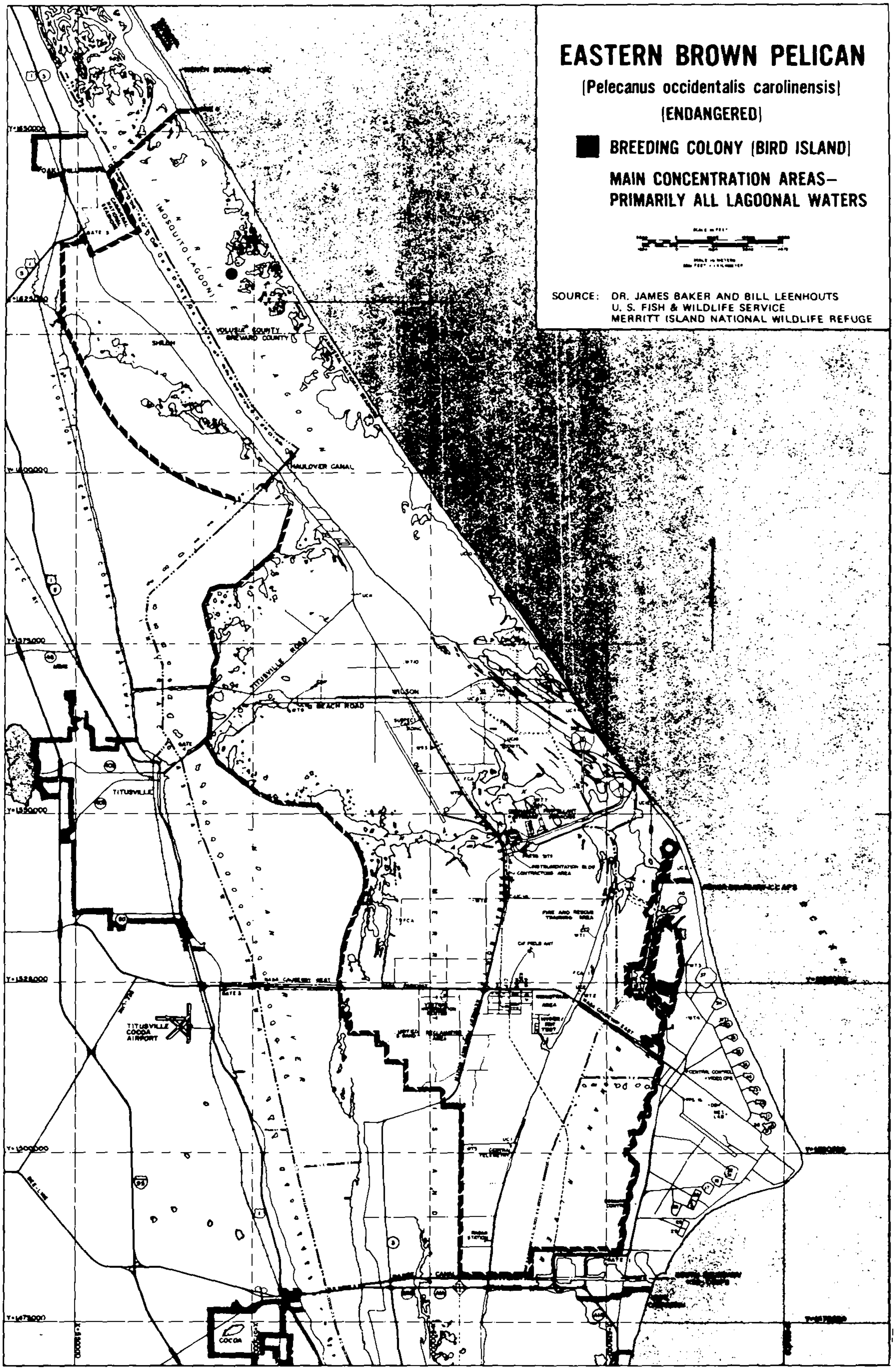


Figure C-3. KSC Range of the Eastern Brown Pelican

C.4 SOUTHERN BALD EAGLE *Haliaeetus l. leucocephalus*; Order: Falconiformes; Family: Accipitridae; Other Names: White-Headed Eagle, American Eagle, Black Eagle (immatures)

C.4.1 DESCRIPTION. Adults are unmistakable large raptors (total length, 1 meter, wingspread, about 2 meters; females distinctly larger than males) with a white head and tail, blackish to dark brown body and wings, and yellow eyes, bill, and feet. Juveniles are uniformly chocolate-brown, sometimes considerably mottled with white on the tail, belly, and wing linings. Older immatures and subadults are dull brown, much lighter in color than juveniles, with extensive and extremely variable whitish mottling. By their fourth year, most immatures acquire a plumage pattern that approximates the adult, but commonly they still have a dusky mottling on the nape and several brownish feathers in the tail. Southern (1964, 1967) summarized the probable age-related plumage changes of immature and subadults and suggested that traces of immature plumage are retained as late as the sixth year.

C.4.2 RANGE (OF THE SUBSPECIES). Formerly distributed across the continent from northern California, New Mexico, Oklahoma, Kentucky, and southeastern Virginia south to the Florida Keys, the Gulf coast, southern Texas, the southwestern United States, and Baja California, the range is difficult to define because the southern and northern subspecies intergrade in a broad belt across the middle of the United States and because seasonal movement brings birds of each subspecies into the range of the other. The eagle is now gone as a nesting species from most of its former range in the interior and greatly reduced in numbers in most coastal areas. Outside Florida, the surviving population of the Southern Bald Eagle is probably fewer than 50 breeding pairs, found mostly along the coasts of California, Texas, Louisiana, and the South Atlantic States.

In Florida, the eagle was once almost ubiquitous, nesting from the Lower Florida Keys along the state's entire coastline and near larger lakes and rivers throughout the interior. The original population of Florida must have been well in excess of 1,000 breeding pairs. The numbers nesting along the middle Gulf and Atlantic coasts of the peninsula (notably around Tampa Bay and in Brevard and Volusia Counties, particularly Merritt Island) were among the densest breeding concentrations of a large raptor known anywhere on Earth. The population had decreased markedly in some sections by the mid-1930's (Howell, 1937) and declined sharply in many coastal areas after the late 1940's (Broley, 1950). The eagle is now absent or rare as a breeder along well-settled parts of the Florida coast and the population is still decreasing in the state at large.

Principal nesting concentrations are found along the extreme southwest coast and in Florida Bay; along the Gulf coast from Pinellas County to the mouth of the Suwannee River; and along the St. Johns-Oklawaha River system from Brevard County to southern Alachua County. Probably no nesting eagles remain in the Florida panhandle west of the Apalachicola River, along the northeast coast from Flagler County northward, and along the southeast coast of the peninsula from Palm Beach (possibly Indian River) County south. The known total of 274 active nests undoubtedly underestimates the present Florida population, because some parts of the state have not been adequately surveyed in recent years. Areas that may hold additional nests are: interior central Florida; the northern Gulf coast between the Suwannee River and St. Marks; coastal Brevard and Volusia Counties; the St. Johns River from Palatka north; and interior north-central Florida along the Suwannee River and its tributaries. Considering all possibilities, it appears that 300 to 325 breeding pairs are a close estimate of the existing Florida population of Bald Eagles. Available data do not sustain a recent statement that the Florida population may number from 500 to 1,000 nesting pairs (Nickerson, 1973).

Details of distribution in several specific regions of Florida are as follows. Extreme Southern Florida (Monroe, Collier, Dade, and Broward Counties): Lower Florida Keys, 2 to 4 pairs; Everglades National Park and environs, 14-year average (1960 to 1961 through 1973 to 1974) 52.5 pairs, range 49 to 55 pairs; Collier County coast north of Park, 8 to 10 pairs; and interior Collier, Dade, and Broward Counties (principally the eastern edge of the Big Cypress) 2 to 5 pairs. None now nest in coastal Dade and Broward Counties north of the extreme south end of Biscayne Bay; some nested as late as the early 1960's on Key Biscayne. Total, 61 to 74 pairs (William B. Robertson, Jr. and David Shea, National Park Service, Everglades National Park, P.O. Box 279, Homestead, Florida, 33030; Lower Keys data from Jack Watson, BSFW, Division of Refuges).

West Central Florida (Gulf coast from Tampa Bay to the Suwannee River): Hillsborough County, 4 to 7 pairs; Pinellas County, 5 to 7 pairs; Pasco County, 4 to 6 pairs; Hernando County, 7 to 9 pairs; Citrus County, 13 to 15 pairs; and Levy County, 5 to 8 pairs. Total, 38 to 52 pairs (Stephen B. Fickett, Jr., Florida Game and Fresh Water Fish Commission, 404 Highland St., Brooksville, Florida, 33512).

Ocala National Forest and vicinity (portions of Marion, Lake, and Putnam Counties): Estimated 25 to 35 nesting pairs (25 known after 2 years of study, but rate of discovery of new nests still high), perhaps the densest existing concentration in Florida, principally in the pine flatwoods and swamps adjoining Lake George. About half the known nests are located on private land within the National Forest (Ben A. Sanders, U.S. Forest Service, P.O. Box 2750, Asheville, North Carolina, 28802).

Band recoveries (Broley, 1947) show that recently fledged juveniles from the peninsular Gulf Coast, and probably throughout Florida, migrate north in their first summer as far as eastern Canada. Older immatures and adults are apparently more sedentary and merely disperse locally in summer.

C.4.3 HABITAT. Eagle habitat is primarily riparian, associated with the coast or with lake and river shores, usually nesting near the water bodies where they feed along shore or over extensive shallow water. Some interior pairs nest far from expanses of open water on tree islands in large marshes or in mainly dry prairies with small marshes and ponds. Where they are numerous, as in the Everglades National Park, immatures fly inland at night and roost communally well away from coastal nesting areas. Outside the nesting season when not as closely limited to shores, both adults and immatures tend to gather where food is most easily available.

C.4.4 LIFE HISTORY AND ECOLOGY. Most nests in Florida are in tall living or dead trees (pine or cypress in most of the state, mangroves along the southwest coast). Eagles doubtless prefer nest sites that command a wide view of the surroundings. In Ocala National Forest (Sanders, pers. comm.), typical nests are located in slash pine or cypress with large crowns, either trees in sparse stands or emergents that stand high above the surrounding forest, but in Florida Bay eagles often nest in small mangroves less than 6 meters above the ground. Unlike Ospreys, they are apparently reluctant to nest on manmade structures. Typical nests are flat-topped heaps of dead sticks lined with finer material (grass, spanish moss, pine needles, seaweed, green leaves) that may be used for years with new material added annually. In the off-season, nests commonly serve as feeding platforms for the adults and a given pair may have several nests or nest sites within its territory. Eagles may commandeer the nests of other large birds, particularly Ospreys. Great Horned Owls sometimes take over eagle nests. Nesting pairs are territorially aggressive toward other eagles (including immatures), Ospreys, and other large raptors in the vicinity of their nest.

In Florida, activity related to breeding occurs almost the year around, except perhaps in midsummer. Eagles are monogamous for the life of the mate, but in thriving populations, lost mates tend to be quickly replaced, sometimes by individuals not yet in full adult plumage. Apparently it is not uncommon for pairs to skip a year without attempting to nest. Established pairs begin to repair nests in early fall and eggs may be laid as early as late October. Females may lay another set of eggs, if the first is lost, and thus active nests with eggs may occur as late as February or, rarely, March. The usual clutch is 2 eggs, but sets of 3 are not uncommon, and sets of 1 and 4 reportedly occur. The incubation period is about 35 days. The eggs are very small for the size of the bird and the young are helpless when they hatch and spend 10 to 12 weeks in the nest before fledging. Both parents participate in incubation and care of the nestlings, but details of the division of labor vary considerably between pairs. Aggression between nestlings is common and causes substantial mortality of small young.

Bald Eagles are thoroughly opportunistic feeders and will take, either alive or as carrion, virtually any vertebrate prey that they can carry away or consume on the spot (Howell, 1932; Bent, 1937; Broley, 1947; Robertson, unpubl. data). Fish, water birds up to the size of Brown Pelicans and medium-sized herons, and turtles comprise the bulk of the diet. Their habit of robbing Ospreys of fish is widely publicized, but it seems to be relatively uncommon in Florida.

C.4.5 PRODUCTIVITY. Over a 14-year period in Everglades National Park, young fledged from 345 of 735 potential reproductive efforts (i.e., at minimum, a pair of adults seen on a known territory at least once during the nesting season), a success rate of about 46.9 percent (Robertson, unpubl. data). Annual success rates varied from 37.0 percent (20 of 54) in 1971 to 1972 to 60.4 percent (32 of 53) in 1967 to 1968 and 60.8 percent (31 of 51) in 1962 to 1963. The 345 successful nestings included 135 broods of 2 young (39.1 percent) and 9 broods of 3 young (2.6 percent) for a total of 498 fledged, about 0.68 young per active site (annual range, 0.56 to 0.82) and 1.44 young per successful site (annual range, 1.25 to 1.60). For populations surveyed less intensively, nesting success rate and number of young per active site tend to be higher than the above figures, presumably because nests that are active only briefly are less likely to be recorded.

Recent productivity data from other areas in Florida (1973 to 1974 breeding season except as stated) include: West Central Florida, 0.60 young per active nest in a sample of 30 active nests (Fickett, pers. comm.); Central Florida ranchlands, 0.91 young per active nest, 1.49 per successful nest, in a sample of 69 active nests, 1964-65 breeding season (Heinzman and Heinzman, 1965); Ocala National Forest, 0.86 young per active nest, 1.46 per successful nest, 1972 to 1973 breeding season (Sanders, pers. comm.); North Central Florida, St. Johns River (excluding Ocala National Forest), 1.13 young per active nest in a sample of 23 active nests (Doris Mager, Florida Audubon Society, P.O. Drawer 7, Maitland, Florida 32751); Alachua County, 1.17 young per active nest in a sample of 6 active nests (Stephen A. Nesbitt, Florida Game and Fresh-Water Commission, 2606 N.E. 17 Terrace, Gainesville, Florida 32601). These data suggest that Bald Eagles throughout Florida are reproducing at a rate that is adequate to maintain the population (see Sprunt, et al., 1973).

C.4.6 SPECIALIZED OR UNIQUE CHARACTERISTICS. Because it is the national emblem of the United States, the Bald Eagle probably enjoys wider public recognition and popular concern than any other species of animal in the country.

C.4.7 BASIS FOR STATUS CLASSIFICATION. It is doubtful that a viable population of the Southern Bald Eagle exists outside Florida and the population in Florida has declined by at least 50 percent in the past 30 years. It probably is still decreasing slowly, despite the fact that many of the remaining eagles nest on publicly owned lands. Persistent pesticides may have played a role in the decline, particularly where DDT was heavily used for mosquito control (Mills, 1946). Weston's account (1965: 42-43) of the disappearance of the species around Pensacola suggests that pesticides may have been a factor in that area. Over most of Florida, however, destruction of coastal nesting habitat and disturbance of nesting eagles by man were undoubtedly the major causes of the decline.

C.4.8 SPECIES STATUS. Merritt Island National Wildlife Refuge is home to both resident breeding and winter migrant populations of Southern Bald Eagles. There are approximately 6 active nests generally producing young each year. The Refuge also provides feeding and resting habitat for as many as 12 winter migrating eagles. This population is surveyed and active nests are monitored periodically to gather data concerning breeding activity. The Refuge is beginning a controlled burning program to protect the nesting sites from destructive wildfires. All efforts are being made to preserve the National Symbol at Merritt Island National Wildlife Refuge.

Assessments of construction and operations activities at KSC have not identified any impacts which might be expected to jeopardize the existence of this specifies. Nesting sites are afforded a minimum 0.8-kilometer (0.5-mile) buffer zone for human activities which might in any way disturb the breeding activities of the eagle.

The range of the Southern Bald Eagle at KSC is shown in figure C-4 which follows.

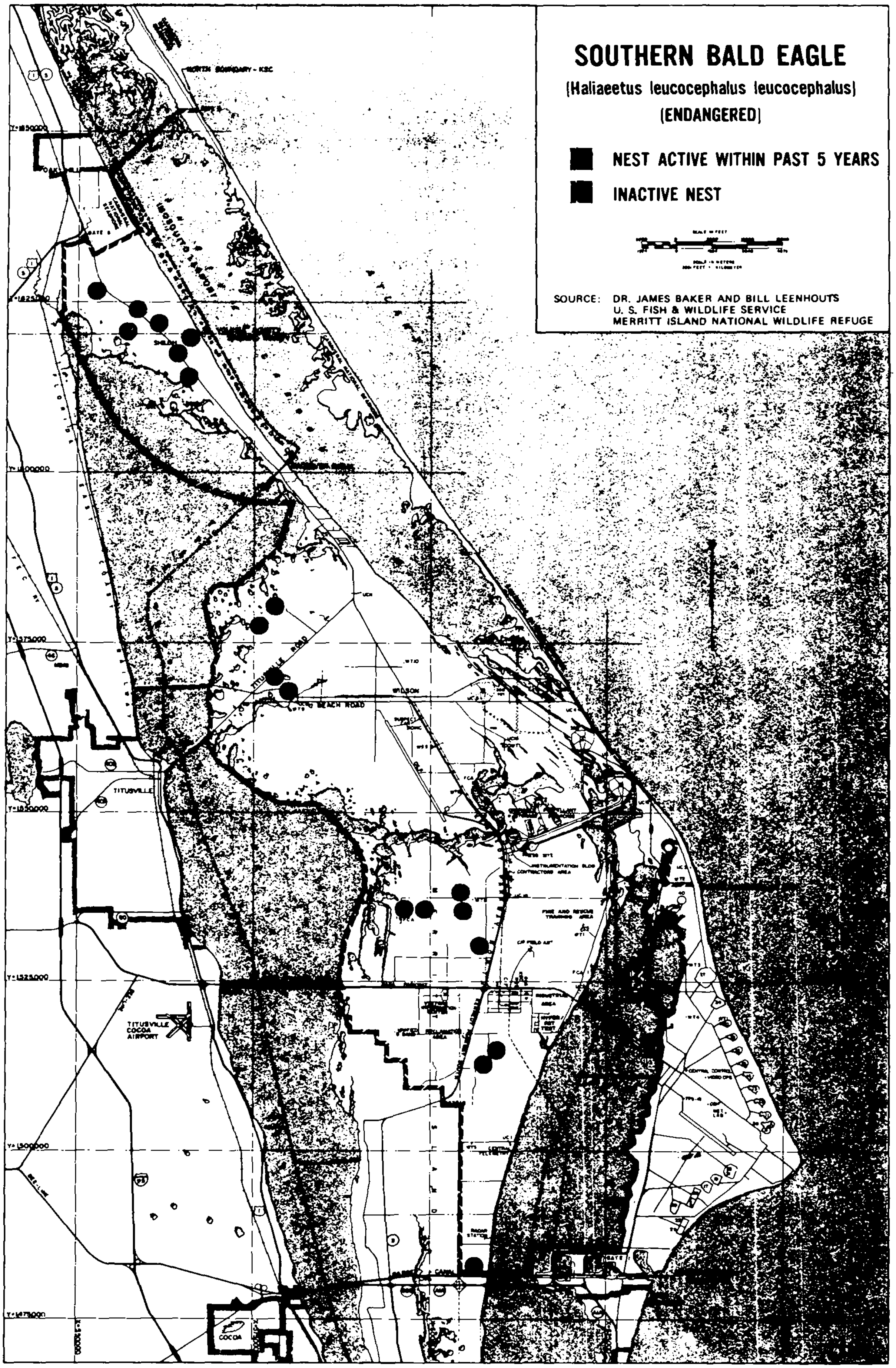


Figure C-4. KSC Range of the Southern Bald Eagle

C.5 ARCTIC PEREGRINE FALCON *Falco peregrinus tundrius*; Order: Falconiformes; Family: Falconidae; Other Names: Duck Hawk, Great-Footed Hawk

C.5.1 DESCRIPTION. The Arctic Peregrine Falcon is a crow-sized raptor about 380 centimeters long with a wingspread of about 1 meter. Sexes are similar, although the female is larger than the male. The adult birds are slaty grey on the back, with a dark cap over the head and a sideburn streak extending down through the eye. The white breast has dark bars, and the feet are conspicuously yellow. The immature is brown-backed with a facial pattern like the adult's; its breast is white with heavy vertical streakings.

The Peregrine's wings are long and pointed, and in flight it gives the impression of effortless power and speed. It is the largest of the three falcons which regularly occur in Florida.

Three subspecies of Peregrine Falcon are recognized in North America: *F. p. anatum*, which formerly occurred over most of the continental U.S. and Canada; *F. p. pealei*, which occurs in the Pacific Northwestern part of North America, including the Aleutians; and *F. p. tundrius*, which occurs in the high arctic.

C.5.2 RANGE. The Peregrine Falcon is a cosmopolitan species and breeds on every continent except Antarctica. Florida and Ohio are the only two states where the Peregrine has not been reported to breed. Florida has been an important wintering area for Peregrines.

C.5.3 LIFE HISTORY AND ECOLOGY. The Peregrine usually requires a cliff site for nesting where the species makes a scrape or depression for a nest, but it may nest in the broken tops of tall trees and on window ledges of tall buildings. An abundant prey is required for breeding; birds are its chief food, and they are usually caught on the wing.

The northern populations of Peregrines tend to be highly migratory, and the southeastern U.S. sees the passage of many arctic falcons each fall. They tend to follow the Mississippi flyway or the Atlantic coast along the barrier beaches. Some winter wherever there are concentrations of wildfowl or shorebirds, while others linger and then move southward to the West Indies and South America.

Florida's wintering population of Peregrines arrives in September or October, usually with passage of a cold front, and departs from March to May. On their wintering grounds Peregrines are relatively sedentary and may remain within a few square kilometers all winter.

C.5.4 HABITAT. Wintering Peregrines in Florida require an area that has a plentiful and dependable supply of birds for food and perches on which to roost, sun, and feed. Florida's coastal areas provide optimum wintering habitat in regions where mangroves are regenerating from hurricane damage, with dead stubs standing among scattered ponds and sloughs, and where ducks, coots, gulls, and herons abound. Peregrines are opportunistic and may be found exploiting a breeding colony of terns, gulls around a dump, Rock Doves in urban centers, or the birdlife that is attracted to agricultural areas.

Impoundments and marshy lakes may attract wintering Peregrines, but those that spend time in areas that are open to hunting may be highly vulnerable to shooting. Hunters traveling by skiff may flush waterfowl, and we have noted that Peregrines may come from some distance to take such prey, and they may learn to follow small boats. Peregrines are especially attracted by wounded or crippled birds.

C.5.5 SPECIALIZED OR UNIQUE CHARACTERISTICS. The Peregrine Falcon has for centuries been one of the most favored birds for falconry. Its beauty, power, and speed have amazed and fascinated, even inspired, man. Hence, its aesthetic value is extremely significant. It is currently the object of great concern among falconers and biologists because its recent population crash has brought it to the brink of extinction as a breeding bird in the continental U.S. Scientists are now attempting to breed Peregrines in captivity in sufficient numbers to ensure a supply of birds for the sport and for restocking purposes in areas that have lost breeding populations. Trained falcons have been used with success to clear airport runways of birds, and thus they have a high economic potential.

C.5.6 BASIS FOR STATUS CLASSIFICATION. The Peregrine Falcon was a highly successful species, and it was initially able to adapt to man's increased presence in its environment. Peregrines are compatible with humans to the extent that, until use of DDT began following World War II, the Peregrine bred successfully in eyries on manmade "cliffs" (skyscrapers) in several Canadian and American cities. That it is a biologically resilient creature also is evidenced by the fact that although the British had to shoot out all the nesting Peregrines along the cliffs of Dover during World War II because the falcons were taking carrier pigeons, after the war, the Peregrine population was on its way to recovery until the widespread use of DDT was introduced. This chemical is credited with causing the population crash of nesting Peregrine Falcons (the subspecies anatum) in the continental U.S. during the last 25 years. Today only a remnant to the former U.S. population still exists, and the future of this subspecies is in grave doubt so long as DDT and its metabolites circulate in the ecosystem.

In recent years there has been an increased interest in the sport of falconry. Responsible falconers plead for the protection of the few remaining eyries of Peregrines, but this has little effect upon those who are bent upon getting birds. The economic incentives make nest-robbing profitable, and at present the harvest of Peregrines for falconry and captive breeding efforts may pose as much of a threat to the remaining few birds as does DDT.

The Peregrine has a chance for recovery in the U.S. if DDT levels continue to drop, and if falconry and captive breeding can be brought under strict Federal and state control. Although Great Britain lost most of its breeding population to pesticide-induced reproductive failure at the same time as did the States, the species there is making a slow comeback, now that some of the more troublesome agricultural chemicals have been banned or restricted.

C.5.7 SPECIES STATUS. The Peregrine Falcon does not nest at the Refuge, but as many as 20 birds may be seen migrating along the barrier island dune system. Most of these birds are of the subspecies *F. p. tundrius*. The Refuge provides feeding and resting habitat during the winter migration period. Some falcons will linger for many days taking advantage of the resources of the Refuge. The U.S. Fish and Wildlife Service monitors the migration of the Peregrine Falcon through the Refuge each year, keeping accounts of numbers, locations of sightings, and length of stay. In a 1978 survey of the fall migration of raptors, conducted by the Refuge, 43 Arctic Peregrine Falcons were counted.

Assessments of construction and operations activities at KSC have not identified any impacts which might be expected to jeopardize the existence of this species.

The range of the Arctic Peregrine Falcon at KSC is shown in figure C-5 which follows.

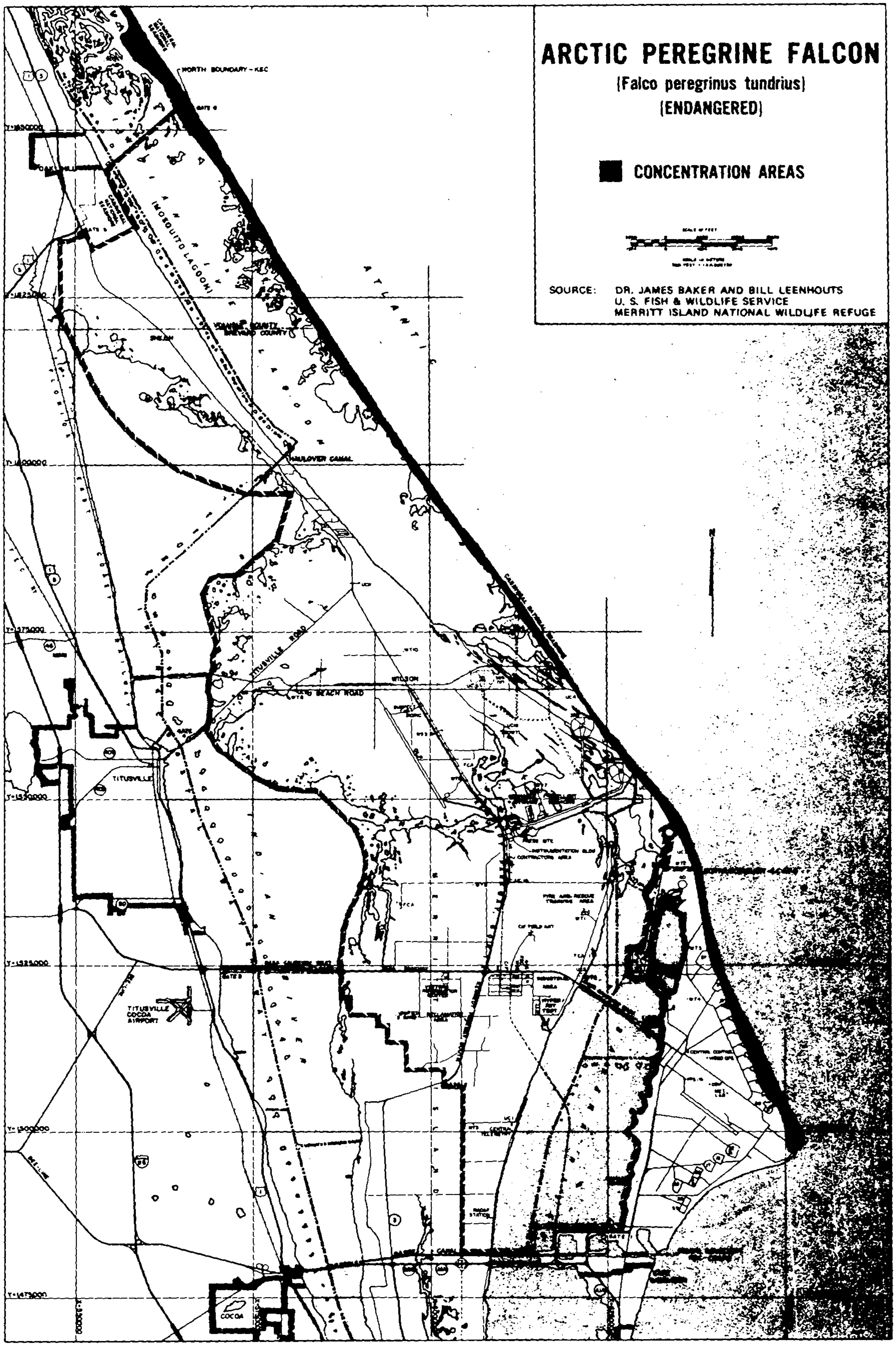


Figure C-5. KSC Range of the Arctic Peregrine Falcon

C.6 DUSKY SEASIDE SPARROW *Ammospiza maritima nigrescens*; Order: Passeriformes; Family: Fringillidae

C.6.1 DESCRIPTION. The Dusky Seaside Sparrow is about the size of other seaside sparrows but is much darker in color. In adults the breast and underparts are heavily streaked with black, and at a distance the bird appears entirely black. A yellow stripe is prominent on the lores and bend of the wing. Both sexes are similar in size and coloration. Immatures are lighter in color with narrower streaking, but in October are indistinguishable from adults. The Dusky's flight is normally short, low and fluttery. The male's song varies but is generally a short buzzing trill uttered from grass tops or low shrubs.

C.6.2 RANGE. Brevard County, Florida, in the St. Johns River floodplain (east side) from north of State Road 520 to State Road 46. Birds were formerly abundant in the Merritt Island salt marshes east of Titusville but have drastically declined within the last 15 years due to habitat changes caused by mosquito control impoundments.

C.6.3 HABITAT. Duskies inhabit cordgrass (*Spartina bakerii*) marshes and wet savannas mainly between 3 and 5 meters above mean sea level on the slightly brackish St. Johns floodplain. Small ponds, salt pans, scattered palms (*Sabal palmetto*), and hammocks are dispersed throughout the area. Because Duskies prefer an unbroken horizon, the presence of trees, particularly groups of trees in the immediate vicinity, precludes occupation of otherwise desirable vegetation by Duskies. The Merritt Island population prefers salt marshes dominated by cordgrass, salt grass (*Distichlis spicata*), and black rush (*Juncus roemerianus*).

C.6.4 LIFE HISTORY AND ECOLOGY. Duskies have small ranges and appear to occupy the same general area the year around. Territories are from 2,000 to 6,000 square meters in size. Duskies are ground feeders. Limited information on food habits indicates that they eat mostly invertebrates, such as spiders, grasshoppers, crickets, beetles, and snails.

Nesting occurs from late March through August with peaks in early May and late June. It is thought that they have two and possibly three broods annually. Nests are constructed of grass about 20 to 38 centimeters above the ground in clumps of cordgrass and occasionally in groundsel (*Baccharis augustifolia*). The usual clutch is 3 to 4 eggs, dirty white spotted with dark reddish brown.

Birds are difficult to observe in fall and winter, but in spring and summer the males sing from the tops of cordgrass and shrubs and are very evident.

C.6.5 SPECIALIZED OR UNIQUE CHARACTERISTICS. A population estimate by Brian Sharp in 1968 revealed about 1,800 birds. Habitat destruction due to highway construction, drainage, and conversion of natural range to improved pasture has probably reduced numbers somewhat on the St. Johns river area. As central Florida continues to be developed, a continued loss of habitat is expected.

The Merritt Island population has been drastically reduced due to impounding of salt marshes for mosquito control.

C.6.6 SPECIES STATUS. The habitat of the Dusky Seaside Sparrow has all but been eliminated by mosquito control impoundments killing the natural *Spartina bakerii* at Merritt Island National Wildlife Refuge. The resulting decline of Duskies on the Refuge has been from a historic high of 1,000 to approximately 2 birds now isolated at Black Point in the last natural salt marsh left. The U.S. Fish and Wildlife Service annually conducts an extensive survey of Dusky Seaside Sparrow habitat to determine the population status each year. Although the Merritt Island area is part of that survey, the 1978 survey failed to observe any of this species. The Refuge is acting on recommendations of the Dusky Seaside Sparrow Recovery Team to enlarge and optimize the existing habitat. Dike removal and habitat improvements of mosquito impoundments in the vicinity of Black Point are underway. Plans call for transplanting birds from the St. Johns population to Merritt Island as soon as a suitable additional habitat is created.

The Dusky Seaside Sparrow and its critical habitat located in the St. Johns River basin will be subjected to the low-level sonic boom generated by Orbiter reentry and landing. The sonic boom in that area, with overpressures not exceeding 101 Newtons per square meter (2.1 pounds per square foot), is expected to resemble the thunderclap which accompanies a lightning strike, a natural phenomenon very common in this region. For this reason, no adverse reactions are expected. However, field monitoring will be attempted in coordination with the U.S. Fish and Wildlife Service to ensure that no adverse impacts occur. Formal consultation with the Department of the Interior will be requested in accordance with provisions of Section 7 of the Endangered Species Act.

The range of the Dusky Seaside Sparrow at KSC is shown in figure C-6 which follows.

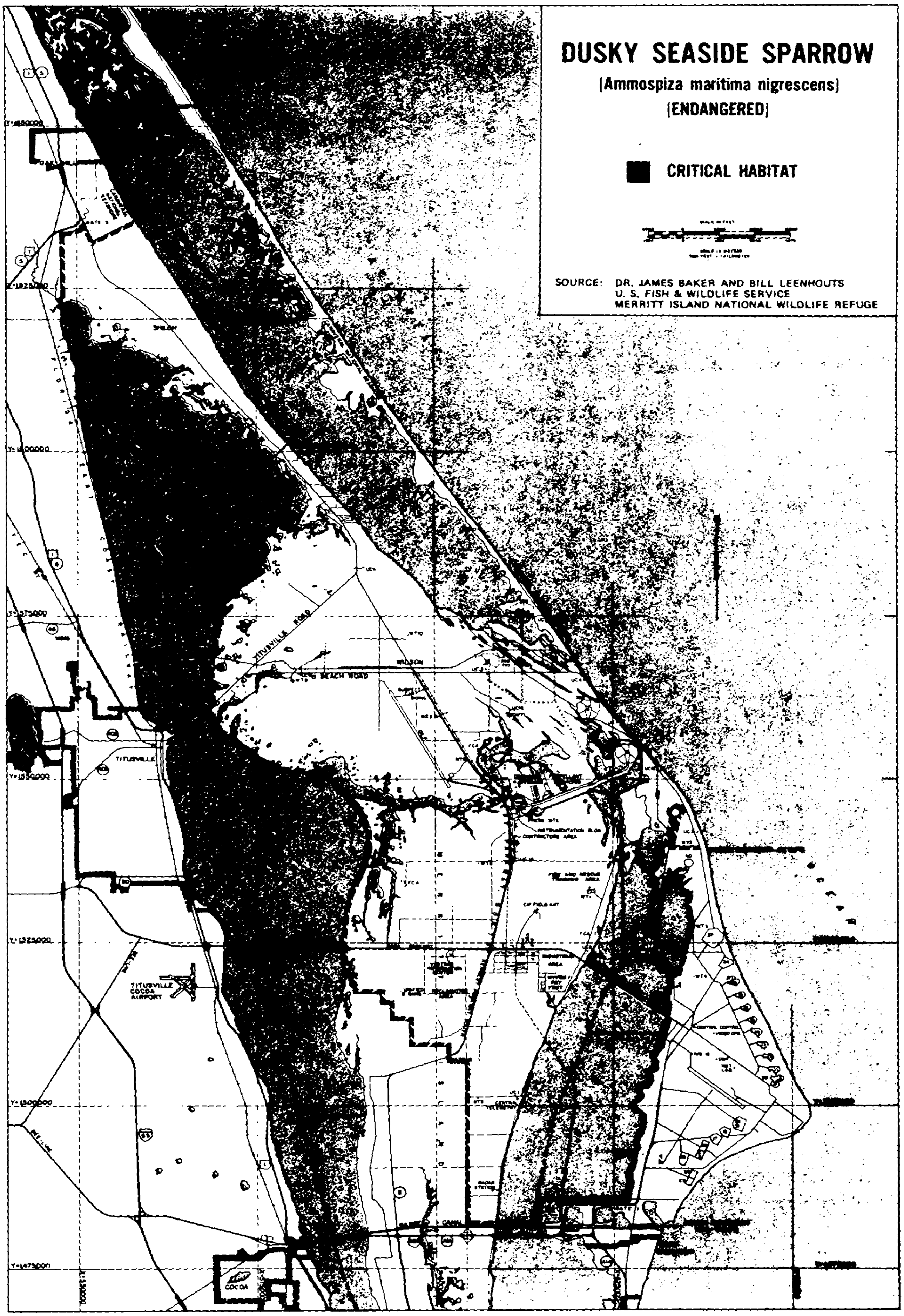


Figure C-6. KSC Range of the Dusky Seaside Sparrow

C.7 ATLANTIC RIDLEY TURTLE *Lepidochelys kempii*; Order: Testudinata; Family: Cheloniidae; Other Names: *Mexican Ridley, Kemp's* Ridley, Bastard Turtle, Lora Turtle

C.7.1 DESCRIPTION. A marine species characterized by a carapace extremely broad in relation to its length - sometimes even broader than long. Inframarginals have a pore at the rear border. Carapace coloration varies from olive-green to black or grey-brown. The carapace size varies from 58 to 71 centimeters with a maximum weight of 45 kilograms.

C.7.2 RANGE. Mature *Lepidochelys kempii* are restricted to the Gulf of Mexico while immature *specimens have been collected* along the Atlantic coast of the United States and infrequently along European shores. Virtually the entire population nests on approximately 16 kilometers of beach between Rancho Nuevo and Boca San Vincente in the State of Tamaulipas, Mexico. Recapture of tagged females indicates a dispersal pattern around the Gulf of Mexico from Key West, Florida to Isla Mujeres on the Yucatan Peninsula, and Cuba. Immature specimens are found seasonally in the Cedar Keys - Crystal River region.

C.7.3 LIFE HISTORY AND ECOLOGY. At least some of the females nest annually. Between April and June, the turtles appear off Tamaulipas where, following a strong wind, they crawl ashore to nest. Nesting occurs in the daylight hours, with a maximum of three nestings each season. Nests contain an average of 110 eggs.

C.7.4 SPECIALIZED OR UNIQUE CHARACTERISTICS. The entire world population of Atlantic Ridley Turtles utilizes one small nesting beach; the range is restricted to Gulf of Mexico to North Atlantic.

C.7.5 BASIS FOR STATUS CLASSIFICATION. When first seen in 1947, the nesting aggregation at Tamaulipas was estimated to contain 40,000 individuals; by 1970 only about 2,000 remained. The total world population today is estimated to contain only 3,000 to 5,000 females.

Reasons for decline include excessive egg collection and slaughter of adults as well as very high predation on unmolested nests. The worst problem today is the drowning of large numbers in shrimp nets.

C.7.6 SPECIES STATUS. Two specimens of the Atlantic Ridley Turtle were recovered in Mosquito Lagoon during the 1977 cold weather turtle stun. This was the first recorded evidence of this species at the Refuge in recent history. Because the Refuge is at the extreme northern boundary of its range, it appears Atlantic Ridley Turtle population here will never be very high. The Merritt Island National Wildlife Refuge is cooperating with Dr. L. M. Ehrhart of the University of Central Florida in conducting extensive sea turtle population nesting and behavioral research. Every effort is being made to protect the remaining sea turtle habitat within the Refuge and ensure young and adult survival.

Assessments of construction and operations activities at KSC have not identified any impacts which might be expected to jeopardize the existence of this species.

The range of the Atlantic Ridley Turtle at KSC is shown in figure C-7 which follows.

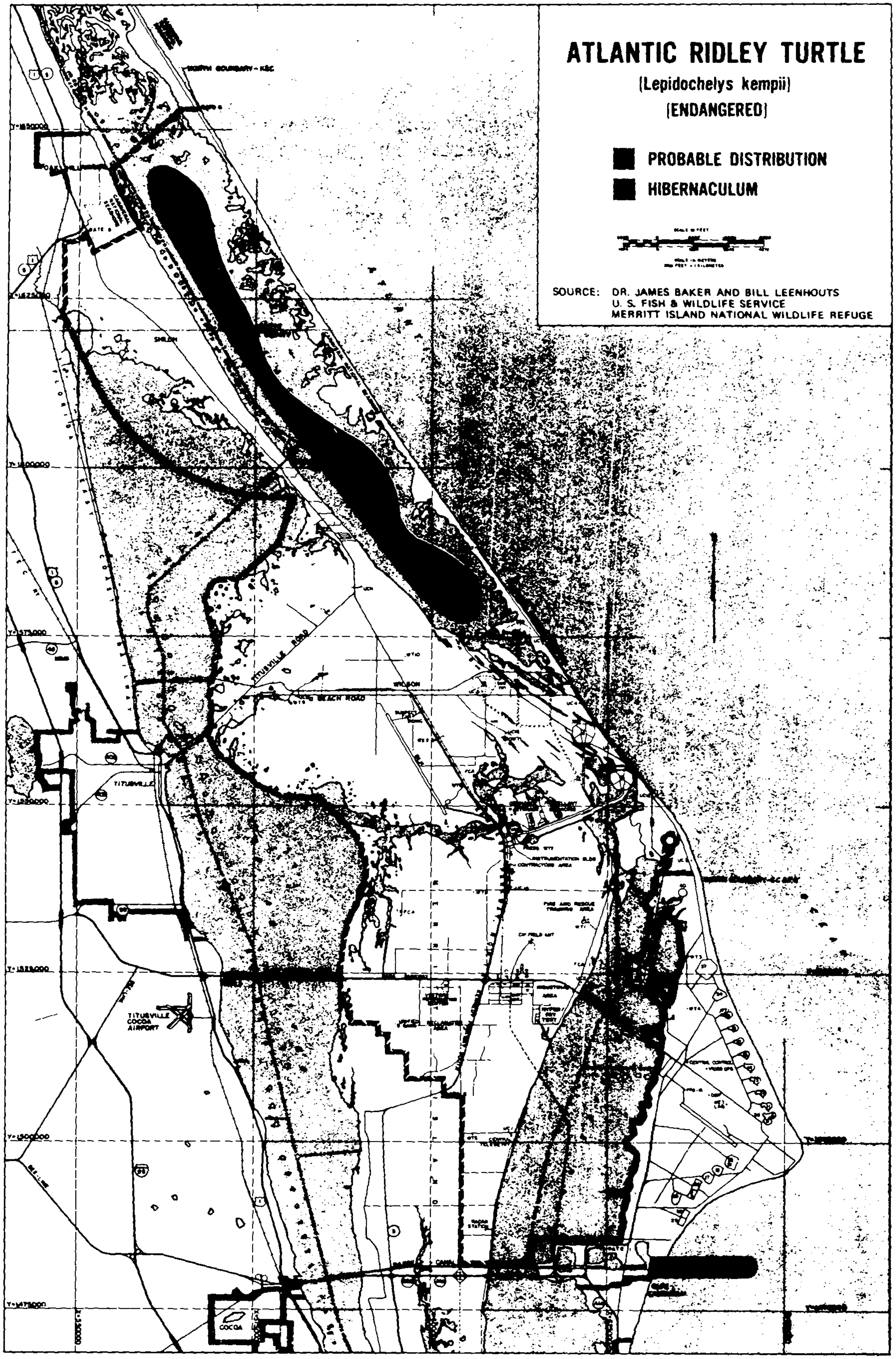


Figure C-7. KSC Range of the Atlantic Ridley Turtle

C.8 AMERICAN ALLIGATOR _Alligator mississippiensis_; Order: Crocodilia; Family: Crocodylidae; Other Name: Gator

C.8.1 DESCRIPTION. This huge, rough-backed, lizard-shaped reptile with a broad, rounded snout is probably more familiar to Florida residents than any member of our rich herpetofauna. Adult males commonly attain lengths of 3 meters and more. Females rarely exceed 3 meters in length. Individuals over 1 meter long are black, while smaller alligators appear crossbanded with yellowish-white, particularly along the sides and lateral surfaces of the tail. The tail is strongly compressed and crested with high, pointed scales. The strongly keeled scales continue along the back to the base of the head in several lateral rows.

The big reptile oftentimes is seen sunning near the water's edge on warm summer days. When disturbed, it will enter the water, submerge, and usually reappear silently so that only the tip of the nose and the eyes are visible.

C.8.2 RANGE. The alligator occurs in suitable habitat throughout Florida. However, its numbers are greater in the peninsula than in the panhandle.

C.8.3 HABITAT. The alligator generally is distributed in the various wetland types which exist statewide. These include the edges of large lakes and ponds, and the interiors of swamps and freshwater marshes. The reptile apparently is very adaptive and seems to be equally at home either in a pond in the middle of Orlando or in the middle of the Everglades.

C.8.4 LIFE HISTORY AND ECOLOGY. Alligators are fairly inactive during the winter, particularly in northern Florida. However, on warm days during the winter, they are often seen basking on the shoreline or stretched out on a log. As the spring approaches, alligators become more active and, until mid-December, remain a visible part of the outdoor scene.

Bellowing usually begins in mid-March. The male emits a very loud, deep, sonorous roar which probably serves the dual purpose of identifying his territory and advertising his presence and availability to sexually receptive females. Females, so inclined, will answer the male with their own bellow which is not so loud nor as deep in pitch as the males'. Alligators have two pairs of musk glands, a pair just inside the vent and a pair near the base of the lower jaw. The latter pair is visibly everted during bellowing. How adults locate one another for breeding is unknown but a combination of the musk gland scent and the mutual bellowing probably functions to this end.

After copulation, the female makes a clearing (if the nest is in marsh habitat) and heaps vegetation in the center with her tail, legs, and mouth. The completed nest is about 2 meters wide and 1/2 to 1 meter high. A clutch of from 20 to 50 eggs is deposited into a central cavity and after the female covers the eggs, the nest is complete.

Some females are protective of the nest and remain near for the entire incubation period. After a period of about 9 weeks, the eggs hatch and the 23-centimeter long young are freed from the nest by the female. Hatching young are very vocal and their high-pitched "umph, umph" calls may stimulate the female to open the nest. The young often remain together in a group called a pod for the remainder of the summer. Tagged young have been recaptured near the nest site as long as 3 years after hatching.

Growth is quite variable but can exceed 30 centimeters a year when weather conditions and food supplies are normal.

Young alligators (less than 1 meter long) are likely to subsist on a diet of insects, mollusks, and crustaceans while older animals will take prey consisting of fish, turtles, snakes, birds, mammals, and crustaceans.

Adult gators (over 2 meters) construct dens or gator holes. These may be tunnelled underground away from a river or from the edge of a lake. In marsh habitats, gator holes resemble small ponds. The adults create and maintain these holes by vigorous activity of both the tail and mouth, tearing vegetation and mud from the center and sweeping them toward the edge of the hole. An underground passageway leads off from the edge of the hole to an enlarged cave a short distance away.

The female will spend most of her time near her den. She will usually wander no more than 460 meters from the site. Home range sizes of 4 adult females studied in a Louisiana marsh varied from 2.6 to 16.6 hectares and averaged 8.5 hectares. In a later study in Louisiana, it was determined that 14 males moved quite a bit more. The home ranges of these adults varied from 180 to 5,000 hectares.

Young alligators are taken by a variety of predators including wading birds, snakes, bullfrogs, otters, raccoons, and black bass. Larger alligators fear only man.

C.8.5 SPECIALIZED OR UNIQUE CHARACTERISTICS. Biologically, the alligator is unique in that its habits promote the welfare of many other wildlife species. The natural levee surrounding the edge of an alligator hole in the Everglades is usually the site of a thicket of willow (Salix caroliniana) and groundsel-bush (Baccharis halimifolia) which serve as nesting areas for many avian species. During droughts the only surface water available is located in gator holes. These holes and their water supply become veritable refuges for numerous vertebrate and invertebrate species until the dry period terminates.

C.8.6 BASIS FOR STATUS CLASSIFICATION. Hunting of this species for its hide continued until the late 1960's and effectively eliminated the animal from many haunts in its historic range (the southeastern states including Texas, Arkansas, and North Carolina). It has been estimated that approximately 10 million alligators were killed from the time when hunting began in earnest, around 1870, until just a few years ago.

Alligator populations, however, are apparently very resilient and through both judicious protection and research the species has been restored in some areas in the southeast. Populations in southwestern Louisiana increased dramatically because of the efforts of the Louisiana Wild Life and Fisheries Commission to the point that the state has conducted two controlled experimental harvests of portions of that population. Some type of control may be warranted in Florida for alligator populations that have recovered to the point where "people-gator" confrontations regularly occur.

In general, the alligator is the one species which typifies the term endangered species to most laymen. The reptile's numbers have increased to the point where the animal definitely is not seriously threatened in Florida. However, the alligator is considered a threatened species by the Florida Game and Fresh Water Fish Commission and legally protected in the state.

C.8.7 SPECIES STATUS. There are at least 5000 alligators on the Merritt Island National Wildlife Refuge; so many that frequent alligator-visitor conflicts are becoming a problem. The Refuge continues to remove problem alligators from areas of concern to more isolated areas. With the high population levels of these animals, these conflicts will continue to be a problem. The U.S. Fish and Wildlife Service is monitoring population levels throughout the Refuge, and manages the species under a protectionist management plan.

Assessments of construction and operations activities at KSC have not identified any impacts which might be expected to jeopardize the existence of this species.

The range of the American Alligator at KSC is shown in figure C-8 which follows.

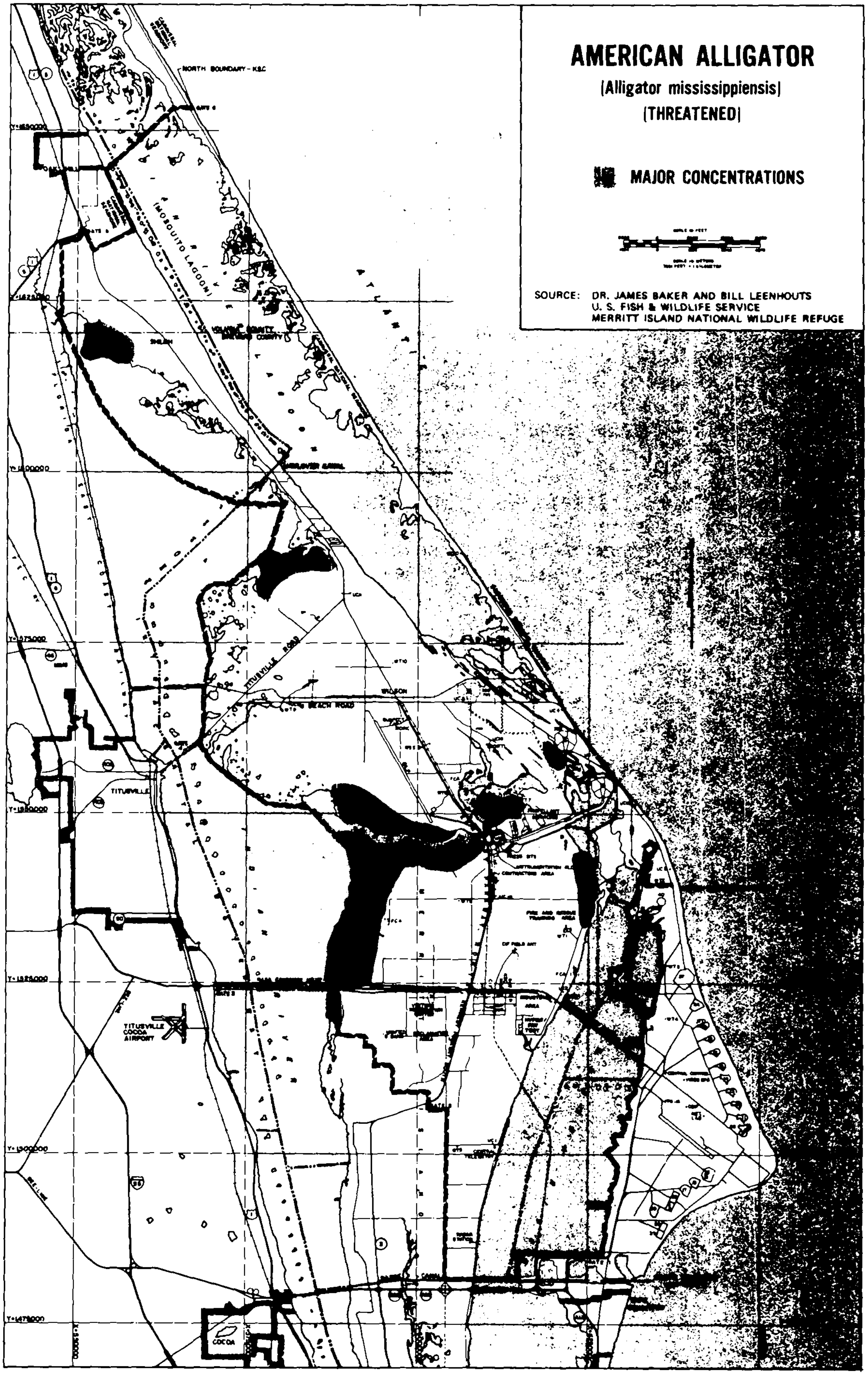


Figure C-8. KSC Range of the American Alligator

C.9 ATLANTIC SALT MARSH SNAKE *Nerodia fasciata taeniata*; Order: Squamata; Family: Colubridae; Other Names: *East Coast Striped Water* Snake, Salt Water Snake

C.9.1 DESCRIPTION. The Atlantic Salt Marsh Snake is a slender, heavily keeled water snake with a pattern of stripes that are variously broken into blotches. The dorsal ground color is pale olive, patterned with a pair of dark brown stripes running down the back and enclosing a pale mid-dorsal stripe. These dark stripes usually become fragmented posteriorly into a series of elongated blotches. There is also a row of dark blotches along the lower side of the body, which may merge to form stripes in the neck region. The Atlantic Salt Marsh Snake is not known to exceed 60 centimeters in length.

C.9.2 RANGE. The Salt Marsh Snake (*Nerodia fasciata taeniata*, *N. f. compressicauda* and *N. f. clarki*) inhabits brackish areas along the coast from the vicinity of Corpus Christi, Texas, to the Atlantic Coast of Central Florida. The Atlantic Salt Marsh Snake is restricted to the coastal areas of Volusia, Brevard, and Indian River Counties, Florida, and has been observed at approximately six localities. The type locality is National Gardens in Volusia County.

C.9.3 HABITAT. The Atlantic Salt Marsh Snake has been found in tidal creeks and salt marshes where it is usually associated with fiddler crab burrows and glassworts (*Salicornia*).

C.9.4 LIFE HISTORY AND ECOLOGY. The Atlantic Salt Marsh Snake is apparently most active at night during periods of low tide, when it feeds on small fish in the shallow water. There is some evidence to suggest that it may seek shelter in fiddler crab burrows. Although nothing is known of the life history of this snake, it is probably much like that of the closely related Gulf Salt Marsh Snake. Females of this Gulf Coast race produce from 2 to 14 young, which are born alive, usually in midsummer. Nothing is known about population dynamics of the Atlantic Salt Marsh Snake.

C.9.5 SPECIALIZED OR UNIQUE CHARACTERISTICS. The Salt Marsh Snakes are the only North American snakes restricted to a brackish environment. The striking similarity between *taeniata* and the *compressicauda X clarki* hybrids from the Florida West Coast suggests that *taeniata* may actually be the product of past hybridization involving *clarki* and *compressicauda* prototypes. Although today *Nerodia fasciata clarki* occurs in Florida only along the West Coast, it is believed that during the Pleistocene epoch, before the geography of Florida was altered by changing sea levels, *compressicauda* and *clarki* may have had adjacent distributions near what is now the range of *taeniata*. The Atlantic Salt Marsh Snake thus appears to be a relictual population of hybrids between two forms that no longer occur in the area.

C.9.6 BASIS FOR STATUS CLASSIFICATION. Progressive destruction of coastal marshes in Volusia, Brevard, and Indian River Counties is threatening the habitat of the Atlantic Salt Marsh Snake. Continued drainage of coastal wetlands will further limit the range of this already restricted reptile. Furthermore, habitat disturbance in these regions may already be responsible for increased genetic interchange between taeniata and the freshwater snake, Nerodia fasciata pictiventris. Such interchange can only lead to obliteration of the taeniata phenotype by the much larger pictiventris gene pool.

C.9.7 SPECIES STATUS. Little is known concerning the status of the Atlantic Salt Marsh Snake at Merritt Island National Wildlife Refuge. A preliminary survey in the spring of 1978 revealed that the taeniata-pictiventris hybrid is present but no pure genetic phenotype was discovered. Current plans call for an extensive survey of suitable habitat along Mosquito Lagoon. The objective of this survey is to determine the population status of pure stock and hybrids, where the phenotypic demarcation is, and the extent of hybridization.

Assessments of construction and operations activities at KSC have not identified any impacts which might be expected to jeopardize the existence of this species.

The range of the Atlantic Salt Marsh Snake at KSC is shown in figure C-9 which follows.

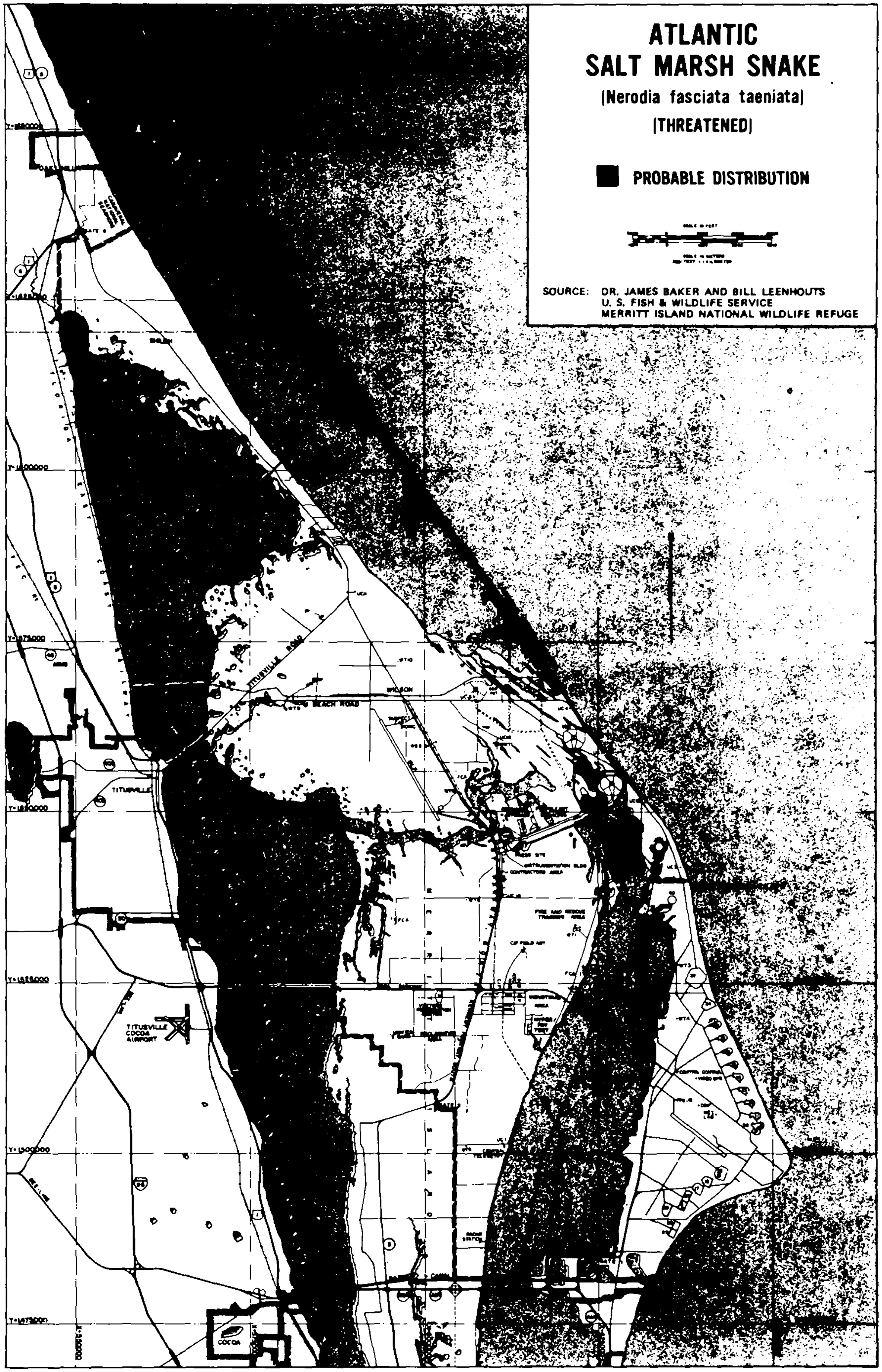


Figure C-9. KSC Range of the Atlantic Salt Marsh Snake

C.10 EASTERN INDIGO SNAKE Drymarchon corais couperi; Order: Squamata; Family: Colubridae; Other Names: Florida Indigo Snake, Gopher Snake, Blue Bull Snake

C.10.1 DESCRIPTION. The Eastern Indigo Snake is a large, heavy-bodied serpent with smooth, shiny scales. Adults are uniformly black or bluish black both above and below, with the chin, throat and lips usually tinged with reddish or orange pigmentation. Hatchlings are often marked with light speckling on a darker ground color. Although the average adult length of the Eastern Indigo Snake is approximately 2 meters, individuals over 3 meters long have been recorded.

C.10.2 RANGE. The Indigo Snake is widely distributed throughout the American tropics, with seven races ranging from southern Texas to northern Argentina. Drymarchon corais couperi, however, is restricted to the southeastern United States, its range being completely isolated from that of the Texas race. It occurs primarily in southeastern Georgia and throughout peninsular Florida, including the Florida Keys, but disjunct colonies have been reported from South Carolina, southern Alabama, and the West Florida panhandle. The type locality is in Georgia.

C.10.3 HABITAT. Although the Eastern Indigo Snake often inhabits dry, sandy areas, especially Florida's high pine communities, it is actually characteristic of moister habitats. It frequently has been encountered in pine flatwoods as well as in the moist tropical hammocks of South Florida. In the drier environments, Indigo Snakes invariably seek shelter in the burrows of the Florida Gopher Tortoise (Gopherus polyphemus), which are also frequently utilized by the Eastern Diamondback Rattlesnake (Crotalus adamanteus).

C.10.4 LIFE HISTORY AND ECOLOGY. Despite the frequent occurrence of the Eastern Indigo Snake in xeric habitats, laboratory experiments indicate that it is susceptible to desiccation. The shelter provided by gopher tortoise burrows therefore appears to constitute a critical factor necessary for the survival of this snake throughout areas of limited moisture.

The Eastern Indigo Snake is active primarily during the day. It is an omnivorous reptile, preying upon small mammals and birds as well as upon frogs, lizards, and other snakes, including venomous species. Observations on captive specimens indicate that the Eastern Indigo Snake lays from 5 to 12 eggs early in the season, usually in May. Hatching occurs during August and September; the young average 46 to 61 centimeters in length. Mating behavior has been observed in captivity during October and January.

C.10.5 SPECIALIZED OR UNIQUE CHARACTERISTICS. With a maximum recorded length of 3.63 meters, Drymarchon corais couperi rates among the largest colubrid snakes in the New World. This large snake is also renowned for its mild disposition.

C.10.6 BASIS FOR STATUS CLASSIFICATION. Due to its impressive size and docile nature, the Eastern Indigo Snake has for years been a prime target of snake fanciers and animal dealers. Currently the Eastern Indigo Snake is considered threatened and legally protected in Florida. This legislation has partially curtailed overcollecting by forbidding the capture, sale, or possession of this species, except under special permit. Nevertheless, reptile collectors continue to exploit the Indigo Snake. The technique of forcing reptiles out of gopher tortoise burrows through the use of gasoline, a practice commonly employed by rattlesnake hunters, is now known to have a lethal effect upon Indigo Snakes. Mount (1975) suggested that the Indigo Snake already may have been eliminated from Alabama.

Unfortunately, no provisions have been made to safeguard the xeric habitats of the Indigo Snake in Florida. Any environmental disturbance that threatens the survival of the Florida Gopher Tortoise will likewise make the Indigo Snake vulnerable to extirpation throughout the drier portions of its range.

C.10.7 SPECIES STATUS. The present knowledge of the status of the Eastern Indigo Snake in the Merritt Island National Wildlife Refuge is very limited. Road-kill survey data indicate that the species is present at moderate population levels. Because of the protection provided by the Refuge, the collection of the snake by snake fanciers and animal dealers is minimal. Plans of the U.S. Fish and Wildlife Service are to assess the status, location, and size of the Eastern Indigo Snake population on the Refuge, and if necessary provide additional suitable habitat for its survival and reproduction.

Assessments of construction and operations activities at KSC have not identified any impacts which might be expected to jeopardize the existence of this species.

The range of the Eastern Indigo Snake at KSC is shown in figure C-10 which follows.

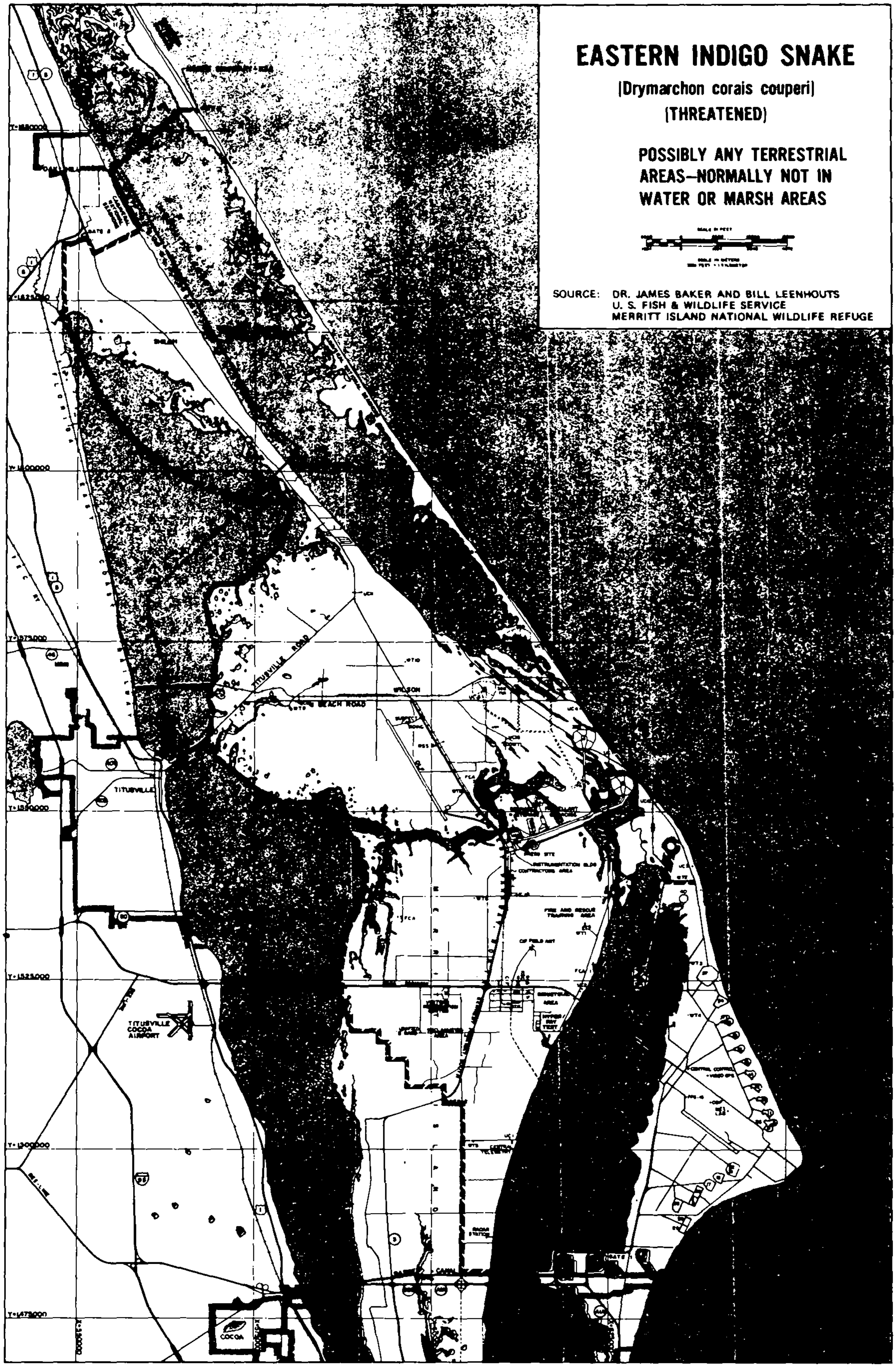


Figure C-10. KSC Range of the Eastern Indigo Snake

C.11 ATLANTIC LOGGERHEAD TURTLE *Caretta caretta caretta*; Order: Testudinata; Family: Cheloniidae; Common Name: Loggerhead

C.11.1 DESCRIPTION. The Loggerhead is characterized by a large head with blunt jaws. The carapace (top shell) and flippers are a reddish-brown color, while the plastron (bottom shell) is yellow. The shell frequently accumulates a heavy layer of barnacles. This turtle has five pairs of costal scutes (horny plates along the sides) and four prefrontals (forehead bones), sometimes with a central azygous (single) scale. Mature turtles weigh from 68 to 91 kilograms; large specimens have exceeded 180 kilograms.

C.11.2 RANGE. The Loggerhead is found in temperate and subtropical waters worldwide, with major nesting beaches in Eastern Australia, Southeastern Africa, and Southeastern United States. In the U.S., nesting occurs on suitable sandy beaches from North Carolina through Florida and, to a lesser extent, on islands off the Gulf states. Most important nesting beaches in the U.S. are the east coast of Florida, between Cape Canaveral and Palm Beach. Hutchinson Island and Jupiter Island are major rookeries within this area.

C.11.3 LIFE HISTORY AND ECOLOGY. Nesting season in the U.S. extends from May until September. Females typically nest every 2 to 3 years and deposit an average of 5 clutches in a season. Clutches contain an average of 120 eggs. Following the nesting season, most of the population disperses. Nesting turtles tagged in Florida have been recovered in South Carolina, Georgia, Alabama, and Louisiana, as well as in Cuba and the Bahama Islands.

C.11.4 SPECIALIZED OR UNIQUE CHARACTERISTICS. *Caretta*, like most species of marine turtles, exhibits considerable site fixity in returning to the same beach for successive nesting. This turtle nests further from the Equator than any other marine turtle.

C.11.5 BASIS FOR STATUS CLASSIFICATION. The Loggerhead population in the U.S. is currently estimated to number between 25,000 and 50,000 individuals. A recent census of *Caretta* nests indicates about 22,000 nests are dug each year in the U.S. Assuming 3.5 nests per turtle and 2.5 years between nestings, the U.S. population should be about 15,714 adult female turtles. Using the same approach, 19,895 nests are dug in Florida each year by a population of 14,210 adult females. Thus, the Florida populations of *Caretta* represent more than 90 percent of the total U.S. population. Excessive nest destruction by raccoons and confusion caused by beachfront lighting are responsible for the loss of large numbers of young. Erosion and oceanfront development have rendered former nesting beaches unsuitable. Shrimping activities off nesting beaches drown many adults and subadults. Both range and population size appear to be decreasing in Florida.

C.11.6 SPECIES STATUS. The population of Loggerheads on the Merritt Island National Wildlife Refuge averages approximately 500 individuals in the lagoonal waters. The 1978 nesting beach survey revealed 650 nesting

Loggerheads along the beaches of the Refuge and Canaveral National Seashore. Raccoon predation of turtle nests is a major problem, resulting in nest losses as high as 99 percent. The Refuge and the University of Central Florida are conducting two projects to increase hatching success and nest survival. Immediately following being laid, eggs are collected, shipped to the Refuge's biological laboratory, and incubated. After hatching, the baby turtles are released into the Atlantic Ocean. In 1978, 6,000 eggs were collected which achieved a 75-percent hatching success. Also in 1978, a raccoon control program was initiated. Because of this program, turtle nest survival increased from less than 5 percent to over 60 percent. Other studies into behavior, movements, and population dynamics are being conducted by the University of Central Florida on the Mosquito Lagoon turtle population. The population of Loggerheads at the Refuge appears to be healthy; however, many variables, some within the Refuge but especially outside of Refuge jurisdiction, still threaten the Loggerhead population.

Assessments of construction and operations activities at KSC have not identified any impacts which might be expected to jeopardize the existence of this species.

The range of the Atlantic Loggerhead Turtle at KSC is shown in figure C-11 which follows.

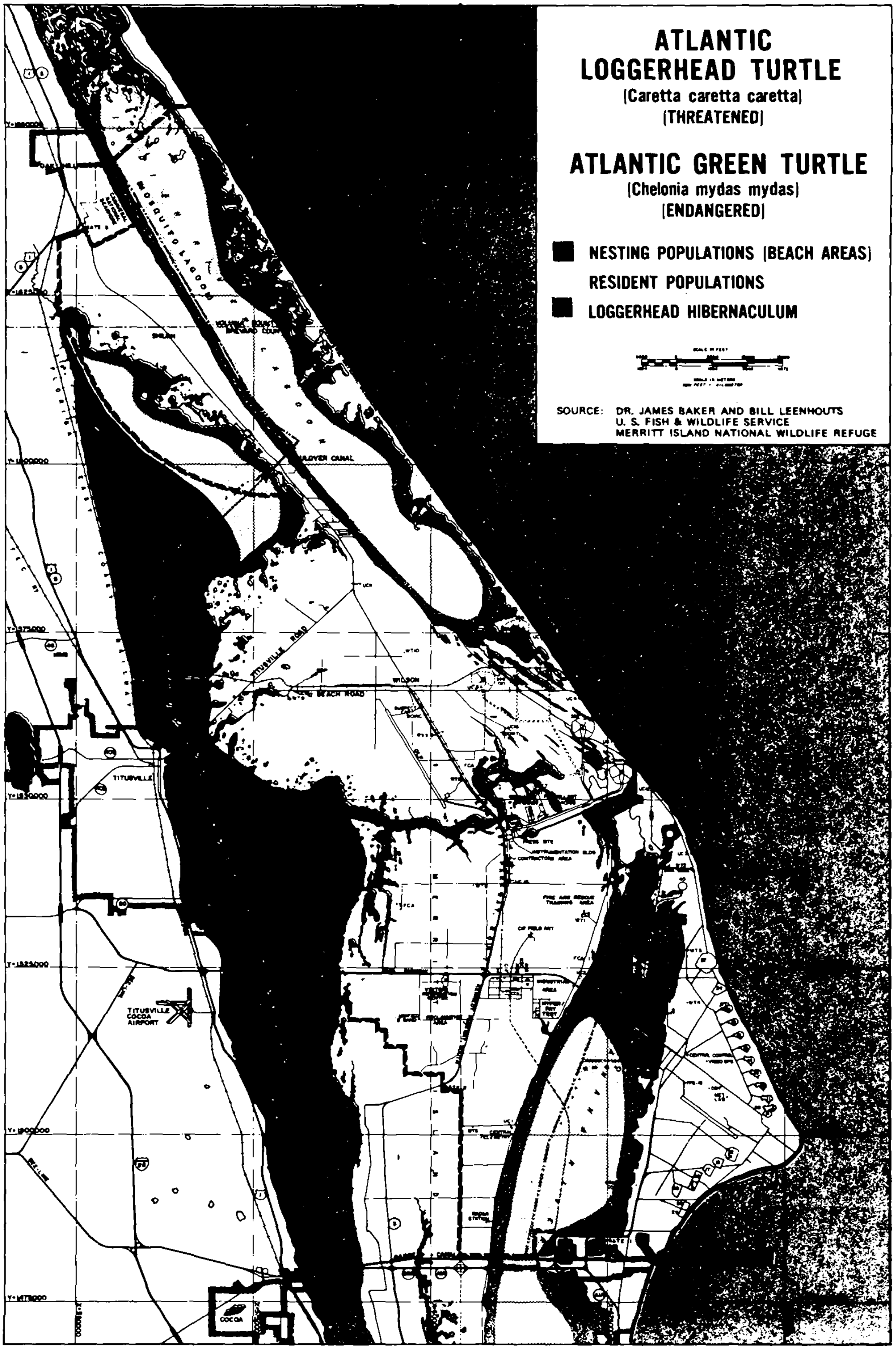


Figure C-11. KSC Range of the Atlantic Loggerhead and Green Turtles

C.12 ATLANTIC GREEN TURTLE *Chelonia mydas mydas*; Order: Testudinata; Family: Cheloniidae; Other Names: Greenback Turtle, Green Turtle

C.12.1 DESCRIPTION. The Green Turtle has a rather small head in proportion to its body, with borders of scales frequently yellow in color. The carapace (top shell) is generally brownish with olive or dark brown spots and streaks, while the plastron (bottom shell) is white. This turtle has four pairs of costal scutes (horny plates along the sides) and one pair of prefrontals (forehead bones). Mature females weigh from 113 to 129 kilograms and measure from 94 to 112 centimeters in carapace length.

C.12.2 RANGE. The Green Turtle is a worldwide species with several subspecies identified. Although the Green Turtle was once abundant in the Caribbean, the only major nesting grounds today are confined to Tortuguero, Costa Rica and Aves Island in the eastern Caribbean. While probably once widespread in Florida, nesting is today confined to the east coast between Cape Canaveral and Palm Beach with Jupiter Island and Hutchinson Island having the greatest nesting. Nesting is occasionally reported on the lower west coast of the state.

C.12.3 LIFE HISTORY AND ECOLOGY. The Green Turtle is chiefly herbivorous and highly migratory in seeking feeding areas often quite distant from nesting beaches. This turtle nests every 2 to 3 years, with the Florida season being May through August. Clutches contain an average of 134 eggs, and as many as 7 clutches of eggs may be laid in a season.

C.12.4 SPECIALIZED OR UNIQUE CHARACTERISTICS. This species is the source of most turtle steak and soup and has been intensively exploited for centuries in the Caribbean. Recently, commerce in flipper skins for leather and the oil for cosmetics also has developed.

C.12.5 BASIS FOR STATUS CLASSIFICATION. While probably once abundant in Florida, the current population is estimated to include no more than 50 mature females. The species, like all sea turtles, is now legally protected within Florida waters, but an active fishery exists in much of the Caribbean.

C.12.6 SPECIES STATUS. The population of Green Turtles on the Merritt Island National Wildlife Refuge averages approximately 125 individuals in the lagoonal waters. The 1978 nesting beach survey revealed 14 nesting Green Turtles along the beaches of the Refuge and Canaveral National Seashore. This represents close to 20 percent of the total Green Turtle nesting within the state of Florida. As with the Loggerhead Turtle, predation by raccoons is a problem (see C.11.5), but efforts are underway to increase nest survival. The University of Central Florida is conducting research into behavior, movements, and population dynamics on the Mosquito Lagoon turtle population. The population of Green Turtles at the Refuge remains low, but this is due to variables outside of Refuge jurisdiction.

Assessments of construction and operations activities at KSC have not identified any impacts which might be expected to jeopardize the existence of this species.

The range of the Atlantic Green Turtle at KSC coincides with that of the Atlantic Loggerhead Turtle as shown in figure C-11.

GLOSSARY

fusiform: rounded and tapering from the middle towards each end

genotype: a specific genetic constitution

hibernaculum: wintering quarters, as of a hibernating animal

inframarginal: situated below a margin or edge

intergrade: to merge gradually, one into another, as different species

lore: the space between the eye and the bill

pachyostosis: thick bone formation

phenotype: the appearance resulting from the interaction of the genotype and the environment

pore: hole or scalloped edge

raptor: adapted for seizing prey, as with talons

refugia: havens

vascular: provided with ducts that convey sap

xeric: arid

APPENDIX D

BACKGROUND MATERIAL FOR SECTIONS II AND V

TABLE OF CONTENTS

APPENDIX D

BACKGROUND MATERIAL FOR SECTIONS II AND V

D.1 INTRODUCTION

This appendix contains background information from which some of the statements and conclusions were drawn in Section II, Space Program Activities, and Section V, Possible Environmental Effects of the Proposed Action.

The following paragraphs contain supplemental data for topics discussed in sections II and V:

- D.2 Fuels and Fluids
- D.3 Pesticides (including herbicides, fungicides, etc.)
- D.4 Shops and Laboratories
- D.5 Facilities [Space Transportation System (STS) component processing and assembly]
- D.6 Spacelab
- D.7 Upper Stages
- D.8 Automated Payloads

D.2 STORAGE AND MANAGEMENT OF FUELS AND FLUIDS

Vast quantities of fuels and fluids (including gases) are received, stored, and dispensed throughout the year at Kennedy Space Center (KSC) in support of the STS and unmanned launch programs. The storage and management of these substances is accomplished in a manner that produces the least amount of significant impact on the KSC and adjoining environment. The fluids listed in tables 2-9 and 2-10 are received at KSC by railroad tank cars, mobile tank trailers, tube bank trailers, containerized shipment, and cross-country lines. They are stored in underground and aboveground tanks, their original containers, and flasks, Dewars, and bottles. They are dispensed through underground and aboveground lines, by mobile tankers, from pressurized containers, and from their original containers.

D.2.1 ENVIRONMENTAL IMPACT. The arrival and departure of service vehicles create an intermittent increase in exhaust fumes and a slight rise in the level of background noise. During the transfer of fluids and gases, small quantities may escape to atmosphere or be spilled on the specially constructed tanker parking pads. Transfers are accomplished through lines having quick connect/disconnect hardware to minimize these releases. The pad construction impounds spills for immediate cleanup. The quiescent boiloff of liquid oxygen and nitrogen diffuses into the atmosphere. All hydrogen boiloff is trapped and directed to a burn pond where it is ignited, producing water.

D.2.2 HAZARDOUS OPERATIONS. Operations involving hypergolic fuels and oxidizers, isopropyl alcohol, ammonia, and various bases and acids are considered hazardous operations. When required by existing NASA/KSC regulation, these operations are performed by qualified personnel wearing suitable protective clothing and working in an area surrounded by a security-guarded perimeter of sufficient dimensions to preclude injury to noninvolved persons. When possible, these operations are accomplished by remote control.

D.2.3 UNPLANNED EVENTS. An accident resulting in the release of uncontrolled amounts of any of the substances listed in tables 2-9 and 2-10 could generate an environmental impact ranging from inconsequential (e.g., helium) to extremely serious (e.g., nitrogen tetroxide).

A worst-case unplanned event would be collison and rupture of a mobile tanker containing up to 18,925 liters (5,000 gallons) of nitrogen tetroxide. This substance would immediately generate a toxic cloud. Depending on the location of the accident, wind direction and velocity, and quantity of spill, the results could be devastation of flora and fauna and a threat to human life.

The interstate shipment of certain hazardous materials must comply with applicable portions of Hazardous Materials Regulations of the Department of Transportation, Title 49, Transportation Code of Federal Regulations, Chapter I, Subtitle B. Shipment of hazardous materials within the State of Florida must comply with applicable regulations promulgated by the Public Service Commission, the Division of the State Fire Marshal, and the Department of Health and Rehabilitative Service.

Strict observance of these regulations is practiced by suppliers to NASA/KSC and makes the probability of such an event exceedingly remote. However, if such an accident were to occur, meteorological data would immediately be provided to predict the cone of danger and all available fire and rescue units would initiate evacuation procedures to mitigate the danger to human life. An equally remote unplanned event would be the rupture of a line during transfer of a hazardous substance from a supply vehicle to a storage vessel or from the storage vessel to the point of use. Such an event is highly unlikely because all lines are certified to have met three criteria: (1) operating pressure, which is the normal internal pressure at which the substance is delivered, (2) proof pressure, which is the highest pressure that would be developed by sudden surge resulting from a control valve malfunction, and (3) burst pressure, which is the lowest pressure that dynamic testing has demonstrated will rupture the line. Burst pressure is at least four times the operating pressure. In the event of such an accident, attendant Self-Contained Atmospheric Protective Ensemble (SCAPE) suited personnel would at once shut down the line and perform the required cleanup and rescue operations.

D.2.4 FUELS AND FLUIDS - GROUND SERVICE EQUIPMENT. Support operations at KSC require the receipt, storage, and dispensing of fuels and fluids for ground service equipment supporting flight activities and related aircraft movements. These fluids are various grades of gasoline, jet fuel, diesel fuel, motor oil, hydraulic fluid, deionized and potable water, and antifreeze compounds. These are handled in the same manner as similar flight operations commodities to assure a minimum impact on the environment.

D.3 PESTICIDES

The use of pesticides is planned and conducted to produce a beneficial impact. Reference to tables 2-7 and 2-11 will explain the unwanted species and reasons for their control or elimination.

D.3.1 ENVIRONMENTAL IMPACT. Adverse environmental effects are avoided by (1) understanding of the characteristics of the chemicals, (2) employment of thoroughly trained personnel, (3) imposition of climatological restrictions, and (4) direct supervision of a graduate entomologist. Every effort is made to direct the chemicals to the target area without overspray, runoff, or adverse impact on beneficial species.

D.3.2 HAZARDOUS OPERATIONS. Two types of hazardous operations are performed; those hazardous to the protected biotic environment and those potentially hazardous to human health.

To prevent wider dispersion of pesticides than desired, all spraying and strewing operations are restricted to conditions during which wind velocity is no greater than 8 knots. Spraying in areas where drainage and outfall ditches could be contaminated by runoff is forbidden. Extreme care is exercised to avoid destructive chemical contact with ornamental shrubs. Poisoned baits are kept in locked boxes.

Personnel working with chemicals which should not be touched or inhaled are protected by issuance of protective coveralls, gloves, and respirators for mandatory use.

The foregoing safety practices are enforced by the direct supervision of the graduate entomologist. All work is done under the constant review of the NASA/KSC agronomist.

D.3.3 UNPLANNED EVENTS. Unauthorized removal of safety equipment by an operator might result in accidental contact with or inhalation of a toxic substance. As soon as such an event was recognized, summoned rescue squad members would administer first aid. Guided by the entomologist's intimate knowledge of the chemical ingredients involved, subsequent medical treatment would mitigate or nullify the adverse effects.

D.4 SHOPS AND LABORATORIES

The following shops and laboratories have been selected for discussion because (1) waste products are generated which require environmentally acceptable reclamation or disposal, (2) work is performed in the presence of high-pressure lines or storage vessels, or (3) flammable or toxic (or both) substances are present. The measures taken to avoid or mitigate environmental impact in these shops can be considered typical for all other shops having similar characteristics. See tables D-1 and D-2 for locations, names, and functions.

D.4.1 PROTECTIVE CLOTHING EQUIPMENT (PCE) SHOP. The PCE shop provides the complete capability for cleaning, preventive and corrective maintenance, test, and storage of SCAPE accouterments. The facility is located in room L109 in Hangar S. Special systems include a fire sprinkler system slaved to a fire detection system, an air-conditioning system, and a 70,307 plus or minus 7,031 grams per square centimeter (gm/cm^2) [1,000 plus or minus 100 pounds per square inch (psi)] gage air supply. A Freon TF storage and transfer system provides 2,082 liters (550 gallons) of clean Freon TF and storage for 1,041 liters (275 gallons) of contaminated Freon TF. The disposal of the contaminated liquid resulting from boot, glove, and suit washing and showering is accomplished by capturing all the wash liquid in the storage tank. The tank is periodically pumped out into a mobile waste tanker for transfer to the Freon-reclamation facility. Other shops which are typical of this category are the Technical Shop (TESH) (K6-1247) where inshop (and onsite) fabrication and assembly of cables and harnesses are performed and TESH (K6-1996) where printed wiring boards are printed, developed, etched, gold and silver plated, and cleaned.

D.4.2 EMERGENCY BREATHING EQUIPMENT (EBE) SHOP. The EBE shop, located in room L108 in Hangar S, is equipped to perform repair, testing, modification, preventive maintenance, pre-mission inspection, and storage of 26 types (about 3,420 separate pieces) of emergency breathing equipment. The EBE shop is equipped with a 196,860-gm/cm^2 (2,800-psi) gage breathing air supply and an automatic fire detection and sprinkler system. All equipment for storing, charging, and transferring the high-pressure air is periodically inspected and issued a dated stamp of acceptance. Accidental rupture of line or vessel is a remote possiblity because working pressures are well below burst pressures. Other shops which are typical of this category are the Cape Canaveral Air Force Station (CCAFS) Environmental Control Unit Shop (3-66220) where cleaning and maintenance of cryogenic breathing equipment require the presence of a 421,840-gm/cm^2 (6,000-psi) gage breathing air system and the CCAFS Clean Room Facility (66220) where life support oxygen equipment repair, modification, and testing require the presence of a 288,260-gm/cm^2 (4,100-psi) gage breathing air supply and a 168,737-gm/cm^2 (2,400-psi) gage gaseous oxygen supply.

D.4.3 PROPELLANT COMPONENTS DECONTAMINATION AREA. The Propellant Components Decontamination Area functions are performed in rooms 100 and 101 of Building K7-417. This shop provides the complete capability for decontamination of

Table D-1. Shops

Location	Name	Function
Operations and Checkout (O&C) Building (M7-355)	Battery Shop	Maintenance, Repair, and Recharging of Batteries
	Mechanical Modification	Machine Shop
	Mechanical Work Area	Minor Mechanical Maintenance and Repair
	Flight Crew Systems	Support of Crew Systems
	CCMS Area	Command Control and Monitor System and CITE Maintenance
	Flight Battery Shop	Service and Maintenance of Flight Batteries
	Communications Work Area	Maintenance of Operational Intercommunication System and Communications
Central Instrumentation Facility (M6-342)	Digital Electronics Shop	Test and Repair of Digital Line-Replaceable-Units and Shop-Replaceable Units
	Instrumentation Shop	Test and Repair of Transducer Signal Conditioner Instrumentation
Communications and Storage Bldg (M6-791)	Communication Shop	Repair and Storage of OIS/OTV/Communications Equipment
Base Support Bldg (M6-486)	Support Service Shops	Welding, Coating, Painting, Fabric, Plumbing, Air-Conditioning, Electrical, Hose/Tube, and General Field Service

Table D-1. Shops (cont)

Location	Name	Function
Vehicle Assembly (K6-848)	Battery Shop	Battery Service
	Fluids/Mechanical Work Area	Maintenance, Modification, and Staging of Fluid Systems
	Mechanical/Ordnance Checkout Area	General Mechanical and Limited Ordnance Support
	Space Shuttle Main Engine Shop	Mechanical Work and SSME Storage and Staging Area
	External Tank Mechanical Shop and Thermal Protection Subsystem Work Area	ET Mechanical Work and TPS Work and Staging Area
	SRB Mechanical Shop	SRB Mechanical Work
	Elevator Shop	Elevator Maintenance and Repair
	SRB and ET Work Area	Various Locations in the VAB, Equipped for General Support and Staging of ET and SRB Components
	Battery and Ground Power Area	Battery Shop and Field Support Area
	Electro-Optics Work Area	Theodolite and Other Test Devices Maintenance and Calibration
	HVAC Instrument Area	Maintenance and Calibration of Heating, Ventilating, and Air-Conditioning Instrumentation
	Various Other Work and Staging Areas	Support Areas for SRB's, Thermal Protection Subsystem, Fluids, ET, and Communications

Table D-1. Shops (cont)

Location	Name	Function
VAB Utility Annex (K6-947)	Environmental Control Work Work Area	In-place Repair and Maintenance of ECS
Orbiter Process (K6-894)	Thermal Protection Subsystem Shop	TPS Molding, Installing, and Staging
	OPF/CCMS Work Area	Maintenance Work on the Orbiter and the Command Control and Monitor System
	Other Work and Staging Areas	General In-Place Support, Maintenance, Modifications, and Storage
Base Maintenance Building (K6-1095)	TPS Shop	TPS Molding and Bonding Area
	Field Support Shop	Field Base Support
Pad Area and Miscellaneous Buildings (LC-39)	Water Pump Station (J7-1388)	Maintenance, Field Support, and Staging for Water System
	CCMS Work Area PTCR (J8-1708)	Maintenance of Command Control and Monitor System in the Pad Terminal Connection Room
	ET Operations Area PTCR (J8-1708)	External Tank Support
	HVAC/Pressurization PTCR (J8-1708)	Maintenance and Staging of HVAC Components
Launch Control Center (K6-900)	Communication Area	Communications On-Line Support
	CCMS Maintenance Area	CCMS Support

Table D-1. Shops (cont)

Location	Name	Function
Launch Control Center (K6-900) (cont)	CDS Maintenance Area	Central Data Subsystem Support
	RPS/RTIF/VSI Maintenance Area	General Electronic Support for Record & Playback System/Real-Time Integration Facility/Video Simulation Interface
CCAFS Hangar AF	Solid Rocket Booster Shop	SRB Retrieval and Disassembly
Hangar S, Hangar S Annex, and 66220	ECLSS Shop	Maintenance and Refurbishment of SCAPE Backpacks and Other Environmental Control Life Support Systems
Supply, Shipping, and Receiving Bldg (M7-505)	LETF Support Area	Testing of Launch Equipment with Machine Shop Support
	Wheel & Tire Shop	Maintenance and Staging
	Waste Collector Area	Orbiter Waste Collector Maintenance
	Payload Accommodation Area	Flight Kit Machine and Mechanical Staging Area
	Sling Maintenance Area	Maintenance and Staging of Selected STS Slings
	Central Staging Area	General Staging
	LIMS/SIMS Control Area	Logistics Inventory Management System and Shuttle Inventory Management System Records and Control

Table D-1. Shops (cont)

Location	Name	Function
Hypergol Maintenance Facilities Complex (M7-961, 1061, 1212, 1410, and 1412)	HMF Complex	Maintenance and Checkout of Orbital Maneuvering Subsystem Pods
POL Storage Building (K7-417)	Propellant Component Decontamination Area	Cleaning and Refurbishment of Components Contaminated with Hypergol Fuel and Oxidizer

Table D-2. Laboratories

Location	Name	Function
Operations and Checkout (O&C) Building (M7-355)	Development Testing Lab	Prototype Research and Development
	Malfunction Investigation Lab	Component Malfunction Investigations
	Microchemical Analysis Lab	Analysis of Materials
	Materials and Environmental Test Lab	Materials and Component Testing
	Analog Lab	Test and Repair of Inertial Devices, Servos, and Optics
Central Instrumentation Facility (M6-342)	Calibration and Standards Labs	Calibration, Maintenance, Repair, and Precision Cleaning
Supply, Shipping, and Receiving Building (M7-505)	Materials Environmental Testing Lab	Materials Testing
Vehicle Assembly Building (K6-848) (to be moved to the Central Instrumentation Facility)	Calibration Labs	Calibration, Maintenance, and Repair
Various Locations	Nondestructive Test Labs (K7-569, 77375, and 77380)	Nondestructive Testing by Neutron Radiography, X-Ray, Ultrasonics, etc.

components and hardware which have been exposed to and contaminated by hypergolic fuel and oxidizer. For safety reasons, rooms 100 and 101 have no interconnecting doors. Room 100 is used to decontaminate parts contaminated with oxidizer to a maximum value of 5.0 parts per million. Room 101 is used to decontaminate parts contaminated with fuel to a maximum of 0.2 part per million.

The decontamination process for both types of contamination is essentially the same, the difference being in the formulation of the neutralizer. The process consists of flushing neutralizer through the component or immersing the component in neutralizer until the hypergol content is reduced to the applicable value stated above. The component is then rinsed with water, purged, dried, and packaged for subsequent disposition. Used neutralizing compounds and the two different wash waters are carefully collected in segregated, identified waste tanks and disposed of properly.

D.4.4 PHOTOGRAPHIC (STILL) PROCESSING LABORATORY. This shop annually consumes the following photographic chemicals:

Common Name	Liters per Year	Gallons per Year
Developers	47,800	12,628
Fixers	20,500	5,400
Kits	15,900	4,200
Stop Baths	9,100	2,400
Bleach	5,700	1,500

These compounds are used for processing black and white and color films. Used sodium thiosulfate (fixer) is processed in the laboratory by a method which is about 90 percent efficient in recovering silver from the spent solution. The residue is flushed with water to the sanitary sewer system. All other chemical wastes are containerized, identified, and removed to Complex 20 for storage prior to final disposal.

D.5 FACILITIES

D.5.1 FIRE AND RESCUE TRAINING AREA. This 137-meter by 86-meter (450-foot by 281-foot) facility is used to train and familiarize propellant mechanics and astronaut rescue teams with the equipment, materials, and techniques for hypergolic firefighting and rescue.

D.5.1.1 Substances. The facility contains a distribution system for gaseous nitrogen, monomethylhydrazine, and nitrogen tetroxide. Gaseous nitrogen is supplied from a tube bank trailer having a 154,675-gm/cm^2 (2,200-psi) gage storage pressure. The tube bank trailer is connected to the fuel and the oxidizer supply trailers to provide transfer pressurization. Yearly consumption of fuel and oxidizer is approximately 7,570 liters (2,000 gallons) of each.

D.5.1.2 Environmental Impact. The gaseous nitrogen pressurization of the hypergol trailers enables the fluids to flow to a burn pan with a 12-meter (40-foot) radius where training is conducted. In the course of these exercises, nitrous oxide and hydrazine vapors are released to the atmosphere. A 30-meter (100-foot) square dilution pond is provided to collect burn pan contaminants. Because of the remote location of this facility (north of the NASA Parkway along the east coast of Merritt Island), the resulting localized and occasional air degradation is acceptable in view of the vital importance of this program. Contents from the dilution pond are treated to an acceptable level of contamination. The ambient noise level is augmented to an insignificant degree by ignition of the hypergols.

D.5.1.3 Hazardous Operations. By the very nature of this program, hazardous materials are used and hazardous situations are simulated to provide the required training and familiarization. Procedures are designed, monitored, and enforced by experienced instructors to avoid injury to trainees.

D.5.1.4 Unplanned Events. A worst-case unplanned event would be the accidental commingling of uncontrolled amounts of fuel and oxidizer. To preclude the occurrence of such an event, the hypergol trailers are separated by a 2-meter (7-foot) high sandbag cement riprap wall. The possibility of trainee injury is remote because of the safety equipment and procedures enforced by directors of the program.

D.5.2 HYPERGOL MAINTENANCE FACILITY (HMF) COMPLEX. The HMF Complex is composed of three buildings as listed below. Hereinafter, the buildings are referred to by their M7 number.

M7-961	Hypergol Module Processing (North)
M7-1061	Hypergol Support Building
M7-1212	Hypergol Module Processing (South)

Under present planning, the two cells in M7-961 will be used to process the Aft Propulsion System (APS) modules, consisting of the Orbital Maneuvering Subsystem (OMS) and the Aft Reaction Control Subsystem (ARCS). The two cells in M7-1212 will be similarly used to process the Forward Reaction Control Subsystem (FRCS) module and the Payload Bay Kit (PBK). The Launch Processing System (LPS) consoles which direct checkout operations in M7-961 and M7-1212 and the facilities for donning, removing, and stowing SCAPE accouterments will be housed in M7-1061.

D.5.2.1 Substances. The following solids, liquids, and gases will be present as residuals or will be used for maintenance operations in M7-961 and M7-1212 (M7-1061 uses and discharges only water):

Solids

No chemical solid wastes will be present.

Liquids

Monomethylhydrazine	Hydrazine
Nitrogen tetroxide	Freon TF
Solutions of sodium sulfite	Isopropyl alcohol
Solutions of sodium hydroxide	Potable water
Solutions of citric acid	

Gases

Gaseous helium	Compressed air
Gaseous nitrogen	

D.5.2.2 Environmental Impact. All checkout operations requiring the use of test fluids and gases will be conducted under controlled conditions. During connection and disconnection of a line, small amounts of liquids or gases may be momentarily released. The liquids will be contained and removed; the gases will be exhausted through roof vent fans. Larger spills will be flushed into a trench system for transfer to a waste tanker. Vented fluids from a checkout operation will be directed to a separator located adjacent to a tanker pad. (Tanker pads themselves are sloped and diked to capture spills in the trench system.) The separator will direct fluids to a sump and gases to a scrubber. Fluids in the separator sump will be pumped into a 208-liter (55-gallon) drum for eventual disposal. Gases directed to the scrubber will be reacted and treated; when released to the atmosphere, the level of contamination will be as low as is attainable with current state-of-the-art equipment. All liquids except incidental rainwater are collected in closed containers or waste tankers restricted to a particular category of material. Such waste material is refined for reuse or is treated and transferred to a disposal area. No solid wastes will be generated. Noise generated by overhead cranes, air-handling equipment, and service vehicles is not expected to exceed 80 dBA.

D.5.2.3 Hazardous Operations. If a hardware malfunction is detected which dictates opening a line or removing a component for repair or replacement, special precautions will be taken for hazardous operations. Personnel wearing SCAPE outfits will accomplish the repair and collect and dispose of released materials. Spills and leaks will be washed down with water hoses present in the facility. This water normally will be collected in the cell trench and valved to the outside trench for collection in a waste tanker. If a situation arises where it is deemed prudent to evacuate personnel from a cell, a deluge system may be activated which will release and direct copious quantities of water to all parts of the cell.

A potentially hazardous condition exists during transportation of the modules listed in D.5.2 from the Orbiter Processing Facility (OPF) to the HMF and again when these modules are returned to the OPF. Danger of mishap is reduced by restricting traffic along the route, preceding and following the transporter with police cars with flashing lights operating, maintaining a regulated maximum speed, and preparations for receiving the components at their destination.

During all activities in the HMF Complex, a hazards warning system of sirens and flashing red lights alerts operating personnel to a potential emergency. This system, together with guards as necessary, denies access to the area of other than authorized persons.

D.5.2.4 Unplanned Events. When the modules listed in D.5.2 arrive at the HMF, residual fuel and oxidizer could be present in the following maximum amounts:

Component	Fuel Kilograms	Fuel (Pounds)	Oxidizer Kilograms	Oxidizer (Pounds)
OMS	222 (each pod)	(490)	369 (each pod)	(813)
ARCS	209	(460)	347	(765)
FRCS	376	(830)	626	(1,380)
PBK	667	(1,470)	1,106	(2,439)

A worst-case event would be the release, from any cause, of uncontrolled amounts of fuel and oxidizer at the same time in a single cell of M7-961 or M7-1212. The ensuing flame and effluent could damage or destroy the facility, cause environmental damage to a surrounding area (as governed by prevailing wind direction, velocity, etc.), and cause loss of life to involved personnel. Reaction to such an event would include immediate activation of the deluge system, together with firefighting and rescue operations by SCAPE-suited personnel either present or summoned to the scene. The deluge system will direct such large quantities of water to all parts of the cell that the cell trench will become saturated and excess water will flow over the door sill. Two factors make the occurrence of such a catastrophe very unlikely; (1) regulations which prohibit more than one hazardous operation at a time in any one cell (thus reducing the chance for human error), and (2) KSC/NASA regulations which mandate periodic inspection and recertification of all lifting devices and of all installation and access structures (making equipment failure unlikely).

If, during the transportation of a module to or from the HMF, an accident occurs causing the rupture of one or both tanks containing fuel and oxidizer, release of toxic fumes and fire would take place in an open-air, uncontrolled environment. Fire, rescue, and safety personnel accompanying the convoy would take immediate action to flood the area with water and to obtain real-time predictions of downwind concentrations and transport direction of the pollutants. Personnel within the predicted hazardous zones would be evacuated until a sweep of the area, using detectors for hazardous substances, confirmed acceptable levels have been reached. Such an event could cause damage or death to local flora and fauna within the path of the resultant cloud, depending on its concentration and the speed of its passage. However, because transportation operations take place well within the confines of KSC [the nearest population area is 12 kilometers (7.5 miles) to the south], all pollutants are expected to be sufficiently diffused to prevent any hazard beyond the boundaries of KSC. The occurrence of an accident of this kind is extremely unlikely and has never been experienced at KSC.

A more likely event would be accidental contact by personnel with monomethylhydrazine, hydrazine, or nitrogen tetroxide. These substances are extreme skin irritants. In this situation, harmful effects would be mitigated by immediate use of the eyewash and shower facilities available throughout the operations area. This flushing would be followed by medical assistance and appropriate examination and treatment at the KSC Occupational Health Facility.

D.5.3 ORBITER PROCESSING FACILITY. The OPF is designed and equipped to prepare a returned Orbiter for mating with an External Tank (ET) and subsequent processing. The OPF is intermediate between Shuttle Landing and Shuttle Vehicle Assembly and Checkout. Tasks include but are not limited to safing, servicing and deservicing, Thermal Protection Subsystem (TPS) refurbishment, Orbiter active systems checkout, payload removal and installation, propellant module removal and installation, culminating with towing the Orbiter to the Vehicle Assembly Building (VAB).

D.5.3.1 Substances. The following solids, liquids, and gases will be present in the OPF, either as required for flush, purge, checkout, and replenish and refurbish operations or as residuals in the Orbiter systems:

Solids

TPS bonding material	Fecal matter
TPS inter-tile insulation	Pyrotechnics

Liquids

Monomethylhydrazine	Lubrication oil
Nitrogen tetroxide	Liquid hydrogen
Hydrazine	Liquid oxygen
Isopropyl alcohol	FC-40 coolant
Solutions of sodium sulfite	Potable water
Solutions of sodium hydroxide	Waste water
Solutions of citric acid	Urine
Hydraulic fluid	

Gases

Ammonia	Gaseous nitrogen
Freon 12	Gaseous helium
Freon 1301	Gaseous hydrogen
Compressed air	Gaseous oxygen
Carbon dioxide	

D.5.3.2 Environmental Impact. Procedures using test fluids and gases to accomplish safing, servicing and deservicing, and checkout of the Orbiter active systems will be performed under controlled conditions. Vented test fluids and gases will be directed through lines and hoses to waste containers and waste tankers provided for individual types of contaminants. The contents of these waste collectors will be refined for sale or reuse, or neutralized and released to a disposal area. During payload and propellant module removal and installation, disconnection and reconnection of lines may result in the momentary release of small amounts of liquids or gases. Minor spills of liquids will be confined and removed for proper disposal; gases will be exhausted to the atmosphere through roof vents. Innocuous wash, flush, and rinse fluids will be trapped in drainage trenches and directed to an underground collection tank for subsequent removal and disposal. Gases will be diluted with air and directed through outside vent stacks for atmosphere release. If damage or leakage is detected, residual gases and liquids will be offloaded to the mobile waste tankers.

Solid wastes generated by the refurbishment of the TPS tiles and the Environmental Control and Life Support Subsystem (ECLSS) waste collection system will be collected and transported to the applicable disposal area. Noise generated in the OPF will be consistent with light industrial activities, augmented intermittently with noise associated with two 27-metric ton (30-ton) bridge cranes, blowers, hydraulic units, and air compressors. An exception occurs periodically when operation of the three hydraulic units is required. The noise generated by the pumps, while not significant outside of the facility, is at a level that dictates wearing of earplugs by personnel in the vicinity in accordance with Occupational Safety and Health Administration (OSHA) regulations. Three diesel engines, which are used only if the deluge system is activated, are housed in an adjacent building; diesel exhausts will be released to atmosphere through three muffled exits. The deluge system is manually activated and can be selectively directed to any or all of five zones within the OPF. Deluge water is contained and directed to an underground collection tank.

D.5.3.3 Hazardous Operations. Any operation which necessitates opening lines containing noxious or flammable gases or liquids is deemed hazardous. If such a situation arises, noninvolved personnel will be evacuated from the immediate area and SCAPE-suited personnel will perform the required operation. Released gases and liquids will be directed and collected as described in D.5.3.2. The prohibition against simultaneous operations involving hypergolic fuel and oxidizer significantly reduces the potential for accidental hypergolic reaction.

Transportation of the propellant modules between the OPF and the HMF (to and from) is considered a hazardous operation. A description of procedures for safely accomplishing this transportation may be found in D.5.2.3.

D.5.3.4 Unplanned Events. When the Orbiter arrives at the OPF, the propellant modules are removed, sent to the HMF for maintenance, and, following this maintenance, received for reinstallation. Residual fuel and oxidizer may be present in the amounts listed in D.5.2.4. A worst-case event in the OPF would be the simultaneous release of substantial amounts of fuel and oxidizer. The ensuing flame and effluent could damage or destroy the facility, cause environmental damage to a surrounding area (as governed by prevailing wind direction, velocity, etc.), and result in injury or loss of life to involved personnel. Reaction to such an event would include immediate activation of the deluge system, together with firefighting and rescue operations by SCAPE-suited personnel either present or summoned to the scene. Such a catastrophe might be caused by human error, but this possiblity is minimized by the use of certified operators. KSC/NASA mandated periodic inspection and recertification of all lifting devices and of installation and access structures rule out equipment failure to the extent possible.

Procedures governing an accidental rupture of hypergolic containers during transportation between the OPF and HMF are discussed in D.5.2.4 as is accidental personnel contact with fuels, hydrazine, or oxidizer.

D.5.4 SOLID ROCKET BOOSTER REFURBISHMENT AND SUBASSEMBLY FACILITY. The Solid Rocket Booster (SRB) Refurbishment and Subassembly Facility (RSF) occupies portions of two levels on the west side of the low bay in the VAB. Two separate, though related, activities take place in the RSF. These are:

a. Assembly and Checkout Cells. Four open cells, on the first level, are equipped and instrumented to receive, assemble, and test new SRB flight hardware and recovered and cleaned SRB hardware from the Recovery and Disassembly Facility (see D.5.13). Major assemblies are the aft skirt, the frustum, and the forward skirt and associated components. Subassemblies which are incorporated into the SRB components are the separation motors, the ordnance ring structure, the parachute canister, the Thrust Vector Control (TVC) system, and the Integrated Electronics System.

b. TPS Area for Solid Rocket Motors (SRM's). Directly behind (west of) the assembly and checkout cells, on the first level, is a closed area designed and equipped for the spray-application and oven-curing of the Marshall Sprayable Ablator (MSA) compound to external surfaces of SRB components. This area also contains the facilities for storing, cutting, applying, and bonding the cork-based ablative protection that is applied to selected surfaces of the SRB and Marshall Trowelable Ablator (MTA) applied for closeout operations.

The second level houses the dry materials and equipment for formulation of the MSA spray-on coating. Solvents are stored in tanks outside the VAB and are pumped to the second level, as needed. Location of this room directly above the TPS application area enables gravity feed of the ablative compound to the spraying equipment through piping and flexible lines. Adjacent to the mixing room is an air-conditioned area for receiving and storing working quantities of dry bulk MSA ingredients. Other facilities on the second level include the console room for the LPS, which will monitor and control checkout of SRB components in the assembly and checkout cells on the first level, and a service room and offices.

D.5.4.1 Substances. The following solids, liquids, and gases will be present and used for production, cleaning, and test, will be generated by operations, or will be present in SRB components.

Solids

Phenolic Microballoons	Chopped glass fibers
Glass microspheres	Milled glass fibers
Separation motor ordnance	Bentone 27 (suspensoid)

Liquids

Epoxy polyurethane resin	Hydraulic fluid
Perchloroethylene	Paint
Methylene chloride	Catalyst (methylene-dianiline and meta-phenylene diamine)
Ethyl alcohol	Deionized water
Acetone	Potable water

Gases

Gaseous helium	Compressed air
Gaseous nitrogen	Solvent fumes

Also present to some degree may be dust and debris agitated by air-bearing moving platforms, and particulates from brushing and sanding of the cured MSA compound.

D.5.4.2 Environmental Impact. Operations in the mixing room and in the paint spray booths will generate toxic fumes and require use of caustic substances. To prevent injury to personnel and to the outside environment, the facility has been equipped with a high-volume, point-to-point exhaust system for capture of fumes and particulates, and with protective clothing and breathing apparatus to protect personnel from contact with contaminated atmosphere or caustic substances. Fumes collected by the exhaust system will be filtered and diffused with air before being released to the atmosphere through a 61-meter (200-foot) stack. All wastes will be collected and removed in closed containers for suitable disposal. Noise generated by this facility will be consistent with light commercial operations as augmented intermittently by the air-handling equipment and the cranes.

D.5.4.3 Hazardous Operations. A hazardous operation will take place when the separation motors are lifted and installed and, again, when the completed assembly is moved. During such operations, all but authorized and certified personnel will be dismissed from the area. A degree of hazard will exist when helium and gaseous nitrogen lines are connected and disconnected for test and checkout purposes. While these operations do not necessitate evacuation of personnel, the area will be restricted to essential, trained operators.

A hazardous operation will take place periodically when the spray-painting equipment is cleaned and flushed. The solvent used will be a mixture of alcohol and acetone. All operations will be performed by personnel wearing protective clothing and equipment and all waste products will be collected in closed containers for subsequent controlled disposal.

D.5.4.4 Unplanned Events. An accident can occur in the RSF as a result of equipment failure or human error. Dropping of a separation motor, depending on distance of the drop and point of impact, could cause ignition. The degree of damage resulting would depend on the orientation of the activated motor. A worst-case combination of proximity to personnel and direction of blast or motor travel could result in serious or fatal injury.

Ignition of cleaning compounds in the paint-spray booths would damage equipment and endanger personnel. Inhalation of noxious vapors and eye or skin contact with caustic substances would be injurious to personnel.

Periodic inspection and recertification of lifting equipment, access platforms, and holding structures preclude equipment failure. Procedural safety regulations coupled with strict and constant supervision will reduce the possibility of human error. Design features providing maximum safety include separate exhaust systems for each spray booth, firex systems for water deluge in the event of fire, and remote control spray equipment to eliminate personnel exposure to hazards. The entire facility has been designed expressly for this operation and incorporates the best practical safeguards.

In the event of mishap, and as required, a sprinkling system and firefighting equipment and personnel would contain the damage to the extent possible. Eyewash and shower stations are available for immediate use by endangered personnel who would subsequently receive medical examination and treatment.

D.5.5 VAB SOLID ROCKET BOOSTER AND EXTERNAL TANK CHECKOUT CELLS. In High Bay 4, ET's are stored and processed, SRB segments are received and staged, and SRB aft booster assemblies are built up. One ET can be stored and another serviced in the two high bay cells. A total of eight SRM segments can be stored simultaneously (two aft, two forward, and four center segments).

Components of the SRB aft booster assembly include:

a. Aft skirt with four separation motors installed

b. Aft segment

c. Nozzle extension with linear-shaped charge installed

d. ET attach and stiffener rings

e. SRB/ET struts with explosive bolts

D.5.5.1 Substances. The following solids, liquids, and gases will be present in the area:

Solids

SRB propellant	TPS tiles
Detonating devices	TPS inter-tile sealant
Linear-shaped charges	TPS foam

Liquids

Potable water	Hydraulic fluid

Gases

Gaseous helium	Compressed air
Gaseous nitrogen	Exhaust fumes (vehicles)

D.5.5.2 Environmental Impact. Air quality will be temporarily and intermittently degraded by the arrival and departure of service vehicles. Very small amounts of gaseous helium may be released during connection and disconnection of lines. These amounts will rapidly disperse in the atmosphere through ceiling manifolds. Gaseous nitrogen used to pressurize the ET during leak tests will be vented to atmosphere. Water quality will be unaffected because no liquid pollutants are generated. Solid wastes from TPS application will be collected and disposed of by approved methods. The level of noise generated by overhead cranes and service vehicles will be consistent with past and present similar activities in the VAB.

D.5.5.3 Hazardous Operations. Transportation, reorientation, and suspension of massive apparatus are inherently hazardous operations. Personnel who manipulate the tag lines which guide suspended equipment into precise position will be closely monitored by safety officials, as will personnel working in the upper levels of the VAB. All movement and emplacement of equipment containing explosive devices will be performed with strict observation of safety regulations. A comprehensive list of safety regulations, applicable particularly to operations in the High Bay 4 area, is continuously monitored and enforced to forestall human error. KSC/NASA mandated inspections and recertification of all movable service and access structures and all lifting devices reduce the possibility of equipment failure to a minimum.

D.5.5.4 Unplanned Events. A worst-case unplanned event would be ignition of one or more of the SRM segments in the VAB which could result in major destruction of property, widespread environmental damage to flora and fauna, and injury and loss of human life. This is an extremely unlikely event, as shown by comprehensive tests and analyses made by manufacturers of solid rocket propellant, by facilities that regularly use solid rocket boosters (other than NASA), and by NASA (including numerous grants to scientific university groups and commercial laboratories). As a result of these investigations, six situations have been identified which could cause unplanned ignition, all of which have a probability of one in a million, or less, of occurring.

a. Friction between hard surfaces

b. Impact between hard surfaces

c. High-velocity impact of an object on the grain (propellant)

d. Excessive heating of grain or a portion of it

e. High-energy electrostatic spark discharge

f. Reaction with incompatible substances

With the sources of potential accidents so identified, regulations and equipment have been devised which reduce the probability of unplanned ignition even further. Details of this mishap are given in 5.10.2.2.

An accident of lesser magnitude, but equally undesirable, could result from rupture of a high-pressure gaseous helium or nitrogen line. Some damage to equipment or facilities would result; the escaped gases would disperse harmlessly into the atmosphere. Personal injury is a remote possibility and would require a remarkable combination of proximity and direction to be damaging. The consequences of such an event would be immediate shutdown of the line, prompt action by safety personnel present during hazardous operations, and subsequent medical care. A detailed investigation would be conducted to analyze the cause and to institute methods to prevent a recurrence.

D.5.6 VAB SHUTTLE ASSEMBLY AREA. During preparations for a Shuttle launch, the Mobile Launcher Platform (MLP) will be stationed in High Bay 3. The MLP provides the movable base for buildup and completion of the two SRB's, erection of the ET for mating with the SRB's, and erection and mating of the Orbiter with the ET/SRB assemblage. Installation of items of ordnance will be accomplished and final purge and checkout procedure will be completed.

D.5.6.1 Substances. The only substances present in High Bay 3 other than the solids, liquids, and gases in the Space Shuttle's sealed systems will be gaseous nitrogen and gaseous helium for test and purge, potable water for fire control, conditioned air for Environmental Control Subsystem (ECS) maintenance, and small ordnance devices.

D.5.6.2 Environmental Impact. Operations in this facility will generate no significant environmental impact. Air quality will be temporarily and intermittently degraded by arrival of the Crawler Transporter, by MLP and Crawler Transporter mating, and by Crawler Transporter departure with the MLP.

Exhausts generated by the Crawler Transporter's diesel engines will be dispersed to atmosphere through the VAB roof vents and the open doors. Very small amounts of gaseous helium and gaseous nitrogen will be released by connection/disconnection of lines and will be allowed to disperse in the atmosphere. Water quality will be unaffected because no liquid pollutants will be generated. The noise level will occasionally be augmented by the Crawler Transporter engines.

D.5.6.3 Hazardous Operations. Major operations in this facility are concerned with transfer, erection, positioning, and mating of the SRB/ET/Orbiter configuration. Final checkout requires the use of gaseous helium and gaseous nitrogen test lines. All of the foregoing operations entail a degree of hazard. The possibility of mishap due to human error is reduced to a minimum by the vigilant supervision of safety and supervisory personnel. Mishap due to equipment failure is made extremely unlikely by KSC/NASA mandated periodic inspection and recertification of all material handling equipment.

D.5.6.4 Unplanned Events. Since the High Bay 3 and the High Bay 4 areas are contiguous with shared transfer aisle space, the description of D.5.5.4 is applicable to this section.

D.5.7 MOBILE LAUNCHER PLATFORM. The MLP is designed to provide a base upon which components of the Space Shuttle can be erected and transported and from which the Space Shuttle can be launched. Environmental impact resulting from prelaunch activities is discussed in D.5.8; this section is confined to environmental impact resulting from operations in the VAB.

D.5.7.1 Substances. Procedures for inspecting and testing interface connections to the two tail service masts on the MLP require the use of gaseous nitrogen, gaseous helium, Freon 21, and compressed air. Hydraulic fluid is the only liquid used; no solid chemicals will be used.

D.5.7.2 Environmental Impact. This operation is expected to produce no significant environmental impact. Water quality will not be degraded because no contaminated liquids will be generated. Air quality will be essentially unaffected by the occasional small amount of gaseous nitrogen or gaseous helium that might escape to atmosphere during connection and disconnection of lines. No solid wastes requiring disposal will be produced. Noise will be generated by overhead cranes, hydraulic units, and by the Crawler Transporter emplacement activities in preparation for movement to the launch pad at Complex 39. This noise will be intermittent, of short duration, and will be consistent with light industrial activities.

D.5.7.3 Hazardous Operations. Physical hazards are posed for personnel working in the confined quarters of the lower levels of the MLP. Low ceilings, overhead lines and structures, and congestion of equipment dictate the requirements for hardhats. All impinging construction and impediments are highlighted with signs and distinctive paint stripes, so a short period of indoctrination and increasing familiarity with the surroundings should reduce the potential for personnel injury.

D.5.7.4 Unplanned Events. A worst-case unplanned event would be rupture of a high-pressure line or a hydraulic fluid spill. Only if a person were standing directly in front of, and close to, the point of rupture would injury result. Rupture of a high-pressure line is extremely unlikely because panels monitor all working pressures and these are well below burst pressures. A more conceivable, but unlikely, unplanned event would be a bump or a fall sustained by personnel, perhaps resulting in a broken bone. First aid equipment is immediately available throughout the area and subsequent medical examination and treatment would be administered. Large amounts of gaseous nitrogen are used on the MLP during scheduled operations. A series of insignificant releases or a line leak could result in a sufficient accumulation of gaseous nitrogen to create an oxygen deficiency in the breathing air. To preclude such an event, monitors are located throughout the MLP which will emit audible and visual alarm signals if the oxygen content of the breathing air falls below a predetermined level.

D.5.8 LAUNCH PAD A, COMPLEX 39. Launch Pad A, at Complex 39, has been extensively modified and is now being prepared for launching the first Space Shuttle from KSC. Major installations are the Fixed Service Structure (FSS), the Rotating Service Structure (RSS) hinged from the FSS, and the launch pad itself. Other components include the surrounding service and support structures, supply lines, tanks, mobile tankers, and electrical distribution facilities.

Major activities at Pad A include vehicle checkout and servicing, payload preparation (with optional installation at the pad of those payloads requiring vertical mating operations), and launch.

The following details include all activities up to the start of terminal countdown but excluding engine ignition and launch.

D.5.8.1 Substances. The following solids, liquids, and gases will be present and some will be used for flush, purge, checkout, servicing, or safety and life support systems.

Solids

Solid rocket propellant	Discarded packaging materials
TPS insulation residue	

Liquids

Monomethylhydrazine	Solutions of sodium hydroxide
Nitrogen tetroxide	Solutions of sodium sulfite
Hydrazine	Solutions of citric acid
Liquid oxygen	Hydraulic fluid
Isopropyl alcohol	Potable water

Gases

Gaseous nitrogen	Gaseous helium
Gaseous hydrogen	Compressed air
Gaseous oxygen	Conditioned air
Freon 21	Ammonia
Freon 12	

Exhaust fumes from service vehicles (internal combustion)

D.5.8.2 Environmental Impact. All operations employing liquids and gases are performed under "closed-loop" conditions. Releases of noxious and toxic fumes will be directed to scrubbers which incorporate the most improved methods of neutralization and purification before release to atmosphere. Large quantities of hydrogen gas released during fill operations will be piped to a burn pond and ignited, producing water. Small quantities of hydrogen gas will be directed to the top of the FSS for venting to atmosphere at the 90-meter (295-foot) level.

Contaminated water and flush fluids produced by prelaunch activities will be trapped in sumps and impoundments for removal and subsequent approved disposal. Consequently, no adverse impact on water quality is foreseen.

Solid waste will consist of empty drums, reels, bottles, and other containers which will be collected, purged, and cleaned as required for reuse, or disposed of at the KSC sanitary landfill.

Noise will be generated by service vehicles and lifting equipment. It will be intermittent and temporary, as service vehicles arrive and depart, cranes are operated, and air-handling and power-generating equipment is active. Noise levels will be consistent with 10 years of prior operations at KSC. An occasional increase in the noise level occurs within the pad in the ECS room when blowers are operating and when the hydraulic charging unit in the pad terminal connection room is activated. The increase in noise level is insignificant outside on the pad, but OSHA regulations dictate the wearing of earplugs by persons inside of these installations.

D.5.8.3 Hazardous Operations. Horizontal and vertical movement of massive equipment creates a potentially hazardous situation. Before such actions take place, safety, traffic, and personnel regulations are enforced and established procedures are strictly observed. The receipt and delivery of hypergolic fluids and of toxic or flammable gases are also potentially hazardous. A safety zone is established and maintained for such operations and precautions are taken to ensure maximum safety for personnel. Constant weather monitoring and forecasts permit restriction or cessation of any operations which would be rendered hazardous by the presence of severe winds or other weather disturbances. Furthermore, computer predictions of transport direction and concentrations of hazardous gases resulting from inadvertent spills/ruptures are provided for each operation conducted.

Hazards warning systems and personnel control systems, including an entry-point badge exchange procedure, are in force 24 hours a day at Pad A. Only qualified, authorized persons are permitted to enter the area and participate in operations.

An accident in this area, of any type, would occur only as a result of human error or equipment failure. Safety regulations, procedures, equipment, and clothing have been designed and are constantly monitored and enforced to forestall human error. KSC/NASA mandated periodic inspection and recertification of equipment serve to reduce the possibility of equipment failure to a minimum. Safety equipment, fire and rescue units, and quick exit and escape facilities are provided wherever their need can be anticipated.

D.5.8.4 Unplanned Events. A worst-case unplanned event would be the deflagration resulting from rupture of the ET and the release of uncontrolled quantities of liquid hydrogen and liquid oxygen. Damage and destruction to adjacent paraphernalia and structures would occur; the surrounding terrain would be scorched and seared, and loss of human life would occur. If fire were to occur, the fireball would be expected to engulf the pad for approximately 10 seconds at 2900°K (4580°F), resulting in vehicle collapse, segment separation, and propellant burn for up to 800 seconds. Extensive facility damage would result, personnel in or on the vehicle would be lost, and flora and fauna in the immediate area of the launch pad would be destroyed. Air quality would be affected by the effluent produced from the fire. Computer simulations of this event have been performed and results show that maximum concentrations of the effluent which might exist beyond the KSC boundaries do not exceed the Public Emergency Limits. The combination of failures, errors in procedures, and departure from regulated operations which would have to take place in concert to result in such an event makes the probability of occurrence extremely low.

A more conceivable, though unlikely, unplanned event would be rupture of a service line, resulting in release of noxious, toxic, or flammable liquid or gas. The consequences of such an event would be a temporary degradation of local atmosphere. Gas releases would escape to atmosphere; liquid spills would be confined by pad construction. Reaction to this type of emergency would include immediate shutdown of the line, followed by cleanup by certified fire and rescue personnel and equipment which remains on standby for such contingencies during each operation. Operational experience over many years of activity indicates that such an event would be rendered safe in the shortest possible time, and impact to the environment would be limited to localized air quality degradation and minor destruction of land and property in the immediate area involved. Following even the smallest event of this kind, investigations would be initiated to discover and correct the conditions which permitted the event to occur.

D.5.9 ASSEMBLY AND CHECKOUT AREA - OPERATIONS AND CHECKOUT (O&C) BUILDING. The south side of the O&C Building is designed and equipped for assembly and checkout of spacelab modules and pallets and to verify that the cargo for a particular flight is compatible in form, fit, and function for horizontal installation in the Orbiter payload bay. Spacelab configurations will be modules and pallets, or pallets equipped with experiments. Cargo Integration Test Equipment (CITE) will be used to perform physical and functional tests. After final approval and acceptance, the cargo will be transported to the OPF.

D.5.9.1 Substances. The following solids, liquids, and gases will be present in the Assembly and Test Area and will be used for cleaning, pressurizing, and testing for environmental control, or will be generated by operations.

Solids

Solid wastes will consist of wood, paper, and cardboard packing and packaging materials.

Liquids

High-pressure water will be present for outside cleaning and for inside fire hoses.

Gases

Gaseous nitrogen
Gaseous helium
Gaseous oxygen
Freon 21
Compressed air

D.5.9.2 Environmental Impact. Air quality will not be degraded because all equipment used will be electrically operated. The gases used for test purposes and for environmental control are confined, and any small releases occasioned by connection or disconnection of lines will dissipate harmlessly in the controlled atmosphere. Solid wastes will not be allowed to accumulate and will be disposed of in accordance with acceptable methods. Water quality will be unaffected. Noise will be at a level normally associated with light commercial activities.

D.5.9.3 Hazardous Operations. Nearly every operation involving movement or lifting of equipment will be associated with large and heavy components. Therefore, a degree of hazard exists for personnel and facilities if mishandling or equipment failure were to cause an impact. Regulated procedures and constant supervisory surveillance will minimize the probability of such a mishap.

D.5.9.4 Unplanned Events. Heavy equipment is used throughout this facility. Therefore, a worst-case unplanned event would be an accident involving dropping a piece of equipment. The result could be extensive damage to the equipment and possible injury or death to personnel. The probability of such an event is made remote by procedures which forbid personnel in a danger area during such moves, and periodic inspection and recertification of service equipment. An unplanned event involving dropping of an experimental package could occur. The results would depend upon the nature of the contents.

D.5.10 VERTICAL PROCESSING FACILITY (VPF). The VPF is located in the building formerly known as Spacecraft Assembly and Encapsulation Facility (SAEF) No. 1. This facility has been modified to accommodate processing and checkout of vertical payloads/cargo. This facility shares the functional CITE checkout equipment with the O&C Building. Processing of vertical and horizontal payloads can proceed simultaneously, but only one CITE program can be conducted at a time. Similar functions are performed in the VPF and the O&C Building Assembly and Test Area with the difference being in the orientation of the cargo.

D.5.10.1 Substances. The following solids, liquids, and gases will be present in the VPF and will be used for cleaning, pressurizing, and testing, for environmental control, will be generated by operations, will be used in the scrubbers, or will be present in the Upper Stages/payloads.

Solids

Solid rocket propellant	Contents of trash containers

[Assuming the presence of a 2-stage Inertial Upper Stage (IUS) in each of the two cells in the facility, maximum quantity of solid rocket propellant present could be 9,525 kilograms (21,000 pounds) in the first stage and 2,722 kilograms (6,000 pounds) in the second stage for a combined total of 24,494 kilograms (54,000 pounds).]

Liquids

Hydrazine	Water (for fire hoses and deluge)
Liquid Freon 21	Solutions of citric acid

[The maximum quantity of hydrazine for the Teleoperator Retrieval System (TRS) could be 683 kilograms (1,505 pounds) in each of four kit tanks and 54 kilograms (120 pounds) in the attitude control core module, for a total of 2,785 kilograms (6,140 pounds).]

Gases

Gaseous nitrogen	Compressed (shop) air
Gaseous helium	Freon 21

D.5.10.2 Environmental Impact. Air quality will be degraded by small amounts of escaped gases, occurring during connection and disconnection of lines. Hydrazine spills will be directed to a 1,360-kilogram (3,000-pound) capacity drain tank equipped with a scrubber to neutralize the fumes before release to the atmosphere. Other spills will be impounded by facility construction and directed to an 18,927-liter (5,000-gallon) tank for subsequent collection by a waste tanker. Solid wastes will be promptly disposed of by approved methods. Noise will be at a level normally associated with light commercial activities.

D.5.10.3 Hazardous Operations. A hazardous operation will take place in the VPF when hydrazine must be loaded into a TRS. To minimize the danger, noninvolved personnel will be dismissed from the area, the hydrazine will be brought to the area by a service vehicle, and SCAPE-suited technicians will perform the operation under strict supervision by safety authorities.

Other hazardous operations will be performed whenever large and heavy components must be moved or lifted. Periodic inspection and recertification of handling equipment will help to minimize the risk of accident due to equipment failure.

D.5.10.4 Unplanned Events. A worst-case unplanned event would be tank rupture followed by ignition of uncontrolled amounts of hydrazine. The ensuing flame and effluent could cause extensive facility damage and could result in injury or loss of life to personnel and wildlife in the immediate vicinity. The mitigating procedures outlined in D.5.2 would immediately be instituted. Another possibility would be accidental ignition of an IUS, with subsequent damage to surrounding facilities.

D.5.11 LAUNCH EQUIPMENT TEST FACILITY. The major installations of the Launch Equipment Test Facility (LETF) are located outside of and adjacent to Building M7-505. Consoles for directing the tests performed are stationed inside the building which is about 0.4 kilometer (1/4 mile) southeast of the O&C Building.

Prior to its installation at the launch complex, or at the VAB on the MLP, the following launch-critical Ground Support Equipment is tested and qualified at this facility:

a. Orbiter Access Arm

b. Tail Service Masts

c. ET gaseous hydrogen vent line and access arm system

d. SRB holddown/support posts system

D.5.11.1 Substances. The following solids, liquids, and gases will be present at the LETF.

Solids

The only solid wastes will be the contents of the trash containers.

Liquids

Liquid nitrogen	Hydraulic fluid
Liquid hydrogen	Potable water

Gases

Gaseous helium	Compressed (shop) air
Gaseous nitrogen	ECS (atmospheric) air
Gaseous hydrogen	

D.5.11.2 Environmental Impact. Air quality will be periodically and intermittently degraded by the exhausts of arriving and departing service vehicles. Released gaseous nitrogen and gaseous helium will quickly disperse in this open-air facility. Gaseous hydrogen releases will be directed to the upper atmosphere through sealed lines to tall vent stacks. Water is used to cool hydraulic units. This water may become contaminated by small leaks of hydraulic fluid. The water flows from a cooling tower, through the cooling chambers surrounding the hydraulic machinery, and ultimately is directed to a sump. The contents of the sump are directed through underground lines to an adjacent, lined, skimmer pond. This pond is bisected by a barrier which skims off any oils present before the water flows under the barrier and is automatically discharged into a drainage ditch. Noise is generated by arriving and departing service vehicles, by the operation of mobile cranes, and by operation of hydraulic pumps. The first two sources present an insignificant increase in the general noise level in the facility area. The operation of the hydraulic pumps generates a significant amount of noise which, however, is muffled by the surrounding concrete modular unit. Personnel required to enter this facility while the pumps are in action must don the earmuff-type noise suppressors supplied per safety regulations. Solid wastes are disposed of by conventional methods.

D.5.11.3 Hazardous Operations. A hazardous operation takes place in this facility when the lines, valves, and connections used to direct the liquid hydrogen to the ET during pad fill are tested. In order to make this operation as safe as possible, this testing takes place only after regular working hours or on weekends when traffic is at its lowest. A 183-meter (600-foot) safety perimeter is installed and monitored at all points by safety personnel and all persons other than those essential to the operations are evacuated from the area. All applicable safety regulations and procedures are continuously monitored and enforced by supervisory personnel. Minor hazardous operations exist and are recognized in the presence of pressurized lines containing liquid nitrogen, gaseous nitrogen, gaseous helium, and hydraulic fluid.

D.5.11.4 Unplanned Events. A serious mishap could occur through the accidental release of uncontrolled amounts of liquid hydrogen. A fire could result which would damage or destroy equipment and present a danger to personnel. The liquid hydrogen is supplied from tankers so the ensuing action would include immediate shutdown of the supply lines, activation of the fire suppression water supply, and rescue and firefighting operations by trained personnel. The occurrence of such an event is unlikely because all hydrogen-related equipment is periodically inspected and recertified in accordance with KSC/NASA regulations. The limited number of personnel in the area would further reduce the possibility of injury. The rupture of any of the fluid or gas-bearing lines could result in equipment damage and a remote possibility of human injury. Shower and eyewash facilities are available for instant use, and medical aid would be promptly administered. The rupture of any of the lines is unlikely because the working pressures are constantly monitored by remote consoles and the safety factor of burst pressure versus working pressure is at least four to one.

D.5.12 CONVERTER/COMPRESSOR FACILITY (CCF). The CCF consists of the lines, valves, compressors, consoles, and panels for receiving, pressure-regulating, and distributing gaseous nitrogen and gaseous helium. This facility delivers the gases at desired pressures to the ECS's at the pads and to the storage batteries at the VAB, the MLP, and at each launch complex. All equipment in the CCF is powered by electricity.

D.5.12.1 Substances. The following solids, liquids, and gases will be present or will be generated by the CCF:

Solids

No chemical solids are used or generated by this facility. Solid waste will consist merely of the contents of trash containers.

Liquids

Potable water is present in this facility for fire hoses and for personnel use. Lubricating oil also is present.

Gases

Gases present are gaseous helium and gaseous nitrogen which pass through the facility for pressure regulation and distribution.

D.5.12.2 Environmental Impact. This facility will produce no significant environmental impact. Water quality will not be degraded because no contaminated liquids will be generated. Air quality will be degraded for short periods by the arrival and departure of service vehicles. All operations concerned with gaseous nitrogen and gaseous helium are performed under confined conditions. Solid waste in the form of paper and cardboard will be removed for compaction and disposal. Noise will be limited to that generated by service vehicles.

D.5.12.3 Hazardous Operations. The hazardous operations connected with the normal activities in the CCF involve high-pressure gases in large quantities. Approved procedures, trained personnel, and extensive equipment maintenance combine to reduce risks to the minimum obtainable.

D.5.12.4 Unplanned Events. A worst-case unplanned event in this facility would be the rupture of a high-pressure (6000 to 7000 psig) line or failure of a seal. The results could be damage to adjacent equipment or injury to personnel. The probability of such an event is remote because pressures are continuously monitored and regulated; burst pressures are four times greater than operating pressures. Atmospheric dispersion would occur within controlled operational areas. No permanent environmental damage would result.

D.5.13 SRB RECOVERY AND DISASSEMBLY FACILITY. An SRB Recovery and Disassembly Facility will be constructed to receive, safe, clean, and disassemble segments and components of retrieved SRB casings. Also received are the retrieved parachutes and the nozzle plug which are immediately forwarded to other facilities for refurbishment.

D.5.13.1 Substances. The following solids, liquids, and gases will be present as residuals in the SRB, will be used for cleaning, or will result from operations:

Solids

MSA and MTA (see D.5.4)	Metallic discards (nuts, bolts, rivets)
Cork ablative coating	Marine growth (barnacles, sand, seaweed)
Charred propellant	Contents of trash containers

Liquids

Wash water	Hydraulic fluid
Detergents	Hydrazine

Gases

Gaseous nitrogen	Compressed air

D.5.13.2 Environmental Impact. Of the areas of environmental impact (air, water, land, noise) which could be affected by operations at this facility, degradation of water quality is the primary concern. The composition of the waste water will not be available until analysis is performed after the first retrieved SRB is processed. For that reason, provisions are being made to ensure that no SRB waste water is released to the environment until it has been rendered acceptable for discharge through the associated land spreading system. Waste water will be directed through troughs and sumps to individual (MSA, propellant, or surfactant) tanks for analysis and field disposal. Air quality will be slightly and intermittently degraded by exhaust emissions from arriving and departing service vehicles. Noise levels will be periodically augmented by operations and by service vehicles but not to a significant degree. Noise produced by occasional hydrolaser stripping may require ear protection. Solid wastes will be removed to the sanitary landfill or incinerated, as required.

D.5.13.3 Hazardous Operations. Operation of the hydrolaser to strip MSA from the SRB could present a hazard to personnel because of the high velocity of the water jet; [57 liters (15 gallons) per minute at 58,590 kg/m^2 (12,000 psi)]. To preclude injury to personnel, a safety perimeter will be established and maintained throughout this operation. Other hazardous operations include removal of up to 7.6 liters (2 gallons) of hydrazine from the TVC system and removal of the linear-shaped self-destruct charge. These operations will be performed by SCAPE-suited personnel.

D.5.13.4 Unplanned Events. A worst-case unplanned event would be ignition of the residual hydrazine in the TVC. Equipment could be damaged or destroyed and a small toxic cloud would develop. Attendant safety personnel would determine the probable course of the cloud and evacuate people in the danger zone as rapidly as possible. Meanwhile, firefighting equipment would be used to extinguish the blaze. Contaminated fluids would be impounded and collected as described in D.5.13.2. Accidental activation of the linear-shaped self-destruct charge would result in flying debris which could injure personnel in the immediate vicinity. Occurrence of such an event is improbable because the charge is safed as a routine part of SRB recovery. A more plausible but unlikely event would be rupture of a gaseous nitrogen line. An event of this type could injure personnel and damage equipment. To preclude such an event, all lines are inspected and tested to verify a burst pressure at least four times greater than operating pressure.

D.5.14 LIFE SCIENCE FACILITY. Hanger L, located at the CCAFS, will be modified to satisfy Life Science experiments requirements. Basically, this facility will provide for preflight receipt and handling of experimental flora and fauna specimens, inflight synchronous ground control of flight specimens and control specimens, and post-flight examination and disposal.

D.5.14.1 Substances. The following solids, liquids, and gases will be present in this facility.

Solids

Cage litter	Carcasses
Animal excrement	Discarded containers

Liquids

Potable water	Liquid radioisotopes
Distilled water	Medicines

Gases

Propane	Anesthetics
Conditioned air	Compressed air (ECS)

Clarification of the purpose and use of some of the foregoing substances may be in order. The cage litter will consist of commercial wood chips in removable trays for catching the droppings of the caged animal above through a grilled floor. The propane gas will be provided for laboratory Bunsen burners. The compressed air (ECS) is temperature and humidity controlled and will provide positive pressure for certain areas; a vacuum system will provide negative pressure in the area where the radioisotopes are used.

D.5.14.2 Environmental Impact. Animal carcasses containing radioactive isotopes will be frozen, collected with other radioactive wastes, and shipped to an offsite Federal repository. An incinerator, designed and certified to meet all applicable regulations with regard to effluents and particulates, will be used to dispose of cage litter and some animal carcasses. All liquid wastes will be directed to the sanitary sewage system. Other solid wastes will be collected for normal trash collection and disposal. No noise above ambient levels will be generated other than arriving and departing service vehicles.

D.5.14.3 Hazardous Operations. The only operation in this facility that could remotely be called hazardous would be handling of live specimens; a possibility of being scratched or bitten exists. However, since the only people handling the specimens will be trained and experienced biologists, this would be very unlikely. Moreover, medical attention and supplies will be immediately available. No environmental impact would ensue.

D.5.14.4 Unplanned Events. A significant unplanned event would be a fire. Specimens could be destroyed and radioisotope fluid could be vaporized. Health physics specialists of the KSC Fire and Rescue Squad would be called to extinguish the fire. Environmental impact would be limited to the immediate premises and no long-term effects would result.

Another unplanned event could be the escape of specimens to the surrounding area. To avert such an event, all flora and fauna so used will be inventoried, secured, and ultimately disposed of in an enviromentally acceptable manner.

D.5.15 PARACHUTE REFURBISHMENT FACILITY. The Parachute Refurbishment Facility consists of two areas. One is an outdoor, covered area and the other is a one-story, air-conditioned building with low and high bay equipment. The function of the facility is to receive, temporarily hold, refurbish, assemble, and ship the decelerator subsystems for the SRB. The subsystems and associated hardware include the main and drogue parachutes, deployment bags, flotation devices, location aids, ordnance devices, support structure, plenum chamber, and altitude switch and tubing.

D.5.15.1 Substances. The following solid, liquids, and gases will be present in this facility and will be used for refurbishment activities or will be the discarded residue from replacement of components.

Solids

Solid wastes will consist of discarded hardware and fabrics.

Liquids

Liquid wastes will consist of potable water and polluted rinse and wash water. No additives (i.e., surfactants, bleaches, softeners) will be used.

Gases

Compressed (shop) air will be present.

D.5.15.2 Environmental Impact. Air quality at this facility will be briefly and intermittently degraded by exhaust effluents from arriving and departing service vehicles. An insignificant increase in the ambient noise level will result from operation of service vehicles, forklifts, overhead cranes, and laundry driers. Wash and rinse water, polluted with salt and some organic residues (e.g., seaweed), will be directed to a holding tank for subsequent testing, dilution, and discharge to a drainage ditch when acceptable levels of purity have been obtained.

D.5.15.3 Hazardous Operations. There are no hazardous operations associated with normal procedures at this facility. The degree of hazard usually connected with the presence of detonating devices is minimal in this vicinity because the leads of these devices are always shorted together for safe handling. No testing or continuity checks of these devices will be performed here.

D.5.15.4 Unplanned Events. Since operations at this facility are essentially similar to those of a commercial laundromat, any unplanned event could only have its origin from an outside source.

D.5.16 LOCOMOTIVE MAINTENANCE. A locomotive maintenance facility will be provided for servicing two 746-kilowatt (1,000 horsepower) diesel-electric switching locomotives. Operations will include refueling, lubrication, washing, cleaning of components, replacement of small components, compressed air cleaning of electrical components, application of liquid insulation, servicing of batteries, and painting.

D.5.16.1 Substances. The following solids, liquids, and gases will be present and will be used for locomotive maintenance or will be produced by operations.

Solids

Lubricating greases	Contents of trash containers

Liquids

Diesel fuel	Wash water
Solvents	Paint
Liquid insulation (glycol)	Paint thinner
Lubricants	

Gases

Compressed (shop) air

D.5.16.2 Environmental Impact. This facility will produce environmental impact comparable to a small service garage. Small spills and drips, as well as the water from washing and rinsing, will disperse into the surrounding soil. Air quality will be minimally degraded by diesel exhaust during arrival and departure of the locomotives. Noise generated by the diesel motors will be intermittent. Solid wastes will be taken to the KSC sanitary landfill.

D.5.16.3 Hazardous Operations. There are no hazardous operations performed in this facility. The 11 types of lubrication used daily, weekly, monthly, quarterly, semiannually, and/or annually will support combustion but are not highly flammable. The paints and thinners are volatile and will be used in a flame-restricted area.

D.5.16.4 Unplanned Events. It is possible that a violation of regulations and procedures could result in a fire. The KSC fire department would at once be summoned and the fire would be suppressed by the means and chemicals indicated for the flammable involved. Damage would be slight, with little or no danger to personnel, and environmental impact would be localized and very temporary. Subsequent cleanup would remove and dispose of residues from the mishap.

D.5.17 BARGE AND TUGBOAT. KSC owns and operates a 20-meter (65-foot), 448-kilowatt (600-horsepower) tugboat and a 79-meter (260-foot) flatdeck barge which are used principally in the Banana River and Port Canaveral area. The barge and tug are berthed either at the VAB dock or at Port Canaveral, depending on the operational needs.

D.5.17.1 Environmental Impact. A professional marine towing company provides, under contract, all manpower, repairs, and materials; major repairs and maintenance are performed in an offsite shipyard. Local maintenance is confined to minor mechanical work and above-water painting. During movement of the vessels, speed is adjusted to generate a minimum of wake to avoid disturbance of sea life and retaining walls.

D.5.17.2 Hazardous Operations. Beyond normal hazards associated with marine transport activities, there are no special hazardous operations performed by this equipment. During periods of violent winds and heavy seas, the barge and tug are moored in protected areas.

D.5.17.3 Unplanned Events. A worst-case unplanned event would be a collision between the barge or tug with another vessel, with bridge supports, or with a manatee. Both vessels comply with applicable U.S. Coast Guard regulations governing equipment and operation, and speed of travel is restricted. Therefore, an accident of this type is extremely unlikely.

D.5.18 SHUTTLE LANDING FACILITY. The Shuttle Landing Facility (SLF) is a 5-kilometer (3-mile) long runway located northwest of the VAB. Included in the equipment stationed at this facility will be:

Landing Aids Control Building

Microwave Scanning Beam Landing System

Orbiter Mate/Demate Device

Mack Tractor (2)

Fire Truck (2)

Ambulance

Convoy Commander's Vehicle

Rescue Vehicle

T-0 (Wheel-Stop) Umbilical Access and Stair Truck (2)

Crew Access Truck

Package Sewage Treatment Plant

D.5.18.1 Substances. The following solids, liquids, and gases will be present at the SLF:

Solids

The only solid wastes present will be the contents of trash containers.

Liquids

Jet fuel
Aviation gasoline
Protein foam
Lubricating oil
Potable water

Gases

The only gases present will be the exhaust fumes from landing and departing aircraft, from service vehicles, and possibly ammonia vapors from the Orbiter.

D.5.18.2 Environmental Impact. Air quality at the SLF will be periodically degraded by the exhaust effluents of landing and departing aircraft and of service and safety vehicles. Landing of the Orbiter will temporarily degrade air quality (ammonia vapors) but no environmental impact is expected. Flushing and rain action will wash fuel and oil residues off the runway and into the surrounding moat. The contents of the moat will be impounded by a removable dam. If analysis of the contents of the moat indicates an acceptable level of purity, the dam will be opened to allow release to the surrounding drainage area. When required, the contents will be chemically treated before release. Noise generated by aircraft and vehicles will be consistent with that of a small commercial airfield. Sonic boom will occur during Orbiter landing approach.

D.5.18.3 Hazardous Operations. Aircraft landing and takeoff activities at this facility entail only the degree of hazard normally associated with such operations. The entire sequence of Orbiter landing is considered a hazardous operation because of the characteristics of the vehicle. The equipment listed in D.5.18 is provided to reduce these hazards to a minimum.

D.5.18.4 Unplanned Events. A worst-case unplanned event in connection with the SLF would be Orbiter crash landing or careening off the runway. Depending on the degree of damage incurred, residual quantities of hydrazine could be released and injury or death of crewmembers or passengers could occur. Every facility for prevention of such an occurrence has been provided and the equipment of D.5.18 will be standing by to take immediate action to ameliorate the results.

Engineering studies have shown that the Orbiter is not significantly threatened by the potential bird strike hazard at KSC. However, conventional aircraft which could ingest birds into the engines or suffer windshield shatter from a bird strike may be susceptible. Studies are underway at KSC to quantify and better define the potential for bird/aircraft collision and to evaluate methods for mitigating this problem area.

D.5.19 HYDRAULIC POWER UNIT TEST FIRING. The Hydraulic Power Unit (HPU) is a part of the TVC system of the SRB. In operation, hot gases generated by catalyzed hydrazine actuate a turbine which provides hydraulic power to the TVC for SRB guidance. Test firings of the HPU to verify performance before installation in the SRB will be performed in Building M7-1411. This L-shaped building, in the vicinity of the HMF Complex, is approximately 14 by 14 meters (45 by 45 feet) with a 3- by 9-meter (10- by 30-foot) dogleg extension.

D.5.19.1 Substances. The following solids, liquids, and gases will be present and will be used for inspection and servicing the HPU systems, for test firing, or will result from operations.

Solids

Contents of trash containers

Liquids

Hydrazine
Hydraulic fluid
Potable water

Gases

Hydrogen emissions
Nitrogen emissions
Ammonia emissions
Gaseous nitrogen
Gaseous helium
Compressed (shop) air

D.5.19.2 Environmental Impact. Preparations for HPU test firings will include placement of a hydrazine service cart outside of the facility. The cart will be connected to the aft skirt quick-disconnect service points. Facility gaseous nitrogen or gaseous helium will be used to pressurize the cart and fill the dual HPU system with up to 10 kg (22 lb) of hydrazine (each module) for a total of 20 kg (44 lb). After fueling, the lines will be disconnected and the cart will be removed to a safe distance. All operations requiring hydrazine servicing and deservicing will be performed by SCAPE-suited personnel. Control, monitoring, and recording of test firing will be provided by an instrumented control van stationed at the adjacent trailer pad and connected by cables to the aft skirt systems.

During the test firing, the north, east, and south doors of the facility will be open and the 566 m^3 (20,000 ft^3) per minute roof exhaust fan will be operating. At actual firings, emissions produced by the dual HPU systems over a period of 166 to 180 seconds will be:

Hydrogen	44% of emissions	46.56 m^3 (1,644 ft^3)
Nitrogen	30% of emissions	31.78 m^3 (1,122 ft^3)
Ammonia	26% of emissions	27.53 m^3 (972 ft^3)

Total of dual system emissions 105.87 m^3 (3,738 ft^3)

Water quality will not be degraded because no pollutants will be released to the water table or the sewage system. Air quality will be briefly degraded by emissions from arriving and departing vehicles and during the 3-minute, maximum, release of the test firing emissions listed above. These emissions which will be exhausted through the 18-meter (58-foot) high roof fan will disperse readily in the atmosphere with insignificant effect. No noise of a significant level will be produced by test operations.

D.5.19.3 Hazardous Operations. The entire sequence of test firing and checkout of the HPU system entails hazardous operations. The aft skirt section of the SRB will be moved from the low bay area of the VAB to the HPU test stand in M7-1412 on a transport dolly. Procedures for averting a traffic accident during transportation are discussed in D.5.2.3. At the test facility, the skirt section, mounted on the transport dolly in flight attitude, will be positioned in the test cell, using an overhead crane. Placement of this massive equipment presents hazards which are overcome by constant supervision by safety personnel and periodic inspection and acceptance of facilities to ensure against equipment failure. The skirt section protective cover will be removed and the HPU systems will be inspected, purged, and leak-tested using facility gaseous nitrogen. Small leaks of gaseous nitrogen which may occur during connection and disconnection of lines will be dissipated through the roof vent. SCAPE-suited personnel will fuel the HPU modules with hydrazine from the service cart. All personnel except the SCAPE-suited technicians will be evacuated from the test cell during these operations. The HPU exhaust gases generated during the remotely controlled firing will exit the nozzle at a temperature of approximately 427°C (800°F). Hydrazine spills of less than 3.8 liters (1 gallon) will be absorbed in waste material and disposed of in an incinerator. Larger spills will be removed by an aspirator and directed to a hydrazine waste tanker stationed on a bermed pad adjacent to the facility. An operational intercommunication system and an area warning system will be used to establish a safety perimeter during all hazardous operations.

D.5.19.4 Unplanned Events. A worst-case unplanned event would be a line rupture resulting in the release to atmosphere of approximately 20 kg (44 lb) of hydrazine. Human life would not be endangered because the only people in the vicinity would be SCAPE-suited. Also, the bermed pad would confine the spill. However, the resulting fumes, depending on wind direction and velocity, could prove harmful or even lethal to any flora or fauna enveloped by the emissions. The aspirator would immediately be employed to remove the spill and direct the pollutants to the tanker and, as required, the pad deluge system would be activated to reduce the hydrazine concentration. No long-term effects are expected.

D.6 SPACELAB OPERATIONS

The processing of Spacelab modules at KSC involves experiment and equipment integration, rack buildup, and module assembly. These tasks require electrical, mechanical, and instrumentation work, lifting and moving efforts, and test/checkout operations typical of aerospace assembly work.

Only a minimum air quality impact due to vehicle and transporter operation is produced. There are no water quality impacts associated with Spacelab operations. Noise is limited to occasional small handtool use and crane and transporter operations consistent with light industrial activities. OSHA noise limits are never exceeded. Standard solvents and cleaning fluids, shop compressed air, oxygen, and gaseous nitrogen for purges present the only hazards from the presence and use of chemical substances. All spills and wastes are collected and transferred to KSC repositories for disposal by appropriate methods. Since the Spacelab is a nonpropulsive cargo for the Space Shuttle, it is integrated into the STS at the OPF.

D.7 UPPER STAGES OPERATIONS

The inertial upper stage (IUS) and the Spinning Solid Upper Stage (SSUS) are propulsive stages which are assembled in dedicated facilities at CCAFS and KSC and integrated into the Space Shuttle at the launch pad. Both types of upper stages are mated with automated payloads, serviced, and checked out prior to STS integration operations. Because an IUS is considerably larger than an SSUS, this discussion is directed towards impacts involving the IUS. However, operations for the SSUS are of a similar nature and will produce impacts of the same kind but of significantly less magnitude.

D.7.1 IMPACT ON AIR QUALITY. NASA ground operations for the IUS program will result in minimum air quality impacts. Generally, impacts will be the result of emissions from project-related automobile, truck, aircraft, and rail traffic. Discharges of gaseous oxygen, hydrogen, nitrogen, and helium are also expected in minimum amounts from normal servicing operations. A catastrophic accident during launch operations, or a production or processing mishap, could produce significant localized air pollution within the controlled area.

Local onbase air quality could be substantially altered for a short time following an uncontrolled SRM ignition and burn during final assembly and ground operations. This would cause an impact of great importance due to the hazard for operations personnel and the potential damage that could occur to property. SRM combustion products are shown in table D-3. Of the major detectable exhaust products, aluminum oxide, carbon monoxide and hydrogen chloride are recognized as air pollutants presenting a potential hazard in the lower atmosphere, depending on their concentrations.

Table D-3. Solid Rocket Motor Exhaust Products at Nozzle Exit Plane

Combustion Product	Weight Fraction (%)	Largest Unit IUS (kg)	Stage Scout (kg)	One SRM Titan III-D (kg)
HCl	21.10	9,954	9,674	197,074
H_2O	4.85	2,288	3,347	68,186
H_2	2.73	1,287	1,149	23,400
CO 1/	26.19	12,357	13,064	266,124
CO_2	2.89	1,365	1,168	23,783
N_2	8.23	3,882	3,893	79,308
Al_2O_3	34.01	16,045	14,171	288,659
Other	-	-	613	12,467
	100.0	47,178	47,079	959,001

Scout and Titan SRM's are shown for comparison.

1/ As the result of observations and analyses, it is anticipated that CO generated by the SRM's will oxidize to CO_2 due to the initial high temperature of the CO and the abundant presence of oxygen in the lower atmosphere.

Because the IUS is much smaller than the Space Shuttle SRM but similar in type, calculations show that ground-level concentrations for exhaust products under catastrophic failure would not exceed public exposure limits.

In the remote event of a catastrophic accident at the launch pad, the IUS would contribute hydrazine and SRM combustion products to those released by the Space Shuttle. The maximum quantities of IUS propellants would occur during missions using the three unit IUS [21,572 kilograms (47,558 pounds) of solid propellant and 38 kilograms (84 pounds) of hydrazine] and during missions using a Department of Defense twin-stage IUS [19,414 kilograms (42,800 pounds) of solid propellant and 143 kilograms (316 pounds) of hydrazine]. These quantities constitute about 2 percent of the solid propellant contained in the Solid Rocket Boosters and 1 percent of the hypergolic propellants contained in the Space Shuttle Orbiter. Calculations for air quality in the event of an on-pad fire have concluded that concentrations would be higher than for normal launches but still within allowable limits. Because of the small contribution the IUS would make to the overall air pollution, its impact is considered insignificant.

D.7.2 IMPACT ON WATER QUALITY. IUS operations are not expected to produce an impact on water quality. Accidental spills or leaks of contaminating substances will be totally contained and appropriately treated. Liquid wastes will be processed through existing approved systems for disposal. There is no planned discharge to the water table or to surface waters.

D.7.3 IMPACT ON LAND QUALITY. IUS operations are performed in existing facilities which have been modified to meet STS requirements. Therefore, no impact was imposed on land quality. A roadway extension from the Air Force Solid Motor Assembly Building to the Complex 39 launch area has been suggested, but no NASA plans exist for this construction. If this suggestion is implemented in the future, impacts on terrain and water will need to be assessed as part of the decisionmaking process.

D.7.4 IMPACT ON NOISE LEVELS. Noise will consist of that produced by assembly and mating activities, lifting devices, and operations using small handtools. No adverse noise impacts are expected to result from normal IUS operations.

D.8 AUTOMATED PAYLOAD OPERATIONS

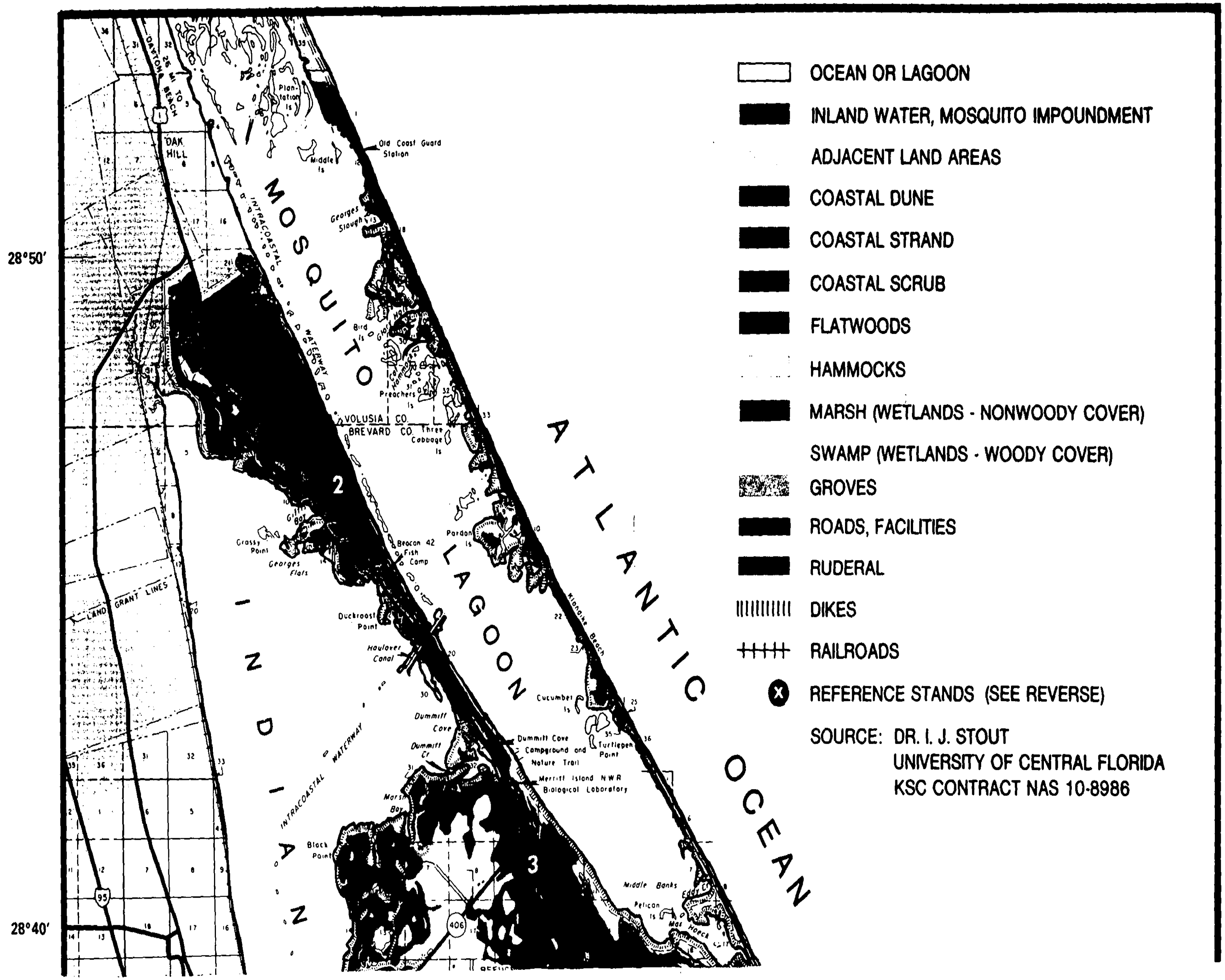
Due to the diversity of payload types, their physical configurations, compounded by lack of firm data for many payloads now only in early development stages, definitive data are minimal. As noted in section I, programmatic impact statements for these elements are the responsibility for NASA Headquarters, Washington, D.C. or the NASA Field Center responsible for program development. However, available information for early payloads indicates that future payloads will be very similar to past and present payloads flown on expendable launch vehicles, and planning at KSC has proceeded on that basis. The facilities already available at KSC and CCAFS have been modified to the extent required for payload processing and no new facilities will be required. Therefore, there are no impacts on land quality. Except for hypergolic fuels and toxic chemicals for pointing and stabilization systems, payloads will be essentially passive, contributing no environmental impacts. The Teleoperated Retrieval System (TRS) envisioned for free-flying STS missions will use hydrazine for propulsion, but processing will be accomplished in the VPF, as is now planned for Upper Stages. No additional impacts are expected.

Common laboratory solvents and cleaning fluids, compressed (shop) air, and gaseous nitrogen are typical of the consumables involved with payload processing, and no significant hazards are associated with these substances. The use of Freon 113 for cleaning imposes a minor impact on local air quality, but quantities are very limited. Moreover, plans for improved recovery systems are under investigation to mitigate effects from even these small amounts. No other impacts to air quality, water quality, or noise level beyond those associated with light industrial activities are expected at KSC.

APPENDIX E

TOPICAL INDEX

Major Vegetation Types on the John F. Kennedy Space Center and Canaveral Peninsula



TITUSVILLE
SOUTH LAKE
LAND GRANT LINES
FLORIDA EAST COAST R.R.
ST. JOHNS NATIONAL WILDLIFE REFUGE
TO ORLANDO 33 MI
BREVARD CO.
ORANGE CO.
ST. JOHNS RIVER
TI-CO AIRPORT
BELLWOOD
SHARPES
TO MELBOURNE 19 MI
COCOA
RIVER
INTRACOASTAL WATERWAY
NASA Security Gate 3
NASA Security Gate 6
NASA 24 Security Gate 2
NASA-USAF Security Gate 1
NASA Parkway E
Gator Cr
Catfish Cr
Peacock Pocket
Banana Creek
Cochran Cove
Pepper Flats
BANANA RIVER
Duck Point
Peterson Point
Quarterman Cove
Middle Point
Home Point
Cape Kennedy
Port Canaveral
CAPE CANAVERAL
Bennett Causeway
KARS
Canal
28°30′
80°50′
80°40′
80°30′

COMMUNITY CLASSIFICATION

The distribution of major plant community types on Merritt Island and Cape Canaveral appears as a complex mosaic. Upland communities are classified as: hammocks, pine flatwoods, coastal scrub, coastal strand, and coastal dunes. Citrus groves are also designated among the upland sites. Wetlands are noted as of two general types, wetlands dominated by woody plants (swamp) and wetlands dominated by nonwoody plants (marsh).

Hammocks are forests primarily dominated by broad-leafed evergreen trees. A well-developed tree layer, usually consisting mostly of live oak and Sabal palm, is always present. A shrub layer varying in height from 0.5 to 3 meters is present. An herb layer may or may not be well developed; however, some herbaceous plants are always present.

Flatwoods are usually dominated by a tree layer of slash pine. However, in areas such as the central portion of the island, the tree layer may be absent. The shrub layer is dominated by saw palmetto but has several additional woody plant species. A well-developed herb layer is present.

Coastal Scrub is an impenetrable thicket of woody plants dominated by myrtle oak. It appears as one layer varying in height from 1 to 3 meters. Little herb layer vegetation is present.

Coastal Strand is a dense thicket of woody plants usually dominated by saw palmetto. Its profile is a single layer from 1 to 4 meters in height; the shrubs on the eastern margin usually are hedged by the salt spray.

Coastal Dune is a single layer of grass, herbs, and dwarf shrubs and is confined to the front of the primary dunes. It exists completely within the salt spray zone, and sea oats is the most obvious species present.

Citrus Groves are the only agricultural areas that exist within the KSC boundaries.

Swamps (wetlands - woody cover) are areas adjacent to the marshes and are characterized by woody shrubs and trees. The mangroves are included within the vegetation type.

Marshes (wetlands - nonwoody cover) are extensive areas of grass and herbs which occur in soils saturated with water. Spartina marsh is a major constituent of this vegetation type. During wet times of the year, some of these areas are covered with standing water.

Ruderal are disturbed areas around structures and facilities and are maintained by man. They are predominantly composed of cultivated grasses, herbs, and in some cases, shrubs and trees.

REFERENCE STANDS

Ten permanent vegetation stands representing the major vegetation types on Merritt Island were selected and extensively sampled over a 3-year period. Species detail within these stands gives a good indication of the vegetation which actually occupies the island.

1. Volusia Pineland (north of KSC boundary and not included on this map) has a mixture of 29 species; five of the six leading dominants are shrubs (i.e., fetterbush and oak). Slash pine is the primary overstory species and wire grass dominates the herb layer.

2. Juniper Hammock has a relatively low number of plant species. The herb layer is dominated by sedges and grasses. The tree and shrub layers consist mostly of holly, *Sabal* palm, hickory, live oak, and juniper.

3. Route 3 Hammock has a relatively large number (63) of plant species. Wild coffee, Virginia creeper, poison ivy, muscadine, and greenbrier are major contributors to the shrub layer. Live oak and *Sabal* palm dominate the tree layer. *Oplismenus* is the principal constituent of the herb layer.

4. Wisconsin Village has a lack of pronounced dominance among its 37 species. A single large slash pine exists in the area along with several seedlings. Wire grass, fetterbush, saw palmetto, and dwarf live oak are the most common plants at the site.

5. Route 3 Scrub contains 27 different species. Myrtle oak, blueberry, and saw palmetto are the dominant species. Most of the species are typical scrub species, but a few are characteristic of flatwoods (i.e., fetterbush and tarflower).

6. Happy Creek Scrub is conspicuously dominated by myrtle oak. Other shrubs which are prominent are fetterbush, huckleberry, and blueberry. Wire grass dominates the herb layer and tarflower, a plant characteristic of flatwoods, is common.

7. Happy Hammock has the most numerous (76) species of all the stands examined. The herb layer is poorly developed and is largely dominated by ferns and grasses. A dense shrub layer is present and is predominantly wild coffee and *Myrsine*. The tree dominants are *Sabal* palm, lancewood, and live oak.

8. Headquarters Pineland is a fairly typical flatwoods area which has a sparse overstory of slash pine. The shrub vegetation is dominated by saw palmetto, fetterbush, scrub live oak, and myrtle oak. Wire grass and tarflower are the primary herb species.

9. Beach Grid is a primary dune community dominated by sunflowers, *Heterotheca subaxillaris*, and sea oats. Most of the 26 species found in the area are herbs. Other common herbs are several grasses, sand *Atriplex*, morning glory vines, and *Croton*.

10. Dune Scrub Grid has myrtle and live oak as the dominant species. The shrub layer is very dense and, in addition to the above 2 species, is primarily composed of saw palmetto, rosemary, blueberry, and fetterbush.