

3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

This Chapter briefly describes the environment that could potentially be affected by the Proposed Action. The potentially affected environment is both local and global. Implementation of the Proposed Action could result in global and local environmental impacts. Global impacts could affect the global atmosphere and land mass. Local impacts could affect the environment at distances of 100 kilometers (km) (62 miles (mi)) or less from the launch site at Cape Canaveral Air Force Station (CCAFS), Florida. In this document the area enclosed by a circle of 100 km (62 mi) radius centered on the CCAFS launch site is referred to as the regional area of interest.

The potentially affected environment has been addressed in previous National Environmental Policy Act (NEPA) documentation and is summarized here. Principal sources for the following information include the National Aeronautics and Space Administration's (NASA) *Final Environmental Impact Statement for the Cassini Mission* (NASA 1995), NASA's *Final Supplemental Environmental Impact Statement for the Cassini Mission* (NASA 1997), the U.S. Air Force's (USAF) *Final Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program* (USAF 1998), and the USAF's *Final Supplemental Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program* (USAF 2000).

3.1 CCAFS AND THE REGIONAL AREA OF INTEREST

As shown in Figure 3-1, CCAFS is located on the Atlantic Seaboard of East Central Florida. The regional area of interest includes all or portions of nine counties in the State of Florida: Brevard, Indian River, Lake, Okeechobee, Orange, Osceola, Polk, Seminole, and Volusia. For this nine-county region, approximately 73% of the total population lives within 100 km (62 mi) of the launch site and could be affected by implementation of the Proposed Action. Relatively small portions of Lake, Okeechobee, and Polk Counties lie within the 100 km (62 mi) radius circle that defines the regional area of interest. Residents of the remaining six counties (Brevard, Indian River, Orange, Osceola, Seminole, and Volusia) comprise approximately 77% of the total population living within the nine-county region (USBC 2001). More than 99% of all persons living within 100 km (62 mi) of CCAFS reside within these six counties.

CCAFS is bounded by uninhabited marsh land and NASA's Kennedy Space Center (KSC) on the north, the Atlantic Ocean on the east, the City of Cape Canaveral approximately 6 km (4 mi) to the south, and the Banana River, KSC, and Merritt Island National Wildlife Refuge (MINWR) on the west. Figure 3-2 shows the location of CCAFS within the region.

3.1.1 Land Use

The six-county region (*i.e.*, Brevard, Indian River, Orange, Osceola, Seminole, and Volusia counties) covers approximately 1.5 million hectares (ha) (3.7 million acres (ac)). Nearly 17% of this area is urbanized or devoted to transportation and other rights-of-way. About 22% of the land in the region is agricultural. The three principal agricultural uses are crops (2.7%), citrus (3.9%), and pasturage (14.2%). The region also contains about 32 ha (80 ac) of historical and archaeological sites.

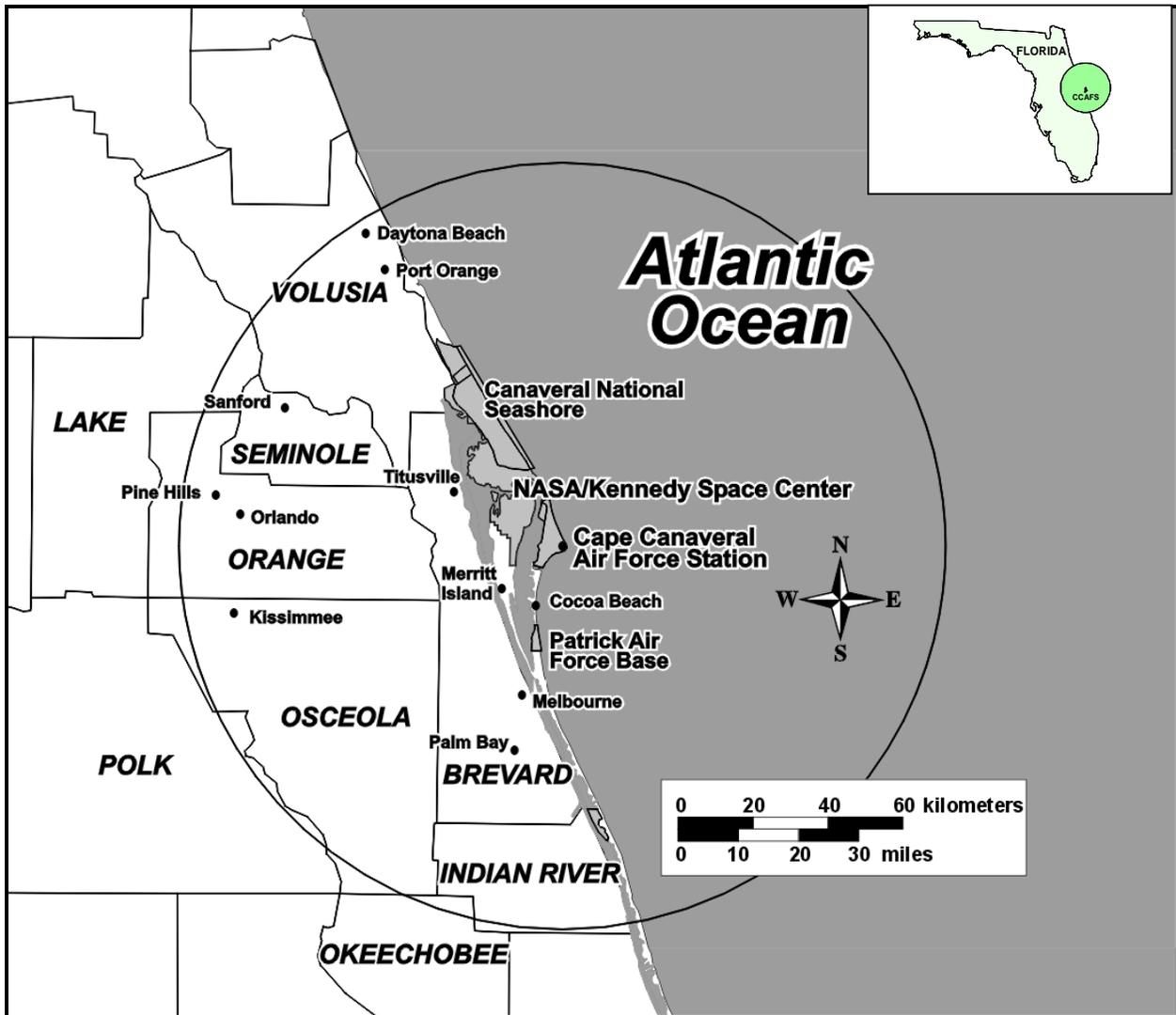


Figure 3-1. The Regional Area of Interest

KSC, immediately to the west of CCAFS, occupies about 57,000 ha (140,000 ac) of Merritt Island. Only about 4% (2,100 ha (5,300 ac)) of KSC is developed, and about 2,600 ha (6,500 ac) are used for NASA operations. About 40% of the KSC area (22,600 ha (55,800 ac)) is open water.

CCAFS occupies about 6,400 ha (15,800 ac) of the barrier island that also contains the City of Cape Canaveral. Major land uses at CCAFS include launch operations, launch support, airfield, port operations, station support areas, and open space. Approximately 1,900 ha (4,700 ac) or 30% of the station is developed, with over 40 space launch complexes (SLC) and support facilities, many of which have been deactivated. The remaining 70% (about 4,500 ha (11,100 ac)) is undeveloped land.

The Delta II Space Launch Complex 17 (SLC-17) is located in the southwestern portion of CCAFS.

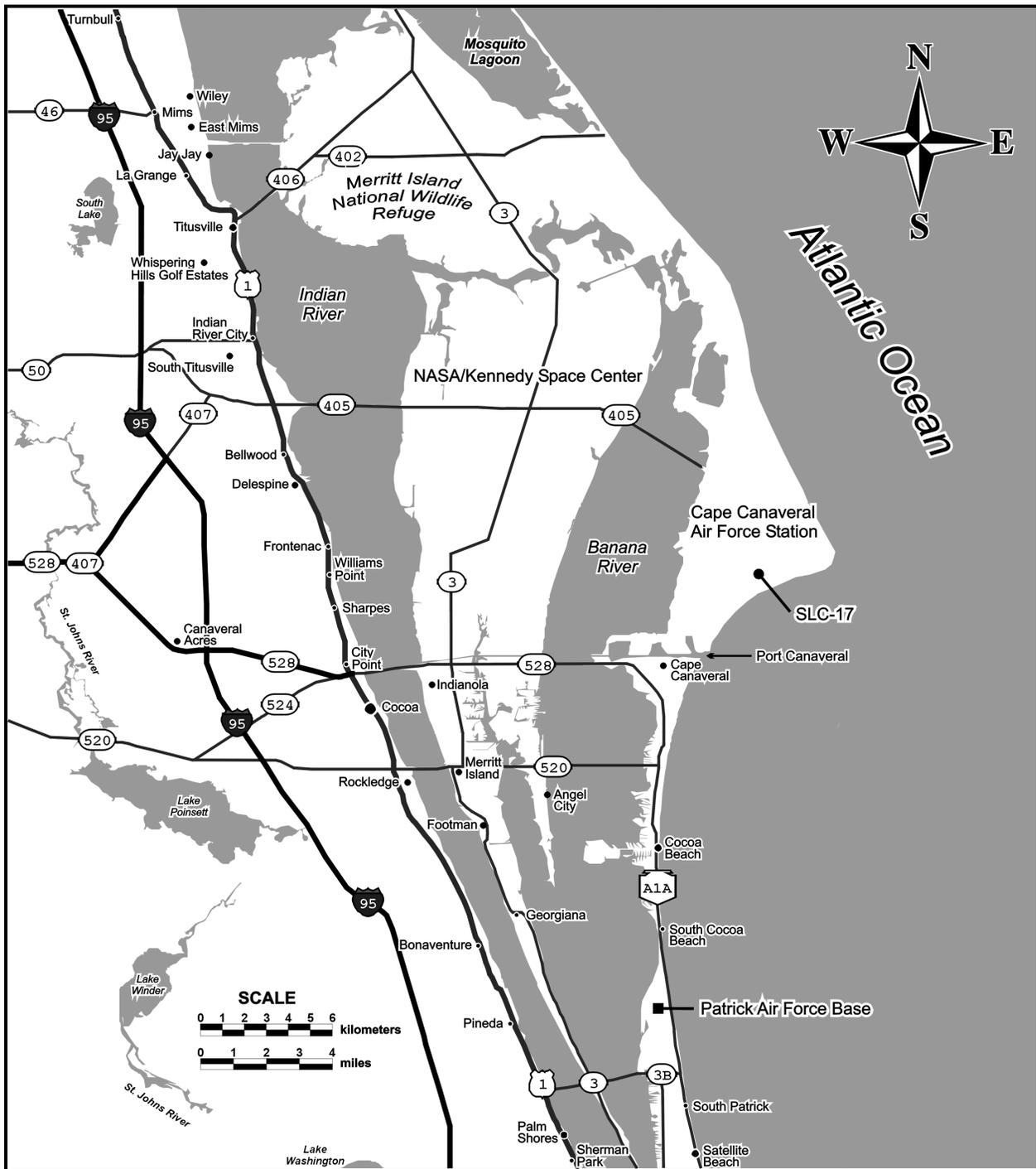


Figure 3-2. Location of CCAFS Relative to the Regional Area of Interest

3.1.2 Atmospheric Environment

3.1.2.1 Climate

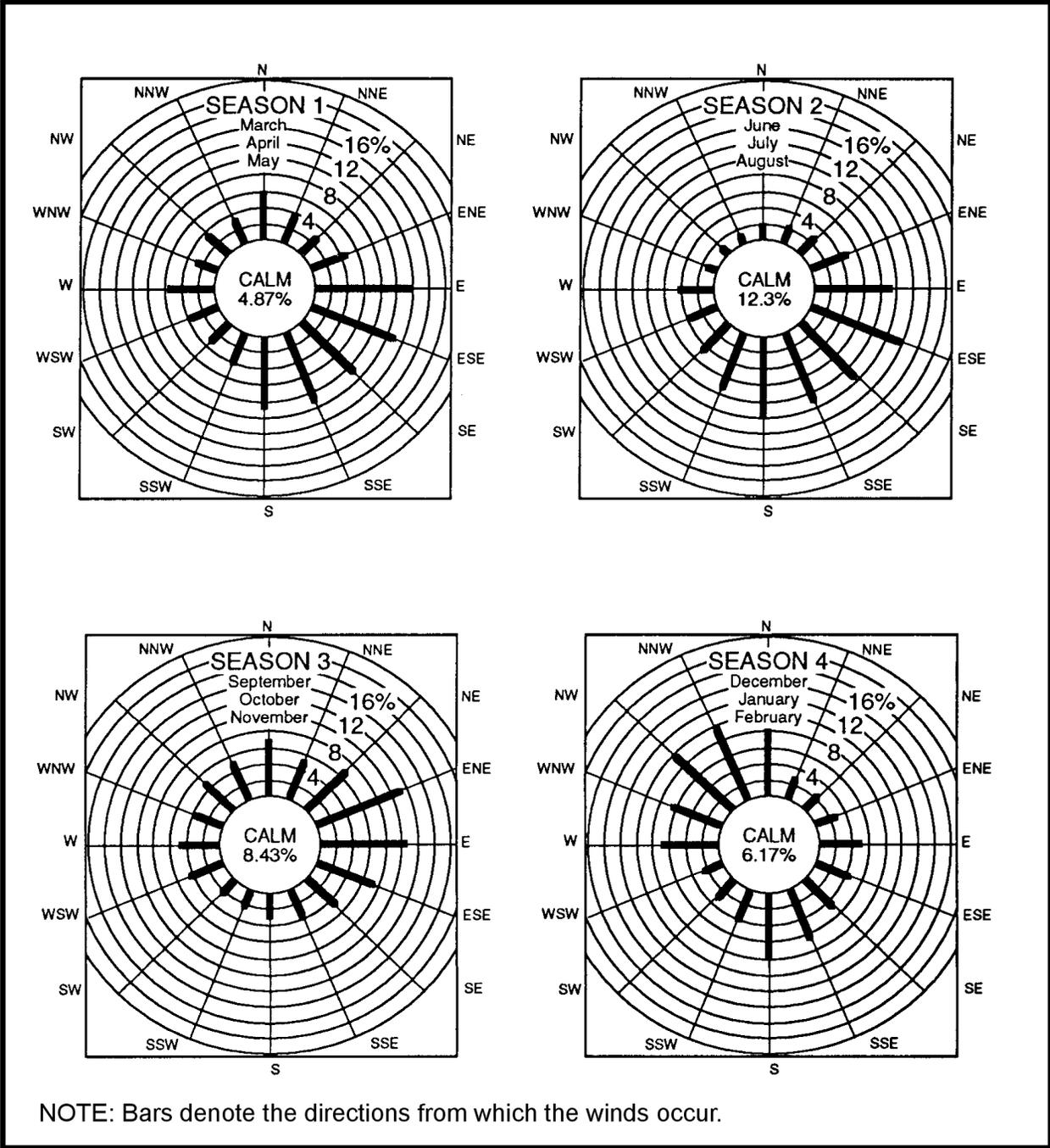
The climate of the region is subtropical with two definite seasons: long, warm, humid summers and short, mild, dry winters. Climatologic data from KSC indicate that winds from September through November occur predominantly from the east to north, shifting to the north and northwest from December through February (see Table 3-1). From March through May, the winds are predominantly from the east and shift east-southeast from June through August. Sea breezes (winds from the ocean towards land) and land breezes (winds from land towards the ocean) commonly occur during summer and fall. Sea breezes, with wind speeds of about 8 to 16 kilometers per hour (km/hr) (5 to 10 miles per hour (mph)) and air column depths of about 150 to 300 meters (m) (500 to 1,000 feet (ft)), occur at the surface during the day, with land breezes occurring at night. Thunderstorms bringing high winds and heavy rain typically occur from May through September. Surface mixing typically occurs during the winter to an altitude of about 700 to 900 m (2,300 to 3,000 ft) and during the summer to an altitude of about 1,200 to 1,400 m (3,900 to 4,600 ft). See Figure 3-3 for typical seasonal wind directions.

Table 3-1. Climatologic Data for Kennedy Space Center

Month	Surface Winds		Precipitation ^a		Fog	Thunderstorms
	Prevailing Direction	Mean Speed (km per hour (mph))	≥0.025 cm (≥0.01 in)	≥1.27 cm (≥0.5 in)	Visibility <3.2 km (<2 mi)	
Mean Number of Days Occurrence						
January	NNW	13 (8)	7	2	9	1
February	N	13 (8)	7	2	7	2
March	SSE	13 (8)	8	2	7	3
April	E	14 (9)	5	1	4	3
May	E	13 (8)	8	2	3	8
June	E	11(7)	12	3	2	13
July	S	10 (6)	11	4	2	16
August	E	10 (6)	11	3	2	14
September	E	10 (6)	13	4	2	10
October	E	13 (8)	11	3	3	4
November	N	11 (7)	7	2	6	1
December	NW	13 (8)	8	1	7	1
Annual	E	11 (7)	108	29	54	76
Years of Record	10	10	26	26	26	26

Source: Adapted from USAF 1998

a. Snowfall has not occurred in over three decades.



Source: NASA 1995

Figure 3-3. Wind Roses Indicating Seasonal Wind Directions for Lower Atmospheric Conditions: Cape Canaveral/Merritt Island Land Mass

3.1.2.2 Air Quality

National ambient air quality is regulated through the National Ambient Air Quality Standards (NAAQS) promulgated under the Clean Air Act (CAA). NAAQS are the Federal primary and secondary air quality standards for criteria pollutants (ozone (O₃), nitrogen oxides (NO_x), sulfur dioxide (SO₂), carbon monoxide (CO), particulates (PM₁₀ and PM_{2.5})¹, and lead (Pb)). The value of the standards is based on human health and welfare. The primary standards address “levels of air quality necessary to protect the public health with an adequate margin of safety.” The secondary standards address “protecting the public welfare from any known or anticipated adverse effects of a pollutant including economic values and personal comfort (e.g., damage to soils, crops, wildlife, weather, climate, and personal comfort)” (40 CFR 50).

Air quality at CCAFS is considered good; Table 3-2 compares measured emission concentrations with current Federal and State standards. CCAFS is in attainment for NAAQS criteria pollutants². Brevard County, including CCAFS, is considered by the Florida Department of Environmental Protection (FDEP) to be “in attainment” or “unclassifiable” with respect to criteria pollutants. Class I Areas are national parks or wilderness areas designated by the Prevention of Significant Deterioration Section of the CAA. There are no Class I areas within the regional area of interest. Under Section 176(c) of the CAA, the general conformity rules require a Federal action to conform to the applicable State Implementation Plan. Because the general conformity rules apply only to nonattainment and maintenance areas, these rules would not apply to the CCAFS region.

On July 18, 1997, the U.S. Environmental Protection Agency (EPA) promulgated a new standard for PM_{2.5} particulate matter. The EPA cannot start implementing the 1997 fine particle standards until the EPA and the States collect three years of monitoring data to determine which areas are not attaining the standards. The fine particle monitoring network was completed in 2000. In most cases, areas would not be designated “attainment” or “nonattainment” for fine particles until 2004-2005. Given that States would need to modify their State Implementation Plan following a determination of non-compliance, and there would be a period of time following such modification before controls would be required, it is unlikely that PM_{2.5} emission restrictions would apply prior to 2005 or 2006. In addition, the EPA promulgated a new ozone standard and is determining the approach and schedule for moving forward with its implementation. The EPA will be conferring with States and other interested parties to that end.

3.1.3 Ambient Noise

Ambient noise levels at CCAFS have not been monitored. The ambient noise levels at KSC, where similar industrial activities occur, range from about 60 A-weighted decibels (dBA) to 80 dBA, similar to levels found in many industrial settings. Noise levels at

¹ PM₁₀ = Particulate matter equal to or less than 10 microns in diameter

PM_{2.5} = Particulate matter equal to or less than 2.5 microns in diameter

² Currently, six pollutants are regulated by NAAQS: carbon monoxide, lead, nitrogen dioxide, ozone, sulfur dioxide, and particulate matter equal to or less than 10 microns in diameter.

resorts and on the beaches near Cape Canaveral probably range from 45 to 55 dBA (USAF 1998).

Table 3-2. Summary Air Quality Data Near CCAFS for 2000

Criteria Pollutant	Averaging Time	Federal Primary Standard ^{a, b} (µg/m ³ (ppm))	Florida State Standard ^a (µg/m ³ (ppm))	2000 Ambient Concentrations Near CCAFS (µg/m ³ (ppm))
Ozone (O ₃)	1 hour ^c	235 (0.12) ^d	235 (0.12)	(0.095)
	8 hours ^e	(0.08)	(0.08)	(0.08)
Sulfur Dioxide (SO ₂)	Annual ^f	80 (0.03)	60 (0.02)	(0.002)
	24 hours ^g	365 (0.14)	260 (0.10)	(0.008)
	3 hours ^g	no standard	1,300 (0.5) ^h	(0.033)
Particulate Matter (PM ₁₀)	Annual ^{i, j}	50 ^d	50	17
	24 hours ^e	150 ^d	150	46
Lead (Pb)	Quarterly	1.5	1.5	no data ^k
	Hourly	no standard	no standard	0.0 ^k
Nitrogen Dioxide (NO ₂)	Annual ^{i, j}	100 (0.053) ^d	100 (0.053)	(0.012)
Carbon Monoxide (CO)	1 hour ^g	40,000 (35)	40,000 (35)	(5)
	8 hours ^g	10,000 (9)	10,000 (9)	(4)

Source: Adapted from USAF 1998; FDEP 2000

- a. Federal and State standards are identical except for SO₂.
- b. Federal Primary Standards are levels of air quality necessary, with an adequate margin of safety, to protect the public health.
- c. Daily maximum one-hour concentration not to be exceeded an average of more than once per year averaged over three consecutive years.
- d. Federal Secondary Standards, which protect the public welfare from any known or anticipated adverse effects of a pollutant, are the same as the Federal Primary Standard.
- e. Not to exceed the three-year average of the fourth highest daily maximum.
- f. Arithmetic mean.
- g. Not to be exceeded more than once per year, averaged over three years.
- h. Florida standard is same as Federal secondary standard.
- i. Calculated as annual arithmetic mean, averaged over three consecutive years.
- j. Cannot be exceeded.
- k. Pb data reported in USAF 1998 is from a weather station in Orange County; the State Pb monitoring sites nearest to CCAFS are in Palm Beach and Tampa.

µg/m³ = micrograms per cubic meter
ppm = parts per million

3.1.4 Geology and Soils

CCAFS lies on a barrier island composed of relict beach ridges. The barrier island, 7.2 km (4.5 mi) at its widest point, has an average land surface elevation of approximately 3 m (10 ft) above mean sea level (USAF 1998).

There are four stratigraphic units at the site: surficial sands, Caloosahatchee Marl, Hawthorn Formation, and the limestone formations of the Floridan Aquifer. The Upper

Floridan Aquifer is under artesian pressure in the vicinity of CCAFS and is about 110 m (360 ft) thick at a depth of about 80 m (260 ft). The Hawthorn Formation separates the Floridan Aquifer from the shallower aquifers in the area. CCAFS is not in an active sinkhole area. It lies in a Seismic Hazard Zone 0 (very low risk of seismic events) (USAF 1998).

Soils in the CCAFS area include five major associations. The three most prominent soil types are contained in the Canaveral-Palm Beach-Welaka Association. These soils are highly permeable and allow water to quickly percolate into the ground. Soils in and around SLC-17 are not considered suitable for commercial agriculture. There are no prime or unique farmland soils at CCAFS (USAF 1998).

3.1.5 Hydrology and Water Quality

3.1.5.1 Surface Waters

The major surface water resources in the region include the upper St. Johns River basin, the Indian River, the Banana River, the Mosquito Lagoon (see Figure 3-2), and a portion of the Kissimmee River on the western border of Osceola County. Except for the portions that are part of the Intercoastal Waterway between Jacksonville and Miami, these water bodies are shallow, estuarine lagoons with average water depths of 0.6 to 0.9 m (2 to 3 ft). The Indian and Banana Rivers join at Port Canaveral. The combined Indian and Banana River watersheds cover 218,500 ha (540,000 ac) and have a combined surface area in Brevard County of 60,000 ha (150,000 ac). Surface drainage at CCAFS is generally westward toward the Banana River (adapted from USAF 1998).

On CCAFS, the 100-year floodplain extends 2 m (7 ft) above mean sea level on the Atlantic Ocean side, and 1.2 m (4 ft) above mean sea level on the Banana River side (USAF 1998). SLC-17 does not lie within the 100-year floodplain.

3.1.5.2 Surface Water Quality

The St. Johns River, from Lake Washington south, and its tributaries are classified by the State of Florida as Class I surface waters (potable water supply) and serve as the source of potable water for Melbourne and for much of the surrounding population. Near CCAFS, the Mosquito Lagoon and portions of the Indian River have been designated as Class II waters (shellfish propagation and harvesting) (see Figure 3-4). The remaining surface waters in the vicinity (the Banana Creek, the Banana River, and portions of the Indian River south of Titusville) have been designated as Class III waters (recreation, fish and wildlife management).

Under Florida's Aquatic Preserve Act of 1975, the following areas located near CCAFS have been designated as Aquatic Preserves (FAC 62-302.700): the Banana River Aquatic Preserve, the Indian River Aquatic Preserve, and the Mosquito Lagoon Aquatic Preserve (see Figure 3-5). Aquatic Preserves have exceptional biological, aesthetic, and scientific values and have substantial restrictions placed on activities like oil and gas drilling and effluent discharges.

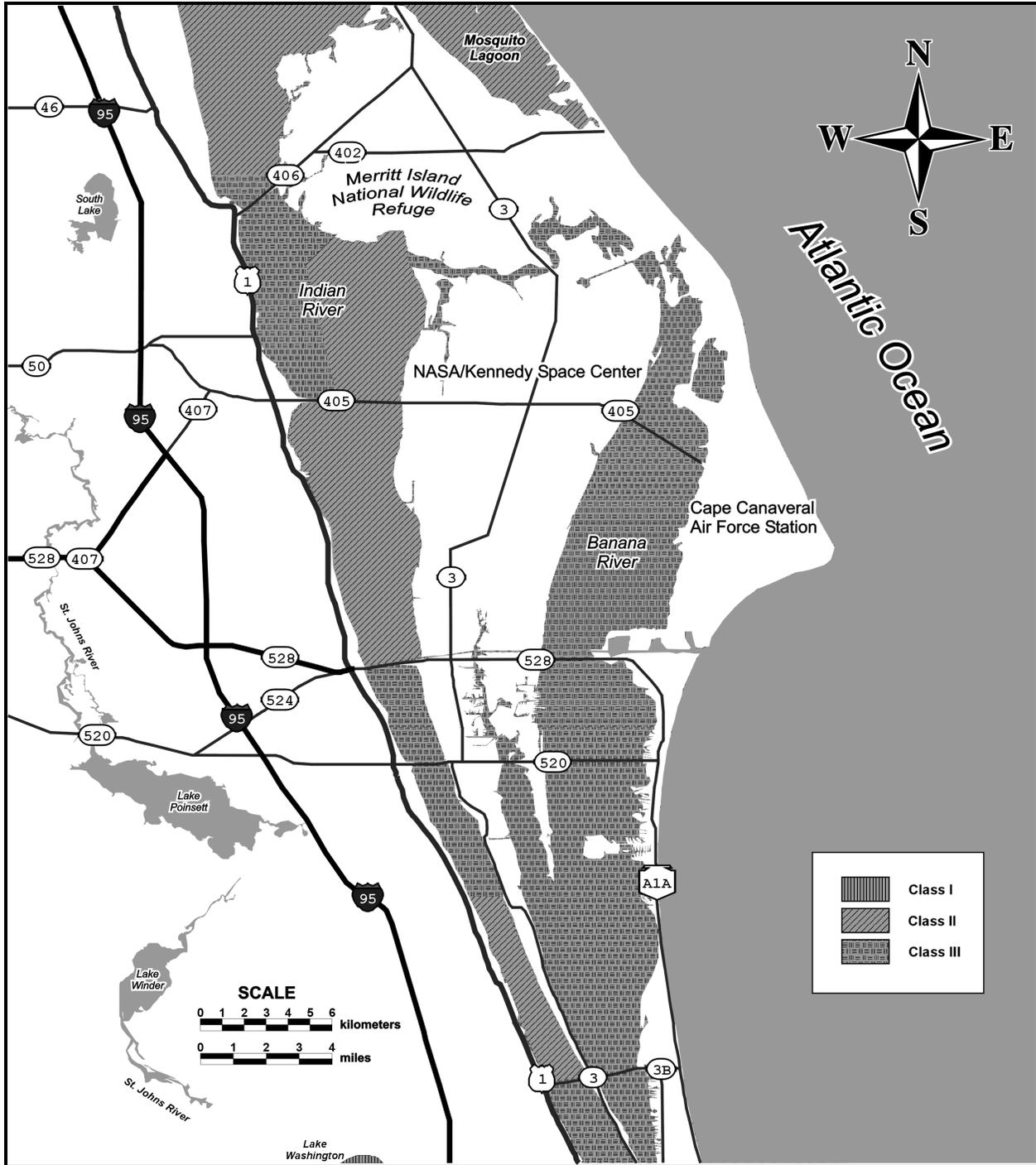


Figure 3-4. Surface Water Classifications Near CCAFS

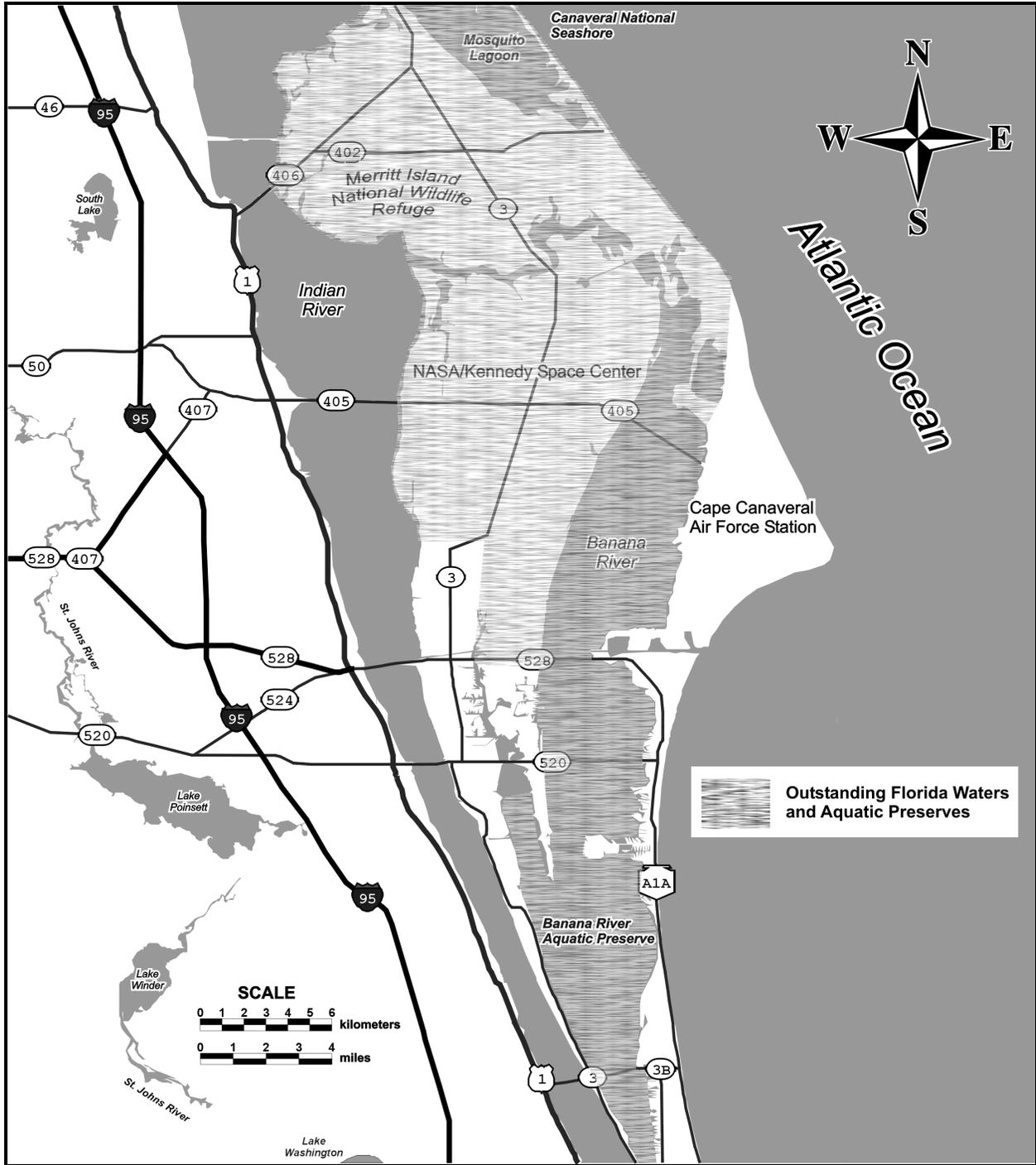


Figure 3-5. Outstanding Florida Waters and Aquatic Preserves Near CCAFS

Surface waters within the following areas located near CCAFS have been designated as Outstanding Florida Waters and as such are afforded the highest protection by the State of Florida (FAC 62-302.700): the Merritt Island National Wildlife Refuge, the Canaveral National Seashore, the Banana River Aquatic Preserve (see Figure 3-5). The Mosquito Lagoon Aquatic Preserve, the Archie Carr National Wildlife Refuge, the Pelican Island National Wildlife Refuge, the Sebastian Inlet State Recreation Area, the Indian River Aquatic Preserve – Malabar to Vero Beach, and the Indian River North Beach Program Area are also in the vicinity of CCAFS but outside the area of Figure 3-5. The State established this special designation for surface waters that demonstrate recreational or ecological significance. In addition, the Indian River Lagoon System, which includes the Mosquito Lagoon, has been selected as an Estuary of National Significance by the EPA's National Estuary Program. The goal of that program is to balance conflicting uses of the Nation's estuaries while restoring or maintaining their natural character. There are no designated wild or scenic rivers located on or near CCAFS.

Surface water quality near CCAFS is monitored at 11 long-term stations. These stations are located in the Mosquito Lagoon, the Banana River, the Banana Creek, the Indian River, and other locations on or near KSC. Other water quality monitoring stations in the area are maintained by Brevard County, the State of Florida, and the U.S. Fish and Wildlife Service (FWS). Surface water quality has been characterized as generally good, with best areas of water quality adjacent to undeveloped areas of the lagoon, *i.e.*, the North Banana River, the Mosquito Lagoon, and the northern-most point of the Indian River. The waters tend to be basic, with an average pH of 8.3, and have good buffering capacity, with alkalinities generally averaging 163 parts per million (ppm). Dissolved oxygen levels are generally above 6.0 ppm (NASA 1997).

Certain parameters—phenols and silver—generally exceed State water quality criteria, with pH, iron, and aluminum occasionally exceeding criteria. A similar pattern has been found in recent water quality data from the northern segment of the Banana River (NASA 1997).

3.1.5.3 Groundwater Sources

Groundwater underlying CCAFS occurs in three aquifer systems: the surficial aquifer, a secondary semi-confined aquifer, and the Floridan Aquifer. The surficial aquifer is unconfined and extends from just below the ground surface to a depth of about 21 m (70 ft). Recharge of the surficial aquifer is largely by percolation of rainfall and runoff. Near CCAFS, wells that tap this aquifer are used primarily for non-potable uses; however, Mims and Titusville, located about 16 km (10 mi) northwest of CCAFS, and Palm Bay, located about 64 km (40 mi) south of CCAFS, use the surficial aquifer for public water supply. The secondary, semi-confined aquifers are found below confining layers, but above and within the Hawthorn Formation. Recharge is minor and depends on leakage through surrounding lower permeability soils (NASA 1997). A confining layer of clays, sands, and limestone, ranging from 24 to 37 m (80 to 120 ft) thick, restricts exchange between the surficial aquifer and the deeper Floridan Aquifer. The Floridan Aquifer is the primary source of potable water in central Florida. The Floridan Aquifer underlying CCAFS is highly mineralized. CCAFS receives its potable water

from the City of Cocoa, which draws its water from a non-brackish area of the Floridan Aquifer (USAF 1998).

3.1.5.4 Groundwater Quality

In the vicinity of CCAFS, groundwater from the Floridan Aquifer is highly mineralized (primarily by chlorides) because of entrapment of seawater in the aquifer, lateral intrusion caused by inland pumping, and lack of flushing because of distant freshwater recharge areas (NASA 1997). Water samples exceeded national drinking water criteria for sodium, chloride, and total dissolved solids (NASA 1998b).

The secondary semi-confined aquifer lies between the surficial aquifer and the Floridan Aquifer and is contained within the relatively thin Hawthorn Formation. Groundwater recharge is by upward leakage from the Floridan system as well as lateral intrusion from the Atlantic Ocean. Water quality varies from moderately brackish to brackish (NASA 1997).

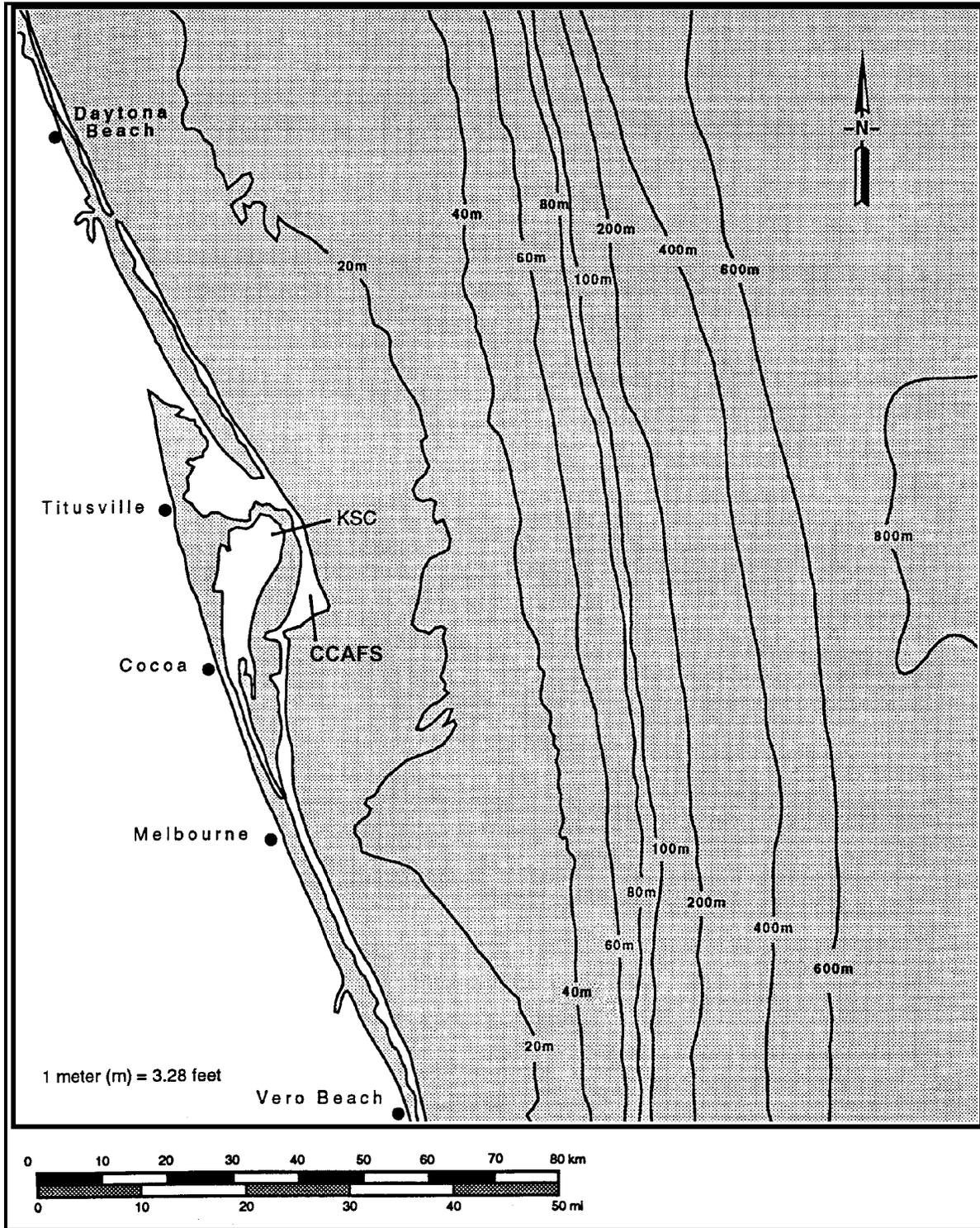
Groundwater in the surficial aquifer system at CCAFS remains good quality because of immediate recharge, active flushing, and a lack of development (NASA 1997). Groundwater from the surficial aquifer meets Florida's criteria for potable water (Class G-II, total dissolved solids less than 10,000 milligrams per liter (10,000 ppm)) and national drinking water criteria for all parameters other than iron and total dissolved solids.

3.1.5.5 Offshore Environment

The Atlantic Ocean near CCAFS can be characterized by its bottom topography and circulation. Out to depths of about 18 m (60 ft), sandy shoals dominate the underwater topography. The sea floor continues to deepen out to about 100 km (62 mi) from the coast, where the bank slopes down to depths of 700 to 900 m (2,400 to 3,000 ft) to the Blake Plateau. The Blake Plateau extends out to about 370 km (230 mi). Figure 3-6 depicts the depths of the offshore waters.

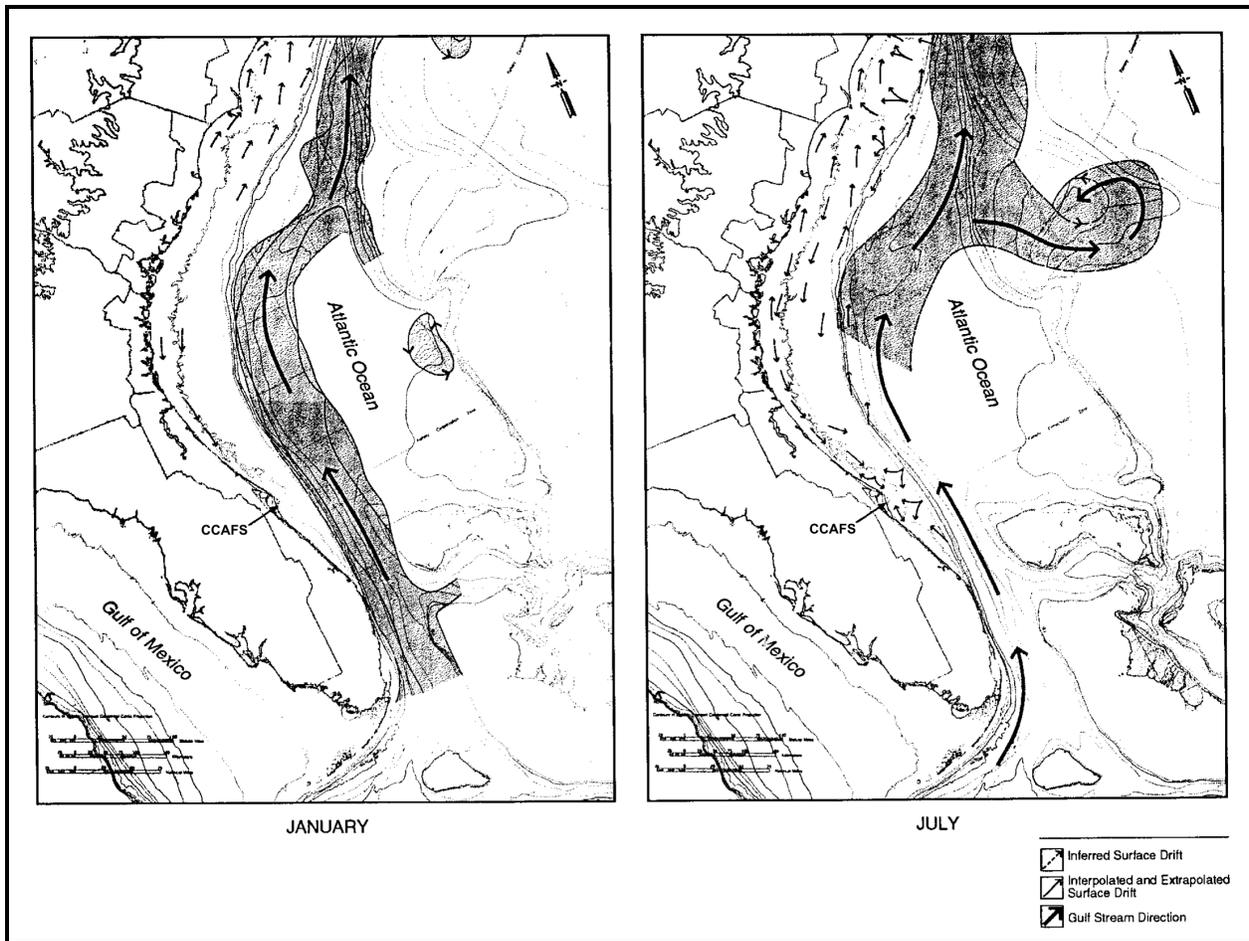
Offshore currents usually reflect the general northern flow of the Gulf Stream, as illustrated in Figure 3-7 (NOAA 1980). Studies of water movements in the area indicate a surface-to-bottom shoreward current out to depths of 18 m (60 ft) (about 33 km (20.5 mi) offshore) at speeds of several kilometers per day, although wind generally determines current flow at the surface. Southeast winds occur from May to October, creating a wet season, and travel clockwise around the Bermuda High. These warm, moisture-laden winds produce thundershowers during this period, which account for about 70% of the yearly rainfall (NASA 1997). In general, during the MER-2003 launch opportunities (May/June/July), prevailing winds would occur from the east in May and then would shift from the south. The prevailing winds transport surface waters toward shore, with an offshore component in shallow bottom waters that diminishes rapidly with distance offshore. The net effect is that material suspended in the water column tends to be confined to the area near the coast, and heavier material (*e.g.*, sand) is deposited in this area. The occasional northward winds result in a net movement of surface waters offshore, with an onshore movement of higher density bottom waters. Materials

suspended in surface waters are transported offshore, and heavier bottom materials move onshore.



Source: Adapted from DOE 1989

Figure 3-6. Offshore Water Depth Near the CCAFS/KSC Region



Source: Adapted from NOAA 1980

Figure 3-7. Ocean Currents and Water Masses Offshore of CCAFS/KSC for January and July

In the region out to the sloping bank (100 km (62 mi)), flow is slightly to the north and tends to move eastward when the wind blows to the south. Water over the Blake Plateau mostly flows to the north and is known as the Florida current, a component of the Gulf Stream.

3.1.6 Biological Resources

As noted in Section 3.1.5.2, the region has several terrestrial and aquatic conservation and special designation areas (e.g., wildlife management areas and aquatic preserves). These areas serve as wildlife habitat and occupy about 25% (about 405,000 ha (1 million ac)) of the total land and water acreage within the region.

3.1.6.1 Terrestrial Resources

Table 3-3 provides an overview of the eight general land use-land cover categories in the six-county region. The data presented in Table 3-3 was extracted from recent geographic information system (GIS) data from two Florida Water Management

Districts. Brevard, Indian River, Seminole, and Volusia counties are entirely within the St. Johns River Water Management District (SJRWMD); Orange and Osceola counties are partly in the SJRWMD and partly in the South Florida Water Management District (SFWMD). Approximately 22% of the region is rangeland and forests of various types, while nearly 13% is open water. Over 26% is classified as wetlands (SJRWMD 1998; SFWMD 1995). The FWS National Wetlands Inventory conducted in 1994 identified a total of 905 ha (2,235 ac) of wetlands on CCAFS (USAF 1998).

Table 3-3. Major Land Cover Types by County in the CCAFS Region

Major Land Use - Land Cover Classification	Brevard	Indian River	Orange	Osceola	Seminole	Volusia	Six- County Region Total
	(Acres ^a (%))	(Acres (%))	(Acres (%))	(Acres (%))	(Acres (%))	(Acres (%))	(Acres (%))
Urban and Built-up	126,620 (15.5)	29,113 (9.3)	158,157 (24.6)	48,055 (5.0)	73,692 (33.3)	119,045 (14.9)	554,682 (14.8)
Agriculture	115,727 (14.2)	137,469 (44.0)	92,127 (14.3)	402,628 (41.7)	22,366 (10.1)	52,498 (6.6)	822,815 (21.9)
Rangeland	61,409 (7.5)	19,080 (6.1)	50,953 (7.9)	62,365 (6.5)	7,473 (3.4)	33,590 (4.2)	234,870 (6.3)
Upland Forests	96,279 (11.8)	28,249 (9.0)	109,020 (16.9)	98,685 (10.2)	26,583 (12.0)	226,072 (28.3)	584,888 (15.6)
Water	176,113 (21.6)	18,302 (5.9)	68,013 (10.6)	84,180 (8.7)	25,748 (11.6)	100,799 (12.6)	473,155 (12.6)
Wetlands	218,196 (26.8)	73,703 (23.6)	136,675 (21.2)	257,333 (26.6)	58,590 (26.5)	252,220 (31.6)	996,717 (26.5)
Barren Land	5,348 (0.7)	2,964 (0.9)	4,620 (0.7)	4,496 (0.5)	1,156 (0.5)	3,149 (0.4)	21,733 (0.6)
Transportation, Communication and Utilities	15,086 (1.9)	3,648 (1.2)	24,094 (3.7)	8,192 (0.8)	5,615 (2.5)	10,989 (1.4)	67,624 (1.8)
Total	814,778 (100.0)	312,528 (100.0)	643,659 (100.0)	965,934 (100.0)	221,223 (100.0)	798,362 (100.0)	3,756,484 (100.0)

Source: Extracted from SJRWMD 1998 and SFWMD 1995

a. One acre equals 0.4047 hectares

Note: The data for this table were compiled directly from the referenced computer databases. The level of precision implied by the numbers is an artifact of the computer compilation process; therefore, data should be viewed only as approximations.

The majority of the land at and near CCAFS, including KSC/MINWR and the Mosquito Lagoon/Cape Canaveral National Seashore, is undeveloped and in a near-natural state. These areas host a variety of plant communities, ranging from mangrove swamps and salt marshes to freshwater wetlands, coastal dunes, and beaches.

Approximately 70% (4,400 ha (11,100 ac)) of the land at CCAFS is undeveloped. Three principal plant communities dominate this undeveloped land. The coastal dune community is the smallest (320 ha (800 ac)) and extends from the high tide line of the Atlantic Ocean across the beach into the dunes along the coastal perimeter of CCAFS

(USAF 1990). The coastal strand community, covering about 920 ha (2,300 ac), lies inland of the coastal dune community. The coastal scrub community, the largest of the three (3,760 ha (9,400 ac)), lies further inland. Three other ecologically important, but smaller, communities exist at CCAFS: mangrove swamp (180 ha (450 ac)), salt marsh (56 ha (140 ac)), and freshwater wetland (80 ha (200 ac)).

Coastal dune communities are inhospitable to many plants because of the constantly shifting substrate, salt deposition, abrasion from wind-blown sand, and effects of storm waves (USAF 1998). Vegetation on the dunes is dominated by sea oats. Other grasses, such as slender cordgrass and beach grass, also occur. Shrubs, such as beach berry and marsh elder, occur in the dune community, along with herbs such as beach sunflower and camphorweed. The beach areas, while largely unvegetated, still provide significant wildlife resources.

Coastal strand occurs between the coastal scrub community and the salt spray zone of the dune system. Strand vegetation has a low profile that is maintained by nearly constant winds. Plants that tolerate strand conditions are saw palmetto, wax myrtle, tough buckthorn, cabbage palm, partridge pea, prickly pear, and various grasses.

White-tailed deer, raccoons, mice, 14 species of birds (e.g., red-tailed hawk and red-headed woodpecker), and two reptile species (gopher tortoise and eastern diamondback rattlesnake), among others, use this community (USAF 1990). The coastal scrub association is characterized by xeric tree species, including scrub oak, live oak, sand live oak, and myrtle oak.

The scrub community is in a harsh environment with low soil moisture. Herbaceous and shrub vegetation is sparse, but includes wire grass, saw palmetto, tar flower, lantana, wax myrtle, greenbriar, prickly pear, gopher apple, and others. Ten species of mammals, including white-tailed deer, armadillo, feral hogs, and bobcat use this habitat type at CCAFS. In addition, 14 species of birds (similar to those inhabiting the coastal strand) and 5 species of reptiles use the scrub community (USAF 1990).

Overall, 68 reptile and amphibian species, more than 300 bird species, and more than 25 mammal species use communities at CCAFS (adapted from NASA 1997). There are eight to nine bird rookeries in the area. Terrestrial wildlife in the region include migratory and native waterfowl (e.g., ringneck, pintail, and baldpate ducks), as well as turkey, squirrel, white-tailed deer, wild hogs, and black bear. Seven State wildlife management areas, primarily in the St. Johns River basin, are hunted for small game, turkey, hogs, and deer.

3.1.6.2 Aquatic Resources

The coastline from Daytona to Melbourne seaward to a depth of 180 m (600 ft) is one of the most productive marine fishery areas along the southern Atlantic coast. Inshore waters support a sea trout and redfish sport fishery. The tidal zone supports an abundance of several species of marine invertebrates, as well as small fish that are food for many shore birds. Several species of gulls, terns, sandpipers, and other birds use the beaches of the Cape Canaveral area. In addition, these beaches are important to nesting sea turtles (USAF 1998).

The lagoons and rivers support limited commercial fishing. At least 141 species of freshwater, estuarine, and marine fish occur in the northern portions of the Indian River Lagoon near CCAFS (ECFRPC 1988). Of these, 65 species are exploited commercially, and 85 are sport fish that may also be commercially fished.

Fishing for crabs, clams, scallops, oysters, and shrimp is an important component of the commercial and recreational fishing effort, particularly in Brevard and Volusia counties. In 1997, 90% (700,933 kg (1,545,292 lb)) of Florida landings of Calico Scallops were produced in Brevard County. Further, Brevard County landings of clams accounted for over 80% (198,065 kg (436,658 lb)) of the Florida east coast clam harvest. Volusia County accounted for over 6% (15,377 kg (33,902 lb)) of clam landings off the Florida east coast (FDEP 1998).

Commercial fishing is an important economic asset to the region. Brevard County and Volusia County ranked first and fourth respectively, among the 12 east coast Florida counties in terms of 1997 finfish landings. Among the 12 east coast Florida counties, Brevard ranked first in invertebrate landings (e.g., crab, clams, and oysters) and shrimp landings, with Volusia sixth and third, respectively, in these categories (FDEP 1998). Mosquito Lagoon is considered among the best oyster and clam harvesting areas on the east coast.

3.1.6.3 Endangered and Threatened Species

The Federal Government's Threatened or Endangered Species List, prepared by the FWS under the Endangered Species Act, currently recognizes 111 endangered or threatened species in the state of Florida. Another 14 species, including 13 plants, are listed as candidate species and are being reviewed for possible Federal listing in the state of Florida (FWS 2002). The State of Florida considers 470 species of plants and animals as endangered or threatened (FFWCC 1997). Roughly half of all the endangered and threatened species occur in wetlands, principally estuarine environments; the other half depends largely on upland habitat (ECFRPC 1991).

Table 3-4 lists 34 Federal and State endangered and threatened species, and species of special concern, known to occur at CCAFS (USAF 1998, FWS 2002, FFWCC 1997). No Federally listed threatened or endangered flora exists at CCAFS, although State-listed species, such as coastal vervain, are located on both CCAFS and KSC.

About 15% of the U.S. population of West Indian Manatee occurs near CCAFS. The following areas have been designated as critical habitat for manatee by the FWS: the entire inland section of the Indian River; the entire inland section of the Banana River; and all the waterways between the Indian and Banana Rivers (exclusive of those existing human-made structures or settlements that are not necessary to the normal needs and survival of the species). On March 11, 1990, the FWS established the waters of the Banana River from State Road 528 north to the NASA Parkway East causeway as a manatee refuge. On January 7, 2002, the FWS declared the Barge Canal, to the immediate south of CCAFS, and Sykes Creek in Brevard County as additional manatee refuge areas.

**Table 3-4. Threatened, Endangered, and Species of Special Concern
Occurring at or Near CCAFS**

Common Name	Scientific Name	Federal Status	State Status
Plants			
Curtiss' milkweed	<i>Asclepias curtissii</i>	---	E
Satin-leaf	<i>Chrysophyllum oliviforme</i>	---	E
Coastal vervain	<i>Verbena maritima</i>	---	E
Nodding pinweed	<i>Lechea cernua</i>	---	T
Hand fern	<i>Ophioglossum palmatum</i>	---	E
Beach-star	<i>Remirea maritima</i>	---	E
Giant Leatherfern	<i>Acrostichum danaeifolium</i>	---	C
Reptiles and Amphibians			
Gopher frog	<i>Rana capito</i>	---	SSC
Gopher tortoise	<i>Gopherus polyphemus</i>	---	SSC
American alligator	<i>Alligator mississippiensis</i>	T(S/A)	SSC
Eastern Indigo snake	<i>Drymarchon corais couperi</i>	T	T
Atlantic green sea turtle	<i>Chelonia mydas</i>	E	E
Atlantic loggerhead sea turtle	<i>Caretta caretta</i>	T	T
Leatherback sea turtle	<i>Dermochelys coriacea</i>	E	E
Atlantic (Kemp's) Ridley sea turtle	<i>Lepidochelys kempii</i>	E	E
Atlantic hawksbill sea turtle	<i>Eretmochelys imbricata imbratica</i>	E	E
Birds			
Wood stork	<i>Mycteria americana</i>	E	E
Bald eagle	<i>Haliaeetus leucocephalus</i>	T	T
Little blue heron	<i>Egretta caerulea</i>	---	SSC
Florida scrub jay	<i>Aphelocoma coerulescens</i>	T	T
Piping plover	<i>Charadrius melodus</i>	T	T
Least tern	<i>Sterna antillarum</i>	---	T
Roseate tern	<i>Sterna dougallii dougallii</i>	T	T
Roseate spoonbill	<i>Ajaia ajaja</i>	---	SSC
Brown pelican ^a	<i>Pelicanus occidentalis</i>	E	SSC
Southeastern American kestrel	<i>Falco sparverius paulus</i>	---	T
Arctic Peregrine falcon	<i>Falco peregrinus tundrius</i>	---	E
Mammals			
West Indian manatee	<i>Trichechus manatus</i>	E	E
Southeastern beach mouse	<i>Peromyscus polionotus niveiventris</i>	T	T
Finback whale	<i>Balaenoptera physalus</i>	E	E
Humpback whale	<i>Megaptera novaeangliae</i>	E	E
Northern right whale	<i>Balaena glacialis</i>	E	E
Sei whale	<i>Balaenoptera borealis</i>	E	E
Sperm whale	<i>Physeter catodon</i>	E	E

Source: Based on FFWCC 1997, USAF 1998, and FWS 2002

a. The Brown Pelican is endangered by Federal Status in the U.S., but the Federal status does not encompass the Brown Pelican population in Florida as listed in the special reprint of 50CFR17.11 and 50CFR17.12 on December 31, 1999.

E = endangered; T = threatened; SSC = state special concern species; C = commercially exploited (S/A) = listed by similarity of appearance to a listed species

One rare species, while not on the Federal or State threatened or endangered lists, is known to inhabit the Indian River. The rainwater killifish has been listed by the Florida Committee on Rare and Endangered Plants and Animals as a "species of special concern."

SLC-17 is within several hundred meters of sea turtle nesting beaches. Loggerhead, green, and leatherback sea turtles use the beaches at CCAFS as nesting habitat. Nesting typically occurs between May and October. The launch complex uses exterior lighting for safety and security reasons. Sea turtle adults and hatchlings are sensitive to artificial lighting near their nesting beaches. Extensive research has demonstrated that artificial lighting deters adult female turtles from emerging from the water and nesting. After emerging from the nests, the hatchlings use moonlight and starlight reflected off the ocean as a guide to finding the ocean. If the inland lighting is brighter than the reflected light, the hatchlings may get disoriented and never reach the ocean. CCAFS's lighting plan minimizes light impacts on sea turtle nesting beaches (USAF 2000; USAF 2001).

Populations of the southeastern beach mouse are high at CCAFS largely because of the amount of coastal dune and strand habitat at the station. Southeastern beach mouse populations have been found at CCAFS launch sites where open grassland habitat is maintained. Coastal grasslands and strand provide the highest population densities at CCAFS.

Peregrine falcons, recently removed from the Endangered Species list but subject to continued monitoring by the FWS, are typically tolerant of humans and use the dune habitat for overwintering. Wood storks are year-around residents of the Cape Canaveral area, nesting in treetops of mangrove swamps and near water impoundments. Florida scrub jays use the oak scrub habitat in the Cape Canaveral-MINWR. The total estimated population in Florida is between 7,000 to 11,000 birds (66 FR 21999). There are about 20 historically used bald eagle nest sites on KSC, but eagles are not known to breed at CCAFS. In 1993, a total of four out of five recently used nests were occupied on KSC, and seven eaglets were fledged (NASA 1997). Least terns typically nest between May and June and use sandy or gravelly beaches and gravel rooftops in an industrial area at CCAFS from April to October. Least terns are sensitive to disturbance during nesting.

Five endangered whale species (finback, humpback, Northern right, sei, and sperm) occur in the coastal waters near CCAFS. The National Marine Fisheries Service (NMFS) has designated critical habitat for the Northern right whale pursuant to the Endangered Species Act. The designated habitat involves marine waters adjacent to the coast of Georgia and Florida, including the Cape Canaveral area (NMFS 1994).

3.1.7 Socioeconomics

Socioeconomic resources in the area surrounding CCAFS include its population; economy; transportation system; public and emergency services; and recreation opportunities. These resources are described below.

3.1.7.1 Population

Implementation of the Proposed Action could result in potential environmental impacts to residents surrounding the launch site at CCAFS. This population includes all persons residing within 100 km (62 mi) of the launch site. This area is referred to as the regional

area of interest, and persons living within it are collectively called the potentially affected population.

Figure 3-8 highlights the population centers located within the regional area of interest. The largest of these include the Daytona Beach/Port Orange area to the north, the Kissimmee/Orlando/Sanford area and Titusville to the west, and the Melbourne/Palm Bay area to the south. Table 3-5 shows populations by county based on data from the census conducted in 2000 (USBC 2001).

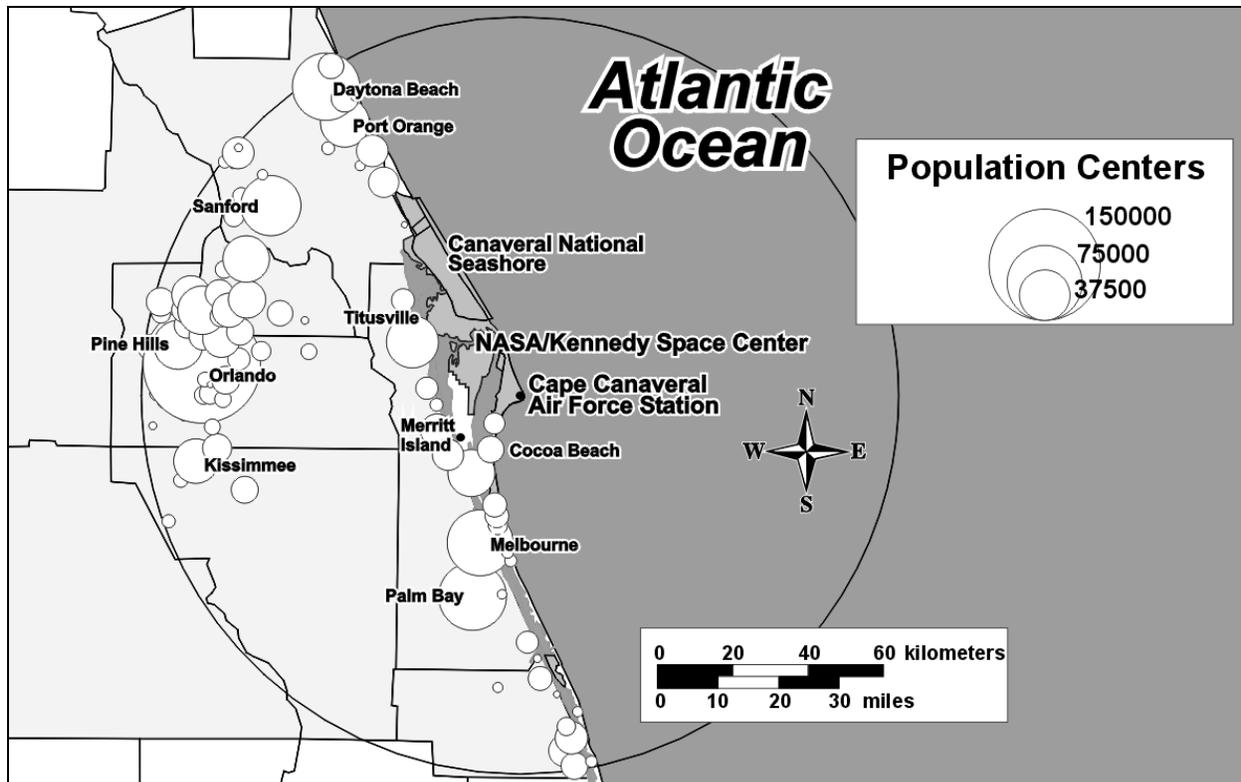


Figure 3-8. Population Centers in the Regional Area of Interest.

Figure 3-9 shows population groups residing within the regional area of interest surrounding CCAFS in 1990 and 2000. The regional population grew at a faster rate than the State's from 1990 to 2000. The six-county region grew by 27.6% (1,932,646 to 2,466,553) whereas the State's population grew by 23.5% (12,937,926 to 15,982,378). The population in Brevard County grew by 19.4% (398,978 to 476,230), a lower rate than both the State and region (USBC 2001). Minorities comprised 19% of the total resident population in 1990. Between 1990 and 2000, the minority population in the regional area of interest nearly doubled, and by 2000, minority persons comprised nearly 30% of the residents in the area. "Hispanic or Latino" and "Black or African American" groups comprised approximately 86% of the potentially affected minority population in 2000 (see Appendix B).

Table 3-5. Population of the Regional Area of Interest

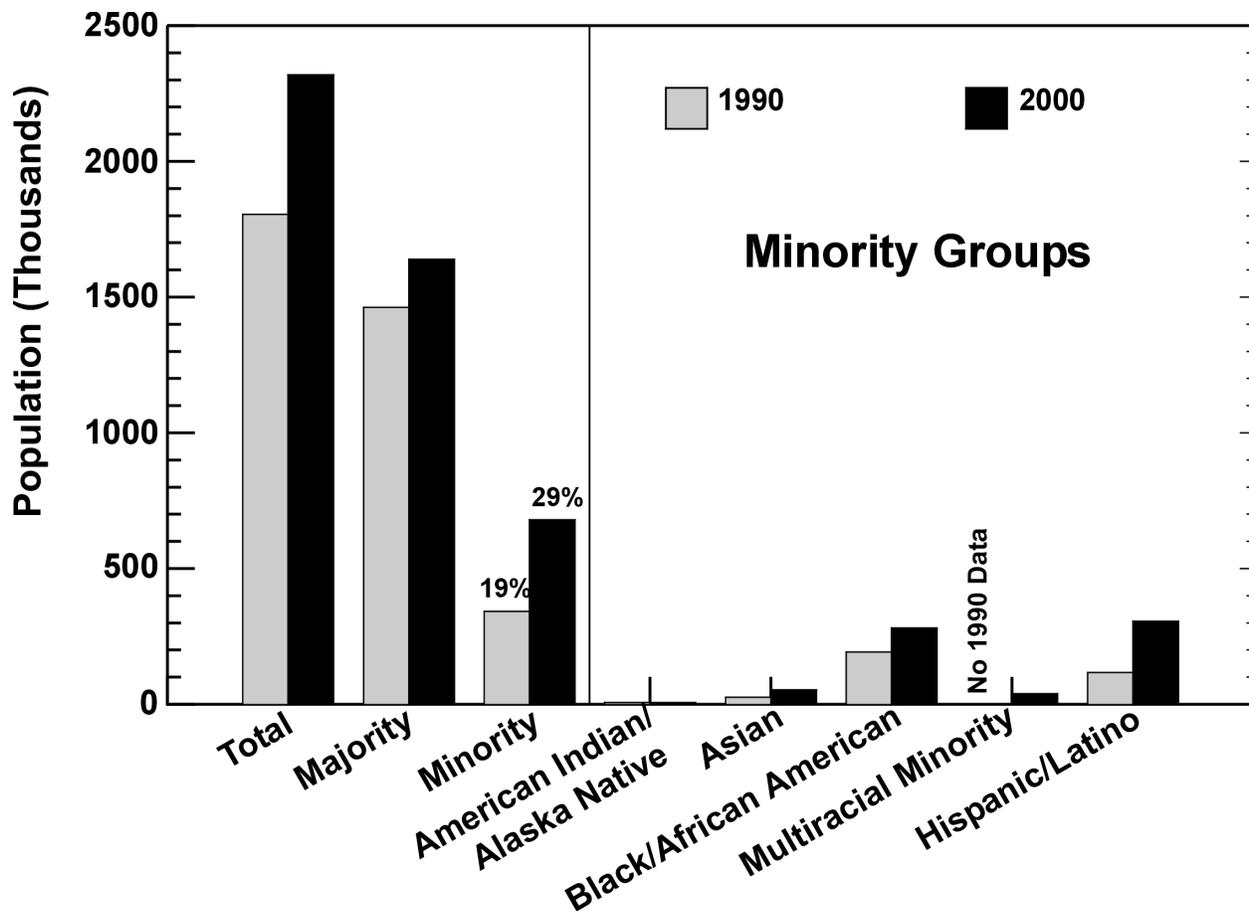
County	2000 Census Population	2003 Projected Population	Estimated Percent of Population Within 100 km of CCAFS	Potentially Affected Population^a in 2003
Brevard	476,230	497,184	100.0	497,184
Indian River	112,947	119,385	95.2	113,654
Orange	896,344	960,881	95.1	913,798
Osceola	172,493	190,087	97.2	184,764
Seminole	365,196	387,108	100.0	387,108
Volusia	443,343	463,737	78.1	362,178
Six-County Region	2,466,553	2,618,382	93.9	2,458,686
Lake	210,528	226,739	0.5	1,134
Okeechobee	35,910	38,675	0.3	116
Polk	483,924	521,186	0.9	4,691
Nine-County Region	3,196,915	3,404,982	72.6	2,464,627

Source: Adapted from USBC 2001

a. Those persons living within 100 km (62 mi) of the launch site at CCAFS.

All counties are expected to have population increases through 2003. The U.S. Bureau of the Census' (USBC's) projected population estimates for 2005 were interpolated to estimate populations in 2003 (see Table 3-5). Orange County is expected to remain the most populated and is projected to grow to 960,881, and Brevard County is expected to increase to 497,184. During the decade from 1990 to 2000, the potentially affected population within 100 km (62 mi) of CCAFS increased from approximately 1.8 million persons to 2.3 million persons. The potentially affected population within the regional area of interest is expected to exceed 2.4 million persons by the year 2003. More than 99% (2,458,686) of the projected potentially affected population in 2003 will reside in the six counties of Brevard, Indian River, Orange, Osceola, Seminole, and Volusia, and less than 0.3% of the potentially affected population will reside in the remaining three counties (Lake, Okeechobee, and Polk).

In 2000, approximately 56,500 people lived within 20 km (12 mi) of the launch site, and about 3,900 lived within a distance of 10 km (6 mi). By 2003 the population residing within 20 km (12 mi) of the launch site is expected to approach 59,000, while the population living within 10 km (6 mi) is projected to exceed 4,000.



Note that a direct comparison of 1990 Census data and 2000 Census data for minority groups is not possible. During the 2000 Census, the USBC modified its enumeration methodology to include multiracial responses and added a separate racial category, "Native Hawaiian or Other Pacific Islander". Persons in the "Native Hawaiian or Other Pacific Islander" group were included in the "Asian or Pacific Islander" group in the 1990 Census data. For the purposes of comparison, the data for the Asian Group shown in Figure 3-9 includes persons self-designated as "Hawaiian or Other Pacific Islander" during the 2000 Census (approximately 1,135 persons). As indicated in Figure 3-9, no data for multiracial persons were gathered during the 1990 Census.

Figure 3-9. Potentially Affected Populations Surrounding CCAFS in 1990 and 2000

In 1990, about 10% of the potentially affected population reported incomes that were below the 1990 poverty threshold (see Appendix B). Persons whose income is less than the poverty threshold are designated as low-income persons by the Council on Environmental Quality (CEQ 1997). Low-income persons comprised approximately 8% of the population residing within 20 km (12 mi) of the launch complex, and approximately 11% of the population residing within 10 km (6 mi) of the launch complex.

3.1.7.2 Economy

The region's economic base is tourism and manufacturing. Regional tourism attracts more than 20 million visitors annually. Walt Disney World®, Sea World®, and Universal Studios Florida®, along with KSC, are among the most popular tourist attractions in the state. Several cruise lines anchor at Port Canaveral, immediately to the south of CCAFS.

As shown in Table 3-6, industrial sectors in Brevard County providing significant employment in 2000 were services, with 61,921 employees (34.2% of total private industry employment); wholesale and retail trade, with 44,125 employees (24.3%); government, with 25,885 employees (14.3%), manufacturing, with 25,085 employees (13.8%); construction, with 10,737 employees (5.9%); finance and real estate, with 6,024 employees (3.3%); transportation and public utilities, with 5,130 employees (2.8%); and agriculture, forestry, and fishing, with 1,975 employees (1.1%) (BEBR 2001).

Table 3-6. Industry Employment Estimates for Brevard County

Standard Industrial Classification ^a	Average Employment		Percent Change
	1999	2000	
Agriculture, Forestry, and Fishing	2,087	1,975	-5.4
Construction	9,906	10,737	8.3
Manufacturing	25,836	25,085	-2.9
Transportation, Communications, and Public Utilities	5,254	5,130	-2.4
Wholesale Trade	5,924	6,581	11.1
Retail Trade	38,111	37,544	-1.5
Finance, Insurance, and Real Estate	6,138	6,024	-1.8
Services	57,889	61,921	7.0
Unassigned Industries	395	381	-1.5
Government ^b	25,057	25,885	3.3
Total	176,597	181,263	2.6

Source: BEBR 2001

- a. Includes all employers covered by Federal and State unemployment compensation laws; excludes proprietors, the self-employed, unpaid volunteers, family workers, domestic workers in households, military personnel, and employees of some Federal agencies.
- b. Includes Federal, State and local civilian employees for all Standard Industrial Classification codes.

An estimated 1,071,361 people were employed in the regional area of interest in 2000. The unemployment rate for the region in 2000 was estimated at 2.9%. Brevard County had an estimated 200,686 people employed in 2000 with an estimated unemployment rate of 3.4% (BEBR 2001).

The employment pool at CCAFS involves about 10,000 military and civilian personnel, all associated with the USAF. Military personnel are attached to the 45th Space Wing at Patrick Air Force Base (PAFB), approximately 24 km (15 mi) away from the duties they perform at CCAFS. Most people employed by the base are contractor personnel from companies associated with missile testing and launch vehicle operations.

3.1.7.3 Transportation

The region's road network includes five major limited access highways: Interstate 4, Interstate 95, Florida's Turnpike, the Spessard L. Holland East-West Expressway, and the Martin L. Andersen Beeline Expressway. In addition, numerous Federal, State, and county roads are located in the region. Primary highways serving CCAFS include Interstate 95, US Route 1, State Route (SR)-A1A, and SR-520. CCAFS is linked to the highway system by the south gate via SR-A1A, NASA Causeway, and General Samuel C. Phillips Parkway.

Rail service for freight is available in all six counties, although passenger service is limited. Rail transportation in the CCAFS/KSC area is provided by Florida East Coast Railway. A mainline traverses the cities of Titusville, Cocoa, and Melbourne.

The region has three major airports: Orlando International, which served over 30 million passengers in 2000 (GOAA 2001); Daytona Beach International, which served over 800,000 passengers in 1996; and Melbourne International, which served almost 600,000 passengers in 1996 (ECFRPC 1997). Melbourne International Airport, the closest air transportation facility of the three, is located 48 km (30 mi) south of CCAFS (see Figure 3-1). CCAFS contains a skid strip for Government aircraft and delivery of launch vehicle components. Air freight associated with the operation of CCAFS launch complexes arrives at the CCAFS skid strip.

Port Canaveral, the nearest navigable seaport, has approximately 480 m (1,600 ft) of dockage. With six cruise terminals and two more planned, Port Canaveral became the busiest cruise port in the Western Hemisphere during 2000, with a record \$3.8 million revenue cruise passengers (Port Canaveral 2001).

3.1.7.4 Public and Emergency Services

A mutual agreement exists among the City of Cape Canaveral, KSC, and the range contractor at CCAFS for reciprocal support in the event of an emergency or disaster (USAF 1990). Further, CCAFS range operations and the Brevard County Office of Emergency Management have agreements for communications, product dissemination, and early warning in the event of a launch accident.

Health care in the region is provided at 28 general hospitals (6,600 beds), three psychiatric hospitals, and two specialized hospitals. Medical services for CCAFS are provided primarily at the Air Force Space Command Hospital at PAFB and at nearby public hospitals located outside of CCAFS.

Nearly 90% of the people in the six-county region rely on public systems for potable water. CCAFS obtains its potable water under contract from the City of Cocoa water system and uses 3.8 million liters (1 million gallons (gal)) per day (USAF 1998). The

Cocoa water system draws its supplies from the Floridan Aquifer. The onsite water distribution system is sized to accommodate the short-term high-volume flows required by the launch deluge system.

3.1.7.5 Recreation

There is an abundance of public recreational opportunities in the six-county region. Recreational activities focus primarily on coastal beaches, inland waterways (e.g., Indian, Banana, and St. Johns Rivers), and freshwater lakes scattered throughout the region (USAF 1998). The Canaveral National Seashore lies to the north of CCAFS, and MINWR, which comprises the bulk of KSC, lies immediately to the west. Within the confines of CCAFS, fishing by CCAFS personnel and their guests is permitted at SLC-34, SLC-16, and two other onsite locations.

Recreational facilities at CCAFS, which are for base personnel only, are located in the industrial and port areas. These include a fitness center, softball field, picnic pavilion, a U.S. Navy service club, and a naval recreation facility. Cultural facilities on station include the Air Force Space and Missile Museum and the original NASA mission control, all located at the southern portion of the base. Off-base military and civilian personnel use recreational and cultural facilities available in local communities. No public school facilities are present on CCAFS (USAF 1990).

3.1.8 Cultural/Historic/Archaeological Resources

There are 81 sites in the region listed on the National Register of Historic Places (DOI 1991), two on the National Registry of Historic Landmarks, and one (Emeralda Marsh) on the National Registry of Natural Landmarks.

Archeological investigations at CCAFS indicate that human occupation of the area first occurred approximately 4,000 years ago. Surveys of CCAFS recorded 56 prehistoric and historic archaeological sites, with 19 identified as eligible for listing on the National Register of Historic Places. Historic building and structure surveys reported 14 properties as listed or eligible for listing on the National Register. Launch Pads 5/6, 13, 14, 19, 26, 34, and the original Mission Control Center at CCAFS are listed and form a National Historic Landmark District. Launch Complexes 1/2, 3/4, 17, 21/22, 25, 31/32, and the Cape Canaveral Lighthouse are considered as eligible for listing on the National Register (USAF 1998).

A 1978 survey of MINWR identified four historic sites: Sugar Mill ruins, Fort Ann, Dummett Homestead, and the Old Haulover Canal. Of the four sites, only the Old Haulover Canal is listed on the National Register of Historic Places (DOI 1991).

3.2 THE GLOBAL ENVIRONMENT

In accordance with Executive Order 12114, this section provides a general overview of the global environment. It includes basic descriptions of the troposphere and stratosphere, general climate characteristics, the distribution of land surface types, and global population distribution and density. It also briefly discusses the global atmospheric inventory of plutonium.

3.2.1 Troposphere

The troposphere is the atmospheric layer closest to the Earth's surface. All life exists and virtually all weather occurs within this layer. Additionally, this layer accounts for more than 80% of the mass and essentially all of the water vapor, clouds, and precipitation contained in the Earth's atmosphere. The height of the troposphere ranges from an altitude of 10 km (6 mi) at the poles to 15 km (9 mi) at the equator (see Figure 3-10).

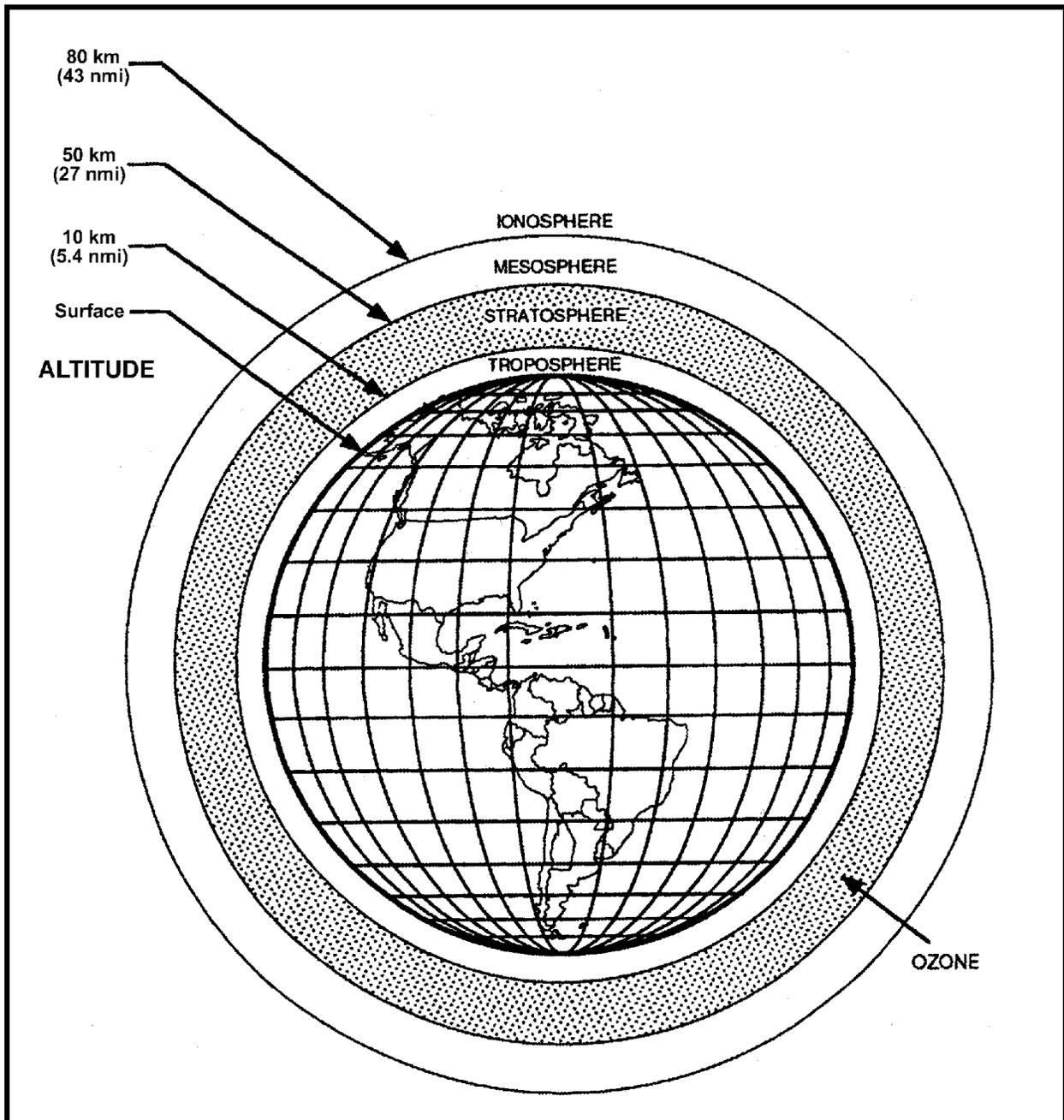


Figure 3-10. Atmospheric Layers and Their Estimated Altitudes

In this layer, temperature decreases with height at a nominal rate of approximately 6.5° Celsius (C) per km (about 3.6° Fahrenheit (F) per 1,000 ft). The troposphere is generally well mixed, but occasionally stagnates. As a result of mixing and scavenging by precipitation, the mean residence time for tropospheric aerosols is short (ranging from a few days to a few weeks). A narrow region called the tropopause separates the troposphere and the stratosphere.

The USAF estimated total annual emissions emitted to the troposphere from a total of 23 Atlas, Delta, and Titan launches from CCAFS in 1995 and 23 launches in 1996. The total estimated annual input to the troposphere was 445 metric tons per year (491 tons per year) of particulate matter, 18 metric tons per year (19.4 tons per year) each of NO_x and CO, and 225 metric tons per year (248 tons per year) of chlorine compounds. Removal of most of these emissions from the troposphere occurs over a period of less than one week, preventing a buildup of these products on a global level (USAF 1998).

3.2.2 Stratosphere

The stratosphere extends from the tropopause up to an altitude of approximately 50 km (31 mi) (see Figure 3-10). In general, vertical mixing is limited within the stratosphere, providing little transport between the layers above and below. Thus, the relatively dry, ozone-rich stratospheric air does not easily mix with the lower, moist ozone-poor tropospheric air. In addition, the lack of vertical mixing and exchange between atmospheric layers provides for extremely long residence times, causing the stratosphere to act as a “reservoir” for certain types of atmospheric pollution. The temperature is relatively constant in the lower stratosphere and gradually increases with altitude, reaching approximately 3° C (37.5° F) at the top of the layer. The temperature increase is caused primarily by the adsorption of short-wave radiation by ozone molecules. Recent measurements indicate that stratospheric chlorine levels are decreasing, consistent with expected declines resulting from the Montreal Protocols. The USAF estimated the total annual input of rocket exhaust products to the stratosphere from a total of 23 Atlas, Delta, and Titan launches from CCAFS in 1995 and 23 launches again in 1996. The total estimated annual input to the stratosphere averaged about 376 metric tons per year (414 tons per year) of particulate matter, 1.4 metric tons per year (1.5 tons per year) of NO_x, 725 metric tons per year (799 tons per year) of CO, and 188 metric tons per year (208 tons per year) of chlorine compounds (USAF 1998).

3.2.3 Population Distribution and Density

The information used for global demographics was adapted from *World Demographic Update Through 1990 for Space Nuclear System Safety Analysis*, prepared for the U.S. Department of Energy (DOE) by Halliburton NUS Environmental Corp. (HNUS 1992). This document used world-wide population statistics and other information distributed among 720 cells of equal size. The cells were derived by dividing the Earth from pole to pole into 20 latitude bands of equal area. Each latitude band was then segmented into 36 equal size cells, for a total of 720 cells. Each of the cells covered an area of 708,438 square kilometers (km²) (273,528 square miles (mi²)). The 1990 population estimates in the document were increased by a growth factor of 1.28 to provide population estimates for 2003 (Firstenberg 2002).

Table 3-7 lists the distribution of the Earth's 2003 projected population across each of the 20 equal-area latitude bands. Figure 3-11 illustrates the land-adjusted population densities within the latitude bands. These exhibits show that, with the exception of the six southernmost latitude bands, the population of the bands varies by about one order of magnitude. The greatest population densities occur in a relatively narrow grouping of the four northern bands between latitudes 44° North and 17° North (bands 4 through 7).

Table 3-7. Latitude Band Populations and Surface Characteristics

Latitude Band	Band 2003 Population Estimate	Population Density ^a (persons/km ² (persons/mi ²))	Band Surface Fractions			
			Water	Land	Land Rock Fraction	Land Soil Fraction
1	7.77 x 10 ⁷	11.4 (29.6)	0.7332	0.2668	1.0 ^b	0.0 ^b
2	2.58 x 10 ⁸	17.1 (44.3)	0.4085	0.5915	1.0 ^b	0.0 ^b
3	6.87 x 10 ⁸	48.6 (126.0)	0.4456	0.5544	0.251 ^b	0.749 ^b
4	1.02 x 10 ⁹	89.3 (231.0)	0.5522	0.4478	0.251	0.749
5	1.07 x 10 ⁹	98.0 (254.0)	0.5718	0.4282	0.153	0.847
6	1.13 x 10 ⁹	113.0 (292.0)	0.6064	0.3936	0.088	0.912
7	8.10 x 10 ⁸	96.5 (250.0)	0.6710	0.3290	0.076	0.924
8	4.61 x 10 ⁸	72.7 (188.0)	0.7514	0.2486	0.058	0.924
9	4.24 x 10 ⁸	69.0 (179.0)	0.7592	0.2408	0.077	0.923
10	2.55 x 10 ⁸	46.6 (121.0)	0.7854	0.2146	0.084	0.916
11	2.55 x 10 ⁸	42.2 (109.0)	0.7630	0.2370	0.044	0.956
12	1.57 x 10 ⁸	28.2 (73.0)	0.7815	0.2185	0.055	0.945
13	1.04 x 10 ⁸	18.5 (48.0)	0.7799	0.2201	0.085	0.915
14	1.09 x 10 ⁸	17.6 (45.6)	0.7574	0.2426	0.089	0.911
15	6.91 x 10 ⁷	12.3 (31.8)	0.7796	0.2204	0.092	0.980
16	7.37 x 10 ⁷	21.3 (55.3)	0.8646	0.1354	0.112	0.888
17	1.32 x 10 ⁷	11.2 (29.0)	0.9538	0.0462	0.296	0.704
18	5.91 x 10 ⁶	10.7 (27.8)	0.9784	0.0216	0.296 ^b	0.704 ^b
19	9.53 x 10 ⁵	5.3 (13.8)	0.9930	0.0070	1.0 ^b	0.0 ^b
20	<10 ⁴	<0.001 (<0.002)	0.3863	0.6137	1.0 ^b	0.0 ^b

Source: Adapted from HNUS 1992

a. Population density on land fraction.

b. Assumed values.

3.2.4 Climate

Worldwide climate types range from the perpetual frost of the polar regions to arid desert.

3.2.5 Surface Types

The worldwide distribution of surface types is an important characteristic in considering the potential consequences of accident scenarios. Table 3-7 provides a breakdown of

the total land fraction for each of the 20 latitude bands. The total land fraction was further subdivided by the fraction consisting of soil or rock cover. For the most densely populated bands (bands 4 through 7), the land fraction varies from about 33% (band 7) to about 45% (band 4), with the soil fraction dominating (75% in band 4 to 92% in band 7).

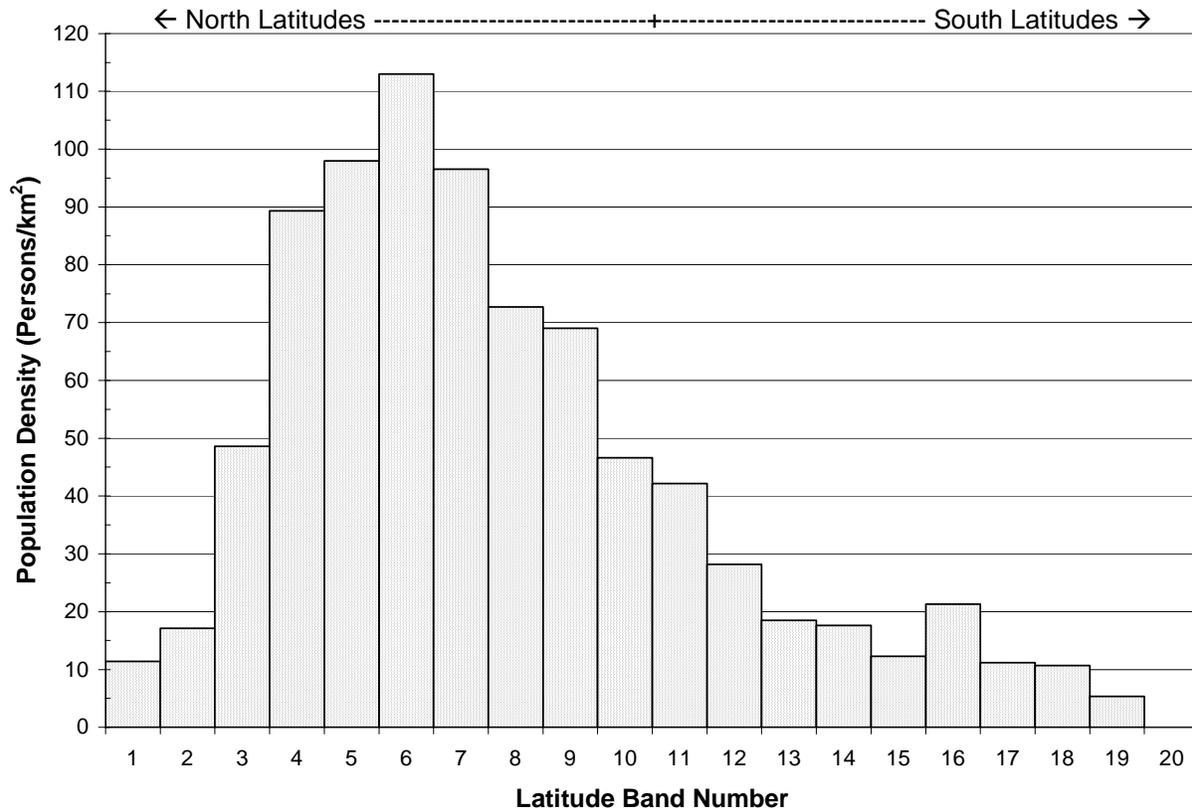


Figure 3-11. Estimated World Population Density by Latitude Bands for 2003

3.2.6 Worldwide Plutonium Levels

Plutonium-238 (Pu-238), used in the RHUs for the MER-2003 rovers, already exists in the environment as a result of atmospheric testing of nuclear weapons and a 1964 launch accident. The following paragraphs describe the worldwide levels of Pu in the environment. This information provides a perspective against which to compare the scope of postulated incremental releases of Pu from potential mission accidents.

Between 1945 and 1974, aboveground nuclear weapons tests released about 440,000 curies (Ci) of Pu to the environment (EPA 1977; AEC 1974). About 97% (about 430,000 Ci) of this plutonium was Pu-239 and Pu-240, essentially identical isotopes with respect to chemical behavior and radiological emission energies. The remainder (about 10,000 Ci) consists primarily of about 9,000 Ci of Pu-238, along with much smaller amounts of Pu-241 and Pu-242. (Some of the Pu-238 and Pu-241 has decayed since the time of release.)

Table 3-8 indicates that the Pu-238 in the atmosphere from weapons tests (about 9,000 Ci) was increased by the 1964 reentry and burnup of a Systems for Nuclear Auxiliary Power (SNAP)-9A radioisotope thermoelectric generator (RTG), which released 17,000 Ci. This release into the atmosphere was consistent with the RTG design philosophy of the time. Since 1964, essentially all of the SNAP-9A release has been deposited on the Earth's surface (AEC 1974). About 25% (approximately 4,000 Ci) of that release was deposited in the northern hemisphere, with the remaining 75% settling in the southern hemisphere. In April 1986, approximately 100,000,000 Ci of various radioisotopes were released to the environment from the Chernobyl accident (NRC 1987). Approximately 810 Ci were Pu-238.

The total plutonium released to the ocean environment by overseas nuclear reprocessing plants between 1967 and 1987 is approximately 20,000 Ci (IAEA 1976; NCRP 1987; UNSCEAR 1988). Assuming that 15% of the total was Pu-238 (based upon the 1980-85 fraction in Great Britain's Sellafield releases), about 3,000 Ci of Pu-238 have been added from these sources, bringing the total of Pu-238 dispersed into the environment up to about 29,810 Ci.

Table 3-8. Major Sources and Approximate Amounts of Plutonium-238 Distributed Worldwide

Source	curies
Atmospheric Testing, 1945-1974	9,000
Space Nuclear Power – SNAP-9A, 1964	17,000
Overseas Nuclear Reprocessing Plants, 1967-1987	3,000
Chernobyl Nuclear Power Station, 1986	810
Total	29,810

Source: NASA 1995