

3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

This chapter of the Draft Environmental Impact Statement (DEIS) for the New Horizons mission briefly describes the local and global areas that could potentially be affected by implementing the Proposed Action. Local impacts could affect the regional area surrounding the launch site at Cape Canaveral Air Force Station (CCAFS), Florida. Global impacts could affect the global atmosphere and landmass.

Both the local and global environments have been addressed in previous National Environmental Policy Act (NEPA) documentation and are summarized in this chapter. Principal sources for the information include the U.S. Air Force's (USAF) *Final Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program* (USAF 1998), *Final Supplemental Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program* (USAF 2000), and the National Aeronautics and Space Administration's (NASA) *Final Environmental Assessment for Launch of NASA Routine Payloads on Expendable Launch Vehicles from Cape Canaveral Air Force Station, Florida and Vandenberg Air Force Base California* (NASA 2002). Other documentation summarized includes, but is not limited to, the CCAFS *Integrated Natural Resource Management Plan* (USAF 2001) and the Kennedy Space Center's (KSC) *Environmental Resources Document* (NASA 2003).

The primary launch opportunity for the proposed New Horizons mission to Pluto would occur in January – February 2006, and a backup launch opportunity would occur in February 2007.

Section 3.1 describes the affected environment at and surrounding CCAFS, and Section 3.2 discusses the global environment.

3.1 CAPE CANAVERAL AIR FORCE STATION REGIONAL AREA

CCAFS is located on the east coast of Florida in Brevard County on the Canaveral Peninsula (Figure 3-1). The Canaveral Peninsula is a barrier island located approximately 96 kilometers (km) (60 miles (mi)) east of Orlando. The regional area, within a 100 km (62 mi) radius of CCAFS, includes all or the major portions of six counties, including Brevard, Indian River, Orange, Osceola, Seminole, and Volusia (the six-county region) and minor portions of Flagler, Lake, Polk, Okeechobee, and St. Lucie counties. The northern boundary of CCAFS abuts the KSC boundary on the barrier island (Figure 3-2). The southern boundary abuts Port Canaveral. CCAFS is separated from KSC to the west by the Banana River. The Atlantic Ocean borders CCAFS along its eastern boundary. The Merritt Island National Wildlife Refuge (MINWR) lies within the boundaries of KSC.

3.1.1 Land Use

The six-county region covers approximately 1.7 million hectares (ha) (4.1 million acres (ac)), of which approximately 1.3 million ha (3.3 million ac) is land and 0.3 million ha (0.8 million ac) is water (USBC 2000). Land use includes urbanized areas or areas devoted to transportation and other rights-of-way (approximately 17 percent of the total

area) and agricultural land (22 percent). The three principal agricultural uses are crops (3 percent), citrus (4 percent), and pasturage (14 percent) (USAF 2001). The region also has historical and archaeological sites.

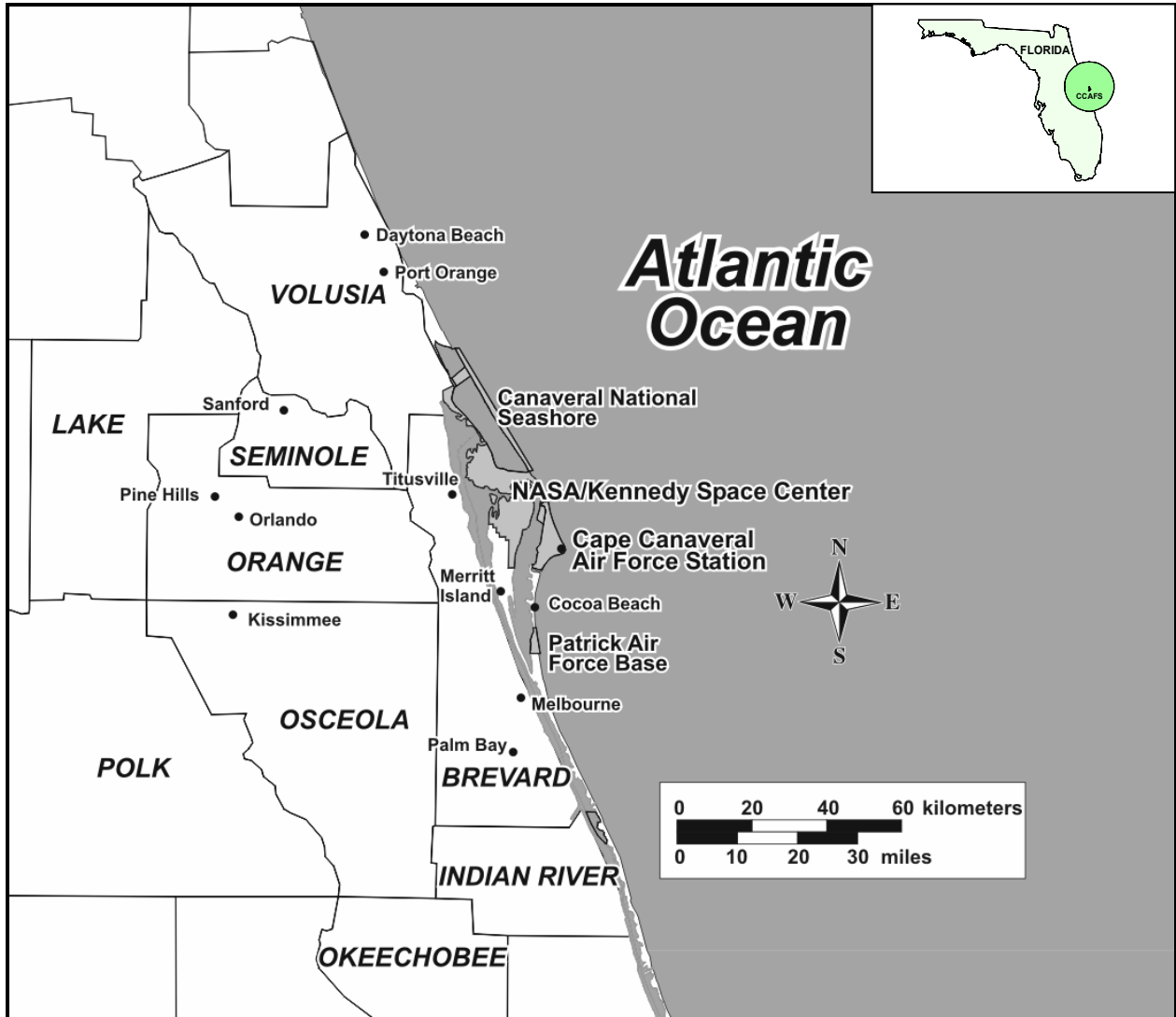


FIGURE 3-1. THE REGIONAL AREA NEAR CCAFS

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 and launch support, restricted development, port operations, industrial area, and airfield operations. Approximately 1,600 ha (3,900 ac) or 25 percent of the station is developed, with over 40 space launch complexes (SLC) and support facilities, many of which have been deactivated. The remaining 75 percent (about 4,800 ha (11,900 ac)) is undeveloped land (USAF 2001).

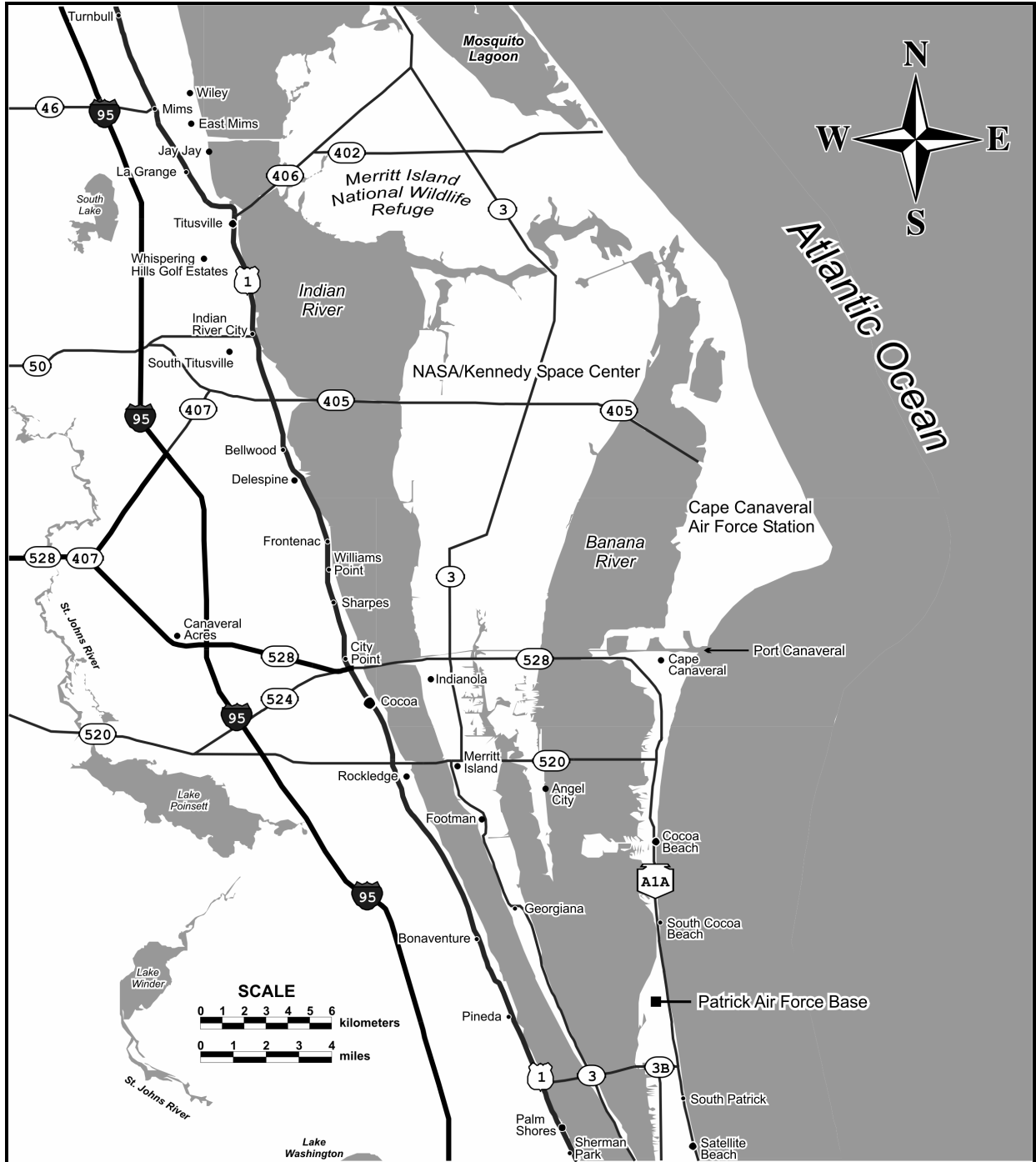


FIGURE 3-2. CCAFS AND THE SURROUNDING AREA

KSC, immediately to the west of CCAFS, occupies about 56,700 ha (140,000 ac) of Merritt Island. Only about 3 percent (1,540 ha (3,800 ac)) of KSC is developed or designated for NASA use. About 40 percent of the KSC area (21,900 ha (54,200 ac)) is open water. NASA has delegated management of the undeveloped areas within KSC to the U.S. Fish and Wildlife Service (FWS) and to the National Park Service (NPS) (NASA 2003).

Land use surrounding CCAFS involves urban areas with land devoted to transportation and other rights-of-way, an active seaport, recreation and wildlife management areas, and agricultural uses, including crops, citrus, and pasturage.

The Atlas V launch vehicle planned for the proposed New Horizons mission would be launched from Space Launch Complex 41 (SLC-41), which is located in the southernmost section of KSC. NASA has permitted CCAFS to use SLC-41 and the surrounding land.

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. Temperatures in both summer and winter are moderated by the waters of the Indian River Lagoon system and the Atlantic Ocean. Maximum temperatures in summer show little day to day variation. Minimum temperatures in winter may vary considerably from day to day, largely due to cold fronts that move across the United States from the northwest to the east and southeast. Rainfall is heaviest in summer, with about 65 percent of the annual total of 142 centimeters (cm) (56 inches (in)) falling from June through October in an average year. The other 35 percent is evenly distributed throughout the average year. Thunderstorms bringing high winds and heavy rain typically occur from May through September. Surface mixing typically occurs during the winter and summer. Climatological data from KSC indicates that winds during the Proposed Action's launch opportunity would occur predominantly from north-northwest (Table 3-1). Sea breezes (winds from the ocean towards land) and land breezes (winds from land towards the ocean) commonly occur daily during summer and fall. Sea breezes occur at the surface during the day, and land breezes occur at night (USAF 1998, USAF 2001).

CCAFS is vulnerable to hurricanes and their associated storm tides during the summer and fall. Historic data show that the storm tide height for a Category 5 (strongest) hurricane would reach to 4.6 meters (m) (15 feet (ft)), inundating most of CCAFS. The high hurricane winds necessitate adherence to special construction codes, established to reduce wind load-damage to structures (USAF 2001).

3.1.2.1 Air Quality

Air quality is regulated through the National Ambient Air Quality Standards (NAAQS) promulgated under the Clean Air Act, as amended (42 U.S.C. 7401 et seq.) (CAA). Under NAAQS, Federal primary and secondary air quality standards are established for six criteria pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO₂), ozone (O₃), particulate matter (PM₁₀ and PM_{2.5}, particulate matter less than 10 and 2.5 microns in diameter, respectively), and sulfur dioxide (SO₂). The Federal primary standards set limits to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. The Federal secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to

animals, crops, vegetation, and buildings from any known or anticipated adverse effects of a pollutant (EPA 2003a).

TABLE 3-1. CLIMATOLOGY DATA FOR BREVARD COUNTY, FLORIDA

Month	Surface Winds		Precipitation ^(a)		Fog	Thunderstorms
	Prevailing Direction	Mean Speed (km per hour (mph))	≥0.25 cm (≥0.1 in)	≥1.27 cm (≥0.5 in)	Visibility <3.2 km (<2 mi)	
Mean Number of Days Occurrence						
January	NNW	13 (8)	4	2	9	1
February	N	13 (8)	5	2	7	2
March	SSE	13 (8)	6	3	7	3
April	E	14 (9)	5	3	4	3
May	E	13 (8)	6	2	3	8
June	E	11(7)	10	4	2	13
July	S	10 (6)	13	5	2	16
August	E	10 (6)	9	5	2	14
September	E	10 (6)	12	6	2	10
October	E	13 (8)	6	5	3	4
November	N	11 (7)	3	1	6	1
December	NW	13 (8)	4	1	7	1
Annual	E	11 (7)	83	39	54	76
Years of Record	10	10			26	26

Sources: USAF 1998, USAF 2001

(a) Snowfall has not occurred in over three decades.

Florida has also established air quality standards for criteria pollutants (FAC 62-204.240). The State standards closely follow the Federal standards, with the following differences: Florida has not established a standard for PM_{2.5}, and has set a standard for SO₂ that is more stringent than the Federal standard for comparable measurement averaging times.

Air quality at CCAFS is considered good (FDEP 2002). Table 3-2 compares ambient concentrations with current Federal and State standards. Ambient concentrations of criteria pollutants for Brevard and Orange Counties for 2001 did not exceed the Federal or State standards. 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 (FDEP 2002). Therefore, the CAA General Conformity Rule would not apply.

On July 18, 1997, the U.S. Environmental Protection Agency (EPA) adopted the 8-hour O₃ standard, which is intended to eventually replace the one-hour standard. On April 15, 2004, the EPA issued the first phase of the final rule in the *Federal Register* (FR),

designating nonattainment areas of the country that exceed the new standard (69 FR 23857). The EPA designated the entire State of Florida as unclassifiable/attainment for the new 8-hour O₃ standard.

Also on July 18, 1997, the EPA promulgated a new standard for fine particles (PM_{2.5}). States were required to submit their recommendations for designating individual counties as attainment or nonattainment by February 2004. On January 5, 2005, the EPA agreed with Florida's recommendations and classified the entire State of Florida as unclassifiable/attainment for the new fine particle standard (70 FR 943).

TABLE 3-2. SUMMARY AIR QUALITY DATA NEAR CCAFS FOR 2002

Criteria Pollutant	Federal Standard ^(a) µg/m ³ (ppm)		Florida State Standard µg/m ³ (ppm)	2002 Ambient Concentrations µg/m ³ (ppm)
Carbon Monoxide (CO)				
1-hour Average	40,000 (35)	Primary	40,000 (35)	(5)
8-hour Average	10,000 (9)	Primary	10,000 (9)	(3)
Lead (Pb)				
Quarterly Average	1.5	Both Primary & Secondary	1.5	no data
Nitrogen Dioxide (NO ₂)				
Annual Arithmetic Mean	100 (0.053)	Both Primary & Secondary	100 (0.053)	(0.011)
Ozone (O ₃)				
1-hour Average	235 (0.12)	Both Primary & Secondary	235 (0.12)	(0.090)
8-hour Average	157 (0.08)	Secondary	no standard	(0.076)
Particulate Matter (PM ₁₀)				
Annual Arithmetic Mean	50	Both Primary & Secondary	50	18
24-hour Average	150	Secondary	150	67
Particulate Matter (PM _{2.5})				
Annual Arithmetic Mean	15	Both Primary & Secondary	no standard	7.8
24-hour Average	65	Secondary	no standard	24
Sulfur Dioxide (SO ₂)				
Annual Arithmetic Mean	80 (0.03)	Primary	60 (0.02)	(0.001)
24-hour Average	365 (0.14)	Primary	260 (0.10)	(0.005)
3-hour Average	1,300 (0.5)	Secondary	1,300 (0.5)	(0.013)

Sources: EPA 2003a, FAC 62-204.240, FDEP 2002

(a) Federal primary standards are levels of air quality necessary, with an adequate margin of safety, to protect the public health. Federal secondary standards are levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

µg/m³ = micrograms per cubic meter

ppm = parts per million

3.1.3 Ambient Noise

Ambient noise levels at CCAFS have not been monitored. The USAF has initiated a project to study the effects of rocket launch noise (USAF 2001). The 24-hour average ambient noise levels at KSC, where similar industrial activities occur, is lower than the upper level of 65 A-weighted decibels (dBA) recommended by the EPA (NASA 2003). Noise levels at resorts and on the beaches near Cape Canaveral probably range from 45 to 55 dBA (USAF 1998).

3.1.4 Geology and Soils

CCAFS, composed of relict beach ridges, is 7.2 km (4.5 mi) at its widest point with elevations ranging from sea level to 6 m (20 ft) above mean sea level (USAF 2001).

The four stratigraphic units from surface downwards are: the surficial sands, the Caloosahatchee Marl, Hawthorn Formation, and the limestone formations of the Floridan Aquifer. The Hawthorn Formation separates the Floridan Aquifer from the shallower aquifers (groundwater basins) in the area. The Upper Floridan Aquifer is under artesian pressure (the natural pressure that helps boost water upwards in wells) in the vicinity of CCAFS. 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 and have a high buffering capacity (Schmalzer et al. 1998). No prime or unique farmland is present 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 (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. The Indian and Banana Rivers are connected by the Barge Canal at Port Canaveral. Surface drainage at CCAFS is generally westward toward the Banana River (USAF 1998).

The 100-year floodplain on CCAFS extends 2 m (7 ft) above mean sea level on the Atlantic Ocean side to the east and 1.2 m (4 ft) above mean sea level on the Banana River side to the west. SLC-41 does not lie within the 100-year floodplain and is not located within a wetland (USAF 1998).

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) (Figure 3-3). 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).

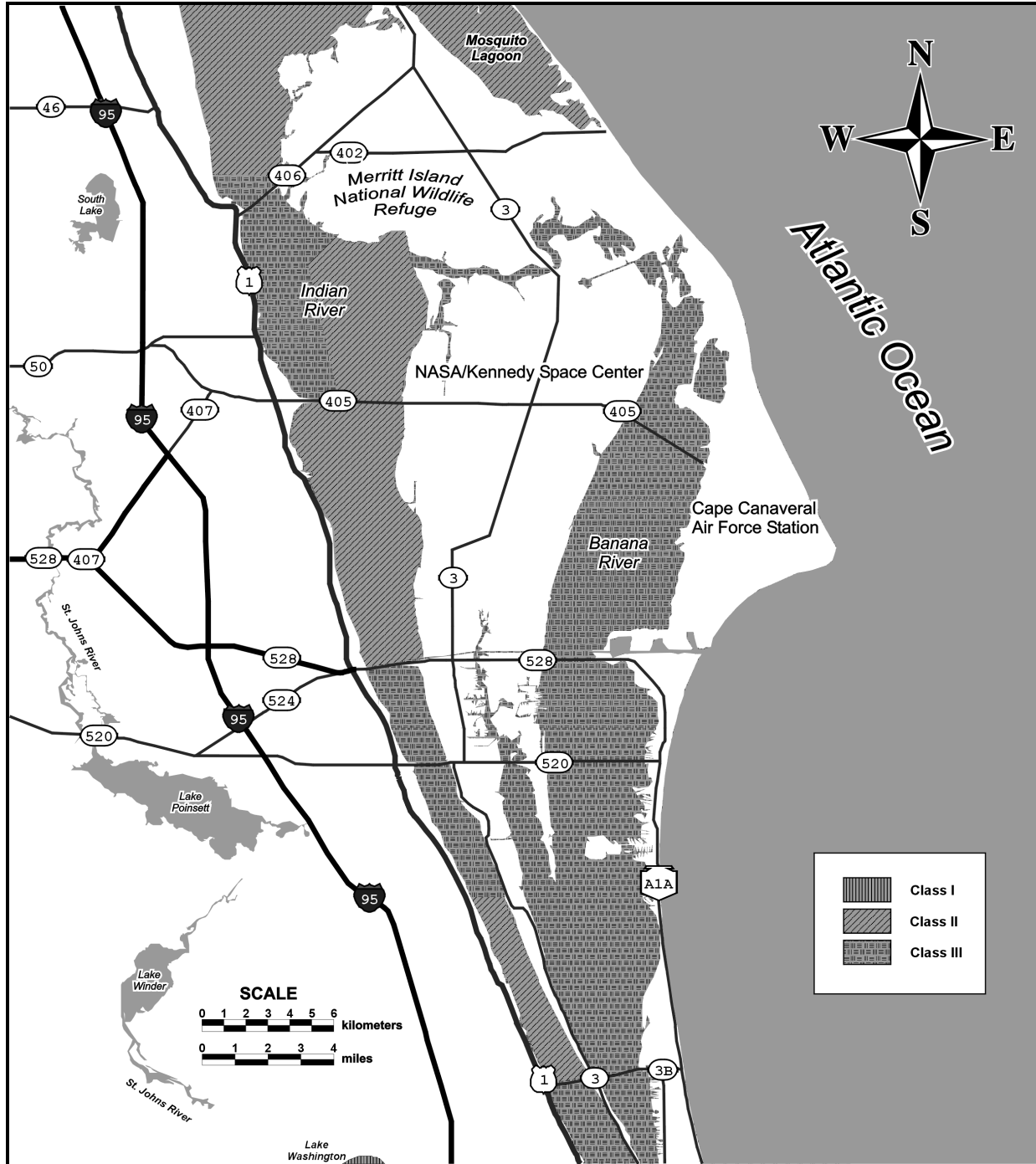


FIGURE 3-3. SURFACE WATER CLASSIFICATIONS NEAR CCAFS

Areas of the Banana River south of CCAFS, and the entire Mosquito Lagoon north of CCAFS have been designated as Aquatic Preserves under Florida's Aquatic Preserve Act of 1975 (FAC 62-302.700). Aquatic Preserves have exceptional biological, aesthetic, and scientific values and have substantial restrictions placed on activities like oil and gas drilling and effluent discharges (NASA 2003).

Surface waters within the MINWR, the Canaveral National Seashore, and the Banana River Aquatic Preserve located near CCAFS have been designated as Outstanding Florida Waters (Figure 3-4), and as such are afforded the highest protection by the State of Florida (FAC 62-302.700). The State established this special designation for surface waters that demonstrate recreational or ecological significance. Other Outstanding Florida Waters in the vicinity of CCAFS include 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. In addition, the EPA's National Estuary Program has selected the Indian River Lagoon System, which includes the Mosquito Lagoon, as an Estuary of National Significance. The goal of this program is to balance conflicting uses of the Nation's estuaries while restoring or maintaining their natural character. No designated wild or scenic rivers are located on or near CCAFS (USAF 1998, NASA 2003).

3.1.5.2 Surface Water Quality

Brevard County, the State of Florida, and the U.S. Fish and Wildlife Service (FWS) maintain long-term water quality monitoring stations located in the Mosquito Lagoon, the Banana River, the Banana Creek, the Indian River, and other locations on or near KSC. 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 portion of the Indian River. The waters tend to be alkaline and have good buffering capacity. Water samples have been analyzed for various parameters from inland bodies of water near CCAFS and KSC. Certain metals (e.g., aluminum, calcium, chlorides, iron, magnesium, potassium, sodium), a pesticide (dieldrin), and some poly aromatic hydrocarbons (e.g., naphthalene, fluorene) were measured above detection limits. However, the detection limits for these parameters were below the Class I (potable water) and Class II (shellfish propagation and harvesting) water quality criteria except for dieldrin (NASA 2003).

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

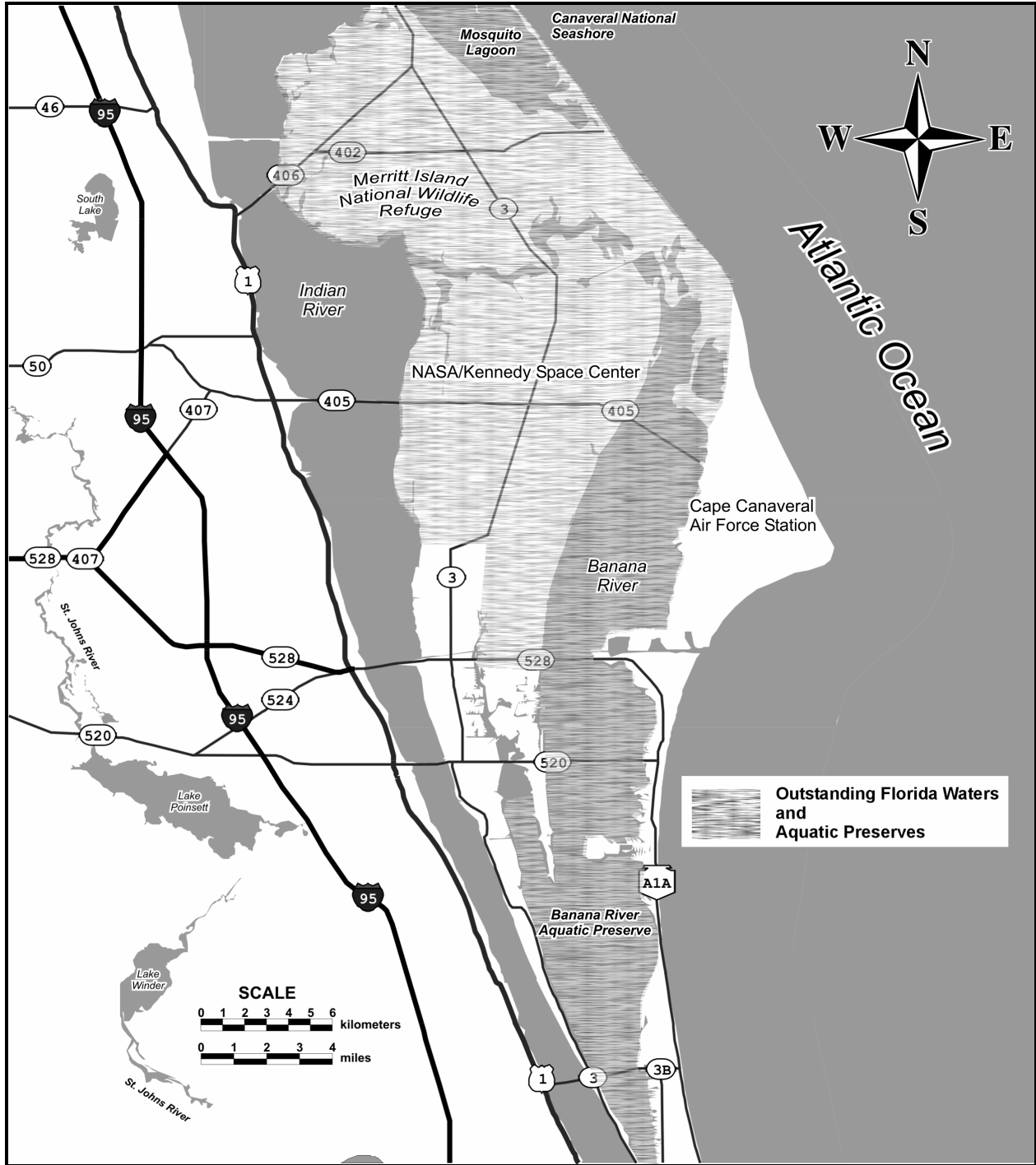


FIGURE 3-4. OUTSTANDING FLORIDA WATERS AND AQUATIC PRESERVES NEAR CCAFS

layers, but above and within the Hawthorn Formation. Recharge is minor and depends on leakage through surrounding lower permeability soils. 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. 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, NASA 2003).

3.1.5.4 Groundwater Quality

In the immediate 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 due to the long distance from freshwater recharge areas.

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.

Groundwater quality in the surficial aquifer system at CCAFS remains good because of immediate recharge, active flushing, and a lack of development. 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 (mg/l) (10,000 parts per million (ppm)) and national drinking water criteria for all parameters other than iron and total dissolved solids.

There are several sites in Florida listed as manufacturers or users of perchlorates. However, Florida (and therefore Brevard County and CCAFS) is not listed as having areas that contain high levels of perchlorate contamination of groundwater or soils (EPA 2003b).

3.1.5.5 Offshore Environment

The Atlantic Ocean near CCAFS can be characterized by its bottom topography and circulation. Near the shore, sandy shoals dominate the underwater topography. The sea floor continues to deepen from the coast extending to the Blake Plateau.

Offshore currents usually reflect the general northern flow of the Gulf Stream (NOAA 1980). Studies of water movements in the area indicate surface to bottom shoreward currents, although wind generally determines current flow at the surface. From November to April, 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. In general, prevailing winds during January and February (the launch opportunity for the proposed New Horizons mission) would occur from the north-northwest (Table 3-1).

In the region out to the sloping bank, 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 3.1.5.1, 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 percent (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. 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 half of the region is rangeland and forests of various types, wetlands, and open water (SFWMD 1995, SJRWMD 1998).

TABLE 3-3. MAJOR LAND COVER TYPES IN THE CCAFS REGIONAL AREA

Major Land Use - Land Cover Classification	Brevard County	Indian River County	Orange County	Osceola County	Seminole County	Volusia County	Six-County Region Total
	acres (percent)	acres (percent)	acres (percent)	acres (percent)	acres (percent)	acres (percent)	acres (percent)
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)

Sources: Extracted from SJRWMD 1998 and SFWMD 1995

Note: One acre equals 0.4047 hectares (0.004 square kilometers)

The majority of the land at and near CCAFS, including KSC, the MINWR, the Mosquito Lagoon, and the 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. The FWS National Wetlands Inventory conducted in 1994 identified a total of 905 ha (2,235 ac) of wetlands on CCAFS (USAF 1998).

Approximately 75 percent (4,800 ha (11,900 ac)) of the land at CCAFS is undeveloped. Within these undeveloped areas there are eleven natural communities: Beach Dune, Scrub, Hydric Hammock, Coastal Grassland, Xeric Hammock, Estuarine Tidal Swamp, Coastal Strand, Maritime Hammock, Estuarine Tidal Marsh, Coastal Interdunal Swale and Shell Mound (USAF 2001).

These natural communities support many reptile, amphibian, bird, and mammal species. Such species include alligator, snakes, turtles, toads, waterfowl, wading birds, warblers, owls, squirrel, raccoon, white-tail deer, skunk, and rabbit (USAF 2001). In addition, the CCAFS/KSC area including the MINWR is host to diverse populations of migratory birds that are protected by the Migratory Bird Treaty Act, as amended (16 U.S.C. 703 et seq.). Many migratory birds also use this area as wintering grounds (NASA 2003, USAF 2001).

3.1.6.2 Aquatic Resources

The coastline from Daytona to Melbourne is one of the most productive marine fishery areas along the southern Atlantic coast. Diverse freshwater, estuarine, and marine fish inhabit the waters around CCAFS. Inland waters support sea trout and redfish sport fisheries. 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.

Commercial and recreational fishing is a major economic asset to the region. Diverse freshwater, estuarine, and marine fish and shellfish inhabit the waters in the CCAFS region. The Mosquito Lagoon is considered among the best oyster and clam harvesting areas on the east coast.

The conservation of essential fish habitat (EFH) is an important component of building and maintaining sustainable fisheries. The Magnuson-Stevens Fishery Conservation and Management Act, as amended (16 U.S.C. 1801 et seq.) (M-S Act), calls for direct action to stop or reverse the continued loss of fish habitats. Toward this end, Congress mandated the identification of habitats essential to managed species and measures to conserve and enhance this habitat. The M-S Act requires cooperation among the U.S. Department of Commerce, acting through the National Marine Fisheries Service (NMFS), eight regional Fishery Management Councils, fishing participants, and Federal and state agencies to protect, conserve, and enhance EFH. Federal agencies are to consult with the NMFS on ways to minimize adverse impacts on EFH from the agencies' non-fishing activities. The USAF has a programmatic consultation in place with the NMFS on EFH regarding Atlas V launches from CCAFS (USAF 2000).

The South Atlantic Fishery Management Council manages identified EFH in the marine area surrounding CCAFS. The Council currently manages habitat for the following species: South Atlantic Snapper-Grouper complex, South Atlantic shrimps, Coastal Migratory Pelagic species, Highly Migratory species, Red Drum, Spiny Lobster, Golden Crab, Calico Scallop and Sargassum.

3.1.6.3 Threatened and Endangered Species

The Federal Threatened or Endangered Species List, prepared by the FWS under the Endangered Species Act, as amended (16 U.S.C. 1531 et seq.), currently recognizes 103 endangered or threatened animal and plant species in the state of Florida. Another 14 species (including 13 plants) in the state of Florida are listed as candidate species and are being reviewed for possible Federal listing. No new animal or plant species are proposed for Federal listing as threatened or endangered at this time (FWS 2003). The State of Florida considers 117 animal species as threatened, endangered, or as species of special concern and 413 plant species as threatened, endangered, or commercially exploited (FDACS 2003, FFWCC 2004). Table 3-4 presents a list of Federal and State endangered and threatened species, and species of special concern, known to occur at or near CCAFS (USAF 2001).

A population of Florida Manatee, a subspecies of the endangered West Indian Manatee, occurs near CCAFS. Areas that have been designated as manatee protection areas (refuges and sanctuaries) by the FWS and State of Florida include 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 manatee). Specific areas include the waters of the Banana River from State Road 528 north to the NASA Parkway East causeway, the Barge Canal, to the immediate south of CCAFS, Sykes Creek in Brevard County, the Banana River just west of Cocoa Beach, and the Haulover Canal at the north end of Merritt Island (67 FR 680, 67 FR 68450, 69 FR 40796, FAC 68C-22).

Loggerhead, green, and leatherback sea turtles use the beaches at CCAFS as nesting habitat. Nesting typically occurs between May and October. The launch complexes use 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. SLC-41 is within several hundred meters of sea turtle nesting beaches. CCAFS's lighting management plan minimizes light impacts on sea turtle nesting beaches (USAF 2001).

A large population of the threatened southeastern beach mouse has been found at CCAFS launch sites where open grassland habitat is maintained. Coastal grasslands and strand provide habitat for the highest population densities at CCAFS. Other primary habitat is the coastal dune (USAF 1998).

TABLE 3-4. THREATENED, ENDANGERED, AND SPECIES OF SPECIAL CONCERN OCCURRING ON OR NEAR CCAFS

Common Name	Scientific Name	Federal Status	State Status
Plants			
Beach-star	<i>Remirea maritima</i>	---	E
Coastal vervain	<i>Verbena maritima</i>	---	E
Curtiss milkweed	<i>Asclepias curtissii</i>	---	E
East coast lantana	<i>Lantana depressa</i> var. <i>floridana</i>	---	E
Hand fern	<i>Ophioglossum palmatum</i>	---	E
Nakedwood	<i>Myrcianthes fragrans</i>	---	T
Nodding pinweed	<i>Lechea cernua</i>	---	T
Sand dune spurge	<i>Chamaesyce cumulicola</i>	---	E
Satinleaf	<i>Chrysophyllum oliviforme</i>	---	T
Scaevola	<i>Scaevola plumieri</i>	---	T
Sea lavender	<i>Tournefortia gnaphalodes</i>	---	E
Shell mound prickly-pear	<i>Opuntia stricta</i>	---	T
Reptiles and Amphibians			
American Alligator	<i>Alligator mississippiensis</i>	T(S/A)	SSC
Atlantic Green Sea Turtle	<i>Chelonia mydas mydas</i>	E	E
Atlantic Hawksbill Turtle	<i>Eretmochelys imbricata</i>	E	E
Atlantic Loggerhead Sea Turtle	<i>Caretta caretta</i>	T	T
Atlantic Ridley Sea Turtle	<i>Lepidochelys kempii</i>	E	E
Eastern Indigo Snake	<i>Drymarchon corais couperi</i>	T	T
Florida Pine Snake	<i>Pituophis melanoleucus mugitus</i>	---	SSC
Gopher Tortoise	<i>Gopherus polyphemus</i>	---	SSC
Leatherback Turtle	<i>Dermochelys coriacea</i>	E	E
Birds			
American Oystercatcher	<i>Haematopus palliatus</i>	---	SSC
Arctic Peregrine Falcon	<i>Falco peregrinus tundrius</i>	---	E
Bald Eagle	<i>Haliaeetus leucocephalus</i>	T	T
Black Skimmer	<i>Rynchops niger</i>	---	SSC
Brown Pelican	<i>Pelecanus occidentalis</i>	---	SSC
Florida Scrub-Jay	<i>Aphelocoma coerulescens</i>	T	T
Least Tern	<i>Sterna antillarum</i>	---	T
Little Blue Heron	<i>Egretta caerulea</i>	---	SSC
Piping Plover	<i>Charadrius melodus</i>	T	T
Reddish Egret	<i>Egretta rufescens</i>	---	SSC
Roseate Spoonbill	<i>Ajaia ajaja</i>	---	SSC
Snowy Egret	<i>Egretta thula</i>	---	SSC
Southeastern American Kestrel	<i>Falco sparverius paulus</i>	---	T
Tricolored Heron	<i>Egretta tricolor</i>	---	SSC
White Ibis	<i>Eudocimus albus</i>	---	SSC
Wood Stork	<i>Mycteria americana</i>	E	E
Mammals			
Finback Whale	<i>Balaenoptera physalus</i>	E	E
Florida Manatee	<i>Trichechus manatus</i>	E	E
Florida Mouse	<i>Peromyscus floridanus</i>	---	SSC
Gray Bat	<i>Myotis grisescens</i>	E	E
Humpback Whale	<i>Megaptera novaeangliae</i>	E	E
North Atlantic Right Whale	<i>Eubalaena glacialis</i>	E	E
Sei Whale	<i>Balaenoptera borealis</i>	E	E
Southeastern Beach Mouse	<i>Peromyscus polionotus niveiventris</i>	T	T

Sources: FDACS 2003, FFWCC 2004, USAF 2001

E = Endangered; SSC = Species of Special Concern; T = Threatened
(S/A) = listed by similarity of appearance to a listed species

Wood storks are year-round residents of the Cape Canaveral area, nesting in treetops of mangrove swamps and near water impoundments. Florida scrub jays use the oak scrub habitat at CCAFS. 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.

Four endangered whale species (finback, humpback, North Atlantic right, and sei) occur in the coastal waters near CCAFS. The NMFS has designated critical habitat for the North Atlantic right whale, which includes marine waters adjacent to the coasts of Georgia and Florida, including the Cape Canaveral area (59 FR 13500).

3.1.7 Socioeconomics

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

3.1.7.1 Population

The regional area consists of six counties: Brevard, Indian River, Orange, Osceola, Seminole, and Volusia. Figure 3-5 highlights population centers located within the six-county region. 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 presents the population for each of the counties in the regional area and the projected populations for 2006.

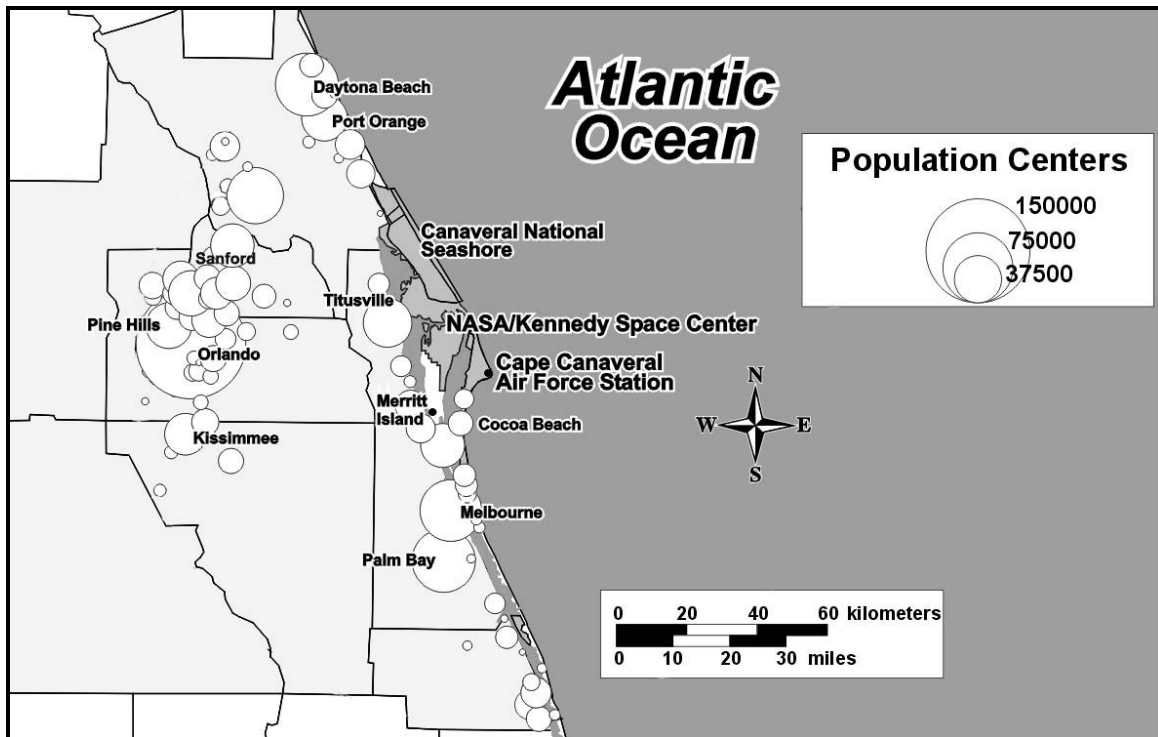


FIGURE 3-5. POPULATION CENTERS IN THE CCAFS REGIONAL AREA

TABLE 3-5. POPULATION OF THE CCAFS REGIONAL AREA

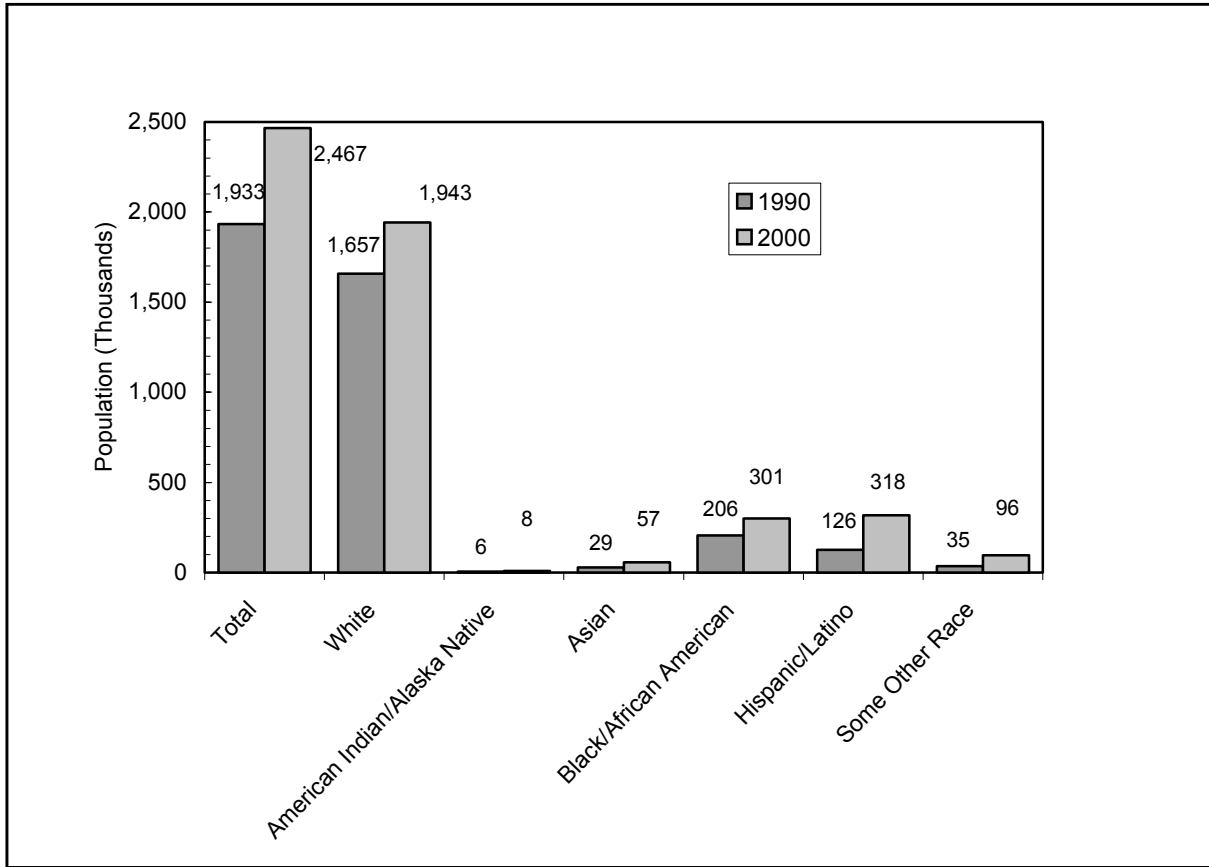
County	Census Population 2000	Projected Population 2006
Brevard	476,230	519,640
Indian River	112,947	126,299
Orange	896,344	1,042,440
Osceola	172,493	208,720
Seminole	365,196	415,820
Volusia	443,343	485,800
Six-County Region	2,466,553	2,798,719

Sources: USBC 2001, BEBR 2002

Figure 3-6 shows population groups residing within the regional area in 1990 and 2000. The regional population grew at a faster rate than the State's from 1990 to 2000 by 27.6 percent (1,932,646 to 2,466,553), whereas the State's population grew by 23.5 percent (12,937,926 to 15,982,378). The population in Brevard County grew by 19.4 percent (398,978 to 476,230), a lower rate than both the State and the six-county region (USBC 2001). Minorities comprised approximately 14.2 percent of the total resident population in the six-county region in 1990. Between 1990 and 2000, the minority population in the regional area of interest increased by more than 50 percent, and by 2000, minority persons comprised about 21 percent of the residents (Appendix C).

The six-county region is expected to have population increases through 2006, with a projected population of almost 2.8 million. The population of Brevard County is projected to increase to 519,640 persons in 2006. Orange County is expected to remain the most populated, with a projected population of 1,042,440 persons by 2006.

Persons whose income is less than the poverty threshold are defined as low-income persons by the Council on Environmental Quality (CEQ 1997). In 1990, about 10 percent of the persons living in the regional area of interest reported incomes that were below the 1989 poverty threshold (Appendix C, Table C-1). By the year 2000, 10.7 percent of the persons living in the regional area of interest reported incomes below the 1999 poverty threshold. In 1990, low-income persons comprised less than 10 percent of the population residing within 20 km (12 mi) of the launch complex. That percentage decreased to less than 8 percent by the year 2000. The percentage of persons living in the regional area of interest and whose incomes were below the poverty threshold (10.7 percent) in 2000 was less than the three-year average of 11.9 percent for the United States as a whole (DOC 2001, USBC 2001).



Note: 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 enumerations methodology to include multiracial responses and added a separate racial category, "Native Hawaiian or Other Pacific Islander". As an individual may report more than one race, the aggregate of Population Group may not match the total. For the 1990 census year, the American Indian includes Eskimo or Aleut groups, the Asian includes Pacific Islander groups, the Hispanic/Latino includes Hispanics of any race. For the 2000 census year, the Asian includes Native Hawaiian and other Pacific Islander groups and the Hispanic/Latino includes Hispanics of any race.

FIGURE 3-6. POPULATION GROUPS IN THE CCAFS REGIONAL AREA

3.1.7.2 Economy

The region's economic base is tourism and manufacturing, with tourism attracting 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 providing a multimillion-dollar economic boost to Brevard County, and the Port's cargo business is emerging as a major economic contributor to Central Florida.

Industrial sectors in Brevard County providing significant employment in 2000 were services (34.2 percent), wholesale and retail trade (24.3 percent), government (14.3 percent), manufacturing (13.8 percent), construction (5.9 percent), finance, insurance,

and real estate (3.3 percent), transportation, communications and public utilities (2.8 percent), and agriculture and fishing (1.1 percent) (BEBR 2001).

An estimated 1,224,643 people were employed in the regional area in 2000. The unemployment rate for the region in 2000 was estimated at 2.9 percent. Brevard County had 220,413 people employed in 2000 with an unemployment rate of 2.8 percent (USBC 2000, BEBR 2001).

Employment at CCAFS includes about 5,700 military and civilian personnel, all associated with the USAF (Chambers 2003). Most employees are contractor personnel from companies associated with missile testing and launch vehicle operations. Military personnel are attached to the 45th Space Wing at Patrick Air Force Base (PAFB), approximately 32 km (20 mi) south of CCAFS (USAF 2001).

3.1.7.3 Transportation Systems

The region is supported by a network of Federal, State and County roads (Figure 3-2). Rail service for freight is available in all six counties, although passenger service is limited. The Florida East Coast Railway provides rail transportation in the CCAFS/KSC area. A main rail line traverses the cities of Titusville, Cocoa, and Melbourne.

The region has three major airports: Orlando International, Daytona Beach International, and Melbourne International. Melbourne International Airport, the closest air transportation facility of the three, is located 48 km (30 mi) south of CCAFS. CCAFS contains a skid strip (runway) for government aircraft and delivery of launch vehicle components. Airfreight associated with the operation of CCAFS launch complexes arrives at the CCAFS skid strip.

Port Canaveral, the nearest navigable seaport to CCAFS, has approximately 480 m (1,600 ft) of dockage. With six cruise terminals and two more planned, Port Canaveral has become the second busiest cruise port in the world (Port Canaveral 2003).

3.1.7.4 Public and Emergency Services

Health care in the region is provided at 28 general hospitals, three psychiatric hospitals, and two specialized hospitals. Emergency medical services for CCAFS personnel are provided at the Occupational Health Facility at KSC. Additional health care services are provided by nearby public hospitals located outside of CCAFS.

Nearly 90 percent 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 up to 3.8 million liters (1 million gallons (gal)) per day (USAF 1998). The Cocoa water system draws its supplies from the Floridan Aquifer. The water distribution system at CCAFS is sized to accommodate the short-term high-volume flows required for launches.

A mutual-aid agreement exists between the City of Cape Canaveral, Brevard County, KSC, and the range contractor at CCAFS for reciprocal support in the event of an emergency or disaster (USAF 1998). Further, CCAFS and the Brevard County Office of

Emergency Management have agreements for communications and early warning in the event of a launch accident.

Range Safety monitors launch surveillance areas to ensure that risks to people, aircraft, and surface vessels are within acceptable limits. Control areas and airspace are closed to the public as required. The USAF is responsible for disseminating a Notice to Aviators through the Federal Aviation Administration (FAA), and air traffic in a FAA-designated area around the launch corridor is controlled. Radar surveillance for intruding aircraft within a 93 km (50 nautical miles) radius of the launch site is conducted beginning 30 minutes prior to a scheduled launch and continuing until the launch is complete. The USAF also ensures that a Notice to Mariners within a predetermined impact debris corridor is disseminated beginning 10 working days prior to a launch. The U.S. Coast Guard transmits marine radio broadcast warnings to inform vessels of the effective closure time for the sea impact debris corridor. In addition, warning signs are posted in various Port Canaveral areas for vessels leaving port (USAF 1998). In addition, PAFB maintains a web site and toll-free telephone number with launch hazard area information for mariners and restricted airspace information for pilots.

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 River), and freshwater lakes scattered throughout the region. The Canaveral National Seashore lies to the north of CCAFS, and the MINWR, which includes most of KSC, lies immediately to the west. Seven State wildlife management areas, primarily in the St. Johns River basin, are used for hunting small game, turkey, hogs, and deer. Within the confines of CCAFS, the use of recreational activities and facilities is limited to CCAFS personnel. Military and civilian personnel may use recreational and cultural facilities available in local communities.

3.1.7.6 Cultural/Historic/Archaeological Resources

Cultural facilities at CCAFS include the Air Force Space and Missile Museum and the original NASA mission control, and are located at the southern portion of the base.

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 (NRHP) (DOI 2003). No NRHP listed or eligible prehistoric or historic archeological sites have been identified at SLC-41.

Archaeological investigations at CCAFS indicate that human occupation of the area first occurred approximately 4,000 years ago. Federal regulations require that NASA takes into consideration the impact of its activities on cultural resources which are on, or are considered eligible for listing on, the NRHP. Surveys of CCAFS recorded 56 prehistoric and historic archaeological sites, with several identified as eligible for listing on the NRHP. Launch Pads 5/6, 14, 19, 26, 34, and the original Mission Control Center at CCAFS are listed on the NRHP and form a National Historic Landmark District associated with the Man in Space Program. Launch Complexes 1/2, 3/4, 9/10, 17,

21/22, 31/32, and the original site of the Cape Canaveral Lighthouse and the Lighthouse itself are considered as eligible for listing on the NRHP (USAF 2001).

3.2 THE GLOBAL ENVIRONMENT

In accordance with Executive Order 12114, *Environmental Effects Abroad of Major Federal Actions*, this section provides a general overview of the global environment. It includes basic descriptions of the troposphere and stratosphere, global population distribution and density, and the distribution of land surface types. It also briefly discusses background radiation and 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 percent 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 (Figure 3-7).

In the troposphere, 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). In general, the troposphere is well mixed and aerosols in the troposphere are removed in a short period of time (ranging from a few days to a few weeks) as a result of both the mixing within this layer and scavenging by precipitation. A narrow region called the tropopause separates the troposphere and the stratosphere.

Emissions from rocket launches include particulate matter, oxides of nitrogen, carbon monoxide, and chlorine compounds. Removal of most of these 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) (Figure 3-7). 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, on the order of months, 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. This temperature increase is caused primarily by the adsorption of short-wave radiation by ozone molecules.

The USAF has documented estimates of the total annual input of rocket exhaust products to the stratosphere from 23 Atlas, Delta, and Titan launches from CCAFS in 1995 and another 23 launches in 1996 (USAF 1998). The total estimated annual input to the stratosphere from these launches averaged about 376 metric tons (414 tons) per

year of particulate matter, 1.4 metric tons (1.5 tons) per year of NO_x, 725 metric tons (799 tons) per year of CO, and 188 metric tons (208 tons) per year of chlorine compounds.

The Montreal Protocol is designed to protect the stratospheric ozone layer by phasing out production and consumption of substances that deplete the ozone layer. It was first signed in 1987 and additional requirements were adopted through 1999. Recent measurements indicate that stratospheric chlorine levels are decreasing, consistent with expected declines resulting from the Montreal Protocol.

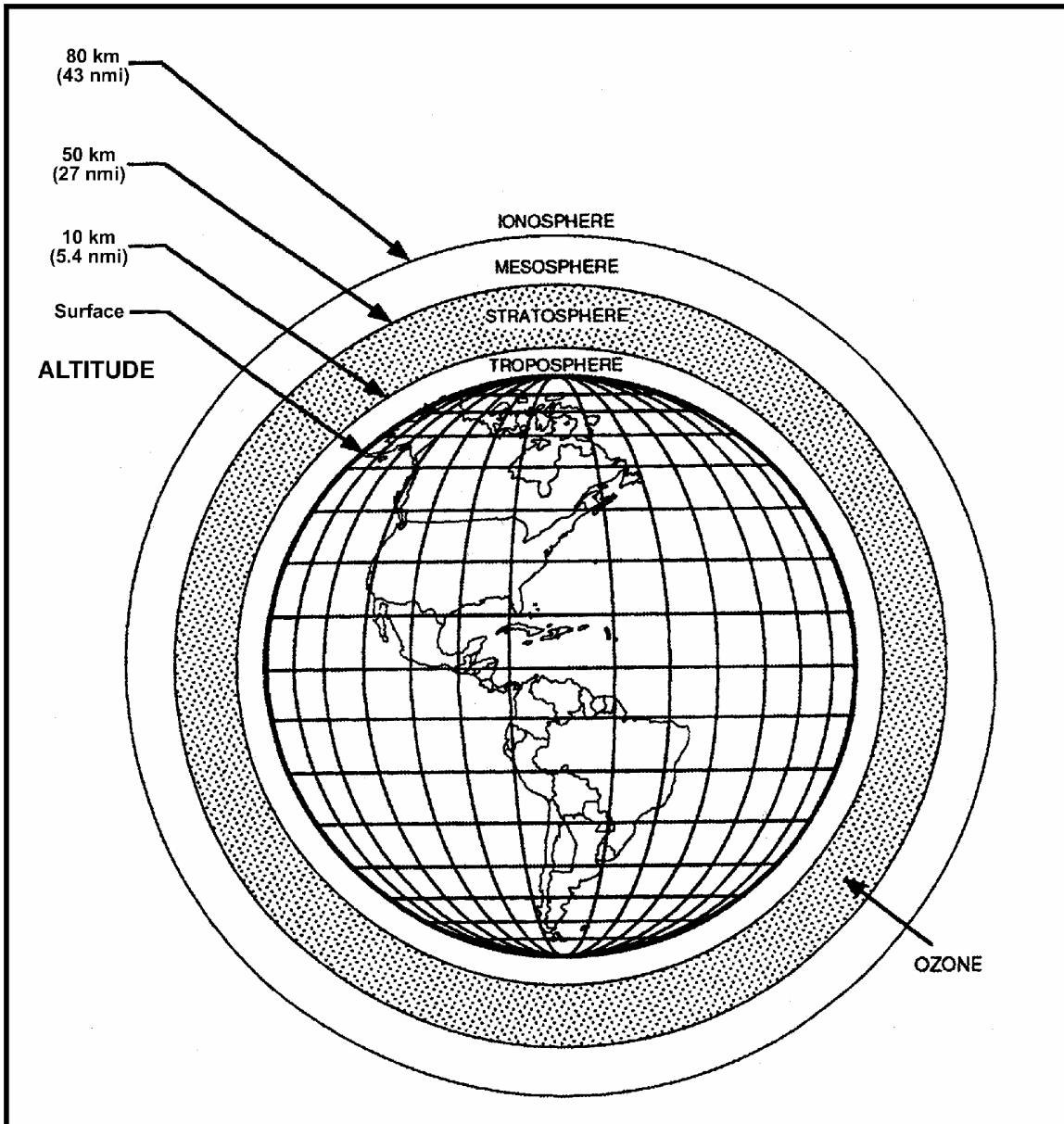


FIGURE 3-7. ATMOSPHERIC LAYERS AND THEIR ESTIMATED ALTITUDE

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 Corporation (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 factor of 1.356 to provide population estimates for 2006 (Bartram 2004).

Table 3-6 lists the distribution of the Earth's projected population for 2006 across each of the 20 equal-area latitude bands. 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 3-6. GLOBAL POPULATION AND SURFACE CHARACTERISTICS BY LATITUDE BAND

Latitude Band	Band Population Estimate for 2006	Population Density ^(a) persons/km ² (persons/mi ²)	Band Surface Fractions			
			Water	Land	Land Rock Fraction	Land Soil Fraction
1	8.23x10 ⁷	12.1 (31.4)	0.7332	0.2668	1.0 ^(b)	0.0 ^(b)
2	2.73x10 ⁸	18.1 (46.9)	0.4085	0.5915	1.0 ^(b)	0.0 ^(b)
3	7.28x10 ⁸	51.5 (133.5)	0.4456	0.5544	0.251 ^(b)	0.749 ^(b)
4	1.08x10 ⁹	94.6 (244.7)	0.5522	0.4478	0.251	0.749
5	1.13x10 ⁹	103.8 (269.1)	0.5718	0.4282	0.153	0.847
6	1.20x10 ⁹	119.7 (309.4)	0.6064	0.3936	0.088	0.912
7	8.58x10 ⁸	102.2 (264.9)	0.6710	0.3290	0.076	0.924
8	4.88x10 ⁸	77.0 (199.2)	0.7514	0.2486	0.058	0.924
9	4.49x10 ⁸	73.1 (189.6)	0.7592	0.2408	0.077	0.923
10	2.70x10 ⁸	49.4 (128.2)	0.7854	0.2146	0.084	0.916
11	2.70x10 ⁸	44.7 (115.5)	0.7630	0.2370	0.044	0.956
12	1.66x10 ⁸	29.9 (77.3)	0.7815	0.2185	0.055	0.945
13	1.10x10 ⁸	19.6 (50.8)	0.7799	0.2201	0.085	0.915
14	1.15x10 ⁸	18.6 (48.3)	0.7574	0.2426	0.089	0.911
15	7.32x10 ⁷	13.0 (33.7)	0.7796	0.2204	0.092	0.980
16	7.81x10 ⁷	22.6 (58.6)	0.8646	0.1354	0.112	0.888
17	1.40x10 ⁷	11.8 (30.7)	0.9538	0.0462	0.296	0.704
18	6.26x10 ⁶	11.3 (29.4)	0.9784	0.0216	0.296 ^(b)	0.704 ^(b)
19	1.01x10 ⁶	5.6 (14.6)	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 Surface Types

The worldwide distribution of surface types is an important characteristic in considering the potential consequences of accident scenarios. Table 3-6 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 percent in band 7 to about 45 percent in band 4, with the soil fraction dominating (from about 75 percent in band 4 to about 92 percent in band 7).

3.2.5 Background Radiation

3.2.5.1 Natural and Manmade Sources

The general population is exposed to various sources of natural and manmade radiation. These sources are divided into six broad categories: (1) cosmic radiation (from space), (2) external terrestrial radiation or groundshine (from naturally occurring radiation in rocks and soil), (3) internal radiation (from inhalation or ingestion), (4) consumer products (from smoke detectors, airport x-ray machines, televisions), (5) medical diagnosis and therapy (diagnostic x-rays, nuclear medical procedures), and (6) other sources (nuclear power plants, transportation, emissions from power stacks).

Dose is the amount of ionizing radiation energy deposited in body tissues via the applicable exposure pathways and is expressed in units of measurement called rems. An average person in the United States receives a total dose of about 0.36 rem per year from all of these sources (see Table 3-7). The largest dose, about 66 percent of the yearly total, is received from internal radiation, where exposure has occurred as a result of inhalation or ingestion of radioactive material. Exposure to radon, the largest component of internal radiation, accounts for about 55 percent or 0.2 rem of the yearly total dose received. Exposure to cosmic radiation and groundshine collectively, is about 15 percent of the yearly total dose, the same percentage contributed from medical diagnosis and therapy. The average yearly dose from consumer products is about 3 percent. For perspective, a modern x-ray results in a dose of about 0.006 rem and about 0.065 rem is received from a diagnostic pelvic and hip x-ray (DOE 2000).

3.2.5.2 Worldwide Plutonium Levels

Plutonium-238 (Pu-238) exists in the environment as a result of atmospheric testing of nuclear weapons and a 1964 launch accident. The following information provides a perspective against which to compare the scope of postulated incremental releases of plutonium from potential mission accidents.

Between 1945 and 1974, aboveground nuclear weapons tests released about 440,000 curies (Ci) of plutonium to the environment (AEC 1974). About 97 percent (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 3-7. AVERAGE ANNUAL EFFECTIVE DOSE EQUIVALENT OF IONIZING RADIATION TO A MEMBER OF THE U.S. POPULATION

Source	Effective Dose Equivalent ^(a)	
	rem per year	percent of total
Natural		
Radon ^(b)	0.2	55
Cosmic	0.027	8
Terrestrial	0.028	8
Internal	0.039	11
Subtotal — Natural	0.3	82
Manmade		
Medical		
X-ray diagnosis	0.039	11
Nuclear medicine	0.014	4
Consumer products	0.010	3
Other		
Occupational	< 0.001	< 0.03
Nuclear fuel cycle	< 0.001	< 0.03
Fallout	< 0.001	< 0.03
Miscellaneous ^(c)	< 0.001	< 0.03
Subtotal — Manmade	0.064	18
Total Natural and Manmade^(d)	0.364	100

Source: NCRP 1987

- (a) Effective dose equivalent is proportional to incremental risk in cancer
- (b) Dose equivalent to bronchi from radon decay products. The assumed weighting factor for the effective dose equivalent relative to whole-body exposure is 0.08.
- (c) U.S. Department of Energy facilities, smelters, transportation, etc.
- (d) The 50-year effective dose commitment is 50 years times 0.364 rem per year, or 18.2 rem.

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 Pu-238 released from SNAP-9A has been deposited on the Earth's surface (AEC 1974). About 25 percent (approximately 4,000 Ci) of that 1964 release was deposited in the northern hemisphere, with the remaining 75 percent settling in the southern hemisphere. In April 1986, approximately 100,000,000 Ci of various radioisotopes were released to the environment from the

Chernobyl nuclear power station 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 was approximately 20,000 Ci (IAEA 1976, NCRP 1987, UNSCEAR 1988). Assuming that 15 percent 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.