

## Section 5

# GEOGRAPHY AND ENVIRONMENT

This section relates to land and water areas, physical geography, climate, air and water quality, noise, and other geographic and environmental measurements of Hawaii. Most statistics on land use and ownership, however, appear in Section 6.

The State consists of eight major islands and 124 minor islands with a total land area of 6,425 square miles and a general coastline of 750 miles. Honolulu is 214 miles from Hilo, 1,367 miles from Kure Atoll (the westernmost end of the State), 2,397 miles from San Francisco, and 4,829 miles from Washington, D.C. The highest peak in the State is Mauna Kea, 13,796 feet above sea level; the longest stream is Kaukonahua Stream, Oahu, 33 miles in length; the most extensive lake or similar body is Kawainui Marsh, 1,000 acres; and the highest named waterfall is Kahiwa, Molokai, a 1,750-foot cascade. Various measures of air pollution, such as suspended particulate matter, indicate that Honolulu is one of the cleanest cities in the nation. There is also relatively little water pollution: the 34 major beaches surveyed in 1985 were found to have fecal coliform levels per 100 ml. ranging from 2.0 to 286.1, and all but one were within EPA standards. More than 1,200 species, subspecies, and varieties of native fauna and flora have been proposed or accepted for inclusion on lists of endangered, threatened, or extinct organisms. Climatically, Hawaii is marked by remarkably balmy temperatures and wide variations in rainfall. The all-time temperature range at Honolulu International Airport, for example, was from 53° to 94°F. Average precipitation, however, ranges from less than nine inches at Kawaihae to 444 inches atop Waialeale. The largest volcanic eruptions in Island history (1859 and 1950) each produced 600 million cubic yards of lava, the worst earthquake (1868) attained 7.5 on the Richter scale, the highest tsunami wave (1946) reached 56 feet, and the most destructive hurricane (Iwa, 1982) gusted to 117 miles per hour. Water withdrawn for use in 1980 averaged 2.9 billion gallons per day, compared with 2.8 billion in 1975 and 2.7 billion in 1970. Among 31 neighborhoods on Oahu, median noise levels in 1981-1982 ranged from 37 decibels (in Mililani) to 57 decibels (in Pawaa).

Important sources of data include the U.S. Geological Survey, National Ocean Survey, National Weather Service, U.S. Bureau of the Census Geography Division, the Division of Water and Land Development of the State Department of Land and Natural Resources, the State Department of Health, and the University of Hawaii Institute of Geophysics. Detailed information is given in Atlas of Hawaii, 2nd edition, published by the University of Hawaii Press in 1983. National data are reported in Statistical Abstract of the United States: 1986, Section 7.

Table 147.-- GREAT CIRCLE DISTANCES BETWEEN SPECIFIED PLACES

| Place  | Statute miles | Kilometers |
|--|---------------|------------|
| <b>DISTANCES FROM HONOLULU INTERNATIONAL AIRPORT</b> |               |            |
| <b>Hawaiian Islands locations:</b>                   |               |            |
| Hilo, Hawaii .....                                   | 214           | 344        |
| Kailua, Kona, Hawaii .....                           | 168           | 270        |
| Kahului, Maui .....                                  | 98            | 158        |
| Lanai Airport .....                                  | 72            | 116        |
| Molokai Airport .....                                | 54            | 87         |
| Lihue, Kauai .....                                   | 103           | 166        |
| Puuwai, Niihau .....                                 | 152           | 245        |
| Nihoa .....  | 283           | 455        |
| Necker Island .....                                  | 520           | 837        |
| French Frigate Shoals .....                          | 556           | 895        |
| Gardner Pinnacles .....                              | 688           | 1,107      |
| Maro Reef .....                                      | 851           | 1,369      |
| Laysan Island .....                                  | 936           | 1,506      |
| Lisianski Island .....                               | 1,065         | 1,714      |
| Pearl and Hermes Atoll .....                         | 1,208         | 1,944      |
| Midway Islands .....                                 | 1,309         | 2,106      |
| Kure Atoll .....                                     | 1,367         | 2,200      |
| <b>Other Pacific locations:</b>                      |               |            |
| Apra Harbor, Guam .....                              | 3,806         | 6,124      |
| Auckland, New Zealand .....                          | 4,393         | 7,068      |
| Hong Kong .....                                      | 5,541         | 8,915      |
| Johnston Atoll .....                                 | 820           | 1,319      |
| Kingman Reef .....                                   | 1,073         | 1,726      |
| Kiritimati (Christmas Island), Kiribati .....        | 1,344         | 2,163      |
| Majuro, Marshall Islands .....                       | 2,271         | 3,654      |
| Manila, Philippines .....                            | 5,293         | 8,516      |
| Nuku Hiva, Marquesas Islands .....                   | 2,400         | 3,864      |
| Pago Pago, American Samoa .....                      | 2,606         | 4,193      |
| Palmyra Atoll .....                                  | 1,101         | 1,772      |
| Papeete, Tahiti .....                                | 2,741         | 4,410      |
| Suva, Fiji .....                                     | 3,159         | 5,083      |
| Sydney (Port Jackson), Australia .....               | 5,070         | 8,158      |
| Tokyo, Japan .....                                   | 3,847         | 6,190      |
| Wake Island .....                                    | 2,294         | 3,691      |
| <b>North and South American locations:</b>           |               |            |
| Anchorage, Alaska .....                              | 2,781         | 4,475      |
| Cape Horn, Chile .....                               | 7,457         | 11,998     |

Continued on next page.

Table 147.-- GREAT CIRCLE DISTANCES BETWEEN SPECIFIED PLACES -- Con.

| Place                                      | Statute miles | Kilometers |
|--|---------------|------------|
| DISTANCES FROM HONOLULU INT. AIRPORT--Con. |               |            |
| North and South American locations, con.:  |               |            |
| Chicago, Illinois .....                    | 4,179         | 6,724      |
| Cristobal, Canal Zone .....                | 5,214         | 8,389      |
| Los Angeles, California .....              | 2,557         | 4,114      |
| Miami, Florida .....                       | 4,856         | 7,813      |
| New York, New York .....                   | 4,959         | 7,979      |
| Portland, Oregon .....                     | 2,595         | 4,175      |
| San Diego, California .....                | 2,610         | 4,199      |
| San Francisco, California .....            | 2,397         | 3,857      |
| Seattle, Washington .....                  | 2,679         | 4,311      |
| Vancouver, B.C. ....                       | 2,709         | 4,359      |
| Tijuana, Mexico .....                      | 2,616         | 4,209      |
| Washington, D.C. ....                      | 4,829         | 7,770      |
| London, England .....                      | 7,226         | 11,627     |
| Bombay, India .....                        | 8,010         | 12,888     |
| Ghanzi, Botswana 1/ .....                  | 12,417        | 19,979     |
| Equator, due south of Honolulu .....       | 1,470         | 2,367      |
| North Pole .....                           | 4,740         | 7,631      |
| OTHER DISTANCES                            |               |            |
| Hilo to --                                 |               |            |
| Los Angeles, California .....              | 2,447         | 3,937      |
| San Francisco, California .....            | 2,315         | 3,725      |
| Kure Atoll to --                           |               |            |
| Cape Kumukahi, Puna, Hawaii 2/ .....       | 1,523         | 2,451      |
| Log Point, Elliot Key, Florida 3/ .....    | 5,852         | 9,416      |
| Tokyo, Japan .....                         | 2,486         | 4,000      |
| West Quoddy Head, Maine .....              | 5,788         | 9,313      |

1/ Ghanzi, Botswana, is Honolulu's antipode, that is, the point precisely opposite to it on the globe.

2/ Cape Kumukahi and Kure Atoll are the points farthest apart in the Hawaiian Archipelago and State of Hawaii.

3/ Log Point and Kure Atoll are the points farthest apart in the fifty states.

Source: U. S. Department of the Interior, Geological Survey, Elevations and Distances in the United States (1973), pp. 22-23, and distance computations prepared for the Department of Planning and Economic Development.

Table 148.-- LATITUDES AND LONGITUDES OF SELECTED PLACES

| Island and place                    | Latitude<br>(North) | Longitude<br>(West) |
|-------------------------------------|---------------------|---------------------|
| Hawaii:                             |                     |                     |
| Hilo (General Lyman Field) .....    | 19° 43'             | 155° 04'            |
| Cape Kumukahi .....                 | 19° 31'             | 154° 49'            |
| Ka Lae .....                        | 18° 56'             | 155° 41'            |
| Keahole Point .....                 | 19° 44'             | 156° 04'            |
| Upolu Point .....                   | 20° 16'             | 155° 52'            |
| Maui:                               |                     |                     |
| Wailuku .....                       | 20° 53'             | 156° 30'            |
| Kahului (Airport) .....             | 20° 54'             | 156° 26'            |
| Hana .....                          | 20° 45'             | 155° 59'            |
| Cape Hanamanioa .....               | 20° 35'             | 156° 25'            |
| Lahaina .....                       | 20° 52'             | 156° 41'            |
| Kahoolawe:                          |                     |                     |
| Puu Moaulanui .....                 | 20° 34'             | 156° 34'            |
| Lanai:                              |                     |                     |
| Airport .....                       | 20° 48'             | 156° 57'            |
| Molokai:                            |                     |                     |
| Kaunakakai .....                    | 21° 05'             | 157° 02'            |
| Laau Point .....                    | 21° 06'             | 157° 19'            |
| Cape Halawa .....                   | 21° 10'             | 156° 43'            |
| Oahu:                               |                     |                     |
| Honolulu: International Airport ... | 21° 20'             | 157° 55'            |
| Aloha Tower .....                   | 21° 19'             | 157° 52'            |
| Kaena Point .....                   | 21° 35'             | 158° 17'            |
| Kahuku Point .....                  | 21° 43'             | 157° 59'            |
| Makapuu Point .....                 | 21° 19'             | 157° 39'            |
| Diamond Head .....                  | 21° 16'             | 157° 49'            |
| Kauai:                              |                     |                     |
| Lihue (Kauai Airport) .....         | 21° 59'             | 159° 21'            |
| Mana .....                          | 22° 02'             | 159° 46'            |
| Kilauea Point .....                 | 22° 14'             | 159° 24'            |
| Niihau:                             |                     |                     |
| Puuwai .....                        | 21° 54'             | 160° 12'            |
| Kure Atoll .....                    | 28° 25'             | 178° 22'            |

Source: U.S. Board on Geographic Names, Gazetteer No. 24, Hawaiian Islands (1956); U.S. Department of Commerce, National Climatic Data Center, Local Climatological Data, Annual Summary with Comparative Data, 1984 for Hilo, Kahului, Honolulu, and Lihue; U.S. Geological Survey, Elevations and Distances in the United States (1973), pp. 22-23; Bernice P. Bishop Museum, Geography and Map Division, information provided April 29, 1986.

Table 149.-- WIDTHS AND DEPTHS OF CHANNELS

| Channel <u>1/</u>                          | Width <u>2/</u> |            | Depth <u>3/</u> |        |
|--|-----------------|------------|-----------------|--------|
|  | Statute miles   | Kilometers | Feet            | Meters |
| Alenuihaha (Hawaii-Maui) .....             | 29.6            | 47.6       | 6,810           | 2,076  |
| Alalakeiki (Kahoolawe-Maui) .....          | 6.7             | 10.8       | 822             | 251    |
| Kealaikahiki (Kahoolawe-Lanai) .....       | 17.8            | 28.6       | 1,086           | 331    |
| Auau (Lanai-Maui) .....                    | 9.5             | 15.3       | 252             | 77     |
| Kalohi (Lanai-Molokai) .....               | 9.2             | 14.8       | 540             | 165    |
| Pailolo (Maui-Molokai) .....               | 8.8             | 14.2       | 846             | 258    |
| Kaiwi (Molokai-Oahu) .....                 | 25.8            | 41.5       | 2,202           | 671    |
| Kauai (Oahu-Kauai) .....                   | 72.1            | 116.0      | 10,890          | 3,319  |
| Kaulakahi (Kauai-Niihau) .....             | 17.2            | 27.7       | 3,570           | 1,088  |
| Niihau-Kaula .....                         | 21.5            | 34.6       | 5,364           | 1,635  |
| Niihau-Nihoa .....                         | 133.9           | 215.5      | 14,550          | 4,435  |
| Nihoa-Necker I. ....                       | 179.6           | 289.0      | 12,600          | 3,840  |
| Necker I.-French Frigate Shoals .....      | 100.3           | 161.4      | 12,780          | 3,895  |
| French Frigate Shoals-Gardner Pinnacles .. | 137.0           | 220.5      | 11,448          | 3,489  |
| Gardner Pinnacles-Marø Reef .....          | 155.5           | 250.3      | 12,300          | 3,749  |
| Marø Reef-Laysan I. ....                   | 65.9            | 106.1      | 8,280           | 2,524  |
| Laysan I.-Lisianski I. ....                | 137.4           | 221.1      | 16,830          | 5,130  |
| Lisianski I.-Pearl and Hermes Atoll .....  | 162.6           | 261.7      | 17,400          | 5,304  |
| Pearl and Hermes Atoll-Midway Islands .... | 86.9            | 139.9      | 15,840          | 4,828  |
| Midway Islands-Kure Atoll .....            | 57.1            | 91.9       | 12,960          | 3,950  |

1/ Listed in geographic order, from east to west. The channels between major islands were measured between the following points:

- Alenuihaha: Upolu Pt., Hawaii, to Puhilele Pt., Maui;
- Alalakeiki: Lae o ka Ule, Kahoolawe, to Nukuele Pt., Maui;
- Kealaikahiki: Makaalae, Kahoolawe, to Kamaiki Pt., Lanai;
- Auau: Kikoa Pt., Lanai, to Lahaina, Maui;
- Kalohi: Wahie Pt., Lanai, to Kamalo, Molokai;
- Pailolo: Lipoa Pt., Maui, to Pohakuloa, Molokai;
- Kaiwi: Ilio Pt., Molokai, to Makapuu Pt., Oahu;
- Kauai: Kaena Pt., Oahu, to Kamilo Pt., Kauai;
- Kaulakahi: Mana Pt., Kauai, to Kaunuopou, Niihau.

2/ Width measured in statute miles between designated points on National Ocean Survey and Coast and Geodetic Survey charts. Width in kilometers calculated from miles (1 mile = 1.60934 km.).

3/ Depths given are the deepest soundings noted at or near the line joining the two designated points, on National Ocean Survey and Coast and Geodetic Survey charts. Depths measured in fathoms and converted to feet and meters (1 fathom = 6 feet = 1.8288 meters).

Source: Compiled by Lee S. Motteler, Geography and Map Division, Bernice P. Bishop Museum, in November 1980.

Table 150.-- GENERAL COASTLINE AND TIDAL SHORELINE OF COUNTIES AND ISLANDS

| County and island                          | General coastline <u>1/</u> |                       | Tidal shoreline <u>2/</u> |                       |
|--|-----------------------------|-----------------------|---------------------------|-----------------------|
|  | Statute miles               | Kilo-meters <u>3/</u> | Statute miles             | Kilo-meters <u>3/</u> |
| State total .....                          | 750                         | 1,207                 | 1,052                     | 1,693                 |
| Counties:                                  |                             |                       |                           |                       |
| Hawaii .....                               | 266                         | 428                   | 313                       | 504                   |
| Maui, including Kalawao .....              | 210                         | 338                   | 343                       | 552                   |
| Honolulu .....                             | 137                         | 220                   | 234                       | 377                   |
| Kauai .....                                | 137                         | 220                   | 162                       | 261                   |
| Islands: <u>4/</u>                         |                             |                       |                           |                       |
| Hawaii .....                               | 266                         | 428                   | 313                       | 504                   |
| Maui .....                                 | 120                         | 193                   | 149                       | 240                   |
| Kahoolawe .....                            | 29                          | 47                    | 36                        | 58                    |
| Lanai .....                                | 47                          | 76                    | 52                        | 84                    |
| Molokai .....                              | 88                          | 142                   | 106                       | 171                   |
| Oahu .....                                 | 112                         | 180                   | 209                       | 336                   |
| Kauai .....                                | 90                          | 145                   | 110                       | 177                   |
| Niihau .....                               | 45                          | 72                    | 50                        | 80                    |
| Kaula .....                                | 2                           | 3                     | 2                         | 3                     |
| Northwestern Hawaiian Islands <u>5/</u> .. | 25                          | 40                    | 25                        | 40                    |
| Nihoa .....                                | 3                           | 5                     | 3                         | 5                     |
| Necker Island .....                        | 2                           | 3                     | 2                         | 3                     |
| French Frigate Shoals .....                | 6                           | 10                    | 6                         | 10                    |
| Laysan Island .....                        | 6                           | 10                    | 6                         | 10                    |
| Lisianski Island .....                     | 3                           | 5                     | 3                         | 5                     |
| Kure Atoll .....                           | 5                           | 8                     | 5                         | 8                     |

1/ Figures are lengths of general outline of seacoast. Data for the four islands of Maui County are not consistent with the reported county total.

2/ Shoreline of outer coast, offshore islands, bays, rivers, and creeks is included to the head of tidewater or to a point where tidal waters narrow to a width of 100 feet.

3/ Derived from data expressed in statute miles; independently rounded and accordingly may not add exactly to indicated totals and subtotals.  
1 mi. = 1.609 km.

4/ Data are not available for five minor islands: Molokini, Lehua, Gardner Pinnacles, Maro Reef, and Pearl and Hermes Atoll.

5/ Excludes the Midway Islands, which are part of the Hawaiian Archipelago but not legally part of the State of Hawaii. Midway has a general coastline of 20 miles and a tidal shoreline of 33 miles.

Source: U.S. Department of Commerce, National Ocean Survey, The Coastline of the United States (1975) and records.

Table 151.-- LAND AND WATER AREA OF COUNTIES AND ISLANDS: 1982

[See maps on page 6]

| County or island                             | Square miles |                |                        |
|--|--------------|----------------|------------------------|
|  | Total        | Land <u>2/</u> | Inland water <u>3/</u> |
| State total .....                            | 6,470.8      | 6,425.2        | 45.6                   |
| Counties: <u>4/</u>                          |              |                |                        |
| Hawaii .....                                 | 4,035.2      | 4,034.2        | 1.0                    |
| Maui .....                                   | 1,171.0      | 1,161.6        | 9.4                    |
| Kalawao .....                                | 14.3         | 13.3           | 1.0                    |
| Honolulu <u>5/</u> .....                     | 620.9        | 596.7          | 24.2                   |
| Kauai <u>5/</u> .....                        | 629.4        | 619.4          | 10.0                   |
| Islands: <u>4/</u>                           |              |                |                        |
| Hawaii .....                                 | 4,035.2      | 4,034.2        | 1.0                    |
| Maui <u>6/</u> .....                         | 734.5        | 728.6          | 5.9                    |
| Kahoolawe .....                              | 45.9         | 45.0           | 0.9                    |
| Lanai .....                                  | 141.2        | 140.4          | 0.8                    |
| Molokai .....                                | 263.7        | 260.9          | 2.8                    |
| Oahu .....                                   | 617.6        | 593.6          | 24.0                   |
| Kauai .....                                  | 558.2        | 549.4          | 8.8                    |
| Niihau <u>7/</u> .....                       | 71.1         | 70.0           | 1.1                    |
| Kaula .....                                  | 0.4          | 0.4            | -                      |
| Northwestern Hawaiian Islands <u>8/</u> .... | 2.910        | 2.690          | 0.220                  |
| Nihoa .....                                  | 0.238        | 0.238          | -                      |
| Necker Island .....                          | 0.105        | 0.105          | -                      |
| French Frigate Shoals .....                  | 0.081        | 0.081          | -                      |
| Gardner Pinnacles .....                      | 0.011        | 0.011          | -                      |
| Maro Reef .....                              | Awash        | Awash          | Awash                  |
| Laysan Island .....                          | 1.454        | 1.234          | 0.220                  |
| Lisianski Island .....                       | 0.586        | 0.586          | -                      |
| Pearl and Hermes Atoll .....                 | 0.106        | 0.106          | -                      |
| Kure Atoll .....                             | 0.329        | 0.329          | -                      |

Continued on next page.

Table 151.-- LAND AND WATER AREA OF COUNTIES AND ISLANDS: 1982 -- Con.

| County or island                        | Square kilometers <u>1/</u> |                | Acres <u>1/</u> |                |
|---|-----------------------------|----------------|-----------------|----------------|
|   | Total                       | Land <u>2/</u> | Total           | Land <u>2/</u> |
| State total .....                       | 16,759.3                    | 16,641.2       | 4,141,312       | 4,112,128      |
| Counties: <u>4/</u>                     |                             |                |                 |                |
| Hawaii .....                            | 10,451.1                    | 10,448.5       | 2,582,528       | 2,581,888      |
| Maui .....                              | 3,032.9                     | 3,008.5        | 749,440         | 743,424        |
| Kalawao .....                           | 37.0                        | 34.4           | 9,152           | 8,512          |
| Honolulu <u>5/</u> .....                | 1,608.1                     | 1,545.4        | 397,376         | 381,888        |
| Kauai <u>5/</u> .....                   | 1,630.1                     | 1,604.2        | 402,816         | 396,416        |
| Islands: <u>4/</u>                      |                             |                |                 |                |
| Hawaii .....                            | 10,451.1                    | 10,448.5       | 2,582,528       | 2,581,888      |
| Maui <u>6/</u> .....                    | 1,902.3                     | 1,887.1        | 470,080         | 466,304        |
| Kahoolawe .....                         | 118.9                       | 116.5          | 29,376          | 28,800         |
| Lanai .....                             | 365.7                       | 363.6          | 90,368          | 89,856         |
| Molokai .....                           | 683.0                       | 675.7          | 168,768         | 166,976        |
| Oahu .....                              | 1,599.6                     | 1,537.4        | 395,264         | 379,904        |
| Kauai .....                             | 1,445.7                     | 1,422.9        | 357,248         | 351,616        |
| Niihau <u>7/</u> .....                  | 184.1                       | 181.3          | 45,504          | 44,800         |
| Kaula .....                             | 1.0                         | 1.0            | 256             | 256            |
| Northwestern Hawaiian Islands <u>8/</u> | 7.5                         | 7.0            | 1,862           | 1,722          |
| Nihoa .....                             | 0.6                         | 0.6            | 152             | 152            |
| Necker Island .....                     | 0.3                         | 0.3            | 67              | 67             |
| French Frigate Shoals .....             | 0.2                         | 0.2            | 52              | 52             |
| Gardner Pinnacles .....                 | 0.0                         | 0.0            | 7               | 7              |
| Maro Reef .....                         | Awash                       | Awash          | Awash           | Awash          |
| Laysan Island .....                     | 3.8                         | 3.2            | 931             | 790            |
| Lisianski Island .....                  | 1.5                         | 1.5            | 375             | 375            |
| Pearl and Hermes Atoll .....            | 0.3                         | 0.3            | 68              | 68             |
| Kure Atoll .....                        | 0.9                         | 0.9            | 211             | 211            |

1/ Areas in square kilometers and acres were calculated directly from the figures shown for square miles; these equivalents were independently rounded, and hence may not add exactly to the indicated totals and subtotals. 1 square mile = 640 acres = 2.58999 square kilometers.

2/ Dry land and land temporarily or partially covered by water, as marshland, swamps, etc.; streams and canals under one-eighth statute mile wide; and lakes, reservoirs, and ponds under 40 acres of area.

Continued on next page.



Table 151.-- LAND AND WATER AREA OF COUNTIES AND ISLANDS: 1982 -- Con.

3/ Permanent inland water surface, such as lakes, reservoirs, and ponds having 40 acres or more of area; streams, sloughs, estuaries, and canals one-eighth statute mile or more in width; deeply indented embayments and sounds, and other coastal waters behind or sheltered by headlands or islands separated by less than 1 nautical mile of water, and islands having less than 40 acres of area.

4/ Because of rounding, island figures may not add to county figures.

5/ Revised to reflect inclusion of Kaula in the City and County of Honolulu rather than in the County of Kauai, as formerly shown; see Hawaii State Department of the Attorney General, "County Jurisdiction Over Kaula," memorandum to Kent M. Keith, August 18, 1986.

6/ Molokini, offshore of Maui, not measured; other sources give the area of Molokini as 18.6 acres (0.03 square miles or 0.075 square kilometers).

7/ Includes Lehua, previously reported as 243 acres (0.38 square miles or 0.98 square kilometers).

8/ Exclusive of the Midway Islands, which are part of the Hawaiian Archipelago but not legally part of the State of Hawaii.

Source: Unpublished data supplied by the Geography Division, U.S. Bureau of the Census, May 5, 1983; cited in the Hawaii State Department of Planning and Economic Development, Remeasurements of the Area of Hawaii, 1982 (Statistical Memorandum 83-6, May 18, 1983).

Table 152.-- LAND AREA OF NEARBY ATOLLS NOT UNDER STATE JURISDICTION

| Atoll                | Year of source | Number of islets | Land area    |          |       |
|----------------------|----------------|------------------|--------------|----------|-------|
|                      |                |                  | Square miles | Hectares | Acres |
| Midway Islands ..... | 1955           | 5                | 2.003        | 518.8    | 1,282 |
| Johnston Atoll ..... | 1976           | 4                | 0.994        | 257.4    | 636   |
| Kingman Reef .....   | -              | -                | Awash        | Awash    | Awash |
| Palmyra Atoll .....  | c. 1975        | 1/ 39            | 2.188        | 566.6    | 1,400 |

1/ Most of Palmyra's 39 islets are now joined by causeways and accretion of coral sand.

Source: Lee S. Motteler, Geography and Map Division, Bishop Museum, July 23, 1986.

Table 153.-- MAJOR AND MINOR ISLANDS IN THE HAWAIIAN ARCHIPELAGO

| Classification                                | Number of islands |                              | Land area<br>(square miles) |
|---|-------------------|------------------------------|-----------------------------|
|   | Total             | Inhabited,<br>1980 <u>1/</u> |                             |
| All named islands .....                       | 137               | 15                           | 6,427.0                     |
| Major islands .....                           | 8                 | 7                            | 6,419.4                     |
| Named minor islands <u>2/</u> .....           | 129               | 8                            | 7.6                         |
| Offshore of major islands .....               | 96                | 4                            | 2.6                         |
| Northwestern Hawaiian Islands <u>3/</u> ..... | 33                | 4                            | 4.9                         |
| Part of State .....                           | 28                | 3                            | 2.9                         |
| Not part of State (Midway Islands) ....       | 5                 | 1                            | 2.0                         |

1/ For populations, see present volume, table 4.

2/ For individual data, see DPED Report GN-6, pp. 3-7.

3/ The 33 islets are in 10 clusters.

Source: Hawaii State Department of Planning and Economic Development, Geographic Names Approved, Second Quarter 1969 (Report GN-6, July 8, 1969), p. 8; data for Midway Islands supplied by Lee S. Motteler, Bishop Museum.

Table 154.-- AREA AND DEPTH OF SELECTED CRATERS

| Island and crater                  | Area<br>(acres) | Maximum<br>depth (feet) |
|------------------------------------|-----------------|-------------------------|
| Hawaii:                            |                 |                         |
| Kilauea Caldera .....              | 2,319           | 476                     |
| Mokuaweoweo Crater <u>1/</u> ..... | 2,221           | 572                     |
| Maui:                              |                 |                         |
| Haleakala Crater <u>2/</u> .....   | 12,575          | 3,028                   |
| Oahu:                              |                 |                         |
| Diamond Head Crater .....          | 255             | 562                     |
| Koko Crater .....                  | 133             | 968                     |
| Punchbowl Crater .....             | 62              | 140                     |

1/ Data exclude North and South Pits.

2/ Data exclude Koolau and Kaupo Gaps.

Source: Measured from U.S. Geological Survey maps by DPED.

Table 155.-- ELEVATIONS OF MAJOR SUMMITS

[Elevation of the highest point on each island  
and other important peaks]

| Island and mountain              | Feet   | Meters |
|----------------------------------|--------|--------|
| <b>Hawaii:</b>                   |        |        |
| Mauna Kea 1/ .....               | 13,796 | 4,205  |
| Mauna Loa 2/ .....               | 13,679 | 4,169  |
| Hualalai .....                   | 8,271  | 2,521  |
| Kaumu o Kaleihoohie .....        | 5,480  | 1,670  |
| Kilauea (Uwekahuna) .....        | 4,093  | 1,248  |
| Kilauea (Halemaumau Rim) .....   | 3,660  | 1,116  |
| <b>Kahoolawe:</b>                |        |        |
| Puu Moaulanui .....              | 1,483  | 452    |
| Puu Moaulaiki .....              | 1,434  | 437    |
| Molokini .....                   | 160    | 49     |
| <b>Maui:</b>                     |        |        |
| Haleakala (Red Hill) .....       | 10,023 | 3,055  |
| Haleakala (Kaupo Gap) .....      | 8,201  | 2,500  |
| Puu Kukui .....                  | 5,788  | 1,764  |
| Iao Needle .....                 | 2,250  | 686    |
| <b>Lanai:</b>                    |        |        |
| Lanaihale .....                  | 3,370  | 1,027  |
| <b>Molokai:</b>                  |        |        |
| Kamakou .....                    | 4,961  | 1,512  |
| Olokui .....                     | 4,606  | 1,404  |
| Kaunuohua .....                  | 4,535  | 1,382  |
| Kalaupapa Lookout .....          | 1,600  | 488    |
| Mauna Loa (Kukui) .....          | 1,430  | 436    |
| <b>Oahu:</b>                     |        |        |
| Kaala .....                      | 4,017  | 1,224  |
| Puu Kalena .....                 | 3,504  | 1,068  |
| Konahuanui .....                 | 3,150  | 960    |
| Tantalus .....                   | 2,013  | 614    |
| Olomana .....                    | 1,643  | 501    |
| Koko Crater (Kohelepelepe) ..... | 1,208  | 368    |
| Nuuanu Pali Lookout .....        | 1,186  | 361    |
| Diamond Head .....               | 760    | 232    |
| Koko Head .....                  | 642    | 196    |
| Punchbowl .....                  | 500    | 152    |

Continued on next page.

Table 155.-- ELEVATIONS OF MAJOR SUMMITS -- Con.

| Island and mountain          | Feet  | Meters |
|------------------------------|-------|--------|
| Kauai:                       |       |        |
| Kawaikini .....              | 5,243 | 1,598  |
| Waialeale .....              | 5,148 | 1,569  |
| Namolokama Mountain .....    | 4,421 | 1,348  |
| Kalalau Lookout .....        | 4,120 | 1,256  |
| Hauptu .....                 | 2,297 | 700    |
| Sleeping Giant (Nonou) ..... | 1,241 | 378    |
| Niihau:                      |       |        |
| Paniau .....                 | 1,281 | 390    |
| Lehua .....                  | 699   | 213    |
| Kaula .....                  | 550   | 168    |
| Nihoa:                       |       |        |
| Millers Peak .....           | 910   | 277    |
| Necker Island:               |       |        |
| Summit Hill .....            | 277   | 84     |
| French Frigate Shoals:       |       |        |
| La Perouse Pinnacles .....   | 135   | 41     |
| Gardner Pinnacles .....      | 190   | 58     |
| Maro Reef .....              | Awash | Awash  |
| Laysan Island .....          | 35    | 11     |
| Lisianski Island .....       | 20    | 6      |
| Pearl and Hermes Atoll ..... | 10    | 3      |
| Midway Islands .....         | 12    | 4      |
| Kure Atoll .....             | 20    | 6      |

1/ According to the 1986 Guinness Book of World Records (p. 94), "The world's tallest mountain measured from its submarine base (3,280 fathoms) in the Hawaiian Trough to peak is Mauna Kea ... with a combined height of 33,476 ft, of which 13,796 ft are above sea level."

2/ Guinness (p. 94) describes Mauna Loa as having "dimensions, but not height, [which] exceed those of Mt Everest .... The axes of its elliptical base, 16,322 ft below sea level, have been estimated at 74 mi and 53 mi."

Source: U.S. National Cartographic Information Center, data provided October 11, 1978; U.S. Geological Survey topographic maps; E. D. Baldwin, 1883 Molokini figure on Hawaiian Government Survey Reg. Map No. 1276; National Geodetic Survey 1969 figure for Kaala, provided by U.S. Geological Survey, Honolulu office, July 23, 1984; U.S.S. Tanager survey, 1923 (for Pearl and Hermes Atoll). Data compiled with assistance of Lee S. Motteler, Bernice P. Bishop Museum.

Table 156.-- MAJOR STREAMS, BY ISLANDS

| Island  | Feature or stream            | Length or ave. discharge |
|---|------------------------------|--------------------------|
| Longest water feature (miles):                              |                              |                          |
| Hawaii .....  | Wailuku River .....          | 32.0                     |
| Maui .....  | Kalialinui-Waiale Gulch .... | 18.0                     |
| Kahoolawe .....   | Ahupu Gulch .....            | 4.0                      |
| Lanai .....   | Maunalei-Waialala Gulch .... | 12.9                     |
| Molokai .....   | Wailau-Pulena Stream .....   | 6.5                      |
| Oahu .....  | Kaukonahua Stream (So. Fork) | 33.0                     |
| Kauai .....   | Waimea River-Poomau Stream . | 19.5                     |
| Niihau .....  | Keanaulii-Puniopo Valley ... | 5.9                      |
| Largest perennial stream (miles): <u>1/</u>                 |                              |                          |
| Hawaii .....  | Wailuku River .....          | 22.7                     |
| Maui .....  | Palikea Stream .....         | 7.8                      |
| Molokai .....   | Wailau-Pulena Stream .....   | 6.5                      |
| Oahu .....  | Kaukonahua Stream .....      | 30.0                     |
| Kauai .....   | Waimea River .....           | 19.7                     |
| Streams with greatest average discharge (million gal./day): |                              |                          |
| Hawaii .....  | Wailuku River .....          | 185                      |
| Maui .....  | Iao Stream .....             | 50                       |
| Molokai .....   | Wailau Stream .....          | 30                       |
| Oahu .....  | Waikele Stream .....         | 25                       |
| Kauai .....   | Hanalei River .....          | 150                      |

1/ Estimated on basis of drainage area rather than stream runoff. Other major streams include Wailoa River, Hawaii (1/2-mile long); Honokohau Stream (9.4 miles long) and Iao Stream (5), both on Maui; Halawa Stream (6.4), Waikolu Stream (4.7), and Pelekunu (2.3), all on Molokai; Waikele Stream (15.3), Kipapa Stream (12.8), Waiakakalaua Stream (11.8), Nuuanu Stream (4), and Ala Wai Canal (1.9), all on Oahu; and the Makaweli River (15.1), Wainiha River (13.8), Hanapepe River (13.3), and Wailua River (11.8), all on Kauai.

Source: Longest water feature from U.S. Geological Survey, records; other data from Hawaii State Department of Land and Natural Resources, Division of Water and Land Development, records.

Table 157.-- LAKES AND LAKE-LIKE WATERS, BY ISLANDS: 1986

| Island and lake       | Type           | Elevation<br>(feet) | Area 1/<br>(acres) | Maximum<br>depth<br>(feet) |
|-----------------------|----------------|---------------------|--------------------|----------------------------|
| <b>Hawaii:</b>        |                |                     |                    |                            |
| Aimakapa .....        | Coastal pool . | (SL)                | 15                 | (NA)                       |
| Green Lake .....      | Lake .....     | 3                   | 2                  | 20                         |
| Lake Waiau 2/ .....   | Lake .....     | 13,020              | 2                  | 10                         |
| Waiakea Pond .....    | Tidal pond ... | (SL)                | 27                 | 7                          |
| <b>Maui:</b>          |                |                     |                    |                            |
| Kanaha Pond .....     | Marsh .....    | (SL)                | 41                 | <3                         |
| Kealia Pond .....     | Marsh .....    | (SL)                | 500                | (NA)                       |
| Violet Lake .....     | Bog pool ..... | 5,020               | 0.02-1             | (NA)                       |
| Wai Anapanapa .....   | Pond .....     | 6,790               | 0.2                | (NA)                       |
| Waieleele .....       | Pond .....     | 6,690               | 0.5                | 21                         |
| <b>Molokai:</b>       |                |                     |                    |                            |
| Kauhako .....         | Pool .....     | (SL)                | 0.9                | 814                        |
| Kualapuu Reservoir .. | Reservoir .... | 821                 | 100                | 50                         |
| Meyer Lake .....      | Impoundment .. | 2,021               | 6-10               | 5                          |
| <b>Oahu:</b>          |                |                     |                    |                            |
| Kaelepulu Pond .....  | Lake .....     | (SL)                | 198                | (NA)                       |
| Kawainui Marsh .....  | Marsh .....    | (SL)                | 1,000              | (NA)                       |
| Salt Lake .....       | Lake .....     | (SL)                | 49                 | 2                          |
| Wahiawa Reservoir ... | Reservoir .... | 842                 | 302                | 85                         |
| <b>Kauai:</b>         |                |                     |                    |                            |
| Nomilu Fishpond ..... | Pond .....     | (SL)                | 20                 | 66                         |
| Waita Reservoir ..... | Reservoir .... | 241                 | 424                | 23                         |
| <b>Niihau:</b>        |                |                     |                    |                            |
| Halalii Lake .....    | Playa .....    | (SL)                | 841-865            | (NA)                       |
| Halulu Lake .....     | Playa .....    | (SL)                | 182-371            | (NA)                       |
| <b>Laysan:</b>        |                |                     |                    |                            |
| Unnamed closed lagoon | Closed lagoon  | (SL)                | 161                | 16                         |

NA Not available.

SL Sea level.

1/ Ranges shown for Violet Lake, Meyer Lake, Halalii Lake, and Halulu Lake reflect differences in estimates between sources.

2/ Highest lake in the State and third highest in the United States.

Continued on next page.

Table 157.-- LAKES AND LAKE-LIKE WATERS, BY ISLANDS: 1986 - Con.

Source: J.A. Maciolek, Lakes and Lake-like Waters of the Hawaiian Archipelago (Bernice P. Bishop Museum, Occasional Papers, Vol. XXV, No. 1, April 30, 1982; Hawaii State Department of Land and Natural Resources, Division of Water and Land Development, data provided June 12, 1985 and May 6, 1986; Hawaii State Department of Planning and Economic Development, Resource Management Plan for Kawainui Marsh (March 1983); William H. Meyer, U.S. Fish and Wildlife Service, transmittal letter (to DPED, Coastal Zone Management Program), for Kealia Pond National Wildlife Refuge, Maui, Hawaii, Final EIS (EIS No. 116, August 1981).

Table 158.-- MAJOR NAMED WATERFALLS, BY ISLANDS

| Island    | Waterfall                          | Height (feet) |         | Horizontal distance (feet) |
|-----------|------------------------------------|---------------|---------|----------------------------|
|           |                                    | Sheer drop    | Cascade |                            |
| Hawaii .. | Kaluahine .....                    | ...           | 620     | 400                        |
|           | Akaka .....                        | 442           | ...     | ...                        |
| Maui .... | Honokohau .....                    | ...           | 1,120   | 500                        |
| Molokai . | Kahiwa .....                       | ...           | 1,750   | 1,000                      |
|           | Papalaua .....                     | ...           | 1,200   | 500                        |
| Oahu .... | Kaliuwa'a (Sacred) <sup>1/</sup> . | 80            | 1,520   | 3,000                      |
| Kauai ... | Waipoo (2 falls) .....             | ...           | 800     | 600                        |
|           | Awini .....                        | ...           | 480     | 500                        |

<sup>1/</sup> Sheer drop refers to northernmost fall of a cascade of six falls.

Source: U.S. Geological Survey, records; Hawaii State Department of Land and Natural Resources, Division of Water and Land Development, records.

Table 159.-- MISCELLANEOUS GEOGRAPHIC STATISTICS, BY ISLANDS

| Island          | Extreme length (miles)            | Extreme width (miles) | Miles of sea cliffs with heights 1,000 ft. or more <sup>1/</sup> | Miles from coast of most remote point | Percent of area within 5 miles of coast |
|-----------------|-----------------------------------|-----------------------|--|---------------------------------------|---|
| The State ..    | ...                               | ...                   | 33   | 28.5                                  | 48.6                                    |
| Hawaii .....    | 93                                | 76                    | 4  | 28.5                                  | 30.0                                    |
| Maui .....      | 48                                | 26                    | -  | 10.6                                  | 76.1                                    |
| Kahoolawe ..... | 11                                | 6                     | -  | 2.4                                   | 100.0                                   |
| Lanai .....     | 18                                | 13                    | 1  | 5.2                                   | 100.0                                   |
| Molokai .....   | 38                                | 10                    | 14   | 3.9                                   | 100.0                                   |
| Oahu .....      | 44                                | 30                    | -  | 10.6                                  | 79.0                                    |
| Kauai .....     | 33                                | 25                    | 11   | 10.8                                  | 67.0                                    |
| Niihau .....    | 18                                | 6                     | 3  | 2.4                                   | 100.0                                   |
| Island          | Percent of area with elevation -- |                       | Approximate mean altitude (feet)                                 | Percent of area with slope --         |   |
|                 | Less than 500 feet                | 2,000 feet or more    |  | Less than 10 percent                  | 20 percent or more                      |
| The State ..    | 20.8                              | 50.9                  | 3,030  | 63.5                                  | 17.0                                    |
| Hawaii .....    | 12.0                              | 68.4                  | 3,950  | 76.0                                  | 4.0                                     |
| Maui .....      | 24.9                              | 41.4                  | 2,390  | 38.5                                  | 36.0                                    |
| Kahoolawe ..... | 38.9                              | 0                     | 600  | 60.0                                  | 9.0                                     |
| Lanai .....     | 24.8                              | 6.3                   | 1,140  | 61.0                                  | 16.0                                    |
| Molokai .....   | 37.3                              | 17.8                  | 1,150  | 53.0                                  | 26.0                                    |
| Oahu .....      | 45.3                              | 4.6                   | 860  | 42.5                                  | 45.5                                    |
| Kauai .....     | 35.6                              | 24.0                  | 1,380  | 33.5                                  | 50.5                                    |
| Niihau .....    | 78.2                              | 0                     | 530  | 68.0                                  | 12.5                                    |

<sup>1/</sup> According to Lee S. Motteler, Geography and Map Division, Bernice P. Bishop Museum, the sea cliffs along the northeastern coast of Molokai between Umilehi Point and Puukaoku Point drop 3,250 feet at an average slope of 58 degrees. These cliffs have been described by the Guinness Book of World Records (1986 edition, p. 99) as "the highest sea cliffs yet pinpointed anywhere in the world."

Source: Hawaii State Department of Planning and Economic Development, Hawai'i, the Natural Environment (1974), p. 19; U.S. Geological Survey, Elevations and Distances in the United States (1978), pp. 4-5.



Table 160.-- VOLCANIC ERUPTIONS: 1975 TO 1986

[Complete through October 24, 1986. Four volcanoes have erupted in historical times: Haleakala, last active around 1790; Hualalai, last active in 1800-1801; and Kilauea and Mauna Loa, both active during the past decade and included in this table]

| Volcano and date of outbreak | Repose period since previous eruption (months) | Duration (days) | Location             | Elevation (feet) | Area (square miles) | Volume (1,000 cubic yards) |
|------------------------------|--|-----------------|----------------------|------------------|---------------------|----------------------------|
| Mauna Loa:                   |  |                 |                      |                  |                     |                            |
| 1975: July 5                 | 301  | <1              | Summit               | 13,000           | 5.2                 | 35,000                     |
| 1984: March 25               | 104  | 22              | Summit,<br>East rift | 13,200-9,400     | 11±                 | 230,000                    |
| Kilauea:                     |  |                 |                      |                  |                     |                            |
| 1975: Nov. 29                | 11.0   | <1              | Caldera              | 3,600-3,520      | 0.1                 | 300                        |
| 1977: Sept. 13               | 21.5   | 18              | East rift            | 2,080-1,600      | 3.0                 | 45,000                     |
| 1979: Nov. 16                | 26.3   | 1               | East rift            | 3,270-3,200      | 0.1                 | 800                        |
| 1982: April 30               | 29.5   | <1              | Caldera              | 3,630            | 0.1                 | 260                        |
| Sept. 25                     | 4.9  | <1              | Caldera              | 3,620            | 0.3                 | 3,900                      |
| 1983: Jan. 3 <u>1/</u>       | 3.3  | 1,390           | East rift            | 2,560-2,120      | 52.1                | 633,000                    |

1/ Still in progress, October 24, 1986. As of that time, there had been 48 separate episodes, with a combined length of 71.9 days.

Source: Gordon A. Macdonald and Douglass H. Hubbard, Volcanoes of the National Parks in Hawaii, 8th edition (Hawaii Natural History Association, 1982), pp. 10, 19, 34, and 58, as updated by the staff of the Hawaiian Volcano Observatory, November 10, 1986.

Table 161.-- EARTHQUAKES OF MAGNITUDE 5 OR GREATER: 1975 TO 1985

[Complete to December 31, 1985. Revised from Data Book 1985,  
table 146]

| Date and time             | Location                   | Magnitude<br>(Richter<br>Scale) |
|---------------------------|----------------------------|---------------------------------|
| 1975: Jan. 2, 3:27 AM ... | Near Pahala, Hawaii .....  | 5.0                             |
| Nov. 29, 3:35 AM ..       | Puna, Hawaii .....         | 5.7                             |
| Nov. 29, 4:47 AM ..       | Puna, Hawaii .....         | 7.2                             |
| 1976: Feb. 20, 7:51 PM .. | Between Maui and Hawaii .. | 5.1                             |
| 1977: Jan. 22, 12:36 PM . | 100 miles S. of Kauai .... | 5.1                             |
| Apr. 20, 6:49 PM ..       | Hamakua, Hawaii .....      | 5.0                             |
| Jun. 5, 11:42 PM ..       | Puna, Hawaii .....         | 5.1                             |
| 1979: Mar. 29, 11:06 PM . | 40 miles S.W. of Oahu .... | 5.5                             |
| Sept. 21, 9:59 PM .       | Puna, Hawaii .....         | 5.5                             |
| 1981: Mar. 5, 4:09 AM ... | Molokai area .....         | 5.3                             |
| Nov. 10, 3:02 AM ..       | Kilauea, Hawaii .....      | 5.3                             |
| 1982: Jan. 21, 11:52 AM . | Mauna Loa, Hawaii .....    | 5.5                             |
| Jan. 21, 12:29 PM .       | Mauna Loa, Hawaii .....    | 5.5                             |
| May 14, 6:26 AM ...       | Off Kawaihae, Hawaii ..... | 5.0                             |
| 1983: Mar. 20, 5:18 PM .. | Off Kalapana, Hawaii ..... | 5.0                             |
| Sept. 9, 6:30 AM ..       | Off Kalapana, Hawaii ..... | 5.4                             |
| Nov. 16, 6:13 AM ..       | S.E. flank of Mauna Loa .. | 6.7                             |
| 1984: Jun. 8, 5:34 PM ... | 80 miles S. of Honolulu .. | 5.3                             |

Source: Hawaii Institute of Geophysics, records; Hawaii Volcano Observatory Summaries; U.S. Geological Survey, National Earthquake Information Service. Data provided by Professor Augustine S. Furumoto, Hawaii Institute of Geophysics, University of Hawaii, September 16, 1986.

Table 162 .-- EARTHQUAKES WITH HONOLULU INTENSITIES OF  
V OR GREATER: 1859 TO 1983

[Based on data for 113 earthquakes recorded in Honolulu,  
from 1859 through 1983]

| Date            | Epicentral location      | Magnitude<br>(Richter<br>scale) | Honolulu average<br>intensity (Modified<br>Mercalli Scale 1/) |
|-----------------|--------------------------|---------------------------------|---|
| 1861: Dec. 5 .. | Molokai-Lanai vic. (?) . | (?)                             | Mid V   |
| Dec. 15 .       | Molokai-Lanai vic. (?) . | (?)                             | Lower V   |
| 1868: Apr. 2 .. | SE coast of Hawaii ..... | 7.5                             | Upper IV - lower V  |
| Apr. 4 ..       | Maui group vicinity (?)  | (?)                             | Lower V   |
| 1871: Feb. 19 . | S coast of Lanai .....   | 7.0                             | Upper VI - lower VII  |
| 1895: Dec. 8 .. | Oahu vicinity (?) .....  | (?)                             | Mid V   |
| 1926: Mar. 19 . | N of Kohala, Hawaii .... | (?)                             | Upper IV - lower V  |
| 1929: Oct. 5 .. | W of Kona, Hawaii .....  | 6.5                             | Lower V   |
| 1938: Jan. 22 . | N of Maui .....          | 6.8                             | Upper V - lower VI  |
| 1948: June 28 . | S coast of Oahu .....    | 4.8                             | Mid VI  |
| 1964: Oct. 11 . | Ka Lae, Hawaii .....     | 5.5                             | Upper IV - lower V  |
| 1973: Apr. 26 . | Hamakua coast, Hawaii .. | 6.2                             | Mid V   |
| 1981: Mar. 5 .. | Kalohi Channel .....     | 5.0                             | Mid V   |

1/ Modified Mercalli Scale of 1931, 1956 abridged version. This scale, which extends from I to XII, reads in part:

IV. Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV wooden walls and frame creak.

V. Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.

VI. Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry cracked. Small bells ring (church, school). Trees, bushes shaken (visibly, or heard to rustle).

VII. Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to weak masonry, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles cornices. Some cracks in ordinary masonry. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.

Source: Doak C. Cox, "Earthquake Experience and Seismic Risk in Honolulu" (paper presented to the Hawaiian Historical Society, Honolulu, March 6, 1986), and letter dated June 23, 1986.

Table 163.-- TSUNAMIS WITH RUN-UP OF 2 METERS (6.6 FEET) OR MORE:  
1946 TO 1986

[Correct to December 31, 1986]

| Date                | Maximum height in Hawaii |      | Deaths in Hawaii | Damage in Hawaii (dollars) |
|---------------------|--------------------------|------|------------------|----------------------------|
|                     | Meters                   | Feet |                  |                            |
| 1946: April 1 ..... | 17.0                     | 55.8 | 159              | 26,000,000                 |
| 1952: Nov. 4 .....  | 6.1                      | 20.0 | -                | 1,000,000                  |
| 1957: March 9 ..... | 16.0                     | 52.5 | -                | 5,000,000                  |
| 1960: May 22 .....  | 10.5                     | 34.5 | 61               | 23,000,000                 |
| 1964: March 27 .... | 4.8                      | 15.7 | -                | 67,590                     |
| 1975: Nov. 29 ..... | 14.6                     | 48.0 | 2                | 1,500,000                  |

Source: George Pararas-Carayannis, Catalog of Tsunamis in the Hawaiian Islands (U.S. Coast and Geodetic Survey, May 1969); Robert C. Schmitt, "Catastrophic Mortality in Hawaii," The Hawaiian Journal of History, Vol. III (1969), pp. 66-86; Harold G. Loomis, The Tsunami of November 29, 1975 in Hawaii (Hawaii Institute of Geophysics, December 1975), pp. 1 and 10; D.C. Cox and J. Morgan, Local Tsunamis and Possible Local Tsunamis in Hawaii (Hawaii Institute of Geophysics, Report HIG 77-14, November 1977); Hawaii Institute of Geophysics, records.

Table 164.-- MAJOR DAMS: 1986

| Name            | Location            | Height (ft.) | Length (ft.) | Volume of water impounded (acre ft.) |
|-----------------|---------------------|--------------|--------------|--------------------------------------|
| Wahiawa Dam ... | Wahiawa, Oahu ..... | 98           | 460          | 7,671                                |
| Waita .....     | Koloa, Kauai .....  | 28           | 3,250        | 6,500                                |
| Kualapuu .....  | Kualapuu, Molokai . | 58           | 7,100        | 4,265                                |
| Alexander Dam . | Kalaheo, Kauai .... | 119          | 600          | 2,500                                |
| Nuuanu No. 4 .. | Honolulu, Oahu .... | 73           | 1,730        | 1,420                                |

Source: Hawaii State Department of Land and Natural Resources, Division of Water and Land Development, records.

Table 165.-- WATER USE, BY TYPE, BY ISLANDS: 1980

[Millions of gallons per year]

| Type of water and use              | State total | Hawaii | Maui    | Lanai | Molokai | Oahu    | Kauai  | Niihau |
|------------------------------------|-------------|--------|---------|-------|---------|---------|--------|--------|
| <b>Agricultural:</b>               |             |        |         |       |         |         |        |        |
| Ground water .....                 | 136,510     | 1,720  | 47,300  | 330   | 140     | 70,360  | 16,650 | 10     |
| Surface water .....                | 237,950     | 3,630  | 129,130 | -     | 990     | 16,170  | 88,030 | -      |
| Recycled water .....               | 32,970      | 50     | 9,730   | -     | -       | 3,350   | 19,840 | -      |
| <b>Commercial:</b>                 |             |        |         |       |         |         |        |        |
| Ground water .....                 | 2,770       | 1,470  | -       | -     | -       | 410     | 890    | -      |
| <b>Domestic:</b>                   |             |        |         |       |         |         |        |        |
| Ground water .....                 | 71,770      | 2,280  | 3,830   | 140   | 270     | 63,250  | 1,990  | 10     |
| Surface water .....                | 3,880       | 130    | 3,500   | -     | 80      | -       | 170    | -      |
| <b>Hydroelectric:</b>              |             |        |         |       |         |         |        |        |
| Surface water .....                | 74,190      | 22,840 | 14,620  | -     | -       | -       | 36,730 | -      |
| <b>Industrial, thermoelectric:</b> |             |        |         |       |         |         |        |        |
| Ground water .....                 | 31,520      | 24,740 | -       | -     | 10      | 4,880   | 1,890  | -      |
| Surface water .....                | 2,170       | -      | -       | -     | -       | -       | 2,170  | -      |
| Seawater <sup>1/</sup> .....       | 447,810     | 3,140  | 14,820  | -     | -       | 425,900 | 3,950  | -      |
| <b>Industrial, other uses:</b>     |             |        |         |       |         |         |        |        |
| Ground water .....                 | 18,680      | 2,030  | 2,810   | -     | -       | 7,340   | 6,500  | -      |
| Surface water .....                | 11,220      | 4,080  | 2,910   | -     | 30      | -       | 4,200  | -      |
| Recycled water .....               | 4,130       | 1,900  | 160     | -     | -       | 200     | 1,870  | -      |

<sup>1/</sup> Includes water from wells near the seacoast.

Source: Data compiled by U.S. Geological Survey, cited in Hawaii State Department of Land and Natural Resources, Division of Water and Land Development, Water Use in Hawaii, 1980 (Report No. R-79, 1984).

Table 166 .-- WATER SERVICES AND CONSUMPTION, FOR COUNTY WATERWORKS:  
1981 TO 1985

| Subject and geographic area                 | 1981    | 1982    | 1983    | 1984    | 1985    |
|---|---------|---------|---------|---------|---------|
| <b>NUMBER OF SERVICES,<br/>JUNE 30</b>      |         |         |         |         |         |
| State total .....                           | 178,250 | 179,648 | 181,980 | 185,044 | 188,271 |
| City and County of Honolulu .               | 125,903 | 126,400 | 127,540 | 129,080 | 130,884 |
| Honolulu 1/ .....                           | 58,349  | 58,159  | 58,173  | 58,462  | 58,801  |
| Rest of Oahu .....                          | 67,554  | 68,241  | 69,367  | 70,618  | 72,083  |
| Hawaii County .....                         | 23,215  | 23,682  | 24,218  | 24,834  | 25,315  |
| Kauai County .....                          | 10,632  | 10,823  | 11,049  | 11,501  | 11,872  |
| Maui County .....                           | 18,500  | 18,743  | 19,173  | 19,629  | 20,200  |
| Maui .....                                  | 17,376  | 17,607  | 18,007  | 18,413  | 18,964  |
| Molokai .....                               | 1,124   | 1,136   | 1,166   | 1,216   | 1,236   |
| <b>CONSUMPTION 2/<br/>(MILLION GALLONS)</b> |         |         |         |         |         |
| State total .....                           | 58,574  | 56,719  | 59,724  | 63,670  | 65,298  |
| City and County of Honolulu .               | 44,216  | 42,646  | 44,535  | 47,389  | 48,308  |
| Honolulu 1/ .....                           | 25,086  | 24,317  | 25,658  | 26,636  | 27,218  |
| Rest of Oahu .....                          | 19,130  | 18,329  | 18,877  | 20,753  | 21,090  |
| Hawaii County .....                         | 4,664   | 4,753   | 5,066   | 5,409   | 5,666   |
| Kauai County .....                          | 2,780   | 2,805   | 3,240   | 3,492   | 3,531   |
| Maui County .....                           | 6,914   | 6,515   | 6,883   | 7,380   | 7,793   |
| Maui .....                                  | 6,620   | 6,235   | 6,592   | 7,073   | 7,493   |
| Molokai .....                               | 294     | 280     | 292     | 307     | 300     |

1/ Maunalua to Moanalua.

2/ Year ended June 30.

Source: Data compiled by Hawaii State Department of Planning and Economic Development from Honolulu Board of Water Supply, Hawaii County Department of Water Supply, Kauai Department of Water, and Maui Department of Water Supply.

Table 167.-- POLLUTION ABATEMENT COSTS AND EXPENDITURES:  
1984

[Millions of dollars. Statistics cover manufacturing establishments with 20 employees or more]

| Subject  | State total |
|--|-------------|
| Total pollution abatement capital expenditures ..... | 6.8         |
| Gross annual cost of pollution abatement .....       | 10.8        |
| Payments to government units .....                   | 0.8         |
| Operating costs, total .....                         | 10.0        |
| Cost recovered through abatement activities .....    | 0.6         |
| Operating costs by form of pollutants abated:        |             |
| Air .....  | 2.3         |
| Water .....  | 5.1         |
| Solid waste, hazardous .....                         | 0.3         |
| Solid waste, non-hazardous .....                     | 2.3         |
| Operating costs by kind of cost:                     |             |
| Depreciation .....                                   | 1.6         |
| Labor .....  | 2.4         |
| Materials and supplies .....                         | 3.3         |
| Services, equipment leasing, and other costs .....   | 2.7         |

Source: U.S. Bureau of the Census, "Pollution Abatement Costs and Expenditures, 1984," Current Industrial Reports, MA-200(84)-1 (May 1986), pp. 16, 34, and 49.

Table 168.-- WATER QUALITY AT SPECIFIED PUBLIC BEACHES: 1982 TO 1985

| Island and beach                       | Number of samples, 1985 | Fecal coliform density 1/ (geometric mean, MPN/100 ml) |       |       |       |
|--|-------------------------|--|-------|-------|-------|
|  |                         | 1982   | 1983  | 1984  | 1985  |
| <b>Hawaii (Hilo Shoreline Area):</b>   |                         |  |       |       |       |
| Exit of Ice Pond .....                 | 17                      | 27.3   | 27.5  | 15.6  | 78.2  |
| Leileiwi Beach Park .....              | 9                       | 222.6  | 121.1 | 109.7 | 182.1 |
| Onakahakaha .....                      | 9                       | 17.3   | 6.4   | 5.6   | 8.8   |
| Puhi Bay No. 3 .....                   | 9                       | 18.1   | 12.6  | 12.9  | 286.1 |
| <b>Hawaii (Kona Shoreline Area):</b>   |                         |  |       |       |       |
| Hapuna Beach .....                     | 11                      | 33.0   | 15.2  | 5.3   | 3.9   |
| Kahaluu Beach .....                    | 11                      | 2.3  | 6.4   | 2.6   | 2.8   |
| Kealahakua Bay (curio stand) .....     | 11                      | 2.3  | 3.9   | 3.3   | 4.6   |
| Kealahakua Bay (canoe landing) .....   | 11                      | 2.3  | 4.4   | 4.4   | 3.9   |
| Magic Sands Beach .....                | 11                      | 8.0  | 3.4   | 5.4   | 4.7   |
| Puako Beach Lots (middle) .....        | 11                      | 29.6   | 21.4  | 9.5   | 11.6  |
| Puako Beach Lots (south end) .....     | 11                      | 74.0   | 21.2  | 46.2  | 20.6  |
| Spencer Beach Park .....               | 11                      | 14.6   | 4.7   | 9.8   | 6.7   |
| <b>Maui:</b>                           |                         |  |       |       |       |
| Hukilau Hotel shoreline .....          | 11                      | 2.9  | 3.3   | 3.0   | 7.4   |
| <b>Oahu:</b>                           |                         |  |       |       |       |
| Ala Moana Park (ewa) .....             | 25                      | 11.0   | 6.8   | 5.7   | 6.7   |
| Ala Moana Park (center) .....          | 12                      | 4.9  | 2.0   | 2.7   | 3.3   |
| Ala Moana Park (diamond head) .....    | 12                      | 5.8  | 6.2   | 3.1   | 7.9   |
| Elks Club Beach .....                  | 12                      | 4.9  | 4.0   | 5.4   | 6.2   |
| Ewa Beach .....                        | 11                      | 5.5  | 4.4   | 4.8   | 5.1   |
| Ft. DeRussy Beach .....                | 12                      | 18.5   | 5.6   | 6.8   | 5.0   |
| Gray's Beach .....                     | 23                      | 6.0  | 5.7   | 5.4   | 7.3   |
| Hanauma Bay .....                      | 12                      | 13.0   | 6.8   | 9.5   | 17.7  |
| Kahana Park Beach .....                | 12                      | 62.2   | 24.0  | 58.2  | 54.1  |
| Kahanamoku Beach .....                 | 12                      | 3.3  | 3.4   | 2.4   | 3.7   |
| Kahanamoku Lagoon (diamond head) ..... | 23                      | 38.5   | 23.3  | 16.8  | 77.0  |
| Kailua Bay outfall shoreline .....     | 12                      | 5.3  | 2.0   | 3.8   | 2.8   |
| Kailua Beach Park .....                | 11                      | 5.7  | 3.1   | 2.5   | 5.0   |
| Kokokahi Pier .....                    | 11                      | 48.5   | 29.8  | 12.1  | 114.5 |
| Kuhio Beach .....                      | 12                      | 23.9   | 9.7   | 8.4   | 22.5  |
| Public Bath Beach .....                | 23                      | 3.3  | 2.5   | 3.3   | 4.8   |
| Tavern Beach .....                     | 12                      | 7.3  | 4.4   | 6.1   | 9.1   |
| Sand Island, Pt. No. 3 .....           | 12                      | 2.7  | 2.9   | 2.3   | 4.2   |

Continued on next page.



Table 168.-- WATER QUALITY AT SPECIFIED PUBLIC BEACHES: 1982 TO 1985 - Con.

| Island and beach          | Number of samples, 1985 | Fecal coliform density 1/ (geometric mean, MPN/100 ml) |      |      |      |
|---------------------------|-------------------------|--|------|------|------|
|                           |                         | 1982   | 1983 | 1984 | 1985 |
| Kauai:                    |                         |  |      |      |      |
| Brennecke Beach .....     | 3                       | 2.0  | 4.1  | 2.5  | 2.0  |
| Hanalei Bay Landing ..... | 3                       | 60.1   | 86.0 | 42.8 | 51.2 |
| Poipu Beach .....         | 3                       | 2.5  | 2.0  | 4.4  | 2.0  |

MPN Most probable number.  
 1/ The geometric mean standard for fecal coliform density is 200 MPN per 100 ml.  
 Source: Hawaii State Department of Health, Pollution Investigation and Enforcement Branch, data supplied April 29, 1986.

Table 169 .-- LITTER ALONG OAHU HIGHWAYS: 1978 TO 1985

| Measure  | 1978  | 1979  | 1981  | 1985  |
|--|-------|-------|-------|-------|
| Visible litter items per mile:                       |       |       |       |       |
| 35 sites .....                                       | 2,128 | 1,369 | 1,471 | 1,110 |
| 52 sites 1/ .....                                    | 2,135 | 1,452 | 1,576 | 1,261 |
| Visible beer/soft drink containers per mile:         |       |       |       |       |
| 35 sites .....                                       | 367   | 187   | 93    | 60    |
| 52 sites 1/ .....                                    | 292   | 148   | 71    | 51    |
| Indiscriminate dumps per 1,000 miles of driving .... | (NA)  | 8.2   | 15.7  | 19.6  |
| Abandoned vehicles per 1,000 miles of driving .....  | (NA)  | 4.9   | 23.6  | 57.4  |

NA Not available.  
 1/ 1978 and 1979 estimated.  
 Source: Daniel B. Syrek, Hawaii Litter: 1985 (Sacramento: The Institute for Applied Research, for the Hawaii State Department of Health, Litter Control Office, May 23, 1985).

Table 170.-- AIR QUALITY IN DOWNTOWN HONOLULU:  
1975 TO 1985

[Sampling is conducted approximately 46 ft. above ground on the roof of the State Health Department building, 1250 Punchbowl Street, Honolulu, Hawaii]

| Year                           | Annual arithmetic means (ug/m <sup>3</sup> ) |               |
|--------------------------------|--|---------------|
|                                | Total suspended particulates                 | Sulfur oxides |
| 1975 .....                     | 40   | 9             |
| 1976 .....                     | 34   | 23            |
| 1977 .....                     | 31   | 17            |
| 1978 .....                     | 29   | 18            |
| 1979 .....                     | 32   | 22            |
| 1980 .....                     | 37   | 18            |
| 1981 .....                     | 40   | 19            |
| 1982 .....                     | 29   | 11            |
| 1983 .....                     | 26   | <5            |
| 1984 .....                     | 25   | <5            |
| 1985 .....                     | 24   | <5            |
| Standards: 1/<br>Primary ..... | 75   | 80            |
| Secondary .....                | 60   | ...           |

1/ Primary and secondary National Ambient air quality standards have been promulgated by the Federal government. Primary standards are designed to prevent adverse effects on public health, while secondary standards are designed to prevent adverse effects on public welfare, including the effects on comfort, visibility, vegetation, animals, aesthetic values, and soiling and deterioration of materials.

Source: Hawaii State Department of Health, Pollution Investigation and Enforcement Branch, data supplied April 29, 1986.

Table 171.-- AIR QUALITY AT SPECIFIED LOCATIONS: 1985

[24-hour sampling, in micrograms per cubic meter]

| Sampling station         | Total suspended particulates |         |                            | Sulfur dioxide |         |                            |
|--------------------------|------------------------------|---------|----------------------------|----------------|---------|----------------------------|
|                          | Annual range                 |         | Arith-<br>metic<br>average | Annual range   |         | Arith-<br>metic<br>average |
|                          | Minimum                      | Maximum |                            | Minimum        | Maximum |                            |
| <b>Oahu:</b>             |                              |         |                            |                |         |                            |
| Barbers Point ...        | 24                           | 138     | 52                         | <5             | 25      | <5                         |
| Downtown Honolulu        | 10                           | 48      | 24                         | <5             | 5       | <5                         |
| Liliha .....             | 11                           | 254     | 46                         | ...            | ...     | ...                        |
| Pearl City <u>1/</u> ... | 16                           | 62      | 35                         | ...            | ...     | ...                        |
| Waimanalo .....          | 13                           | 52      | 26                         | ...            | ...     | ...                        |
| <b>Maui:</b>             |                              |         |                            |                |         |                            |
| Kahului <u>2/</u> .....  | 26                           | 105     | 57                         | <5             | 31      | 6.2                        |
| Kihei <u>2/</u> .....    | 16                           | 190     | 54                         | ...            | ...     | ...                        |
| <b>Hawaii:</b>           |                              |         |                            |                |         |                            |
| Hilo <u>2/</u> .....     | 8                            | 28      | 6                          | <5             | 6       | <5                         |
| Kona <u>3/</u> .....     | 6                            | 22      | 12                         | <5             | 8       | <5                         |
| <b>Kauai:</b>            |                              |         |                            |                |         |                            |
| Lihue <u>4/</u> .....    | 17                           | 76      | 34                         | ...            | ...     | ...                        |

1/ Discontinued sampling for SO<sub>2</sub> on January 1, 1985.

2/ Site discontinued October 1, 1985; samples based on 9 months of data.

3/ Site established June 1, 1985 at Kona Hospital.

4/ Data based on 9 months of sampling.

Source: Hawaii State Department of Health, Pollution Investigation and Enforcement Branch, data supplied April 29, 1986.

Table 172.-- SOURCES OF AIR POLLUTANT EMISSIONS, BY COUNTIES: 1980

[Percent distributions for the sums of weights of sulfur oxides, particulate matter, carbon monoxide, hydrocarbons, and nitrogen oxide emissions]

| Source  | State total | Hawaii | Honolulu | Kauai | Maui  |
|---|-------------|--------|----------|-------|-------|
| All sources .....                                 | 100.0       | 100.0  | 100.0    | 100.0 | 100.0 |
| Transportation .....                              | 43.0        | 38.1   | 47.4     | 40.6  | 35.8  |
| Motor vehicles .....                              | 40.1        | 36.2   | 43.9     | 35.7  | 33.1  |
| Aircraft .....                                    | 2.3         | 1.1    | 2.9      | 2.3   | 1.6   |
| Vessels .....                                     | 0.6         | 0.8    | 0.6      | 2.6   | 1.1   |
| Fuel combustion in                                |             |        |          |       |       |
| stationary sources .....                          | 29.7        | 34.9   | 26.7     | 32.2  | 35.3  |
| Steam electric .....                              | 23.1        | 19.8   | 24.6     | 18.5  | 22.4  |
| Gas utilities .....                               | 0.1         | (N)    | 0.1      | (N)   | (N)   |
| Agricultural fuel .....                           | 6.5         | 15.1   | 2.0      | 13.7  | 12.9  |
| Industrial process losses ..                      | 14.6        | 7.7    | 20.3     | 3.2   | 3.5   |
| Refinery .....                                    | 4.8         | (N)    | 6.5      | (N)   | (N)   |
| Petroleum storage .....                           | 0.7         | 1.1    | 0.8      | (N)   | 0.5   |
| Metalurgical .....                                | 0.1         | (N)    | 0.1      | (N)   | (N)   |
| Mineral products .....                            | 6.9         | 3.9    | 10.8     | 0.9   | 1.1   |
| Off-highway const., farms<br>and industries ..... | 2.1         | 2.7    | 2.1      | 2.3   | 1.9   |
| Municipal incinerator .....                       | 0.9         | (N)    | 1.3      | (N)   | (N)   |
| Agricultural burning .....                        | 11.7        | 19.3   | 4.3      | 24.2  | 25.4  |

N Less than 0.05 percent.

Source: Hawaii State Department of Health, Environmental Permits Branch, information provided April 28, 1986.

Table 173.-- NOISE LEVELS DURING DAYLIGHT HOURS IN SPECIFIED NEIGHBORHOODS ON OAHU: 1981-1982

| Neighborhood     | Noise levels (in decibels) exceeded -- |                    |                    |                    |                    |                    |
|------------------|--|--------------------|--------------------|--------------------|--------------------|--------------------|
|                  | Manual sampling                        |                    |                    | Automatic sampling |                    |                    |
|                  | 10 percent of time                     | 50 percent of time | 90 percent of time | 10 percent of time | 50 percent of time | 90 percent of time |
| Aina Haina ..... | 45.6                                   | 42.1               | 39.5               | 53.5               | 46.2               | 43.2               |
| Aina Koa .....   | 48.1                                   | 43.1               | 40.1               | 52.9               | 45.8               | 42.5               |
| Downtown .....   | 57                                     | 55                 | 54                 | 60                 | 57                 | 55                 |
| Hawaii Kai ..... | 46.5                                   | 41.6               | 38.9               | 53.5               | 46.9               | 42.9               |
| Kahala .....     | 48.0                                   | 44.5               | 42.4               | -                  | -                  | -                  |
| Kaimuki .....    | 51.8                                   | 44.6               | 41.7               | 57.2               | 47.6               | 43.3               |
| Kalihi .....     | 53.5                                   | 49.6               | 47.4               | -                  | -                  | -                  |
| Kapahulu .....   | 47.2                                   | 45.0               | 42.0               | -                  | -                  | -                  |
| Kapalama-Liliha  | 46.4                                   | 45.1               | 42.5               | -                  | -                  | -                  |
| Kuliouou .....   | 48.6                                   | 45.9               | 43.4               | 52.5               | 47.9               | 45.4               |
| Liliha .....     | 46                                     | 45                 | 43                 | -                  | -                  | -                  |
| Makiki .....     | 52.7                                   | 46.9               | 45.3               | 56.5               | 50.5               | 48.6               |
| Manoa .....      | 45.4                                   | 42.6               | 40.7               | 51.5               | 46.0               | 43.4               |
| Moiliili .....   | 53.7                                   | 50.2               | 46.9               | 60.0               | 53.4               | 48.9               |
| Nuuanu .....     | 46.6                                   | 43.6               | 40.8               | -                  | -                  | -                  |
| Palolo .....     | 49.3                                   | 44.6               | 41.6               | 65.0               | 52.4               | 45.4               |
| Pawaa .....      | 59.8                                   | 57.1               | 55.2               | 60.8               | 57.1               | 54.7               |
| Salt Lake .....  | 56                                     | 52                 | 49                 | -                  | 56                 | 51                 |
| Waikiki .....    | 57.8                                   | 55.4               | 54.1               | 61.6               | 57.5               | 55.3               |
| Waialae Iki ...  | 46.4                                   | 43.1               | 40.6               | 54.6               | 44.8               | 41.7               |
| Aiea .....       | 58                                     | 54                 | 52                 | 59                 | 56                 | 54                 |
| Halawa .....     | 52                                     | 46                 | 44                 | 55                 | 50                 | 47                 |
| Hauula .....     | 53                                     | 48                 | 45                 | 56                 | 51                 | 47                 |
| Kailua .....     | 49.2                                   | 45.5               | 42.9               | 54.9               | 49.6               | 45.2               |
| Kaneohe .....    | 43.8                                   | 40.9               | 38.9               | 49.7               | 43.5               | 40.9               |
| Mililani .....   | 44                                     | 37                 | 34                 | 53                 | 46                 | 41                 |
| Nanakuli .....   | 54                                     | 50                 | 47                 | 58                 | 52                 | 48                 |
| Pearl City ....  | 51                                     | 47                 | 45                 | 55                 | 50                 | 48                 |
| Wahiawa .....    | 47.1                                   | 44.7               | 42.4               | 51.8               | 47.3               | 43.9               |
| Waimanalo .....  | 53                                     | 50                 | 48                 | 55                 | 51                 | 49                 |
| Waipahu .....    | 54.1                                   | 50.5               | 47.4               | 58.8               | 53.6               | 50.4               |

Source: Hawaii State Department of Health, Environmental Protection and Health Services Division, Noise and Radiation Branch, records.

Table 174.-- TEMPERATURES AND PRECIPITATION FOR SELECTED PLACES

| Island and station                | Ground elevation (feet) | Average temperature (°F.) |               | Extreme temperature of record (°F.) |         | Average annual precipitation (inches) |
|-----------------------------------|-------------------------|---------------------------|---------------|-------------------------------------|---------|---------------------------------------|
|                                   |                         | Coolest month             | Warmest month | Lowest                              | Highest |                                       |
| <b>Hawaii:</b>                    |                         |                           |               |                                     |         |                                       |
| Hilo Airport .....                | 30                      | 71.1                      | 75.8          | 53                                  | 94      | 129                                   |
| Hawaii Volcanoes Nat. Park Hdq. . | 3,970                   | 57.6                      | 63.2          | 37                                  | 85      | 101                                   |
| Naalehu .....                     | 675                     | 70.2                      | 75.2          | (NA)                                | (NA)    | 47                                    |
| Kailua .....                      | 30                      | 72.1                      | 77.3          | 54                                  | 93      | 25                                    |
| Puako <u>1/</u> .....             | 5                       | 73.1                      | 79.8          | 52                                  | 98      | 10                                    |
| Waimea (Kamuela) .....            | 2,670                   | 61.3                      | 66.8          | 34                                  | 90      | 31                                    |
| Honokaa .....                     | 1,070                   | 67.6                      | 75.5          | (NA)                                | (NA)    | 86                                    |
| Mauna Kea summit <u>2/</u> .....  | 13,796                  | 31.3                      | 42.5          | 11                                  | 66      | 20                                    |
| <b>Maui:</b>                      |                         |                           |               |                                     |         |                                       |
| Hana .....                        | 120                     | 71.3                      | 76.8          | 50                                  | 90      | 69                                    |
| Haleakala summit .....            | 10,025                  | 42.6                      | 50.0          | 14                                  | 73      | 44                                    |
| Kihei <u>3/</u> .....             | 85                      | 70.9                      | 78.4          | 49                                  | 98      | 13                                    |
| Kahului Airport .....             | 40                      | 71.5                      | 79.2          | 48                                  | 96      | 19                                    |
| Lahaina .....                     | 45                      | 71.5                      | 78.0          | 52                                  | 93      | 15                                    |
| <b>Molokai:</b>                   |                         |                           |               |                                     |         |                                       |
| Kaunakakai .....                  | 10                      | (NA)                      | (NA)          | (NA)                                | (NA)    | 14                                    |
| Molokai Airport .....             | 450                     | 70.2                      | 77.6          | 48                                  | 90      | 27                                    |
| <b>Lanai:</b>                     |                         |                           |               |                                     |         |                                       |
| Lanai City .....                  | 1,620                   | 65.8                      | 72.8          | 46                                  | 88      | 37                                    |
| <b>Oahu:</b>                      |                         |                           |               |                                     |         |                                       |
| Honolulu International Airport .. | 10                      | 72.6                      | 81.0          | 53                                  | 94      | 23                                    |
| Waikiki (Honolulu Zoo) .....      | 10                      | 71.9                      | 80.6          | 51                                  | 93      | 25                                    |
| Manoa (Lyon Arboretum) .....      | 500                     | 69.4                      | 75.2          | (NA)                                | (NA)    | 158                                   |
| Kaneohe MCAS .....                | 10                      | 72.9                      | 79.1          | 58                                  | 90      | 40                                    |

Continued on next page.

Table 174.-- TEMPERATURES AND PRECIPITATION FOR SELECTED PLACES -- Con.

| Island and station             | Ground elevation (feet) | Average temperature (°F.) |               | Extreme temperature of record (°F.) |         | Average annual precipitation (inches) |
|--------------------------------|-------------------------|---------------------------|---------------|-------------------------------------|---------|---------------------------------------|
|                                |                         | Coollest month            | Warmest month | Lowest                              | Highest |                                       |
| Oahu (con.):                   |                         |                           |               |                                     |         |                                       |
| Kahuku .....                   | 25                      | 71.6                      | 78.8          | 49                                  | 95      | 40                                    |
| Wheeler AFB .....              | 845                     | 68.2                      | 75.5          | 52                                  | 89      | 40                                    |
| Waianae .....                  | 10                      | 72.1                      | 79.7          | 45                                  | 96      | 20                                    |
| Kauai:                         |                         |                           |               |                                     |         |                                       |
| Kilauea (town) .....           | 315                     | 68.7                      | 75.6          | 49                                  | 94      | 68                                    |
| Lihue Airport .....            | 100                     | 71.2                      | 79.1          | 50                                  | 90      | 44                                    |
| Poipu (Makahuena Pt.) .....    | 50                      | 72.4                      | 79.4          | 50                                  | 93      | 35                                    |
| Kokee (Kanalohuluhulu) .....   | 3,600                   | 54.9                      | 65.5          | 31                                  | 83      | 70                                    |
| Waialeale .....                | 5,075                   | (NA)                      | (NA)          | (NA)                                | (NA)    | 444                                   |
| Northwestern Hawaiian Islands: |                         |                           |               |                                     |         |                                       |
| Midway .....                   | 10                      | 65.0                      | 78.6          | 52                                  | 89      | 44                                    |

NA Not available.

1/ Temperature data are for Mahukona.

2/ Based on incomplete and non-continuous data for 1966-1972. Precipitation estimated.

3/ Temperature data refer to Puunene Airport.

Source: Hawaii State Department of Land and Natural Resources, Division of Water and Land Development, data supplied September 19, 1986.

Table 175.-- CLIMATIC NORMALS, MEANS, AND EXTREMES FOR  
HILO, KAHULUI, HONOLULU, AND LIHUE AIRPORTS

| Subject                                  | Hilo   | Kahului | Honolulu | Lihue |
|--|--------|---------|----------|-------|
| Normal temperatures (°F.):               |        |         |          |       |
| Daily maximum .....                      | 81.2   | 83.8    | 84.2     | 81.1  |
| Daily minimum .....                      | 65.9   | 67.2    | 69.7     | 69.3  |
| Monthly: Coolest month .....             | 71.1   | 71.5    | 72.6     | 71.2  |
| Warmest month .....                      | 75.8   | 79.2    | 81.0     | 79.1  |
| Annual .....                             | 73.5   | 75.5    | 77.0     | 75.2  |
| Extreme temperatures (°F.):              |        |         |          |       |
| Record highest .....                     | 94     | 96      | 94       | 90    |
| Record lowest .....                      | 53     | 48      | 53       | 50    |
| Normal degree days, base 65°F.:          |        |         |          |       |
| Heating .....                            | -      | -       | -        | -     |
| Cooling .....                            | 3,134  | 3,851   | 4,389    | 3,758 |
| Precipitation (inches):                  |        |         |          |       |
| Normal .....                             | 128.15 | 19.85   | 23.47    | 44.02 |
| Maximum monthly .....                    | 50.82  | 14.46   | 20.79    | 22.91 |
| Minimum monthly .....                    | 0.28   | 0.00    | T        | T     |
| Relative humidity (percent):             |        |         |          |       |
| 8 A.M. ....                              | 80     | 74      | 72       | 78    |
| 2 P.M. ....                              | 68     | 57      | 56       | 66    |
| Wind speed (m.p.h.):                     |        |         |          |       |
| Mean .....                               | 7.1    | 12.8    | 11.6     | 11.9  |
| Fastest observation, 1 minute <u>1</u> / | 29     | 44      | 46       | 65    |
| Percent of possible sunshine .....       | 41     | 69      | 67       | 56    |
| Mean number of days:                     |        |         |          |       |
| Clear .....                              | 35.5   | 130.3   | 87.5     | 53.4  |
| Partly cloudy .....                      | 128.8  | 145.1   | 179.1    | 179.9 |
| Cloudy .....                             | 201.0  | 89.9    | 98.5     | 132.0 |
| Precipitation .01 inch or more .         | 278.7  | 96.7    | 100.1    | 201.4 |

T Trace amount.

1/ Kahului figure refers to fastest mile.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, Local Climatological Data, Annual Summary with Comparative Data, 1985 for Hilo, Kahului, Honolulu, and Lihue.



Table 176.-- MONTHLY AND ANNUAL CLIMATIC DATA FOR HONOLULU INTERNATIONAL AIRPORT

| Month        | Normal temperature (°F) |               |         | Extreme temperature (°F) <u>1/</u> |               | Precipitation (inches) |                 |                 |                     |
|--------------|-------------------------|---------------|---------|------------------------------------|---------------|------------------------|-----------------|-----------------|---------------------|
|              | Daily maximum           | Daily minimum | Monthly | Record highest                     | Record lowest | Normal total           | Maximum monthly | Minimum monthly | Maximum in 24 hours |
| January ...  | 79.9                    | 65.3          | 72.6    | 87                                 | 53            | 3.79                   | 14.74           | 0.21            | 6.72                |
| February ..  | 80.4                    | 65.3          | 72.8    | 88                                 | 53            | 2.72                   | 13.68           | 0.06            | 6.88                |
| March .....  | 81.4                    | 67.3          | 74.3    | 88                                 | 55            | 3.48                   | 20.79           | 0.01            | 17.07               |
| April .....  | 82.7                    | 68.7          | 75.7    | 89                                 | 57            | 1.49                   | 8.92            | 0.01            | 4.21                |
| May .....    | 84.8                    | 70.2          | 77.5    | 90                                 | 60            | 1.21                   | 7.23            | 0.05            | 3.44                |
| June .....   | 86.2                    | 71.9          | 79.1    | 91                                 | 65            | 0.49                   | 2.46            | T               | 2.28                |
| July .....   | 87.1                    | 73.1          | 80.1    | 92                                 | 67            | 0.54                   | 2.01            | 0.03            | 1.03                |
| August ..... | 88.3                    | 73.6          | 81.0    | 93                                 | 67            | 0.60                   | 3.08            | T               | 2.35                |
| September .  | 88.2                    | 72.9          | 80.6    | 93                                 | 66            | 0.62                   | 2.74            | 0.05            | 1.40                |
| October ...  | 86.7                    | 72.2          | 79.5    | 94                                 | 64            | 1.88                   | 11.15           | 0.11            | 7.57                |
| November ..  | 83.9                    | 69.2          | 76.6    | 90                                 | 58            | 3.22                   | 14.72           | 0.03            | 9.15                |
| December ..  | 81.4                    | 66.5          | 74.0    | 89                                 | 54            | 3.43                   | 12.09           | 0.06            | 8.14                |
| Annual ..... | 84.2                    | 69.7          | 77.0    | 94                                 | 53            | 23.47                  | 20.79           | T               | 17.07               |

Continued on next page.

Table 176.-- MONTHLY AND ANNUAL CLIMATIC DATA FOR HONOLULU INTERNATIONAL AIRPORT -- Con.

| Month    | Relative humidity<br>(percent) <u>2/</u> |        | Wind<br>(miles/hour) |                           | Percent<br>of<br>possible<br>sun-<br>shine | Mean<br>sky<br>cover,<br>sunrise<br>to sun-<br>set <u>4/</u> | Mean number of days |        |                                |
|----------|--|--------|----------------------|---------------------------|--|--|---------------------|--------|--------------------------------|
|          | 8 A.M.                                   | 2 P.M. | Mean<br>speed        | Fastest<br>obs. <u>3/</u> |  |  | Sunrise to sunset   |        | Precip.<br>.01 inch<br>or more |
|          |  |        |                      |                           |  |  | Clear               | Cloudy |                                |
| Jan. ... | 82                                       | 63     | 9.7                  | 32                        | 62   | 5.5  | 9.1                 | 8.8    | 10.1                           |
| Feb. ... | 78                                       | 59     | 10.5                 | 30                        | 64   | 5.7  | 7.4                 | 8.3    | 9.3                            |
| Mar. ... | 73                                       | 58     | 11.6                 | 30                        | 68   | 5.9  | 7.2                 | 9.7    | 9.1                            |
| Apr. ... | 70                                       | 57     | 12.0                 | 31                        | 66   | 6.2  | 5.4                 | 10.6   | 9.3                            |
| May .... | 68                                       | 54     | 12.1                 | 30                        | 68   | 6.0  | 6.4                 | 9.5    | 7.3                            |
| June ... | 67                                       | 53     | 12.8                 | 26                        | 70   | 5.7  | 5.7                 | 7.0    | 5.9                            |
| July ... | 68                                       | 52     | 13.5                 | 28                        | 73   | 5.3  | 7.6                 | 5.3    | 7.4                            |
| Aug .... | 68                                       | 53     | 13.2                 | 28                        | 75   | 5.3  | 7.9                 | 6.3    | 6.4                            |
| Sept. .. | 68                                       | 52     | 11.5                 | 26                        | 75   | 5.2  | 8.1                 | 5.9    | 7.1                            |
| Oct. ... | 69                                       | 55     | 10.8                 | 25                        | 68   | 5.7  | 7.4                 | 8.5    | 8.9                            |
| Nov. ... | 75                                       | 59     | 10.8                 | 46                        | 61   | 5.7  | 7.1                 | 9.3    | 9.3                            |
| Dec. ... | 79                                       | 61     | 10.6                 | 29                        | 59   | 5.5  | 8.3                 | 9.4    | 10.0                           |
| Ann. ... | 72                                       | 56     | 11.6                 | 46                        | 67   | 5.6  | 87.5                | 98.5   | 100.1                          |

T Trace amount.

1/ For periods October 1962 through December 1964 and September 1971 through December 1985.

2/ Data for 1963, 1964, and 1972-1985.

3/ Fastest observation, 1 minute, during 5-year period of record.

4/ Sky cover is expressed in a range of 0 for no clouds or obscuring phenomena to 10 for complete sky cover.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, Local Climatological Data, Annual Summary With Comparative Data, Honolulu, 1985.

Table 177.-- CLIMATIC DATA FOR HONOLULU INTERNATIONAL AIRPORT: ANNUALLY, 1975 TO 1985

| Year     | Average temperature (°F)    |               |                         | Extreme temp. (°F) |                              | Precipitation (inches)                   |
|----------|-----------------------------|---------------|-------------------------|--------------------|------------------------------|--|
|          | Annual                      | Coolest month | Warmest month           | Lowest             | Highest                      |  |
| 1975 ... | 76.2                        | 72.4          | 80.1                    | 56                 | 90                           | 24.39                                    |
| 1976 ... | 76.8                        | 72.0          | 80.8                    | 53                 | 91                           | 12.90                                    |
| 1977 ... | 78.2                        | 73.7          | 82.2                    | 59                 | 92                           | 12.36                                    |
| 1978 ... | 76.8                        | 72.4          | 80.5                    | 57                 | 91                           | 25.05                                    |
| 1979 ... | 77.0                        | 69.9          | 81.1                    | 57                 | 93                           | 16.93                                    |
| 1980 ... | 77.5                        | 71.9          | 81.6                    | 56                 | 91                           | 26.90                                    |
| 1981 ... | 77.1                        | 73.2          | 80.7                    | 53                 | 90                           | 13.41                                    |
| 1982 ... | 76.9                        | 71.7          | 81.4                    | 56                 | 92                           | 34.92                                    |
| 1983 ... | 77.2                        | 71.3          | 82.4                    | 53                 | 92                           | 5.03                                     |
| 1984 ... | 78.1                        | 74.1          | 81.7                    | 57                 | 94                           | 17.08                                    |
| 1985 ... | 76.9                        | 71.4          | 81.9                    | 54                 | 93                           | 17.38                                    |
| Year     | Relative humidity (percent) |               | Wind speed (miles/hour) |                    | Percent of possible sunshine | Days with precipitation .01 inch or more |
|          | 8 A.M.                      | 2 P.M.        | Annual average          | Fastest mile 1/    |                              |  |
| 1975 ... | 72                          | 56            | 12.2                    | 36                 | 62                           | 82                                       |
| 1976 ... | 64                          | 52            | 11.5                    | 38                 | 60                           | 105                                      |
| 1977 ... | 71                          | 55            | 12.2                    | 37                 | 68                           | 81                                       |
| 1978 ... | 74                          | 58            | 11.9                    | 34                 | 69                           | 90                                       |
| 1979 ... | 74                          | 57            | 11.4                    | 34                 | 68                           | 89                                       |
| 1980 ... | 75                          | 59            | 11.9                    | 35                 | 69                           | 115                                      |
| 1981 ... | 76                          | 59            | 10.7                    | 30                 | 72                           | 97                                       |
| 1982 ... | 73                          | 59            | 10.4                    | 46                 | 56                           | 124                                      |
| 1983 ... | 75                          | 52            | 9.8                     | 23                 | 64                           | 78                                       |
| 1984 ... | 72                          | 53            | 10.2                    | 40                 | 71                           | 81                                       |
| 1985 ... | 72                          | 55            | 10.6                    | 46                 | 69                           | 87                                       |

1/ 1984 and 1985 figures refer to peak gust.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, Local Climatological Data, Annual Summary With Comparative Data, Honolulu, Hawaii (annual).

Table 178.-- CLIMATIC DATA FOR THE PERIOD OF RECORD

| Subject                                       | Date              | Place                       | Magnitude |
|---|-------------------|-----------------------------|-----------|
| Long-term averages:                           |                   |                             |           |
| Lowest monthly average minimum temp. (°F.) .. | February .....    | Mauna Kea summit ..         | 23.5      |
| Lowest monthly average daily temp. (°F.) .... | February .....    | Mauna Kea summit ..         | 31.3      |
| Highest monthly average maximum temp. (°F.) . | September .....   | Kawaihae 1/ .....           | 91.9      |
| Highest monthly average daily temp. (°F.) ... | September .....   | Kawaihae <u>1</u> / .....   | 80.8      |
| Lowest average annual rainfall (inches) ..... | .....             | Kawaihae .....              | 8.7       |
| Highest average annual rainfall (inches) .... | .....             | Waialeale .....             | 444       |
| Single events:                                |                   |                             |           |
| Lowest temperature of record (°F.) .....      | Jan. 20, 1970 ... | Mauna Kea summit <u>2</u> / | 1.4       |
| Highest temperature of record (°F.) .....     | April 27, 1931 .. | Pahala .....                | 100       |
| Lowest annual rainfall of record (inches) ... | 1953 .....        | Kawaihae .....              | 0.2       |
| Highest annual rainfall of record (inches) .. | 1982 .....        | Waialeale .....             | 666       |
| Highest wind speed of record (m.p.h.) .....   | Nov. 23, 1982 ... | Makahuena Pt. <u>3</u> / .. | 117       |

1/ Puukohola Heiau National Historical Site, Kawaihae, Hawaii.

2/ Recorded by Dr. Alfred Woodcock 60 meters inside the Mauna Kea summit cone, at 6:50 a.m. The rim at that time had a temperature of 39° F.

3/ Makahuena Point Coast Guard Station, Poipu, Kauai.

Source: Hawaii State Department of Land and Natural Resources, Division of Water and Land Development, data supplied September 19, 1986.

Table 179.-- RAINFALL AT SPECIFIED LOCATIONS: ANNUALLY,  
1975 TO 1985

[In inches]

| Year     | Hawaii       |                    |               | Maui            |               |             |
|----------|--------------|--------------------|---------------|-----------------|---------------|-------------|
|          | Hilo Airport | Wai-me <u>a</u> 1/ | Kona Village  | Kahului Airport | Kihei         | Lahaina     |
| 1975 ... | 99.93        | 12.35              | 15.64         | 13.74           | 10.63         | 12.19       |
| 1976 ... | 114.67       | 11.10              | 7.04          | 12.83           | 8.84          | 8.86        |
| 1977 ... | 90.38        | 5.42               | 3.40          | 11.50           | 7.88          | 8.28        |
| 1978 ... | 119.09       | 14.83              | 8.68          | 19.15           | 9.91          | 11.97       |
| 1979 ... | 158.77       | 29.23              | 16.00         | 26.82           | 21.32         | 20.85       |
| 1980 ... | 127.74       | 28.31              | 16.90         | 27.87           | 20.27         | 22.69       |
| 1981 ... | 89.91        | 13.30              | 7.02          | 12.85           | 9.72          | 8.13        |
| 1982 ... | 170.36       | 56.29              | 26.88         | 34.04           | 29.11         | 34.36       |
| 1983 ... | 68.09        | 12.95              | 8.51          | 13.05           | 8.60          | 9.70        |
| 1984 ... | 100.08       | 8.87               | 8.15          | 8.56            | 5.64          | 6.30        |
| 1985 ... | 112.96       | 16.58              | 8.60          | 20.00           | 13.86         | 13.48       |
| Year     | Oahu         |                    |               | Kauai           |               |             |
|          | Waikiki      | Univ. of Hawaii    | Nuuanu Res. 4 | Koloa           | Lihue Airport | Princeville |
| 1975 ... | 25.98        | 39.25              | 101.42        | 49.91           | 35.52         | 62.36       |
| 1976 ... | 13.59        | 26.83              | 86.44         | 62.60           | 32.83         | 109.34      |
| 1977 ... | 15.73        | 32.83              | 88.96         | 52.51           | 40.34         | 84.55       |
| 1978 ... | 27.18        | 41.56              | 124.42        | 70.64           | 39.11         | 130.82      |
| 1979 ... | 26.22        | 46.74              | 111.56        | 55.98           | 37.09         | 93.19       |
| 1980 ... | 28.50        | 48.52              | 140.70        | 78.78           | 54.64         | 130.55      |
| 1981 ... | 19.09        | 31.71              | 112.46        | 66.26           | 38.14         | 130.72      |
| 1982 ... | 39.96        | 57.98              | 168.16        | 96.75           | 74.40         | 241.22      |
| 1983 ... | 9.80         | 19.77              | 74.32         | 50.69           | 16.40         | 46.93       |
| 1984 ... | 19.35        | 33.13              | 71.32         | 48.82           | 30.12         | 71.58       |
| 1985 ... | 25.61        | 42.19              | 101.20        | 48.70           | 28.91         | 55.22       |

NA Not available.

1/ Lalamilo Field Office.

Source: U.S. Department of Commerce, National Climatic Data Center, Climatological Data, Annual Summary, Hawaii and Pacific (annual); and Hawaii State Department of Land and Natural Resources, Division of Water and Land Development, records.

Table 180.-- MAJOR HURRICANES: 1950 TO 1986

[Complete to September 22, 1986]

| Hurricane name | Date <sup>1/</sup>   | Islands most affected | Maximum winds ashore (m.p.h.) |       | Deaths | Property damage (million dollars) |
|----------------|----------------------|-----------------------|-------------------------------|-------|--------|-----------------------------------|
|                |                      |                       | Sustained                     | Gusts |        |                                   |
| Hiki .....     | Aug. 12-16, 1950     | Kauai .....           | 68                            | (NA)  | 1      | 0.200                             |
| Della .....    | Sept. 1-17, 1957     | French Frig. Shoals   | 82                            | 109   | -      | Minor                             |
| Nina .....     | Nov. 29-Dec. 7, 1957 | Kauai .....           | 92                            | (NA)  | 4      | 1.056                             |
| Dot .....      | Aug. 1-8, 1959       | Kauai .....           | 81                            | 103   | -      | 5.5+                              |
| Fico .....     | July 17-28, 1978     | Hawaii .....          | (NA)                          | 58+   | -      | 0.188                             |
| Iwa .....      | Nov. 19-25, 1982     | Kauai, Oahu .....     | 65                            | 117   | -      | 234                               |

NA Not available.

<sup>1/</sup> Total duration, including period outside Hawaiian waters.

Source: Samuel L. Shaw, A History of Tropical Cyclones in the Central North Pacific and the Hawaiian Islands, 1832-1979 (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, September 1981); Hawaii State Department of Defense, Civil Defense Division, Catalogue of Natural and Man-Caused Incidents and Disasters in the Hawaiian Islands (December 1978); The Governor's Ad Hoc Committee on the Economic Impact of Hurricane Iwa, Hurricane Iwa's Economic Impact on Hawaii (January 1983); "The History of Hurricanes in Hawaii," Honolulu Star-Bulletin, July 18, 1983, p. A-5; Hawaii State Department of Land and Natural Resources, Division of Water and Land Development, letters dated December 5, 1983 and September 19, 1986.

Table 181.-- TRADE WINDS, HIGH SURF, AND TEMPERATURES IN HAWAIIAN WATERS,  
BY MONTHS

| Month    | Trade wind frequency <u>1/</u><br>(percent) | Expected days of strong trade winds <u>2/</u> | Highest surf <u>3/</u><br>(average number of days) |                | Water temperature <u>4/</u><br>(°F.) |              |
|----------|---|---|--|----------------|--------------------------------------|--------------|
|          |   |   | Flat or 1 foot                                     | 6 feet or more | Mean maximum                         | Mean minimum |
| Jan. ... | 42  | 9   | 1  | 19             | 74.7                                 | 71.1         |
| Feb. ... | 55  | 7   | 1  | 16             | 75.6                                 | 70.3         |
| March .. | 61  | 10  | 1  | 12             | 76.5                                 | 71.8         |
| April .. | 74  | 10  | 3  | 7              | 77.7                                 | 73.0         |
| May .... | 86  | 7   | 8  | 3              | 79.5                                 | 74.7         |
| June ... | 91  | 7   | 15   | -              | 81.1                                 | 77.7         |
| July ... | 95  | 10  | 16   | -              | 81.1                                 | 78.3         |
| Aug. ... | 94  | 7   | 15   | -              | 81.9                                 | 79.2         |
| Sept. .. | 83  | 4   | 10   | 2              | 81.9                                 | 78.4         |
| Oct. ... | 71  | 4   | 1  | 12             | 81.1                                 | 77.2         |
| Nov. ... | 64  | 8   | -  | 19             | 79.3                                 | 74.5         |
| Dec. ... | 57  | 9   | -  | 20             | 75.9                                 | 71.4         |
| Ann. ... | 65  | 92  | 71   | 110            | 78.6                                 | 74.8         |

1/ Mean monthly frequency of trade winds in Hawaiian waters.

2/ Expected number of hazardous days in Hawaiian waters due to strong trade winds.

3/ Observations at Sunset Beach, Oahu. Annual averages were: flat or 1 foot, 71 days; 2-5 feet, 184 days; 6-10 feet, 71 days; 11-15 feet, 26 days; 16 feet or higher, 13 days.

4/ Observations at Kaneohe, Oahu. The mean ranged from 73.0 in January and February to 80.2 in August. Absolute maximums and minimums were respectively 84 (in July, August, and October) and 68 (December and February).

Source: Paul Haraguchi, Weather in Hawaiian Waters (Honolulu: Pacific Weather, Inc., 1979), pages 14, 22, 56, and 74.

Table 182.-- AVERAGE WATER TEMPERATURES AT WAIKIKI BEACH

[In Fahrenheit degrees]

| Month        | Morning | Afternoon |
|--------------|---------|-----------|
| March .....  | 75      | 77        |
| August ..... | 77      | 82        |

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, Local Climatological Data, Annual Summary With Comparative Data, Honolulu, Hawaii, 1983.

Table 183.-- SUNRISE, SUNSET, AND HOURS OF DAYLIGHT AT HILO, HONOLULU, AND LIHUE, FOR SELECTED DATES

[Hawaiian Standard Time]

| Subject            | March 21 | June 21 | Sept. 23 | Dec. 22 |
|--------------------|----------|---------|----------|---------|
| Sunrise (A.M.):    |          |         |          |         |
| Hilo .....         | 6:24     | 5:42    | 6:09     | 6:51    |
| Honolulu .....     | 6:35     | 5:50    | 6:21     | 7:05    |
| Lihue .....        | 6:41     | 5:55    | 6:26     | 7:12    |
| Sunset (P.M.):     |          |         |          |         |
| Hilo .....         | 6:32     | 7:02    | 6:16     | 5:47    |
| Honolulu .....     | 6:43     | 7:16    | 6:27     | 5:55    |
| Lihue .....        | 6:49     | 7:23    | 6:33     | 6:00    |
| Hours of daylight: |          |         |          |         |
| Hilo .....         | 12:08    | 13:20   | 12:07    | 10:56   |
| Honolulu .....     | 12:08    | 13:26   | 12:06    | 10:50   |
| Lihue .....        | 12:08    | 13:28   | 12:07    | 10:48   |

Source: Nautical Almanac Office, U.S. Naval Observatory, Tables of Sunrise and Sunset, No. 1083 and 1084 and records.



Table 184 .-- HAWAII AUDUBON SOCIETY BIRD COUNTS OF THE  
HONOLULU AREA: 1982 TO 1985

[Counts are made in late December, in a circle, 15 miles  
in diameter, centered near Nuuanu Pali]

| Species <sup>1/</sup>     | 1982   | 1983   | 1984   | 1985   |
|---------------------------|--------|--------|--------|--------|
| All species:              |        |        |        |        |
| Species .....             | 45     | 46     | 46     | 51     |
| Individual birds ..       | 16,649 | 22,279 | 25,809 | 28,803 |
| Endemic species:          |        |        |        |        |
| 'Apapane .....            | 68     | 106    | 96     | 66     |
| Hawaiian Coot .....       | 62     | 135    | 40     | 23     |
| Hawaiian Stilt .....      | 77     | 110    | 87     | 118    |
| Oahu 'Amakihi .....       | 65     | 140    | 59     | 125    |
| Indigenous species:       |        |        |        |        |
| Great Frigatebird .....   | 24     | 37     | 17     | 194    |
| Red-faced Booby .....     | 425    | 370    | 624    | 531    |
| Introduced species:       |        |        |        |        |
| Cattle Egret .....        | 331    | 384    | 477    | 656    |
| Common Myna .....         | 2,790  | 3,080  | 3,611  | 3,586  |
| House Sparrow .....       | 1,489  | 2,518  | 2,169  | 2,793  |
| Japanese White-eye .....  | 1,121  | 1,706  | 1,235  | 1,628  |
| Red-vented Bulbul .....   | 1,199  | 2,195  | 2,051  | 1,972  |
| Spotted Dove .....        | 1,052  | 1,606  | 2,650  | 2,774  |
| Zebra (Barred) Dove ..... | 3,442  | 3,840  | 7,624  | 7,299  |
| Migratory species:        |        |        |        |        |
| Lesser Golden-Plover ...  | 1,402  | 1,747  | 1,359  | 1,846  |
| Ruddy Turnstone .....     | 291    | 269    | 295    | 268    |

<sup>1/</sup> Separate data are shown for endemic birds averaging more than 25 individuals in 1975-1979, indigenous birds more than 200, introduced birds more than 500, and migratory species and stragglers more than 100. Endemic birds are those peculiar to a particular region, in this case Hawaii, and therefore found nowhere else in the world; indigenous birds are those native to a given region, in this case Hawaii, but with a total range of distribution encompassing a much wider area. The classification is that in Andrew J. Berger, Hawaiian Birdlife (1972).

Source: Hawaii Audubon Society, The 'Elepaio (monthly).

Table 185.-- HAWAII AUDUBON SOCIETY BIRD COUNT OF THE HONOLULU AREA, BY TYPE OF SPECIES: DECEMBER 22, 1985

| Type of species <u>1/</u> | Number of species | Number of individuals |
|---------------------------|-------------------|-----------------------|
| All species .....         | 51                | 28,803                |
| Endemic .....             | 7                 | 383                   |
| Indigenous .....          | 8                 | 884                   |
| Introduced .....          | 31                | 25,374                |
| Migratory .....           | 5                 | 2,162                 |

1/ For definitions, see preceding table, footnote 1.  
Source: Hawaii Audubon Society, "Christmas Bird Count, 1985," 'Elepaio, March 1986, pp. 97-99, as corrected.

Table 186.-- TREES ALONG STREETS OR IN PARKS UNDER THE JURISDICTION OF THE CITY AND COUNTY OF HONOLULU: 1980 TO 1985

[As of June 30]

| Year                 | Along City and County streets and highways <u>1/</u> | In City and County parks |
|----------------------|--|--------------------------|
| 1980 .....           | 108,202  | 95,700                   |
| 1981 .....           | 110,975  | 96,250                   |
| 1982 .....           | 113,489  | 96,296                   |
| 1983 <u>2/</u> ..... | 114,320  | 96,504                   |
| 1984 .....           | 117,133  | 96,873                   |
| 1985 .....           | 118,437  | 96,727                   |

1/ Excludes Federal, State, and private thoroughfares.

2/ Revised from Data Book 1985, table 169.

Source: City and County of Honolulu, Department of Parks and Recreation, data provided March 13, 1986.

Table 187.-- THREATENED, ENDANGERED, AND EXTINCT SPECIES OF NATIVE FAUNA AND FLORA: NOVEMBER 1986

| Type of fauna or flora     | Native species | Candidate <u>1/</u> | Threatened <u>1/</u> | Endangered <u>1/</u> | Extinct <u>2/</u> |
|----------------------------|----------------|---------------------|----------------------|----------------------|-------------------|
| Land mammals .....         | 1              | -                   | -                    | 1                    | -                 |
| Marine mammals .....       | 18             | -                   | -                    | 8                    | -                 |
| Reptiles and amphibians .. | 5              | -                   | 3                    | 2                    | -                 |
| Birds .....                | 87             | -                   | 1                    | 29                   | 23                |
| Freshwater fish .....      | 6              | 1                   | -                    | -                    | -                 |
| Invertebrates .....        | (3/)           | 150                 | -                    | 41                   | 4/ 88             |
| Plants .....               | 2,734          | 787                 | -                    | 19                   | <u>4/</u> 100     |

1/ Categories of the Federal List of Endangered and Threatened Species, as published in the Federal Register. Candidate species are those being officially considered for listing as threatened or endangered.

2/ Since 1778.

3/ Not known, but nearly 10,000 native species of insects and more than 1,000 native species of land snails have been estimated.

4/ Incomplete and probably much higher.

Source: U.S. Department of the Interior, Fish and Wildlife Service records; P. Q. Tomich, Mammals in Hawaii (1969); Robert L. Pyle, "Checklist of Birds of Hawaii," The 'Elepaio, November 1983; correspondence from W. C. Gagné, Entomology Department, Bishop Museum, July 3, 1985; H. St. John, List and Summary of the Flowering Plants in the Hawaiian Islands (1973), p. 519; University of Hawaii Department of Geography, Atlas of Hawaii (1983), pp. 80 and 83.