

# Waikiki, Oahu, Hawaii

**SHORELINE CHANGE RATES**

■ Accretion Rate  
■ Erosion Rate

Historical shoreline positions are measured every 66 ft along the shoreline. These sites are denoted by yellow shore-normal transects. Changes in the position of the shorelines through time are used to calculate shoreline change rates (ft/yr) at each transect location.

Annual shoreline change rates are shown on the shore-parallel graph. Red bars on the graph indicate a trend of beach erosion, while blue bars indicate a trend of accretion. Approximately every fifth transect and bar of the graph is numbered. Where necessary, transects have been purposely deleted to maintain consistent along-shore spacing. As a result, transect numbering is not consecutive everywhere.

The EX method is used to calculate shoreline change rates for the study area. The rates are smoothed along shore using a 1-3-5-3-1 technique to normalize rate differences on adjacent transects. For more information on erosion rate methods and results see: <http://www.soest.hawaii.edu/coasts/oahu/index.asp>

**HISTORICAL SHORELINES**

- 1927
- Feb 1949
- Oct 1951
- Sept 1952
- Dec 1957
- Jan 1958
- Dec 1959
- Feb 1966
- May 1969
- Nov 1970
- Dec 1974
- Mar 1975
- Dec 1982
- Aug 1985
- Jan 1992
- Feb 1999
- Jan 2001
- Dec 2005

■ Erosion rate reassessment locations (shore-normal transects)

Historical beach positions, color coded by year, are determined using orthorectified and georeferenced aerial photographs and National Ocean Survey (NOS) topographic survey charts. The low water mark is used as the historical shoreline, or shoreline change reference feature (SCRFF).

Movement of the SCRFF along shore-normal transects (spaced every 66 ft) is used to calculate erosion rates.

**AREA DESCRIPTION**

The Waikiki shoreline (transects 1 – 193) extends 2.4 miles from Diamond Head to Ala Wai Boat Harbor. Waikiki is an urban shoreline and bears little resemblance to its condition prior to western contact. The modern Waikiki shoreline is largely the result of engineering efforts (e.g. groins, sand-fill, and sea walls) intended to widen the beach and move the shoreline seaward (Miller and Fletcher, 2003 and Weigel, 2006). The coast in this area is exposed to restricted easterly trade-wind waves and seasonal swell during summer months. The inner reef and shoreline are protected from large, long period swell by the fringing reef. Engineering events at Waikiki Beach (adapted from Miller and Fletcher, 2003 and Weigel, 2006):

- 1917 Ft DeRussy concrete storm drain installed.
- 1927 War Memorial Natatorium constructed.
- 1939 Northern Kuhio Beach (660 ft) constructed with submerged offshore breakwall.
- 1951 Kapahulu storm drain installed.
- 1953 Kuhio Beach constructed with 1,341,780 ft<sup>3</sup> of sand fill.
- 1956 Construction of central and southern Kuhio groins and southern Kuhio breakwater.
- 1956 Duke Kahanamoku Beach and Lagoon constructed.
- 1957 Queens Beach groin and uniform beach to the Natatorium constructed.
- 1957 Kapolei Park Beach constructed with 1,341,780 ft<sup>3</sup> of sand fill, shore-parallel swimming basin dredged.
- 1959 Kuhio Beach: 506,149 ft<sup>3</sup> sand fill added.
- 1963 Outrigger Canoe Club groin and beach constructed.
- 1969 Ft DeRussy storm drain lengthened.
- 1972 Ft DeRussy Beach expanded, stone rubble groin installed next to storm drain.
- 1975 Kuhio Beach reconfigured, 323,953 ft<sup>3</sup> sand added.
- 1975 Northern Kuhio breakwater extended to 3 ft along some segments, 256,457 ft<sup>3</sup> of sand added.
- 1981 Ft DeRussy: 13,488 ft<sup>3</sup> sand fill added.
- 1991 Kuhio Beach area enlarged by 3,981 ft<sup>3</sup> with sand fill.
- 2000 South Kuhio Beach: 37,641 ft<sup>3</sup> sand fill added.

Historical shorelines from aerial photographs 1927 – 2005 are available for most of the Waikiki shoreline. Due to extensive shoreline reconstruction, only historical shorelines for the modern configuration of each beach are used to calculate change rates. Overall, the Waikiki shoreline (transects 1 – 193) is eroding at an average rate  $-0.04 \pm 0.18$  ft/yr. Outrigger Canoe Club Beach (transects 11 – 13) is eroding at an average rate  $-0.46 \pm 0.10$ . The northern end of Kaimama Beach (transects 14 – 15) was lost to erosion prior to 1992. The remainder of Kaimama Beach (transects 16 – 23) is accreting at an average rate  $1.53 \pm 0.13$  ft/yr. The southern portion of Queens Beach (transects 24 – 35) was mostly lost to erosion by 1969. The remaining portion of Queens Beach (transects 36 – 42) is eroding at an average rate  $-1.77 \pm 0.32$  ft/yr. Kapolei Park Beach (transects 44 – 62) is accreting at an average rate  $0.26 \pm 0.17$  ft/yr. South Kuhio Beach (transects 63 – 73) is stable to accreting at an average rate  $0.04 \pm 0.30$  ft/yr. North Kuhio Beach (transects 75 – 87) is eroding at an average rate  $-0.47 \pm 0.20$  ft/yr. Royal Hawaiian Beach (transects 89 – 116) is accreting at an average rate  $0.72 \pm 0.14$  ft/yr. The eastern portion of Halekulani Beach (transects 118 – 123) was lost to erosion between 2001 and 2005. The central portion of Halekulani Beach (transects 124 – 129) is accreting at an average rate  $0.37 \pm 0.20$  ft/yr. Little or no beach has existed at transects 130-132 in the time span of this study. The western portion of Halekulani Beach is accreting at an average rate  $0.39 \pm 0.17$  ft/yr. Fort DeRussy Beach is eroding at an average rate  $-0.62 \pm 0.20$  ft/yr. Duke Kahanamoku Beach is eroding or stable with an average rate  $-0.00 \pm 0.10$  ft/yr.

For more information see: <http://www.soest.hawaii.edu/coasts/oahu/index.asp>

Miller, T.L. and Fletcher C.H. (2003), "Waikiki: historical analysis of an engineered shoreline" *Journal of Coastal Research*, 19(4), 1026-1043.

Weigel, R.L. (2006), "A History of Waikiki: the history of its transformation from a natural to an urban shoreline." *Groin and Beach*, 79(2), 3-36.

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