

Prepared in cooperation with the Kaho'olawe Island Reserve Commission

Streamflow, Suspended-Sediment, and Soil-Erosion Data from Kaulana and Hakioawa Watersheds, Kaho'olawe, Hawai'i, 2006 to 2010



Open-File Report 2010–1182

Cover:

Reddish-brown sediment plumes discharging to the ocean from the northern coast of Kaho'olawe, Hawai'i. (Photograph by S.K. Izuka, U.S. Geological Survey, January 2007.)

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By Scot K. Izuka and Lyman L. Abbott

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Executive Summary

Various events over the last two centuries have destroyed the vegetation and caused rapid soil erosion on large areas of the small, arid, windy tropical shield-volcano island of Kaho‘olawe, Hawai‘i. These activities were largely halted in the 1990s, and efforts have been made to restore the island’s vegetation in order to stem erosion. In 2003, the Kaho‘olawe Island Reserve Commission (KIRC) began restoration efforts using native vegetation. In 2006 to 2010, the U.S. Geological Survey (USGS), in cooperation with the KIRC, monitored streamflow, fluvial suspended-sediment transport, and erosion rates in the Hakioawa and Kaulana watersheds on northeastern Kaho‘olawe to provide information needed to assess the effectiveness of restoration efforts. This report presents the results from this monitoring.

Results.—Hakioawa and Kaulana gulches were dry about 90 percent of the time during the monitoring period; mean annual flow was 0.06 ft³/s at Hakioawa Gulch gage and 0.01 ft³/s at the Kaulana Gulch gage. For the period when the sediment gages on both gulches were operating concurrently (October 2007 to September 2009), sediment discharge was higher from Hakioawa Gulch than from Kaulana Gulch. The annual suspended-sediment loads for the concurrent period averaged 1,880 tons at the Hakioawa Gulch gage and 276 tons at the Kaulana Gulch gage.

Of the 77 erosion-monitoring sites in the Hakioawa and Kaulana watersheds, 50 had overall rates of change indicating erosion for the monitoring period, ranging from –1 to –10 mm/yr and averaging –3 mm/yr. Seven sites had rates of change indicating overall deposition, ranging from 1 to 15 mm/yr and averaging 5 mm/yr. Twenty had rates of change below detection (less than ±1 mm/yr).

The average rate of change for the 26 sites in areas that have undergone restoration by the KIRC was below the detection limit of the erosion-monitoring method. In comparison, the 51 sites in nonrestoration areas averaged –2 mm/y. Both

of these averages, however, include sites that showed overall erosion as well as sites that showed overall deposition.

The average rate of change was –1 mm/yr for both the 32 sites on rills and the 42 sites on interfluves; both categories include sites that showed deposition as well as sites that showed erosion. All three sites on hummocks showed overall erosion, with an average rate of –8 mm/yr. Both the Hakioawa and Kaulana watersheds showed an average rate of change of –1 mm/yr, and both included sites that showed erosion and sites that showed deposition.

For sites with negative rates of change indicating erosion, the average rate of change during the monitoring period was –2 mm/yr in restoration areas and –3 mm/yr in nonrestoration areas. For sites with positive rates of change indicating deposition, the average rate of change was 5 mm/yr in restoration areas and 6 mm/yr in nonrestoration sites. The average rate of change for rills was 1 mm/yr in restoration areas and –2 mm/yr in nonrestoration sites. The average rate of change for interfluves was below detection in restoration areas and –1 mm/yr in nonrestoration areas.

Potential Use and Limitation of Data.—Additional statistical comparisons of various subsets of erosion data can be used to assess the effectiveness of restoration efforts or how existing landforms, vegetation, climate, and other physical basin characteristics affect erosion and fluvial sediment transport in the watersheds. Further investigation to identify what factors cause the Kaulana watershed to have much lower runoff and sediment loads than the Hakioawa watershed may yield valuable information for developing and modifying restoration strategies. Continued monitoring of streamflow, sediment transport, and erosion is key to assessing the long-term effectiveness of restoration and can provide insight to the island’s recovery since the eradication of feral goats and cessation of use as a military bombing range; the results of this study provide the essential baseline data to which data from continued monitoring can be compared.

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Conversion Factors and Datums

Multiply	By	To obtain
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi ²)	2.590	square kilometer (km ²)
cubic foot per second (ft ³ /s)	0.02832	cubic meter per second (m ³ /s)
inch per year (in/yr)	25.4	millimeter per year (mm/yr)
ton, short (2,000 lb)	0.9072	megagram (Mg)

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Elevation refers to distance above mean sea level.

Suspended-sediment concentrations in water are given in milligrams per liter (mg/L).

Streamflow, Suspended-Sediment, and Soil-Erosion Data from Kaulana and Hakioawa Watersheds, Kaho‘olawe, Hawai‘i, 2006 to 2010

By Scot K. Izuka and Lyman L. Abbott¹

Introduction

Kaho‘olawe is a basaltic shield-volcano island of 45 mi² in the tropical Pacific Hawaiian Archipelago (fig. 1) (Stearns, 1940; Macdonald and others 1983). The highest point on the island is 1,483 ft above sea level. Kaho‘olawe is arid—about 15 in/yr of rainfall (Ziegler and Giambelluca, 1998)—and windy, in part because of its proximity to Haleakalā, a tall and massive mountain on the island of Maui that alters the prevailing northeasterly oceanic trade winds and the moisture they carry (Stearns, 1940; Macdonald and others, 1983; Merlin and Juvik, 1992).

Kaho‘olawe has been the site of a wide variety of land uses since humans first arrived from Polynesia, probably sometime between the 5th and 11th centuries (Kaho‘olawe Island Reserve Commission, 2010). Archeological evidence indicates that the island had fishing villages and was used for agriculture (Kirch, 1982; Graves and Murakami, 1993; Kaho‘olawe Island Reserve Commission, 2010). An outcrop of dense igneous rock was also mined and traded widely across the Pacific as material for adzes (Collerson and Weisler, 2007). Goats were introduced to the island near the beginning of the 19th century, and a large feral goat population developed. Kaho‘olawe was used briefly as a penal colony in the first half of the 19th century and for goat, sheep, and cattle ranching in the latter half of the 19th century and the early 20th century. During World War Two, the U.S. military began using the island as a bombing and weapons testing range; this use continued until 1990. An effort was made to clear the island of unexploded ordnance, but much of the island remains only partially cleared and some areas have not been cleared at all. The island is currently administered by the State of Hawai‘i, Kaho‘olawe Island Reserve Commission (KIRC), and is uninhabited except for a few workers and volunteers that stay on island for as long as several days at a time.

Ungulates, both domesticated and feral, contributed substantially to the large-scale denudation of vegetation and

subsequent erosion in the interior uplands of Kaho‘olawe (see, for example, Stearns, 1940; Merlin and Juvik, 1992; Warren and Aschman, 1993; Kaho‘olawe Island Reserve Commission, 2010). The feral goat population was estimated to have reached as high as tens of thousands of animals (Kaho‘olawe Island Reserve Commission, 2010) before they were finally eradicated by the U.S. Navy in the early 1990s. Descriptions of vegetation destruction by goats and other herbivorous ungulates and extensive soil erosion in the uplands predate the use of the island as a bombing range (for example, Stearns, 1940). Opinions vary on how much the antecedent Polynesian agricultural practices may have contributed to the island’s present condition (for example, Kirch, 1982; Merlin and Juvik, 1992; Graves and Murakami, 1993).

Regardless of the cause, large bare areas are still evident in aerial views of the island (fig. 2). From the ground, indications of erosion such as rills, gulches, and badlands are also evident (fig. 3). In some areas, grass-topped hummocks lie on a hardpan of deeply weathered bedrock. The hummocks are about six to eight feet high and are the remnants of the upper soil horizons that have been largely eroded away (Macdonald and others, 1983). Transport of sediment to the ocean by water is evident from plumes emanating from the mouths of streams after rainfall (fig. 4) and from studies of offshore turbidity (Presto and others, 2010). Erosion and sediment transport by wind is evident from dust plumes that have been seen blowing from the top of the island (Macdonald and others, 1983) and from substantial loess deposits downwind from the bare areas (Stearns, 1940).

Several efforts have been made to restore the vegetation on Kaho‘olawe with both native and nonnative species, and there is evidence that these efforts have had an effect in curbing erosion (Warren and Aschmann, 1993; Ziegler and Giambelluca, 1998; Ziegler and others, 2000). More recently, the KIRC has continued efforts to address concerns about the loss of soil and the potential environmental effects of soil deposition in the surrounding marine environment. In 2003, the KIRC began an effort to restore native vegetation on parts of Kaho‘olawe.

¹Kaho‘olawe Island Reserve Commission

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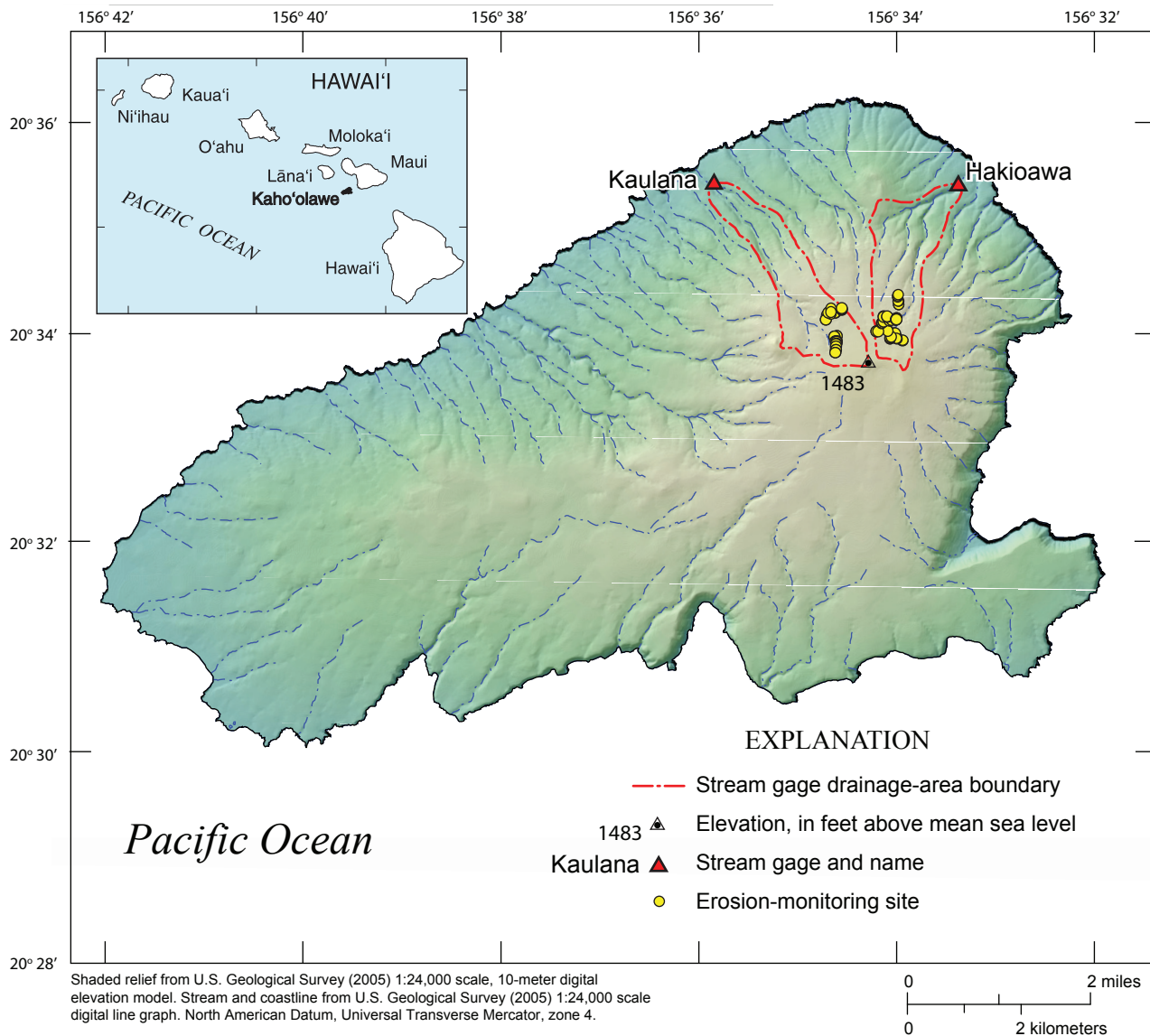


Figure 1. Map of Kaho'olawe, Hawai'i, showing locations of stream gages and erosion-monitoring sites in the Hakioawa and Kaulana watersheds.

Objectives and Scope

In 2006, the KIRC and the U.S. Geological Survey (USGS) began a cooperative multiyear study to monitor erosion rates, streamflow, and fluvial sediment transport from the Hakioawa and Kaulana watersheds (fig. 1) to provide data that can be used to assess the effectiveness of restoration efforts. Both watersheds include large areas of bare land, parts of which are undergoing restoration of native vegetation. Runoff from the watersheds discharges to the ocean through their respective gulches. This report summarizes data from that study. Daily streamflow and sediment data are also available in the USGS Annual Data Reports (U.S. Geological Survey, 2007a,b, 2008a,b, 2009a,b) and from the USGS National Water Information System database (NWISWeb), both of

which may be accessed through links in the USGS website (www.usgs.gov) and the USGS Pacific Islands Water Science Center website (<http://hi.water.usgs.gov>).

Acknowledgments

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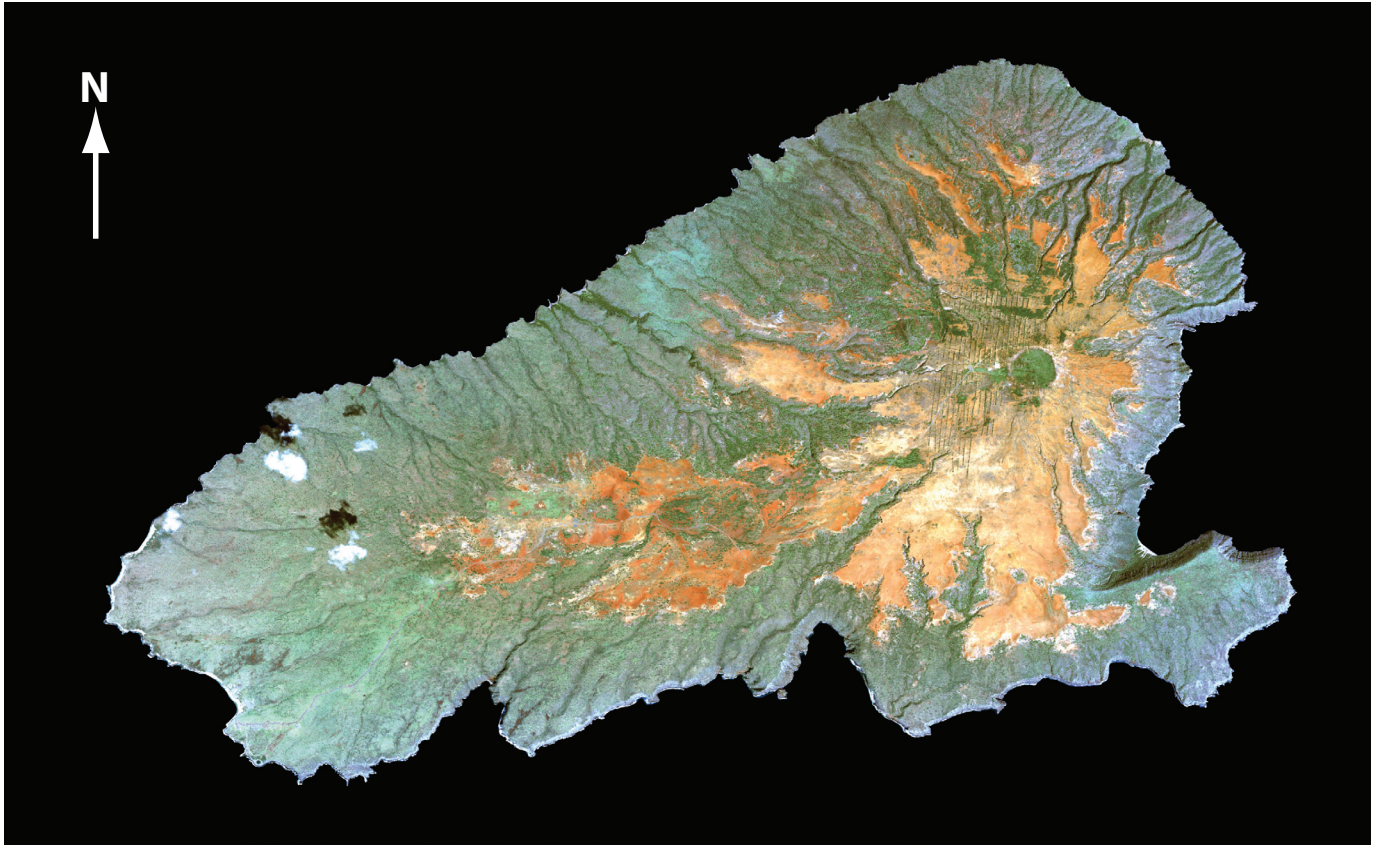


Figure 2. Satellite image of Kaho'olawe, Hawai'i (2005 QuickBird image from U.S Geological Survey and U.S. Department of Agriculture, Natural Resources Conservation Service. Includes copyrighted material of DigiGlobe, Inc., all rights reserved). The island is about 11 miles (18 km) long. Brown areas are bare soil .

Saguibo, Adam Johnson, and Jacob Matthews of the USGS and Jason Anthony (volunteer) assisted with data acquisition and processing. Barry Hill (U.S. Department of Agriculture Forest Service) and Sarah Rosa (USGS) provided technical reviews of the report.

Streamflow and Suspended-Sediment Monitoring

Streamflow and suspended-sediment concentrations were monitored using stream gages installed on Hakioawa Gulch (gage number 16681000; drainage area 1.09 mi²) and Kaulana Gulch (16682000; 1.20 mi²) near the points where the gulches intersect the coast (fig. 1, table 1). The gages were operated in the 2007, 2008, and 2009 water years (October 1, 2006, through September 30, 2009). A water year is designed to avoid splitting the winter-spring wet season between two different years. The USGS uses a water year that begins on October 1 of the previous year and ends on September 30. For example, the 2007 water year includes the period from October 1, 2006, to September 30, 2007. The standard USGS water

year is consistent with the climate of most of the United States (Rantz and others, 1982b) including Hawai'i.

Methods

The stream gages were equipped with water-level (stage) recorders, automated water samplers, and satellite telemetry. Under ideal circumstances, stage is converted to streamflow using a rating curve developed on the basis of periodic direct current-meter measurements made at various stages while water is flowing in the gulches (Rantz and others, 1982a, 1982b). However, Hakioawa and Kaulana Gulches are dry most of the time; when water does flow, the duration of the flow is brief. The gage sites were also remote, and there was no means available to quickly reach the gage sites to measure flow directly during the brief and infrequent flows. Development of the rating curves for these gages therefore relied on flow measured using indirect methods, which can have high uncertainties in small, high-gradient streams (Rantz and others, 1982a; Jarrett, 1987). The stream gages were programmed to scan stage every 5 minutes, and under conditions when the stage showed little variation, the instantaneous stage was

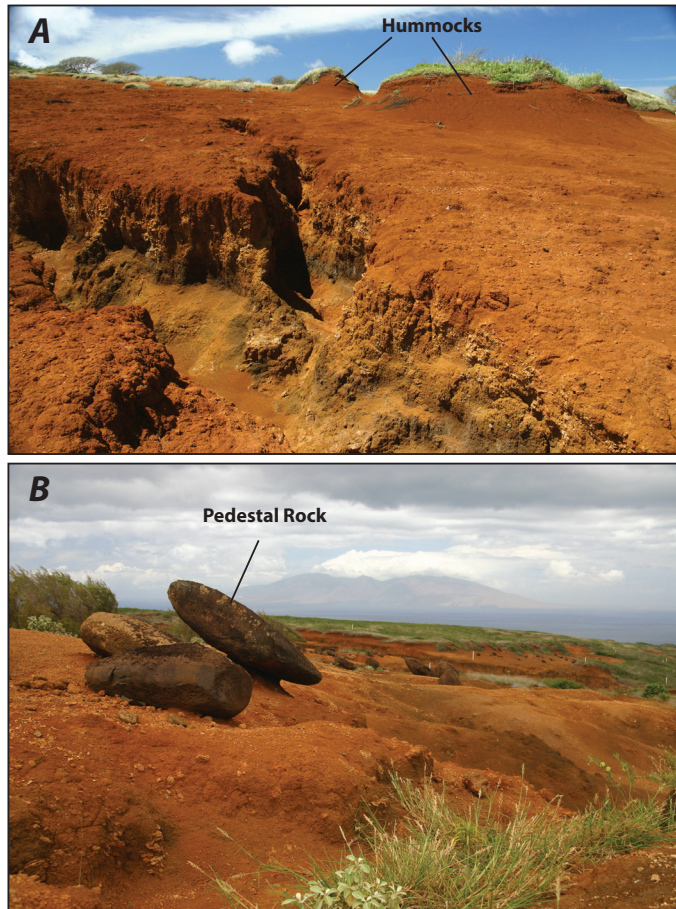


Figure 3. Geomorphic features on Kaho'olawe, Hawai'i. *A*, Grass-topped hummocks in the Hakioawa watershed are remnants of soil layers that have been mostly eroded away. Gully in foreground shows evidence of water erosion into lower soil layers and deeply weathered rock. (Photographed March 2008, by S.K. Izuka, U.S. Geological Survey.) *B*, Badlands with pedestal rocks in the Hakioawa watershed. (Photographed September 2007, by S.K. Izuka, U.S. Geological Survey.)

recorded at 15-minute intervals. The 15-minute instantaneous stage readings were converted to instantaneous streamflow using the rating curve. The instantaneous streamflow values are used in the computation of other statistics, such as the daily and monthly mean discharges.

The gages were programmed to begin measuring stage more frequently and collect water samples when stage rose above specified triggering thresholds. The gage at Hakioawa Gulch began recording at 5-minute intervals when the stage reached a height corresponding to a streamflow of 1.8 ft³/s, and water sampling began when streamflow reached 18.6 ft³/s. The gage at Kaulana Gulch began recording at 5-minute intervals when the stage reached a height corresponding to a streamflow of 1.2 ft³/s, and water sampling began when

streamflow reached 1.6 ft³/s. At both gages, the first five samples were taken at 5-minute intervals; thereafter samples were taken at 15-minute intervals until the stage dropped back below the triggering threshold or the sampler reached capacity.

The objective of the sampling was to assess suspended sediment in the stream; therefore the intakes of the samplers were positioned about 0.5 ft above the stream bottom to avoid sampling bed sediment. Also, some samples were analyzed for grain size to ensure bed sediment was not being sampled. Samples were analyzed at the USGS Cascades Volcano Observatory for suspended-sediment concentration. Ideally, samples would also be occasionally collected manually during periods of flow to assess how sediment concentrations vary across the width of flow in the gulch. As discussed previously, however, it was not possible to access the gage sites during periods of flow. For sediment-load computations, it was assumed that the sediment concentrations were uniform across the channel during the brief and infrequent flows; this assumption is considered reasonable because the episodic flows in the gulches are likely to be turbulent and well mixed.

Daily, monthly, and annual suspended-sediment loads were computed from the streamflow and sediment-concentration data using techniques described by Porterfield (1972) and the computer program GCLAS (Koltun and others, 2006). Inasmuch as sediment loads are computed as a product of sediment concentration and streamflow, they are subject to the same uncertainty as streamflow. Uncertainties in the flow data do not affect the sediment-concentration data.

Streamflow Data

Daily mean streamflow and suspended-sediment data are given in appendix 1 (also available at <http://pubs.usgs.gov/of/2010/1182/>). Both Hakioawa and Kaulana Gulches



Figure 4. Reddish-brown plumes of sediment discharging to the ocean from the northern coast of Kaho'olawe, Hawai'i. (Photographed in January 2007 by S. K. Izuka, U.S. Geological Survey.)

Table 1. Stream gages on Kaho'olawe, Hawai'i, operated during this study.

[NAD83, North American Datum of 1983]

Gage characteristic	Hakioawa Gulch	Kaulana Gulch
U.S. Geological Survey station number	16681000	16682000
Latitude (decimal degrees, NAD83)	20.5897 N	20.5903 N
Longitude (decimal degrees, NAD83)	156.5564 W	156.5972 W
Approximate elevation above mean sea level	75 feet	100 feet
Drainage area	1.09 mi ²	1.20 mi ²
Period of stream-discharge record	10/1/06 through 9/30/09	10/1/06 through 9/30/09
Period of suspended-sediment record	10/1/07 through 9/30/09	10/1/06 through 9/30/09

Table 2. Monthly streamflow for the Hakioawa Gulch (16681000) and Kaulana Gulch (16682000) gages, Kaho'olawe, Hawai'i.[ft³/s, cubic feet per second; WY, water year.]

Month	Streamflow, Hakioawa Gulch (ft ³ /s)				Streamflow, Kaulana Gulch (ft ³ /s)			
	Monthly mean			Mean monthly	Monthly mean			Mean monthly
	WY 2007	WY 2008	WY 2009		WY 2007	WY 2008	WY 2009	
October	0.21	0.00	0.00	0.07	0.11	0.00	0.00	0.04
November	0.09	0.13	0.00	0.07	0.05	0.02	0.00	0.02
December	0.00	0.95	0.20	0.38	0.00	0.06	0.06	0.04
January	0.00	0.01	0.38	0.13	0.00	0.00	0.10	0.03
February	0.01	0.14	0.00	0.05	0.00	0.02	0.00	0.01
March	0.04	0.00	0.00	0.01	0.03	0.00	0.00	0.01
April	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
June	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
July	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
August	0.03	0.00	0.05	0.03	0.01	0.00	0.01	0.01
September	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

are dry most of the time. During the period of record, a daily mean flow of zero was recorded for 1,025 (94 percent) of the days at Hakioawa Gulch and 1,062 (97 percent) of the days at Kaulana Gulch. The highest daily mean flow for the period of record at the Hakioawa Gulch gage was 15 ft³/s on December 6, 2007. The highest daily mean flow for the period of record at Kaulana Gulch gage was 3.3 ft³/s on October 16, 2006.

Instantaneous streamflow recorded by the gage ranged from 0 to 230 ft³/s at the Hakioawa Gulch gage and from 0 to 97 ft³/s at the Kaulana Gulch gage.

Monthly streamflow statistics are given in table 2. Entire months with no flow were common at both gages. When there was flow, it occurred primarily between October and March. The mean annual flow was 0.06 ft³/s at the gage on Hakioawa Gulch and 0.01 ft³/s at the gage on Kaulana Gulch (table 3).

Table 3. Annual streamflow statistics for the Hakioawa Gulch (16681000) and Kaulana Gulch (16682000) gages, Kaho'olawe, Hawai'i.[ft³/s, cubic feet per second]

Water year	Annual mean streamflow (ft ³ /s)	
	Hakioawa	Kaulana
2007	0.03	0.02
2008	0.10	0.01
2009	0.05	0.01
Average	0.06	0.01

Table 4. Monthly and annual sediment loads for the Hakioawa Gulch (16681000) and Kaulana Gulch (16682000) gages, Kaho'olawe, Hawai'i.

[WY, water year; tons/mo, tons per month; —, no data]

Month	Hakioawa Gulch				Kaulana Gulch			
	Monthly sediment load (tons)			Mean monthly (tons/mo)	Monthly sediment load (tons)			Mean monthly (tons/mo)
	WY 2007	WY 2008	WY 2009		WY 2007	WY 2008	WY 2009	
October	—	0.00	0.00	0.00	151	0.00	0.00	50.4
November	—	630	0.00	315	75.9	75.0	0.03	50.3
December	—	1,500	127	813	0.00	34.6	140	58.3
January	—	0.02	1,310	655	8.10	0.00	240	82.7
February	—	180	0.00	90.2	2.80	48.9	0.00	17.2
March	—	0.02	0.00	0.01	69.8	0.00	0.00	23.3
April	—	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May	—	0.00	0.01	0.01	0.00	0.00	0.00	0.00
June	—	0.00	0.00	0.00	0.00	0.00	0.00	0.00
July	—	0.00	0.00	0.00	0.00	0.09	0.00	0.03
August	—	0.00	19.5	9.76	91.0	0.00	13.0	34.7
September	—	0.00	0.00	0.00	1.30	0.00	0.00	0.43
Sum	—	2,310	1,460	1,880	400	159	393	317

Suspended-Sediment Data

The suspended-sediment record for the gage at Kaulana Gulch is complete for the entire monitoring period of this study (appendix 1, also available at <http://pubs.usgs.gov/of/2010/1182/>). Suspended-sediment data for the gage at Hakioawa Gulch, however, were only collected during the 2008 and 2009 water years because the automatic sediment sampler failed during the 2007 water year. During the monitoring period, both gages showed numerous days of zero suspended-sediment concentration and load corresponding to days of zero streamflow. A total of 45 samples were taken at the Hakioawa Gulch gage during the 2-year operating period of the sampler; these samples were taken during instantaneous streamflows ranging from 11 to 224 ft³/s. In the 3-year operating period of the sampler at the Kaulana Gulch gage, 93 samples were taken during instantaneous streamflows ranging from 0.51 to 97 ft³/s.

The highest daily mean suspended-sediment concentration was 10,300 mg/L on January 27, 2009, at the gage on Hakioawa Gulch and 24,600 mg/L on August 31, 2007, at the gage on Kaulana Gulch. The highest daily suspended-sediment load was 878 tons on January 27, 2009, at the gage on Hakioawa Gulch and 151 tons on October 16, 2006, at the gage on Kaulana Gulch.

Monthly and annual statistics for suspended-sediment load are given in table 4. Entire months with no

suspended-sediment loads were common at both gages and correspond with periods of zero streamflow. The highest monthly suspended-sediment load at the Hakioawa Gulch gage was 1,500 tons in December 2008. At the Kaulana Gulch gage, the highest monthly suspended-sediment load was 240 tons in January 2009. Annual suspended-sediment loads for the Hakioawa Gulch gage in water years 2008 and 2009 were 2,310 and 1,460 tons, respectively. Annual suspended-sediment loads for the Kaulana Gulch gage in water years 2007, 2008, and 2009 were 400, 159, and 393 tons, respectively. For the period when both sediment gages were operating concurrently (October 2007 to September 2009), the annual suspended-sediment loads averaged 1,880 tons at the Hakioawa Gulch gage and 276 tons at the Kaulana Gulch gage.

Erosion Monitoring

The erosion monitoring was conducted from January 2007 to March 2010 at 44 sites in the Hakioawa watershed and 33 sites in the Kaulana watershed (figs. 1 and 5, tables 5 and 6). Monitoring sites were selected to include rills, interfluves (low-relief areas between rills), and slopes of remnant hummocks (fig. 6). Sites were also selected to include areas that had been or were undergoing restoration by the KIRC, as well as areas that were not restored.

Table 5. Erosion-monitoring sites in the Hakioawa watershed, Kaho'olawe, Hawai'i.

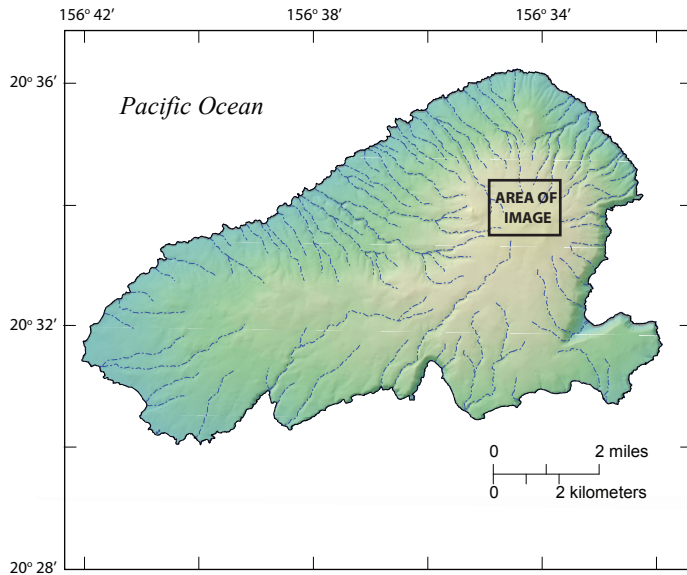
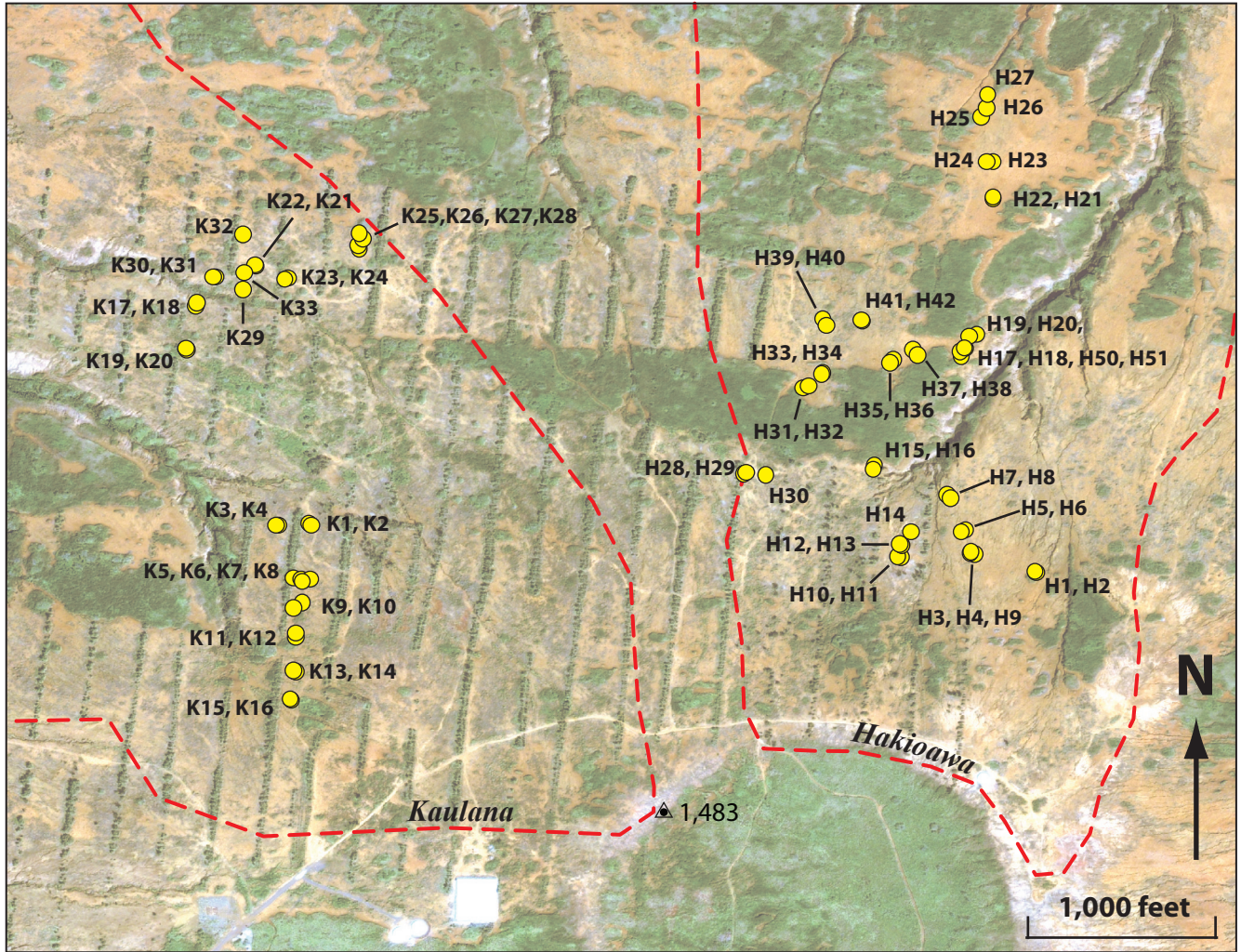
[N, north; W, west. Coordinates are relative to North American Datum of 1983 (NAD83); slope and aspect measured in March 2008]

Site	Coordinates (decimal degrees)		Morphology	Slope (degrees)	Aspect	Restoration
	Latitude (N)	Longitude (W)				
H1	20.56523	156.56573	Interfluve	11	Northeast	Nonrestoration
H2	20.56525	156.56575	Interfluve	9	North	Nonrestoration
H3	20.56552	156.56667	Interfluve	5	North	Nonrestoration
H4	20.56553	156.56673	Interfluve	14	North	Nonrestoration
H5	20.56588	156.56680	Rill	7	North	Restoration
H6	20.56585	156.56687	Interfluve	6	Northwest	Restoration
H7	20.56642	156.56708	Rill	2	North	Restoration
H8	20.56637	156.56703	Interfluve	4	North	Restoration
H9	20.56555	156.56672	Rill	6	North-northwest	Nonrestoration
H10	20.56547	156.56778	Rill	7	North	Nonrestoration
H11	20.56548	156.56783	Interfluve	9	Northeast	Nonrestoration
H12	20.56565	156.56777	Rill	4	Northeast	Nonrestoration
H13	20.56567	156.56780	Interfluve	4	North	Nonrestoration
H14	20.56585	156.56763	Rill	5	East-northeast	Nonrestoration
H15	20.56687	156.56818	Rill	0	Northeast	Nonrestoration
H16	20.56680	156.56820	Interfluve	1	Northeast	Nonrestoration
H17	20.56852	156.56687	Interfluve	9	East	Nonrestoration
H18	20.56863	156.56680	Rill	6	East	Nonrestoration
H19	20.56885	156.56663	Rill	5	East	Nonrestoration
H20	20.56882	156.56675	Interfluve	9	East	Nonrestoration
H21	20.57090	156.56638	Interfluve	1	Northeast	Restoration
H22	20.57093	156.56638	Interfluve	0	Northeast	Restoration
H23	20.57147	156.56638	Rill	2	North	Restoration
H24	20.57147	156.56648	Interfluve	3	North	Restoration
H25	20.57215	156.56657	Hummock	24	Northeast	Nonrestoration
H26	20.57228	156.56648	Rill	19	North	Nonrestoration
H27	20.57248	156.56647	Hummock	22	Northeast	Nonrestoration
H28	20.56673	156.57017	Rill	2	Northwest	Nonrestoration
H29	20.56675	156.57013	Interfluve	4	North-northwest	Nonrestoration
H30	20.56672	156.56983	Interfluve	3	North	Restoration
H31	20.56803	156.56927	Hummock	13	Northeast	Nonrestoration
H32	20.56807	156.56918	Interfluve	12	Northeast	Restoration
H33	20.56827	156.56897	Rill	5	North	Restoration
H34	20.56825	156.56898	Interfluve	9	North-northeast	Restoration
H35	20.56847	156.56790	Rill	2	North-northwest	Restoration
H36	20.56842	156.56795	Interfluve	9	North	Restoration
H37	20.56862	156.56760	Rill	2	East-northeast	Restoration
H38	20.56853	156.56753	Interfluve	4	Northeast	Restoration
H39	20.56908	156.56897	Rill	4	North	Restoration
H40	20.56898	156.56892	Interfluve	3	Northeast	Restoration
H41	20.56905	156.56837	Rill	5	Northeast	Restoration
H42	20.56907	156.56838	Interfluve	9	Northeast	Restoration
H50	20.56859	156.56688	Interfluve	8	East	Nonrestoration
H51	20.56864	156.56682	Rill	5	East	Nonrestoration

Table 6. Erosion-monitoring sites in the Kaulana watershed, Kaho'olawe, Hawai'i.

[N, north; W, west. Coordinates are relative to North American Datum of 1983 (NAD83); slope and aspect measured in March 200]

Site	Coordinates (decimal degrees)		Morphology	Slope (degrees)	Aspect	Restoration
	Latitude (N)	Longitude (W)				
K1	20.56598	156.57677	Rill	3	Northwest	Restoration
K2	20.56595	156.57673	Interfluve	9	Northwest	Restoration
K3	20.56595	156.57723	Interfluve	4	Northwest	Nonrestoration
K4	20.56595	156.57727	Interfluve	5	Northwest	Nonrestoration
K5	20.56515	156.57700	Interfluve	15	Northwest	Nonrestoration
K6	20.56513	156.57688	Interfluve	9	Northwest	Nonrestoration
K7	20.56513	156.57675	Rill	5	Northwest	Nonrestoration
K8	20.56510	156.57687	Rill	5	Northwest	Nonrestoration
K9	20.56478	156.57687	Interfluve	6	Northwest	Restoration
K10	20.56470	156.57700	Interfluve	7	Northwest	Nonrestoration
K11	20.56425	156.57697	Interfluve	4	West-northwest	Nonrestoration
K12	20.56432	156.57697	Interfluve	4	Northwest	Nonrestoration
K13	20.56373	156.57697	Rill	6	West-northwest	Nonrestoration
K14	20.56375	156.57700	Interfluve	5	Northwest	Nonrestoration
K15	20.56330	156.57703	Rill	6	Northwest	Nonrestoration
K16	20.56332	156.57705	Interfluve	6	Northwest	Nonrestoration
K17	20.56928	156.57848	Rill	6	Northwest	Nonrestoration
K18	20.56933	156.57847	Interfluve	7	Northwest	Nonrestoration
K19	20.56862	156.57862	Rill	5	South	Nonrestoration
K20	20.56863	156.57863	Interfluve	3	Southwest	Nonrestoration
K21	20.56988	156.57757	Rill	3	West	Nonrestoration
K22	20.56990	156.57758	Interfluve	2	Southwest	Nonrestoration
K23	20.56970	156.57708	Rill	4	Southwest	Nonrestoration
K24	20.56968	156.57713	Interfluve	5	Southwest	Nonrestoration
K25	20.57015	156.57600	Interfluve	2	Northwest	Restoration
K26	20.57020	156.57602	Interfluve	7	Northwest	Restoration
K27	20.57030	156.57595	Interfluve	7	Northwest	Restoration
K28	20.57038	156.57600	Interfluve	0	Northwest	Nonrestoration
K29	20.56953	156.57777	Rill	6	Southwest	Nonrestoration
K30	20.56972	156.57818	Rill	12	South	Nonrestoration
K31	20.56972	156.57822	Rill	15	South-southwest	Nonrestoration
K32	20.57037	156.57777	Rill	4	West-southwest	Nonrestoration
K33	20.56978	156.57775	Rill	5	Southwest	Nonrestoration



- EXPLANATION**
- - - Stream gage drainage-area boundary
 - K32 Erosion-monitoring site and number
 - ▲ 1,483 Location and elevation of highest point on island

Figure 5. Erosion-monitoring sites in Hakioawa and Kaulana watersheds, Kaho'olawe, Hawai'i. (2005 QuickBird image from U.S. Geological Survey and U.S. Department of Agriculture, Natural Resources Conservation Service. Includes copyrighted material of DigiGlobe, Inc., all rights reserved).

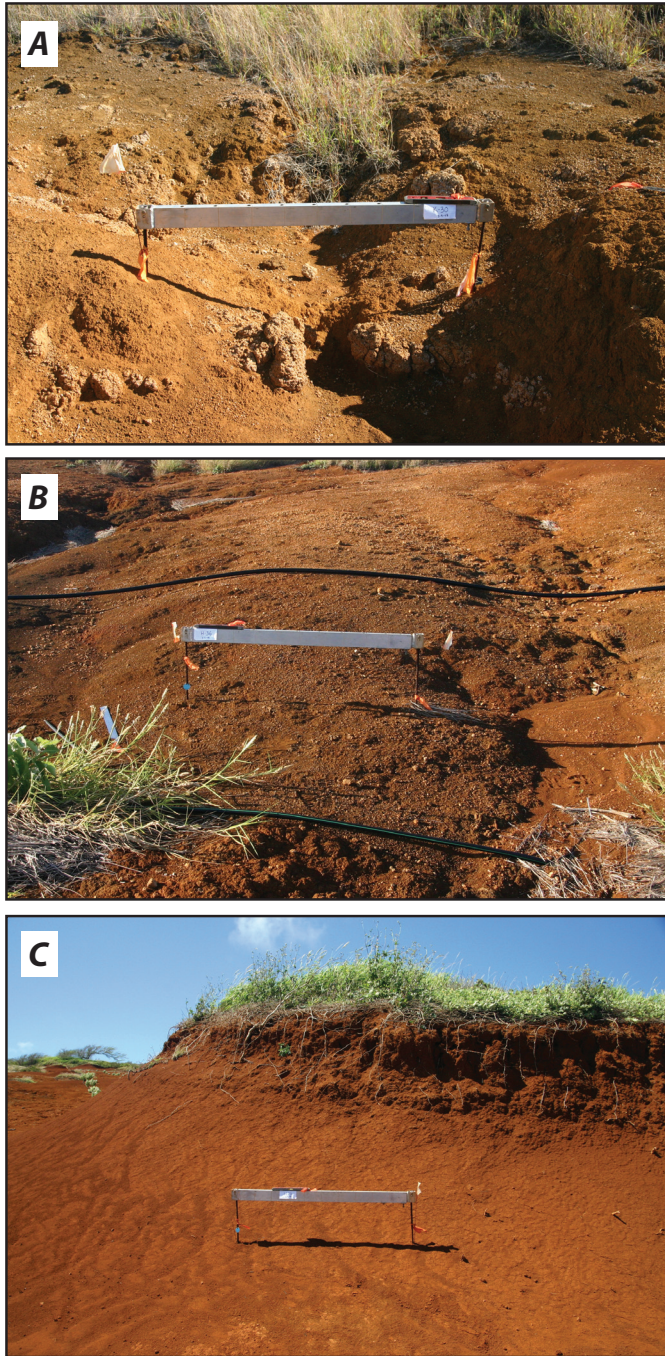


Figure 6. Examples of erosion-monitoring sites on Kaho'olawe, Hawai'i. A, Rill in the Kaulana watershed. B, Interfluvium in the Hakioawa watershed. C, Hummock in Hakioawa watershed. (Photographed March 2008 by S.K. Izuka, U.S. Geological Survey.)

Methods

Land-surface changes resulting from erosion or deposition were monitored using a device consisting of a portable aluminum tube that was placed across a pair of metal stakes inserted vertically one meter apart into the ground at the erosion-monitoring site (fig. 7). During installation, the stakes were adjusted so that when the tube was placed on them, the top of the tube was horizontal. The stakes remained in place for the entire study period. The tube had a rectangular cross section; its flat top served as a reference datum from which the ground surface could be measured along the length of the tube. The tube had nine vertical holes drilled at 10-cm spacing.

To make a measurement of the ground profile at a given site, the aluminum tube was placed on the stakes (fig. 7). The ends of the aluminum tube had slots to receive the stakes, which ensured that the tube's placement on the stakes was consistent each time. A steel rod was inserted into one of the holes in the tube and lowered until the bottom of the rod touched the ground surface. The height of the rod above the top of the aluminum tubing was then measured with a ruler and recorded. This procedure was repeated for each of the holes along the length of the tube, and each of the holes was measured twice during each site visit. At each monitoring site, the rod measurements made during a site visit were averaged. The smallest change detectable using this method is 1 millimeter.

The measurements were made during seven site visits over the 38-month monitoring period. Differences in the average rod measurements from one site visit to the next indicate changes due to erosion (negative change) or deposition (positive change) at the site. A typical site visit was 3 to 4 days. Time between visits ranged from 5 to 8 months. To allow comparison between sites that had different monitoring periods, the rate of change was computed by dividing the total change measured over the monitoring period by the length of the monitoring period. The smallest detectable rate of change using this approach is ± 1 mm/yr.

Erosion Data

Average rod measurements are given in appendix 2 (also available at <http://pubs.usgs.gov/of/2010/1182/>). Changes in rod measurements from one site visit to the next indicate erosion (negative change) or deposition (positive change) (tables 7 and 8). All but a few sites were measured on all of the seven site visits. Exceptions include sites H50 and H51, which were not installed until September 2008. These sites were also not measured in October 2009.

Of the 77 monitoring sites in this study, 50 had negative rates of change indicating overall erosion for the monitoring period, with rates of change ranging from -1 to -10 mm/yr and averaging -3 mm/yr (tables 7, 8, and 9). Seven sites had positive rates of change indicating overall deposition, with

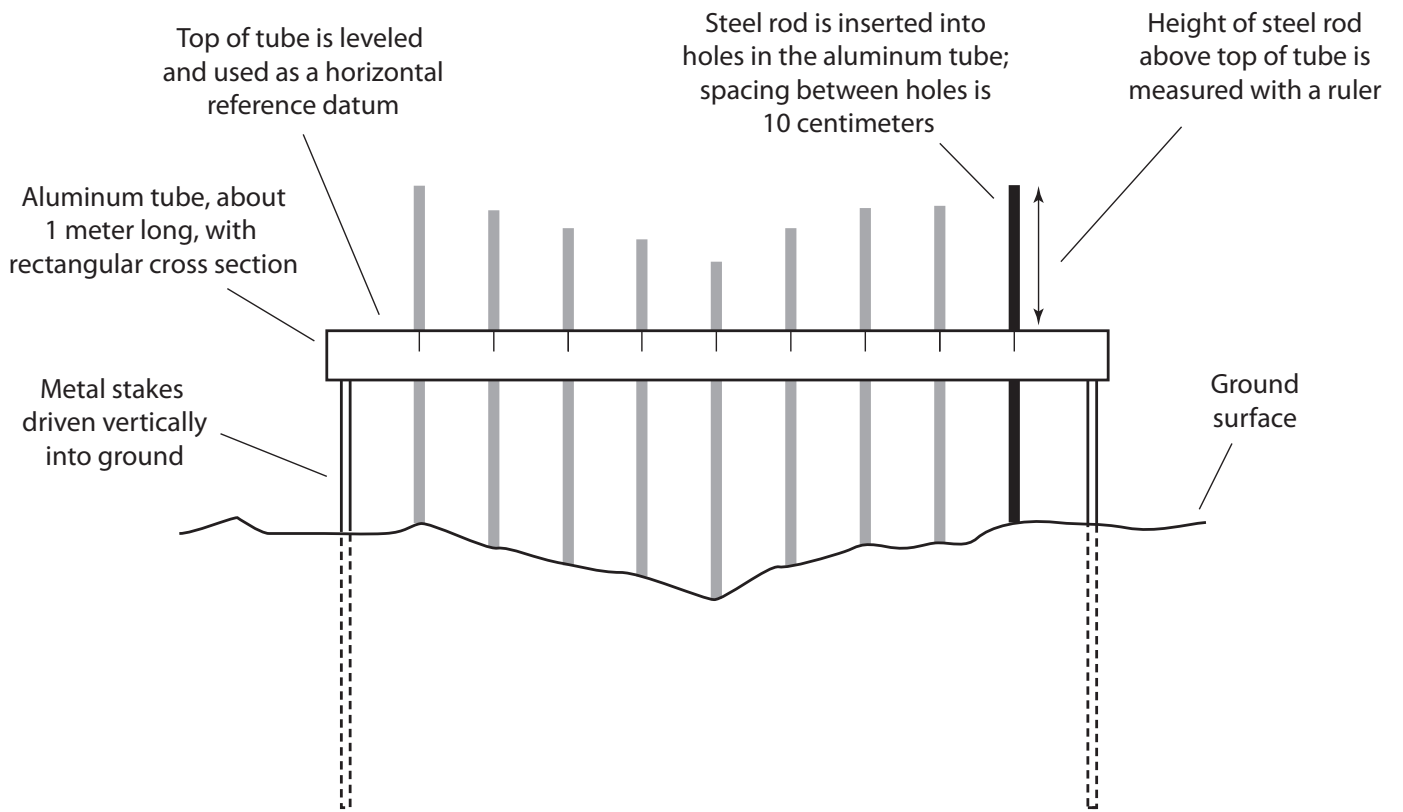


Figure 7. Schematic drawing and photograph of the device used to monitor erosion rates in the Hakioawa and Kaulana watersheds, Kaho'olawe, Hawai'i. (Photographed March 2008 by S.K. Izuka, U.S. Geological Survey.)

Table 7. Change in average rod measurement for erosion-monitoring sites in the Hakoawa watershed, Kaho'olawe, Hawai'i.

[mm, millimeters; mm/yr, millimeters per year, —, no data. Negative change indicates erosion. Zero indicates change is below detection.]

Site	Change relative to previous site visit (mm)						Monitoring period		
	Sep 2007	Mar 2008	Sep 2008	May 2009	Oct 2009	Mar 2010	Days	Total change (mm)	Average rate of change (mm/yr)
H1	-1	-1	2	-2	-1	0	1,153	-3	-1
H2	-1	-2	1	-2	-1	0	1,153	-5	-2
H3	-2	0	-1	-1	0	-1	1,153	-5	-2
H4	0	-1	-1	0	-2	1	1,153	-3	-1
H5	-2	-1	1	-3	0	1	1,153	-4	-1
H6	-2	1	1	-1	0	-2	1,153	-3	-1
H7	4	-3	1	-5	0	0	1,153	-3	-1
H8	-1	1	1	0	-2	1	1,153	0	0
H9	0	0	2	-3	-1	1	1,153	-1	0
H10	-1	-4	0	-5	0	-2	1,154	-12	-4
H11	-2	-1	-1	0	0	-1	1,154	-5	-2
H12	-5	4	1	-1	-2	3	1,154	0	0
H13	-1	-1	-1	-1	0	1	1,154	-3	-1
H14	-2	-10	2	-10	3	8	1,154	-9	-3
H15	11	18	4	4	4	6	1,155	47	15
H16	-1	0	-1	1	0	0	1,155	-1	0
H17	-1	-1	1	-3	-1	-1	1,155	-6	-2
H18	-1	-6	6	-11	-2	0	1,155	-14	-4
H19	-1	-8	0	-7	-1	0	1,155	-17	-5
H20	0	-6	1	-5	-1	-1	1,155	-12	-4
H21	0	1	0	-4	0	2	1,155	-1	0
H22	2	1	1	-3	3	0	1,155	4	1
H23	3	-3	4	-6	0	1	1,155	-1	0
H24	0	-1	1	-2	-1	1	1,155	-2	-1
H25	-1	-11	-3	-15	-1	0	1,155	-31	-10
H26	0	-6	0	-2	-1	-1	1,155	-10	-3
H27	0	-8	-1	-20	2	0	1,155	-27	-9
H28	1	-1	1	-1	1	-2	1,156	-1	0
H29	0	0	1	-1	0	1	1,156	1	0
H30	0	0	-1	0	-1	1	1,156	-1	0
H31	3	-5	-4	-7	-2	-2	1,155	-17	-5
H32	-1	0	1	-1	0	1	1,155	0	0
H33	1	-2	1	-1	-2	2	1,155	-1	0
H34	5	-6	0	-2	0	-1	1,155	-4	-1
H35	-4	19	6	-6	-5	-5	1,155	5	2
H36	0	-2	0	-3	1	-1	1,155	-5	-2
H37	1	51	2	-2	-2	-1	1,155	49	15
H38	-2	2	-1	-1	-1	0	1,155	-3	-1
H39	0	0	0	-1	0	-1	1,155	-2	-1
H40	0	-1	0	-2	-1	1	1,155	-3	-1
H41	-3	-9	-1	-10	13	-16	1,155	-26	-8
H42	-2	0	0	-1	0	0	1,155	-3	-1
H50	—	—	0	-7	—	-3	735	-10	-5
H51	—	—	0	-9	—	-4	735	-13	-6

Table 8. Change in average rod measurement relative to previous measurement for erosion-monitoring sites in the Kaulana watershed, Kaho'olawe, Hawai'i.

[mm, millimeters; mm/yr, millimeters per year. Negative change indicates erosion. Zero indicates change is below detection.]

Site	Change relative to previous site visit (mm)						Monitoring period		
	Sep 2007	Mar 2008	Sep 2008	May 2009	Oct 2009	Mar 2010	Days	Total change (mm)	Average rate of change (mm/yr)
K1	0	1	-1	1	-2	0	1,155	-1	0
K2	1	2	-1	0	-1	1	1,155	2	1
K3	-1	-2	2	-2	-1	2	1,155	-2	-1
K4	1	-3	-2	2	-1	1	1,155	-2	-1
K5	-1	4	-2	-3	0	-1	1,154	-3	-1
K6	0	0	0	0	-1	-1	1,154	-2	-1
K7	7	-7	2	-1	2	-1	1,154	2	1
K8	4	-5	1	-1	1	0	1,154	0	0
K9	-1	-1	0	0	0	-1	1,154	-3	-1
K10	-2	1	-1	-1	-1	2	1,154	-2	-1
K11	-1	-5	-1	-5	-1	0	1,154	-13	-4
K12	-2	1	0	-1	-1	0	1,154	-3	-1
K13	0	-2	1	-1	1	-1	1,154	-2	-1
K14	1	1	-3	0	2	-1	1,154	0	0
K15	1	-3	0	-1	-1	2	1,154	-2	-1
K16	0	0	0	-1	0	1	1,154	0	0
K17	-2	-9	-1	-13	-1	-1	1,155	-27	-9
K18	1	-1	0	0	-1	0	1,155	-1	0
K19	-4	-7	3	-13	1	-4	1,155	-24	-8
K20	0	-4	1	0	-1	-1	1,155	-5	-2
K21	-1	-1	0	-1	0	0	1,155	-3	-1
K22	-3	0	-1	0	-2	0	1,155	-6	-2
K23	2	-2	0	-4	0	-2	1,155	-6	-2
K24	4	-4	0	-1	0	-1	1,155	-2	-1
K25	-1	1	-1	-1	1	0	1,155	-1	0
K26	1	-1	0	0	-1	1	1,155	0	0
K27	0	2	-1	-1	1	0	1,155	1	0
K28	2	0	0	0	-1	1	1,155	2	1
K29	0	-2	0	1	-1	-1	1,156	-3	-1
K30	-1	-7	0	-7	3	0	1,156	-12	-4
K31	0	-6	-2	-4	1	-1	1,156	-12	-4
K32	-1	0	-1	0	0	0	1,156	-2	-1
K33	0	0	-1	-1	1	0	1,156	-1	0

Table 9. Overall rates of change for the monitoring period for various categories of erosion-monitoring sites in the Hakiowa and Kaulana watersheds, Kaho‘olawe, Hawai‘i.

[mm/yr, millimeters per year; NR, not relevant. Negative change indicates erosion. Zero indicates change is below detection.]

Sites	Hakioawa		Kaulana		Both watersheds	
	Number	Mean rate of change (mm/yr)	Number	Average rate of change (mm/yr)	Number	Average rate of change (mm/yr)
Showing erosion	29	-3	21	-2	50	-3
Showing deposition	4	8	3	1	7	5
Showing no change	11	0	9	0	20	0
Restoration	20	0	6	0	26	0
Nonrestoration	24	-2	27	-2	51	-2
Rill	18	0	14	-2	32	-1
Interfluve	23	-1	19	-1	42	-1
Hummock	3	-8	0	NR	3	-8
All	44	-1	33	-1	77	-1

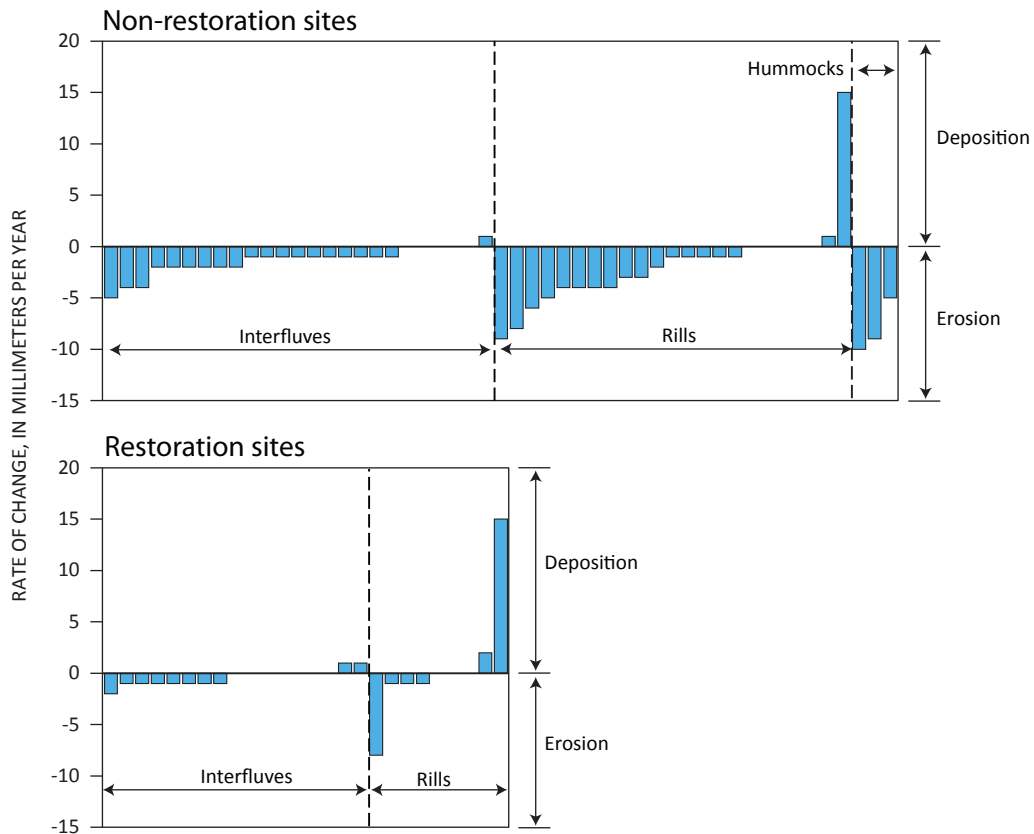


Figure 8. Rates of change for erosion-monitoring sites in nonrestoration and restoration areas of the Hakioawa and Kaulana watersheds, Kaho‘olawe, Hawai‘i. Each bar represents one site; negative values indicate erosion, positive values indicate deposition. Within each group, sites are arranged from highest erosion on the left to highest deposition on the right. Sections with no bars represent sites for which the rate of change was below detection.

Table 10. Overall rates of change for the monitoring period for various categories of erosion-monitoring sites in restoration and nonrestoration areas of the Hakioawa and Kaulana watersheds, Kaho‘olawe, Hawai‘i.

[mm/yr, millimeters per year. Negative change indicates erosion. Zero indicates change is below detection.]

Sites	Restoration		Nonrestoration	
	Number	Average rate of change (mm/yr)	Number	Average rate of change (mm/yr)
Showing erosion	12	-2	38	-3
Showing deposition	4	5	3	6
Rill	9	1	23	-2
Interfluve	17	0	25	-1
All	26	0	51	-2

rates of change ranging from 1 to 15 mm/yr and averaging 5 mm/yr. The remaining 20 sites had rates of change below detection during the monitoring period.

The average rate of change over the period of monitoring for the 26 sites located in areas that have undergone restoration (planting of vegetation by the KIRC) was below detection, whereas the average for the 51 sites in nonrestoration areas was -2 mm/yr (table 9). Both of these averages include sites that showed overall erosion as well as sites that showed overall deposition (fig. 8). A one-tailed Wilcoxon rank-sum test indicates that the average erosion rate in the restoration sites is significantly less (p-value of 0.0006) than in the nonrestoration sites.

The average overall rate of change for the 32 sites on rills was -1 mm/yr; the average for the 42 sites on interfluves was also -1 mm/yr (table 9). Both of these averages include sites that showed deposition as well as sites that showed erosion (fig. 8). All three sites on hummocks showed overall erosion for the monitoring period, with an average rate of -8 mm/yr. Both the Hakioawa and Kaulana watersheds showed an overall rate of change of -1 mm/yr, including sites that showed erosion and sites that showed deposition.

Table 10 further compares restoration and nonrestoration areas. For sites with negative rates of change indicating erosion, the average rate of change during the monitoring period was -2 mm/yr in restoration areas and -3 mm/yr in nonrestoration areas. For sites with positive rates of change indicating deposition, the average rate of change was 5 mm/yr in restoration areas and 6 mm/yr in nonrestoration areas. The average rate of change for rills was 1 mm/yr in restoration areas and -2 mm/yr in nonrestoration areas. The average rate of change for interfluves was below detection in restoration areas and -1 mm/yr in nonrestoration areas.

Potential Use and Limitations of Data

The data in this report can be used in interpretive analyses to advance understanding of erosion rates and processes and their connection to natural and anthropogenic factors on Kaho‘olawe. Statistical comparisons of various subsets of erosion data can be used to assess the effectiveness of restoration efforts or how existing landforms, vegetation, climate, and other physical basin characteristics affect erosion and fluvial sediment transport in the watersheds.

The data indicate that streamflow and sediment loads from the Hakioawa watershed are six times higher than from the Kaulana watershed, even though the watersheds are close together and nearly the same size. Presto and others (2010) also found that during 2005 to 2008, turbidity offshore from the mouth of Hakioawa Gulch was higher than it was offshore from the mouth of Kaulana Gulch. Further investigations comparing the two watersheds in terms of basin characteristics, such as slope, aspect relative to wind direction, channel density, percent of area covered by vegetation versus bare soil, and history of past and current restoration efforts, can help identify what factors cause runoff and sediment transport to be much lower in one basin than another. Such information can be valuable to developing and modifying restoration strategies.

The data in this study reflect conditions that existed in a brief 3-year study period while many areas within the watersheds were undergoing restoration. The effects of restoration on erosion and fluvial sediment transport are likely to change as the planted vegetation grows. If monitoring is continued, the results of this study will provide an essential baseline to which future data can be compared to assess the long-term effectiveness of restoration. Continued monitoring can also provide insight to the island’s recovery since the eradication of feral goats and cessation of its use as a military bombing range.

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Appendix 1. Daily Mean Streamflow and Suspended-Sediment Data

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho‘olawe, Hawai‘i.

[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
10/1/2006	2007	0	—	—	0	0	0
10/2/2006	2007	0	—	—	0	0	0
10/3/2006	2007	0	—	—	0	0	0
10/4/2006	2007	0	—	—	0	0	0
10/5/2006	2007	0	—	—	0	0	0
10/6/2006	2007	0	—	—	0	0	0
10/7/2006	2007	0	—	—	0	0	0
10/8/2006	2007	0	—	—	0	0	0
10/9/2006	2007	0	—	—	0	0	0
10/10/2006	2007	0	—	—	0	0	0
10/11/2006	2007	0	—	—	0	0	0
10/12/2006	2007	0	—	—	0	0	0
10/13/2006	2007	0	—	—	0	0	0
10/14/2006	2007	0	—	—	0	0	0
10/15/2006	2007	0	—	—	0	0	0
10/16/2006	2007	5.6	—	—	3.3	6410	151
10/17/2006	2007	0.31	—	—	0.03	771	0.18
10/18/2006	2007	0.08	—	—	0	0	0
10/19/2006	2007	0.07	—	—	0	0	0
10/20/2006	2007	0.28	—	—	0.01	0	0
10/21/2006	2007	0.15	—	—	0	0	0
10/22/2006	2007	0.03	—	—	0	0	0
10/23/2006	2007	0	—	—	0	0	0
10/24/2006	2007	0	—	—	0	0	0
10/25/2006	2007	0	—	—	0	0	0
10/26/2006	2007	0	—	—	0	0	0
10/27/2006	2007	0	—	—	0	0	0
10/28/2006	2007	0	—	—	0	0	0
10/29/2006	2007	0	—	—	0	0	0
10/30/2006	2007	0	—	—	0	0	0
10/31/2006	2007	0	—	—	0	0	0
11/1/2006	2007	0	—	—	0	0	0
11/2/2006	2007	1.8	—	—	1.3	4040	75
11/3/2006	2007	0.26	—	—	0.02	966	0.13
11/4/2006	2007	0.09	—	—	0	0	0
11/5/2006	2007	0.07	—	—	0	0	0
11/6/2006	2007	0.05	—	—	0	0	0
11/7/2006	2007	0	—	—	0	0	0
11/8/2006	2007	0	—	—	0	0	0
11/9/2006	2007	0	—	—	0	0	0
11/10/2006	2007	0	—	—	0	0	0
11/11/2006	2007	0	—	—	0	0	0
11/12/2006	2007	0.26	—	—	0.03	787	0.26
11/13/2006	2007	0.05	—	—	0	0	0
11/14/2006	2007	0	—	—	0	0	0
11/15/2006	2007	0	—	—	0	0	0
11/16/2006	2007	0	—	—	0	0	0
11/17/2006	2007	0	—	—	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho'olawe, Hawai'i.—Continued[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
11/18/2006	2007	0	—	—	0	0	0
11/19/2006	2007	0	—	—	0	0	0
11/20/2006	2007	0	—	—	0	0	0
11/21/2006	2007	0	—	—	0	0	0
11/22/2006	2007	0	—	—	0.06	881	0.49
11/23/2006	2007	0	—	—	0	66	0
11/24/2006	2007	0	—	—	0	0	0
11/25/2006	2007	0	—	—	0	0	0
11/26/2006	2007	0	—	—	0	0	0
11/27/2006	2007	0	—	—	0	0	0
11/28/2006	2007	0	—	—	0	0	0
11/29/2006	2007	0	—	—	0	0	0
11/30/2006	2007	0	—	—	0	0	0
12/1/2006	2007	0	—	—	0	0	0
12/2/2006	2007	0	—	—	0	0	0
12/3/2006	2007	0	—	—	0	0	0
12/4/2006	2007	0	—	—	0	0	0
12/5/2006	2007	0	—	—	0	0	0
12/6/2006	2007	0	—	—	0	0	0
12/7/2006	2007	0	—	—	0	0	0
12/8/2006	2007	0	—	—	0	0	0
12/9/2006	2007	0	—	—	0	0	0
12/10/2006	2007	0	—	—	0	0	0
12/11/2006	2007	0	—	—	0	0	0
12/12/2006	2007	0	—	—	0	0	0
12/13/2006	2007	0	—	—	0	0	0
12/14/2006	2007	0	—	—	0	0	0
12/15/2006	2007	0	—	—	0	0	0
12/16/2006	2007	0	—	—	0	0	0
12/17/2006	2007	0	—	—	0	0	0
12/18/2006	2007	0	—	—	0	0	0
12/19/2006	2007	0	—	—	0	0	0
12/20/2006	2007	0	—	—	0	0	0
12/21/2006	2007	0	—	—	0	0	0
12/22/2006	2007	0	—	—	0	0	0
12/23/2006	2007	0	—	—	0	0	0
12/24/2006	2007	0	—	—	0	0	0
12/25/2006	2007	0	—	—	0	0	0
12/26/2006	2007	0	—	—	0	0	0
12/27/2006	2007	0	—	—	0	0	0
12/28/2006	2007	0	—	—	0	0	0
12/29/2006	2007	0	—	—	0	0	0
12/30/2006	2007	0	—	—	0	0	0
12/31/2006	2007	0	—	—	0	0	0
1/1/2007	2007	0	—	—	0	0	0
1/2/2007	2007	0	—	—	0	0	0
1/3/2007	2007	0	—	—	0	0	0
1/4/2007	2007	0	—	—	0	0	0
1/5/2007	2007	0	—	—	0	0	0
1/6/2007	2007	0	—	—	0	0	0
1/7/2007	2007	0	—	—	0	0	0
1/8/2007	2007	0	—	—	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho‘olawe, Hawai‘i.—Continued[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
1/9/2007	2007	0	—	—	0	0	0
1/10/2007	2007	0	—	—	0	0	0
1/11/2007	2007	0	—	—	0	0	0
1/12/2007	2007	0	—	—	0	0	0
1/13/2007	2007	0	—	—	0	0	0
1/14/2007	2007	0	—	—	0	0	0
1/15/2007	2007	0	—	—	0	0	0
1/16/2007	2007	0	—	—	0	0	0
1/17/2007	2007	0	—	—	0	0	0
1/18/2007	2007	0	—	—	0	0	0
1/19/2007	2007	0	—	—	0	0	0
1/20/2007	2007	0	—	—	0	0	0
1/21/2007	2007	0	—	—	0	0	0
1/22/2007	2007	0	—	—	0	0	0
1/23/2007	2007	0	—	—	0	0	0
1/24/2007	2007	0	—	—	0	0	0
1/25/2007	2007	0	—	—	0	0	0
1/26/2007	2007	0	—	—	0	0	0
1/27/2007	2007	0	—	—	0	0	0
1/28/2007	2007	0	—	—	0	0	0
1/29/2007	2007	0	—	—	0	0	0
1/30/2007	2007	0	—	—	0	0	0
1/31/2007	2007	0.13	—	—	0.13	4080	8.1
2/1/2007	2007	0.21	—	—	0.12	3670	2.8
2/2/2007	2007	0.03	—	—	0	0	0
2/3/2007	2007	0	—	—	0	1	0
2/4/2007	2007	0	—	—	0	1	0
2/5/2007	2007	0	—	—	0	2	0
2/6/2007	2007	0	—	—	0	2	0
2/7/2007	2007	0	—	—	0	3	0
2/8/2007	2007	0	—	—	0	3	0
2/9/2007	2007	0	—	—	0	4	0
2/10/2007	2007	0	—	—	0	4	0
2/11/2007	2007	0	—	—	0	5	0
2/12/2007	2007	0	—	—	0	5	0
2/13/2007	2007	0	—	—	0	6	0
2/14/2007	2007	0	—	—	0	6	0
2/15/2007	2007	0	—	—	0	7	0
2/16/2007	2007	0	—	—	0	7	0
2/17/2007	2007	0	—	—	0	8	0
2/18/2007	2007	0	—	—	0	8	0
2/19/2007	2007	0	—	—	0	9	0
2/20/2007	2007	0	—	—	0	9	0
2/21/2007	2007	0	—	—	0	10	0
2/22/2007	2007	0	—	—	0	10	0
2/23/2007	2007	0	—	—	0	11	0
2/24/2007	2007	0	—	—	0	11	0
2/25/2007	2007	0	—	—	0	12	0
2/26/2007	2007	0	—	—	0	12	0
2/27/2007	2007	0	—	—	0	13	0
2/28/2007	2007	0	—	—	0	13	0
3/1/2007	2007	0	—	—	0	14	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho'olawe, Hawai'i.—Continued[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
3/2/2007	2007	0	—	—	0	14	0
3/3/2007	2007	0	—	—	0	15	0
3/4/2007	2007	0	—	—	0	15	0
3/5/2007	2007	0	—	—	0	16	0
3/6/2007	2007	0	—	—	0	16	0
3/7/2007	2007	0	—	—	0	17	0
3/8/2007	2007	0	—	—	0	17	0
3/9/2007	2007	0	—	—	0	18	0
3/10/2007	2007	0	—	—	0	18	0
3/11/2007	2007	0	—	—	0	19	0
3/12/2007	2007	0	—	—	0	19	0
3/13/2007	2007	0	—	—	0	20	0
3/14/2007	2007	0.69	—	—	0.76	4310	69
3/15/2007	2007	0.48	—	—	0.07	1020	0.55
3/16/2007	2007	0.07	—	—	0.03	636	0.22
3/17/2007	2007	0	—	—	0	0	0
3/18/2007	2007	0.03	—	—	0	0	0
3/19/2007	2007	0	—	—	0	0	0
3/20/2007	2007	0	—	—	0	0	0
3/21/2007	2007	0	—	—	0	0	0
3/22/2007	2007	0	—	—	0	0	0
3/23/2007	2007	0	—	—	0	0	0
3/24/2007	2007	0	—	—	0	0	0
3/25/2007	2007	0	—	—	0	0	0
3/26/2007	2007	0	—	—	0	0	0
3/27/2007	2007	0	—	—	0	0	0
3/28/2007	2007	0	—	—	0	0	0
3/29/2007	2007	0	—	—	0	0	0
3/30/2007	2007	0	—	—	0	0	0
3/31/2007	2007	0	—	—	0	0	0
4/1/2007	2007	0	—	—	0	0	0
4/2/2007	2007	0	—	—	0	0	0
4/3/2007	2007	0	—	—	0	0	0
4/4/2007	2007	0	—	—	0	0	0
4/5/2007	2007	0	—	—	0	0	0
4/6/2007	2007	0	—	—	0	0	0
4/7/2007	2007	0	—	—	0	0	0
4/8/2007	2007	0	—	—	0	0	0
4/9/2007	2007	0	—	—	0	0	0
4/10/2007	2007	0	—	—	0	0	0
4/11/2007	2007	0	—	—	0	0	0
4/12/2007	2007	0	—	—	0	0	0
4/13/2007	2007	0	—	—	0	0	0
4/14/2007	2007	0	—	—	0	0	0
4/15/2007	2007	0	—	—	0	0	0
4/16/2007	2007	0	—	—	0	0	0
4/17/2007	2007	0	—	—	0	0	0
4/18/2007	2007	0	—	—	0	0	0
4/19/2007	2007	0	—	—	0	0	0
4/20/2007	2007	0	—	—	0	0	0
4/21/2007	2007	0	—	—	0	0	0
4/22/2007	2007	0	—	—	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho‘olawe, Hawai‘i.—Continued[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
4/23/2007	2007	0	—	—	0	0	0
4/24/2007	2007	0	—	—	0	0	0
4/25/2007	2007	0	—	—	0	0	0
4/26/2007	2007	0	—	—	0	0	0
4/27/2007	2007	0	—	—	0	0	0
4/28/2007	2007	0	—	—	0	0	0
4/29/2007	2007	0	—	—	0	0	0
4/30/2007	2007	0	—	—	0	0	0
5/1/2007	2007	0	—	—	0	0	0
5/2/2007	2007	0	—	—	0	0	0
5/3/2007	2007	0	—	—	0	0	0
5/4/2007	2007	0	—	—	0	0	0
5/5/2007	2007	0	—	—	0	0	0
5/6/2007	2007	0	—	—	0	0	0
5/7/2007	2007	0	—	—	0	0	0
5/8/2007	2007	0	—	—	0	0	0
5/9/2007	2007	0	—	—	0	0	0
5/10/2007	2007	0	—	—	0	0	0
5/11/2007	2007	0	—	—	0	0	0
5/12/2007	2007	0	—	—	0	0	0
5/13/2007	2007	0	—	—	0	0	0
5/14/2007	2007	0	—	—	0	0	0
5/15/2007	2007	0	—	—	0	0	0
5/16/2007	2007	0	—	—	0	0	0
5/17/2007	2007	0	—	—	0	0	0
5/18/2007	2007	0	—	—	0	0	0
5/19/2007	2007	0	—	—	0	0	0
5/20/2007	2007	0	—	—	0	0	0
5/21/2007	2007	0	—	—	0	0	0
5/22/2007	2007	0	—	—	0	0	0
5/23/2007	2007	0	—	—	0	0	0
5/24/2007	2007	0	—	—	0	0	0
5/25/2007	2007	0	—	—	0	0	0
5/26/2007	2007	0	—	—	0	0	0
5/27/2007	2007	0	—	—	0	0	0
5/28/2007	2007	0	—	—	0	0	0
5/29/2007	2007	0	—	—	0	0	0
5/30/2007	2007	0	—	—	0	0	0
5/31/2007	2007	0	—	—	0	0	0
6/1/2007	2007	0	—	—	0	0	0
6/2/2007	2007	0	—	—	0	0	0
6/3/2007	2007	0	—	—	0	0	0
6/4/2007	2007	0	—	—	0	0	0
6/5/2007	2007	0	—	—	0	0	0
6/6/2007	2007	0	—	—	0	0	0
6/7/2007	2007	0	—	—	0	0	0
6/8/2007	2007	0	—	—	0	0	0
6/9/2007	2007	0	—	—	0	0	0
6/10/2007	2007	0	—	—	0	0	0
6/11/2007	2007	0	—	—	0	0	0
6/12/2007	2007	0	—	—	0	0	0
6/13/2007	2007	0	—	—	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho‘olawe, Hawai‘i.—Continued

[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
6/14/2007	2007	0	—	—	0	0	0
6/15/2007	2007	0	—	—	0	0	0
6/16/2007	2007	0	—	—	0	0	0
6/17/2007	2007	0	—	—	0	0	0
6/18/2007	2007	0	—	—	0	0	0
6/19/2007	2007	0	—	—	0	0	0
6/20/2007	2007	0	—	—	0	0	0
6/21/2007	2007	0	—	—	0	0	0
6/22/2007	2007	0	—	—	0	0	0
6/23/2007	2007	0	—	—	0	0	0
6/24/2007	2007	0	—	—	0	0	0
6/25/2007	2007	0	—	—	0	0	0
6/26/2007	2007	0	—	—	0	0	0
6/27/2007	2007	0	—	—	0	0	0
6/28/2007	2007	0	—	—	0	0	0
6/29/2007	2007	0	—	—	0	0	0
6/30/2007	2007	0	—	—	0	0	0
7/1/2007	2007	0	—	—	0	0	0
7/2/2007	2007	0	—	—	0	0	0
7/3/2007	2007	0	—	—	0	0	0
7/4/2007	2007	0	—	—	0	0	0
7/5/2007	2007	0	—	—	0	0	0
7/6/2007	2007	0	—	—	0	0	0
7/7/2007	2007	0	—	—	0	0	0
7/8/2007	2007	0	—	—	0	0	0
7/9/2007	2007	0	—	—	0	0	0
7/10/2007	2007	0	—	—	0	0	0
7/11/2007	2007	0	—	—	0	0	0
7/12/2007	2007	0	—	—	0	0	0
7/13/2007	2007	0	—	—	0	0	0
7/14/2007	2007	0	—	—	0	0	0
7/15/2007	2007	0	—	—	0	0	0
7/16/2007	2007	0	—	—	0	0	0
7/17/2007	2007	0	—	—	0	0	0
7/18/2007	2007	0	—	—	0	0	0
7/19/2007	2007	0	—	—	0	0	0
7/20/2007	2007	0	—	—	0	0	0
7/21/2007	2007	0	—	—	0	0	0
7/22/2007	2007	0	—	—	0	0	0
7/23/2007	2007	0	—	—	0	0	0
7/24/2007	2007	0	—	—	0	0	0
7/25/2007	2007	0	—	—	0	0	0
7/26/2007	2007	0	—	—	0	0	0
7/27/2007	2007	0	—	—	0	0	0
7/28/2007	2007	0	—	—	0	0	0
7/29/2007	2007	0	—	—	0	0	0
7/30/2007	2007	0	—	—	0	0	0
7/31/2007	2007	0	—	—	0	0	0
8/1/2007	2007	0	—	—	0	0	0
8/2/2007	2007	0	—	—	0	0	0
8/3/2007	2007	0	—	—	0	0	0
8/4/2007	2007	0	—	—	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho‘olawe, Hawai‘i.—Continued

[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
8/5/2007	2007	0	—	—	0	0	0
8/6/2007	2007	0	—	—	0	0	0
8/7/2007	2007	0	—	—	0	0	0
8/8/2007	2007	0	—	—	0	0	0
8/9/2007	2007	0	—	—	0	0	0
8/10/2007	2007	0	—	—	0	0	0
8/11/2007	2007	0	—	—	0	0	0
8/12/2007	2007	0	—	—	0	0	0
8/13/2007	2007	0	—	—	0	0	0
8/14/2007	2007	0	—	—	0	0	0
8/15/2007	2007	0	—	—	0	0	0
8/16/2007	2007	0	—	—	0	0	0
8/17/2007	2007	0	—	—	0	0	0
8/18/2007	2007	0	—	—	0	0	0
8/19/2007	2007	0	—	—	0	0	0
8/20/2007	2007	0	—	—	0	0	0
8/21/2007	2007	0	—	—	0	0	0
8/22/2007	2007	0	—	—	0	0	0
8/23/2007	2007	0	—	—	0	0	0
8/24/2007	2007	0	—	—	0	0	0
8/25/2007	2007	0	—	—	0	0	0
8/26/2007	2007	0	—	—	0	0	0
8/27/2007	2007	0	—	—	0	0	0
8/28/2007	2007	0	—	—	0	0	0
8/29/2007	2007	0	—	—	0	0	0
8/30/2007	2007	0.1	—	—	0	3	0
8/31/2007	2007	0.76	—	—	0.25	24600	91
9/1/2007	2007	0.06	—	—	0	449	0
9/2/2007	2007	0.01	—	—	0	0	0
9/3/2007	2007	0	—	—	0	0	0
9/4/2007	2007	0	—	—	0	0	0
9/5/2007	2007	0	—	—	0	0	0
9/6/2007	2007	0	—	—	0	0	0
9/7/2007	2007	0	—	—	0	0	0
9/8/2007	2007	0	—	—	0.03	2630	1.3
9/9/2007	2007	0	—	—	0	0	0
9/10/2007	2007	0	—	—	0	0	0
9/11/2007	2007	0.01	—	—	0	0	0
9/12/2007	2007	0	—	—	0	0	0
9/13/2007	2007	0	—	—	0	0	0
9/14/2007	2007	0	—	—	0	0	0
9/15/2007	2007	0	—	—	0	0	0
9/16/2007	2007	0	—	—	0	0	0
9/17/2007	2007	0	—	—	0	0	0
9/18/2007	2007	0	—	—	0	0	0
9/19/2007	2007	0	—	—	0	0	0
9/20/2007	2007	0	—	—	0	0	0
9/21/2007	2007	0	—	—	0	0	0
9/22/2007	2007	0	—	—	0	0	0
9/23/2007	2007	0	—	—	0	0	0
9/24/2007	2007	0	—	—	0	0	0
9/25/2007	2007	0	—	—	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho'olawe, Hawai'i.—Continued[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
9/26/2007	2007	0	—	—	0	0	0
9/27/2007	2007	0	—	—	0	0	0
9/28/2007	2007	0	—	—	0	0	0
9/29/2007	2007	0	—	—	0	0	0
9/30/2007	2007	0	—	—	0	0	0
10/1/2007	2008	0	0	0	0	0	0
10/2/2007	2008	0	0	0	0	0	0
10/3/2007	2008	0	0	0	0	0	0
10/4/2007	2008	0	0	0	0	0	0
10/5/2007	2008	0	0	0	0	0	0
10/6/2007	2008	0	0	0	0	0	0
10/7/2007	2008	0	0	0	0	0	0
10/8/2007	2008	0	0	0	0	0	0
10/9/2007	2008	0	0	0	0	0	0
10/10/2007	2008	0	0	0	0	0	0
10/11/2007	2008	0	0	0	0	0	0
10/12/2007	2008	0	0	0	0	0	0
10/13/2007	2008	0	0	0	0	0	0
10/14/2007	2008	0	0	0	0	0	0
10/15/2007	2008	0	0	0	0	0	0
10/16/2007	2008	0	0	0	0	0	0
10/17/2007	2008	0	0	0	0	0	0
10/18/2007	2008	0	0	0	0	0	0
10/19/2007	2008	0	0	0	0	0	0
10/20/2007	2008	0	0	0	0	0	0
10/21/2007	2008	0	0	0	0	0	0
10/22/2007	2008	0	0	0	0	0	0
10/23/2007	2008	0	0	0	0	0	0
10/24/2007	2008	0	0	0	0	0	0
10/25/2007	2008	0	0	0	0	0	0
10/26/2007	2008	0	0	0	0	0	0
10/27/2007	2008	0	0	0	0	0	0
10/28/2007	2008	0	0	0	0	0	0
10/29/2007	2008	0	0	0	0	0	0
10/30/2007	2008	0	0	0	0	0	0
10/31/2007	2008	0	0	0	0	0	0
11/1/2007	2008	0	0	0	0	0	0
11/2/2007	2008	0	0	0	0	0	0
11/3/2007	2008	0	0	0	0	0	0
11/4/2007	2008	0.13	2050	5.2	0	0	0
11/5/2007	2008	0	0	0	0	0	0
11/6/2007	2008	0	0	0	0	0	0
11/7/2007	2008	0	0	0	0	0	0
11/8/2007	2008	0	0	0	0	0	0
11/9/2007	2008	0	0	0	0	0	0
11/10/2007	2008	0	0	0	0	0	0
11/11/2007	2008	0	0	0	0	0	0
11/12/2007	2008	0	0	0	0	0	0
11/13/2007	2008	0	0	0	0	0	0
11/14/2007	2008	0	0	0	0	0	0
11/15/2007	2008	0	0	0	0	0	0
11/16/2007	2008	0	0	0	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho‘olawe, Hawai‘i.—Continued

[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
11/17/2007	2008	0	0	0	0	0	0
11/18/2007	2008	0	0	0	0	0	0
11/19/2007	2008	0	0	0	0	0	0
11/20/2007	2008	0	0	0	0	0	0
11/21/2007	2008	0	0	0	0	0	0
11/22/2007	2008	0	0	0	0	0	0
11/23/2007	2008	0	0	0	0	0	0
11/24/2007	2008	0	0	0	0	0	0
11/25/2007	2008	0	0	0	0	0	0
11/26/2007	2008	0	0	0	0	0	0
11/27/2007	2008	0	0	0	0	0	0
11/28/2007	2008	3.7	2770	625	0.5	5140	75
11/29/2007	2008	0.11	0	0	0	0	0
11/30/2007	2008	0	0	0	0	0	0
12/1/2007	2008	0	0	0	0	0	0
12/2/2007	2008	0	0	0	0	0	0
12/3/2007	2008	1	70	0.31	0.06	8	0
12/4/2007	2008	0.25	20	0.03	0.03	8	0
12/5/2007	2008	9.1	3800	834	0.5	1060	9.2
12/6/2007	2008	15	3080	629	0.55	2720	7.4
12/7/2007	2008	2.3	7	0.07	0.33	1850	5
12/8/2007	2008	0.23	0	0	0	0	0
12/9/2007	2008	0	0	0	0	0	0
12/10/2007	2008	0	0	0	0	0	0
12/11/2007	2008	0	0	0	0	0	0
12/12/2007	2008	0	0	0	0	0	0
12/13/2007	2008	0	0	0	0	0	0
12/14/2007	2008	0	0	0	0	0	0
12/15/2007	2008	0	0	0	0	0	0
12/16/2007	2008	0	0	0	0	0	0
12/17/2007	2008	0	0	0	0	0	0
12/18/2007	2008	0	0	0	0	0	0
12/19/2007	2008	0	0	0	0	0	0
12/20/2007	2008	0	0	0	0	0	0
12/21/2007	2008	0	0	0	0	0	0
12/22/2007	2008	0	0	0	0	0	0
12/23/2007	2008	0	0	0	0	0	0
12/24/2007	2008	0	0	0	0	0	0
12/25/2007	2008	0	0	0	0	0	0
12/26/2007	2008	0	0	0	0	0	0
12/27/2007	2008	0	0	0	0	0	0
12/28/2007	2008	0	0	0	0	0	0
12/29/2007	2008	0	0	0	0	0	0
12/30/2007	2008	0	0	0	0	0	0
12/31/2007	2008	1.5	3180	36	0.47	1020	13
1/1/2008	2008	0.13	30	0.02	0	0	0
1/2/2008	2008	0.01	0	0	0	0	0
1/3/2008	2008	0.03	0	0	0	0	0
1/4/2008	2008	0	0	0	0	0	0
1/5/2008	2008	0	0	0	0	0	0
1/6/2008	2008	0	0	0	0	0	0
1/7/2008	2008	0	0	0	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho'olawe, Hawai'i.—Continued[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
1/8/2008	2008	0	0	0	0	0	0
1/9/2008	2008	0	0	0	0	0	0
1/10/2008	2008	0	0	0	0	0	0
1/11/2008	2008	0	0	0	0	0	0
1/12/2008	2008	0	0	0	0	0	0
1/13/2008	2008	0	0	0	0	0	0
1/14/2008	2008	0	0	0	0	0	0
1/15/2008	2008	0	0	0	0	0	0
1/16/2008	2008	0	0	0	0	0	0
1/17/2008	2008	0	0	0	0	0	0
1/18/2008	2008	0	0	0	0	0	0
1/19/2008	2008	0	0	0	0	0	0
1/20/2008	2008	0	0	0	0	0	0
1/21/2008	2008	0	0	0	0	0	0
1/22/2008	2008	0	0	0	0	0	0
1/23/2008	2008	0	0	0	0	0	0
1/24/2008	2008	0	0	0	0	0	0
1/25/2008	2008	0	0	0	0	0	0
1/26/2008	2008	0	0	0	0	0	0
1/27/2008	2008	0	0	0	0	0	0
1/28/2008	2008	0	0	0	0	0	0
1/29/2008	2008	0	0	0	0	0	0
1/30/2008	2008	0	0	0	0	0	0
1/31/2008	2008	0	0	0	0	0	0
2/1/2008	2008	0	0	0	0	0	0
2/2/2008	2008	0	0	0	0	0	0
2/3/2008	2008	0	0	0	0	0	0
2/4/2008	2008	0	0	0	0	0	0
2/5/2008	2008	0	0	0	0	0	0
2/6/2008	2008	0	0	0	0	0	0
2/7/2008	2008	0	0	0	0	0	0
2/8/2008	2008	3.2	2640	172	0.62	4510	48
2/9/2008	2008	0.19	6	0	0.01	1	0
2/10/2008	2008	0.06	0	0	0	0	0
2/11/2008	2008	0.04	0	0	0	0	0
2/12/2008	2008	0	0	0	0	0	0
2/13/2008	2008	0	0	0	0	0	0
2/14/2008	2008	0	0	0	0	0	0
2/15/2008	2008	0	0	0	0	0	0
2/16/2008	2008	0	0	0	0	0	0
2/17/2008	2008	0	0	0	0	0	0
2/18/2008	2008	0	0	0	0	0	0
2/19/2008	2008	0	0	0	0	0	0
2/20/2008	2008	0	0	0	0	0	0
2/21/2008	2008	0	0	0	0	0	0
2/22/2008	2008	0	0	0	0	0	0
2/23/2008	2008	0	0	0	0	0	0
2/24/2008	2008	0	0	0	0	0	0
2/25/2008	2008	0.52	1170	8.4	0.03	1640	0.9
2/26/2008	2008	0.07	0	0	0	0	0
2/27/2008	2008	0.02	0	0	0	0	0
2/28/2008	2008	0	0	0	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho‘olawe, Hawai‘i.—Continued[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
2/29/2008	2008	0	0	0	0	0	0
3/1/2008	2008	0	0	0	0	0	0
3/2/2008	2008	0	0	0	0	0	0
3/3/2008	2008	0	0	0	0	0	0
3/4/2008	2008	0	0	0	0	0	0
3/5/2008	2008	0	0	0	0	0	0
3/6/2008	2008	0	0	0	0	0	0
3/7/2008	2008	0	0	0	0	0	0
3/8/2008	2008	0	0	0	0	0	0
3/9/2008	2008	0	0	0	0	0	0
3/10/2008	2008	0	0	0	0	0	0
3/11/2008	2008	0	0	0	0	0	0
3/12/2008	2008	0	0	0	0	0	0
3/13/2008	2008	0	0	0	0	0	0
3/14/2008	2008	0	0	0	0	0	0
3/15/2008	2008	0	0	0	0	0	0
3/16/2008	2008	0	0	0	0	0	0
3/17/2008	2008	0.06	14	0.02	0	0	0
3/18/2008	2008	0	0	0	0	0	0
3/19/2008	2008	0	0	0	0	0	0
3/20/2008	2008	0	0	0	0	0	0
3/21/2008	2008	0	0	0	0	0	0
3/22/2008	2008	0	0	0	0	0	0
3/23/2008	2008	0	0	0	0	0	0
3/24/2008	2008	0	0	0	0	0	0
3/25/2008	2008	0	0	0	0	0	0
3/26/2008	2008	0	0	0	0	0	0
3/27/2008	2008	0	0	0	0	0	0
3/28/2008	2008	0	0	0	0	0	0
3/29/2008	2008	0	0	0	0	0	0
3/30/2008	2008	0	0	0	0	0	0
3/31/2008	2008	0	0	0	0	0	0
4/1/2008	2008	0	0	0	0	0	0
4/2/2008	2008	0	0	0	0	0	0
4/3/2008	2008	0	0	0	0	0	0
4/4/2008	2008	0	0	0	0	0	0
4/5/2008	2008	0	0	0	0	0	0
4/6/2008	2008	0	0	0	0	0	0
4/7/2008	2008	0	0	0	0	0	0
4/8/2008	2008	0	0	0	0	0	0
4/9/2008	2008	0	0	0	0	0	0
4/10/2008	2008	0	0	0	0	0	0
4/11/2008	2008	0	0	0	0	0	0
4/12/2008	2008	0	0	0	0	0	0
4/13/2008	2008	0	0	0	0	0	0
4/14/2008	2008	0	0	0	0	0	0
4/15/2008	2008	0	0	0	0	0	0
4/16/2008	2008	0	0	0	0	0	0
4/17/2008	2008	0	0	0	0	0	0
4/18/2008	2008	0	0	0	0	0	0
4/19/2008	2008	0	0	0	0	0	0
4/20/2008	2008	0	0	0	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho‘olawe, Hawai‘i.—Continued

[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
4/21/2008	2008	0	0	0	0	0	0
4/22/2008	2008	0	0	0	0	0	0
4/23/2008	2008	0	0	0	0	0	0
4/24/2008	2008	0	0	0	0	0	0
4/25/2008	2008	0	0	0	0	0	0
4/26/2008	2008	0	0	0	0	0	0
4/27/2008	2008	0	0	0	0	0	0
4/28/2008	2008	0	0	0	0	0	0
4/29/2008	2008	0	0	0	0	0	0
4/30/2008	2008	0	0	0	0	0	0
5/1/2008	2008	0	0	0	0	0	0
5/2/2008	2008	0	0	0	0	0	0
5/3/2008	2008	0	0	0	0	0	0
5/4/2008	2008	0	0	0	0	0	0
5/5/2008	2008	0	0	0	0	0	0
5/6/2008	2008	0	0	0	0	0	0
5/7/2008	2008	0	0	0	0	0	0
5/8/2008	2008	0	0	0	0	0	0
5/9/2008	2008	0	0	0	0	0	0
5/10/2008	2008	0	0	0	0	0	0
5/11/2008	2008	0	0	0	0	0	0
5/12/2008	2008	0	0	0	0	0	0
5/13/2008	2008	0	0	0	0	0	0
5/14/2008	2008	0	0	0	0	0	0
5/15/2008	2008	0	0	0	0	0	0
5/16/2008	2008	0	0	0	0	0	0
5/17/2008	2008	0	0	0	0	0	0
5/18/2008	2008	0	0	0	0	0	0
5/19/2008	2008	0	0	0	0	0	0
5/20/2008	2008	0	0	0	0	0	0
5/21/2008	2008	0	0	0	0	0	0
5/22/2008	2008	0	0	0	0	0	0
5/23/2008	2008	0	0	0	0	0	0
5/24/2008	2008	0	0	0	0	0	0
5/25/2008	2008	0	0	0	0	0	0
5/26/2008	2008	0	0	0	0	0	0
5/27/2008	2008	0	0	0	0	0	0
5/28/2008	2008	0	0	0	0	0	0
5/29/2008	2008	0	0	0	0	0	0
5/30/2008	2008	0	0	0	0	0	0
5/31/2008	2008	0	0	0	0	0	0
6/1/2008	2008	0	0	0	0	0	0
6/2/2008	2008	0	0	0	0	0	0
6/3/2008	2008	0	0	0	0	0	0
6/4/2008	2008	0	0	0	0	0	0
6/5/2008	2008	0	0	0	0	0	0
6/6/2008	2008	0	0	0	0	0	0
6/7/2008	2008	0	0	0	0	0	0
6/8/2008	2008	0	0	0	0	0	0
6/9/2008	2008	0	0	0	0	0	0
6/10/2008	2008	0	0	0	0	0	0
6/11/2008	2008	0	0	0	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho‘olawe, Hawai‘i.—Continued[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
6/12/2008	2008	0	0	0	0	0	0
6/13/2008	2008	0	0	0	0	0	0
6/14/2008	2008	0	0	0	0	0	0
6/15/2008	2008	0	0	0	0	0	0
6/16/2008	2008	0	0	0	0	0	0
6/17/2008	2008	0	0	0	0	0	0
6/18/2008	2008	0	0	0	0	0	0
6/19/2008	2008	0	0	0	0	0	0
6/20/2008	2008	0	0	0	0	0	0
6/21/2008	2008	0	0	0	0	0	0
6/22/2008	2008	0	0	0	0	0	0
6/23/2008	2008	0	0	0	0	0	0
6/24/2008	2008	0	0	0	0	0	0
6/25/2008	2008	0	0	0	0	0	0
6/26/2008	2008	0	0	0	0	0	0
6/27/2008	2008	0	0	0	0	0	0
6/28/2008	2008	0	0	0	0	0	0
6/29/2008	2008	0	0	0	0	0	0
6/30/2008	2008	0	0	0	0	0	0
7/1/2008	2008	0	0	0	0	0	0
7/2/2008	2008	0	0	0	0	0	0
7/3/2008	2008	0	0	0	0	0	0
7/4/2008	2008	0	0	0	0	0	0
7/5/2008	2008	0	0	0	0	0	0
7/6/2008	2008	0	0	0	0	0	0
7/7/2008	2008	0	0	0	0	0	0
7/8/2008	2008	0	0	0	0	0	0
7/9/2008	2008	0	0	0	0	0	0
7/10/2008	2008	0	0	0	0	0	0
7/11/2008	2008	0	0	0	0	0	0
7/12/2008	2008	0	0	0	0	0	0
7/13/2008	2008	0	0	0	0	0	0
7/14/2008	2008	0	0	0	0	0	0
7/15/2008	2008	0	0	0	0	0	0
7/16/2008	2008	0	0	0	0	0	0
7/17/2008	2008	0	0	0	0	0	0
7/18/2008	2008	0	0	0	0	0	0
7/19/2008	2008	0	0	0	0.06	94	0.09
7/20/2008	2008	0	0	0	0	1	0
7/21/2008	2008	0	0	0	0	0	0
7/22/2008	2008	0	0	0	0	0	0
7/23/2008	2008	0	0	0	0	0	0
7/24/2008	2008	0	0	0	0	0	0
7/25/2008	2008	0	0	0	0	0	0
7/26/2008	2008	0	0	0	0	0	0
7/27/2008	2008	0	0	0	0	0	0
7/28/2008	2008	0	0	0	0	0	0
7/29/2008	2008	0	0	0	0	0	0
7/30/2008	2008	0	0	0	0	0	0
7/31/2008	2008	0	0	0	0	0	0
8/1/2008	2008	0	0	0	0	0	0
8/2/2008	2008	0	0	0	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho'olawe, Hawai'i.—Continued[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
8/3/2008	2008	0	0	0	0	0	0
8/4/2008	2008	0	0	0	0	0	0
8/5/2008	2008	0	0	0	0	0	0
8/6/2008	2008	0	0	0	0	0	0
8/7/2008	2008	0	0	0	0	0	0
8/8/2008	2008	0	0	0	0	0	0
8/9/2008	2008	0	0	0	0	0	0
8/10/2008	2008	0	0	0	0	0	0
8/11/2008	2008	0	0	0	0	0	0
8/12/2008	2008	0	0	0	0	0	0
8/13/2008	2008	0	0	0	0	0	0
8/14/2008	2008	0	0	0	0	0	0
8/15/2008	2008	0	0	0	0	0	0
8/16/2008	2008	0	0	0	0	0	0
8/17/2008	2008	0	0	0	0	0	0
8/18/2008	2008	0	0	0	0	0	0
8/19/2008	2008	0	0	0	0	0	0
8/20/2008	2008	0	0	0	0	0	0
8/21/2008	2008	0	0	0	0	0	0
8/22/2008	2008	0	0	0	0	0	0
8/23/2008	2008	0	0	0	0	0	0
8/24/2008	2008	0	0	0	0	0	0
8/25/2008	2008	0	0	0	0	0	0
8/26/2008	2008	0	0	0	0	0	0
8/27/2008	2008	0	0	0	0	0	0
8/28/2008	2008	0	0	0	0	0	0
8/29/2008	2008	0	0	0	0	0	0
8/30/2008	2008	0	0	0	0	0	0
8/31/2008	2008	0	0	0	0	0	0
9/1/2008	2008	0	0	0	0	0	0
9/2/2008	2008	0	0	0	0	0	0
9/3/2008	2008	0	0	0	0	0	0
9/4/2008	2008	0	0	0	0	0	0
9/5/2008	2008	0	0	0	0	0	0
9/6/2008	2008	0	0	0	0	0	0
9/7/2008	2008	0	0	0	0	0	0
9/8/2008	2008	0	0	0	0	0	0
9/9/2008	2008	0.11	1	0	0	0	0
9/10/2008	2008	0.03	0	0	0	0	0
9/11/2008	2008	0	0	0	0	0	0
9/12/2008	2008	0	0	0	0	0	0
9/13/2008	2008	0	0	0	0	0	0
9/14/2008	2008	0	0	0	0	0	0
9/15/2008	2008	0	0	0	0	0	0
9/16/2008	2008	0	0	0	0	0	0
9/17/2008	2008	0	0	0	0	0	0
9/18/2008	2008	0	0	0	0	0	0
9/19/2008	2008	0	0	0	0	0	0
9/20/2008	2008	0	0	0	0	0	0
9/21/2008	2008	0	0	0	0	0	0
9/22/2008	2008	0	0	0	0	0	0
9/23/2008	2008	0	0	0	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho‘olawe, Hawai‘i.—Continued[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
9/24/2008	2008	0	0	0	0	0	0
9/25/2008	2008	0	0	0	0	0	0
9/26/2008	2008	0	0	0	0	0	0
9/27/2008	2008	0	0	0	0	0	0
9/28/2008	2008	0	0	0	0	0	0
9/29/2008	2008	0	0	0	0	0	0
9/30/2008	2008	0	0	0	0	0	0
10/1/2008	2009	0	0	0	0	0	0
10/2/2008	2009	0	0	0	0	0	0
10/3/2008	2009	0	0	0	0	0	0
10/4/2008	2009	0	0	0	0	0	0
10/5/2008	2009	0	0	0	0	0	0
10/6/2008	2009	0	0	0	0	0	0
10/7/2008	2009	0	0	0	0	0	0
10/8/2008	2009	0	0	0	0	0	0
10/9/2008	2009	0	0	0	0	0	0
10/10/2008	2009	0	0	0	0	0	0
10/11/2008	2009	0	0	0	0	0	0
10/12/2008	2009	0	0	0	0	0	0
10/13/2008	2009	0	0	0	0	0	0
10/14/2008	2009	0	0	0	0	0	0
10/15/2008	2009	0	0	0	0	0	0
10/16/2008	2009	0	0	0	0	0	0
10/17/2008	2009	0	0	0	0	0	0
10/18/2008	2009	0	0	0	0	0	0
10/19/2008	2009	0	0	0	0	0	0
10/20/2008	2009	0	0	0	0	0	0
10/21/2008	2009	0	0	0	0	0	0
10/22/2008	2009	0	0	0	0	0	0
10/23/2008	2009	0	0	0	0	0	0
10/24/2008	2009	0	0	0	0	0	0
10/25/2008	2009	0	0	0	0	0	0
10/26/2008	2009	0	0	0	0	0	0
10/27/2008	2009	0	0	0	0	0	0
10/28/2008	2009	0	0	0	0	0	0
10/29/2008	2009	0	0	0	0	0	0
10/30/2008	2009	0	0	0	0	0	0
10/31/2008	2009	0	0	0	0	0	0
11/1/2008	2009	0	0	0	0	0	0
11/2/2008	2009	0	0	0	0	0	0
11/3/2008	2009	0	0	0	0	0	0
11/4/2008	2009	0	0	0	0	0	0
11/5/2008	2009	0	0	0	0	0	0
11/6/2008	2009	0	0	0	0	0	0
11/7/2008	2009	0	0	0	0	0	0
11/8/2008	2009	0	0	0	0	0	0
11/9/2008	2009	0	0	0	0	0	0
11/10/2008	2009	0	0	0	0	0	0
11/11/2008	2009	0	0	0	0	0	0
11/12/2008	2009	0	0	0	0	0	0
11/13/2008	2009	0	0	0	0	0	0
11/14/2008	2009	0	0	0	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho'olawe, Hawai'i.—Continued[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
11/15/2008	2009	0	0	0	0.01	69	0.03
11/16/2008	2009	0	0	0	0	0	0
11/17/2008	2009	0	0	0	0	0	0
11/18/2008	2009	0	0	0	0	0	0
11/19/2008	2009	0	0	0	0	0	0
11/20/2008	2009	0	0	0	0	0	0
11/21/2008	2009	0	0	0	0	0	0
11/22/2008	2009	0	0	0	0	0	0
11/23/2008	2009	0	0	0	0	0	0
11/24/2008	2009	0	0	0	0	0	0
11/25/2008	2009	0	0	0	0	0	0
11/26/2008	2009	0	0	0	0	0	0
11/27/2008	2009	0	0	0	0	0	0
11/28/2008	2009	0	0	0	0	0	0
11/29/2008	2009	0	0	0	0	0	0
11/30/2008	2009	0	0	0	0	0	0
12/1/2008	2009	0	0	0	0	0	0
12/2/2008	2009	0	0	0	0	0	0
12/3/2008	2009	0	0	0	0	0	0
12/4/2008	2009	0	0	0	0	0	0
12/5/2008	2009	0	0	0	0	0	0
12/6/2008	2009	0	0	0	0	0	0
12/7/2008	2009	0	0	0	0	0	0
12/8/2008	2009	0	0	0	0	0	0
12/9/2008	2009	0	0	0	0	0	0
12/10/2008	2009	0	0	0	0	0	0
12/11/2008	2009	5	2500	126	1.6	6590	138
12/12/2008	2009	0.89	174	1.2	0.17	1320	2
12/13/2008	2009	0.12	11	0	0	0	0
12/14/2008	2009	0.1	6	0	0.04	174	0.18
12/15/2008	2009	0.07	3	0	0	0	0
12/16/2008	2009	0.02	0	0	0	0	0
12/17/2008	2009	0	0	0	0	0	0
12/18/2008	2009	0	0	0	0	0	0
12/19/2008	2009	0	0	0	0	0	0
12/20/2008	2009	0	0	0	0	0	0
12/21/2008	2009	0	0	0	0	0	0
12/22/2008	2009	0	0	0	0	0	0
12/23/2008	2009	0	0	0	0	0	0
12/24/2008	2009	0	0	0	0	0	0
12/25/2008	2009	0	0	0	0	0	0
12/26/2008	2009	0	0	0	0	0	0
12/27/2008	2009	0	0	0	0	0	0
12/28/2008	2009	0	0	0	0	0	0
12/29/2008	2009	0	0	0	0	0	0
12/30/2008	2009	0	0	0	0	0	0
12/31/2008	2009	0	0	0	0	0	0
1/1/2009	2009	0	0	0	0	0	0
1/2/2009	2009	0	0	0	0	0	0
1/3/2009	2009	0	0	0	0	0	0
1/4/2009	2009	0	0	0	0	0	0
1/5/2009	2009	0	0	0	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho‘olawe, Hawai‘i.—Continued[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
1/6/2009	2009	0	0	0	0	0	0
1/7/2009	2009	0	0	0	0	0	0
1/8/2009	2009	0	0	0	0	0	0
1/9/2009	2009	0	0	0	0	0	0
1/10/2009	2009	0	0	0	0	0	0
1/11/2009	2009	3	4190	412	0.75	5410	104
1/12/2009	2009	0.04	3	0	0	0	0
1/13/2009	2009	0	0	0	0	0	0
1/14/2009	2009	0	0	0	0	0	0
1/15/2009	2009	0	0	0	0	0	0
1/16/2009	2009	0.13	56	0.05	0	0	0
1/17/2009	2009	0.1	49	0.03	0	0	0
1/18/2009	2009	0	0	0	0	0	0
1/19/2009	2009	0	0	0	0	0	0
1/20/2009	2009	0	0	0	0	0	0
1/21/2009	2009	0	0	0	0	0	0
1/22/2009	2009	0	0	0	0	0	0
1/23/2009	2009	0	0	0	0	0	0
1/24/2009	2009	0	0	0	0	0	0
1/25/2009	2009	0	0	0	0	0	0
1/26/2009	2009	0	0	0	0	0	0
1/27/2009	2009	6.9	10300	878	1.5	3670	102
1/28/2009	2009	1.5	1460	20	0.84	3060	34
1/29/2009	2009	0.08	25	0.01	0	7	0
1/30/2009	2009	0.05	3	0	0	0	0
1/31/2009	2009	0.05	2	0	0	0	0
2/1/2009	2009	0.05	1	0	0	0	0
2/2/2009	2009	0.01	0	0	0	0	0
2/3/2009	2009	0	0	0	0	0	0
2/4/2009	2009	0	0	0	0	0	0
2/5/2009	2009	0	0	0	0	0	0
2/6/2009	2009	0	0	0	0	0	0
2/7/2009	2009	0	0	0	0	0	0
2/8/2009	2009	0	0	0	0	0	0
2/9/2009	2009	0	0	0	0	0	0
2/10/2009	2009	0	0	0	0	0	0
2/11/2009	2009	0	0	0	0	0	0
2/12/2009	2009	0	0	0	0	0	0
2/13/2009	2009	0	0	0	0	0	0
2/14/2009	2009	0	0	0	0	0	0
2/15/2009	2009	0	0	0	0	0	0
2/16/2009	2009	0	0	0	0	0	0
2/17/2009	2009	0	0	0	0	0	0
2/18/2009	2009	0	0	0	0	0	0
2/19/2009	2009	0	0	0	0	0	0
2/20/2009	2009	0	0	0	0	0	0
2/21/2009	2009	0	0	0	0	0	0
2/22/2009	2009	0	0	0	0	0	0
2/23/2009	2009	0	0	0	0	0	0
2/24/2009	2009	0	0	0	0	0	0
2/25/2009	2009	0	0	0	0	0	0
2/26/2009	2009	0	0	0	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho'olawe, Hawai'i.—Continued[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
2/27/2009	2009	0	0	0	0	0	0
2/28/2009	2009	0	0	0	0	0	0
3/1/2009	2009	0	0	0	0	0	0
3/2/2009	2009	0	0	0	0	0	0
3/3/2009	2009	0	0	0	0	0	0
3/4/2009	2009	0	0	0	0	0	0
3/5/2009	2009	0	0	0	0	0	0
3/6/2009	2009	0	0	0	0	0	0
3/7/2009	2009	0	0	0	0	0	0
3/8/2009	2009	0	0	0	0	0	0
3/9/2009	2009	0	0	0	0	0	0
3/10/2009	2009	0	0	0	0	0	0
3/11/2009	2009	0	0	0	0	0	0
3/12/2009	2009	0	0	0	0	0	0
3/13/2009	2009	0	0	0	0	0	0
3/14/2009	2009	0	0	0	0	0	0
3/15/2009	2009	0	0	0	0	0	0
3/16/2009	2009	0	0	0	0	0	0
3/17/2009	2009	0	0	0	0	0	0
3/18/2009	2009	0	0	0	0	0	0
3/19/2009	2009	0	0	0	0	0	0
3/20/2009	2009	0	0	0	0	0	0
3/21/2009	2009	0	0	0	0	0	0
3/22/2009	2009	0	0	0	0	0	0
3/23/2009	2009	0	0	0	0	0	0
3/24/2009	2009	0	0	0	0	0	0
3/25/2009	2009	0	0	0	0	0	0
3/26/2009	2009	0	0	0	0	0	0
3/27/2009	2009	0	0	0	0	0	0
3/28/2009	2009	0	0	0	0	0	0
3/29/2009	2009	0	0	0	0	0	0
3/30/2009	2009	0	0	0	0	0	0
3/31/2009	2009	0	0	0	0	0	0
4/1/2009	2009	0	0	0	0	0	0
4/2/2009	2009	0	0	0	0	0	0
4/3/2009	2009	0	0	0	0	0	0
4/4/2009	2009	0	0	0	0	0	0
4/5/2009	2009	0	0	0	0	0	0
4/6/2009	2009	0	0	0	0	0	0
4/7/2009	2009	0	0	0	0	0	0
4/8/2009	2009	0	0	0	0	0	0
4/9/2009	2009	0	0	0	0	0	0
4/10/2009	2009	0	0	0	0	0	0
4/11/2009	2009	0	0	0	0	0	0
4/12/2009	2009	0	0	0	0	0	0
4/13/2009	2009	0	0	0	0	0	0
4/14/2009	2009	0	0	0	0	0	0
4/15/2009	2009	0	0	0	0	0	0
4/16/2009	2009	0	0	0	0	0	0
4/17/2009	2009	0	0	0	0	0	0
4/18/2009	2009	0	0	0	0	0	0
4/19/2009	2009	0	0	0	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho‘olawe, Hawai‘i.—Continued[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
4/20/2009	2009	0	0	0	0	0	0
4/21/2009	2009	0	0	0	0	0	0
4/22/2009	2009	0	0	0	0	0	0
4/23/2009	2009	0	0	0	0	0	0
4/24/2009	2009	0	0	0	0	0	0
4/25/2009	2009	0	0	0	0	0	0
4/26/2009	2009	0	0	0	0	0	0
4/27/2009	2009	0	0	0	0	0	0
4/28/2009	2009	0	0	0	0	0	0
4/29/2009	2009	0	0	0	0	0	0
4/30/2009	2009	0	0	0	0	0	0
5/1/2009	2009	0	0	0	0	0	0
5/2/2009	2009	0	0	0	0	0	0
5/3/2009	2009	0	0	0	0	0	0
5/4/2009	2009	0	0	0	0	0	0
5/5/2009	2009	0	0	0	0	0	0
5/6/2009	2009	0	0	0	0	0	0
5/7/2009	2009	0	0	0	0	0	0
5/8/2009	2009	0	0	0	0	0	0
5/9/2009	2009	0	0	0	0	0	0
5/10/2009	2009	0	0	0	0	0	0
5/11/2009	2009	0	0	0	0	0	0
5/12/2009	2009	0	0	0	0	0	0
5/13/2009	2009	0	0	0	0	0	0
5/14/2009	2009	0	0	0	0	0	0
5/15/2009	2009	0	0	0	0	0	0
5/16/2009	2009	0	0	0	0	0	0
5/17/2009	2009	0	0	0	0	0	0
5/18/2009	2009	0	0	0	0	0	0
5/19/2009	2009	0	0	0	0	0	0
5/20/2009	2009	0	0	0	0	0	0
5/21/2009	2009	0	0	0	0	0	0
5/22/2009	2009	0	0	0	0	0	0
5/23/2009	2009	0.04	14	0.01	0	0	0
5/24/2009	2009	0.03	1	0	0	0	0
5/25/2009	2009	0	0	0	0	0	0
5/26/2009	2009	0	0	0	0	0	0
5/27/2009	2009	0	0	0	0	0	0
5/28/2009	2009	0	0	0	0	0	0
5/29/2009	2009	0	0	0	0	0	0
5/30/2009	2009	0	0	0	0	0	0
5/31/2009	2009	0	0	0	0	0	0
6/1/2009	2009	0	0	0	0	0	0
6/2/2009	2009	0	0	0	0	0	0
6/3/2009	2009	0	0	0	0	0	0
6/4/2009	2009	0	0	0	0	0	0
6/5/2009	2009	0	0	0	0	0	0
6/6/2009	2009	0	0	0	0	0	0
6/7/2009	2009	0	0	0	0	0	0
6/8/2009	2009	0	0	0	0	0	0
6/9/2009	2009	0	0	0	0	0	0
6/10/2009	2009	0	0	0	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho‘olawe, Hawai‘i.—Continued

[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
6/11/2009	2009	0	0	0	0	0	0
6/12/2009	2009	0	0	0	0	0	0
6/13/2009	2009	0	0	0	0	0	0
6/14/2009	2009	0	0	0	0	0	0
6/15/2009	2009	0	0	0	0	0	0
6/16/2009	2009	0	0	0	0	0	0
6/17/2009	2009	0	0	0	0	0	0
6/18/2009	2009	0	0	0	0	0	0
6/19/2009	2009	0	0	0	0	0	0
6/20/2009	2009	0	0	0	0	0	0
6/21/2009	2009	0	0	0	0	0	0
6/22/2009	2009	0	0	0	0	0	0
6/23/2009	2009	0	0	0	0	0	0
6/24/2009	2009	0	0	0	0	0	0
6/25/2009	2009	0	0	0	0	0	0
6/26/2009	2009	0	0	0	0	0	0
6/27/2009	2009	0	0	0	0	0	0
6/28/2009	2009	0	0	0	0	0	0
6/29/2009	2009	0	0	0	0	0	0
6/30/2009	2009	0	0	0	0	0	0
7/1/2009	2009	0	0	0	0	0	0
7/2/2009	2009	0	0	0	0	0	0
7/3/2009	2009	0	0	0	0	0	0
7/4/2009	2009	0	0	0	0	0	0
7/5/2009	2009	0	0	0	0	0	0
7/6/2009	2009	0	0	0	0	0	0
7/7/2009	2009	0	0	0	0	0	0
7/8/2009	2009	0	0	0	0	0	0
7/9/2009	2009	0	0	0	0	0	0
7/10/2009	2009	0	0	0	0	0	0
7/11/2009	2009	0	0	0	0	0	0
7/12/2009	2009	0	0	0	0	0	0
7/13/2009	2009	0	0	0	0	0	0
7/14/2009	2009	0	0	0	0	0	0
7/15/2009	2009	0	0	0	0	0	0
7/16/2009	2009	0	0	0	0	0	0
7/17/2009	2009	0	0	0	0	0	0
7/18/2009	2009	0	0	0	0	0	0
7/19/2009	2009	0	0	0	0	0	0
7/20/2009	2009	0	0	0	0	0	0
7/21/2009	2009	0	0	0	0	0	0
7/22/2009	2009	0	0	0	0	0	0
7/23/2009	2009	0	0	0	0	0	0
7/24/2009	2009	0	0	0	0	0	0
7/25/2009	2009	0	0	0	0	0	0
7/26/2009	2009	0	0	0	0	0	0
7/27/2009	2009	0	0	0	0	0	0
7/28/2009	2009	0	0	0	0	0	0
7/29/2009	2009	0	0	0	0	0	0
7/30/2009	2009	0	0	0	0	0	0
7/31/2009	2009	0	0	0	0	0	0
8/1/2009	2009	0	0	0	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho‘olawe, Hawai‘i.—Continued[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
8/2/2009	2009	0	0	0	0	0	0
8/3/2009	2009	0	0	0	0	0	0
8/4/2009	2009	0	0	0	0	0	0
8/5/2009	2009	0	0	0	0	0	0
8/6/2009	2009	0	0	0	0	0	0
8/7/2009	2009	0	0	0	0	0	0
8/8/2009	2009	0	0	0	0	0	0
8/9/2009	2009	0	0	0	0	0	0
8/10/2009	2009	0	0	0	0	0	0
8/11/2009	2009	0	0	0	0	0	0
8/12/2009	2009	1.1	1550	19	0.39	2770	13
8/13/2009	2009	0.37	271	0.51	0.01	50	0.02
8/14/2009	2009	0.05	2	0	0	0	0
8/15/2009	2009	0	0	0	0	0	0
8/16/2009	2009	0	0	0	0	0	0
8/17/2009	2009	0	0	0	0	0	0
8/18/2009	2009	0	0	0	0	0	0
8/19/2009	2009	0	0	0	0	0	0
8/20/2009	2009	0	0	0	0	0	0
8/21/2009	2009	0	0	0	0	0	0
8/22/2009	2009	0	0	0	0	0	0
8/23/2009	2009	0	0	0	0	0	0
8/24/2009	2009	0	0	0	0	0	0
8/25/2009	2009	0	0	0	0	0	0
8/26/2009	2009	0	0	0	0	0	0
8/27/2009	2009	0	0	0	0	0	0
8/28/2009	2009	0	0	0	0	0	0
8/29/2009	2009	0	0	0	0	0	0
8/30/2009	2009	0	0	0	0	0	0
8/31/2009	2009	0	0	0	0	0	0
9/1/2009	2009	0	0	0	0	0	0
9/2/2009	2009	0	0	0	0	0	0
9/3/2009	2009	0	0	0	0	0	0
9/4/2009	2009	0	0	0	0	0	0
9/5/2009	2009	0	0	0	0	0	0
9/6/2009	2009	0	0	0	0	0	0
9/7/2009	2009	0	0	0	0	0	0
9/8/2009	2009	0	0	0	0	0	0
9/9/2009	2009	0	0	0	0	0	0
9/10/2009	2009	0	0	0	0	0	0
9/11/2009	2009	0	0	0	0	0	0
9/12/2009	2009	0	0	0	0	0	0
9/13/2009	2009	0	0	0	0	0	0
9/14/2009	2009	0	0	0	0	0	0
9/15/2009	2009	0	0	0	0	0	0
9/16/2009	2009	0	0	0	0	0	0
9/17/2009	2009	0	0	0	0	0	0
9/18/2009	2009	0	0	0	0	0	0
9/19/2009	2009	0	0	0	0	0	0
9/20/2009	2009	0	0	0	0	0	0
9/21/2009	2009	0	0	0	0	0	0
9/22/2009	2009	0	0	0	0	0	0

Table 1–1. Daily mean streamflow and daily suspended-sediment data from gages on Hakioawa Gulch and Kaulana Gulch, Kaho'olawe, Hawai'i.—Continued[ft³/s, cubic feet per second; mg/L, milligrams per liter; —, no data.]

Date	Water year	Hakioawa (16681000)			Kaulana (16682000)		
		Streamflow (ft ³ /s)	Suspended sediment		Streamflow (ft ³ /s)	Suspended sediment	
			Concentration (mg/L)	Load (tons)		Concentration (mg/L)	Load (tons)
9/23/2009	2009	0	0	0	0	0	0
9/24/2009	2009	0	0	0	0	0	0
9/25/2009	2009	0	0	0	0	0	0
9/26/2009	2009	0	0	0	0	0	0
9/27/2009	2009	0	0	0	0	0	0
9/28/2009	2009	0	0	0	0	0	0
9/29/2009	2009	0	0	0	0	0	0
9/30/2009	2009	0	0	0	0	0	0

Appendix 2. Average Rod Measurements

Table 2–1. Average rod measurements from erosion monitoring in the Hakioawa watershed, Kaho'olawe, Hawai'i.

[Avg rod is the average of rod measurements, in millimeters; —, no data.]

Site	Jan 2007		Sep 2007		Mar 2008		Sep 2008		May 2009		Oct 2009		Mar 2010	
	Date	Avg rod	Date	Avg rod	Date	Avg rod	Date	Avg rod	Date	Avg rod	Date	Avg rod	Date	Avg rod
H1	11	249	18	248	03	247	10	249	12	247	06	246	09	246
H2	11	196	18	195	03	193	10	194	12	192	06	191	09	191
H3	11	265	18	263	05	263	10	262	12	261	06	261	09	260
H4	11	194	18	194	05	193	10	192	12	192	06	190	09	191
H5	11	161	18	159	05	158	10	159	12	156	06	156	09	157
H6	11	213	18	211	05	212	10	213	12	212	06	212	09	210
H7	11	213	18	217	05	214	10	215	12	210	06	210	09	210
H8	11	322	18	321	05	322	10	323	12	323	06	321	09	322
H9	11	239	18	239	05	239	10	241	12	238	06	237	09	238
H10	10	233	18	232	05	228	09	228	13	223	07	223	09	221
H11	10	235	18	233	05	232	09	231	13	231	07	231	09	230
H12	10	203	18	198	05	202	09	203	13	202	07	200	09	203
H13	10	241	18	240	05	239	09	238	13	237	07	237	09	238
H14	10	245	18	243	05	233	09	235	13	225	07	228	09	236
H15	09	185	18	196	05	214	09	218	13	222	07	226	09	232
H16	09	263	18	262	05	262	09	261	13	262	07	262	09	262
H17	10	247	19	246	05	245	10	246	13	243	07	242	10	241
H18	10	189	19	188	05	182	10	188	13	177	07	175	10	175
H19	10	230	19	229	05	221	10	221	13	214	07	213	10	213
H20	10	230	19	230	05	224	10	225	13	220	07	219	10	218
H21	10	276	19	276	05	277	10	277	13	273	07	273	10	275
H22	10	262	19	264	05	265	10	266	13	263	07	266	10	266
H23	10	213	19	216	05	213	10	217	13	211	07	211	10	212
H24	10	262	19	262	05	261	10	262	13	260	07	259	10	260
H25	10	235	19	234	05	223	10	220	13	205	07	204	10	204
H26	10	250	19	250	05	244	10	244	13	242	07	241	10	240
H27	10	253	19	253	05	245	10	244	13	224	07	226	10	226
H28	09	210	18	211	04	210	09	211	12	210	07	211	10	209
H29	09	180	18	180	04	180	09	181	12	180	07	180	10	181
H30	09	137	18	137	04	137	09	136	12	136	07	135	10	136
H31	10	204	18	207	04	202	10	198	13	191	07	189	10	187
H32	10	204	18	203	04	203	10	204	13	203	07	203	10	204
H33	10	180	18	181	04	179	10	180	13	179	07	177	10	179
H34	10	243	19	248	04	242	10	242	13	240	07	240	10	239
H35	10	304	19	300	05	319	10	325	13	319	07	314	10	309
H36	10	215	19	215	05	213	10	213	13	210	07	211	10	210
H37	10	204	19	205	05	256	10	258	13	256	07	254	10	253
H38	10	230	19	228	05	230	10	229	13	228	07	227	10	227
H39	10	246	19	246	04	246	10	246	13	245	07	245	10	244
H40	10	258	19	258	04	257	10	257	13	255	07	254	10	255
H41	10	211	19	208	04	199	10	198	13	188	07	201	10	185
H42	10	250	19	248	04	248	10	248	13	247	07	247	10	247
H50	—	—	—	—	05	219	10	219	13	212	—	—	10	209
H51	—	—	—	—	05	178	10	178	13	169	—	—	10	165

Table 2–2. Average rod measurements from erosion monitoring in the Kaulana watershed, Kaho'olawe, Hawai'i.

[Avg rod is the average of rod measurements, in millimeters.]

Site	Jan 2007		Sep 2007		Mar 2008		Sep 2008		May 2009		Oct 2009		Mar 2010	
	Date	Avg rod	Date	Avg rod	Date	Avg rod	Date	Avg rod	Date	Avg rod	Date	Avg rod	Date	Avg rod
K1	08	190	17	190	03	191	08	190	11	191	05	189	08	189
K2	08	280	17	281	03	283	08	282	11	282	05	281	08	282
K3	08	260	18	259	03	257	08	259	11	257	06	256	08	258
K4	08	248	18	249	03	246	08	244	11	246	06	245	08	246
K5	09	159	17	158	03	162	08	160	11	157	05	157	08	156
K6	09	294	17	294	03	294	08	294	11	294	05	293	08	292
K7	09	97	17	104	03	97	08	99	11	98	05	100	08	99
K8	09	166	17	170	03	165	08	166	11	165	05	166	08	166
K9	09	241	17	240	04	239	08	239	11	239	05	239	08	238
K10	09	260	17	258	04	259	08	258	11	257	05	256	08	258
K11	09	181	17	180	04	175	08	174	11	169	05	168	08	168
K12	09	191	17	189	04	190	08	190	11	189	05	188	08	188
K13	09	230	17	230	04	228	08	229	11	228	05	229	08	228
K14	09	234	17	235	04	236	08	233	11	233	05	235	08	234
K15	09	217	17	218	04	215	08	215	11	214	05	213	08	215
K16	09	172	17	172	04	172	08	172	11	171	05	171	08	172
K17	09	219	17	217	03	208	09	207	12	194	06	193	09	192
K18	09	329	17	330	03	329	09	329	12	329	06	328	09	328
K19	09	237	17	233	03	226	09	229	12	216	06	217	09	213
K20	09	252	17	252	03	248	09	249	12	249	06	248	09	247
K21	09	273	20	272	04	271	09	271	12	270	06	270	09	270
K22	09	224	20	221	04	221	09	220	12	220	06	218	09	218
K23	09	212	20	214	04	212	09	212	12	208	07	208	09	206
K24	09	194	20	198	04	194	09	194	12	193	07	193	09	192
K25	09	218	19	217	04	218	09	217	12	216	07	217	09	217
K26	09	217	19	218	04	217	09	217	12	217	07	216	09	217
K27	09	244	19	244	04	246	09	245	12	244	07	245	09	245
K28	09	267	19	269	04	269	09	269	12	269	07	268	09	269
K29	08	187	20	187	04	185	09	185	12	186	08	185	09	184
K30	08	173	20	172	04	165	09	165	12	158	06	161	09	161
K31	08	147	20	147	04	141	09	139	12	135	06	136	09	135
K32	08	215	20	214	04	214	09	213	12	213	06	213	09	213
K33	08	167	20	167	04	167	09	166	12	165	06	166	09	166

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