U.S. Department of the Interior

Rainfall, Streamflow, and Water-Quality Data During Stormwater Monitoring, Halawa Stream Drainage Basin, Oahu, Hawaii, July 1, 2000 to June 30, 2001

U.S. GEOLOGICAL SURVEY

Open-File Report 01-256

Prepared in cooperation with the

STATE OF HAWAII DEPARTMENT OF TRANSPORTATION

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Rainfall, Streamflow, and Water-Quality Data During Stormwater Monitoring, Halawa Stream Drainage Basin, Oahu, Hawaii, July 1, 2000 to June 30, 2001

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Abstract

The State of Hawaii Department of Transportation Stormwater Monitoring Program was started on January 1, 2001. The program includes the collection of rainfall, streamflow, and water-quality data at selected sites in the Halawa Stream drainage basin. Rainfall and streamflow data were collected from July 1, 2000 to June 30, 2001. Few storms during the year met criteria for antecedent dry conditions or provided enough runoff to sample. The storm of June 5, 2001, was sufficiently large to cause runoff. On June 5, 2001, grab samples were collected at five sites along North Halawa and Halawa Streams. The five samples were later analyzed for nutrients, trace metals, oil and grease, total petroleum hydrocarbons, fecal coliform, biological and chemical oxygen demands, total suspended solids, and total dissolved solids.

INTRODUCTION

The State of Hawaii Department of Transportation (DOT) Stormwater Monitoring Program Plan (State of Hawaii Department of Transportation, 2000) was started on January 1, 2001, to monitor the Halawa Stream drainage basin, Oahu, Hawaii (fig. 1). The stormwater monitoring program plan was designed to fulfill permit requirements for the National Pollutant Discharge Elimination System (NPDES) program. The stormwater monitoring program plan includes the collection of rainfall, streamflow, and water-quality data at selected sites in the Halawa Stream drainage basin.

This report summarizes stormwater monitoring activities and water-quality data collected by the U.S. Geological Survey as part of the stormwater monitoring program plan. This report presents rainfall and streamflow data collected during July 1, 2000 to June 30, 2001, as well as water-quality data for the period from the implementation of the stormwater monitoring program plan, January 1, 2001, to June 30, 2001. Included with the water-quality data are the descriptions of sampling activities during the 6-month sampling period.

DATA-COLLECTION NETWORK

As part of the ongoing stormwater monitoring program, rainfall, stream-stage, stream-discharge, and water-quality data are collected at selected sites in the Halawa Stream drainage basin (fig. 1). Rainfall data are collected at two sites, the North Halawa Valley rain gage at tunnel (abbreviated to Tunnel rain gage, 212428157511201) and the North Halawa rain gage near Honolulu (abbreviated to Xeriscape garden rain gage, 212304157542201). Stage and discharge data are collected at two sites within North Halawa Valley, at Storm drain C (212353157533001) and at Xeriscape garden streamflow-gaging station (16226200). A third streamflow-gaging station is under construction near the Quarantine station in North Halawa Valley. Rainfall and streamflow data are collected daily using cell phones and modems from the two rain gages and the two streamflow-gaging stations.

Water-quality data are collected at five sites, Bridge 8 (212356157531801), Storm drain C, Xeriscape garden, Quarantine station (16226400), and Stadium (16227100). The Bridge 8 site is located above

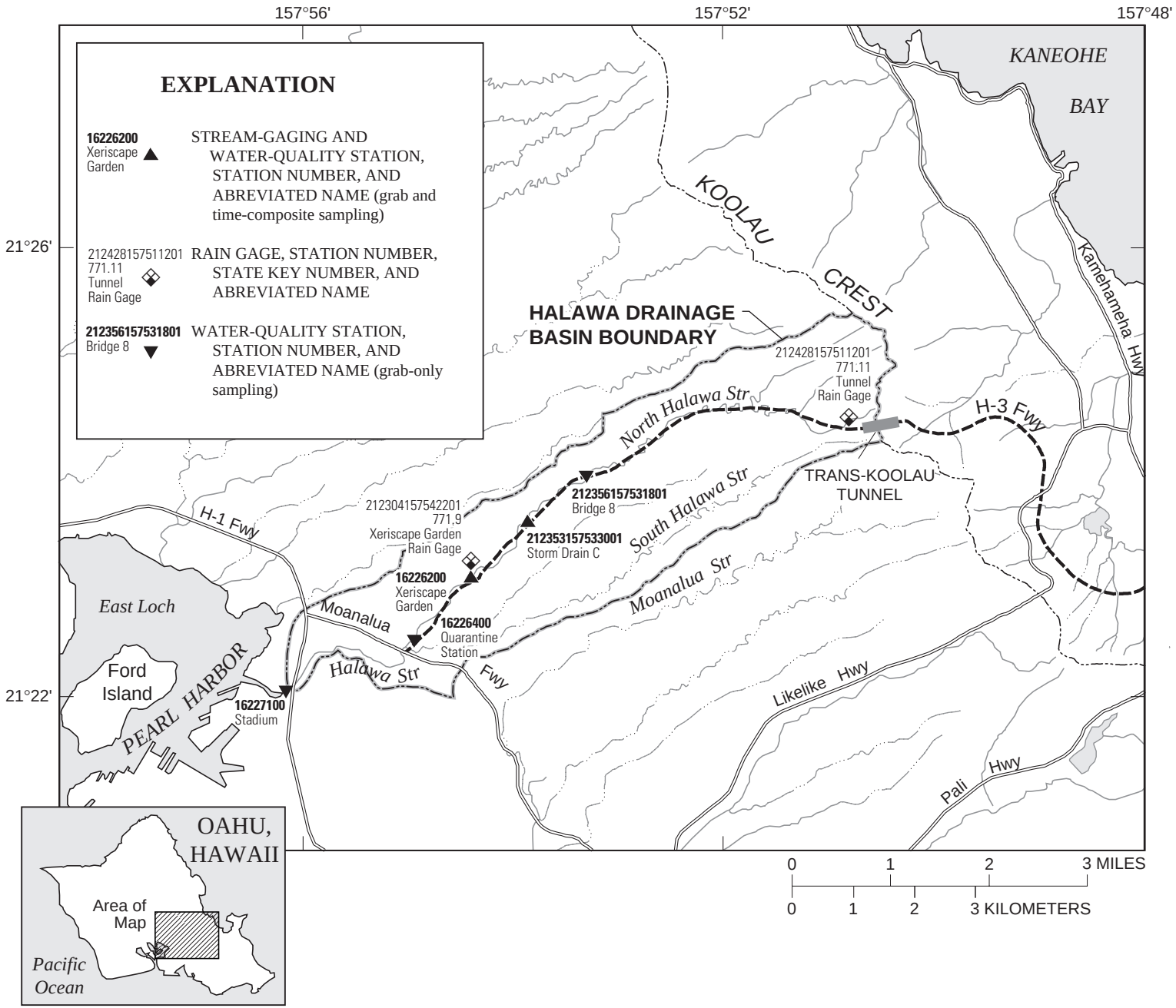


Figure 1. Rain gages, streamflow-gaging stations, and water-quality sampling sites in the Halawa Stream drainage basin, Oahu, Hawaii.

the discharge point of Storm drain C on North Halawa Stream. The Xeriscape garden gage is directly upstream from a light industrial area, the Quarantine station site is within the light industrial area, and both are on North Halawa Stream. The Stadium site is below the confluence of North and South Halawa Streams, downstream from the crossing of H-1 freeway, and directly upstream from the mouth.

Water-quality samples are collected at least once per quarter from the five sites and include both grab and time-composite samples. In general, grab samples are collected manually using isokinetic, depth-integrating methods (Wilde and others, 1998), whereas time-composite samples are collected over a several-hour time period using an automatic (point) sampler. Isokinetic sampling devices are designed with nozzles that allow stream water to enter the sample bottle at the same velocity as the ambient stream velocity. These sampling devices allow for the proper collection of sediment-laden stream water. Storm drain C and Xeriscape garden streamflow-gaging station are equipped with automatic samplers that allow composite samples to be collected from a single point in the storm drain or near the bank of the stream, respectively, for a minimum of 3 hours during the storm. A third automatic sampler is under construction at the Quarantine station site.

RAINFALL AND STREAMFLOW DATA

Hydrographs of daily rainfall and daily mean streamflow data for the period July 1, 2000 through June 30, 2001 are shown in figure 2. The highest daily rainfall at the Tunnel rain gage was 7.3 inches (in.) on August 20, 2000. Other days of high rainfall (daily rainfall above 2.7 in.) at the Tunnel rain gage were July 11, September 27, and October 29, 2000, and February 12, March 31, and June 5, 2001. The highest daily rainfall at Xeriscape garden rain gage was 2.3 in. on March 31, 2001.

For Storm drain C, the highest daily mean discharge, 3.0 cubic feet per second (ft^3/s), occurred on August 20, 2000. Daily mean discharge values greater than 1.5 ft^3/s occurred on three other days within the 12-month period; September 27, 2000, October 29, 2000, and June 5, 2001. At Xeriscape garden streamflow-gaging station, the highest daily mean discharge also was on August 20, 2000, with a value of 129 ft^3/s. Daily mean discharge values greater than 30 ft^3/s also were recorded on October 29, 2000, April 29, 2001, and June 5, 2001.

STORMWATER SAMPLING: CONDITIONS AND RESULTS

During the period January 1 through June 30, 2001, few storms met sampling criteria as outlined in the U.S. Environmental Protection Agency's (USEPA) Storm Water Sampling Guidance Manual (U.S. Environmental Protection Agency, Office of Water, 1993). Only the June 5, 2001 storm was sampled. The February 12, 2001 storm met criteria to sample (fig. 3); however, this storm coincided with a week of instrumentation modifications, and no samples were collected. During April 2001, North Halawa Stream at the Xeriscape garden gage rose to a level high enough to sample on five different days (figs. 2 and 4). These events during April 2001 were not sampled because they did not meet antecedent dry weather criteria as outlined in the USEPA Storm Water Sampling Guidance Manual, which requires that sampling only should be performed on storms that are preceded by at least 72 hours of dry weather. At this gage, the stage that triggers the sampler is 1.24 ft over the stage of zero flow, which has been found by experimentation and previous experience to capture only the larger runoff events.

Hydrologic Conditions During Sampling and Data Collection, Storm of June 5, 2001

Hydrographs of streamflow at Storm drain C and Xeriscape garden during the storm of June 5, 2001 are shown in figure 4. Sample collection times also are displayed in the storm hydrograph in figure 4. Time of sample collection and corresponding discharge at the time of sample collection are listed in table 1. Because of an equipment malfunction, samples were not collected until more than 12 hours after the peak of streamflow. Ideally, samples should be collected as streamflow rises.

Sampling and Discharge Measurement Methods, Storm of June 5, 2001

Only grab samples were collected at five sites during the storm on June 5, 2001. Because of an equipment malfunction, composite samples were not collected at Storm drain C and Xeriscape garden streamflow-gaging station. No field duplicates were collected during this sampling.

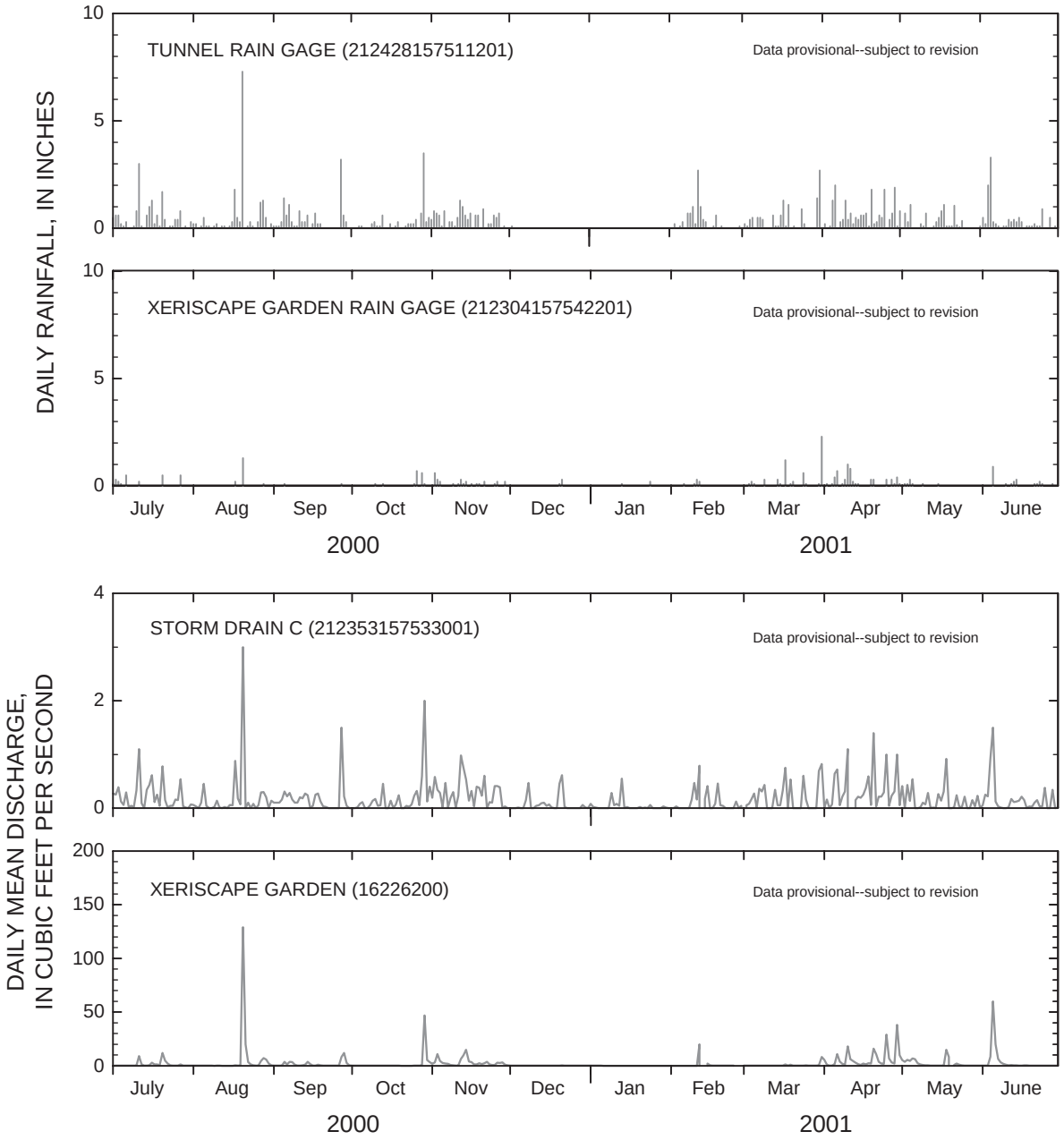


Figure 2. Hydrographs of rainfall and stream discharge for stations within the Halawa Stream drainage basin, Oahu, Hawaii, for July 1, 2000 to June 30, 2001.

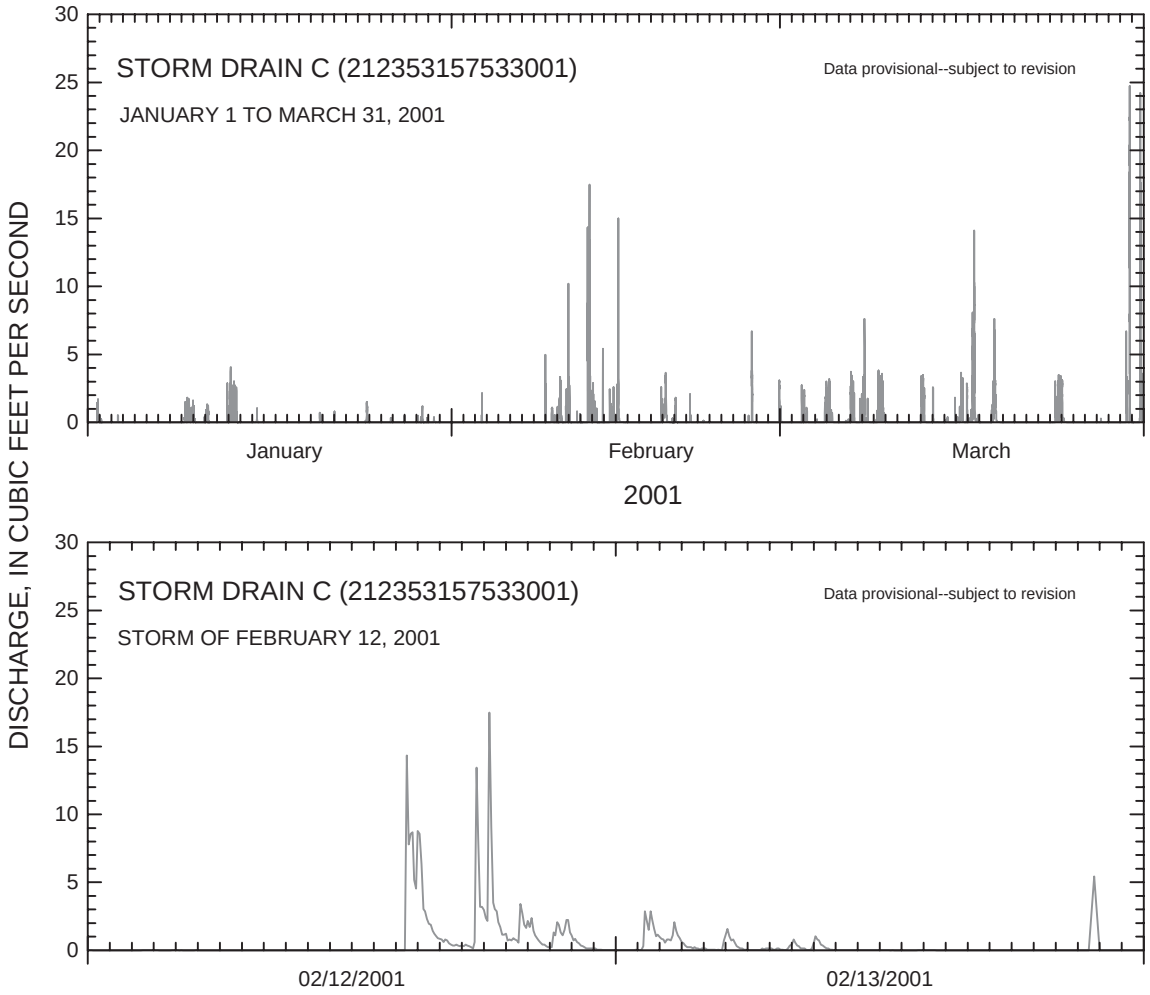
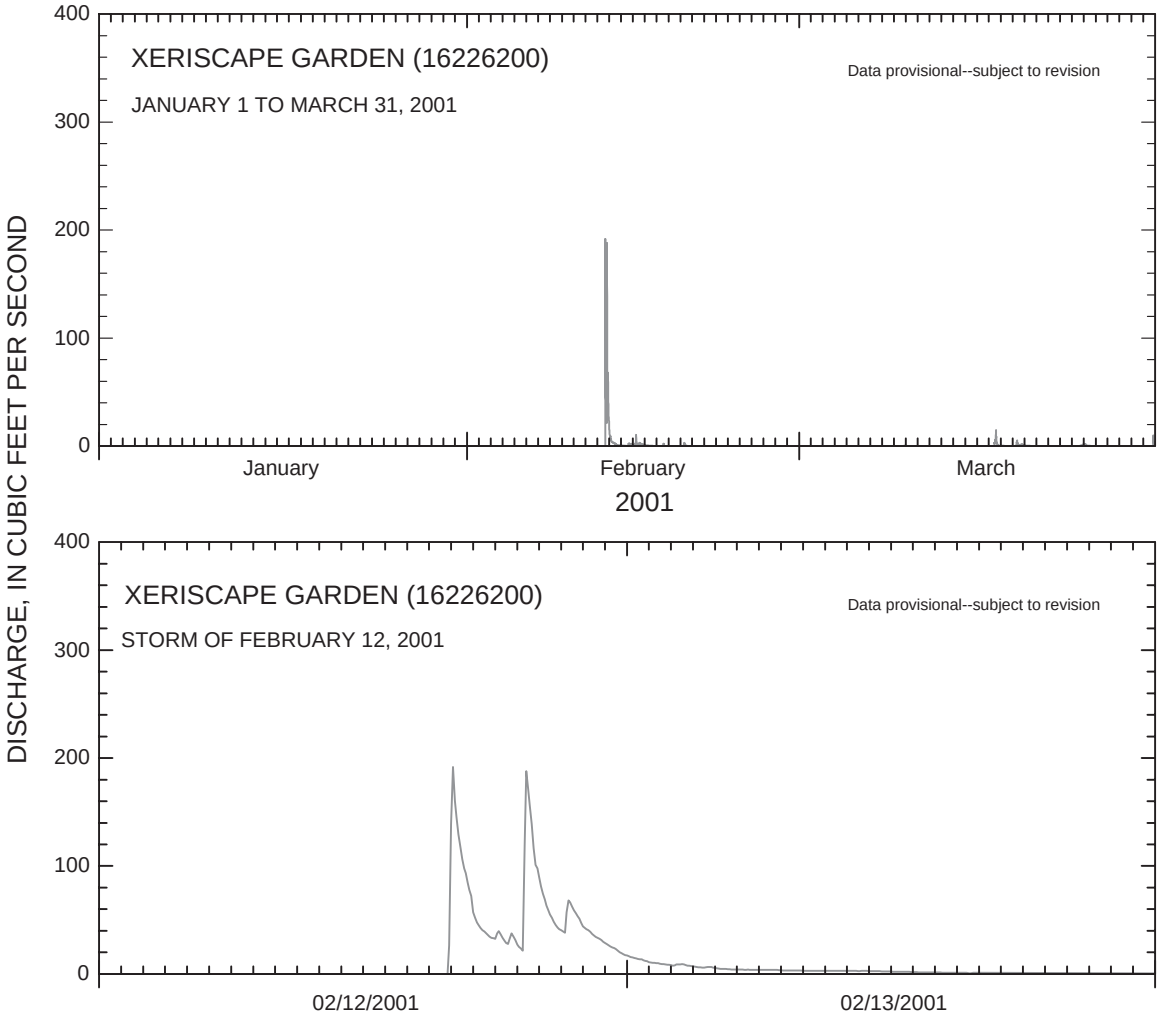


Figure 3. Hydrographs of stream discharge for Storm drain C (212353157533001) and Xeriscape garden (16226200) gaging stations, Oahu, Hawaii, for January 1 to March 31, 2001, and detailed hydrographs of the 2-day period from February 12–13, 2001.



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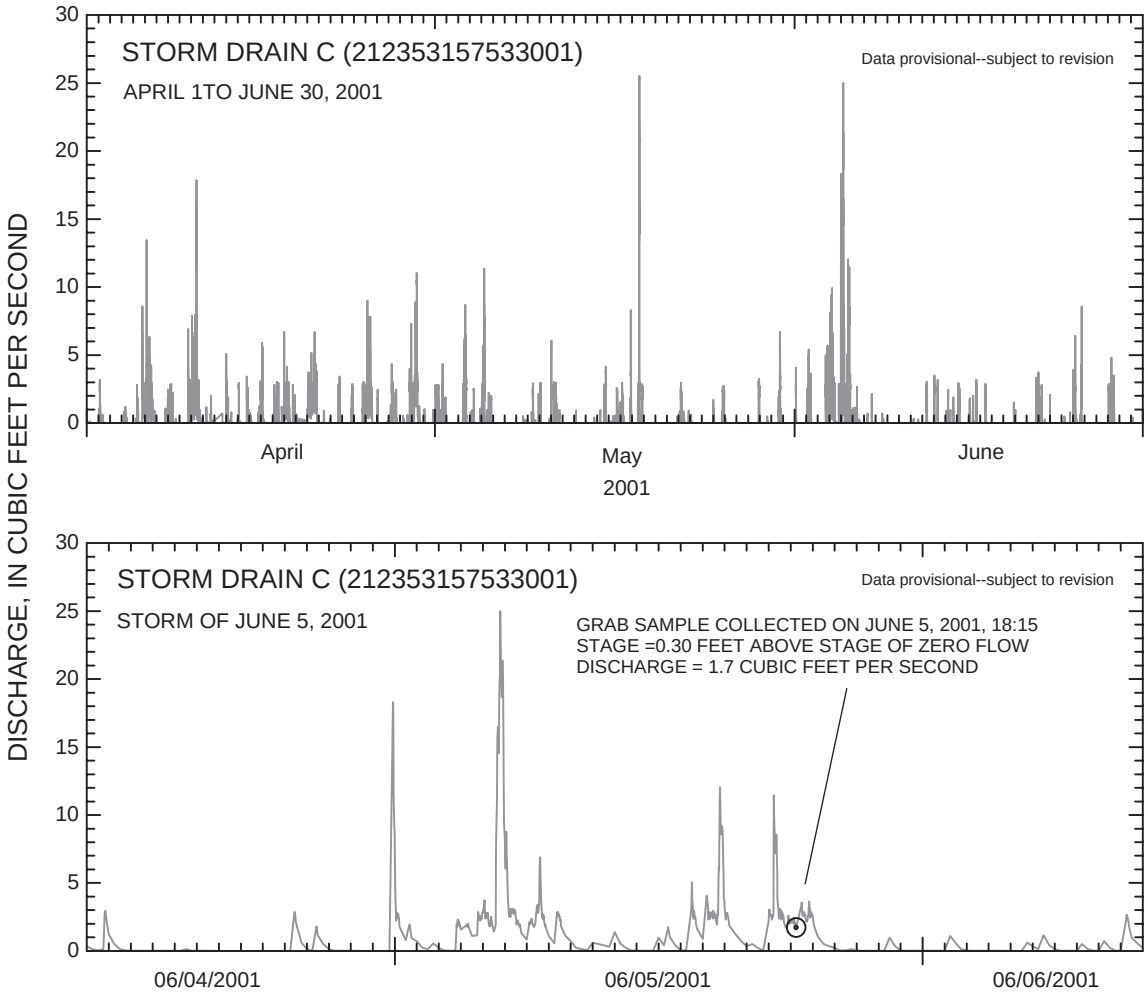

Figure 4. Hydrographs of stream discharge for Storm drain C (212353157533001) and Xeriscape garden (16226200) gaging stations, Oahu, Hawaii, for April 1 to June 30, 2001, and detailed hydrographs of the 2-day period from 10:00 June 4, 2001 to 10:00 June 6, 2001.

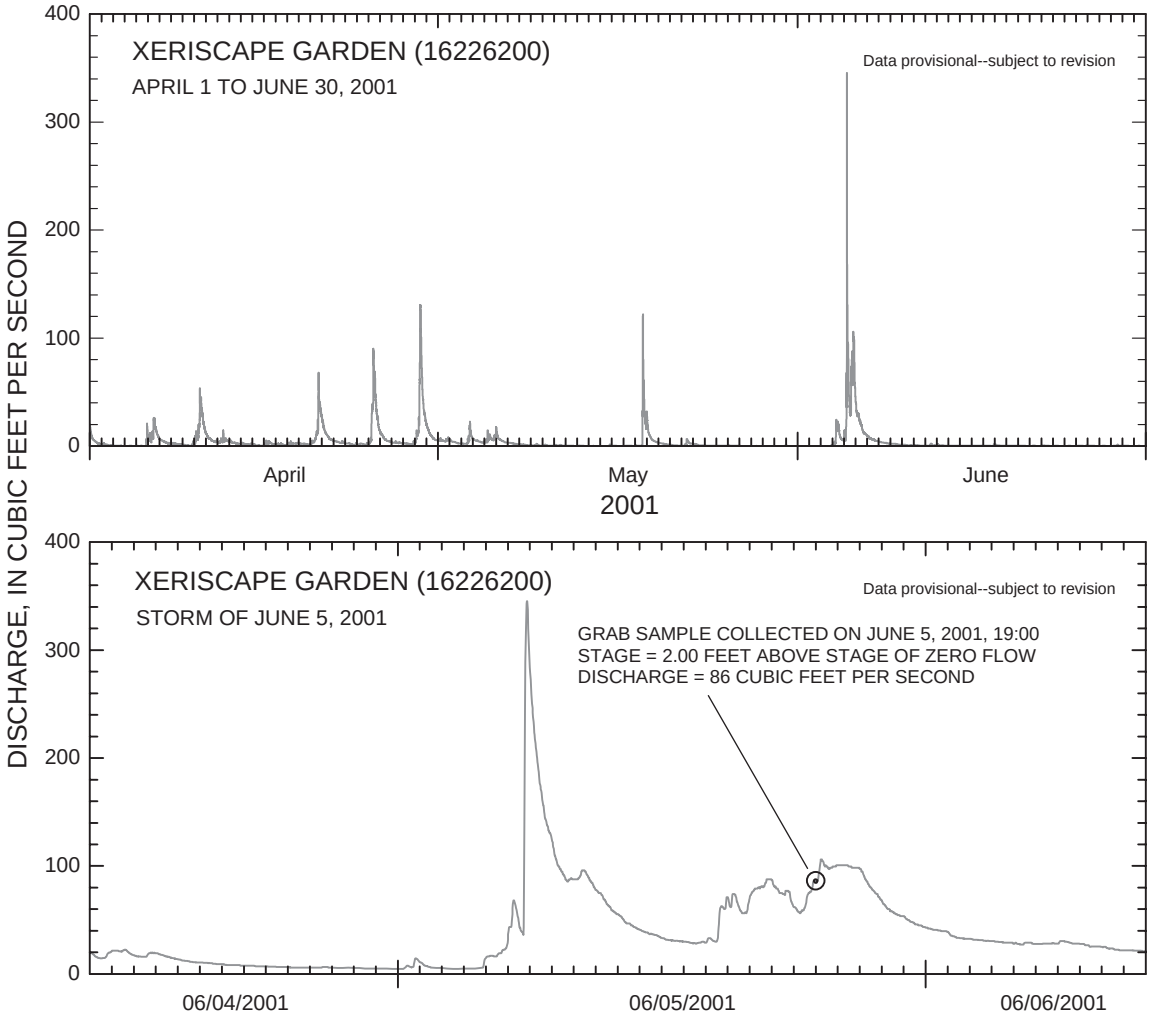

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Table 1. Hydrologic conditions during grab-sample collection, June 5, 2001, Halawa Stream drainage basin, Oahu, Hawaii
Data provisional--subject to revision
[--, no data available; ft^3/s, cubic feet per second]

Abbreviated station name and station number	Time of peak discharge	Peak stage, in feet over stage of zero flow	Peak discharge in ft^3/s	Time of grab-sample collection	Stage at time of grab- sample collection, in feet over stage of zero flow	Discharge at time of grab-sample collection, in ft^3/s
Bridge 8 (212356157531801)	--	--	--	17:15	--	43
Storm drain C (212353157533001)	04:47	1.52	25	18:15	0.30	1.7
Xeriscape garden (16226200)	05:52	3.52	345	19:00	2.00	86
Quarantine station (16226400)	--	--	--	17:20	--	66
Stadium (16227100)	--	--	--	16:05	--	83

Bridge 8.-- Equal-width sampling technique (Wilde and others, 1998) was implemented using five evenly distributed sampling points along the cross section of the stream. Stream width was about 26 ft. A high-density polyethylene (HDPE) isokinetic sampling device was used to collect the sample. Discharge was estimated using float measurement techniques. Discharge was concentrated in the middle 6 feet of the stream cross section.

Storm drain C.--A grab sample was collected at the estimated centroid of flow by submersing the HDPE churn (sample splitting device). Discharge was determined using the instantaneous stage at the time of sample collection and the stage/discharge rating for this gage.

Xeriscape garden.--A grab sample was collected at the centroid of flow using an HDPE 1-liter open-mouth bottle. Discharge was determined using the stage at the mean time of sample collection and the stage/discharge rating for this gage. Sample water from this site also was used for "spiked" analyses of nutrients, metals and chemical oxygen demand.

Quarantine station.--Equal-width sampling technique was implemented using 15 sampling points along the cross section of the stream. Stream width was about 20 ft. An HDPE isokinetic sampling device was used to collect the sample. Discharge was measured using a current meter.

Stadium.--A grab sample was collected at eight intervals spaced 5 to 6 ft apart, using an HDPE 1-liter open-mouth bottle due to the shallow depths and swift-moving water. Stream width was about 64 ft. Discharge measurement was made using a current meter. Sample water from this site also was used for duplicate analyses of nutrients, metals, and chemical oxygen demand.

Analytical Results and Loads, Storm of June 5, 2001

Field measurements of temperature, pH, and specific conductance were measured by personnel. Fecal coliform and biological oxygen demand for the five grab samples were analyzed locally by Aecos Incorporated laboratory, Oahu, Hawaii. All other analyses were completed by the National Water Quality Laboratory, Denver, Colorado.

Table 2 shows temperature, pH, and specific conductance for the five grab samples. Table 3 shows concentrations and instantaneous loads of constituents required by the DOT Stormwater Monitoring Program plan (State of Hawaii Department of Transportation, 2000) for the five grab samples.

Table 2. Temperature, pH, and specific conductance field measurements for grab samples collected on June 5, 2001, Halawa Stream drainage basin, Oahu, Hawaii

Data provisional--subject to revision

[°C, degrees Celsius; µS/cm, microsiemens per centimeter]

Physical property	Unit	Reporting level	Abbreviated station name and number				
			Bridge 8 (212356157531001)	Storm drain C (212353157533001)	Xeriscape garden (16226200)	Quarantine station (16226400)	Stadium (16227100)
Temperature	°C	nearest 0.5°C	21.0	23.0	no measurement	23.0	25.0
pH	pH	nearest 0.1	7.3	6.9	6.9	6.5	8.3
Specific conductance	µS/cm	3 significant figures	88.8	65.6	94.5	101	116

QUALITY ASSURANCE

Field and laboratory quality-assurance and quality-control procedures were implemented as described in the DOT Storm Water Monitoring Program Plan (State of Hawaii Department of Transportation, 2000). Rinsate blanks were collected from the automatic sampler at Storm drain C before and after cleaning on April 2, 2001. The rinsate blanks were analyzed for nutrients, and for cadmium, copper, lead, and zinc. Concentrations of the analytes were at or below the minimum reporting level for the rinsate blank collected after cleaning the sampling lines. For the rinsate blank collected prior to cleaning, only zinc was above the minimum reporting level. The zinc concentration of this blank was 7 mg/L, and the minimum reporting level is 3 mg/L.

REFERENCES

State of Hawaii Department of Transportation, 2000, Storm water monitoring program plan, prepared by Belt Collins Consultants, 45 p.

U.S. Environmental Protection Agency, Office of water (1993), NPDES Storm water sampling guidance manual, prepared by C.K. Smoley, CRC Press, Inc. 165 p.

Wilde, F.D., Radtke, D.B., Gibs, Jacob, and Iwatsubo, R.T., 1998, National field manual for the collection of water-quality data, U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chapter A4, 114 p.

Table 3. Concentrations and instantaneous loads of physical properties and constituents for grab samples collected from Halawa Stream drainage basin on June 5, 2001, Oahu, Hawaii

Data provisional--subject to revision.

[--, no data available; <, actual value is less than value shown, mg/L, milligrams per liter; µg/L, micrograms per liter; MPN/100 mL, most probable number (of colonies) per 100 milliliters; loads reported as lbs/day, pounds per day]

Physical property or constituent	Concentration unit	Instantaneous load unit	Minimum reporting level[a]	Abbreviated station name and number									
				Bridge 8 (212356157531801)		Storm drain C (212353157533001)		Xeriscape garden (16226200)		Quarantine station (16226400)		Stadium (16227100)	
				Conc.	Instant. load	Conc.	Instant. load	Conc.	Instant. load	Conc.	Instant. load	Conc.	Instant. load
Chemical oxygen demand	mg/L	lbs/day	10	20	4,600	10	91	20	9,300	30	11,000	20	8,900
Total suspended solids	mg/L	lbs/day	10	58	13,000	<10	<91	49	23,000	90	32,000	92	41,000
Total dissolved solids	mg/L	lbs/day	10	58	13,000	40	370	76	35,000	82	29,000	86	38,000
Nitrogen, total organic + ammonia[b]	mg/L	lbs/day	0.08	0.78	180	0.16	1.5	0.47	220	0.69	250	0.68	300
Ammonia, dissolved, as N[c]	mg/L	lbs/day	0.04	<0.04	<9	<0.04	<0.4	<0.04	<20	<0.04	<10	<0.04	<20
Nitrogen, nitrite, dissolved, as N[c]	mg/L	lbs/day	0.006	0.007	2	<0.006	<0.05	<0.006	<3	<0.006	<2	0.006	3
Nitrate + nitrite, dissolved, as N[c]	mg/L	lbs/day	0.05	<0.05	<10	<0.05	<0.4	<0.05	<20	<0.05	<20	<0.05	<20
Total nitrogen, as N[d]	mg/L	lbs/day	--	<0.83	<190	<0.21	<1.9	<0.52	<240	<0.74	<260	<0.73	<330
Organic nitrogen, as N[e]	mg/L	lbs/day	--	<0.74	<170	<0.12	<1.1	<0.43	<200	<0.65	<230	<0.64	<280
Total phosphorus, as P	mg/L	lbs/day	0.06	0.11	25	<0.06	<0.55	0.09	40	0.15	54	0.20	90
Dissolved phosphorous, as P	mg/L	lbs/day	0.06	<0.06	<10	<0.06	<0.6	<0.06	<30	<0.06	<20	0.07	30
Total cadmium	µg/L	lbs/day	0.035	<0.035	<0.0081	0.095	0.00087	<0.035	<0.016	0.04	0.01	0.08	0.04
Total copper	µg/L	lbs/day	0.6	3.6	0.83	7	0.06	4.3	2.0	6.6	2.3	9.5	4.3
Total lead	µg/L	lbs/day	1	<1	<0.2	2	0.02	<1	<0.5	1	0.4	3	2
Total zinc	µg/L	lbs/day	1	9	2	34	0.31	9	4	12	4.4	30	13
Oil and grease	mg/L	lbs/day	1	<1	<200	<1	<10	<1	<500	<1	<400	2	900
Total petroleum hydrocarbons	mg/L	lbs/day	2	<2	<500	<2	<20	<2	<900	<2	<700	<2	<900
Biologic oxygen demand	mg/L	lbs/day	1	<1	<200	1	9	<1	<500	1	400	2	900
Fecal coliform	MPN/100mL	billion colonies per day	2	1,700	1,800	800	33	3,000	6,300	5,000	8,100	5,000	10,000

[a] Minimum reporting levels are based on values published by the USGS National Water Quality Laboratory.

[b] Nitrogen, total organic + ammonia is total Kjeldahl nitrogen.

[c] Ammonia, nitrite, and nitrate + nitrite are analyzed from filtrate. In January 1993, USGS National Water Quality Laboratory analyses for total ammonia, total nitrite, and total nitrate + nitrite were discontinued and only dissolved ammonia, dissolved nitrite, and dissolved nitrate + nitrite were analyzed after that date. Values for the total and for the dissolved constituents were statistically indistinguishable (U.S. Geological Survey Office of Water Quality Technical Memorandum 93.04). USGS National Water Quality Laboratory methods for these constituents are different than EPA methods, however, USGS methods have similar or more accurate results.

[d] Total nitrogen is calculated by adding nitrogen, total organic and ammonia (Kjeldahl) to nitrate + nitrite, dissolved.

[e] Organic nitrogen is calculated by subtracting ammonia, dissolved, from nitrogen, total organic and ammonia (Kjeldahl).