PREPARED IN COOPERATION WITH THE
HAWAII STATE DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF WATER AND LAND DEVELOPMENT

INTRODUCTION

Between 1931 and 1965, about 5,000 acres of sugarcane land was converted to other uses—principally, pineapple cultivation, and military, urban, and industrial use. This report relates changes in land use to changes in the basal water supply.

The basal water consists of a freshwater body, a transition zone, and the underlying sea water (geochemical section, sheet 2) contained in the basaltic aquifer. The fresh water grades both horizontally and vertically into the underlying sea water, but a thick section of poorly permeable coastal-plain deposits (generalized geologic section) effectively isolates the basal water from the Pacific Ocean. Wells, shafts, and springs located along the north shore of Pearl Harbor draw water from the gradational transition zone. The chloride concentration of the water that is discharged depends on the position and depth of the well or shaft in the transition zone, and on any changes in extent or salinity of the transition zone. These changes, for the most part, are related to changes in either recharge to or discharge from the basal-water supply.

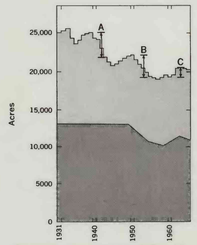
This report was prepared to document the changes in (1) land use, (2) ground-water recharge and discharge, and (3) chloride concentration of the basal water.

LAND USE

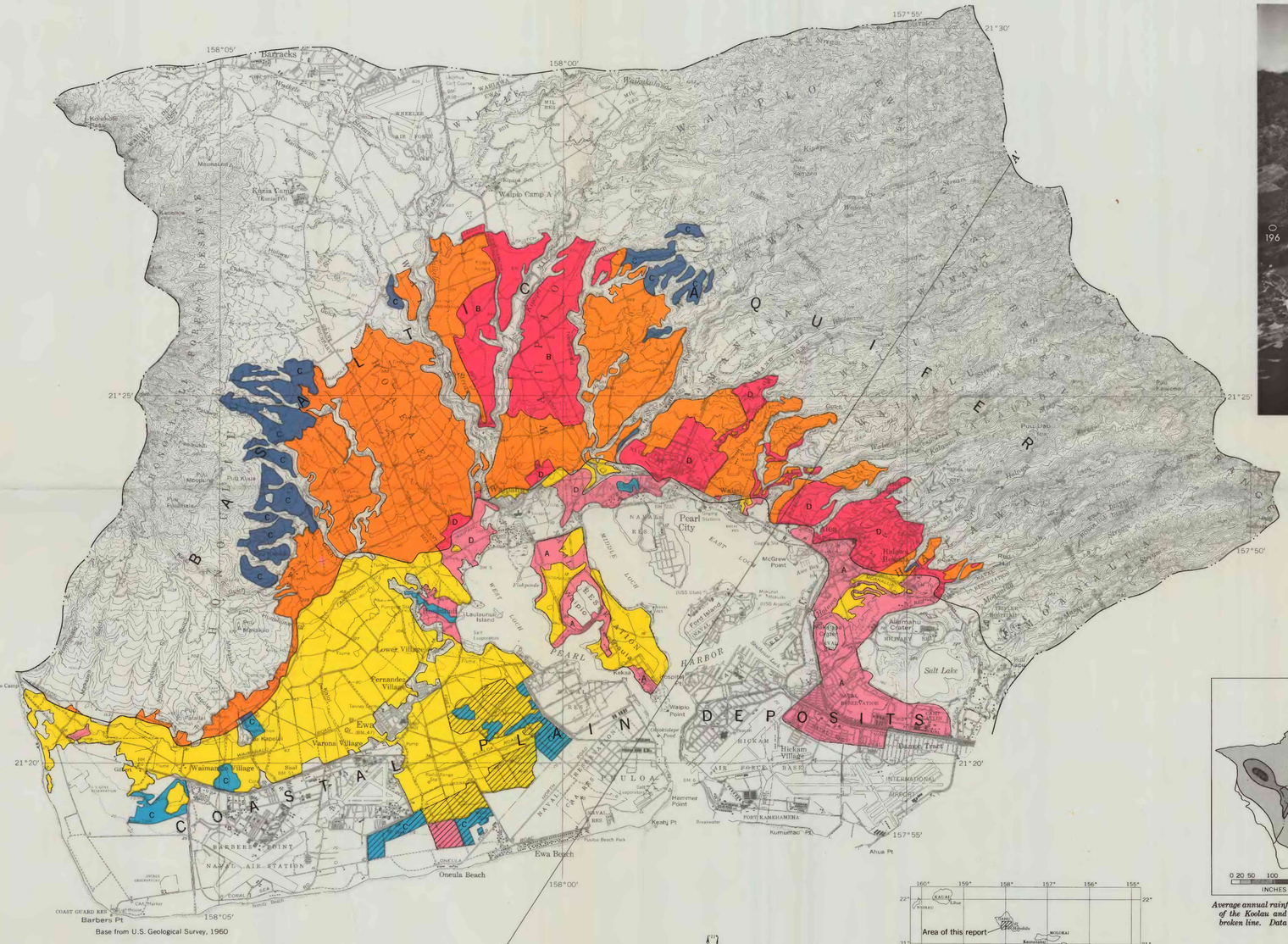
Of the 100,000 acres in the Pearl Harbor area, 25,000 acres was planted to sugarcane in 1931. By 1965 sugarcane acreage had been reduced to 20,000 acres. Three periods of reduction and one period of addition in acreage resulted in the net decrease of 5,000 acres. Between 1939 and 1944 about 3,000 acres on the coastal plain was converted to military use (A). Between 1950 and 1955 about 2,000 acres on the basaltic aquifer was converted to unirrigated pineapple (B). Between 1960 and 1962 about 2,000 acres, mainly on the basaltic aquifer, was converted from unimproved land to sugarcane cultivation (C). And, between 1949 and 1964 about 2,000 acres, mainly on the basaltic aquifer, was converted to urban and industrial use (D).

Changes in sugarcane acreage

Change	Date of change	Acreage change	
		Total	Basalt outcrop area
A	1939–1944	−3000	0
B	1950–1955	−2000	−2000
C	1960–1962	+2000	+1500
D	1949–1964	−2000	−1500
Net change		−5000	−2000



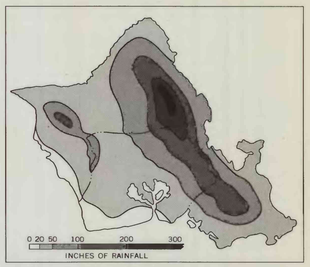
Sugarcane acreage, 1931–65. A, B, and C refers to major changes in land use.



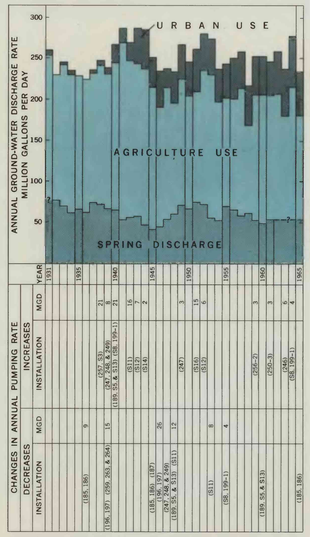
IRRIGATED LAND USE

Aerial photograph of Pearl Harbor, 1951

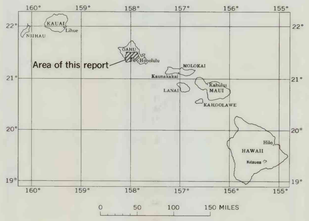
Rainfall infiltrating near the crest of the Koolau Range originally discharged at Kalauao and other springs that border the north shore of Pearl Harbor. Since the beginning of the century, wells and shafts have been constucted to divert this ground-water flow before it is wasted to the sea. The water was first used mostly to irrigate sugarcane, but in recent years land and water use has been progressively changing from sugarcane to urban. The Aiea development in the center of the picture had recently been completed when this photograph was taken.



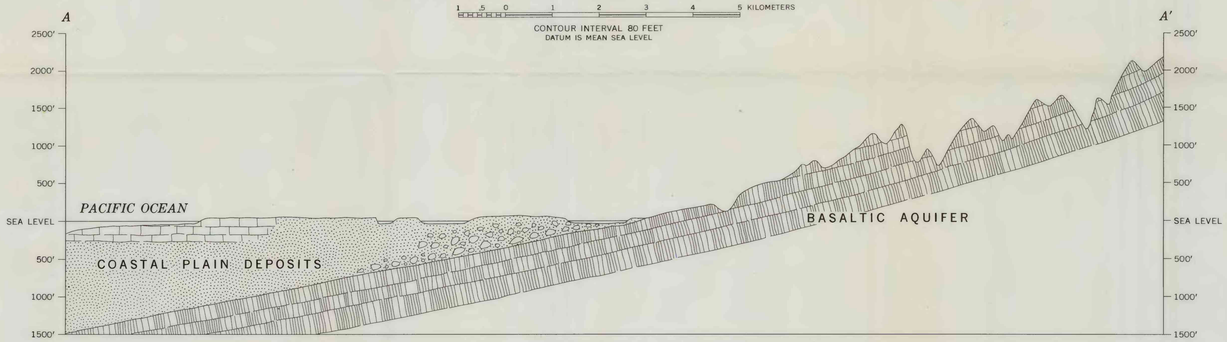
Average annual rainfall on Oahu. The maximums occur near the crest of the Koolau and Waianae Ranges. Project area is outlined by broken line. Data from Honolulu Board of Water Supply (1963).



Ground water discharge rate, 1931–1965. Numbers in parentheses refer to the individual pumpage diagrams on sheet 2. Shafts are prefixed on this table with S.



INDEX MAP SHOWING AREA OF THIS REPORT



GENERALIZED GEOLOGIC SECTION

Poorly permeable coastal plain deposits overlie the highly permeable basaltic aquifer

EXPLANATION

IRRIGATED LAND USE 1931 TO 1965

Sugarcane — Withdrawn from sugarcane — Added to sugarcane

Darker colors indicate land overlying outcrop area of the basaltic aquifer. Ruled areas are not irrigated by water from the basaltic aquifer

MAJOR CHANGES IN LAND USE

A : Sugarcane to military use
B : Sugarcane to pineapple cultivation
C : Unimproved land to sugarcane
D : Sugarcane to urban and industrial use

Contact between coastal plain deposits and basaltic aquifer

Basin boundary

GROUND-WATER RECHARGE AND DISCHARGE

Recharge and discharge quantities are expressed as an average daily rate. Throughout the period 1931–65 the estimated average daily ground-water discharge rate was approximately 250 mgd (million gallons per day). This is equivalent to 45 inches of recharge over the basaltic-aquifer outcrop area.

RECHARGE

Recharge to the ground water is by direct infiltration of rain principally in the Ewa Forest Reserve, and by infiltration of irrigation water applied in excess of plant requirements on the outcrop area of the basaltic aquifer.

The average annual rainfall rate for the entire area ranged from 250 to 500 mgd, and averaged 400 mgd for the period of this study. Annual rainfall in excess of 200 inches occurs in the Ewa Forest Reserve, whereas less than 20 inches falls on the southwestern part of the Coastal Plain. An estimate of the percentage of rainfall that infiltrates to the basal-water supply is beyond the scope of this report. Of importance to this report is the order of magnitude of the potential infiltration.

Infiltration of irrigation water applied in excess of plant requirements on the basaltic aquifer was determined as the residual between water applied and potential transpiration. The average annual irrigation water applied was 9.3 feet for the 35-year period. Transpiration by sugarcane, based on an evaporation pan to lysimeter ratio of 1 to 1 (Campbell, Chang, and Cox, 1959, p. 643), is 5.8 feet per year. Infiltration, as a residual quantity, is 3.5 feet per year. Estimated infiltration from irrigation water from 1931 to 1949 was 40 mgd.

In 1959 the minimum estimated agricultural acreage on the basaltic aquifer was 10,000 acres. Estimated infiltration for that year was 30 mgd.

DISCHARGE

Overall, ground-water discharge has been at a nearly constant rate of 250 mgd. On the basis of use, this discharge can be divided into three components—spring discharge, agricultural use, and urban use.

Spring discharge is used primarily for industrial cooling and small watercress farms, with a large part of the discharge flowing unused into Pearl Harbor. The estimate of the total spring discharge was made by correlating short-term records of the various springs around Pearl Harbor with the long-term record of Kalouao Springs (sheet 2). The discharge of these springs has ranged from 40 to 75 mgd.

Agricultural pumpage is the summation of 19 pumping installations used to supply water for sugarcane (sheet 2), plus 10 mgd from flowing wells near Waiawa Springs. The discharge of these wells has ranged from 110 mgd in 1958 to 220 mgd in 1941.

Urban use includes the water used for domestic, industrial, and military supply. Total discharge consists of the summation of 8 installations (sheet 2) plus several installations of less than 1 mgd capacity. Discharge of these wells has increased from 10 mgd in 1931 to 50 mgd in 1965.

Changes in average ground-water discharge rate, in million gallons per day, between 1931 and 1965

	1931–32	1964–65	Changes
Spring discharge	70	60	−10
Agricultural use	170	140	−30
Urban use	10	50	+40
Total	250	250	
Infiltrated irrigation water	−40	−30	
Net ground-water discharge	210	220	+10

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—1967—W67155

LAND USE AND ITS EFFECT ON THE BASAL WATER SUPPLY, PEARL HARBOR AREA, OAHU, HAWAII, 1931–65

By
R. H. Dale

1967

For sale by U.S. Geological Survey, price $1.25 per set