INTRODUCTION

The practice of using the land for onsite disposal of wastes is growing in the Hawaiian Islands, owing mostly to extensive land developments far from existing sewer facilities and partly to the prohibitively high cost to the private developer of ocean disposal, which calls for multistage treatment plants and ocean outfalls to meet water-quality standards of receiving waters.

The success of onsite waste-disposal practices and the degree to which such practices influence the usefulness of ground-water resources depends in large part on the geologic and hydrologic environments underlying the waste-disposal sites. This report outlines the general geologic and hydrologic conditions that are characteristic of the Hawaiian Islands, considers known and inferred relations between waste disposal and ground-water aquifers, and evaluates some of the chemical results that may follow from onsite disposal practices. The report further deals with the specific situations on the islands of Hawaii, Kauai, Maui, and Oahu with respect to local geology and hydrology, the waste-disposal sites and methods used, land-use practices, and the effects on ground-water quality that have been observed or that can reasonably be inferred from known chemical and hydrologic principles.

This report also shows the scope of the present and planned future practices of subsurface and surface disposal of wastes as of December 1972. There is a compilation of information on the type of wastes, disposal methods and sites, receiving aquifers, and related water quality. Information concerning areas in sugarcane cultivation is also included because the generally pervious nature of surface-rock types allows leachates from those sources easy access to underlying water bodies.

The information in this report should provide to the public a more complete understanding of waste-disposal practices in relation to island hydrology than has previously been available. The data and interpretations presented should also be of use to planners and decision makers as new uses are made of lands now in cultivation or presently unused.

Field investigations were generally limited to meetings with health and environmental officials of the State, counties, sugar companies, and large private developers on each island. The hydrology and geology of the islands, as outlined in this report, are based on published reports and on records on file with the U.S. Geological Survey.

The author wishes to acknowledge the assistance and cooperation of many individuals and organizations, both private and governmental, who freely gave their time in providing information relating to the disposal of wastes in the Hawaiian Islands. Special thanks are given Mr. Ralph K. Yukumoto, Acting Chief, Sanitary Engineering Branch of the State Department of Health, and Messrs. James Nakahara, Noboru Takamura, and Sam Goo, chief sanitarians of the State Department of Health in Hawaii, Kauai, and Maui Counties, respectively.

GEOLOGIC AND HYDROLOGIC ENVIRONMENT

Liquid waste injected into the subsurface, or the leachate from waste deposited on the land surface behave nearly the same as recharge of rainwater and runoff into the subsurface. They all move through and saturate the same rocks under the same conditions. Therefore, the geologic and hydrologic environments must be understood if hydrologic problems related to the subsurface disposal of waste are to be identified.

The Rocks and their Water-Bearing Properties

The Hawaiian Islands are the tops of shield volcanoes in the Pacific Ocean. Each of the major islands consists of one to five volcanic domes, the bulk of which are composed of thousands of generally thin-bedded, highly vesicular, basaltic lava flows. Structural features associated with them, such as clinker sections, voids between flow surfaces, and shrinkage joints and fractures, make these volcanic deposits highly porous and pervious. The lavas emanated in repeated eruptions from narrow zones of fissures associated with each volcano. When eruption ceased, lava remaining in the fissures was quickly chilled by the surrounding rock and filled the fissures with narrow vertical sheets of rock with low permeability, called dikes. This rock assemblage of highly permeable lava intruded in part by dikes of low permeability makes up the principal aquifer in the Hawaiian Islands.

Some eruptions near the seashore were moderately explosive because of the steam formed when hot magma encountered ground water close to land surface. In these eruptions, the magma (molten rock) was exploded into tiny fragments and droplets, which hardened in the air to form particles of glassy volcanic ash. The larger fragments fell close to the vent but the finer material was scattered widely, and when covered by subsequent lava flows, formed extensive sheets of material less permeable than the lavas.

Commonly, the top of the shield volcano collapsed and produced a depression or caldera. Lavas that ponded in the calderas are thicker, more massive and much less permeable than those that were extruded on the flanks outside the calderas.

Typically, the earlier-formed basaltic shield volcano is totally capped and buried by more siliceous lava flows of andesite. The andesitic flows are more viscous than the basaltic flows and are consequently thicker and more massive and less permeable. The structural features generally associated with the highly permeable basaltic flows are much less extensive in the andesitic flows. In the principal islands, the andesite cap is absent from basaltic flows that make up the Koolau, Kilauea, and Mauna Loa volcanoes. Some volcanoes have, in later stages, erupted basalts which are less siliceous than the early basalts, as well as trachytes which are even more siliceous and viscous than the andesites.

The andesitic flows, although widespread, do not generally extend below sea level except near the coast. They are less permeable than the basaltic flows and, except locally, are not important aquifers. The later basaltic lava flows are not extensive below sea level. They, too, are not important aquifers except locally.

There are isolated deposits of alluvium and talus in the lower and middle reaches of stream valleys but most sedimentary deposits, both terrestrial and marine, are in the coastal plain. Marine sediments consists of coralline limestone and sand derived from coral and sea shells. Owing to past changes in sea level, marine sediments can occur some distance below or above the present level of the sea. Terrestrial sediments consist of talus, older and younger alluvium, and clay. Older alluvium is moderately to well consolidated, is weathered in its entirety, and mainly consists of silt and clay. Younger alluvium consists largely of reworked older alluvium in and near stream channels and is generally poorly consolidated.

The permeability of the sediments is variable, ranging from nearly impermeable for clay to highly permeable for beach sand and coralline limestone. Clay and weathered lava constitute a mass of rock that is much less permeable than fresh lava. The combination of the clay in the clay beds, which are interbedded with calcareous sediments in many places, and weathered lava is locally known as caprock and commonly forms artesian conditions in underlying fresh lava.

A diagrammatic cross section showing the geologic structure of a typical Hawaiian volcanic island in the form of an idealized volcanic dome is shown (fig. 1, sheet 1). The stratigraphy and water-bearing properties of the principal rock units are summarized and distribution of the rocks are shown on geologic maps of each island prepared for bulletins published by the Hawaii Division of Hydrography. The bulletin number for each island is shown on the map of the Hawaiian Islands (fig. 2, sheet 1). The geologic units used in this report are simplified to differentiate only volcanic rock, alluvium, and calcareous sediments.

Ground-Water Occurrence and Development

Ground water occurs as basal water, as dike-impounded water, and as perched water. Ground water in dike-free rocks outside the eruptive zones occurs as basal water, the fresher part of which forms a lens-shaped body floating on saline ground water whose salinity approaches that of sea water. Where permeable rocks are overlain by caprock material in coastal-plain areas, basal-water bodies occur under artesian conditions and are commonly several hundred feet thick. Where caprock material is absent, basal-water bodies are thin, are generally brackish near the coast, and occur under water-table conditions. Basal-water bodies provide most of the ground water developed in the Hawaiian Islands.

Dike-impounded ground-water bodies occur mostly in dike-intruded lava flows and occasionally in other rock types within the eruptive zones. Occurrence of these bodies in calcareous sediments is not known in the Hawaiian Islands. Because they occur and are easily developed at the higher altitudes, they provide important sources for gravity-flow domestic and irrigation-water systems. The natural discharge from dike-impounded water bodies provides the base flow of many large perennial streams.

Ground-water bodies perched above dike-impounded and basal-water bodies are common in Hawaii. Most, however, are small and quickly drained after rains. The perching members are weathered ash, weathered lava surfaces, soil, or any poorly permeable horizon interbedded in lava flows, cinders, calcareous sediments, or other permeable rocks. Many perched water bodies have been developed by tunneling and provide important sources of water, especially at high altitudes in isolated places.

A diagrammatic cross section showing occurrence and development of ground water in an idealized Hawaiian volcanic dome is shown (fig. 3, sheet 1).

Ground-Water and Related Waste-Water Circulation

Most recharge to ground water occurs in the wet interior mountains, generally upgradient from lower-lying developed land areas where waste disposal is more likely to occur. This natural deterrent by position of the recharge area has so far kept much of Hawaii's ground water in its pristine quality state. As land developments encroach toward the recharge areas, some deterioration of the ground water is to be expected--the degree of which will depend greatly on onsite waste-disposal practices.

Recharge to basal-water bodies in volcanic rocks is from leakage or underflow of dike-impounded and perched-water bodies, rainfall, percolation of streamflow, and infiltration of irrigation water. Where the basal-water body occurs in sedimentary material, recharge also occurs by underflow from basal-water bodies in volcanic rocks. Owing to the extensiveness of basal ground water, especially at the lower and middle altitudes where most residential and agricultural developments take place, basal-water bodies are the chief recipients of wastes and leachates from wastes disposed of on land or in the subsurface. Away from the coast and coastal-plain deposits, basal water generally occurs under water-table or unconfined conditions in volcanic rocks. In these areas, any waste injected into or placed on the ground may be received by the underlying basal-water body.

In the coastal plain where basal water in the volcanic aquifer is confined and under artesian conditions, waste injected at or near the surface is mostly intercepted by permeable horizons in the confining coastal-plain sediments.

Except where confined, basal ground water in a volcanic or sedimentary aquifer discharges naturally at about sea level at or near the shore. It is likely then that any waste received by the basal-water body would likewise be similarly discharged. Possible contamination of beaches and nearshore areas then becomes the main concern regarding subsurface disposal to the basal-water body in low-lying areas and in the coastal plain.

Recharge to dike-impounded water bodies is mostly by rainfall and by percolation of streamflow. If perched-water bodies overlie dike-impounded water, recharge is also from leakage of perched water. Because urban and agricultural developments are few in the eruptive zones, which are mostly at high altitudes, dike-impounded water bodies are generally not recipients of waste.

Perched ground-water bodies occur at all altitudes. They are recharged by rainfall, percolation of streamflow, and infiltration of irrigation water. They may be recipients of waste disposed on or in the overlying rocks. Discharge of perched water is to the surface, or by leakage to dike-impounded or basal-water bodies.

Ground-Water Storage Related to Waste Disposal

Most ground water in Hawaii is stored in volcanic rocks. The top of the volcanic reservoir extends to an altitude of several thousand feet in perched and dike-impounded ground-water bodies. The bottom of dike-impounded water bodies is not known, but probably extends to some great depth below sea level, where rock permeability becomes nil. The amount of stored water is greatest in dike-impounded water bodies in rift zones and in thick basal-water bodies in the interior of islands or underlying coastal-plain areas under artesian conditions.

Stored fresh water is significantly less near the coast in thin unconfined basal-water bodies in permeable volcanic rocks. Stored water is small in sedimentary rocks because saturated rock volume is small and ground water occurs mostly in thin basal-water bodies. These water bodies underlie low-lying developed areas and are most susceptible to deterioration by the disposal of waste in the subsurface. These bodies are not used as a source of domestic water at present, but waste injected into them is nevertheless of concern. Owing to their proximity to the coast and their small volume and thickness, waste injected into these water bodies is likely to spread laterally and eventually discharge at the coast.

Summary of Rock Types and their Characteristics for Receiving Wastes

The rock types and their characteristics for receiving wastes, their advantages and disadvantages, and the ground-water bodies affected by the disposal of waste into the subsurface are summarized in table 1, sheet 1.

LAND USE AND WASTE DISPOSAL

Land Development and Waste-Disposal Practices

Much of the early land development went unsewered and was located along low-lying nearshore areas and in coastal plains, where the underlying ground water was generally brackish or, when fresh, was often confined in volcanic aquifers overlain by sedimentary rocks. Sewage disposal was mostly by covered, partially-lined cesspools, and the practice was generally successful owing to the low housing density. Little attention was given to the sewage after it entered the ground. As sewage volume increased with more dense developments more areas became sewered, mainly because cesspool failures became more common but partly because of growing concern for possible pollution of the underlying water bodies. Most of the sewered waste was untreated and disposed of through ocean outfalls.

There were few industrial waste products other than those from the cultivation and processing of sugarcane and pineapple. Most of the liquid waste from the sugar operations was discharged to sea. Some wastes from pineapple cannery operations were discharged into nearby canals and streams.

The most common method for solid waste disposal was by open burning in scattered dumps throughout the State. Incineration and landfill gradually replaced open-burning dumps in most localities on Oahu.

Land Development and Waste-Disposal Practices, as of December 1972

Waste disposal is a growing environmental problem in Hawaii because of rapid and intensive urban growth and a lag in the installation of satisfactory disposal measures to cope with the increasing volume of waste accompanying this growth.

The adoption of surface-water quality standards for Hawaii and the growing concern of many people about pollution to the nearshore environment caused onsite land disposal of waste to be more frequently considered, especially as the cost of ocean outfalls becomes almost prohibitive to most developers. For the interim period until publicly financed sewage-treatment plants and disposal measures that meet regulations are put in operation, most planners and developers plan to utilize the land for the onsite disposal of wastes. Some of the larger developers have installed secondary sewage-treatment plants but most systems are less sophisticated and range from cesspools and septic tanks to small, packaged aerobic sewage-disposal units. Some of the sewage effluent, especially that from the secondary treatment plants, is reused for irrigation but most is disposed of through injection wells or by discharging to stream channels. However, the Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500, includes provisions relating to the pollution of ground water, and new State controls governing the treatment of wastes and their onsite disposal on land will probably be forthcoming.

The increase in subsurface disposal of wastes, especially of inadequately treated sewage, is of growing concern to health officials and water developers. In inland areas, the concern is for the possible contamination of potable water supplies; and in nearshore disposal areas, the concern is for the possible pollution of beaches and with regard to presently unknown effects on the offshore environment.

A small but significant growth of industry has accompanied the extensive urbanization. Industrial wastes and their disposal problems are concentrated mostly on Oahu. In the sewered areas, industrial waste is accepted into the sanitary sewer system subject to restrictions set by the municipality as to volume, temperature, acidity, toxicity, and composition. Municipal storm sewers generally carry only runoff and drainage from rain and ground-water seepage. Industrial wastes not acceptable to municipal sanitary and storm sewer systems are disposed of into the subsurface through injection wells. In December 1972, none of the industrial wastes were recycled.

On Oahu open burning of solid wastes has been replaced by the landfill method or by incineration except at small private dumps. Open burning still exists on the other islands, but is gradually being replaced by the landfill method. Other contemplated methods of disposal include recycling and ocean dumping. Careful selection and preparation of solid-waste disposal sites is required to prevent the leachate from becoming a source of ground-water pollution.

The growing and processing of sugarcane creates wastes such as cane wash water, excess irrigation water, cane trash, and bagasse. These were commonly discharged to the sea and created offshore and nearshore pollution problems. Since the adoption of water-quality standards for surface water, these problems are becoming both terrestrial and subsurface pollution problems as land disposal replaces ocean disposal.

A summary of potential waste types for land disposal is given in table 2, sheet 1. Disposal methods include subsurface injection by wells, discharge into streams, flooding of unused lands, and irrigation reuse of ponded or treated water. Onsite disposal includes seepage from cesspools and leachate from solid waste-disposal sites, dairies, piggeries, and chicken farms.

State and Local Policy Related to Subsurface Disposal of Wastes, as of December 1972

Much of the present policy governing the practice of subsurface waste disposal derives its authority from statutes first passed by the Legislature of the Territory of Hawaii, Session of 1939. The law, which placed upon the then Territorial Board of Health the responsibility of maintaining precautions necessary for public health, empowered the Board to regulate, supervise, and control all waters within the Territory of Hawaii. This included drainage, water supplies, water systems or plants, sewage-outfall areas, sewage or refuse systems or plants, and sewage or refuse disposal. The State Department of Health, successor to the Territorial Board of Health, grants approval for the method of treatment and the method of disposal of wastes into the subsurface.

Although the authority to govern the practice of subsurface waste disposal is specific, policy problems still exist. There are no established criteria for different environments for the subsurface disposal of wastes, and there is no classification of wastes that could be used to determine their reaction in the subsurface. Criteria related to the environment and classification of wastes for subsurface disposal need to be established, if permit provisions of P. L. 92-500 are to be implemented so as to allow the practice of subsurface waste disposal to be considered as an alternative. Many of the policy problems may then be resolved.

On Oahu, in addition to sanction by the State Health Department, written approval of the Chief Engineer of the Honolulu Board of Water Supply must be obtained for all plans proposing the following waste-disposal facilities:

a. Sewage-disposal systems
   1. Cesspools
   2. Septic-tank systems
   3. Individual household aerobic-treatment units
b. Disposal wells
c. Sanitary landfills
d. Refuse-disposal dumps
e. Sewage-treatment plants
f. Stabilization ponds
g. Any other wastewater-disposal facilities.

This authority was established in 1972 by the Charter of the City and County of Honolulu, which conferred upon the Board of Water Supply the authority to establish rules and regulations to protect, conserve, and regulate the development of water resources within the City and County of Honolulu. As mandated by the Charter, "Rules and Regulations for the Protection, Development and Conservation of Water Resources in the City and County of Honolulu" were adopted by resolution to be effective March 15, 1972.

Need for Baseline Data and Guidelines

The needs of Federal, State, and local governments, of the water manager, and of the consultant-developer for baseline data and guidelines related to the practice of subsurface and surface waste disposal are summarized in table 3, sheet 1.

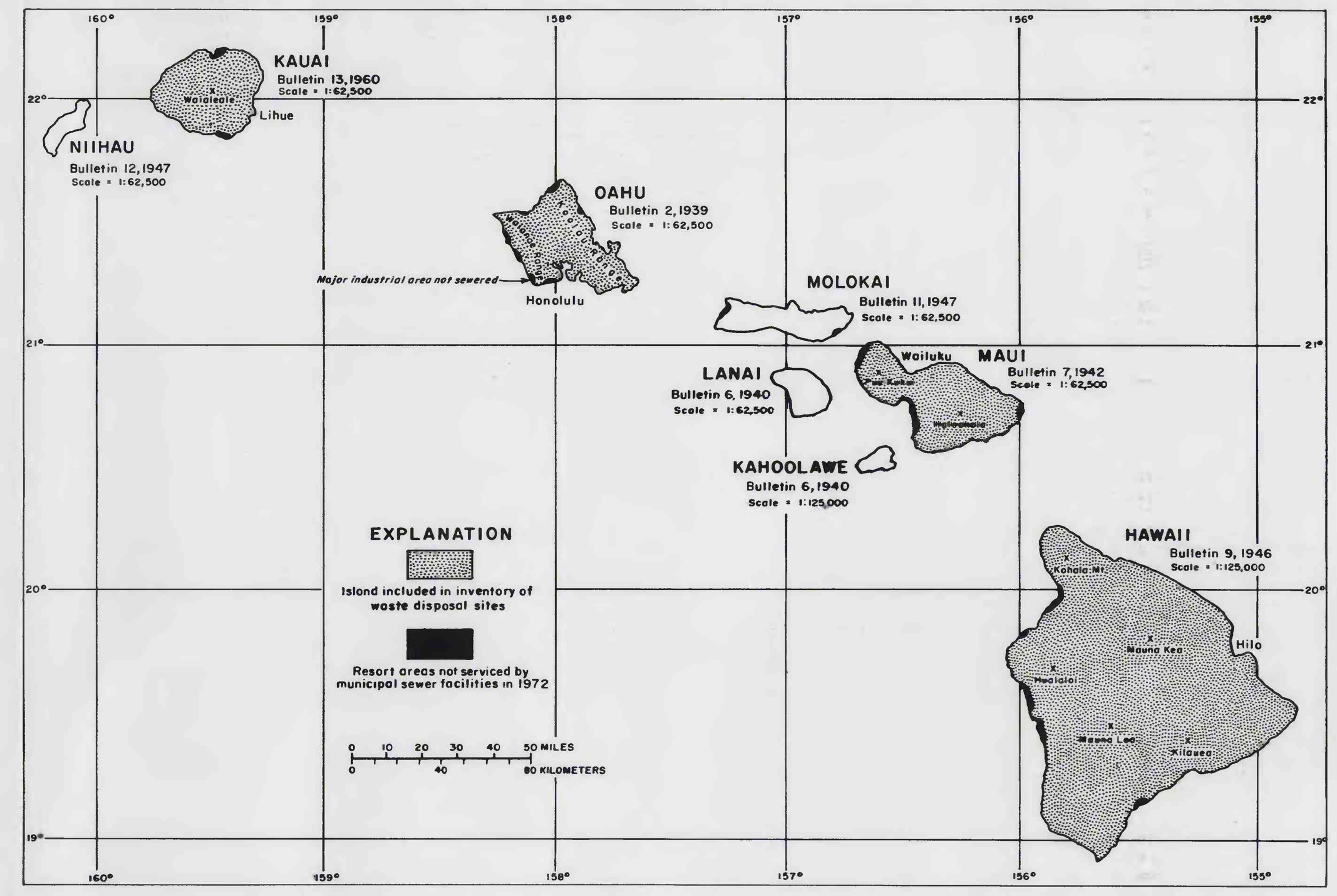

FIGURE 2. MAP OF HAWAIIAN ISLANDS SHOWING ISLANDS INVENTORIED IN STUDY, RESORT AREAS NOT SERVICED BY MUNICIPAL SEWER FACILITIES, AND AVAILABILITY OF GEOLOGIC MAPS IN HAWAII DIVISION OF HYDROGRAPHY BULLETINS.

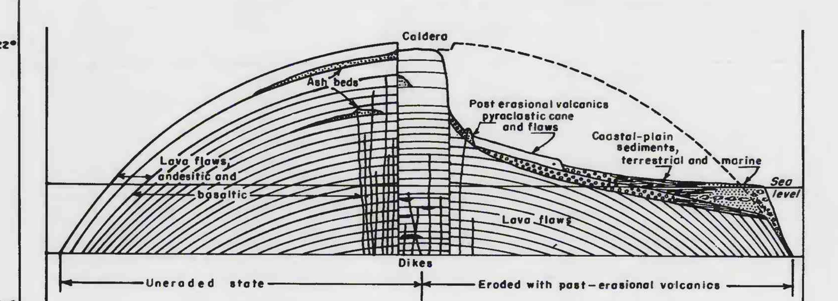

FIGURE 1. DIAGRAMMATIC CROSS SECTION SHOWING GEOLOGIC STRUCTURE OF AN IDEALIZED HAWAIIAN VOLCANIC DOME (AFTER COX, 1954).

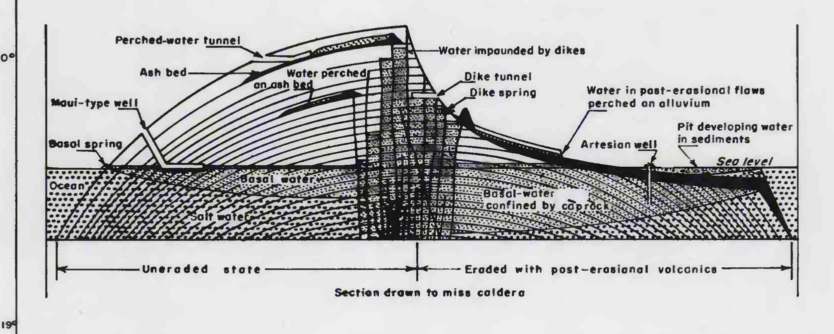

FIGURE 3. DIAGRAMMATIC CROSS SECTION SHOWING OCCURRENCE AND DEVELOPMENT OF GROUND WATER IN AN IDEALIZED HAWAIIAN VOLCANIC DOME (AFTER COX, 1954).

TABLE 1. ROCK TYPES AND THEIR CHARACTERISTICS FOR RECEIVING WASTES

ROCK	PERMEABILITY	ADVANTAGES AS RECEIVING AQUIFER	DISADVANTAGES AS RECEIVING AQUIFER	GROUND-WATER BODY AFFECTED: BASAL	DIKE-IMPOUNDED	PERCHED	OTHER	REMARKS
VOLCANIC ROCKS	Low to high	Great areal and vertical distribution.	Ultimate recipient of all liquid wastes except those intercepted by sediments near coast. Contain most fresh ground water.	x	x	x	Saline	------------------
Basaltic lava flows	High, except where weathered	Great areal and vertical distribution. Where unconfined, contain ground water of high salinity near shore or at shallow depths below the fresh-water lens. Where confined, permeable horizons in caprock intercept wastes.	High danger of pollution to ground water of good quality away from coastal areas. Major aquifer for domestic water sources.	x	x	x	Saline	------------------
Andesitic lava flows	Low to moderate, decreases with weathering	Generally contain ground water of high salinity near shores. Minor aquifer for domestic water sources.	High danger of pollution to ground water of good quality away from coastal areas. Overlie more permeable basaltic lava flows.	x	x	x	Saline	Not extensive below sea level except near coast.
Post-erosional lava flows	Low in trachyte lava flows to high in unponded ultrabasic picritic basaltic lava flows.	Generally contain ground water of high salinity near shores. Minor aquifer for domestic water sources.	High danger of pollution to ground water of good quality away from coastal areas.	x	x	x	Saline	Not extensive below sea level except near coast.
Cinders	High where unweathered	Minor aquifer of limited distribution.	High danger of pollution to perched-water bodies where present.	--	--	x	------	------------------
Ash	Low	Little importance as aquifer.	Will accept only very small quantities of wastes at a very low rate.	x	--	x	------	Acts as perching member and retards infiltration.
SEDIMENTARY DEPOSITS	Low to high	Widespread distribution in heavily developed coastal-plain areas. Generally contain ground water not suitable for domestic supply.	Minor amounts of permeable rock types at the higher altitudes.	x	--	x	Saline	------------------
Coralline limestone	High	Contains ground water of high salinity near shores or at shallow depths below the fresh-water lens. If present in caprock, it intercepts waste and prevents it from infiltrating to underlying volcanic aquifer.	High danger of pollution to good-quality ground water away from coastal areas.	x	--	x	Saline	Recipient of most waste disposed in subsurface in Honolulu area.
Unconsolidated coralline sand deposits	High, low to moderate where consolidated	Generally contains brackish to saline water only.	High danger of pollution to beaches if untreated waste injected in sand near shore.	x	--	--	Saline	Few cesspools or liquid-waste drainage problems.
Unconsolidated younger alluvium	Moderate	Limited importance as source of fresh water.	Limited distribution. Quickly drains after rains. High danger of pollution to underlying water bodies.	x	--	x	------	Usually of adequate permeability for small cesspool seepage.
Consolidated older alluvium	Low	Retards infiltration of wastes, such as leachates from agricultural wastes and solid-waste disposal sites, to underlying water bodies.	Limited distribution. Causes many cesspool and other drainage problems.	--	--	--	------	------------------

TABLE 2. SUMMARY OF WASTE TYPES AND NONOCEAN DISPOSAL METHODS

	DISPOSAL: WELL	STREAM GULLY	IRRIGATION	FLOODING	ONSITE	TREATMENT	REMARKS
Municipal wastes							
Effluent from sewage-treatment plants------------	x	x	x	--	--	Yes	------------------
Effluent from small aerobic sewage-disposal units------	x	--	--	--	--	Yes and no	Chlorination in some----------
Seepage from cesspools and septic tanks-------	x	--	--	--	x	No	------------------
Leachate from solid waste-disposal sites-------	x	--	--	--	x	No	------------------
Flood and urban runoff removed from storm drains-------	x	x	--	x	--	No	------------------
Industrial wastes							
Waste containing specified toxic, radioactive, and irritating substance not acceptable by municipal sewers---------	--	--	--	--	--	----------	Problem has not been faced as yet owing to present industrial waste types-----
Heated water, phenols, and organics from oil refineries-------	x	--	--	--	--	Partial	Stabilization ponds----------
Cooling waters from air-conditioning plants---------	x	--	--	--	--	No	------------------
Cooling waters from electric-generating plants-------	--	x	--	--	--	Yes and no	Cooling towers in some----------
Car-wash and laundry waste, not severed-----------	x	--	--	--	--	Partial	Sediment and grease traps----------
Cooling waters and other wastes from possible nuclear power plants	--	--	--	--	--	----------	Potential disposal problem----------
Brines from possible desalinization plants---------	--	--	--	--	--	----------	----------Do----------
Agricultural wastes							
Cane-wash and processing water containing sediments and organics from sugarcane mills---------	--	--	x	x	--	Partial	Settling in most----------
Return irrigation water---------	--	--	--	--	x	No	------------------
Leachate from dairy, piggery, and chicken farms--------	--	--	--	--	x	No	Spreading of wastes on some farms-----
Waste from rural residential and resort complexes							
Effluent from sewage-treatment plants------------	x	x	x	--	--	Yes	------------------
Effluent from small aerobic sewage-disposal units-----	x	--	--	--	--	Yes and no	Chlorination in some----------
Seepage from cesspools and septic tanks-------	x	--	--	--	x	No	------------------
Flood runoff------------	x	x	x	x	--	No	------------------
Leachate from solid-waste disposal sites-------	x	--	--	--	x	No	------------------

TABLE 3. NEEDS FOR BASELINE DATA AND GUIDELINES RELATED TO SUBSURFACE AND SURFACE WASTE DISPOSAL

	MUNICIPAL AND STATE GOVERNMENTS	WATER MANAGER	CONSULTANT AND DEVELOPER	REMARKS
NEED FOR BASELINE DATA Hydrologic, chemical, and biological data.	To design studies to determine effects of disposal in time and space. To establish criteria on geologic and hydrologic environments for disposal. To establish classification of waste for disposal. To design monitoring system to protect water resource and recreational waters. To identify hydrologic problems.	To protect resource. To assure quality of supplies.	To assure some degree of success of designed facility. To design and locate disposal facility. To design treatment facility.	Information poor: Capability of rock types to accept and transmit waste. Hydraulics of flow of injected waste and of receiving ground water in fresh water, transition, and saline zones of basal-water systems. Chemical and biological reactions between waste, receiving aquifer, and receiving wastes in basal-water systems. Life of receiving aquifer as waste receptacle.
Inventory of waste, disposal methods, and disposal sites.	To assess scope and magnitude of practice. To assess impact on environment.	To assess impact on resources.	To assess waste disposal and treatment facilities.	Inventory includes: Ground-water resources affected by waste disposal. Solid-waste disposal sites. Areas in sugarcane cultivation.
NEED FOR GUIDELINES Criteria on geologic and hydrologic environments for disposal.	To assess alternative risks. To enforce policy. To police practice. To issue permits. To allow classification of lands. To protect health and welfare of public.	To protect resource.	To locate and design disposal facility. To comply with regulations.	Policy problems now exist.
Classification of waste for disposal.	To police practice. To protect health and welfare of public. To formulate alternative plans for waste disposal.	To assure quality of supplies.	To design treatment facility. To comply with regulations.	Policy problems now exist.

HYDROLOGIC CONDITIONS RELATED TO SUBSURFACE AND SURFACE DISPOSAL OF WASTES IN HAWAII

By
Kiyoshi J. Takasaki
1974