HAWAII WATER PLAN

HAWAII COUNTY WATER USE AND DEVELOPMENT PLAN

Commission on Water Resource Management
Department of Land and Natural Resources
State of Hawaii

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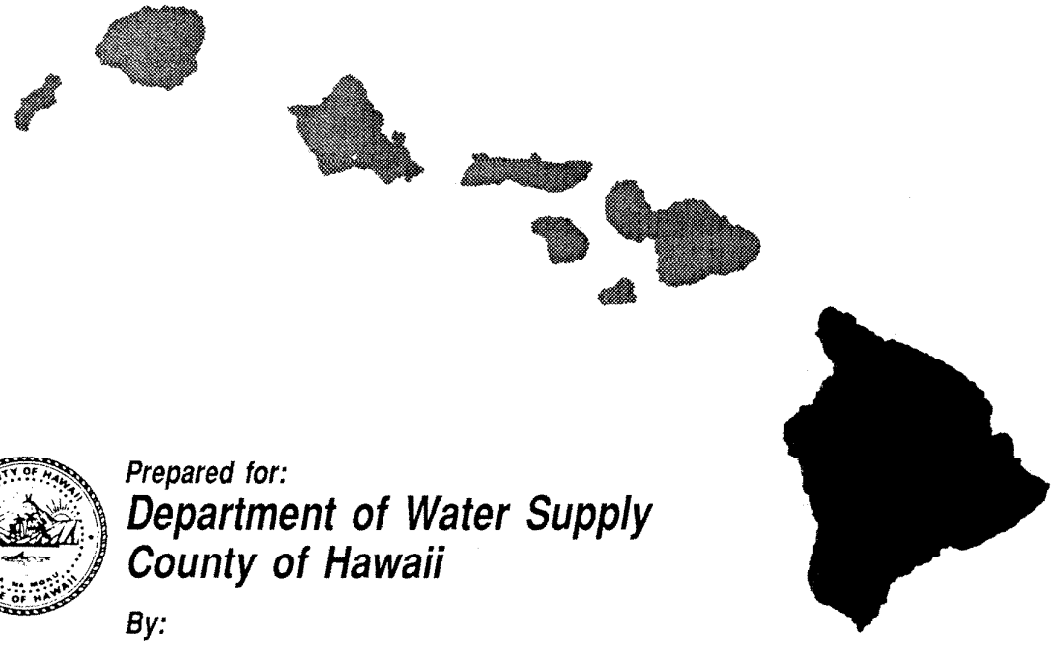

Prepared for:
Department of Water Supply
County of Hawaii

By:
Megumi Kon, Inc.

Commission on Water Resource Management
Department of Land and Natural Resources
State of Hawaii

December 1989

JOHN WAIHEE
Governor

DEPARTMENT OF LAND AND NATURAL RESOURCES

COMMISSION ON WATER RESOURCE MANAGEMENT

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COUNTY OF HAWAII

DEPARTMENT OF WATER SUPPLY

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Preface

In 1987, the State Legislature passed the State Water Code (HRS Chapter 174C) to protect and manage Hawaii's surface and ground water resources. Part III of the State Water Code calls for the formulation of a Hawaii Water Plan, an integrated program for the protection, conservation, and management of the waters of the State. The **Hawaii County Water Use and Development Plan** is one of seven subplans which collectively comprise the Hawaii Water Plan.

The Hawaii County Water Use and Development Plan, adopted by Hawaii County ordinance and endorsed by the Mayor on May 10, 1990, will serve as a continuing long-range guide for water resource development in the County.

On June 27, 1990, the State Commission on Water Resource Management accepted the Hawaii County Water Use and Development Plan for incorporation into the Hawaii Water Plan, with the following stipulations:

(1) The Water Use and Development Plan (WUDP) will be reviewed and revised by the County and resubmitted to the Commission by July 1, 1991. The Commission would provide the County with supplemental assistance funds for this initial plan revision period. Thereafter, because the WUDP obtains its primary directions from the Hawaii Water Plan, periodic plan reviews and revisions, at the County's expense, will be timed to coincide with the review process of the Hawaii Water Plan.

(2) Amendments to the County's WUDP are to be adopted by ordinance and transmitted to the Commission within ten working days from their date of adoption for review, acceptance, and incorporation into the Hawaii Water Plan.

Hawaii County

WATER USE AND

DEVELOPMENT PLAN

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1.1 INTRODUCTION

1.1.1 HAWAII WATER CODE AND PLAN

Hawaii's state constitution mandates that the State has an obligation to protect, control, and regulate the use of Hawaii's water resources for the benefit of its people. To meet this mandate, a State Water Code was established by Act 45, Session Laws of Hawaii (SLH) 1987, now codified as Chapter 174C, Hawaii Revised Statutes. The Code calls for a six member Commission on Water Resources Management to set policies governing water quality, use and conservation for the State of Hawaii.

The Code also requires the development of a Hawaii Water Plan to serve as a long-range guide for water resources management. The Plan would consist of four parts: 1) a water resource protection plan to be prepared by the commission; 2) a water use and development plan for each county to be prepared by each separate county; 3) a state water projects plan to be prepared by the agency having jurisdiction over such projects; and 4) a water quality plan to be prepared by the Department of Health.

This Hawaii County Water Use and Development Plan (WUDP) is one of four county components of the Hawaii State Water Plan.

1.1.2 PURPOSE

The purpose of the county water use and development plan is to meet a requirement of the Water Code and to aid the Commission on Water Resource Management in granting permits for water use and designating water management areas. The plan is also intended for use as a technical reference document on current and future water resource conditions in the county.

1.1.3 SCOPE

Subchapter 3 of the Hawaii Administrative Rules relating to preparation and establishment of the county water use and development plan is located in **Appendix A.** The subchapter calls for the plan to essentially:

1. Include an inventory of existing water uses and developments by hydrologic units;
2. Address future land uses and related water needs through regional plans for water development;
3. Be consistent with the State's land use classification and policies, water resource and protection plan and water quality plan and with the county land use plans and policies, including the general plan, regional development plans, and zoning ordinance;
4. Be adopted by the county council by ordinance, and;
5. Be updated and maintained by the county.

1.2 PHYSICAL SETTING

1.2.1 LOCATION AND SIZE

The County of Hawaii encompasses the Island of Hawaii, the most southeastern and largest island of the Hawaiian archipelago. Its longest and shortest dimensions are 93 miles and 76 miles, and covers a land area of 4,038 square miles. The island is divided into 9 judicial districts as shown on **Figure 1.2-1.** It has 9 aquifer sectors whose locations are shown on **Figure 1.3-3.** The island's estimated population in 1987 was 114,300 residents. Other than in Hilo and Kailua, the population is widely spread on the island in small communities.

1.2.2 CLIMATE

The size of the island and the range of land elevations contribute to a climate of great diversity. The island lies in the path of the northeast trade winds and has an orographic rainfall pattern typical of the larger islands in the Hawaiian chain. Rainfall reaches a maximum intensity from 2,000 to 3,000 feet elevation and then diminishes, so that the upper slopes are semi-arid. In northeast Hawaii the moisture laden trades are cooled as they rise up the mountain slopes, losing much of their moisture as rain. The prevalence of trades throughout much of the year accounts for the island's high average annual rainfall of 72 inches. Over 300 inches fall annually on parts of the windward or northeast slopes of the island.

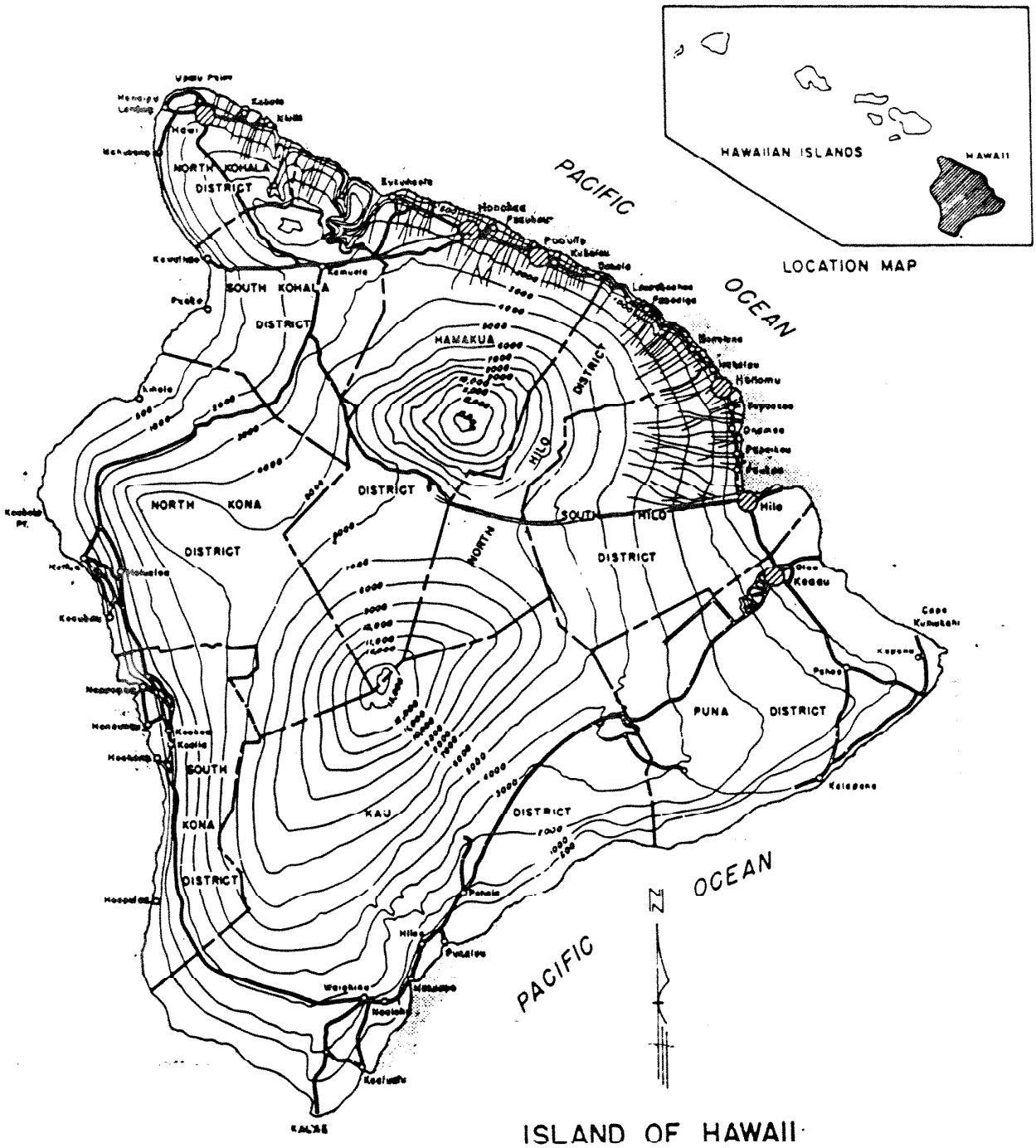
As the winds descend along the leeward slopes, the air becomes dryer and warmer. Rainfall declines accordingly, resulting in near arid climate along the leeward coastline. The mean annual rainfall in most leeward areas is approximately 10 inches. Along the Kona coast, however, the difference between land and water temperatures on warm days, particularly in summer, generates a moderate sea breeze circulation which results in frequent and heavy enough showers to produce a much higher mean rainfall than in other leeward areas. See **Figure 1.2-2** for rainfall map of the island.

Generally, in areas where trade winds predominate, the dry months of the year occur from May through September and the wet months from October through April. However, in the Kona region, sheltered from the trades, summer rainfall predominates.

Because of the mild equable temperatures of the ocean waters surrounding the islands, temperatures in the air moving across the ocean and over the island are also mild and equable. The warmest month is August and coldest is February. Temperature above 90°F is very unusual, except in the dry leeward area of South Kohala where maximum temperatures in the low 90's are moderately common. Temperature less than 55°F is uncommon, except at elevations above 2,500 feet. The summits of Mauna Kea and Mauna Loa are frequently covered with snow in winter.

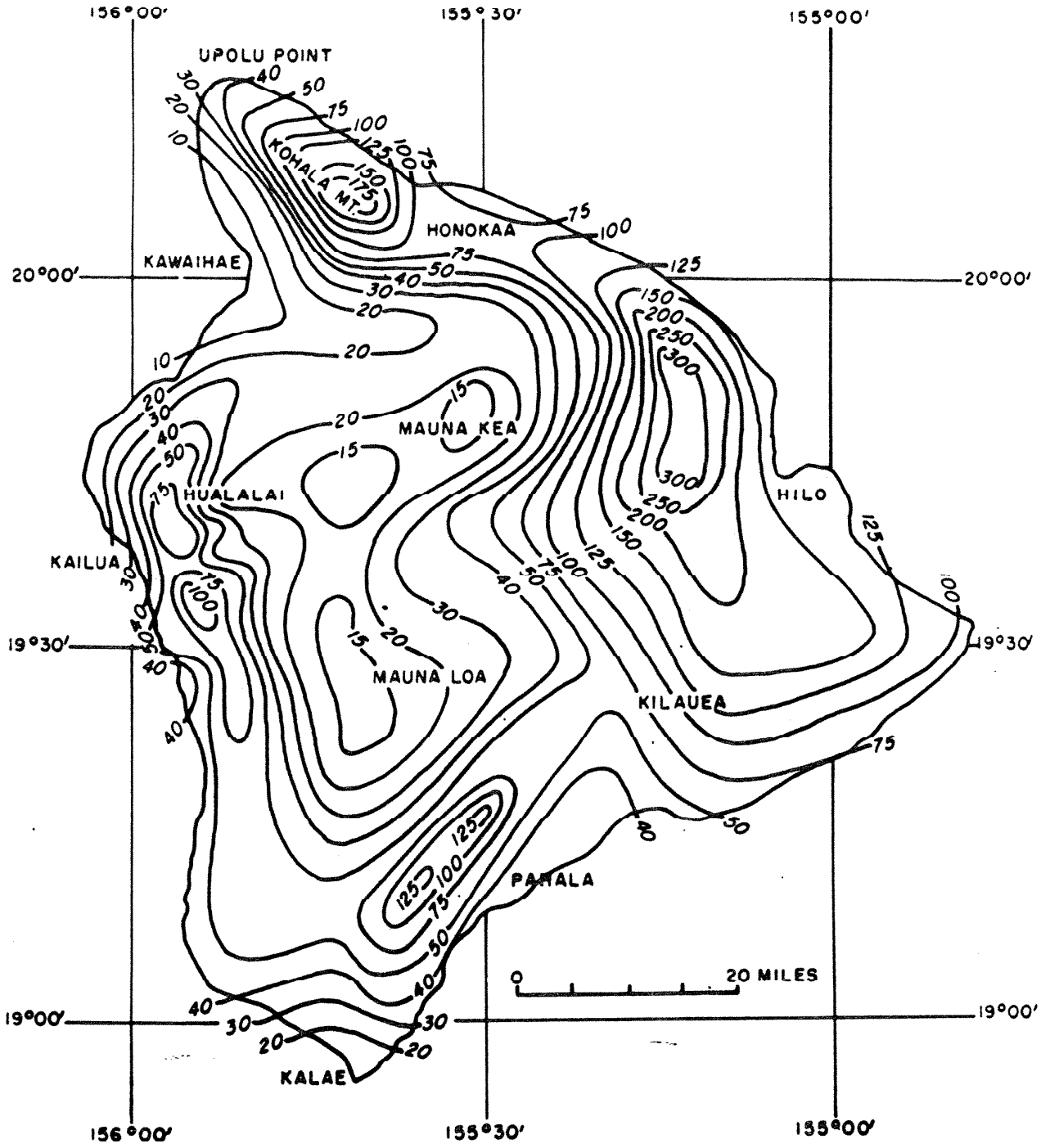
Northeasterly trade winds prevail much of the time on the island of Hawaii, as elsewhere in the state. Although these winds approach the island at a fairly constant speed, the uniform flow is distorted as the trade winds traverse the island and combine with local winds on the mountain slopes and lowlands to form complex wind patterns. During the cooler winter months, especially, trades are replaced by other general winds, primarily the southerlies. Occasional tropical storms also generate winds from various directions. Over the ocean surrounding the island, average wind speeds are highest during the summer trade wind period, exceeding 12 miles per hour 50 percent of the time. During the winter months wind speeds exceed 12 miles per hour about 40 percent of the time.

Under prevailing trade wind conditions, from 50 to 70 percent of the time, moisture distribution in the air surrounding the island mass is greatly influenced by the characteristic temperature inversion. Moisture is high and well distributed below the inversion level, which varies between 5,000 and 7,000 feet elevation; air above the inversion is relatively dry. Relative humidity below



JUDICIAL DISTRICTS

FIG. 1.2-1



Mean Annual Rainfall In Inches

RAINFALL MAP

Source: USGS Report R47

FIG. 1.2-2

the inversion is roughly 70 to 80 percent in windward areas, as compared to 60 to 70 percent in the dryer leeward areas. Above the inversion, relative humidity is generally less than 40 percent, often declining to 10 or even 5 percent. (State DLNR Report R34)

1.2.3 GEOLOGY

The Hawaiian Islands is part of a chain of islands that extend southeast from the Aleutian Islands. Most of the islands northwest of the Hawaiian Archipelago have disappeared or only small portions of land or tips of the islands rise above the sea. These islands are called the Leeward Islands, or the Northwestern Hawaiian Islands, and include Midway Island, Kure Atoll and French Frigate Shoals. The Hawaiian Islands are the newest land mass of this chain of islands.

The island of Hawaii is the largest of the eight major islands of the Hawaiian Archipelago. Its size, 4,038 square miles, makes it larger than the rest of the islands combined, and represents 62% of the 6,425 square miles that constitute the Hawaiian Islands. The island is the youngest, geologically speaking, and rocks from its earliest volcano are estimated to be about 700,000 years old. In contrast, Kauai is over 3 million years old, and Oahu is at least 2 million years old.

The island of Hawaii was formed by five shield volcanoes: Kohala, Mauna Kea, Mauna Loa, Hualalai, and Kilauea. Kohala is considered extinct; Mauna Kea has not erupted for 2,000 years or so, yet it may only be dormant and not extinct; and, Hualalai last erupted in 1801 and is considered dormant. Mauna Loa and Kilauea are active volcanoes.

The bulk of each volcanic dome is composed of permeable thin-bedded basaltic lava flows. A veneer of andesitic lavas covers much of Mauna Kea, and one of andesite and trachyte covers part of the Kohala Mountains attesting to the older age of the Kohala volcanic series. The andesitic and trachytic flows are mostly thick-bedded and are poorly permeable.

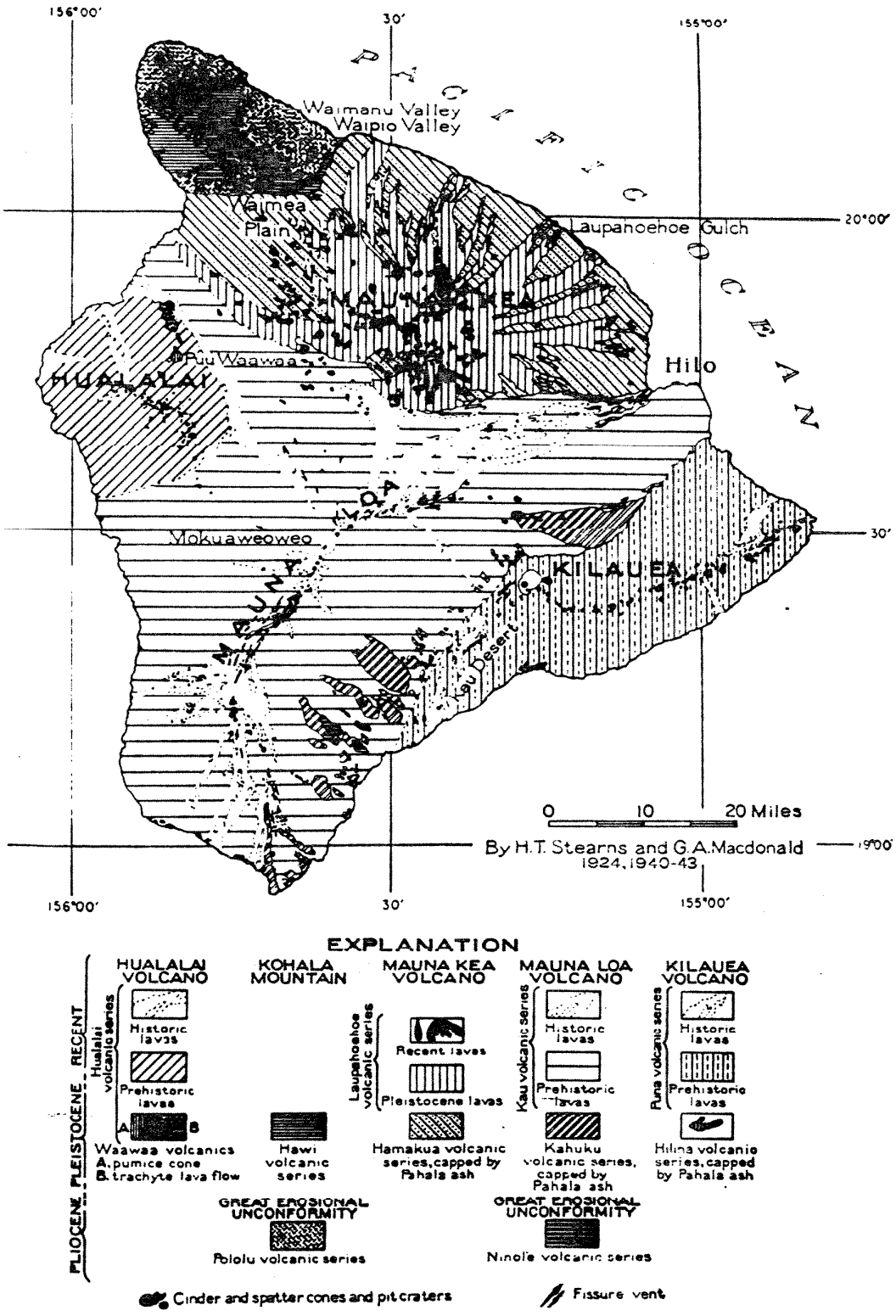
Numerous dikes have intruded lava flows in the rift zones, but dikes are exposed only in deeply eroded valleys in the eastern slope of Kohala Mountain. They form almost impermeable vertical barriers, which cut across lava flows and often times impound large quantities of ground water. Volcanic-ash deposits, several feet thick in places, crop out in about 450 square miles of the northern, northeastern, and southeastern parts of the island. Most of the ash has been buried by later lava flows. The buried ash deposits, intercalated in permeable lava flows, act as perching members for important high-altitude perched-water bodies in many of the northeastern and southeastern parts of the island. Only a limited number of perennial streams are found confirming the highly pervious nature of many of the surface rocks. These streams are found on the eastern (or windward) slopes of Mauna Kea and Kohala Mountains. A few streams flow perennially in their wet upper reaches but lose their water flowing over the permeable ground well before reaching the coast. However, these streams are subject to flash floods during heavy rains.

There is little evidence of extensive coastal-plain sedimentation and of deep erosion, except in the northeastern slopes of the Kohala and Mauna Kea mountains. Sedimentary materials, as a result, are sparse and scattered. They include alluvium, talus, dune and beach deposits: and glacial deposits on Mauna Kea. They are not important hydrologically, owing to their sparse distribution.

A geologic map of Hawaii Island is shown in **Figure 1.2-3.** Accompanying the geologic map is **Table 1.2-1** showing the stratigraphic sequence of the volcanic rock units on Hawaii Island.

1.2.4 HYDROLOGY

The gross water supply of the island is the precipitation reaching the ground surface. This precipitation or rainfall may be lost through evapo-transpiration; it may run-off into streams and



SIMPLIFIED GEOLOGICAL MAP OF HAWAII

Source: Geology and Ground Water Resources Island of Hawaii
Stearn & MacDonald

FIG. 1.2-3

Stratigraphic rock units in the island of Hawaii

(The volcanic rocks of Mauna Loa, Mauna Kea, and Hualalai, those of Mauna Kea and Kohala, and those of Mauna Loa and Kilauea interfinger)

Age	Hualalai	Kohala Mountain	Mauna Loa	Kilauea	Mauna Kea
Historic	Historic member of the Hualalai volcanic series (1800–01)	Unconsolidated alluvium, dunes and landslides	Historic member of the Kau volcanic series (1832-1942); Mud flow of 1868	Historic member of the Puna volcanic series (1790–1934)	Ribbons of gravel and small alluvial fans
Recent	Prehistoric member of the Hualalai volcanic series		Dunes	Dunes	Upper member of the Laupahoehoe volcanic series
		Fluvial conglomerates	Prehistoric member of the Kau volcanic series	Prehistoric member of the Puna volcanic series	Glacial debris and fluvial conglomerates
					Lower member of the Laupahoehoe volcanic series
					Local erosional unconformity
Late Pleistocene	Pahala ash (exposed on Waawaa volcanics only)	Pahala ash (not differentiated)	Pahala ash	Pahala ash	Pahala ash
Early and middle Pleistocene	Waawaa volcanics and lower unexposed part of Hualalai volcanic series	Fluvial conglomerates	Kahuku volcanic series	Hilina volcanic series	Hamakua volcanic series
		Hawi volcanic series			
		Great erosional unconformity			
Pliocene		Pololu volcanic series	N Ninole volcanic series		

STRATIGRAPHIC ROCK UNITS ISLAND OF HAWAII

Source: USGS Bulletin 9
Stearns & MacDonald

TABLE 1.2-1

empty into the ocean; or it may infiltrate the ground to become soil moisture or collect in the basal water table (or aquifers) to eventually escape to the sea. This cycle of water movement is referred to as the hydrological cycle.

The island of Hawaii, which lies in the path of the prevailing northeast trade winds, has an orographic rainfall pattern. The moisture laden trades are cooled as they rise up the mountain slopes and deposit moisture as rain. As expected, the heaviest rainfall occurs on the eastern or windward side of the island. The leeward or western slopes receive little of the orographic trade wind rainfall. Rain in the leeward side is generally the result of convective-type showers. The island as whole receives an average annual rainfall of 72 inches, the equivalent amount of water is computed at 13.820 billion gallons per day. Rainfall gradients are very steep as evidenced by viewing the isohyetal lines of the rainfall map shown in **Figure 1.2-2.** The dry leeward side at Kawaihae averages less than 7 inches of rain per year while the Hilo Forest Reserve averages 300 inches per year. Rainfall fluctuations from year to year are very great, often exceeding 300 percent. The intensity of rainfall is also very high with 12 inches or more rain a day occurring at least once a year. Over 30 inches of rain per day has been recorded.

The steep and permeable slopes generally result in ephemeral or flashy streams; perennial streams are scarce except on the Kohala Mountain slopes of Mauna Kea between Hilo and Maulua River near Laupahoehoe. This can be attributed to the abundant rainfall which is fairly well distributed throughout the year to yield water in excess of the infiltration capacity of the permeable surfaces.

The subterranean or underground basal water table provides the most dependable sources of water as it is less affected by droughts and seasonal changes in the weather. Ground water now accounts for most of the water sources managed by the County Water Department and its use is expected to increase even to the point of straining some of the resources in certain areas. A large part of the rainfall sinks into the permeable ground surfaces and moves down towards the water table. Some is trapped by dikes or perched on impervious layers. However, the greatest ground water reservoir is near sea level in the basal water table creating a fresh water lens which "floats" on sea water. This phenomenon is known as the Ghyben-Herzberg principle. Due to the difference in specific gravities between sea water and fresh water, for every foot of fresh water above sea level 40 feet of fresh water extend below sea level to maintain the equilibrium. However, in actuality, allowance must be made for a zone of mixture or transition zone from sea water to fresh water.

Depending on the infiltration rate of rainwater, the basal water table rises from sea level at the shore inland on gradients of about 1 to 4 feet per mile. The highest gradients or basal water levels, 15 to 20 feet, are found south of Hilo on the eastern flanks of Kilauea Volcano. The huge discharge of fresh water, 100 million gallons a day, into the Waiakea Pond in Hilo is a manifestation of this high basal water level.

Developable high level water supplies impounded by dikes are found in the central part of the Kohala Mountain. The estimated discharge from dike compartments into streams of Kohala Mountain is estimated at 100 million gallons a day. Much of this is diverted by ditches such as the lower Hamakua Ditch and the Kohala Ditch, for irrigation. Other high level water supplies confined by dikes occur in the rift zones of the other mountains; however, they cannot be recovered economically.

Water perched on impervious strata of ash beds can be found in Kau. Small volumes of water perched on dense lava flows occur ubiquitously in the wet slopes of Mauna Kea and in a few places on Kohala Mountain. Inter-bedded soils formed by weathered lava supplies numerous springs and tunnels in Kohala Mountain between the lavas of Hawi and Pololu volcanic series.

The generalized maps in **Figures 1.3-1 and 1.3-2** showing ground water areas on the island and locations where ground water may be recovered by wells and tunnels, prepared by the U.S. Geological Survey in 1946, are still applicable today with a few modifications.

1.3 HYDROLOGIC UNITS AND WATER AVAILABILITY

1.3.1 HYDROLOGIC UNITS

The State, as part of its Water Resource Protection Plan, has established an aquifer coding system to identify and describe aquifers in the State of Hawaii. An aquifer is generally described as a water bearing stratum of permeable rock, sand or gravel and constitutes a source of ground water.

Under the aquifer coding system, each island is used as the largest component in the hierarchy, followed by Aquifer Sectors, then Aquifer Systems located within the sectors. Aquifer Types and Aquifer Units will be identified later. For this water use and development plan purpose the Aquifer Sector and System coding will be utilized.

The classification scheme of aquifers is based on ground water as the point of reference, with surface water run off basins as secondary consideration. An Aquifer Sector reflects an area with broad hydrogeological (subsurface) similarities while maintaining traditional hydrographic (surface), topographic and historical boundaries where possible. The Aquifer System is an area within a sector that is more specifically defined by hydrogeologic continuity, particularly hydraulic connections among aquifer types and units. This classification scheme updates the island's hydrographic areas initially established in 1959.

The aquifer code number begins with the U.S. Geological Service number for each island. The island numbers are 1-Niihau, 2-Kauai, 3-Oahu, 4-Molokai, 5-Lanai, 6-Maui, 7-Kahoolawe, and 8-Hawaii. The island number is followed by a two-digit sector number and a two-digit system number. The sectors and systems also have geographic names. The boundaries and aquifer codes for the aquifer sectors and systems for Hawaii Island are shown on **Figure 1.3-3.** The names of the aquifer sectors and systems are listed on **Table 1.3-1 in Appendix E.**

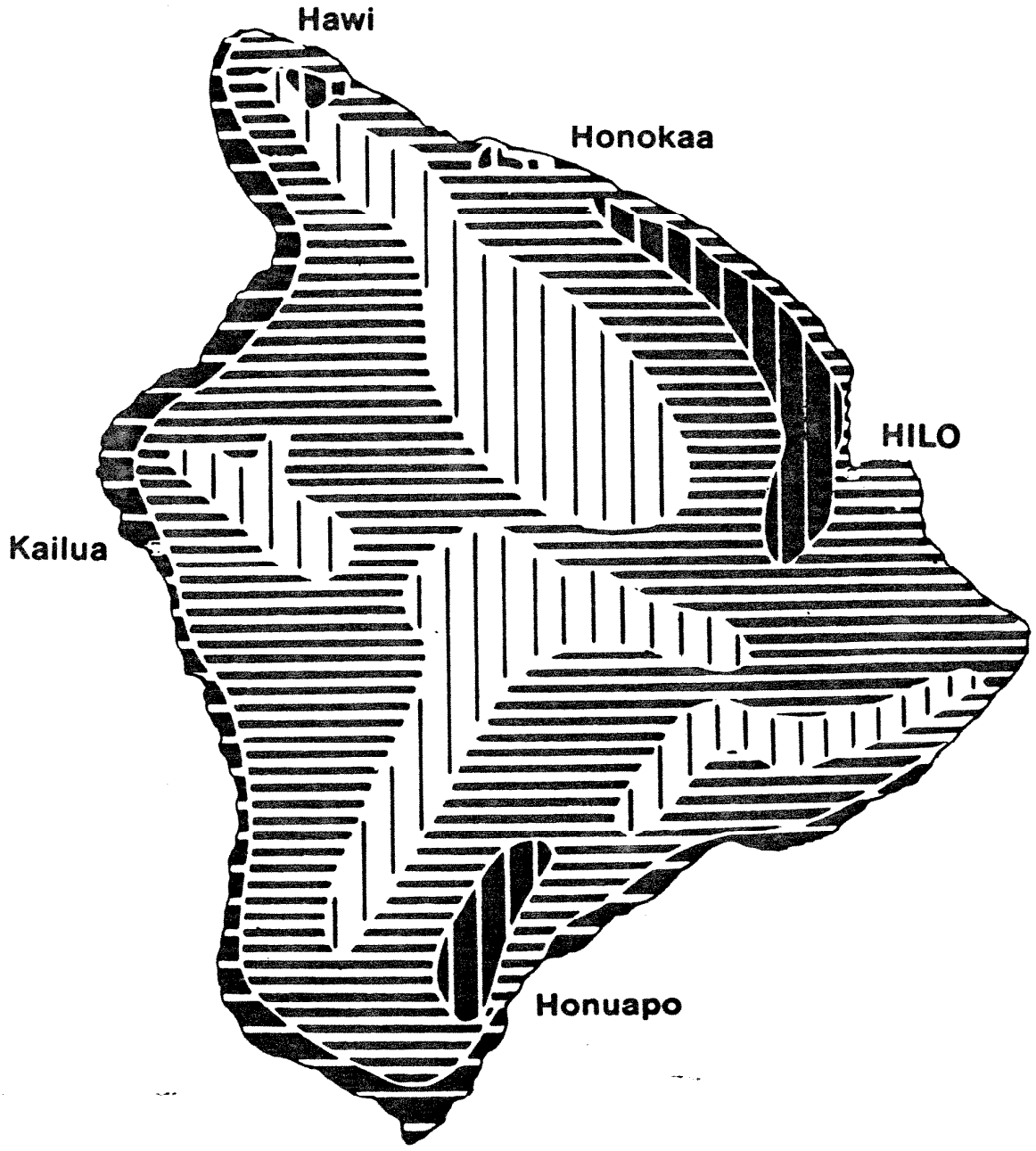
1.3.2 WATER AVAILABILITY

Water sources are divided into two general categories -- surface water and ground water. Surface water sources include streams, lakes, and springs. Ground water sources include wells, shafts, and tunnels.

The relatively young, slightly dissected domes comprising the Hawaii island have gentle slopes and little soil. The unweathered and highly permeable lavas allow much of the rainfall to percolate to the water table. Hence, there are few perennial streams on the island. Streams of any consequence are located in the windward areas of higher rainfall, and practically all are located on the slopes of Kohala Mountain and Mauna Kea. In other areas, streams are intermittent or non-existent.

In the past, the sugar plantations built several major ditch and flume systems to take advantage of surface water sources. Several of the ditches such as the Kohala Ditch and the Kehena Ditch in North Kohala, the Upper Hamakua Ditch in South Kohala, and the Lower Hamakua Ditch in Hamakua are still in limited use today. The flume systems in the Pahala and Naalehu areas of Kau, the Waiakea-uka and Kaumana areas of Hilo, and along the Hilo-Hamakua coast areas have been abandoned.

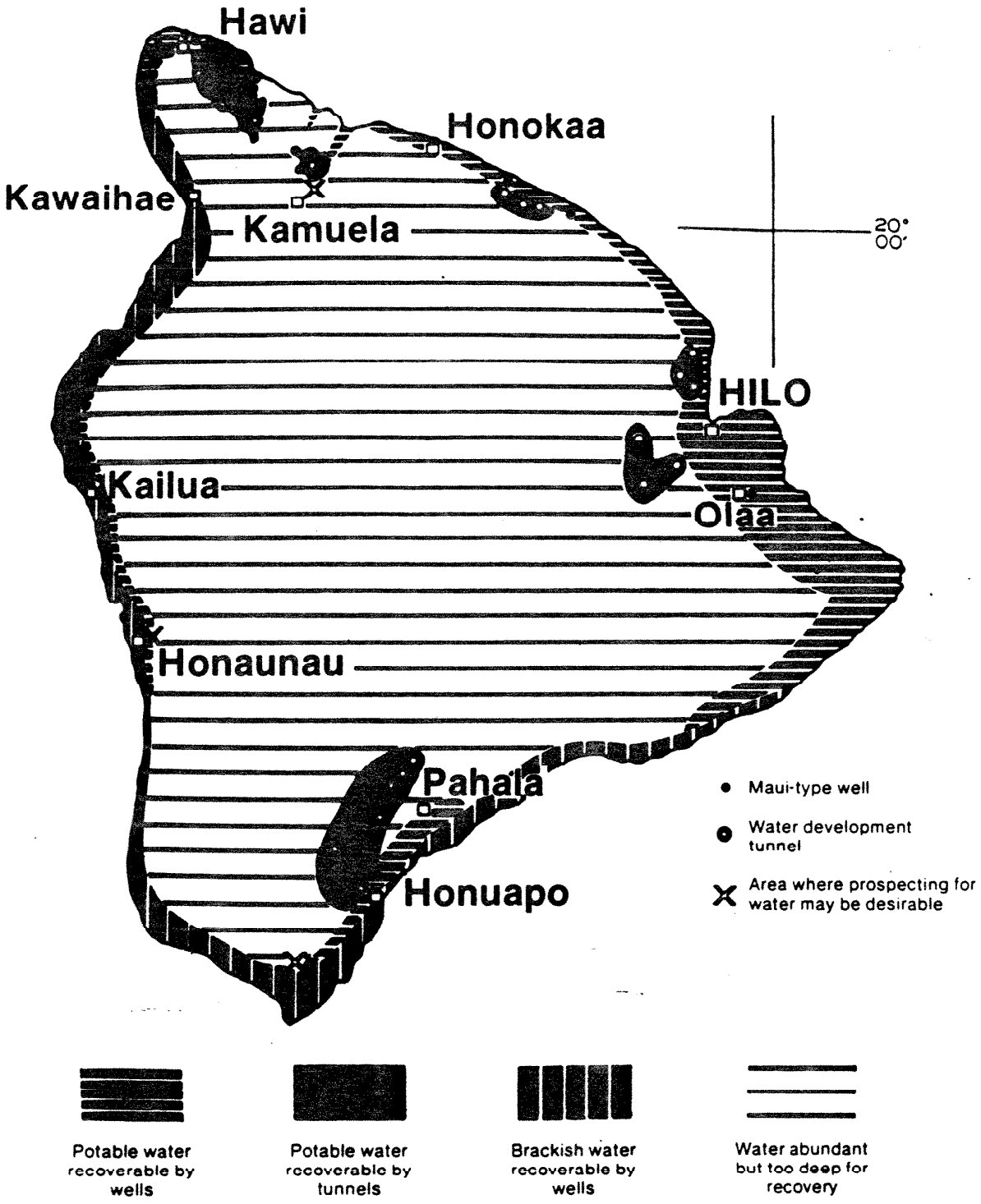
Today, surface water remains a significant source for irrigation and industrial uses. The Kohala Ditch, although much less used today than two decades ago, with an estimated current flow of 15 mgd, provides water for agricultural irrigation, hydroelectric generation and aquaculture use in Kohala. The Upper Hamakua Ditch, with a maximum potential capacity of 30 mgd is the main source of supply for the Waimea Agricultural Irrigation System which supplies irrigation water to farmers in the Puukapu and Lalamilo areas of Waimea. The Lower Hamakua Ditch, with an estimated average discharge of 22 mgd, continues to serve the industrial, irrigation, and domestic use need of the Hamakua Sugar Co. The Wailuku River, in addition to providing water for the Hilo county water system, provides water for a hydroelectric power plant.



GROUND WATER RESOURCE AREAS

Source: USGS Bulletin 9
Stearns & MacDonald

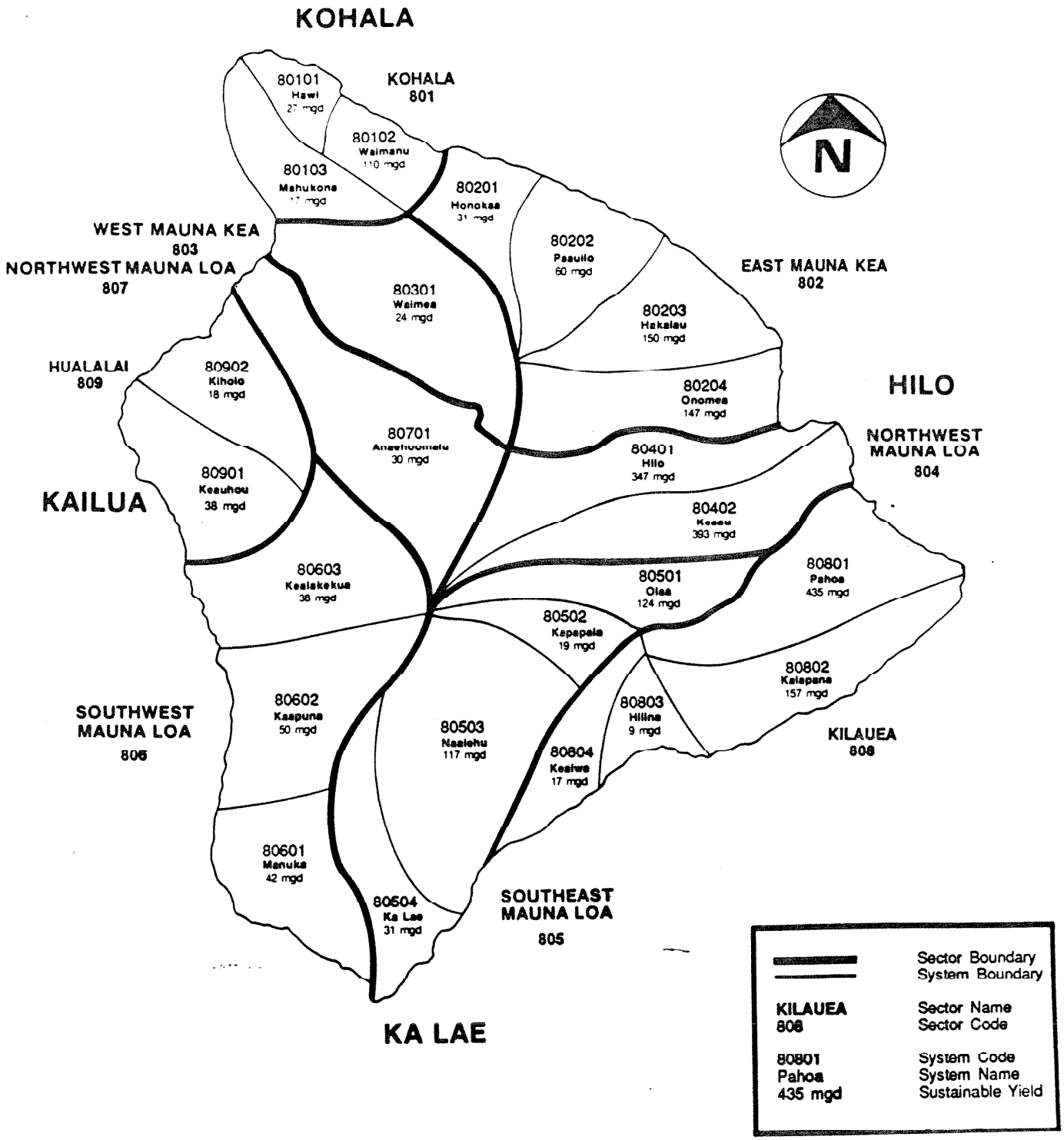
FIG. 1.3-1



WATER RECOVERABLE BY WELLS & TUNNELS

Source: USGS Bulletin 9
Stearns & MacDonald

FIG. 1.3-2



AQUIFER SECTORS AND SYSTEMS

FIG. 1.3-3

Ground water is the primary source of supply for the majority of water users on the island, municipal as well as private systems. The island's ground water can be classified into four general categories: (1) basal water floating on salt water; (2) dike confined water; (3) water perched on relatively impervious soil or rock formation; and (4) shallow ground water. **Figure 1.3-1** shows ground water resource areas on the island. **Figure 1.3-2** shows areas where water can be recovered by wells and tunnels. As can be seen from **Figure 1.3-2**, although there appears to be an abundant supply of basal water underlying the island, the ground elevations in many parts of the island would make it very expensive to recover the basal water.

The amount of ground water that is available in an aquifer is quantified as the sustainable yield for the aquifer. Sustainable yield is defined as the rate of total pumpage which could be continually withdrawn from an aquifer without affecting either the quality or quantity of the output. The estimates of sustainable yields for the aquifer sector and systems in Hawaii Island, prepared by hydrologist Mink & Yuen, Inc., are shown on **Figure 1.3-3**, and in **Table 1.3-1 in Appendix E.**

The sustainable yields are computed by a water balance technique for pre-development conditions, and transfer of water from one system to another for irrigation and the recycling of irrigation recharge is not taken into account. In view of the limited information on the extent and behavior of groundwater resources on the island, the confidence level of the sustainable yield estimates is given at level 3, where 1 is the highest and 3 is the lowest. Also, the quantities do not reflect either accessibility or developability of the ground water. **It should be emphasized that sustainable yield is calculated as the total water which could be developed and includes potable and non-potable ground water. Therefore, care must be taken in interpreting how much of the sustainable yield in an aquifer is retrievable as potable water. According to hydrologist Mink & Yuen, Inc., on the west side of Hawaii Island, non-potable water constitutes a sizable fraction of the sustainable yield of several aquifers. These aquifers are listed below.**

Aquifer Sector 801	System 80103 - Mahukona	Sustainable Yield = 17 mgd
Aquifer Sector 806	System 80601 - Manuka	Sustainable Yield = 42 mgd
	System 80602 - Kaapuna	Sustainable Yield = 50 mgd
	System 80603 - Kealakekua	Sustainable Yield = 38 mgd
Aquifer Sector 807	System 80701 - Anaehoomalu	Sustainable Yield = 30 mgd
Aquifer Sector 809	System 80901 - Keauhou	Sustainable Yield = 38 mgd
	System 80902 - Kiholo	Sustainable Yield = 18 mgd
Aquifer Sector 808	Complex groundwater conditions in this sector also affect availability of potable water.	Sustainable Yield = 618 mgd

1.4 ECONOMY AND POPULATION

1.4.1 ECONOMY

The economy of the island has experienced significant changes over the past two decades. While the island's economic base has historically been in agriculture, tourism and related businesses are presently the largest contributors to the island's economy. They are responsible for most of the recent economic growth of the island and are expected to continue their rapid expansion. Employment in tourism is expected to increase substantially. Employment and population patterns reflect a shift from agriculture to tourism and other service categories. Tourism related facilities and activities are primarily located on the west side of the island. The major resort areas are located along the Kohala-Kona coastal areas between Kawaihae and Keauhou. A huge increase in the housing inventory will be required for people working in the resorts and support services.
Agriculture, not including related processing or ancillary services, continues to be an important

part of the economic sector. Employment in the sugar industry is projected to decline slowly. However, national and international economic and political forces could result in the demise of the industry. Trends indicate that production of diversified agricultural crops such as macadamia nuts, papaya, flowers and coffee are increasing. Many of the manufacturing activities on the island are closely associated with the processing of agricultural crops such as sugar and macadamia nuts. Modest increases are expected in non-sugar manufacturing enterprises.

Fishing and aquaculture continue to be part of the economic sector. Aquaculture activities at the Ke-ahole Hawaii Ocean Science and Technology Park are showing potential for aquaculture to become an important sector of the economy.

Educational, research and development related activities with strong potential for expansion include university and other educational facilities, astronomy and space research, geothermal and related research, and ocean related energy and aquaculture research.

1.4.2 POPULATION

With the shift from an agriculture based economy towards a visitor-service industry based economy, the island's population is projected to continue its steady growth started in the 1970's. Because of tourism, most of the added population is expected to be distributed closer to the resort areas on the west side of the island. **See Figure 1.4-1.**

South Hilo, which currently has 39% of the island's population, although seen as continuing its role as the island's major center of government and commerce, will have a lesser share of the island's year 2010 population. South Kohala and North Kona are expected to experience tremendous growth and have about 37% of the future population as compared to 24% in the past. As land and housing prices escalate in these districts as a result of the rapid growth, housing markets will most likely develop in the neighboring districts such as North Kohala and Hamakua which may result in greater increase in population in those districts than expected.

The other districts on the island, with the exception of Puna, are not expected to have large population growth. Interestingly, although no major job producing activity is foreseen in the Puna District, it is expected to continue its rapid gain in population.

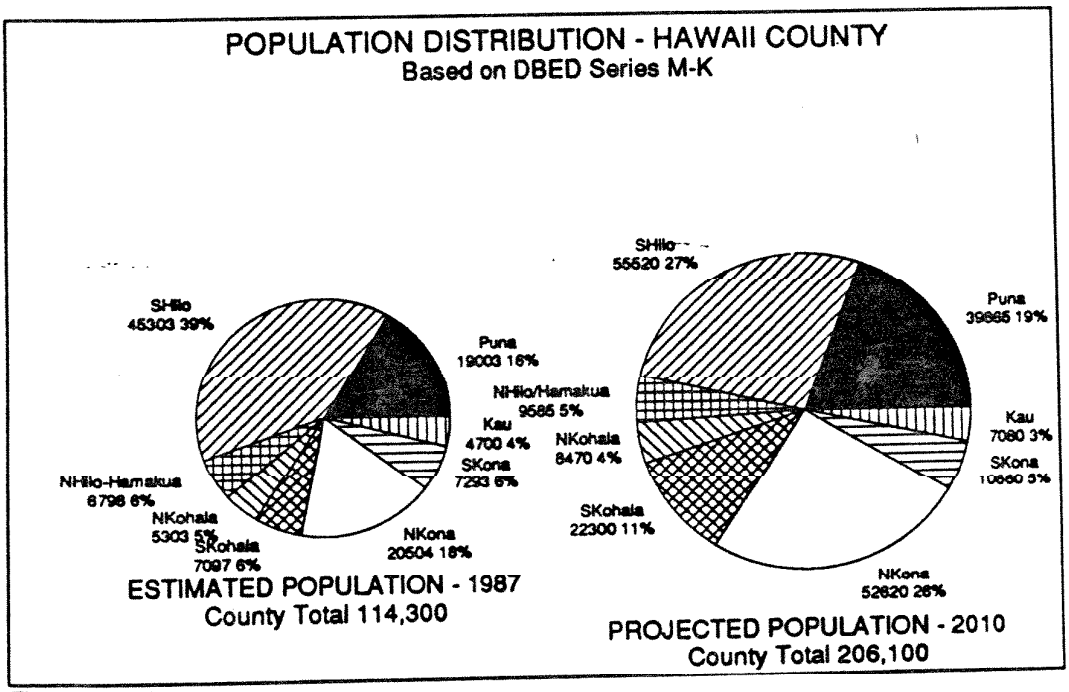


Figure 1.4-1

The County General Plan has three series of population projections for the island up to the year 2005, Series A being the most conservative projection, Series B being a medium projection, and Series C being an optimistic outlook on the County's future. None of the projections given in the series are considered as statement of county population goals. The three series are shown below in **Figure 1.4-2.**

Figure 1.4-2 also shows a comparison of the General Plan projections and the M-K population projections generated by the Hawaii County Planning Department for a period to year 2010 based on the State Department of Economic Development Series M-K projections. The same projections are also being utilized by the Planning Department for its transportation plan study with the State. Although there is a differential of 5 years in time period, the graph shows that the projections derived from the Series M-K data is reasonably consistent with the Series B projections of the General Plan. The Series M-K based projections also gave distribution of the projected population in districts with larger population which was essential in estimating water demand locations. For the above given reasons, **the Series M-K projections shown below in Figure 1.4-2 were utilized in estimating future water demands for this WUDP.**

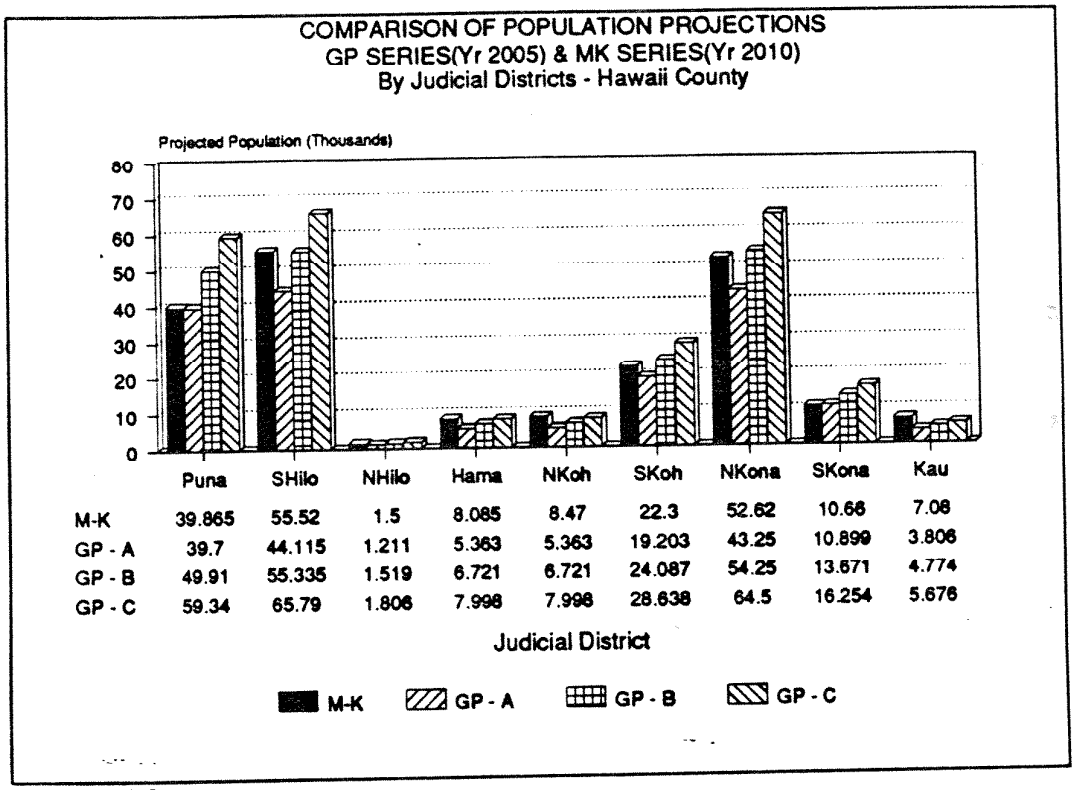


Figure 1.4-2

1.5 LAND USE

1.5.1 GENERAL PLAN

The County of Hawaii General Plan is the policy document for the long-range comprehensive development of the Island of Hawaii. It provides direction for the future growth of the County. The General Plan Land Use Pattern Allocation Guide Map indicates the general location of various land uses in the county. The land use pattern is a broad, flexible design intended to guide the direction and quality of future developments in a coordinated and rational manner.

The proposed land use pattern allocation acreages by districts are shown in **Table 1.5-1.** Modified land use maps showing combined categories of land uses in areas of the island pertinent to this WUDP are shown on **Figures 1.5-1 to 1.5-7 following page 11-2.**

TABLE 1.5-1 PROPOSED LAND USE PATTERN ACREAGE
(Source: County General Plan, 1989)

District	Residential	Commercial	Industrial	Resort	Total
Puna	22,535	2,254	3,380	91	28,260
S. Hilo	24,045	2,405	6,259	293	33,002
N. Hilo	650	65	98	-	813
Hamakua	2,878	288	437	60	3,663
N. Kohala	2,951	295	661	120	4,027
S. Kohala	11,056	1,106	2,034	746	14,942
N. Kona	25,066	2,507	5,068	1,160	33,801
S. Kona	5,122	512	768	90	6,492
Kau	2,062	206	525	135	2,927
TOTAL	96,365	9,638	19,230	2,695	127,926

1.5.2 COUNTY ZONING

The Zoning Guide Maps delineate specific uses for the allocation of acreage for zoning in conformity with the designated uses in the General Plan land use pattern. The zoning acreage allocations proposed in the General Plan are shown below in **Table 1.5-2.**

TABLE 1.5-2 PROPOSED ZONING ACREAGE ALLOCATION IN NET ACRES
(Source: County General Plan Draft, 1987)

	Residential	Commercial	Industrial	Resort
County Allocation	38,546	3,855	7,691	1,558
Land Zoning Bank	9,636	964	1,924	201
Puna	9,014	901	1,352	55
South Hilo	9,618	962	2,504	195
North Hilo	261	26	39	-
Hamakua	1,152	115	174	6
North Kohala	1,181	118	264	12
South Kohala	4,422	442	814	439
North Kona	10,027	100	2,027	733
South Kona	2,050	205	307	54
Kau	930	93	210	64

1.5.3 STATE LAND USE

The 1987 State Land Use District acreages in Hawaii County were:

Urban District includes lands in urban use with sufficient reserve to accommodate foreseeable growth. In the Hawaii County this district is made up of about 39,638 acres or 1.6% of island's total land area.

Rural District includes lands primarily comprised of small farms mixed with low density residential lots with minimum of one-half acre lot size. There are about 689 acres in this category on the island.

Agricultural District includes lands with a high capacity for intensive cultivation as well as those with low capacity. This district has about 1,186,674 acres or slightly over 47% of the total land area of the island.

Conservation District primarily includes those lands in the existing forest and water reserve zones. This district has the largest land area with about 1,296,095 acres or 51% of the total land area of the island.

1.5.4 GENERAL PLAN GOALS AND POLICIES

The General Plan goals and policies indicate the desired long-range directions and seek to provide a cohesive and comprehensive framework within which social an economic programs and governmental effort can be coordinated. The policies state the methods or strategies which should be undertaken to attain the goals stated. The General Plan goals and policies concerning county economy and population, environmental quality, water, and land use are referenced in **Appendix B.**

1.6 EXISTING WATER USES AND DEVELOPMENTS

1.6.1 OVERVIEW OF WATER USES

Summaries of total water drawn from ground and surface water sources by aquifer sectors and by districts are shown in **Figures 1.6-1 and 1.6-2,** below.

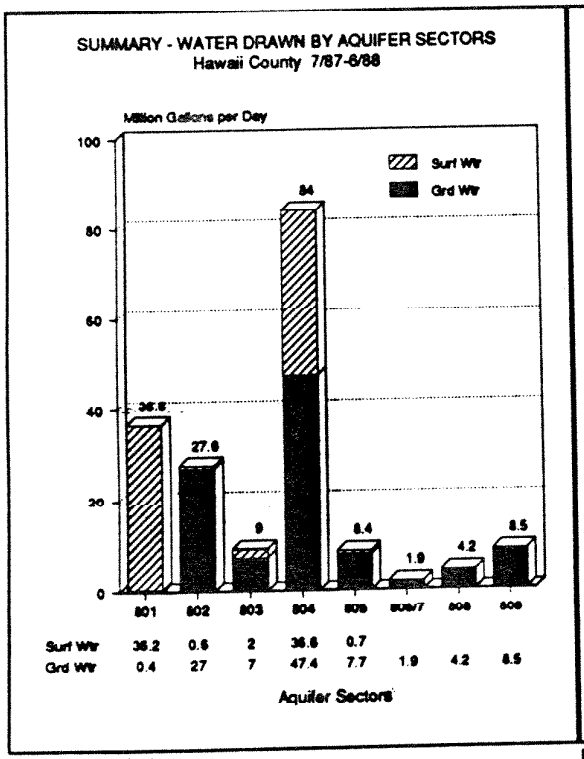


Figure 1.6-1

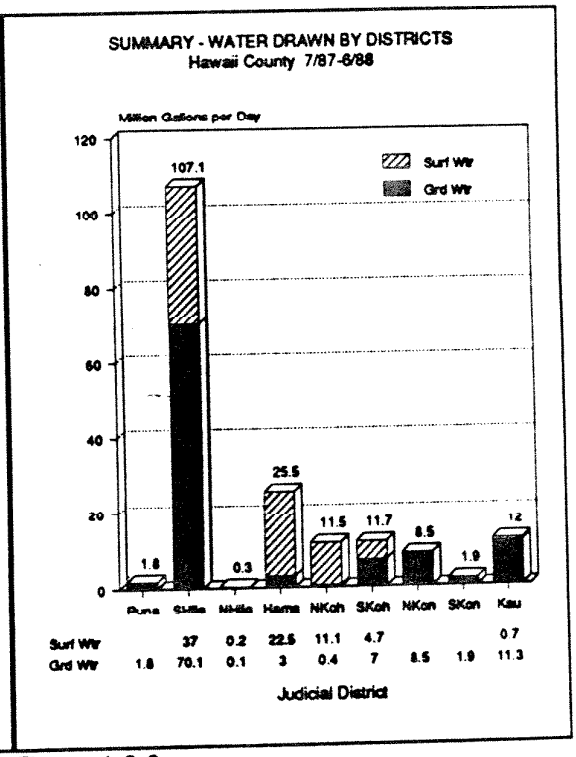


Figure 1.6-2

For this WUDP purpose, water uses in the island were categorized into the following six use groups: municipal systems; agricultural irrigation systems; military systems; private domestic, commercial, and industrial systems; native Hawaiian auwai systems; and other systems. The types of uses included in the groups are described in **Appendix C.** A tabulation of water withdrawn from ground and surface sources by use categories and aquifer sectors is given in **Table 1.6-1, and by use categories and districts is given in Table 1.6-2 in Appendix E.** Summaries of data from the tables are shown below in **Figures 1.6-3 and 1.6-4.**

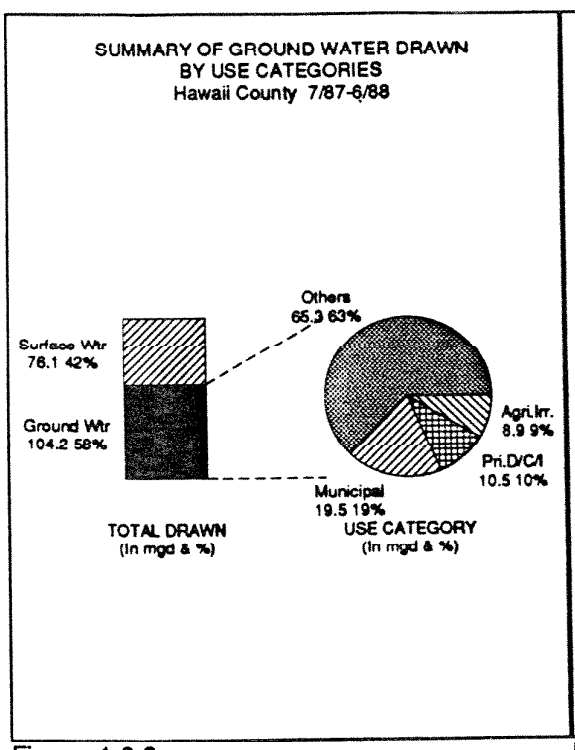


Figure 1.6-3

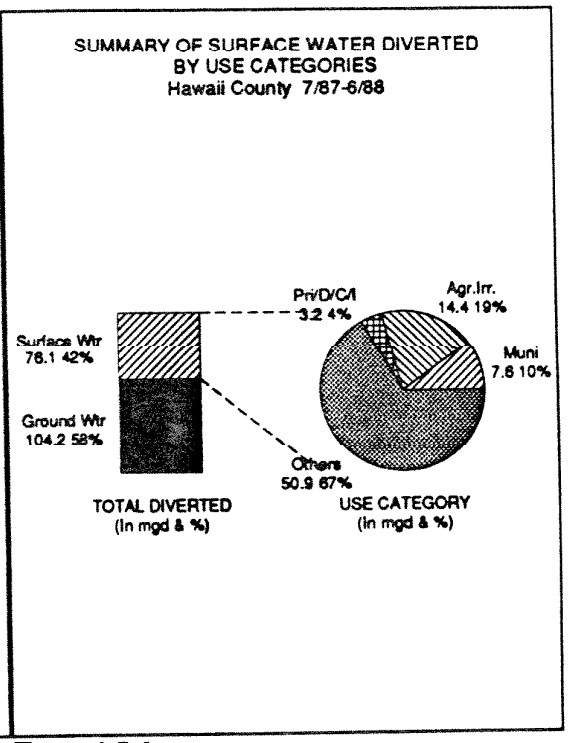


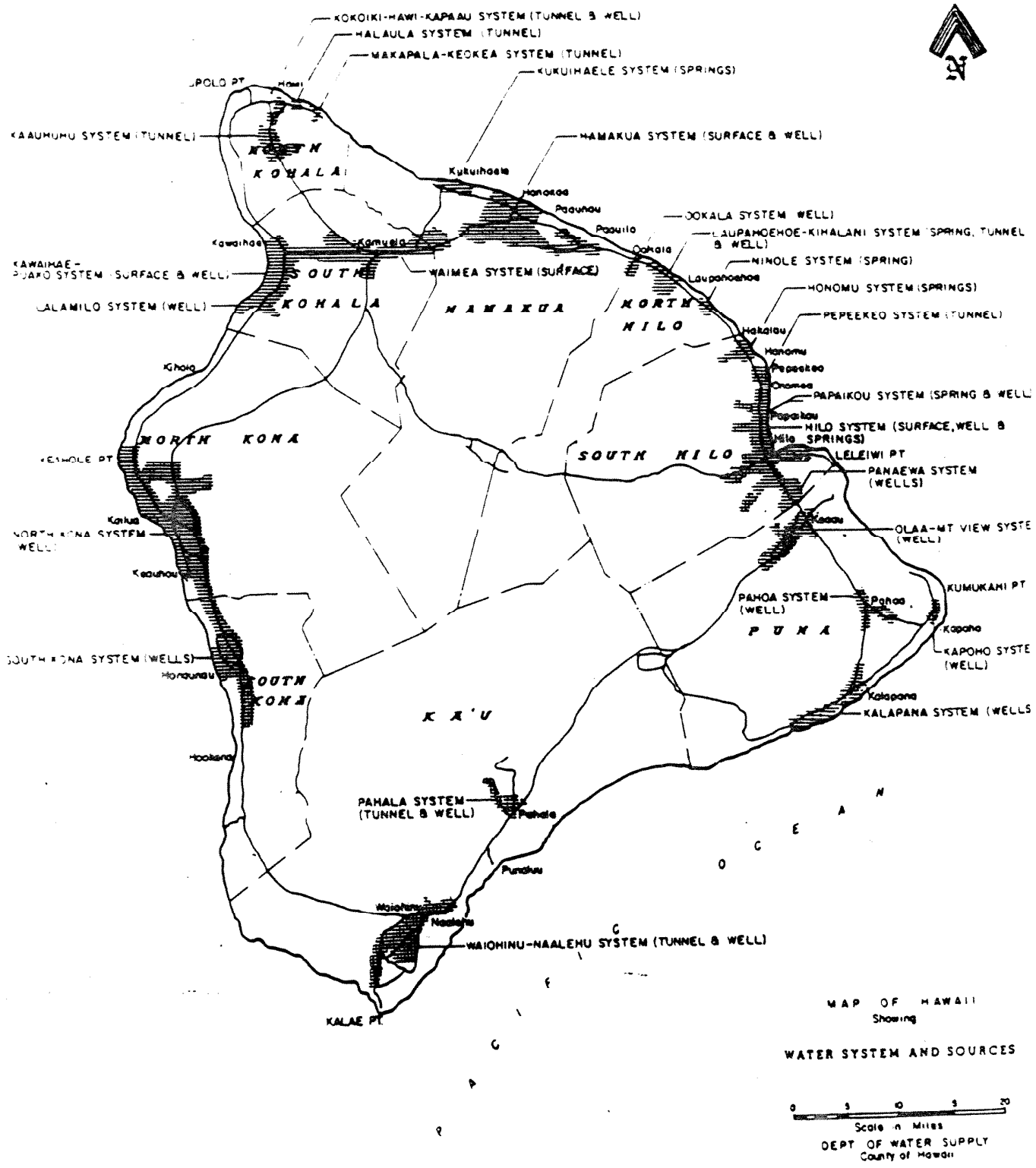
Figure 1.6-4

1.6.2 INVENTORY OF EXISTING WATER USES AND DEVELOPMENTS

An inventory of existing water uses and developments in Hawaii County by aquifer sectors is **Appendix C.** The inventory is summarized by use categories in the following sections.

1.6.3 MUNICIPAL SYSTEMS

The Hawaii County Water Department owns and operates 26 water systems on the island. These systems are located widely around the island and vary in size from the largest in Hilo with 11,603 services to the smallest in Ookala with 29 services. Several of the systems are interconnected to optimize use of resources. The general locations of the systems on the island are shown on **Figure 1.6-5 Municipal Water Systems.** The service areas and water sources of each system are shown on **Figures 1.9-1 to 1.9-7 Regional Water Development Plans.** Descriptions of the individual water systems are covered under the existing water uses and developments section of the pertinent district report.



MUNICIPAL WATER SYSTEMS

Source: Hawaii County Department of Water Supply

FIG. 1.6-5

The water sales pattern for the recent four year period is shown below in **Figure 1.6-5.** There were no significant increases in water sales during the last four years. A summary of water sold, source capacity, and draw on groundwater and usage of surface water by aquifer sector and systems is tabulated in **Table 1.6-3 in Appendix E.**

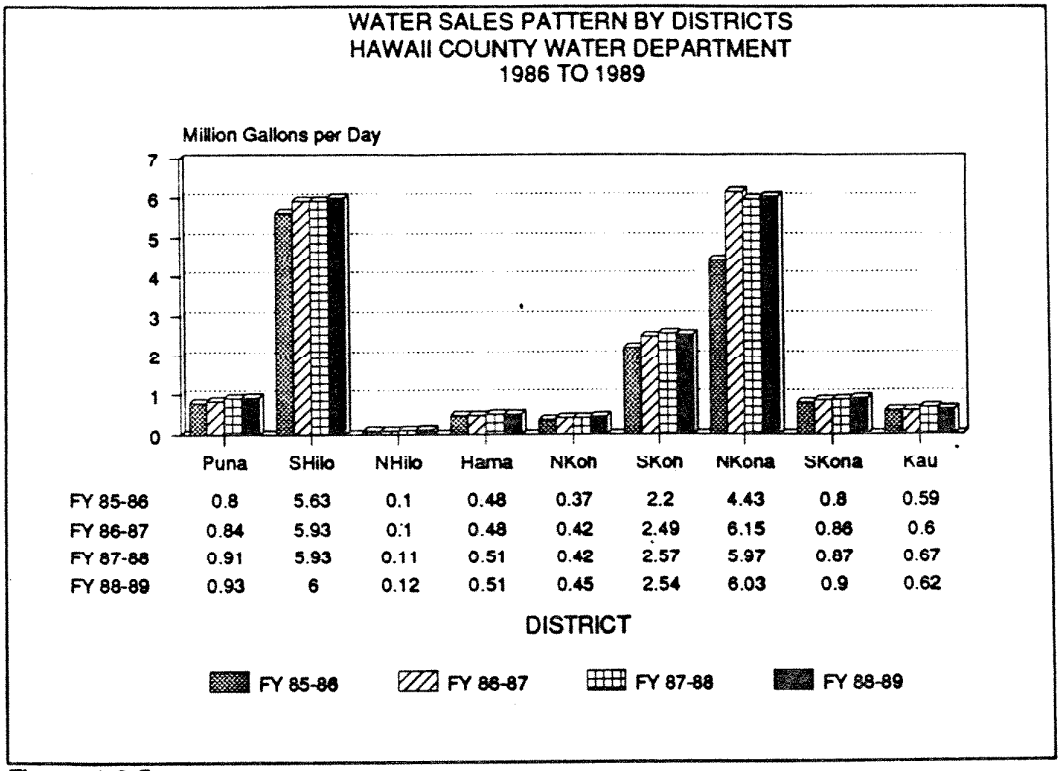


Figure 1.6-5

1.6.4 AGRICULTURAL IRRIGATION SYSTEMS

Agricultural water systems used a total of 23.3 million gallons a day or 12.8% of ground and surface water drawn in the island. Although surface water was extensively used in the past, surface water today makes up a much lesser share of irrigation water. Of the total used for irrigation, 14.4 mgd or 62% of the water were from surface sources. The remaining 8.9 mgd was derived from ground water sources.

The one agricultural irrigation system on the island dedicated solely for agricultural irrigation water is the State owned and operated Waimea Irrigation System in the South Kohala. The system presently serves 73 farmers cultivating about 478 acres of truck farms in Lalamilo, Puukapu, and the Hawaiian Home Lands farm lots in Kamuela (Waimea). Consumption is 1 to 2 million gallons a day. The Upper Hamakua Ditch in the Kohala mountains is the source for the system. A program to repair the ditch is currently underway.

The Kohala Ditch was once used to provide irrigation water for the Kohala Sugar Company sugar cane fields. Sugar is no longer cultivated in North Kohala. Today, in addition to agricultural irrigation for diversified agriculture, it supplies water to a hydroelectric power generation plant and to aquaculture projects.

Kehena Ditch on the west slope of Kohala Mountain is a multi-use surface water source with

an estimated divertable flow of 10 mgd. It is used for irrigation and livestock water. The other multi-use surface water source is the Lower Hamakua Ditch operated by Hamakua Sugar Company. In addition to water used for irrigation of the sugar cane fields, the ditch continues to provide industrial cooling and mill use water for the Haina sugar mill and domestic water for the company's Paahau Camp near Honokaa.

1.6.5 MILITARY SYSTEMS

There are two military water systems on the island. The Kilauea Military Camp located in the Volcano National Park relies on an extensive catchment and storage system for its water supply. The Pohakuloa Training Area in the saddle area between the slopes of Mauna Kea and Mauna Loa utilizes spring sources and tanker hauled water for its supply. The population of this military training camp fluctuates with the number of troops involved in the training being held at a specific time, and water demand fluctuates accordingly. For example, the population can increase up to 5,000 troops for major exercises, usually held during May to October. The annual water consumption is approximately 22 million gallons. Of this amount, depending on the weather, about 8 to 12 million gallons are supplied from three spring sources in Pohakuloa Gulch. The water from the springs is shared with the State's Pohakuloa Park. The balance of the water requirement for the training area is provided by private water haulers from Waimea and Hilo municipal systems.

1.6.6 PRIVATE DOMESTIC, COMMERCIAL, AND INDUSTRIAL SYSTEMS

This category accounted for 16.0 mgd or 8.8% of the total water use in the island. Of this total amount, ground water made up for 78%, most of which were from private wells for resort and domestic uses in west Hawaii and Kau. There is one small private system for domestic use in a subdivision in Puna. Industrial and domestic uses in various parts of the island made up the balance of the use. It should be noted that water for livestock and pasturage uses are included in this category.

1.6.7 NATIVE HAWAIIAN AUWAI SYSTEMS

Native Hawaiian auwai systems are mainly found in areas with spring or stream water sources such as in North Kohala, Hamakua and Kau districts. Since the auwai system of irrigation water is normally family-oriented and based on geneological records, there were no requirements for record keeping by the beneficiaries. In some cases, several families utilize the same stream for water source and the division of flow is usually based on arrangement between the families. This is the case in Waipio Valley where several families share the Waipio Stream flow for irrigation of the taro patches. The water is freely used and at times, returned to the stream.

1.6.8 OTHER SYSTEMS

This category which includes industrial cooling uses such as in electric generation plants and sugar mills, hydroelectric power generation, and aquaculture was the largest category of use and utilized 116 mgd or 63.6% of ground and surface waters. The power generation plants, which depend on wells for their supply, are located in the Hilo area, aquifer sector 804 which has a high sustainable yield capacity. The major hydroelectric plant is also located in Hilo and diverts surface water from the Wailuku River for its supply.

1.7 FUTURE WATER NEEDS

1.7.1 METHODOLOGY AND ESTIMATE OF NEEDS

Estimating future water needs is extremely difficult because of the many variables influencing the estimate. For this WUDP planning purpose, projected population for the districts were utilized as the base for estimating future water needs for areas of the island where municipal services would probably be utilized by all or the large majority of water users. Included in this category are potential demands of large land developments that may develop their own water systems in the future. For private systems now in operation, where possible, estimates were obtained from discussions with the system operators. In cases where future demand was not certain or available, the existing system capacity was assumed as the future demand.

The estimate for future municipal demand for each district was calculated by taking a modified per capita demand factor for a district and multiplying it by the projected population of the district, plus demand for hotel and resort condominium units located in the district. The modified per capita demand factor is intended to account for water demands for all categories of uses, except for hotel and resort condominium units. The rationale for this modified demand factor is to adjust for the larger than normal water usage by the hotels and resort condominiums, especially for landscape irrigation. The modified demand factor for a district was calculated by taking the daily consumption figure provided by the County Water Department, less estimated usage by the hotels and resort condominiums, and dividing it by the estimated existing population during the period of water consumption. The projected future population for the districts were provided by the County Planning Department. Where information was readily available, the estimates for the districts were cross checked with estimates from other sources. The calculations for the future need estimates are shown in **Appendix D.**

The estimated required future capacities of the water systems by categories of use are summarized by aquifer sectors in **Table 1.7-1** and by district in **Table 1.7-2,** in **Appendix E.** The summaries from the tables are illustrated, below, in **Figures 1.7-1 to 1.7-4.**

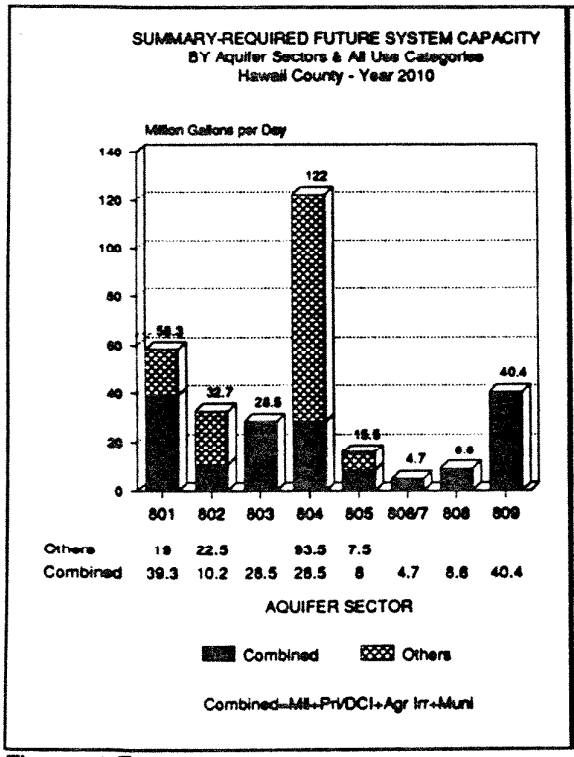


Figure 1.7-1

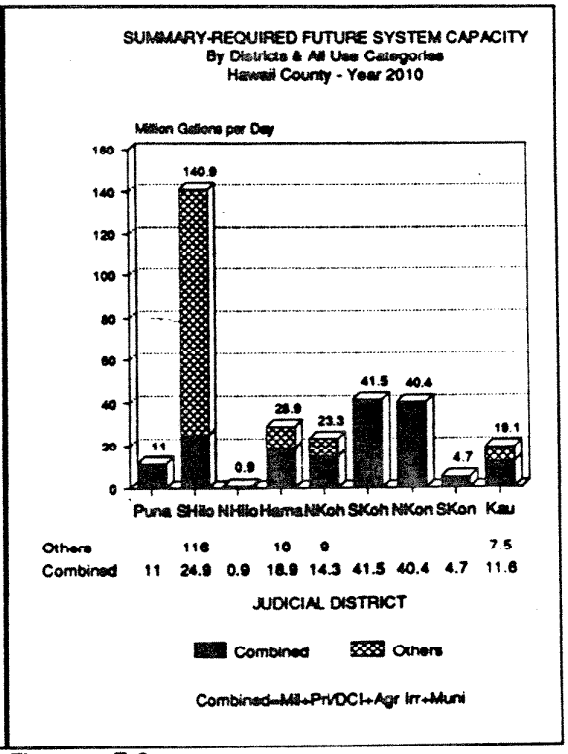


Figure 1.7-2

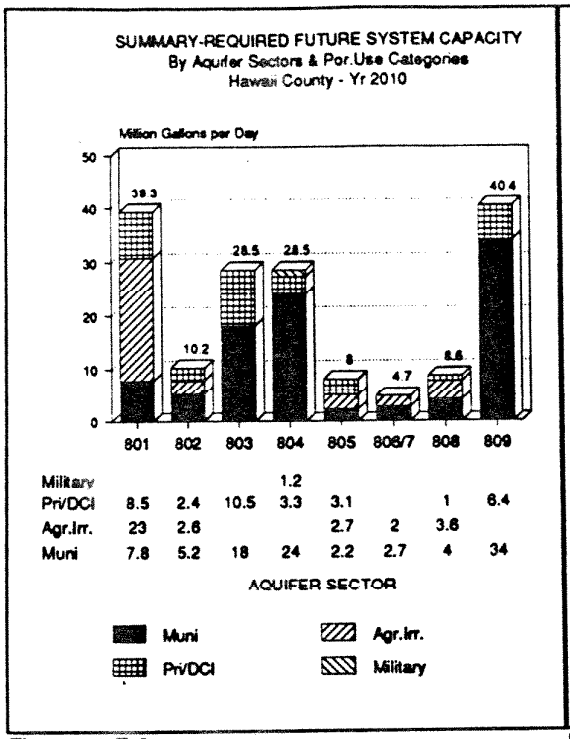


Figure 1.7-3

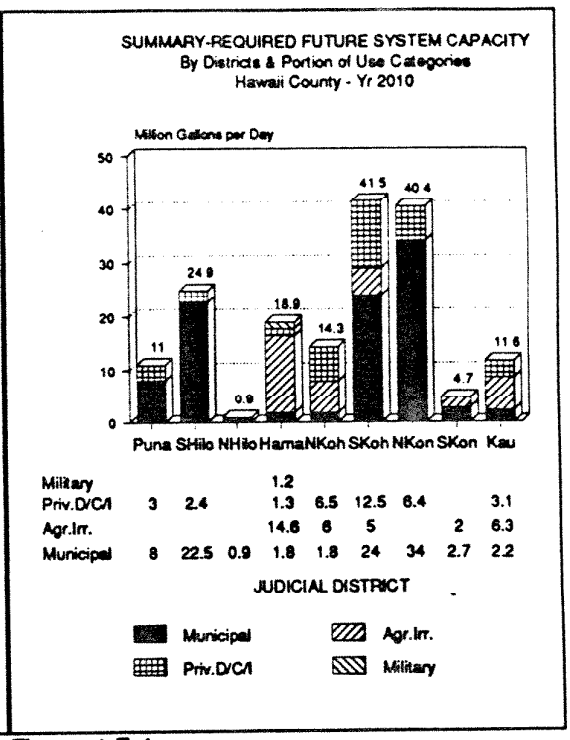


Figure 1.7-4

1.7.2 OVERVIEW

Figures 1.7-5 and 1.7-6, on the next page, give a comparison of the existing and estimated future water withdrawals from all sources for the aquifer sectors and judicial districts. In reading the graphs, care should be taken in comparing aquifer sector values and district values because boundaries of the sectors and districts do not coincide. In districts with small populations, such as in North Hilo and Kau, future withdrawals may appear relatively large because all future withdrawal values include capacities of backup wells. Although Puna shows the largest increase in future withdrawal (8.6 time current withdrawal), how much of it will actually occur would depend on the timing and extent to which water distribution systems are installed in the many non-standard subdivisions that currently lack water systems. Part of the increase shown in the South Hilo value is a result of assuming the existing capacity of the industrial users as future demand. Future withdrawals in South Kohala and North Kona are seen as having major increases at 3.6 and 4.6 times current withdrawals.

Figure 1.7-7, on the next page, shows a much larger role for the municipal system in the future. Of the total projected water withdrawals by all categories of uses, municipal systems would be drawing 32% of the total. As an approximate comparison, in 1987-88 year the municipal systems used 15% of the total consumption. This upward trend will probably continue as the county becomes more urbanized and water quality regulations become more stringent. On the other hand, although agricultural irrigation category is seen as reducing, some of the reduction can be attributed to farmers locating in State sponsored agricultural parks which rely on municipal systems for their water supplies. The increase in private sector systems is primarily due to water systems being developed by the resorts and subdivisions to supply water for their own uses such as for resort hotels and condominiums, resort landscape and golf courses, and subdivision homes, amenities and landscape.

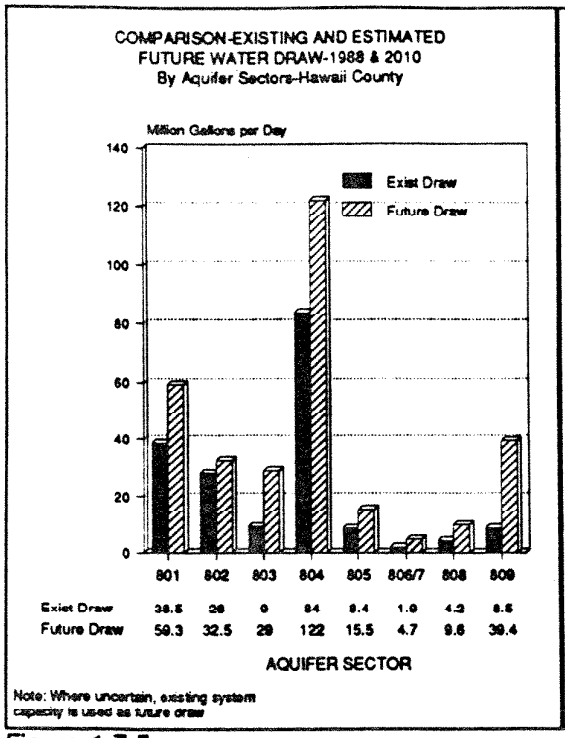


Figure 1.7-5

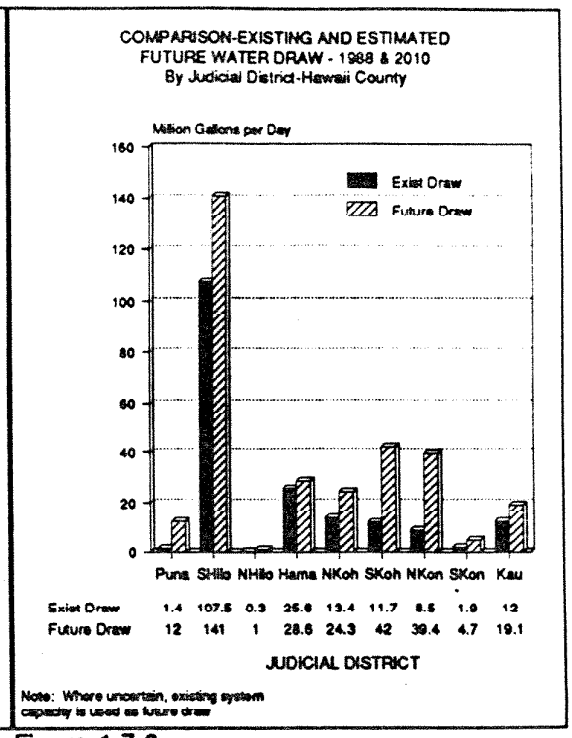


Figure 1.7-6

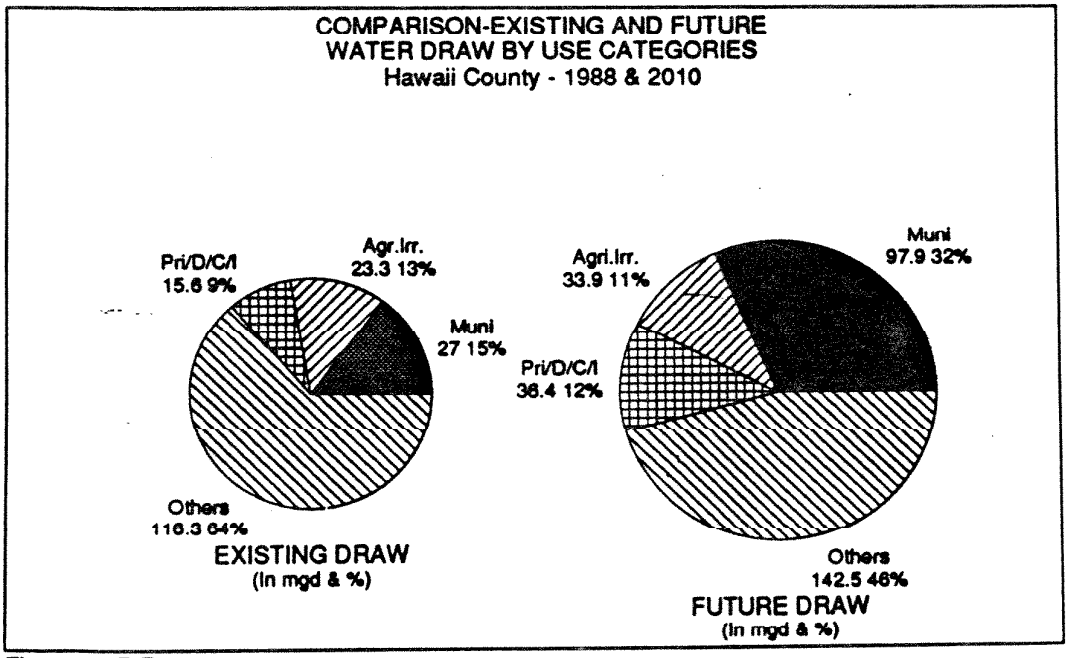


Figure 1.7-7

The island districts that are now experiencing the tremendous surge in resort and related developments face major challenges in meeting their future water needs. The two districts that will be impacted most heavily are South Kohala and North Kona. The primary growth area in South Kohala is expected to be in the lower coastal region anchored by the Mauna Kea Beach, Mauna Lani and Waikoloa resorts. In this coastal region served by the County's Kawaihae-Hapuna-Puako System, the source is the Lalamilo well field. The total future municipal water requirement is estimated to be 15.8 mgd. At present, the Lalamilo well field's maximum production is 3.8 mgd from three wells. A fourth well is expected to go on line boosting the total capacity to 4.8 mgd. Further exploration should be initiated immediately to determine feasibility of locating additional well sites or finding alternative sources to meet future needs. The Waikoloa Resort has its own private water system and its future water demand will be fulfilled from its own well field.

The other growth area anticipated in South Kohala is the upper region of Waimea Village and its surrounding residential/agricultural community. There has been unprecedented commercial expansion in recent years in Waimea Village. The present total water usage exceeds 1.6 mgd. The capacity of the municipal system will be limited by its storage capacity, currently at 3.6 mgd. As experienced in the past, the 3.6 mgd capacity will probably be insufficient during prolonged periods of dry weather, particularly if more consumption than anticipated occurs. A standby source, such as a deep well, or wells providing up to 2.0 mgd should be considered. The Parker Ranch 20/20 Master Plan will in all probability result in increased domestic supply in the Waimea Village area. In addition to domestic water supplies, plans are in progress for expanding the Waimea Irrigation System to serve additional Hawaiian Homes Land farm and ranch lots at Puukapu, and additional farm acreage at the State's Lalamilo Agricultural Park. The additional irrigation and livestock water need is estimated to be 2.0 mgd bringing the total future requirement to about 5.0 mgd.

In the North Kona area, based on development plans approved, pending and proposed, the region north of Kailua Village extending to the State lands of Puuwaawaa, is poised for tremendous growth. State plans for Kealakehe and the Ke-ahole Airport and HOST Park, and development of private lands at Kohanaiki, Ooma, Kukio, Kaupulehu, and other lands indicate a total future water need of 33.0 mgd for the North Kona District including private water systems. The municipal system will require 26.6 mgd. This estimate could increase another 3.0 mgd depending on the activities in the Ke-ahole Airport vicinity including the NELH and HOST Park, airport expansion including commercial and industrial uses, Keahole Agricultural Park, and the privately owned Mahaiula beach site. While the area of greatest future need will be in the area north of Kailua Village, the future municipal water consumption is expected to be equally divided between the area north of Kailua Village to Ke-ahole Airport and the area south of the Village, including the mauka communities from Holualoa to Kainaliu.

The remaining districts on the island are not expected to be as heavily impacted as South Kohala and North Kona from the accelerated tourism activities. The Hawi area in North Kohala and Honokaa area in Hamakua will probably experience spinoff impact in terms of housing demands from those working in resort areas and subdivisions with larger and more expensive homesites, both resulting in added water needs. The southern side of North Kohala along the slopes of Kohala Mountain and parts of the coast are also beginning to develop as luxury homesites and ranches. These types of developments are expected to be higher than normal water consumers, primarily because of landscape irrigation needs. The Kohala Ranch project has developed a private water system for its own needs.

On the east side of the island, from Hamakua to Kau, no major increases in water demands are anticipated. The one exception is the Puna District, where considerable population growth in projected. However, many of the new residents will probably reside in non-standard subdivisions and rely on private individual roof catchment systems for water. Thus, future water demand is not expected to fully develop until such time that means are found to install water distribution systems in the subdivisions.

Many of the municipal systems on the east side rely on springs and streams for all or part of their water supply. The need to develop new ground water sources to replace these surface

water sources is expected to arise as decisions are reached on bringing existing municipal systems into compliance with federal water quality regulations. Thirteen of the twenty-six County systems, including the large Hilo system will be affected by the regulations. Allowances have been included in the future water need estimates in anticipation of such move and also to provide for backup wells. The issue of compliance with the water quality regulations is discussed in Section 1.8 below.

1.8 WATER PROBLEMS AND OPPORTUNITIES

Historically, the windward and rainier side of Hawaii Island, with its plentiful water supply, sustained the bulk of the economic activities and population. Today, with the island's economic activities shifting toward visitor-service oriented industries, the sunny and dryer leeward side of the island, with its limited supply of water, is becoming the prime location for tourism facilities and supporting infrastructure.

The leeward side of the island, more specifically the districts of South Kohala and North Kona, is facing the problem of huge demands versus limited supply of ground water. The windward side, although not faced with the problem of huge future water demands, is facing the problem of bringing its spring and surface water sources into compliance with federal safe drinking water regulations and water quality standards and upgrading many of its older systems.

Figure 1.8-1, below, gives a comparison of the existing water drawdrawals, estimated future withdrawals and estimated sustainable yield values of the aquifer sectors. With the exception of Sectors 803 and 809, the remaining sectors appear to have sufficient margin over future withdrawals to meet future needs. Sectors 803 and 809 are discussed on the following page.

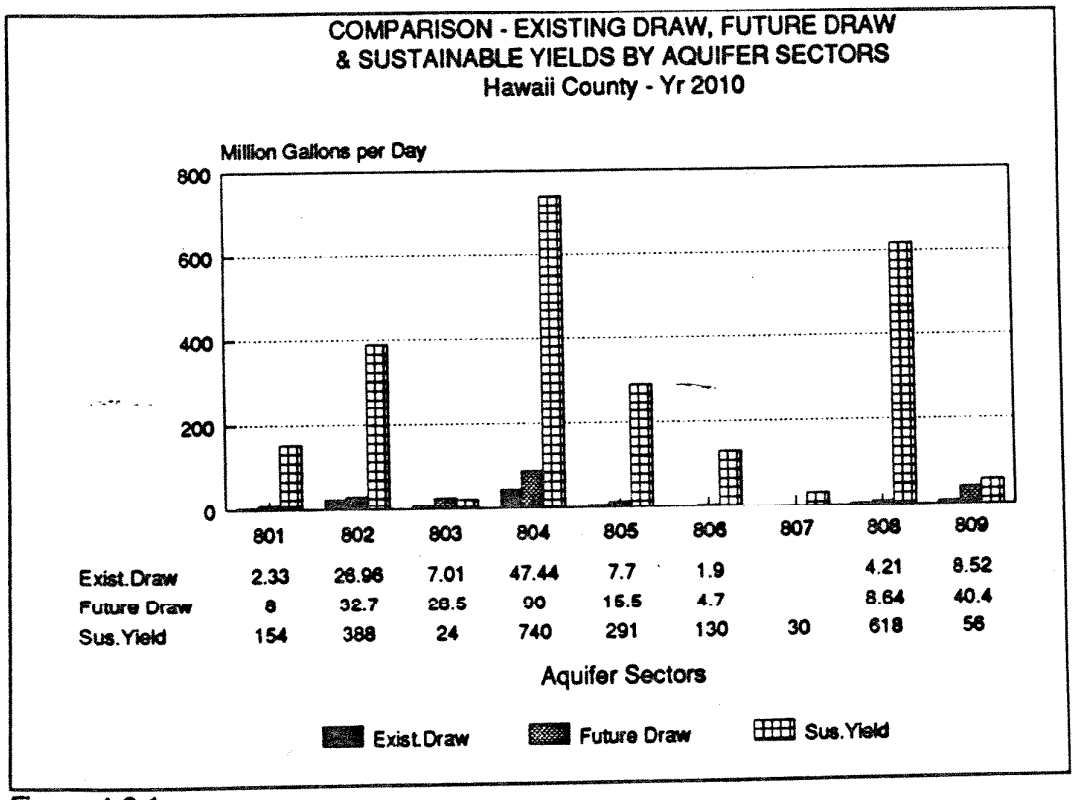


Figure 1.8-1

Although the coastal region of the South Kohala District is seen as the focal point of resort hotel and condominium projects, the mauka Waimea Village and surrounding areas are also blossoming into a bustling community. The mauka areas must continue to rely on high level water supplies, primarily from the Kohala Mountain streams. However, because of its limited supply during dry weather, alternative sources such as high level dike impounded waters need to be explored and tapped. In the makai coastal areas, the demand may possibly exceed the capacity of the Lalamilo well field. Although further explorations in the region may discover additional water, the projected demand of about 16 mgd will require considerable aquifer resource. Alternative means such as transfer of water from the Hawi area must be considered if growth is to continue in the makai area.

The unprecedented growth of the North Kona District is taxing the existing well sources to near capacity. The existing North Kona basal water table source was developed only after exhaustive studies. However, it appears that the success of the Kahaluu well site cannot be duplicated elsewhere in Kona. Even at the lower section of this site, the Kahaluu inclined shaft well source is precariously close to over-pumping. The chloride content has risen to dangerously high level. New well sites must be found to supplement the Kahaluu site. The well-drilling program by the State has to be accelerated. Should a new well test favorably, much of the well development and related equipment costs can be passed on to prospective users in the form of impact fees.

Figure 1.8-2 shows a more detailed look at the two aquifers underlying the portions of South Kohala and North Kona where most of the growth in the Kona-Kohala Coast region is anticipated. **In evaluating the future draw requirements against the sustainable yield estimates, careful consideration must be given to the caution cited on Page 1-6 that the sustainable yield value includes potable and non-potable water, and that in Sector 809, non-potable water constitutes a sizable fraction of the sustainable yield.** In any case, it appears that projected future needs will exceed the sustainable yield value estimates for Sectors 803 and 809. Consequently, early action must be taken to manage the ground water resources and to seek alternative ways to obtain added water supply for the pertinent areas to have continued growth.

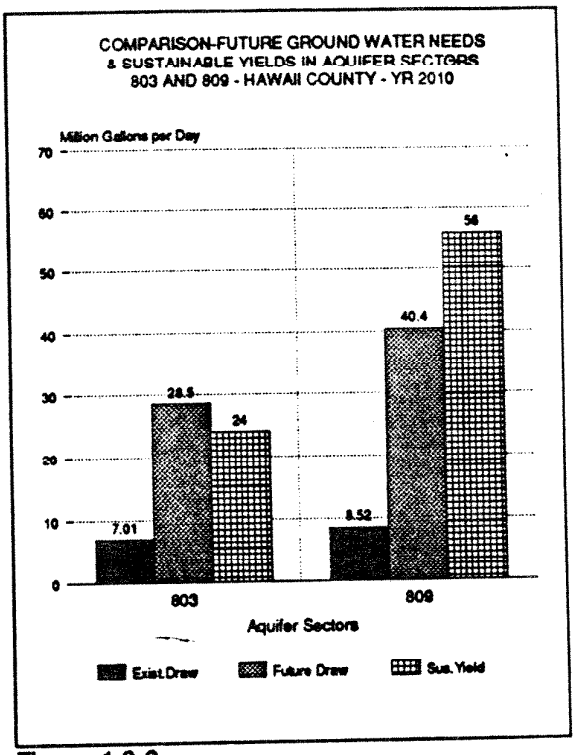


Figure 1.8-2

Figures 1.8-3 and 1.8-4 on the following page, show possible water demand growth scenarios for Sectors 803 and 809. Although variations will probably occur from the assumed straight line increase approach, the scenarios for both sectors essentially show that time is critical since demand could approach the practical limits of withdrawal capacity in the next 5 to 10 years. Because of the lack of ground water information in the affected region, in order to develop a sensible and workable resource management and development plan, it is critical that the on-going well exploratory program be given the highest priority for funding and work accelerated as quickly as possible.

In order to help ease future water demand on the aquifers, now is an opportune time to begin researching and encouraging ways to conserve water, particularly in reducing potable water use for crop and landscape irrigation. Some of the ways would include selective landscaping planting and material, use of brackish water for irrigation, particularly in the lower elevation

areas, drip and other water conservative techniques for irrigation, and use of recycled effluent from wastewater treatment plant for applicable irrigation. Public planning can take a lead role in encouraging water conservation. For example, care can be taken in selecting the plant material and method of irrigation for the landscaping concept proposed in the draft of the County's Kea-hole to Kailua Development Plan to minimize use of potable water for irrigation. Although still a relatively expensive alternative for obtaining potable water, advances in desalinization techniques warrant monitoring of the process for possible application to the idea of utilizing brackish water sources for potable water supply.

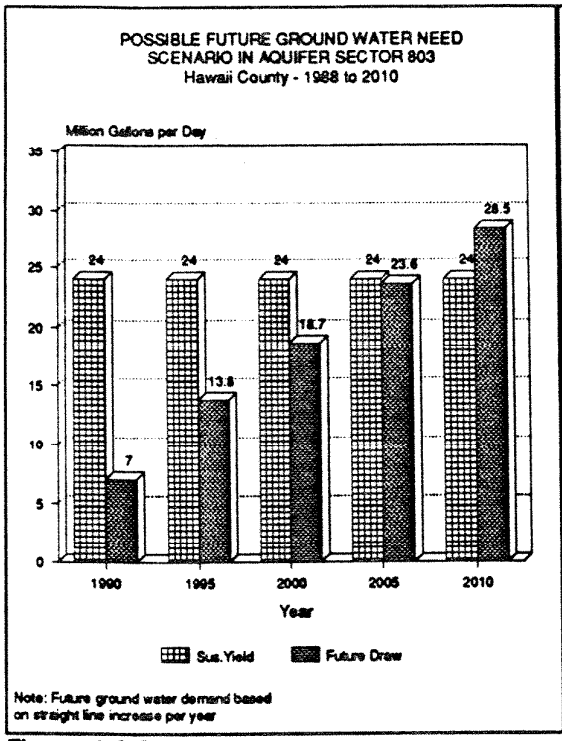


Figure 1.8-3

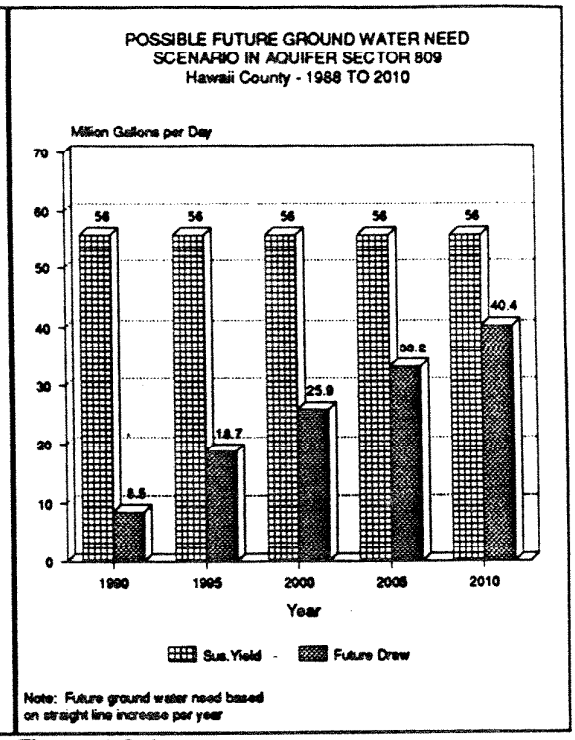


Figure 1.8-4

The federal Safe Drinking Water Act regulations will impact all public water systems. Under the regulations all public water systems must meet stringent monitoring requirements to test for four groups of contaminants-lead, microbiological, radiological, and disinfection by-products. In addition, they must monitor for presence of a large number of chemicals and a list of non-regulated contaminants. The systems on the windward side from North Kohala to Kau that utilize springs and streams as water sources will be impacted most heavily since the rule requires those sources designated by the State Department of Health must filter and disinfect the water prior to distribution, unless site specific conditions are met. The State Department of Health must determine by June 1990 which systems with surface water sources must filter its water. By 1991, all public water systems designated by the Health Department must meet the filtration requirement. Compliance with the regulations may be a major cost item, depending on the systems designated for compliance with filtration requirements. Per customer cost will be particularly high for those systems with small number of service accounts.

The Puna District is forecasted to have a relatively large population growth despite the lack of employment opportunities in the district. Many of the new residents are expected to live in homes built on the thousands of non-standard subdivision lots available in the district. The County civil defense agency estimates that more than 8,000 homes in the Puna, Kau, and

South Kona districts depend on individual roof catchments and storage systems for their water supply. To provide water services to these residents will be a major undertaking. In addition to the cost of the distribution hardware, acquisition of water facility easements will be a problem because the large number of absentee owners. Financing of the improvements through a vehicle such as improvement district bond would be a possibility, but, obtaining consensus among the affected property owners may be a major obstacle to such financing. However, because of the large number of residences and population that are affected by the lack of a reliable water supply, particularly during drought periods, effort must be made to seek a solution to the problem.

1.9 REGIONAL WATER DEVELOPMENT PLANS

1.9.1. MUNICIPAL AND STATE PLANS

The most ambitious project proposed for the island is the Kohala Coastal Transmission Pipeline to provide for the long term water needs of South Kohala coastal resort region. The approximately 20 mgd capacity of this project will accommodate the anticipated growth of the South Kohala coastal region and also the potential development along the leeward coast of North Kohala. The proposal calls for establishing a well field in the area between Hawi and Pololu. The water would be transported through a large diameter pipeline to a series of distribution reservoirs located along the South Kohala coast. The estimated cost of the project is $50 million.

In the mauka Waimea area, the State is proposing to expand the Waimea Irrigation System to allow an increase in irrigated farm acreage and also provide additional stock water. This project will add 363 acres of irrigated farm lands to the Waimea Irrigation System. Approximately 22,800 acres will be served by a separate livestock water distribution system. The Puukapu deepwell development project will be the first high level well source for the Waimea area in the South Kohala District. The initial use will be as a standby source for the Waimea Irrigation System with a capacity of 1.0 mgd, more or less.

The most urgent program in North Kona is the accelaration of well exploration and development of additional wells at new sites to lessen the load on the Kahaluu well and shaft sites to prevent increase in salinity content. From experience, it appears that rather than clustering many wells in one location, it is better to have the wells spread out over a larger area to prevent over-drawing at any one single location.

Since about half of the projected population in North Kona is expected to reside in the area south of Kailua Village, the County's Alii Drive realignment plan presents an opportunity to install a major transmission main between Kailua Village and Keauhou Resort to service the abutting lands and also strengthen the distribution network located south of Kailua Village.

The thrust of the water development proposals for the Hamakua, Puna and South Hilo districts is to develop sufficient ground water sources and storage reservoirs to adequately service the urban expansion areas designated in the General Plan land use pattern allocation guide map. Because of the heavy dependence on surface water in the Hilo system, the proposal is to do a study on filtration versus well system to determine which course of action to take in complying with the federal Safe Drinking Water Act regulations. In conjunction with this study, an investigation into the problem of high unaccounted water use is recommended because of the effect on operational cost.

Development proposals for systems in the Hawi to Makapala area of North Kohala, North Hilo, Kau, rural South Hilo and parts of Hamakua are primarily aimed at meeting federal water quality standards and upgrading the systems to provide new wells and improve storage capacity.

The general locations of the proposed water developments described above and in the district sections of this WUDP are shown on **Figures 1.8-1 to 1.8-7.** Descriptions of proposed water development plans that are pertinent to specific districts, including projected impacts and estimated costs of municipal plans, are given in the district sections of this WUDP.

1.9.2 PRIVATE PLANS

Water development plans for the private sector in West Hawaii are, for the most part, based on inadequate data. It is not so much if water can be found but it is the sustainable yield of the aquifers that is of concern. While large tracts of land have been re-classified to urban district, water development details have been sketchy. Most of the private North Kona development proposals have water supply improvements based on limited data or include statement that the improvements will conform to County subdivision water requirements. The lack of accurate water resource data, more particularly basal supply and its sustainable yield may delay anticipated private development plans.

Except for very large resort developments such as at Waikoloa which has its own private water company, it may be more feasible for private entrepreneurs to provide capital for water development than for water exploration. It appears at this time that because of the huge expenditures necessary for water development in North Kona-Kohala Coast region, in order to organize and aggregate the necessary funds for water developments, the practical alternative is to plan and fund a municipal water system expansion program in the region to service future needs. Such a program would work in conjunction with an accelerated State exploratory well program, and an impact fee assessment program to be applied to all parties requiring water for development.

On the east side of the island, the vast majority of the water consumers are serviced by municipal systems, including small farms on individual lots and in State sponsored agricultural parks. Private systems are primarily owned and operated for industrial purposes. It appears that most systems have sufficient system capacity for the foreseeable future. However, in the event additional system capacity is required, the water resources that are within reach of these industrial users have capacities to accommodate future needs.

1.10 PLAN IMPLEMENTATION

Water facilities development, operations, and maintenance of the municipal systems in the County of Hawaii are managed by the County Department of Water Supply. The general descriptions of the proposed municipal water developments reported in this WUDP reflect the Department's plans for system upgrades and developments. Of particular importance is the proposal to accelerate ground water source exploration in the west side of the island from North Kohala to South Kona. The results of the exploration will be critical in determining the extent of recoverable potable ground water in the west Hawaii aquifers.

Although much of the system upgrade projects are included in the Water Departments 5-year capital improvements program budget, intermediate and long range CIP plans for source development and major projects such as the Kohala Coastal Transmission Pipeline should be prepared.

Programming and implementing water development projects such as source development, transmission main, distribution lines, pump stations, and reservoirs can proceed with a better degree of coordination under an integrated long range planning program. The Keahole to Kailua Development Plan by Hawaii County, though still in draft form, and the West Hawaii Regional Plan by the State are the types of long range planning needed. The speculative aspects of water development can be minimized and water use regulations administered more efficiently and effectively.

In addition to CIP appropriations from the State and Federal governments, the use of impact fee is expected to increase. The impact fee provision will help prevent undue costs to existing consumers for system expansions. The goal is to assess costs commensurate with the benefits to the intended users or target group. The public and private sectors should work together to find and establish alternative approaches for financing of water developments.

COUNTY OF HAWAII STATE OF HAWAII

BILL NO. 246
(Draft 2)

ORDINANCE NO. 90 60

AN ORDINANCE AMENDING THE HAWAII COUNTY CODE 1983, BY ADDING A NEW CHAPTER RELATING TO WATER USE AND DEVELOPMENT.

BE IT ORDAINED BY THE COUNCIL OF THE COUNTY OF HAWAII:

SECTION 1. The Hawaii County Code 1983, is hereby amended by adding a new chapter, relating to water use and development, to be appropriately numbered and to read as follows:

"Chapter _____

WATER USE AND DEVELOPMENT

SECTION . Purpose. Recognizing that the waters of the State are held for the benefit of the citizens of Hawaii, and that such citizens have a right to have those waters protected for their use, the State Legislature established by Act 45, Session Laws of Hawaii (SLH) 1987, the State Water Code, which is intended to address problems relating to the supply and conservation of water and to serve as a program of comprehensive water resources planning. As a method of facilitating this intent, the Code, now codified as Chapter 174C, Hawaii Revised Statutes, mandates the creation of a Hawaii water plan which shall be directed toward the achievement of the following objectives:

1. The attainment of maximum reasonable-beneficial use of water;

2. The proper conservation and development of the waters of the State;

3. The control of the waters of the State for such public purposes as navigation, drainage, sanitation, and flood control;

4. The attainment of adequate water quality; and

5. The implementation of water resources policies.

Among other things, the Hawaii water plan shall consist of water use and development plans for each county which shall be prepared by each separate county. Such water use and development plans shall set forth the allocation of water to land use in each particular county and are intended to serve as technical reference documents on the current and future water resource conditions on each island.

A Hawaii County water use and development plan has been prepared under the direction of the Hawaii County Department of Water Supply. The document is intended to fulfill the requirements set forth by the State Water Code and includes the following:

1. The status of water and related land development, including an inventory of existing water uses for domestic, municipal, and industrial users, agriculture, aquaculture, hydropower development, drainage, reuse, reclamation, recharge, and resulting problems and constraints;

2. An analysis of future land uses, as described in the Hawaii County General Plan, and related water needs; and

3. Regional plans for water developments including recommended and alternative plans, costs, adequacy of plans, and relationship to water resource protection and quality plan.

Pursuant to the provisions of the State Water Code, each county water and development plan is required to be adopted through ordinance by the council of the county to which it pertains before it may properly be incorporated into the Hawaii water plan.

SECTION . The Hawaii County Water Use and Development Plan. The Hawaii County Water Use and Development Plan of December 1989, incorporated herein by reference, is hereby adopted.

SECTION . This ordinance may be amended in the same manner as any general ordinance.

SECTION . Mandatory Plan Review. The Hawaii County Water Use and Development Plan shall be reviewed in 1995 and every fifth year thereafter. The Water Commission of the County of Hawaii shall serve as the plan review committee. The planning director and the manager of the department of water supply shall serve as technical advisors to the plan review committee. The committee shall hold at least one public hearing in East Hawaii and West Hawaii in

order to ascertain whether amendments to the plan are necessary. The committee may propose amendments to the existing plan and all such proposed amendments shall be submitted to the council in bill form no later than December 31, of the plan review year."

SECTION 2. New material is underscored. In printing this ordinance, the underscoring need not be included.

SECTION 3. If any provision of this ordinance or the application thereof to any person or circumstance is held invalid, such invalidity shall not affect other provisions or applications of the ordinance which can be given effect without the invalid provision or application, and to this end, the provisions of this ordinance are declared to be severable.

SECTION 4. This ordinance shall take effect upon its approval.

INTRODUCED BY:

COUNCIL MEMBER, COUNTY OF HAWAII

Hilo, Hawaii

Date of Introduction: April 18, 1990
Date of 1st Reading: April 18, 1990
Date of 2nd Reading: May 2, 1990
Effective Date: May 10, 1990

SECTION 2. PUNA DISTRICT

2.1 DISTRICT PROFILE

The district of Puna occupies the southeast sector of the island and has 318,054 acres from sea level to 5,000 feet elevation in the Kulani area. **See Figure 1.2-1,** following page 1-2, for map showing location of the district and its boundaries.

Average temperature ranges from 70 to 90°F in coastal areas and drops to 50°F at 5,000 feet elevation. Average annual rainfall in the coastal areas ranges between 59 inches along the dryer, southern coastline to 118 inches along its windward or eastern coast line. Heaviest rainfall at 196 inches a year occurs at the 2,000 to 3,000 feet elevations in the general area of Mountain View and decreases to 118 inches at the district's uppermost areas. **See Figure 1.2-2** for Rainfall Map.

The major economic activity for this district is diversified agriculture, primarily in fruits and vegetables, macadamia nuts and flowers. These activities consist of large tracts of commercial macadamia orchids on the Hilo side of Keaau, extensive papaya groves in Kapoho, and major productions of orchids and anthuriums in Mountain View, Pahoa and Kapoho. These are activities that have experienced rapid growth in recent years but are constrained by labor shortages, housing, processing requirements and plant disease.

The State has been encouraging the development of alternative energy from geothermal sources located in the district. The emergence of geothermal energy could open opportunities for development of agricultural and manufacturing related activities in the district.

Puna has the fastest growing population on the island. Its population increased from 11,775 in 1980 to an estimated 19,000 in 1987. This recent growth is attributed partly to new employment opportunities in Hilo, expanded agricultural activities in the district, and new residents seeking housing in affordable priced house lots. There are thousands of lots in the district in non-standard subdivisions on which residential construction has increased considerably.

The population is projected to reach 39,865 by year 2010, an increase of 110% from 1987. The distribution of this population is estimated at 19,650 persons in the Keaau-Mt.View-Volcano region and 20,215 persons in the Hawaiian Paradise Park-Pahoa-Kalapana region. The district's population centers are expected to be in the Keaau and Pahoa areas. Although the district remains agricultural in character and economy, it is likely to also become a bedroom community for people working in other districts.

There are 3,188 acres of land zoned for single-family residential use in the district, of which 2,493 acres or 78% were vacant. It is estimated that there were 6,350 single-family units in 1987. By year 2010, this number is projected to double to 13,080 units. The Puna district has few areas zoned for multi-family residential use. There were 89 units in 1985. This number is expected to increase to about 210 units by year 2010.

Although there are 197,000 acres of land in the district zoned for agricultural use, less than 50,000 acres are in actual agricultural production. A large portion of the agriculturally zoned lands has been subdivided into lots which are being used primarily for residential use. These lots are mostly located in non-standard subdivisions created prior to the adoption of the County's zoning ordinance. The district is the major papaya growing region in the State. Expansion of macadamia nut orchids is planned for former sugar lands. Extensive banana plantings occur in Keaau. There are numerous truck farms in the Volcano area producing cabbage and lettuce.

Keaau and Pahoa serve as the commercial centers for the district. Keaau has a shopping center with grocery and general merchandise stores, service stations, retail shops, post office, police and fire stations and other miscellaneous services.

The major industrial activity in Puna is a macadamia nut processing plant. Other industrial activities include a rock quarry operation, slaughter house, flower packaging, papaya processing and packaging, and several cottage industries. An industrial park developed by WH Shipman Ltd. in Keaau is attracting many new industrial tenants to the district.

There are no visitor accommodations in Puna. Although resorts have been proposed in the district, the general lack of infrastructure improvements and the potential danger from volcanic activity in certain areas will probably continue to discourage developments. However, there has been renewed interest in the King's Landing area of the district for resort-residential type uses.

Data from Hawaii County General Plan, 1989. **See Figures 1.5-1 & 1.5-2,** following page 11-2 for Land Use Maps showing Puna District land use pattern.

Proposed Land Use Pattern Acreage Allocation:

Residential	Commercial	Industrial	Resort	Total
22,535 ac.	2,254 ac.	3,380 ac.	91 ac.	28,260 ac.

Proposed Zoning Acreage Allocation:

Residential	Commercial	Industrial	Resort	Total
9,014 ac.	901 ac.	1,352 ac.	55 ac.	11,322 ac.

Urban Expansion Locations:

Keaau Village and Kurtistown
Area mauka of Volcano Highway between Keaau and Kurtistown
Pahoa Village

Land Use Policies and Water Utility Courses of Action:

The General Plan goals and policies relating to the county economy and population, environmental quality, water, and land use are listed in **Appendix B** - County General Plan Goals and Policies.

The water utility courses of action proposed for the Puna District are:

- Improve inadequate water system facilities.
- Continue water source investigation and exploration in order to provide service for anticipated needs.

2.2 EXISTING WATER USE AND DEVELOPMENT

2.2.1 INVENTORY

An inventory of existing water uses and developments in Hawaii County is detailed by aquifer sectors and systems in **Appendix C.** The inventory for the Puna District is summarized by use categories in the following sections.

2.2.2 SUMMARY OF WATER USE, SYSTEM CAPACITY AND WATER DRAW

Table 2.2-1, on the next page, gives a summary of the average amount of water sold daily by the municipal systems or used by private systems, the surface flow or well pump capacity of the water source, and the volume of water drawn from the source. Where recorded data was not available, estimates of water drawn were made based on information from system operators, well and stream diversion registration forms, and other available data.

Deep wells are the only sources utilized for water supply in Puna. The total water usage in the district may appear small in relation to its land size and estimated population. One reason is

the several thousand residences in the district that rely on private individual roof-catchment and storage system for their domestic water. Another reason is the absence of large industrial cooling usage since the closing of the Puna sugar mill in Keaau.

The total average amount of water drawn from the aquifer was 640,000 gallons per day. Of this total, municipal systems and private domestic accounted for over 95% of the water. It should be noted that the State's Pahoa Agricultural Park and many of the small farmers draw their irrigation water supply from the municipal systems.

TABLE 2.2-1

SUMMARY OF WATER USE, SYSTEM CAPACITY, AND WATER DRAW - PUNA

System	Aquifer Code	Average Use mgd	Low Flow or Pump Capacity mgd	Ground Water Draw mgd	Surface Water Draw mgd
Muni/Keaau-Mt.View	80402	0.488	2.340	0.729	-
Muni/Pahoa	80801	0.294	1.872	0.426	-
Muni/Kapoho	80802	0.057	0.144	0.065	-
Muni/Kalapana	80802	0.071	0.878	0.086	-
Muni Total		0.422	2.894	0.577	-
Priv/Domestic	80801	0.032	0.500	0.032	-
Priv/Commercial	80402		0.144	0.001	-
Priv/Industrial	80402	0.024	0.216	0.024	-
Priv/Industrial	80402	0.380	1.224	0.038	-
Priv Total				0.063	

2.2.3 MUNICIPAL SYSTEMS

The Hawaii County Department of Water Supply has four separate water systems in Puna with a total of 1,987 service accounts. The systems consumed an average of 422,000 gallons per day in 1988. Descriptions of the systems are given below. The general locations of each system's service areas and water sources are shown on **Figures 1.9-1 and 1.9-6,** Regional Water Development Plans - Puna.

The Keaau-Mt. View System utilizes two deep wells at the former Olaa Sugar Mill site as its source. The source has good quality water with chloride content of 4 to 9 ppm. This system has a linear service area essentially following the alignment of the Volcano Highway from Keaau Village to Glenwood. Water from the source is pumped through a series of booster pumps and storage tanks to the uppermost service area at Glenwood. A recently completed well located on the mauka side of Volcano Highway near the old dispensary camp will be added to the existing sources during 1990 or later as the need arises.

The Pahoa System obtains its water from one well at Keonepoko and two wells at the Pahoa well field. Both sources have good quality water with chloride content between 4 to 27 ppm. The system provides water for commercial and domestic uses for customers in the Pahoa area and vicinity. It also provides water for the Pahoa Agricultural Park and several anthurium farms and other agricultural customers.

The Kapoho Water System depends on an infiltration gallery type of well at the Kapoho Crater. Its primary customers are agricultural users and domestic users in the area east of Kapoho Crater. The water is relatively high in chloride content, ranging between 79 and 190 ppm.

The Kalapana Water System obtains its water supply from two wells located at the southwesterly edge of Keauohana Forest Reserve near the Pahoa-Kalapana Highway. The water has a relatively high chloride content of between 107 and 124 ppm. The system's service area runs from the forest reserve along the highway to Kaimu area and along the coastal road to the Queens Bath area. However, the recent volcanic eruptions at Puu O'O have destroyed a large number of residences in the service area around Queens Bath and lava has buried segments of the highway and water main.

2.2.4 AGRICULTURAL IRRIGATION SYSTEMS

The district does not have any irrigation system utilizing its own surface or ground water sources. The State sponsored Pahoa Agricultural Park receives its water supply through the County's Pahoa Water System. A few farmers may have small rainfall catchment systems for irrigation.

2.2.5 MILITARY SYSTEMS

The district does not have any military water system.

2.2.6 PRIVATE DOMESTIC, COMMERCIAL, AND INDUSTRIAL SYSTEMS

There is one private domestic system, one commercial system, and two industrial systems in the district. The systems used a total of 63,000 gallons per day.

The private domestic system provides water services for the Hawaiian Shores subdivision located northeast of Pahoa. It is owned and operated by the Hawaiian Shores Community Association and utilizes one deep well as its source. It has good quality water with chloride content of 1 and 27 ppm.

There is one deep well above Keaau Village, owned by WH Shipman Ltd., with high quality water that is intended for commercial export of water to the US mainland.

The two industrial systems in the district, located near Keaau have deep wells for their sources. One system is used for fruit processing in a papaya packaging plant, and the other is used for industrial uses in a macadamia nut processing plant and visitor center, and a small amount for irrigation of macadamia nut plantings.

2.2.7 NATIVE HAWAIIAN AUWAI SYSTEMS

There is no known auwai system used for irrigation at this time in Puna.

2.2.6 OTHER SYSTEMS

There are several geothermal wells in the district but none are in use at this time. A new well to utilize geothermal energy for electrical generation is currently being drilled near the volcano region of the district.

2.3 FUTURE WATER NEEDS

2.3.1 MUNICIPAL SYSTEMS

The County General Plan, 1989, recognizes Puna as the fastest growing district on the island. In one decade from 1970 to 1980, the population has more than doubled from 5,154 persons to 11,775. The 1987 estimate of population is 19,000. By year 2010, the district's population is projected to more than double to about 39,900 people.

This influx of new people to the district is projected despite the uncertain potential for new high employment industries or businesses establishing in Puna. However, the district is expected to expand as a major bedroom community for persons working in Hilo and Keaau areas and others seeking affordable housing opportunities. Thus, the major generator of future water needs is expected to be residential related land uses.

In view of the volcanic activity of Kilauea and the history of damages that have been incurred to properties in the Kapoho and Kalapana, future developments in those areas, other than for agricultural uses, will most likely be very minimal. Consequently, most residential expansion is expected to occur in the Pahoa area for the Pahoa-Kapoho-Kalapana region and in the Keaau-Mt.View area for the Keaau-Volcano region. In support of these potential growth places, the General Plan sets aside urban expansion areas in the Pahoa Village area and on the mauka side of the Volcano Highway from Keaau to Kurtistown. **See Figures 1.5-1 and 1.5-2,** CountyGeneral Plan Land Use Map for locations of these urban expansion areas.

The water requirement to support the projected year 2010 population in the district on municipal system is estimated at 5.18 mgd. The distribution is estimated to be 2.55 mgd for the Keaau-Volcano region and 2.63 mgd for the Pahoa-Kapoho-Kalapana region. The calculations for the estimates may be found in **Appendix D.**

2.3.2 PRIVATE SYSTEMS

In view of the uncertainty of new activities with large water demand emerging in the district, the future needs of the private systems were assumed to be at the system capacity of the existing systems rounded to the higher one-half million gallons. The tenants of the Shipman Industrial Park are expected to draw water from the County's water system. Fortunately, the aquifers underlying sections of the district where new activities requiring additional water would probably occur have large sustainable yield capacities. **See Figure 1.3-3** following page 1-5.

TABLE 2.3-1

SUMMARY OF EXISTING AND FUTURE SYSTEM CAPACITIES

System	Aquifer Code	Estimated Future Demand mgd	Existing Draw mgd	Existing Capacity mgd	Required Future Capacity * mgd
Muni/Keaau-Mt.View	80402	2.55	0.729	2.34	4.0
Muni/Pahoa	80801	2.63	0.426	1.87	4.0
Muni/Kapoho	80802	**	0.065	0.14	0.14
Muni/Kalapana	80802	**	0.086	0.88	0.88
Priv Sys/DCI	80402		0.71	1.58	2.0
Priv Sys/DCI	80801		0.03	0.50	1.0

* Includes backup well capacity ** Included w/ Pahoa System

2.4 WATER PROBLEMS AND OPPORTUNITIES

The most significant problem in providing water services for the built up areas of the district is the gross inadequacy of roadway and waterline improvements in most of the existing subdivisions in the district. The existing streets in these subdivisions are non-standard and remain in private ownership. There is no water distribution system in most cases.

The Hawaii County Civil Defense Agency estimates that more than 8,000 homes in the Puna, Kau and South Kona districts depend on individual roof catchment and storage systems for their water supply. These homes are mostly located in non-standard subdivisions with private roads and are spread out in the districts.

To provide municipal or private water services to these homes will require the installation of a series of water transmission mains, storage reservoirs, and distribution systems. Because the service areas would be very large with relatively low customer density, both development and operational costs will be high. In addition to the cost of the distribution system hardware, the acquisition of water facility easements will be a problem because of the many private roads and absentee owners involved. Financing of the improvements through a vehicle such as improvement district bond would be a possibility. but obtaining consensus among affected property owners may be a major obstacle to such financing.

The creation of a private water company to install and operate a water system for a subdivision or an area is an option. The Hawaiian Shores Community Association presently owns and operates a private system that provides water for domestic and fire protection in the Hawaiian Shores Subdivision in Pahoa.

Because of the large population forecasted for the district, a cooperative effort between property owners and government should be made to improve the water supply situation for residents now on roof catchment systems to avoid major logistical and health problems during prolonged droughts. The State Department of Land and Natural Resources in response to the State Legislature House Concurrent Resolution No. 63, 1988 recommended that the homeowners in the affected areas upgrade their storage tank to provide for a minimal water demand of 8,500 gallons during periods of drought.

2.5 REGIONAL WATER DEVELOPMENT PLANS

2.5.1 MUNICIPAL PLANS

In anticipation of the growth projected for the Puna District, the General Plan sets aside major urban expansion areas around Keaau Village and on the mauka side of the Volcano Highway between Keaau and Kurtistown, and around Pahoa Village. These urban expansion areas will allow for a mix of uses and supplement the low and medium density designations existing in and around the core of these two villages. Fortunately, the two systems which will be impacted by future needs have aquifers with large sustainable yield capacities and high probability of good quality potable water (aquifer system 80402 and 80801). The major development plans for the district are directed toward improving system capacity and reliability by providing backup wells and reservoir capacity. The water developments will also be planned to allow phase-in of additional sources to assure adequate supply when ways are found to install distribution systems within existing subdivisions that now lack water services.

Keaau-Mt.View System. As described in the section on future water needs, 2.55 mgd will be required in the Keaau-Mountain View System to meet the demands of the projected year 2010 population. The present capacity of the system is 2.34 mgd. The fiscal year 1987/88 average daily consumption for the system was 0.49 mgd.

Although the population may be increasing relatively rapidly, because many of the new residences are being built on lots not served by the municipal system, the water demand is not expected to increase in proportion to the increase in population. Because of this expectation, the capacity of the existing system may be sufficient to meet the system's requirements for several years until new subdivisions and housing are built in the urban expansion areas.

As part of its source improvements program, the Department of Water Supply and State Department of Land and Natural Resources recently completed drilling a new well located on the mauka side of the Volcano Highway near the old dispensary camp. The well is to be equipped with a 2.0 million gallon capacity pump. As demand develops two additional wells are proposed in the Keaau-Mountain View corridor for a total system capacity of 4.0 million gallons a day. Part of the capacities of these wells is intended as eventual replacement for the two existing wells at the former Olaa Mill site. The Water Department is planning for these new wells to improve operational efficiency and to avoid problems arising from any contamination of the old mill wells in the future from the mauka urbanized areas. These proposed wells will provide the necessary capacity to meet future needs and also improve system reliability by providing backup for its well sources in the event of downtime for equipment repair or change.

In addition to the source developments, a total water storage of 4 million gallons is proposed to enable the system to handle peak loads and optimize well pumping time. Larger transmission lines and upgraded booster pump stations are also proposed. **See Figure 1.9-1** for general areas where source developments and reservoir locations are proposed.

Keaau-Pahoa Transmission Line. There is a partially completed 12" transmission main along the Keaau-Pahoa Highway from Keaau Village to Kaloli Drive at Hawaiian Paradise Park subdivision. Upon its completion, the main will connect to the Pahoa System at the Keonepoko well site. The main will have sufficient capacity to service the existing subdivisions along the Keaau-Pahoa Highway. However, it should be noted that no development plan is proposed for the installation of distribution systems in any of the existing subdivisions. **See Figure 1.9-1** for location of the above described transmission line.

Pahoa System. Since most of the future housing and other developments are expected to occur in and around Pahoa Village, and little or none in the Kapoho and Kalapana service areas, the future water need for the Pahoa-Kapoho-Kalapana region will be in the Pahoa System service area. The future demand is estimated at about 2.63 mgd. The system's existing capacity is 1.87 mgd. The fiscal 1987/88 year average daily consumption was 0.29 mgd. For the same reason explained under the Keaau-Mt.View system, the increase in water demand is not expected to rise in proportion to the population growth. Because of the low volume of consumption in the system, the capacity of the existing system may be sufficient to meet the system's requirements for several years until new subdivisions and housing activities are completed in the urban expansion areas around Pahoa Village.

Fortunately, the Pahoa area has an abundant supply of high quality water in the vicinity of the present well fields. The Water Department proposes to add one well each at the Keonepoko well field at the Pahoa well field for a total system capacity of 4.0 mgd. These additional wells will not only provide the additional capacity required to meet future needs but also add to system reliability.

To enable the system to meet peak demands and optimize well pumping time, a total water reservoir capacity of about 4 mg is proposed for the system on a phased basis as demand develops. In addition to source developments and storage construction, booster pump stations, additional transmission mains, and upgrading of existing distribution system are proposed. **See Figure 1.9-1** for general areas where source developments and reservoir locations are proposed.

Kapoho and Kalapana Systems. In view of the minimum amount of increase in water demand anticipated in these systems, no new source developments are planned. However, because of the potential for expanded agricultural activities in the Kapoho area and also to provide higher quality water, an 8" transmission line from Pahoa to Kapoho is proposed.

2.5.1.1 PROJECTED IMPACTS OF MUNICIPAL PLANS

Upon their implementation, the proposed water developments will be a positive factor in promoting the County's desired land use development pattern, and assuring new areas requiring water for proper development will have access to adequate and dependable water supply source.

The proposed water developments, by providing an adequate water supply, will help to encourage expansion of diversified agricultural crop production and related activities in the district.

Although the water development proposals have allowed for sufficient capacity to meet the needs of the forecasted year 2010 population and supporting land uses, the proposals will provide minimal benefits to the residents of subdivisions currently without water service until such time that water distribution systems can be installed. In addition, the uncertainty of when distribution systems would be installed will impact heavily on the phasing and timing of the proposals.

2.5.1.2 ESTIMATE OF MUNICIPAL PLAN COSTS

The magnitude of cost estimates of the water development projects proposed in the Puna district are as follows:

Keaau-Mountain View System: $11.5 million which include deep wells, concrete reservoirs and sites, new and upgraded booster pump stations, and new transmission lines.

Pahoa System: $10 million which include deep wells, concrete reservoirs and sites, new and upgraded booster pump stations, new transmission lines. The estimated costs of the Pahoa by-pass highway water main and the Keaau-Pahoa water main are included under this system.

2.5.2 PRIVATE PLANS

See comments in Section 2.3.2.

SECTION 3. SOUTH HILO DISTRICT

3.1 DISTRICT PROFILE

The district of South Hilo sits on the eastern slopes of Mauna Kea and has 250,897 acres of land with elevations running from sea level to 6,000 feet. It has approximately 20 miles of coastline. See **Figure 1.2-1**, following page 1-2, for location of the district and its boundaries.

Average temperature for this district ranges between 65 to 85°F. Coastal areas register 137 inches a year in median rainfall which increases to a high of 196 inches in a lateral band between 1,000 to 3,000 feet elevation, and within which occurs an area with the island's highest median rainfall of 300 inches a year. Annual median rainfall diminishes to 78 inches at 6,000 feet. **See Figure 1.2-2** following page 1-2, for rainfall map.

The seat of county government, branch offices of federal and state agencies, and commercial, industrial, and various service activities for the island are located in Hilo. The island's major deep draft harbor and a modern international airport are also located in Hilo, as well as the University of Hawaii at Hilo with a 4-year college, community college, and affiliated research programs.

Sugar is the largest single industry in the district, with Hilo Harbor serving as it's main shipping point. Although the district has some economic benefits from tourism, much of it is an indirect spinoff from the surge of tourism in West Hawaii.

The largest concentration of population on the island is in South Hilo, numbering 42,320 or 30% of the island's residents in 1980. In 1987, the population was estimated at about 45,300 people, an increase of 7% over 1980. By year 2010, it is projected to increase by another 23% to about 55,520 people.

Of the several communities in the district, Hilo is the only one which continues to gain in numbers while the older plantation communities such as Hakalau, Honomu, Papaikou have declined over the years.

The distribution of the projected year 2010 population is estimated at 9,649 in the Keaukaha-Kanoelehua corridor area, 17,825 in the downtown Hilo-Waianuenue-Mouhouli-Kaumana area, 18,549 in the Waiakea-uka area, and 9,497 in the Papaikou-Pepeekeo area. The Waiakea-uka area is seen as the growing area as compared to the other areas of Hilo.

The South Hilo District has 7,344 acres of single-family residential zoned lands. Of the total acreage zoned for this use, 3,033 acres or 41% of the total are undeveloped. The 1985 housing inventory showed there were 11,505 single-family residential units in the district. This number is projected to increase to about 15,530 in year 2010 for a 35% increase in inventory.

There are 312 acres zoned for multiple family residential use in the district, which includes 109 acres zoned for duplex residential use. Of this total 94 acres are not developed. The 1985 land use inventory showed 444 duplex units and 2,681 apartment/condominium units in the district.

By year 2010, the number of multi-family housing units is projected to increase to about 3,590 apartments plus about 150 resort condominium units. Except for about 190 units, the units are expected to be in the Hilo City area.

The district has 1,280 acres of land are zoned for agricultural use, most having a minimum size of 20+ acres. Sugar is the principal crop grown on these lands. Other agricultural activities include dairy farm, hog and poultry production, vegetable production, and flower and foliage cultivation particularly anthuriums, chrysanthemums, orchids, and landscape plants. Cattle is grazed on the upper lands.

Hilo as the commercial center of the island has two major shopping centers with department store anchors and the usual array of retail shops, food markets and convenience goods outlets. Other retail and wholesale shops, restaurants, medical and other offices, and service outlets are located throughout the city.

The principal industrial areas are the Kanoelehua area, Hilo port and surrounding area, and the sugar processing mill area in Pepeekeo. Numerous businesses which service the sugar industry such as industrial equipment manufacturing and repair, fertilizer plant, and machine shops are located in Hilo. Other industrial activities include quarrying, construction material manufacturing and fabrication, storage, wholesaling facilities, garment manufacturing and numerous service activities. There are also industries involved with the processing and packaging of locally grown products like papaya, guava and passion fruit puree, juices and jellies, and dairy goods.

Hilo has 139 acres zoned for resort use. Of that total, 51 acres are vacant. With the cessation of direct mainland air service to Hilo, tourism has not been a major activity for the district. The majority of hotel units are located in the Waiakea Peninsula area. The Puueo and Keaukaha areas also have resort zoning but are not currently used as for such purpose.

150,102 acres or 59.4% of the lands in the district are public lands. Of this amount, 10,955 acres are under the jurisdiction of the Hawaiian Homes Land Department.

Data from Hawaii County General Plan, 1989. **See Figure 1.5-2** for Land Use Map showing North and South Hilo land use pattern.

Proposed Land Use Pattern Allocation:

Residential	Commercial	Industrial	Resort	Total
24,045 ac.	2,405 ac.	6,259 ac.	293 ac.	33,002 ac.

Proposed Zoning Acreage Allocation:

Residential	Commercial	Industrial	Resort	Total
9,618 ac.	962 ac.	2,504 ac.	195 ac.	13,279 ac.

Urban Expansion Locations:

Mauka of Komohana Street between Waiakea and Kaumana
Mauka of Volcano Highway between Haihai Street and Panaewa Forest

Land Use Goals, Policies and Water Utility Courses of Action:

The General Plan goals and policies relating to county economy and population, environmental quality, water and land use are listed in **Appendix B** - County General Plan Goals and Policies.

The water utility courses of action proposed for the South Hilo District are:

- The Hilo Water System should be improved to provide the city with a dependable and consistently clean water supply.
- Booster pumps and water transmission lines should be installed to boost Panaewa Well water to higher elevations.
- Further investigate future surface and ground water resources.
- Replace portion of the Honomu system transmission line and add new storage tanks.

3.2 EXISTING WATER USES AND DEVELOPMENTS

3.2.1 INVENTORY

An inventory of existing water uses and developments in Hawaii County is detailed by aquifer sectors in **Appendix C**. The inventory for the South Hilo District is summarized by use categories in the following sections.

3.2.2 SUMMARY OF WATER USE, SYSTEM CAPACITY, AND WATER DRAW

Table 3.2-1, below, gives a summary of the average amount of water sold daily by the municipal systems or used by private systems, the surface flow or well pump capacity of the water source, and the volume of water drawn from the source. Where recorded data was not available, estimates of water draw were made based on information from system operators, well and stream diversion registration forms, and other available data.

TABLE 3.2-1

SUMMARY OF WATER USE, SYSTEM CAPACITY, AND WATER DRAW - S.HILO

System	Aquifer Code	Average Use mgd	Low Flow or Pump Capacity mgd	Ground Water Draw mgd	Surface Water Draw mgd
Muni/Hilo (S.Por.)	80402	5.434	8.496	5.44-w	-
Muni/Hilo (N.Por.)	80401	*	6.048	0.92-w	-
Muni/Hilo (N.Por.)	80401	*	-	0.54-t	4.7 -est
Muni/Pauka-Honolii	80401	0.051		**	**
Total		5.485	14.544	6.90	4.7
Muni/Papaikou-Kalaoa	80204	0.196	0.51	0.18	0.04-est
Muni/Pepeekeo	80204	0.161	0.43	-	0.19-est
Muni/Honomu	80203	0.088	-	-	0.09-est
Muni/Wailea-Hakalau	80203	0.038	0.07	0.04	-
Total		0.483	1.01	0.22	0.32
Agr Irrigation	80204	-	-	-	0.04-est
Agr Irrigation	80203	-	-	-	0.02-est
Total					0.06
Pri/Industrial	80204	-	-	-	0.01-est
Pri/Industrial	80203	-	1.08	1.08	-
Pri/Industrial	80401	-	1.29	0.29	-
Total				1.37	0.01
Oth/Ind cooling	80401	-	61.49	39.1	-
Oth/Hydroelectric	80401	-	-		31.9
Oth/Aquaculture	80401	-	-	-	-
Oth/Ind cooling	80203	-	22.5	22.5	
Total				61.6	31.9
TOTAL FOR DISTRICT				70.09	36.99
				65.5%	34.5%

* Included in (S.Por.) ** Included in Hilo System t= tunnel w= well

In the South Hilo District, 65.5% of the water supply was drawn from ground water sources, primarily the Panaewa and Piihonua well fields. Surface water provided 34.5% of the supply.

The largest use of ground water was for industrial cooling for two electric generation plants and a sugar mill at 61.6 million gallons a day (mgd) followed by the county water system at a far less amount of 7.1 mgd, and other industrial uses at 1.4 mgd.

Hydroelectric power generation by Hilo Electric Light Co., and a small private plant accounted for nearly all of the surface water use at 31.9 mgd or 86%. The county systems used an average of 5.0 mgd. Agricultural irrigation category was comparatively very small at less than half million gallons a day, partly because most farmers in the district rely on rainfall and county water system for irrigation water. Also, the sugar cane fields rely on rainfall for irrigation.

3.2.3 MUNICIPAL SYSTEMS

The Hawaii County Department of Water Supply has one large and four small systems in the South Hilo District with a total of 12,835 accounts in 1988. Descriptions of the water systems are given below. The general locations of the service areas and water sources for the systems are shown in **Figure 1.9-2** Regional Water Development Plan--N/S Hilo, following page 11-2.

The Hilo System, the largest on the island with 11,406 accounts in 1988, consumed an average of 5.49 mgd of water from five surface sources and five deep well sources. The surface sources are the Waiakea-uka Tunnel in Waiakea-uka, Olaa Flume Spring and the Lyman Spring in upper Kaumana, and the Wailuku River-Hookelekele Stream and Kaohama Stream in Piihonua. During normal weather, the system utilizes as much surface water as practical to minimize power cost for pumping of ground water. However, the turbidity of the surface water increases considerably during heavy rains and must be supplemented with well water. Hence, the division between surface water and ground water usage varies each day depending on the weather condition. The Panaewa and Piihonua well fields produce excellent quality water with very low salinity, 2 to 8 parts per million. The Hilo System provides potable water supply for nearly all water users in South Hilo, with the exception of industrial cooling water and hydroelectric plant use.

Paukaa-Honolii System covers an area that is adjacent to Hilo along the belt highway on the northwest side. The system had 199 accounts in 1988. It is connected to the Hilo system for its water supply. The system also is a link between the Hilo system and the Papaikou System to provide supplementary supply to the Papaikou System when needed.

The Papaikou and Pepeekeo systems utilize a combination of spring and deep well sources for their supply. The spring sources serving Papaikou are not very reliable during dry weather conditions, however the well source can provide ample supply for the needs of the community. The Pepeekeo system obtains its water from the Maukaloa Spring which is a relatively reliable source. However, with the increase in residential units in the Kulaimano area, the system now has a deep well to supplement the spring as necessary. In 1988, the Papaikou System had 540 service accounts while the Pepeekeo System had 440 accounts. The average water consumptions were 196,000 gallons a day for Papaikou and 161,000 gallons a day for Pepeekeo.

The Honomu System, with 250 accounts, has a relatively reliable supply from the Akaka Falls Spring. However, because of its spring source which is considered as surface water, the system will require upgrading in order to comply with the Safe Drinking Water Act requirements. The daily average consumption in 1988 was 88,000 gallons a day.

The Wailea-Hakalau System serves a former plantation community with water from a well source. It originally relied on a spring source which was developed years ago by the plantation. Approximately 40 families are serviced by the system. The system consumed 38,000 gallons a day in 1988.

3.2.4 AGRICULTURAL IRRIGATION SYSTEMS

Although there are large sugar cane fields and macadamia orchids, little if any irrigation is done. Normally, rainfall provides sufficient moisture for the crops. Small truck farms use the county system for their water supply. Mauna Kea Agribusiness Co. which has 22 surface and ground water sources from earlier days now utilizes small amounts from three springs for agricultural irrigation by small farmers.

3.2.5 MILITARY SYSTEMS

The district does not have any military water system.

3.2.6 PRIVATE DOMESTIC, COMMERCIAL AND INDUSTRIAL SYSTEMS

There are three industrial systems in the district. Two systems utilize wells for their sources. One well system is used for quarry operations in Hilo, and the second well system is used for sugar mill operations in Pepeekeo. The third system uses an old spring flume line source to feed a standpipe used for trucking water for industrial use by the plantation.
There are no private domestic or commercial systems in the district.

3.2.7 NATIVE HAWAIIAN AUWAI SYSTEMS

There are no known native Hawaiian auwai systems used for irrigation at this time in the district.

3.2.8 OTHER SYSTEMS

There are two commercial hydroelectric plant intakes on Wailuku River and one private plant intake on Ainako Stream. The Pepeekeo sugar mill and Hawaii Electric Light Company both have well systems for industrial cooling waters. There is one small aquaculture operation that obtains water from two springs located on the property in aquifer system 80401 (no flow estimate).

3.3 FUTURE WATER NEEDS

3.3.1 MUNICIPAL SYSTEMS

The city of Hilo in the South Hilo District is seen as continuing to be the center of commerce, education and government for the island and county of Hawaii. This central function is reflected in the relatively large concentration of population in the district. The estimated count in 1987 was 45,300 people. By year 2010, the population is projected to stand at about 55,450 people for an average growth rate of about 1.0% per annum. With the exception of a few isolated cases, the developed areas of the district are provided with domestic and fire protection services by the county water systems. The relatively stable population of the district is reflected in the number of service accounts and average daily consumption during the past five fiscal years.

Fiscal Year	1985	1986	1987	1988	1989
No. of Services	12,267	12,448	12,667	12,835	13,047
Consumption (mgd)	5.577	5.742	5.915	5.946	6.004

The future municipal water requirement to support the projected year 2010 population in the district is estimated at 13.8 million gallons a day for the district, not including large usages by private systems for such purposes as industrial cooling or hydroelectric power generation. This total requirement is estimated to be distributed at 12.5 mgd for the Hilo area and 1.3 mgd for the rural areas from Papaikou to Hakalau. The calculations for these estimates are shown in **Appendix D.**

In the estimate for the Hilo System, an allowance of 6 mgd is included to compensate for the large amount of unaccounted water use. Most of the unaccounted for water is thought to be due to heavy leakage in the system's aged mains. Other causes that may be adding to the unaccounted water use are old meters not functioning properly; fire department uses; cleaning, flushing, other maintenance uses; and emergency uses.

3.3.2 PRIVATE SYSTEMS

Since most farmers in the district rely on the county system for irrigation water, and because of the relatively small existing usage in agricultural irrigation category, it has been assumed that the future needs of farmers and other agricultural irrigation needs can be met with municipal water. The estimates for private industrial and other use categories are assumed to remain relatively level over the planning period. However, in the event new agricultural activities materialize in the future or additional needs arise from industrial users, the district's aquifer systems and/or surface water sources have large capacities that can be tapped.

TABLE 3.3-1

SUMMARY OF EXISTING AND FUTURE SYSTEM CAPACITIES

System	Aquifer Code	Estimated Future Demand mgd	Existing Draw mgd	Existing Capacity mgd	Required Future Capacity * mgd
Municipal/ Hilo	80401/02	12.5	11.50	14.54-g	20.0-g
Municipal/ Rural	80203/04	1.3	0.54	1.00-g	2.5-g
Priv Sys/DCI-Oth	80401/02		39.4-g	62.8 -g	62.8-g
Priv Sys/Other	80401		31.9-s		32.0-s
Priv Sys/DCI-Oth	80203/04		23.6-g	23.6 -g	23.6-g

* Includes backup well capacity

3.4 WATER PROBLEMS AND OPPORTUNITIES

Because of the relatively small projected population increase in the South Hilo District and the abundance of ground water in the district, there appears to be no immediate need to focus on finding and developing new sources as compared to districts in west Hawaii. The existing well fields in Panaewa and Piihonua have sufficient capacity to meet future needs. On the other hand, new well sites may be needed to maintain operational efficiency in the event the present mauka surface water sources are to be abandoned because of the water quality regulations discussed below.

There are two major problems that must be addressed, one in the near future to meet regulatory requirements, and one over a longer period to correct a deficiency in the system that could result in large operational savings.

The federal Safe Drinking Water Act will require that all public water systems meet stringent monitoring requirements to test for four groups of contaminants--lead, microbiological, radiological, and disinfection by-products. In addition, the systems must be monitored for the presence of a long list of chemicals and non-regulated contaminants. For systems that utilize surface water sources, such as the Hilo System, the regulations require filtration of the water unless site specific conditions are met. For systems with surface water sources, the State Department of Health must determine by June 1990 which systems must filter its water. By 1991, all public water systems designated by the Health Department must meet the filtration requirement.

For the Hilo System, if surface water sources are to be curtailed and only ground water is to be used, well capacity will not be a major problem but the power cost of the well pumps can be expected to rise sharply and increase operational cost. In addition, the storage capacity of the system would need to be increased to assure sufficient reserve to meet peak demands and to optimize pumping time, particularly to service the proposed urban expansion areas located mauka of Komohana Street. The question of which approach to take, filtration of surface waters or converting fully to ground water sources, should be analyzed and decided early to allow compliance with the water quality regulations in a timely way. The same question must be addressed for the Honomu System which uses the Akaka Falls Spring as its water source.

The other major problem in the Hilo System is the large amount of leakages that are suspected in the old water mains, especially those mains with oakum caulk and leaded joints. It is difficult to pinpoint exactly where the leakages are occurring because, rather than a major leak like in a cracked main, it is thought that there are many leaks in various parts of the system. The Hilo System has many mains with leaded joints. The magnitude of the apparent loss of water from main leaks and other causes can be surmised by taking the difference between the average consumption and the total of the ground and surface waters drawn for the system -- about 6 million gallons a day. The reduction of this unaccounted water could reduce the system's daily need by nearly one-half, which can translate into significant savings in operational cost, particularly if it is decided to use only ground water to supply the system in the future. Although the Water Department has a limited on-going program to reduce its unaccounted water problem, the program should be provided with more funds to allow an accelerated work schedule to correct the deficiency.

3.5 REGIONAL WATER DEVELOPMENT PLANS

3.5.1 MUNICIPAL PLANS

Hilo System. The General Plan land use allocation guide map shows urban expansion areas in the area mauka of Komohana Street between Kaumana and Waiakea and in the area mauka of the Volcano Highway between Haihai Street and Panaewa forest. **See FIGURE 1.5-2** County General Plan Land Use Map-N/S Hilo for locations of these designated areas. Both of these areas are within proximity of existing well fields that can be support additional wells. However, new areas mauka of Komohana Street with potential for use as future well sites should be investigated in the event surface sources are to be phased out.

Because the Hilo System utilizes a large amount of surface water during normal weather for its supply, an evaluation on whether to continue using surface sources with a filtration plant or to convert completely to ground water sources will be made as part of the study to determine cost and problems related to complying with the federal Safe Drinking Water Act.

The future need of the Hilo System is estimated at 12.5 mgd, based on average daily consumption. The capacity of the well sources is 14.5 mgd (for planning purpose. surface water

sources have not been counted because of the possible curtailment of those sources in the future). The existing storage capacity in the system is about 7 million gallons. In order to provide a stronger reserve to meet peak demand requirements, the proposal is to increase total system storage capacity to at least 12 million gallons. This additional storage would be important in providing reliable service to the mauka areas of the city, particularly if the mauka surface water sources are abandoned. Also, the total storage requirement is based on the premise that a program will be initiated to reduce the amount of unaccounted water use by at least 75% during the planning period.

In addition to storage capacity improvements, new transmission lines and booster pump stations are proposed in order to transport water more efficiently from the well fields to the reservoirs and distribution networks.

Rural Hilo Systems. The future need in the rural Hilo systems is estimated 1.2 mgd. The existing capacity of the systems totaling 1.0 mgd was based on well sources only. One new well source is proposed in the vicinity of a proposed reservoir site near Papaikou. The 1988 consumption in Papaikou was about 39% of its well capacity and about 37% for Pepeekeo. Because of their proximity to places of employment in Hilo, there is potential for further growth in these communities and in the areas along the coastal highway between these places and Hilo town. To allow for development of these in-between areas, a transmission-distribution line to link the Papaikou and Pepeekeo systems is proposed. This linkage would also allow water from the Hilo city system to be fed into the Pepeekeo system, if necessary.

Additional, storage reservoirs are proposed to balance pumping and peak demand service requirements. Upgrading of booster pump stations is also planned to improve services to the areas mauka of the highway.

The Honomu System depends on the Akaka Falls Spring for its water supply. The need to comply with the Safe Drinking Water Act requirements may pose a major cost problem for this system, especially because of its isolation from existing well sources and the small number of customers. An analysis to determine whether to continue with the spring source is proposed to be done in together with the study on the Hilo System surface water sources.

3.5.1.1 PROJECTED IMPACTS OF MUNICIPAL PLANS

Upon their implementation, the proposed water developments will be a positive factor in promoting the County's desired land use development pattern, and assuring that new areas requiring water for proper development will have access to a sufficient and reliable water supply.

The implementation of a scheduled repair program to reduce unaccounted water use in the system will result in gradual savings on water draw which can amount to 4 to 5 million gallons a day by end of the planning period.

The development of ground water sources and storage in the existing rural systems would provide the rural customers with a reliable system producing higher quality water, particularly during dry weather.

Compliance with the federal Safe Drinking Water Act will be accomplished with the studies and resultant developments. Ultimately, the consumers will benefit directly by receiving high quality water.

3.5.1.2 ESTIMATE OF MUNICIPAL PLAN COSTS

The magnitude of cost estimates of the water developments proposed in the South Hilo District are as follows:

Hilo System: $23.0 million which include deep wells, concrete reservoirs and sites, new transmission lines and booster stations, upgrading of system lines and appurtenances, and program to reduce unaccounted water use.

Rural Hilo System: $4.0 million which include deep wells, concrete reservoirs and site, new booster pump stations at well or reservoir sites, upgrading of existing booster pump stations, new transmission line, and upgrading of system lines and appurtenances.

3.4.2 PRIVATE PLANS

See comments in first paragraph of Section 3.3.2.

SECTION 4. NORTH HILO DISTRICT

4.1 DISTRICT PROFILE

The North Hilo district contains the southern part of Hamakua Coast and has 173,732 acres primarily in sugarcane fields, and small villages strung out along about 15 miles of coastline. Its land elevations run from sea level and along the eastern slopes of Mauna Kea to nearly the summit of Mauna Loa. See See **Figure 1.2-1**, following page 1-2, for location of the district and its boundaries.

Average temperature ranges between 65°F to 85°F, except at the mountain summits where average temperature ranges between 30°F and 50°F. Coastal areas have average annual rainfall of 157 inches from sea level to about the 4000 foot elevation, gradually decreasing with rise in elevation to 23 inches at the summit of Mauna Loa. A pocket of heavier rainfall reaching 196 inches to 236 inches annually occurs at the southerly part of the district at about the 3000 foot elevation. **See Figure 1.2-2** for Rainfall Map.

Sugar cane cultivation is the major economic activity in the district. Two sugar plantations cultivate sugar cane in the district, however, processing of the crop is done outside the district. Sugar cane grown by the Hamakua Sugar Company is processed at the Haina Mill in Honokaa, and those grown by the Mauna Kea Agribusiness Company is processed at Pepeekeo Mill by the Hilo Coast Processing Company.

Economic growth under present conditions is limited in the district. Improved sugar cane cultivation and processing techniques coupled with the economic problems faced by the sugar industry has lessened the demand for labor. Although diversified agriculture appears to have potential for growth, no strong activity in this direction has appeared thus far.

The district has the smallest population on the island, numbering 1,691 in 1980. Although its population center at Laupahoehoe remains relatively stable, it is estimated that by 1987 the population had declined further to 1,495 persons, paralleling the reduced activity in sugar. The district's population is expected to remain level over the next two decades and having 1,500 persons in year 2010.

There are 400 acres of land zoned for single-family residential use in the district. 163 acres remain undeveloped. The 1985 existing housing inventory indicated there were 566 single-family residential units in the district. It was estimated that by 1987 the inventory had increased to 597 units and is expected to remain at that level to the year 2010. There is no area zoned for multi-family residential use, however, existing commercial zoned areas may be utilized for multi-family units. The 1985 existing housing inventory showed there were 47 duplex and apartment units in the district. By the year 2010, the number of multi-family units is projected to level off at 39 units.

The North Hilo district has 132,800 acres of state land or 76.5% of the district's total area. This is the highest proportion of public lands among all districts on the island. 48,800 acres of these public lands are under the state Hawaiian Homes Land Department.

There are 223,174 acres zoned for agricultural use in North Hilo and Hamakua districts or 39% of the total area of the two districts. Sugar cultivation dominates the agricultural scene in both North Hilo and Hamakua districts. The Hamakua Sugar Company has about 35,000 acres in sugar in North Hilo and Hamakua districts. Within both districts there are small truck farms which raise vegetables, fruits, flowers and macadamia nuts. Ranching operations are also found on the higher slopes.

Commercial services are found mainly in Laupahoehoe, with one or two stores in the smaller villages. Hilo serves as the major shopping area for residents of the district. Industrial activities

are primarily related to sugar industry. A very limited amount of warehousing space is located in Laupahoehoe. Presently the visitor industry plays no significant role in the district. Resort development in the foreseeable future is unlikely.

Data from Hawaii County General Plan, 1989. **See Figure 1.5-2**, following page 11-2, for Land Use Map showing North Hilo land use pattern.

Proposed Land Use Pattern Acreage Allocation

Residential	Commercial	Industrial	Resort	Total
650 ac.	65 ac.	98 ac.	----	813 ac.

Proposed Zoning Acreage Allocation

Residential	Commercial	Industrial	Resort	Total
261 ac.	26 ac.	39 ac.	----	326 ac.

Urban Expansion Locations

Laupahoehoe

Land Use Goals, Policies and Water Utility Courses of Action

The General Plan goals and policies relating to county economy and population, environmental quality, water and land use are listed in **Appendix B** - County General Plan Goals and Policies.

The water utility courses of action proposed for North Hilo District are:

- Coordinate plans for new systems with the relocation program for plantation camps.
- Install a deep well pump which will be used to supplement the spring sources during dry spells.
- Replace old and deteriorating lines and storage facilities.

4.2 EXISTING WATER USES AND DEVELOPMENTS

4.2.1 INVENTORY

An inventory of existing water uses and developments in Hawaii County is detailed by aquifer sectors in **Appendix C.** The inventory for the North Hilo District is summarized by use categories in the following sections.

4.2.2 SUMMARY OF WATER USAGE, SOURCE CAPACITY AND WATER DRAW

Table 4.2-1, on the next page, gives a summary of average amount of water sold daily by the municipal systems or used by the private systems, the surface flow or well pump capacity of the water source, and the volume of water drawn from the source. Where recorded data was not available, estimates of water draw were made based on information from system operators, data from well and stream diversion registration forms, and other available data.

Overall, the total ground and surface water drawn in the district was relatively small because of the small population, no irrigation of sugar cane lands and no heavy industrial uses. Of the total water drawn daily, ground water provided 46% of the supply and surface waer made up the balance. Water for municipal and private domestic use accounted for over three-fourths of the 260,000 gallons per day drawn in the district. The balance was drawn for agricultural irrigation. Ground water provided 67% of the water for the combined municipal and private domestic uses.

TABLE 4.2-1

SUMMARY OF CONSUMPTION, SOURCE CAPACITY, AND WATER DRAW - N.HILO

Category	Aquifer Code	Average Use mgd	Low Flow or Pump Capacity mgd	Ground Water Draw mgd	Surface Water Draw mgd
Muni/Ookala	80202	0.009	*	*	-
Muni/Laupahoehoe	80203	0.087	0.576	0.04	0.06-est
Muni/Ninole	80203	0.017		-	0.02-est
		0.113		0.04	0.08
Agri Irrigation	80203	-	-	-	0.02-est
Agri Irrigation	80202			0.04	-
Priv/Domestic	80203	-	-	-	0.04-est
Priv/Domestic	80202	-	0.70	0.04	-
				0.08	0.06
Total For District				0.12	0.14

* Included in Priv/Domestic 80202 ground water draw

4.2.3 MUNICIPAL SYSTEMS

The Hawaii County Department of Water Supply has three systems in the North Hilo District with 368 service accounts. The total average water draw from ground and surface sources was 163,000 gallons a day. The county water systems drew nearly 70% of the total followed by private domestic use at 35%. Surface water sources provided a little more than half of the water at 55%, with ground water making up the balance. The Laupahoehoe System utilizes a combination of surface and ground water sources for its supply. The Ninole System relies on a spring for its supply while the Ookala System obtains its supply from a plantation system deep well. The general locations of the service areas and water sources for the systems are shown in **Figure 1.9-2** Regional Water Development Plan - N/S Hilo, following page 11-2.

The Ookala System is a small system that provides domestic water service to 29 residences in Ookala Village near the former Ookala Mill. The supply for the system is purchased from the Hamakua Sugar Co. The Ookala Shaft at the site of the former Ookala Mill supplies water to the plantation system.

The Laupahoehoe System, like many of the systems along the Hamakua Coast, normally obtains its supply from high level springs to service its 288 customers. The two springs that supplies the system are the Manowaiopae Spring and the Kihalani Spring (Kuwaikahi Gulch). These springs are not dependable during dry weather periods, and at times flow had to be diverted from the Manowaiopae Stream to supplement the spring sources. However, with the installation of two deep wells in Laupahoehoe, the spring sources are now supplemented with water from the deep wells. During the 1987-88 fiscal year about one third of the system's supply was provided by the wells. In view of the relatively high cost of improvements and operations to have the spring sources be in compliance with the federal Safe Drinking Water Act, the Water Department plans to stop using the spring sources and rely fully on the deep wells for the system's water supply.

The system's service area has been extended to include certain parts of Papaaloa and the Kapehu Camp, relieving these areas from dependance on spring sources for their water supply and also minimizing the task of bringing their water services in compliance with the federal Safe Drinking Water Act.

The Ninole System, completed in 1977, is a small system that services 51 customers, some of which were formerly plantation housing. The system obtains its supply from Chaves Spring, a short distance above Ninole. Since spring water is considered to be surface water, the source for this system will need to be upgraded to comply with the federal Safe Drinking Water Act.

4.2.4 AGRICULTURAL IRRIGATION SYSTEMS

The district has one small agricultural irrigation system that provides water for a watercress farm. Although two plantations have sugar cane fields in the district, very little water is used for irrigation. The many spring and tunnel sources in the district were used in the early days of the plantations to provide water primarily for the flume systems that were used to transport the sugar cane from the fields to the mills, and also for mill use.

The Hamakua Sugar Co. has about 9 tunnel and 6 spring sources, and 1 well source in the district. The tunnel sources and three of the spring sources are not currently in use. Three springs and the well are used as sources for domestic water. The well source normally provides water only for domestic use water, but during very dry periods, the well has the capacity to provide water for irrigation use.

The Mauna Kea Agribusiness Co. has about 8 spring water sources in the North Hilo District, of which only one is used for irrigation. The balance are currently not in use. Mauna Kea Agribusiness depends on natural rainfall for irrigation.

4.2.5 MILITARY SYSTEMS

The district does not have any military water system.

4.2.6 PRIVATE DOMESTIC, COMMERCIAL AND INDUSTRIAL SYSTEMS

The Hamakua Sugar Company has 3 systems in the district that provides water to old plantation camps. There are no commercial or industrial systems in the district. The domestic use systems all depend on surface water sources for their supply. Although the flow from the sources may run low during dry weather, the supply appears to be adequate. As suppliers of domestic water to more than 25 customers with systems with surface water sources, the company will need to address the problem of complying with the Safe Drinking Water Act regulations.

3.2.7 NATIVE HAWAIIAN AUWAI SYSTEMS

There are no known native Hawaiian auwai systems used for irrigation at this time in the district.

3.2.8 OTHER SYSTEMS

There are no systems in this category in the district.

4.3 FUTURE WATER NEEDS

4.3.1 MUNICIPAL SYSTEMS

The North Hilo District can be characterized as a rural area with sugar cane fields in most of the arable areas from the sea coast to about 1300 feet elevation, and small villages strung out

along the coastal highway through the district. The sugar cane fields in the district rely on natural rainfall for irrigation. Thus, the little water that is consumed for agricultural use is mainly from surface sources for diversified crops such as orchids, peanuts and watercress. Should diversified agricultural crops expand greatly, existing sources not in use may need to be reactivated or new agricultural water sources developed.

Although Laupahoehoe and Papaaloa may have potential for small residential expansion, the remainder of the small villages will most likely remain as they are. **See Figure 1.5-2** General Plan Land Use Map, following page 11-2, for location of proposed urban expansion areas in the district. The district population is projected to remain constant over the next two decades. As As shown below, water consumption has been relatively stable over the past four years.

Fiscal Year	1985	1986	1987	1988	1989
No. of Services	329	334	335	368	366
Consumption (mgd)	0.115	0.104	0.103	0.113	0.122

Laupahoehoe System. The future water needs for the district will be primarily for domestic use. The year 2010 water need is estimated at 150,000 mgd. Most of this volume is expected to be required in the Laupahoehoe System which has an existing capacity of 0.576 mgd. If all of the homes in the Papaaloa area currently under the plantation system were to be provided water from the county system, there is sufficient capacity to accommodate the added demand.

The Ninole System is not expected to have any significant increase in demand and the existing source should have sufficient capacity to meet future needs. However, as with other systems with surface water sources, the issue of the federal Safe Drinking Water Act must be addressed.

4.3.2 PRIVATE SYSTEMS

Private systems in North Hilo are for small irrigation and domestic uses. No significant changes are expected in future needs.

TABLE 4.3-1

SUMMARY OF EXISTING AND FUTURE SYSTEM CAPACITIES

System	Aquifer Code	Estimated Future Demand mgd	Existing Draw mgd	Existing Capacity mgd	Required Future Capacity mgd
Muni/Ookala	80202	-	-	-	0.14
Muni/Laupahoehoe	80203	-	0.10	0.576	0.57
Muni/Ninole	80203	-	0.03		0.10
Muni/Total		0.135			0.81
Pri/Agr	80203				0.05

4.4 WATER PROBLEMS AND OPPORTUNITIES

The Ninole System is the only system in the district that depends wholly on a spring as its water source. A spring is considered to be a surface water source and as such must meet the water filtration requirements of the federal Safe Drinking Water Act. The alternative is to either connect to another system with ground water source or to develop its own ground water

source. Because of the systems isolated location and small number of customers, either alternative will be expensive in terms of per customer cost.

Connecting to another system is not practical because of the distance to the nearest system with a ground water source. Although the initial cost of a packaged filtration plant maybe less costly than a new well, it should be weighed against the long term monitoring and operational costs and source reliability. The Water Department favors a small capacity deep well, principally because of its reliability during very dry weather periods and dependability from a maintenance standpoint.

The private domestic water systems operated by the Hamakua Sugar Co. will face the same problem as the Ninole System. In view of the economic problems faced by the sugar industry, bringing their systems into compliance with the Safe Drinking Water Act will be a heavy financial burden. The state and county agencies affected by the Act should work jointly with the company in addressing the compliance problem for the public and private water systems in North Hilo.

4.5 REGIONAL WATER DEVELOPMENT PLANS

4.5.1 PROPOSED MUNICIPAL PLANS

The major water development effort for the district is to address the problem of compliance with the Safe Drinking Water Act requirements for the Ninole System. The Water Department is proposing to install a low volume well to replace the current spring source.

To provide optimum balance between peak demand requirements and pumping time, concrete reservoirs are proposed for systems at Laupahoehoe, Ninole and Ookala. **See FIGURE 1.9-2,** Regional Water Development Plan - N/S Hilo for general locations of the proposed developments.

4.5.1.1 PROJECTED IMPACTS OF MUNICIPAL PLANS

The proposed water developments for the district will give the residents of this small district a good and dependable water supply and systems that are in compliance with the federal Safe Drinking Water Act standards.

4.5.1.2 ESTIMATE OF MUNICIPAL PLANS

The magnitude of cost estimates of the water developments proposed in the North Hilo District total **$ 1.5 million,** which include a deep well at Ninole, reservoirs at Ninole, Laupahoehoe, and Ookala, and upgrading of system lines and appurtenances.

4.5.2 PRIVATE PLANS

See comments in Section 4.3.2.

SECTION 5. HAMAKUA DISTRICT

5.1 DISTRICT PROFILE

The Hamakua District extends inland from the northern portion of the Hamakua Coast, covers the summit and upper areas of Mauna Kea and terminates at the summit of Mauna Loa. It includes Waipio Valley and much of the island's rugged northeastern sea coast. It runs along more than 36 miles of this coastline, and consists of 400,040 acres. It is the second largest district in area after Kau. **See Figure 1.2-1** for map showing location of the district and its boundaries.

Average rainfall in coastal areas ranges from 78 to 137 inches, diminishing to 15 inches a year at the summits of Mauna Kea and Mauna Loa. In the north east sector of the district are the Kohala Mountains where the district's high median annual rainfall of 157 inches occurs at about 3000 feet elevation. **See Figure 1.2-2, following page 1-2, for rainfall map.**

Elevations run from sea level to the 13,796 feet summit of Mauna Kea and 13,677 feet at Mauna Loa. Average temperature in this district ranges from 60°F to 80°F at the lower elevations to between 25°F to 45°F at the upper elevations of Mauna Kea and Mauna Loa.

The district's major employer is Hamakua Sugar Company. Other sources of income and employment include cattle feedlot and slaughterhouse, macadamia nuts and diversified crops. The district is expected to continue in an agriculturally based economy. Although there is little direct effect on district's economy by tourism, the district has the potential of blossoming as a bedroom community for many people working in South Kohala.

In 1980, there were 5,146 residents in the district. The 1987 estimate of the population was 5,303. The population increase is attributed mainly to the increasing resort activity in the neighboring district of South Kohala and the continuing settlement of the rural homestead areas. The district's population is projected to reach about 8,085 by year 2010 for an increase of 53% over 1987. The distribution of this population is estimated at about 5,840 in the Honokaa area and 2,245 in the Paauilo area.

The district has 638 acres zoned for single-family residential use, 163 acres of which are undeveloped. Most of the communities in this district were originally built to house and provide support for those working on the sugar plantations. There are also many homestead lots as a result of the Homesteading Acts of the prior territorial government of Hawaii. The 1985 land use inventory showed 1,650 single-family units in the district. By year 2010, the number of single-family housing units is projected to increase to about 2,475 units. Except for a duplex zoned area in Paauilo, the district has no area zoned for multi-family residential use. The 1985 existing housing inventory showed 22 duplex units and 44 multi-family units in the district. By year 2010, the number of multi-family housing units is projected at 62 units, mostly in the Honokaa area.

The state holds over half of the lands in the district at 58% or 232,497 acres. Of these public lands, 12,197 acres are Hawaiian Homes Land.

There are 223,174 acres zoned for agricultural use in the North Hilo and Hamakua districts. Sugar cultivation dominates the agricultural land use in both districts. The Hamakua Sugar Company has about 35,000 acres in sugar in the North Hilo and Hamakua districts. Within both districts there are small truck farms which raise vegetables, fruits, flowers and macadamia nuts. Ranching operations are also found on the higher slopes.

Honokaa town provides commercial and government services for the Hamakua district. It has a high school, government offices, library, police and fire stations, general hospital, and numerous stores and services. Sugar processing is the major industrial activity with one factory

in Haina. Haina is also the site of a macadamia nut processing plant. The Hamakua Sugar Company has recently developed a 10,000 head cattle feedlot and slaughterhouse plant near Paauilo. Other industrial uses are small family operated activities such as dairy farming, miscellaneous food processing, sawmill and woodcarving, and other service-oriented endeavors.

Within the district there is one small hotel in Honokaa that caters primarily to local businessmen and construction workers. There are no significant areas for resort developments, although there are areas attractive to visitors such as Waipio Valley and Honokaa towns' main street. There is possibility of small scale retreat-type resort development.

Data from Hawaii County General Plan, 1989. **See Figure 1.5-3**, following page 11-2, for Land Use Map showing Hamakua District land use pattern.

Proposed Land Use Pattern Acreage Allocation

Residential	Commercial	Industrial	Resort	Total
2,878 ac.	288 ac.	437 ac.	120 ac.	3,663 ac.

Proposed Zoning Acreage Allocation

Residential	Commercial	Industrial	Resort	Total
1,152 ac.	115 ac.	174 ac.	6 ac.	1,447 ac.

Urban expansion areas
Honokaa

Land Use Goals and Policies and Water Utility Courses of Action:
The General Plan goals and policies relating to county economy and population, environmental quality, water and land use are listed in **Appendix B** - County General Plan Goals and Policies.

The water utility courses of action proposed for the Hamakua District are:
- Extend the water line from Kukaiau to Keehia.
- Extend Honokaa system toward Kukuihaele.
- Replace inadequate mains.
- Improve existing storage, transmission and distribution facilities.
- Develop Paauilo Exploratory Well into a production well.

5.2 EXISTING WATER USES AND DEVELOPMENTS

5.2.1 INVENTORY OF EXISTING WATER USES AND DEVELOPMENTS

An inventory of existing water uses and developments in Hawaii County is detailed by aquifer sectors in **Appendix C.** The inventory for the Hamakua District is summarized by use categories in the following sections.

5.2.2 SUMMARY OF WATER USE, SYSTEM CAPACITY, AND WATER DRAW

TABLE 5.2-1, on the next page, gives a summary of the average amount of water sold daily by the municipal systems or used by private systems, the surface flow or well pump capacity of the source, and the volume of water drawn from the source. Where recorded data was not available, estimates of water draw were made based on information from system operators, well and stream diversion registration forms, and other available data.

Surface water use accounted for 92.6% or 20.2 mgd of the water used in the district. This high

percentage was primarily due water used from the Lower Hamakua Ditch for irrigation, industrial and domestic purposes. Of the ground water use, 1.3 mgd or 80.2% was use for industrial purpose, mainly for a feedlot and slaughter house operation. Municipal systems used an average of 0.51 mgd but about one-half of the supply was provided from South Kohala as described below.

TABLE 5.2-1

SUMMARY OF WATER USE, SOURCE CAPACITY, AND WATER DRAW - HAMAKUA

System	Aquifer Code	Average Use mgd	Low Flow or Pump Capacity mgd	Ground Water Draw mgd	Surface Water Draw mgd
Muni/Ahualoa-Honokaa	80102	0.241	(1)	0	(1)
Muni/Paauilo	80202	0.031	(2)	(2)	0
Muni/Ahualoa-Honokaa	80201	0.201	0.576	0.201	0
Muni/Kukuihaele	80201	0.040	-	0	0.04-est
Total		0.513	0.576	0.201	0.04
Agri Irr/LH Ditch	80102	12	-	0	12 -est
Priv Dom/LH Ditch	80102	0.1	-	0	0.1 -est
Priv Dom/Paauilo Sh	80202	-	-	0.12	0
Priv Ind/LH Ditch	80102	10	-	0	10 -est
Priv Ind/Well #1	80202	-	1.30	1.30	0
Military/Pohakuloa	80301	-	-	0	0.03-est
TOTAL FOR DISTRICT				1.62	20.17
				7.4%	92.6%

(1) Draw charged to Waimea TP (2) Draw charged to HSCo - Paauilo Well

5.2.3 MUNICIPAL SYSTEMS

The Hawaii County Department of Water Supply has three systems in the Hamakua District. The Ahualoa-Honokaa utilizes a combination of surface and ground water sources for its supply. The surface water supply comes from the Waimea Water Treatment Plant via the Waimea-Puukapu-Nienie System which crosses into Hamakua from South Kohala. The Paauilo System receives its supply from an extension of the Ahualoa-Honokaa System. The Kukuihaele System relies on a spring for its supply. **See FIGURE 1.9-4** Regional Water Development Plan - Hamakua/S.Kohala, following page 11-2, for general location of each system's service area.

5.2.4 AGRICULTURAL IRRIGATION SYSTEMS

The Lower Hamakua Ditch has been the primary source of irrigation water for the sugar cane fields in Hamakua. The ditch has also provided industrial water for the mills and domestic water for the plantation camps. Since the consolidation of the plantations and sugar mills, only the Hamakua Sugar Co. and its mill in Haina are in operation. The Lower Hamakua Ditch continues to serve as the main irrigation water source but is supplemented with well water in the Paauilo area. Both the Haina Mill and Paauhau Camp continue to use the Ditch for their water sources. A deep well is also available for irrigation use.

5.2.5 MILITARY SYSTEM

One of two military water systems in the county is located at the Pohakuloa Training Area in the saddle region between Mauna Kea and Mauna Loa. Not including the small permanent staff, the population of this military training camp fluctuates with the number of troops involved in the training being held at a specific time and water demand fluctuates accordingly. For example, the population can increase up to 5,000 troops for major exercises, usually held during May to October. The annual water consumption is approximately 22 million gallons per year. Of this amount, about 10 to 12 million gallons are supplied from three spring sources which are shared with the State Pohakuloa Park. The balance of the water requirement is hauled by private and military tankers from water standpipes in Hilo or Kamuela. Three 420,000 gallon steel tanks provide storage for the camp's water system. During periods of high consumption, additional water is hauled by private and military tankers from municipal systems either in Hilo or Kamuela.

5.2.6 PRIVATE DOMESTIC, COMMERCIAL AND INDUSTRIAL SYSTEMS

The Hamakua Sugar Company has 2 systems in the district for domestic use. One system takes water from the Lower Hamakua Ditch and passes it through sand filtration and chlorination before distribution to the Paauhau Camp. The other system has a well source at the old Paauilo mill and services the camps around Paauilo. It also feeds water to the county system. The one industrial system in this category uses a deep well source to service the sugar company's feedlot and slaughterhouse operations near Paauilo.

5.2.7 NATIVE HAWAIIAN AUWAI SYSTEMS

There are several native Hawaii auwai systems in operation in the district, especially in the Kukuihaele-Waipio Valley area. Since the auwai system is normally family-oriented and based on genealogical records, there was no requirement for record keeping of water consumption. In some cases, several families utilize the same stream for the source, and the division of flow is usually based on arrangements between families. This is the case in Waipio Valley where stream water is used for irrigating taro patches. The water is freely used and at times, returned to the stream. Approximately 30 declarations for owners or users of water rights involving kuleana and taro lands in Hamakua were filed with the State Water Commission during the 1989 filing period.

5.2.8 OTHER SYSTEMS

The Hamakua Sugar Co.'s sugar mill in Haina draws water from the Lower Hamakua Ditch through a penstock and storage system for industrial cooling and wash purposes at the Haina Mill.

5.3 FUTURE WATER NEEDS

5.3.1 MUNICIPAL SYSTEMS

The rapidly rising cost of land and housing in Waimea and the Kohala coast will increase the probability of a housing demand being created in the Hamakua District by employees working in those areas. This would be particularly applicable to the Ahualoa-Honokaa area of the district. The population projection for the district sees an increase of 53% from 5,303 in 1987 to 8,085 in year 2010. Of this number, it is estimated that about 72% or 5,630 persons are expected to live in the Honokaa-Ahualoa area where community infrastructure and conveniences are already available nearby.

Based on the assumption that the large majority of the projected population and supporting community infrastructure and activities would be serviced by the municipal system, the future municipal water need is estimated at 0.59 mgd for the Honokaa-Ahualoa area and 0.20 mgd for the Paauilo-Kalopa area. See **Appendix D** for future need calculations.

5.3.2 PRIVATE SYSTEMS

The major user of water in the Hamakua District, at present, is the Hamakua Sugar Co. Currently, an average flow of about 22 mgd in the Lower Hamakua Ditch is utilized for irrigating sugar cane fields, industrial cooling and processing at the Haina sugar mill, and domestic use for the Paauhau Camp. With the reduction in sugar production activities, the current average flow in the Lower Hamakua Ditch is thought to be adequate to accommodate the needs of the above described uses for the foreseeable future. In view of the Safe Drinking Water Act requirements, the plantation must assess whether to upgrade its Paauhau Camp water treatment facilities or install a transmission line from the municipal system to the camp for its water supply.

The Hamakua Sugar Co. also has several deep wells to provide water for irrigation, industrial use at its cattle feedlot and slaughterhouse, and domestic use in its camps. The domestic use requirements which are very small and will most likely be less in the future can be easily met from the wells that now provide the supply. The irrigation and industrial needs are assumed to remain level at the combined capacity of the two newer wells.

5.3.3 MILITARY SYSTEMS

The Pohakuloa Training Area is under consideration by the military for possible expansion. In the event an expansion program is implemented, the water supply requirement is estimated to increase to about 600,000 gallons a day. A study on the water supply for an expanded facility recommended that a well at a lower elevation on the Hilo side be drilled for water supply. The recommended vicinity of the well source falls within aquifer system 80401 in the South Hilo area. An alternative would be to work jointly with the Waiki'i Ranch to increase the existing capacity at the ranch to accommodate the PTA requirements.

TABLE 5.3-1

SUMMARY OF EXISTING AND FUTURE SYSTEM CAPACITIES

System	Aquifer Code	Estimated Future Demand mgd	Existing Draw mgd	Existing Capacity mgd	Potential Future Capacity * mgd
Muni/Honokaa	80201	0.60	0.24	0.57	1.1
Muni/Paauilo	80202	0.19	0.03	-	0.3
Muni/Kukuihaele	80201	-	-	-	0.1
Private-s.w.	80102	-	22.0	-	22.0
Private-g.w.	80202	-	3.9	-	3.9

* Includes back up well capacity

5.4 WATER PROBLEMS AND OPPORTUNITIES

The district's municipal water distribution systems are not only stretched out very thinly but are old and under capacity in many areas, often causing low pressure and flow. Since several sections of the distribution lines were inherited from the plantation, they are located in cane fields and other difficult to maintain places. Consequently, system upgrading is a major task that needs to be undertaken.

The increasing demands that will be placed on the Waimea water source from the developments in the Waimea area, and the potential of large expansion in housing units in the Ahualoa-Honokaa vicinity will require development of new water sources and storage in the district.

The spring and surface water sources supplying domestic water for the small communities in the district will be affected by the federal Safe Drinking Water Act regulations. Compliance with the regulations may be a costly item for the users of the system, be it the county or the plantation.

In view of the situations described above, it may be an opportune time to do a thorough study of all the systems in the district with the objective of arriving at a comprehensive plan to upgrade the systems so they will be able to meet the future needs of the district and also be in compliance with the federal Safe Drinking Water Act regulations.

5.5 REGIONAL WATER DEVELOPMENT PLANS

5.5.1 MUNICIPAL PLANS

The thrust of the development plans for the district is to develop an independent source of water supply for its water systems and to provide new storage reservoirs for the Ahualoa service areas and the urban expansion areas mauka of the highway.

Ahualoa-Honokaa System. The service area of this system is stretched out over an extremely large area with low customer density. About one-half of the supply for the Ahualoa-Honokaa area is piped from the Waimea Treatment Plant. The other half comes from one well located below Honokaa town. In view of the expected increase in water demand in South Kohala the proposal is to develop new ground water sources in Honokaa vicinity and discontinue using water from the Waimea system for the Ahualoa area. The State Department of Land and Natural Resources is preparing to drill an exploratory well at the site of Honokaa Reservoir. Should the findings be as expected, it will be the first of two wells proposed for the Ahualoa-Honokaa System. In addition to the wells, a series of new reservoirs to service the urban expansion areas mauka of the highway is proposed. The general locations of the proposed developments are shown on **Figure 1.9-3,** following page 11-2.

Kukuihaele System. The spring source for this small system may be affected by the federal Safe Drinking Water Act regulations. Like other systems that utilize surface water sources, an assessment should be made, as early as possible, on whether to maintain the spring in compliance with the regulations or to abandon it in favor of an alternate source.

Paauilo System. The Water Department presently purchases water for the Paauilo System from the plantation. The proposal is to develop a deep well for the system for better control over well output in light of new federal water quality regulations.

5.5.1.1 PROJECTED IMPACTS OF MUNICIPAL PLANS

Upon their implementation, the proposed water developments will be a positive factor in promoting the County's desired land use development pattern in the district. and assuring that new areas requiring water for proper development will have access to good quality and dependable water supply.

The proposed developments will provide independent water sources for the district's water systems and remove the necessity of the district competing for water supply with the rapidly growing Waimea region.

Compliance with the federal Safe Drinking Water Act will be accomplished with studies and developments proposed for the district and result in higher quality water supply for the consumers.

5.5.1.2 ESTIMATE OF MUNICIPAL PLAN COSTS

The magnitude of cost of the water developments proposed in the Hamakua District is estimated at $ 5.0 million which includes deep wells and reservoirs in the Paauilo, Honokaa, and Kukuihaele systems, and upgrading of system lines and appurtenances.

5.5.2 PRIVATE PLANS

See comments in Section 5.3.2.

6. NORTH KOHALA DISTRICT

6.1 DISTRICT PROFILE

The land mass of the North Kohala district is made up of the Kohala volcano system, the oldest on the island. The district is situated at the northern end of the island and is the smallest in land area with 79,769 acres. Surrounding it on three sides is 30 miles of coastline which comprises the east or windward section, the north section around Upolu Point, and the west or leeward section. **See Figure 1.2-1,** following page 2-1, for map showing location of the district and its boundaries.

The district runs from sea level to 5000 feet in the Kohala Mountain, the district's oldest and dominant geographic feature. It creates an almost northerly to southerly spine separating the district into two distinct sections. The eastern or windward side is deeply segmented by a series of valleys and gulches with lush green vegetation.

Rainfall averages 39 inches a year. The heaviest rainfall of 200 inches per year is on the mountain top while the dry western or leeward slopes of the Kohala Mountain have an annual average rainfall of about 10 inches in the coastal areas. **See Figure 1.2-2,** following page 1-2, for rainfall map. Average overall temperatures in this district range from 76°F along the leeward coastline to 60°F on the mountain top. The temperature at Kapaau has a mean maximum of 77.6°F, minimum of 65.8°F.

The economy of the North Kohala District is based on agriculture. Historically, its agricultural production was large scale sugar production. At one time, this district was home to 5 sugar plantations. Since the phasing out of the last plantation, Kohala Sugar Company, in the mid 1970's, its agricultural activities have been in cattle, plant nursery products and macadamia nuts. The two major ranches with lands in the district, Kahua Ranch and Parker Ranch produce almost one-half of the Big Island cattle sales. In 1986, Big Island cattle ranchers produced more than 76 percent of all feedlot cattle marketed in the State. The high rainfall in the upper areas above the main road between Hawi and Niulii is ideal for the macadamia nut industry. There are several hundred acres of macadamia nut orchards in the area. All production from the area is transported to Hamakua for processing.

The population of the district is projected to reach 8,470 people by year 2010, an increase of 135% from 1987. The population centers are Hawi and Kapaau. Although the district remains agricultural in character and economy, it has potential for becoming a bedroom community for people working in the Kohala-Kona Coast resort areas. Should this potential develop, it may result in greater population increase than projected.

In 1987, there were 550 acres zoned for single family residential use in the district, of which 167 acres were undeveloped. It is estimated that there were 1,232 single-family units in 1987. By year 2010, this number is projected to increase by 87% to 2,302 units. The district had only one area zoned for multiple-family residential use in 1987. Because of the housing demands that may develop in the district because of increased employment in nearby resort areas, about 720 multi-family units are projected for the district by the year 2010.

Tourism and its related service industries provide another source of income and employment for the district. Even though there are no major visitor facilities in the North Kohala district, many residents from this district work in the visitor-related facilities in adjacent South Kohala.

Commercial activity in North Kohala district is located primarily in Hawi and Kapaau, with a small amount in Halaula. Waimea Village in South Kohala provides additional commercial needs for North Kohala residents. Industrial activity in North Kohala consists of small agriculture-related services.

There are limited overnight accommodations in the district. Its two hotels are generally used by local businessmen and construction workers. In addition to being an agricultural community, there are people, many of whom once worked on the plantation, who live in this district and commute to work at the South Kohala resorts. The district has some potential for resort development in the vicinity of Mahukona Harbor which is designated in the General Plan for minor resort. There are also areas of great cultural and historical significance besides the natural beauty of the district that already serve as visitor attractions.

Data from Hawaii County General Plan, 1989. **See Figure 1.5-4,** following page 11-2, for Land Use Map showing North Kohala District land use pattern.

Proposed Land Use Pattern Acreage Allocation:

Residential	Commercial	Industrial	Resort	Total
2,951 ac.	295 ac.	661 ac.	120 ac.	4,027 ac.

Proposed Zoning Acreage Allocation:

Residential	Commercial	Industrial	Resort	Total
1,181 ac.	118 ac.	264 ac.	12 ac.	1,575 ac.

Urban Expansion Locations:
Hawi

Land Use Policies and Water Utility Courses of Action:

The General Plan goals and policies relating to county economy and population, environmental quality, water, and land use are listed in **Appendix B** - County General Plan Goals and Policies.

The water utility courses of action proposed for the North Kohala District are:

- Explore further sources for future needs.
- Improve and replace inadequate distribution mains and storage facilities.
- Encourage efforts to improve the Kohala ditch system and its use for agricultural purposes.

6.2 EXISTING WATER USES AND DEVELOPMENTS

6.2.1 INVENTORY

An inventory of existing water uses and developments in Hawaii County is detailed by aquifer sectors in **Appendix C.** The inventory for the North Kohala District is summarized by use categories in the following sections.

6.2.2 SUMMARY OF WATER USE, SYSTEM CAPACITY, AND WATER DRAW

Table 6.2-1, on the next page, gives a summary of the average amount of water sold daily by the municipal systems or used by private systems, the surface flow or well pump capacity of the source, and the volume of water drawn from the source. Where recorded data was not available, estimates of water draw were made based on information from system operators, well or stream diversion registration forms, and other available data.

The district utilizes both surface and water sources located on the slopes of Kohala Mountain for its water needs. Surface water, mainly from the Kohala Ditch, accounted for 11.3 mgd or 98% of the total water drawn in the district. Of this amount hydroelectric generation was the largest user at 9.0 mgd or 80%. Irrigation and industrial uses took 15% and the remaining

5% was made up of aquaculture and municipal uses. Ground water drawn was used about one-half for private domestic purpose and one-half for municipal systems.

TABLE 6.2-1

SUMMARY OF CONSUMPTION, SOURCE CAPACITY, AND WATER DRAW - N.KOHALA

System	Aquifer Code	Average Use mgd	Low Flow or Pump Capacity mgd	Ground Water Draw mgd	Surface Water Draw mgd
Muni/Kaauhuhu-Kokoiki	80101	0.099	0.093	0.12 *	-
Muni/Hawi-Kapaau-Kynn	80101	0.237	0.576	0.10	0.16-est
Muni/Halawa-Halaula	80101	0.088	0.200	0.11 *	-
Muni/Makapala-Keokeo	80101	0.027	0.070	-	0.03-est
		0.451		0.33	0.19
Priv/Kohala Ditch	80101		15.0	-	10.10-est
Priv/Dom	80101			-	0.10-est
Priv/Ind	80101			-	0.70-est
Priv/Dom	80103		2.0	0.10	
				0.10	10.90
TOTAL FOR DISTRICT				0.43	11.09

* Hawi well supplements supply for these systems

6.2.3 MUNICIPAL SYSTEMS

The Hawaii County Department of Water Supply has four water systems in the North Kohala District with a total of 1,167 service accounts. The systems consumed an average of 477,000 gallons per day in 1987-88. Three systems use a combination of well and tunnel water for their supply. One system relies on tunnel water sources. **See Figure 1.9-4,** following page 11-2, for general location of each system's service areas.

The Kaauhuhu-Kokoiki system serves the upper Kaauhuhu Homesteads and the Kokoiki area above the Kohala Ditch. The former supply source for Kaauhuhu was the Kehena Ditch; however, this was discontinued with negotiations for Lindsey Tunnel flow with its better quality water. The installation of a transmission pipeline from Lindsey Tunnel to the old Kaauhuhu Reservoir in 1950 was the first capital improvement program undertaken by the newly created Board of Water Supply. Originally, these were separate rural water systems but as part of a program to meet efficiency of operations, the systems were merged in 1962 by installing a 3-inch pipeline from Kaauhuhu Homesteads to Kokoiki. The lower Kokoiki area once depended on Kohala Ditch water which was discontinued with the merger of the two systems. However, with improvements to the Hawi water system, the lower Kokoiki area no longer is served by the upper Kaauhuhu source from Lindsey Tunnel. The system is old as it was built in 1925 with some addition in 1931. Most of the system, constructed with small size galvanized pipes, have since been replaced with larger and longer-lasting cast iron pipes. Old redwood tanks have been replaced with steel tanks and, in more recent years, with concrete storage tanks in line with standards developed by the Water Department.

In recent years, two large subdivision developments have opened up in this area. These include the Maliu Ridge Subdivision which has completed 114 lots from 1 to 5 acres in size and is now planning 52 additional lots from 1 to 6 acres in size, and the Waiwailani Subdivision with 72 lots of 5 acre size in a 406 acre tract.

The Lindsey Tunnel water output fluctuates with the weather and available records indicate low flows under extreme dry weather conditions. This problem has been alleviated by connecting this system to the Hawi well as a condition of approval for the Maliu and Waiwailani subdivisions. During low tunnel flows, a series of pump stations will boost water to this upper Kaauhuhu-Kokoiki area to maintain service.

The Hawi-Kokoiki-Kynnersly-Kapaau System serves the area along the main government highway between Kapaau and lower Kokoiki to the Loran Station at Upolu. In the past, the Hawi area was served with water the County purchased from the plantation. The Kokoiki area was served with Kohala Ditch water also purchased from the plantation. Similarly, the Kapaau system derived its source from the Kohala Ditch but treated to some extent with sedimentation and slow sand filtration. These old systems, constructed in 1927-31, were largely replaced under a cooperative arrangement with Kohala Sugar Company. The plantation undertook an employee housing program and turned over the domestic water system to the Water Department with both parties improving the existing facilities to assure adequate service. One of the first developments for plantation employee housing ownership was the Kynnersly Subdivision in 1961. During this period in the early 60's, the separate systems at Hawi and Kapaau were connected to increase source dependability and operational efficiency. The plantation sources at Watt Tunnel and Hapahapai Tunnel were turned over to the Water Department under this improvement program.

Since the shutdown of the plantation, Castle and Cooke, owner of Kohala Sugar Company, has converted some of the sugar lands to residential subdivisions at Ainakea below Kapaau Village and at Hawi below the main road. The County also developed a duplex housing project on State lands at Kahei in the early '70s.

In 1975, the Hawi well was drilled with funds appropriated by the State. This well, which is presently interconnected with the upper Kaauhuhu-Kokoiki system, assures a dependable source of water to cope with the occasional dry weather conditions which affect this region. This was the first deep well in North Kohala developed by the Water Department for domestic use. The chloride content is very low at 17 ppm.

The Halawa-Halaula system is a small one serving the area near the former Kohala sugar mill. The plantation, as part of its employee home ownership program, improved the water system in this area and turned the system over to the Water Department. The principal source of water supply is Bond Tunnel No.1. The Water Department purchases water from this source from the Bond Estate. The largest development served by this system is the Halaula Subdivision developed by the plantation for its employees. In recent years, this system has been interconnected with the nearby Kapaau system which permits the Water Department to divert Hawi well water to serve this area during periods of low tunnel flows.

The Makapala-Keokea System is a small system serving the residents and small business firms in the area. These customers were serviced formerly by a plantation system. The closing of the plantation left this area without a managed water system. The State provided funds which enabled the Water Department to renovate the old water system which had small galvanized pipelines and small redwood storage tanks. The new system, which began in 1982, also provides fire protection heretofore not available in the area. The transmission line from Murphy Tunnel is still the old galvanized pipeline installed by the plantation.

6.2.4 AGRICULTURAL IRRIGATION SYSTEMS

The Kohala Ditch system provides water for agricultural irrigation uses, as well as uses listed in the Others category shown below. The Kahua Ranch system and the Bond Estate system also have multiple uses and they are listed below under Private Domestic, Commercial and Industrial category.

6.2.5 MILITARY SYSTEMS

The district does not have any military water system.

6.2.6 PRIVATE DOMESTIC, COMMERCIAL, AND INDUSTRIAL SYSTEMS

The district has two domestic systems utilizing ground water sources and one industrial system utilizing surface water sources.

The Kohala Estates/Kohala Joint Venture subdivision initiated by Hilton Head, with lands purchased from Kahua Ranch, has expanded beyond its original scope. The development presently utilizes less than 0.10 mgd. The additional developments approved and pending will require considerably more water. The Kohala Ranch development which followed the Kohala Estates subdivision, developed its own water source by drilling 2 deep wells at elevation 1470. The wells have pump capacity of 1.008 mgd each. A third well is projected for future needs. The wells are approximately 2.65 miles inland from the coast and have a chloride content of 35 to 65 ppm.

The Bond Estate owns Bond Tunnel No. 1 (sometimes called the Bond Relief Tunnel) which is at Iole/Halaula on Wainaia Stream. At one time this source was used by the plantation. At present, the Water Department purchases water from the Estate which is represented by the Iole Development Corporation. Approximately 30 million gallons are purchased annually; however, this source tends to run low during extended dry weather and demand is met with water from Kapaau/Hawi. The Estate has lands which are served from Kamehameha Springs which is of limited flow.

The Kahua Ranch owns approximately 4500 acres and leases 10,000 acres. Its water resources include 52 stream diversions, tunnel intakes, and one deep well. The main sources are the stream intakes. The two large intakes are the Kahua Waterhead at elevation 4173 which has a divertable flow of 15 mgd, and the Kehena Ditch source which has a divertable flow of 10 mgd. Both sources are subject to dry weather conditions which can substantially reduce stream flows. Storage tanks are necessary for ranch operations. The domestic flow for the ranch and its employees is provided by the Kahua Waterhead and Piliwai intakes. The estimated annual use by Kahua Ranch is 0.65 to 0.80 mgd which is primarily for livestock. The domestic use for the ranch and its employees is estimated, more or less, at 0.01 mgd. As stated above, the water sources for the ranch are surface sources and subject to dry weather conditions which means the streams run low or even dry up at times.

Chalon International of Hawaii purchased the assets of Kohala Corporation which makes this firm the largest water producer in North Kohala. According to records, Chalon has 42 wells and 39 stream diversions. Not all of the sources are in use at this time. The primary water facility is the Kohala Ditch. This ditch system originates at Waikoloa Stream which lies between Waimanu and Honokane Iki valleys and is known as the Awini Ditch Section. At Honokane Nui, the flow enters the Kohala Ditch.

The listed 42 wells are, for the most part, tunnels or shafts. According to recent information, the current flow is approximately 15 mgd. Since the shut down of Kohala Sugar Company, maintenance of the ditch system has been substantially reduced as water requirements have dropped with the demise of the sugar industry in North Kohala. No maintenance work is performed on the Awini Ditch section of the system. Measurements in the past indicate that the ditch had a maximum capacity of 76 mgd with a mean flow of 23.2 mgd.

Present use of the ditch flow is for agricultural, aquacultural and hydroelectrical purposes which are estimated to be: agricultural, 0.3 to 1.0 mgd; aquacultural, 0.1 mgd; hydroelectrical, 5.0 to 9.0 mgd. The use is primarily by others who purchase water from the Kohala Ditch. Since the Awini Ditch section is not maintained at present, the ditch flow has been reduced to approximately 15 mgd.

6.2.7 NATIVE HAWAIIAN AUWAI SYSTEMS

There are many such systems in the North Kohala District, particularly in the area from Hawi to Honokane Canyon. Since the auwai systems depend on surface run-off, the quantity of flow varies considerably as it is affected by the weather. No water consumption records are kept by the individual users except that the amount that can be diverted has been estimated in some cases. Since the auwai system is family-oriented based on genealogical records, there was no requirement for record keeping. In instances, several families utilize the same stream and division of flow is a matter of individual arrangements. As there is no charge to the kuleana owner for the water it is freely used, and in certain cases, returned to the stream.

The auwai system does not appear to affect the operations of the County Water Department since it relies on tunnels it has acquired or purchases water from owners of other tunnels.

Some of the streams in North Kohala for which kuleana rights have been claimed include, but are not limited to, the following: Aamakoa, Waikani, Wai'apuka, Wakaina, Neue, Waikane, Honokane Nui, Honokane Iki, Waiakalae, Pololu, and Puakea.

6.2.8 OTHER SYSTEMS

The Kohala Ditch, in addition to providing agricultural irrigation water, provides water to a hydroelectric plant that uses about 5.0 to 9.0 mgd, and for an aquaculture project that uses about 0.10 mgd.

6.3 FUTURE WATER NEEDS

6.3.1 MUNICIPAL SYSTEMS

The population of North Kohala has remained relatively stable despite the closing of Kohala Sugar. In view of the high level of resort activities in the neighboring South Kohala district, the population is projected to grow to 8,470 persons, more than double its 1987 estimate of 3,600 people.

In addition to the new subdivisions such as Maliu, Waiwailani and Kohala Estate and Ranches with large lots, more subdivisions, such as Ainakea, with smaller house lots are expected to be built in the district to meet rising housing demands. Since North Kohala has the infrastructure necessary for community growth, the prospect is good that the district may become a mixed bedroom community for resort workers and luxury home community for the affluent in the larger lot subdivisions. As such, future water demands on a per capita basis are expected to be higher than in earlier years.

The municipal water requirement to support the projected year 2010 population in the district is estimated at 0.65 mgd. The calculations for the estimate are given in **Appendix D.**

6.3.2 PRIVATE SYSTEMS

Private interests are expected to develop new water sources and pipeline improvements at their expense as exactions or impact fees, or as privately owned water systems. Proposed developments that can be expected to bear such development costs or require additional water include:

Kohala Joint Venture which will serve:		
Kohala Estates	0.255 mgd	
Kohala Ranches	2.385 mgd	
Kohala Makai	0.417 mgd	
Off-site		
De Luz (NSBL)	0.045 mgd	
Kahua Ranch	0.251 mgd	3.323 mgd
Mahukona Resort (Dom & Irr)		3.000 mgd
Kapaanui Subdivision		0.102 mgd

Chalon International: The water resources purchased from Kohala Sugar Company is expected to be utilized more efficiently than is currently managed. As more users are served by the Kohala Ditch, improvements to the system can be expected. The present 15 mgd flow will be maintained. Should land use changes be effected for some urban type use, additional water will be required. However, any urban type development will probably utilize ground water (from wells) to comply with stringent federal water quality requirements. Future water requirements will range between the present 15 to 20 mgd.

Native Auwai Systems: Those families and individuals exercising their kuleana water rights are expected to continue this traditional farming practice. No significant increase in water use is foreseen. No records are kept of usage. The auwai system depends on stream flow which is susceptible to weather conditions. The weather patterns are unpredictable and, hence, this farming activity is more suited for subsistence farming than an economic activity.

TABLE 6.3-1

SUMMARY OF EXISTING AND FUTURE SYSTEM CAPACITIES

System	Aquifer Code	Estimated Future Demand mgd	Existing Draw mgd	Existing Capacity mgd	Required Future Capacity mgd
Muni/Kaauhuhu-Kokoiki	80101	*	0.10	-	0.3
Muni/Hawi-Kapaau-Kynn	80101	*	0.24	0.57	1.2
Muni/Halawa-Halaula	80101	*	0.09	0.20	0.3
Muni/Makapala-Keokea	80101	*	0.03	0.07	**
		0.65			
Priv/Dom-Com	80103		0.10	2.02	6.5
Priv/Irr-Oth	80101		10.10	15.0	20.0-sw

* Included in Total ** Incl in Halawa-Halaula Sys

6.4 WATER PROBLEMS AND OPPORTUNITIES

The State-owned Kehena Ditch was renovated in the '70s. It was designed to serve the makai or lower area. The project was not completed and the project remains idle. In view of the growth of the western coastal section of North Kohala, the Kehena Ditch project should be pursued to completion; it could be used for irrigation purposes to avoid expensive treatment required of surface supplies. An alternative would be for a private enterprise be licensed to develop and operate this source. Being a high level source, hydroelectric power may be developed in conjunction with agricultural use of the water. The average flow of this source based on earlier measurements is 7 mgd. The flow, however, is exceedingly low during dry weather conditions.

The systems operated by the County Water Department is in a "water-rich" area. The 4 systems managed and operated by the Department lies below an area with abundant rainfall. Generally, the streams in the area from Kapaau to Honokane have good flows most of the time attesting to the high mauka rainfall. What is important is the recharge of the excellent basal water in this general area. The problem is one of developing additional well sources for a dependable supply as contrasted to the high level tunnel flows which are influenced by the weather.

Private developers with large scale plans are located on the west coast (dry) side of North Kohala. As with resort or recreation oriented developments, sunshine, lots of it, is a key factor. This west coastal zone is not only dryer than the other sections, but the ground contour rises sharply from the seashore to the upper ranch and forest lands. No high level tunnel water of consistent flow is available. Water must be produced from deep wells over 2 miles inland from the coast and at an elevation of over 1200 feet. The sustainable yield from this basal source will probably average out to 1 mgd, more or less, per mile of coastline. Wells have been successfully developed in this dry or sunny west side of North Kohala. The long term productivity and quality of the wells must be monitored, especially if the wells are concentrated and not spaced out.

In essence, there appears to be sufficient water in North Kohala to meet foreseeable future demands. It is only on the west coastline where some resort activity is proposed that cost of developing water will be relatively expensive.

Some relief is offered by the proposal of the County Water Department to supply water to South Kohala from a well field, Hawi to Pololu Valley, with a large transmission pipeline. Water service to lower elevation west coast lands of North Kohala would supplement the privately owned deep wells. Since the Department's proposal includes reservoirs at elevation 600 feet, these private deep wells with its apparently limited sustainable yield could conceivably accommodate the upper areas beyond the Department's established service zone.

The Kohala Ditch, which served the plantations of North Kohala in years past, is not fully utilized. The maintenance of the ditch system is minimal. This valuable water resource needs to be evaluated. If agriculture is to be a force in North Kohala, the ditch system must be adequately maintained and returned to its former state as an irrigation water production facility. Should the importance of agriculture be discounted, then other uses for the ditch water should be found. It does seem that the soil, climate and water resources of North Kohala can sustain a significant agricultural industry with the key to this being the improvement and proper maintenance of the Kohala Ditch. A proposal was made in the 1970's for the State to take over the Kohala Ditch to preserve the agricultural lands of North Kohala; this has not been pursued. Since North Kohala is in transition, new land owners with new development proposals, it would be an opportune time to assess the Kohala Ditch system and its impact upon the future of the agricultural aspects of North Kohala.

The North Kohala district retains many kuleana water rights and the auwai system is still widely used. This use of stream flows for subsistence farming or for supplemental income should be encouraged. The use of stream flows, though subject to the vagaries of the weather, lessens the demand on the higher priced domestic water supply. Further, it contributes to the retention of our Hawaiian culture. Some of the Kuleana rights may have to be clarified. There appears to be some conflicting claims.

6.5 REGIONAL WATER DEVELOPMENT PLANS

6.5.1 MUNICIPAL PLANS

Kohala Coastal Transmission Pipeline: A preliminary plan has been prepared for the construction of a large transmission pipeline to handle 20 mgd from North Kohala to South Kohala where the future need is evident. The proposal is to establish a well field in the area between Hawi and Pololu. The well production would be set for an elevation of 600 feet. The final distribution reservoir would be at an elevation of 300 feet which would service the major resort developments along the coast which lie below Queen Kaahumanu Highway.

The municipal water systems managed and operated by the County Water Department in North Kohala will require additional wells to assure a dependable source. Past records indicate tunnel sources fluctuate with the weather and can adversely affect community water supplies. Pipeline enlargements or extensions will be required to service new subdivisions and developments. Some improvements proposed by the Department to accommodate natural growth of the area and improvements to replace old facilities include:

Pipeline to Lapakahi State Park
Second Hawi well, Kokoiki well, Halaula well
Improvement to Murphy Tunnel transmission line
Halaula interconnection with Makapala
New reservoirs and replacement of old storage tanks

6.5.1.1 PROJECTED IMPACTS OF MUNICIPAL PLANS

The full scale development of the South Kohala resort region will be assured of a dependable water supply. The Lalamilo wells may not be sufficient in the long term to handle the full scale development of the resort region. The project will reduce the present pumping charges associated with the Lalamilo wells located at elevation 1200 feet, more or less, and provide the County Water Department significant savings in pumping costs. While State funding is required to construct this project; most, if not all, of the funds will be recovered from the service charges from customers on the system. Further, those North Kohala projects along the Akoni Pule State Highway where the transmission pipeline will be installed will be assured of water in an exceptionally dry area. These projects could include the Mahukona Resort, Hawaiian Homes Lands properties at Kawaihae 1, Lapakahi State Historical Park, and other State lands. The State and Hawaiian Homes Land properties could be developed for residential purposes and be available to employees for the South Kohala resort region.

6.5.1.2 ESTIMATE OF MUNICIPAL PLAN COSTS

The magnitude of cost estimates of the municipal water developments proposed in the North Kohala District are as follows:

Kohala Coastal Transmission Pipeline Project: $50 million which include deep wells, reservoirs, and a minimum 24-inch transmission main over 25 miles long.

North Kohala System Upgrading: $5.0 million which include new deep wells, concrete reservoirs, and upgrading of system lines and appurtenances.

6.5.2 PRIVATE PLANS

See comments in Section 6.3.2.

SECTION 7. SOUTH KOHALA DISTRICT

7.1 DISTRICT PROFILE

The South Kohala district has 150,942 acres in land area and occupies approximately 15 miles of the island's northwest shoreline. It runs from sea level to 5000 feet at the Kohala Mountain's south western slope. **See Figure 1.2-1,** following page 1-2, for location of the district and its boundaries.

Average temperature in the upper elevations of the district ranges between 60°F in winter to 80°F in summer. Along the coast, average temperature ranges from 70°F to 90°F. Rainfall in the lower coastal region, the resort areas, average 9 inches a year while at Waimea Village the average is about 75 inches a year. The crest of the canyons at the headwaters of Waipio Valley above Waimea Village approaches 200 inches of rain per year. **See Figure 1.2-2,** following page 1-2, for rainfall map.

The South Kohala district includes the port of Kawaihae, extensive cattle ranch land, and the northern portion of the Kona resort coastline. The visitor industry has emerged as the primary economic activity for the district, followed by cattle ranching and diversified crop farming.

Other activities which contribute to the economy are education and scientific research employment associated with the observatories on Mauna Kea. Cattle ranching utilizes most of the land area, with pastures running from high mountain slopes to sea level. The Parker Ranch, headquartered in Waimea, has a total of 225,000 acres in the districts of South and North Kohala, and Hamakua and is one of nation's largest ranches. The ranch's 139,301 acres are privately owned while the balance is leased land.

Waimea is also one of the most productive areas for temperate zone vegetable crops on the Big Island. Cabbages, celery, lettuce, daikon (turnip), peppers, broccoli and carrots are grown here. Diversified agriculture is expected to grow with locally grown vegetables, beef and eggs already in demand by the hotels in the region. In 1987, the Big Island accounted for 76% of the diversified crops in the State and cattle marketed accounted for 75% of the State total.

Kawaihae Harbor is the second deep water port on the island, and is where one of the islands' four military installations are located. Activity at Kawaihae Harbor has increased since the introduction of ships by the military to transport men and material between Oahu and the Big Island Pohakuloa training area. The harbor also handles receipt and shipments of general cargo, bulk raw sugar, molasses, lava cinders, petroleum products, and bulk fertilizer.

Investor interest in South Kohala centers on three major resorts, the Mauna Kea Beach Resort, Mauna Lani Resort and the Waikoloa Beach Resort. These three resorts are proposing to add a total of 5,300 hotel units and 5,680 condominium units to their existing combined inventory of 1,200 hotel units and 350 condominium units.

The population of South Kohala almost doubled between 1970 and 1980, increasing 99.4% from 2,310 to 4,607 people. In 1987, it is estimated that the district had about 7,100 people. By year 2010 the population is projected to grow to 22,300 people, a tripling of the 1987 figure. This reflects 16.6% of the island's total growth, making it the third fastest growing district in county. The distribution of population is estimated as follows:

	Population	% of District
Waimea (mauka of Waiaka)	8,352	37.5%
Kawaihae (Waiaka & makai)	1,644	7.4%
Waikoloa Village	8,511	38.2%
MKB-S.Kohala Resort	2,670	12.0%
Mauna Lani/Waikoloa Resort	1,123	5.0%

The South Kohala district has 3,041 acres of single family residential zoned lands, primarily located in Waimea and Waikoloa Village. 2,422 or 80% of the total zoned area lie undeveloped. The 1985 land use inventory showed 1,989 single-family units in the district. The Puukapu area has a number non-conforming residential lots lacking standard subdivision improvements. By year 2010, the number of single-family housing units is projected to reach about 6100 units.

The South Kohala district has about 782 acres of multi-family residential zoned land with the vast majority located in the resort areas. Because of the projected increase in population and consequent housing demand, multi-family units are expected to increase considerably. The 1985 existing housing inventory showed 687 duplex, apartment and condominium units in the district. By year 2010, multi-family residential units are projected to reach about 2220 units.

Of the 101,541 acres zoned for agriculture in the district, over half are vacant. Although land in the Waimea area is considered to be the most productive in the County, there is a need to develop a more reliable agricultural water system to fully utilize this potential.

Commercial activity is centered in the Waimea and Kawaihae areas. The Waimea area contains a number of commercial facilities and professional services. The major facility is the Parker Ranch shopping center. This shopping complex includes a supermarket, variety store, banks, post office, and retail stores and services. Several new retail, office and restaurant facilities are being built or planned. Waimea's commercial growth is expected to continue because of its central location in the resort and residential areas in the northern sector of the island, the deep water port at Kawaihae and inter-island airport at Kamuela. The Kawaihae area contains a few small commercial shops and restaurants near the port. With the projected expansion of the resort complexes in the coastal region, ancillary commercial in this area is expected to increase substantially.

Industrial activity is centered in Waimea and Kawaihae Harbor. Many of Waimea's industrial activities are linked with agricultural activities scattered throughout the district such as a vacuum cooling plant for vegetable packing, warehousing, equipment sales and repair, and dairy farming. The South Kohala District has 51,551 acres of state lands. Of this total acreage, 44% are Hawaiian Homes land.

There are 297 acres zoned for resort use of which 115 or 61% is utilized. In addition, all three major coastal resort areas have 268 acres zoned for multiple-family residential use. Vacation rental condominiums are permitted in these areas. The South Kohala district has been long envisioned as a prime visitor destination area. It includes not only the dry, sunny coastal climate and the cool uplands of Waimea but also varied land and ocean recreational attractions. The hotel room inventory at the three major South Kohala resorts has increased from 315 rooms in 1969 to 2,600 rooms at the end of 1988. About 5,850 hotel rooms are projected in the district by year 2010. In addition, about 4,000 resort condominium units are projected.

Data from Hawaii County General Plan, 1989. See **FIGURE 1.5-5 for Land Use Map** showing South Kohala District land use pattern.

Proposed Land Use Pattern Acreage Allocation:

Residential	Commercial	Industrial	Resort	Total
11,056 ac.	1,106 ac.	2,034 ac.	746 ac.	14,942 ac.

Proposed Zoning Acreage Allocation:

Residential	Commercial	Industrial	Resort	Total
4,422 ac.	442 ac.	814 ac.	439 ac.	6,117 ac.

Urban Expansion Locations:

- Waimea
- Kawaihae
- Hapuna-mauka of highway
- Waikoloa-mauka of highway

Land Use Policies and Water Utility Courses of Action:

The General Plan goals and policies relating to county economy and population, environmental quality, water and land use are listed in **Appendix B** - County General Plan Goals and Policies.

The water utility courses of action proposed for the South Kohala District are:

- Improve and replace inadequate distribution mains and steel tanks.
- Further efforts should be made to develop adequate quantities and acceptable quality of basal ground water at appropriately placed site mauka of the shoreline.
- Additional sources for the Waimea System shall be investigated.
- Encourage expansion of sources and storage capacity for both the agricultural and domestic water systems.

7.2 EXISTING WATER USES AND DEVELOPMENTS

7.2.1 INVENTORY

An inventory of existing water uses and developments in Hawaii County is detailed by aquifer sectors in **Appendix C.** The inventory for the South Kohala District is summarized by use categories in the following sections.

7.2.2 SUMMARY OF WATER USE, SYSTEM CAPACITY, AND WATER DRAW

Table 7.2-1, below, gives a summary of the average amount of water sold daily by the municipal systems or used by private systems, the surface flow or well pump capacity of the source, and the volume of water drawn from the source. Where recorded data was not available, estimates of water drawn were made based on information from system operators, well or stream diversion registration forms, and other available data.

TABLE 7.2-1

SUMMARY OF WATER USE, SOURCE CAPACITY, AND WATER DRAW - S.KOHALA

System	Aquifer Code	Average Use mgd	Low Flow or Pump Capacity mgd	Ground Water Draw mgd	Surface Water Draw mgd
Muni/Waimea-Puukapu	80102	0.724	-	-	1.38
Muni/Kawaihae-Puako	80301	1.840	4.752	1.849	-
Agri/Waimea Irr Sys	80102	-	4.0	-	1.3
		2.564		1.849	2.68
Priv/Domestic	80301	-	0.42	0.42	-
Priv/Commercial	80301	-	6.3	4.74	-
Priv/Industrial	80301	-	-	-	2.0-est
				5.16	2.0
Total For District				7.01	4.68
				60.0%	40.0%

A total of 11.69 mgd of water from both surface and ground sources were drawn during 1987-88 period. Although surface water was the primary source in the past, with the advent of resort

developments along the coastal areas, ground water sources in the lower elevation well fields provided 60% of the total water drawn in the district. The private systems operated by Waikoloa Water Company and Waiki'i Ranch made up 74% of the ground water total. The County's Kawaihae-Puako system accounted for the balance. This trend toward use of ground water is expected to continue, primarily because of source reliability.

Surface water was used by the municipal systems to service the higher elevation areas of Waimea-Puukapu and Honokaa-Ahualoa. Municipal use accounted for about one-third of the surface water drawn. Two-thirds of the total was drawn for agricultural irrigation and livestock uses by the State's Waimea Irrigation System.

7.2.3 MUNICIPAL SYSTEMS

The Hawaii County Department of Water Supply has two major systems in the South Kohala District with a total of 2,323 service accounts. The systems consumed an average of 2,837,000 gallons per day in 1987-88. The first system is the Waimea-Puukapu-Nienie System which utilizes surface water supplies from Kohala Mountain. This system also provides water to the Ahualoa-Honokaa system in Hamakua and the subdivision developments which border the Waimea-Kawaihae Road above Kawaihae. The second system is the Kawaihae-Hapuna-Puako System which relies upon the new Lalamilo well field for its source. **See Figures 1.9-3 and 1.9-4** Regional Water Development Plan, following page 11-2, for general location of each system's service area.

The Waimea-Puukapu-Nienie System serves the Puukapu Homesteads; the Hawaiian Homes Lands farm and ranch lots and residential projects at Puukapu-Nienie and Kuhio Village; Waimea Village; Kamuela Airport; and subdivision developments along the Waimea-Kawaihae Road down to the storage tank at elevation 580 feet above Kawaihae. Since 1950, improvements to the system have increased reservoir capacity, enlarged the distribution pipelines and extended the system to meet the growth of this rapidly developing community. The principal sources for this system are the mountain supplies from Waikoloa Stream, first developed in 1925, and the Kohakohau Stream diversion which was completed in 1971 and added to the Waimea system. The Waikoloa Stream source was improved during World War II by the construction of a diversion dam on the stream by the U.S. Marines. The reservoir capacity until the end of the 1960's totalled 14 million gallons, all built by the Marine Division personnel who were stationed in Waimea. Today, the storage facilities have been increased by 150 million gallons with the latest addition of a third 50-mg reservoir. Due to its origin in the wet mountain regions of the Kohala Mountain forest reserve, the surface water is treated by sand filtration for odor and color control. A supplementary source at the Hauani Stream in the Puukapu Homestead area has been discontinued; the limited stream flow with periods of no flow during dry weather periods led to the decision to abandon this source.

An 8-inch pipeline, beginning near the Puu Pulehu Reservoir, transports water by gravity flow from the Waimea-Puukapu-Nienie System to the Ahualoa-Honokaa water system in Hamakua District.

The Waimea and Ahualoa areas which are so dependent on surface water supplies, are subject to extreme in climatic conditions as reflected in stream flows of flood portions at times, and periods of extended low flows during drought weather. During a critical period in the '80s, emergency pumps were installed to boost water from the lower Kawaihae-Puako system to Waimea. A small mountain spring between Alakahi and Kawainui streams was also tapped at great expense to provide water during the same drought.

The Kawaihae-Hapuna-Puako System was originally designed to service the small village of Kawaihae. A small 2-inch pipeline transported water from the Waimea system down to Kawaihae generally following the Kawaihae Road. In the 1950's, the State developed a deep draft harbor at Kawaihae and the Puako subdivision. This necessitated replacement of the existing small lines and extension of the system to Puako. The small pipeline from Waimea to

Kawaihae was replaced with a 6-inch pipeline and additional storage tanks erected. In the 1960's, the Rockefeller development at Mauna Kea Beach opened a new era for this region. To develop sufficient supply, high level exploratory deep wells were attempted along the Kawaihae Road. These resulted in marginal quality water with high chloride content. The high chloride content and temperature reflected the geothermal anomaly which occurs in this area. However, these wells supplemented the limited supply from Waimea by blending with the fresh mountain water supply and enabled development planning to continue. Based on the success of the adjacent Waikoloa deep wells, the State drilled an exploratory well on the State lands of Lalamilo at an elevation of approximately 1200 feet in 1977. The well has produced water of good quality with a chloride content of 78 ppm. Subsequently, additional wells were drilled with financing by the Mauna Lani Resort developer. These wells have allowed the Mauna Lani and Mauna Kea Beach resorts to expand their facilities. The present wells A, B, and C, produce a total of 2,700 gpm (3.88 mgd) with a fourth well, Lalamilo D, to be added. Water supply from the upper Waimea treatment plant no longer serves this area. The Kawaihae Village area around the harbor has also expanded reflecting the growth potential of the West Hawaii coastal area.

7.2.4 AGRICULTURAL IRRIGATION SYSTEMS

The State Department of Land and Natural Resources manages the Waimea Irrigation System. The water resource for the Waimea Irrigation System is the Upper Hamakua Ditch. Honokaa Sugar Company operated and maintained this system. built over 80 years ago. to irrigate its cane fields in the upper elevations. In 1948, the plantation discontinued use of this system which collected water on government lands in the Kohala Forest Reserve and the system reverted to State ownership and control. In 1961 the Waimea Irrigation System began operations serving the State Lalamilo Farm Lot Subdivision. The initial 25 farm lot system was expanded in 1981 to serve additional farm lots in Puukapu, including the Hawaiian Homes Land farm lots. The system currently serves 73 farm lots. The principal sources for this irrigation system are the streams in the Kohala Forest Reserve, namely, Kawainui, Alakahi, Kawaiki, Koiawe, and Waima. The first three are the main contributors to the ditch flow. In 1988, that portion of the stream flow diverted into the system amounted to 694 million gallons.

The ditch is able to handle large flows in excess of 30 mgd according to past records of the plantation. However, to reduce possible damage to the ditch facilities, the maximum ditch flow will be kept to 30 mgd, more or less. This 80-year system is currently being renovated and improved to reduce losses and increase irrigation supplies. This work will take 3 years to complete. The existing Puu Pulehu 100-mg reservoir is being converted to a lined reservoir and expected to hold 110-mg upon completion.

7.2.5 MILITARY SYSTEMS

The district does not have any military water system.

7.2.6 PRIVATE DOMESTIC, COMMERCIAL, AND INDUSTRIAL SYSTEMS

The district has one industrial system that services the needs of Parker Ranch, and one large domestic/commercial system that services the Waikoloa Village and Resort.

The Parker Ranch is comprised of 225,000 acres of which 139,301 acres are privately owned; the balance is leased land. The Ranch maintains approximately 50,000 head of livestock. The Ranch has a far-flung water system to service its numerous pasture lots. The Ranch also purchases water from the County Water Department where such supply is available. Since the sources for the Ranch livestock are stream diversions, yearly consumption varies depending on the weather and its related rainfall. The annual Ranch livestock water requirement is estimated to be over 2.0 mgd. This use may increase as intensive pasture improvements are made

providing for greater carrying capacity of the Ranch lands. The water consumption for domestic uses is provided from both the County and Ranch sources. The Ranch use from the County system is approximately 0.062 mgd, 0.051 mgd for pasture use and 0.011 mgd for domestic/commercial use. In recent years, the Ranch has prepared a master plan for residential, commercial, and other related uses. This is the Parker Ranch 20/20 plan. This is discussed under the next section: Future Water Needs.

The Waikoloa Resort lands were purchased in 1968 from Parker Ranch by Boise Cascade. The company embarked on a program for resort hotel construction which also included a residential development on higher elevation lands located above the beach resort. In recent years, ownership has changed and today the three principal developers include Waikoloa Land and Cattle Company, ATPAC Land Company, and Waikoloa Development Company. The Waikoloa project was responsible for the first successful fresh water deep well in this region. This assured the development of the resort project. Two wells currently provide 2 mgd for the resort hotels and the residential units. Brackish water and reclaimed waste water are used to provide 750 gpm and 800 gpm, respectively. Three brackish wells provide 2.7 mgd for the golf courses supplemented by 0.3 mgd reclaimed waste water.

The Waiki'i Ranch has developed wells on this 2,995-acre tract for a ranch lot subdivision at elevations ranging from 3800 feet to 4800 feet on the slopes of Mauna Kea along the Saddle Road.

7.2.7 NATIVE HAWAIIAN AUWAI SYSTEMS

There are some native Hawaiian auwai systems in the district; however, use is small and intermittent.

7.2.8 OTHER SYSTEMS

The district does not have any water systems in this category.

7.3 FUTURE WATER NEEDS

7.3.1 MUNICIPAL AND STATE SYSTEMS

Municipal system: The present capacity of the Waimea-Puukapu-Nienie system is about 3.6 mgd while consumption is approximately 2.0 mgd. In addition, the capacity of the Waimea Treatment Plant is about 4.0 mgd. However, most of the 1.6 mgd available for expansion is committed to serve existing lots and planned and approved projects. It is expected that this margin will be reached within 5 to 10 years. Since Waimea Village is the commercial and government center for the district, growth will continue. The Parker Ranch 20/20 plan to develop sufficient water for its expansion program will be a significant factor in the capability of the municipal water system to handle future water requirements of this expanding community. The residential development by the Department of Hawaiian Home Lands is expected to utilize a large share of the 1.6 mgd available for future consumption.

The lower coastal region served by the Kawaihae-Hapuna-Puako Water System will require an additional 8.44 mgd in the near future based on the anticipated consumption of the Mauna Lani and Mauna Kea Beach resorts (including the new South Kohala Resort). With other developments proposed or in the planning stages, such as the Signal Puako and Hawaiian Home Land projects, the future water needs could reach 12.88 mgd.

The Waimea Irrigation System maintained by the State serves the farmers at Lalamilo, Puukapu and those on the Hawaiian Home Lands farm lots. Presently, an improvement program is underway to replace, renovate and otherwise improve the old Upper Hamakua Ditch system to eliminate the losses that have compounded the occasional drought conditions which occur in this area. There is a request for expanding the irrigation system boundaries to serve additional 363 acres of Hawaiian Home Lands farm lands and livestock water to 22,88 acres of pasture lands including Hawaiian Home Lands properties. Since the area is subject to recurring drought conditions, additional storage would be required to serve any additional load on the present system. The size of the reservoir would be determined by the future requirements of the new additions based on the type of crops to be grown balanced against the characteristics of the ditch flow. As an alternate, high level well(s) may be used to supplement the present system; in such case, pumping costs will be high compared to the sale price of irrigation water. The present 2 to 3 mgd consumption will require up to an additional 2 mgd to handle the new irrigation demands.

The Department of Hawaiian Home Lands has plans for developing its lands at Puukapu as noted above and at Kawaihae 1 at the North Kohala boundary. Plans are tentative at this time. However, the potential of developing the 10,000-acre Kawaihae 1 tract into house lots and farm lots is great providing water requirements can be met. Full scale development would require up to 10 mgd. It would appear the 2.0 mgd for the planning period would be reasonable to expect for service from the Kawaihae-Hapuna-Puako Water System for the long term providing the Kohala Coastal Transmission Pipeline is constructed. Present plans call for a well in the higher elevation of this Hawaiian Home Lands tract to assess the basal water table in this area. If successful, this well will provide the water for the initial development.

7.3.2 · PRIVATE SYSTEMS

Parker Ranch is expected to develop its own water sources under plans underway for its 20/20 Master Plan which covers three separate areas totalling 800 acres. Water requirements are estimated at 0.607 mgd in the first 5 years; an additional 0.406 mgd in the second 5 years; and 0.320 mgd beyond 10 years for a total of 1.333 mgd. Well-exploratory drilling has proceeded.

Waikoloa Resort, with the completion of its third well, has a fourth well under construction. Both wells will have pumps with 1500 gpm (2 mgd) capacity. They will be placed into operation at the appropriate time. The development plans of this extremely large project which includes besides the resort facilities, large ranch lots, single family residential units, condominiums, apartments, etc., will require additional wells in the future to provide as much as 6 to 7 mgd additional water. As the basal water production has been excellent with hardly any increase in chlorides from its present wells, prospects appear favorable that the future water requirements will be met.

Waiki'i Ranch has begun sales of its ranch lot subdivision of 205 lots on 2,995 acres. The lots vary from 10 to 40 acres in size. The two deep wells should satisfy the estimated 0.200 mgd consumption. The wells are unusually deep, extending 4,350 feet down and encountering high level water which stands 1,500 feet above sea level. The chloride content is low at 27 ppm.

TABLE 7.3-1

SUMMARY OF EXISTING AND FUTURE SYSTEM CAPACITIES

System	Aquifer Code	Estimated Future Demand mgd	Existing Draw mgd	Existing Capacity mgd	Required Future Capacity mgd
Muni/Waimea-Puukapu	80102	1.27	1.62	3.6	6.0-sw
Muni/Kawaihae	80102	0.25	*	*	*
Muni/Puako-Hapuna	80301	10.10	1.85	4.7	14.0
Muni/Hawn Homes	80301	3.50	-	-	4.0
		15.12			6.0-sw 18.0-gw
Agri/Waimea Irrigation	80102	4.0	1.3	4.0	5.0-sw
Priv/Dom-Comm	80301	7.5		6.72	10.5
Priv/Industrial	80102			2.0	2.0-sw
					7.0-sw 10.5-gw
Total For District					13.0-sw 28.5-gw

7.4 WATER PROBLEMS AND OPPORTUNITIES

Municipal System. Most of the old facilities have been replaced; however, other old pipelines and tanks will also have to be changed. These replacement costs will be borne by the Water Department and/or developers as impact fees. However, as the community grows additional water sources will have to be found and more storage facilities may have to be constructed such as impounding Kohakohau Stream to create a multi-million gallon reservoir. The high elevation of Waimea Village discourages pumping from the fresh water basal lens due to the high pumping costs. Exploration should be continued to determine the extent and volume of high level perched water supplies which hydrologists suspect exists. Other streams above Waimea Village may have to be tapped and such flows diverted into new reservoirs. The present surface water supplies are treated to comply with health regulations. Expansion of the treatment facility is foreseen if the additional surface supplies are added to the system.

The Kawaihae-Hapuna-Puako system which serves the coastal resort region is dependent upon the Lalamilo well field. The production from this source has been good so far. However, the chloride content and height of the basal water table indicate that this source is not equal to the adjoining Waikoloa well field. Further, the expansion of the Lalamilo well field, which is at the southern boundary of the State Lalamilo lands, will have to extend towards the Kawaihae Road to the northern boundary of the State-owned lands. Since the earlier Kawaihae wells along the Kawaihae Road disclosed the presence of a geothermal anomaly, the production from such a well field extension must be viewed with caution. This can be assessed only by the drilling of additional wells.

7.5 REGIONAL WATER DEVELOPMENT PLANS

7.5.1 MUNICIPAL PLANS

Expansion of Waimea Irrigation System: The Federal Government and the State of Hawaii are working on plans to expand the Waimea Irrigation System under the Waimea-Paauilo Watershed Program. The plan proposes to add 363 acres of irrigated cropland and supply 22,800 acres of pasture land with livestock water to support an additional 8,200 head. The plan envisions

joint use of the Upper Hamakua Ditch System to supply a new 133-mg reservoir, and the necessary pipeline network to supply crop irrigation water and livestock water. The Puukapu deep well is expected to be developed for use in an emergency. This will provide an additional 1.0 mgd.

Kohala Coastal Transmission Pipeline: This project was described in Section 6.5. The project is to ensure a dependable water supply of good quality water for the South Kohala resort region by importing water from the North Kohala aquifer. The long term dependability of the Lalamilo well field to handle the full scale development of this region is uncertain at this time due to the higher chloride content and lower height of the basal water table as compared to the Waikoloa wells, the presence of a geothermal anomaly nearby, and the relatively narrow width of the State Lalamilo land to develop a spread out well field to produce the high yield required.
Puukapu Deep well Development: The deep well in the Kohala Forest Reserve in Puukapu will be placed into service. This well will be connected to the Waimea Irrigation System intake pipeline and serve as a standby source should irrigation water be required.

7.5.1.1 PROJECTED IMPACTS OF THE MUNICIPAL PLANS

Expansion of Waimea Irrigation System: The project will increase the agricultural productivity of farm and pasture lands owned by the Department of Hawaiian Homes Lands. The proposed Lalamilo Agricultural Park will also be served by this expansion. This project will strengthen the agricultural base of Waimea which has seen large agricultural areas shifted into the urban district in the past. The lands affected by this project are currently classified agriculture and no changes in land use will result.

Kohala Coastal Transmission Pipeline: The tremendous investment in the South Kohala resort region deserves a dependable water system of good quality water. The present Lalamilo well field has produced good results so far. Looking to the future and based on the operational experience of deep wells in West Hawaii, the sustainable yield of good quality water from the Lalamilo well field to meet long term requirement is questionable at this time. Further, the high cost of pumping can be significantly reduced by the coastal transmission pipeline. These two factors coupled with the project costs being fully or partially recovered by users of the system appear to be adequate justification for the project. The alternative would be the drilling of additional wells without the assurance that the expanded well field production will meet future requirements with good quality water.

Puukapu Deep Well Development: This high level water source will serve to assure water to the Waimea Irrigation System farmers in case of need. The proximity of this well to the domestic system in Waimea could result in additional supply to the domestic water system as an alternative, also.

7.5.1.2 ESTIMATE OF MUNICIPAL PLAN COSTS

Expansion of Waimea Irrigation System: Preliminary figures indicate the project costs to be $9,648,700. The major cost will be the new 133 million gallon reservoir.

Kohala Coastal Transmission Pipeline: The cost for this project is estimated at $50 million and includes wells, reservoirs and a large transmission pipeline.

Puukapu Deep Well Development: The estimated cost to provide the deep well with pumps and related equipment is slightly over $1 million.

7.5.2 PRIVATE PLANS

See comments in Section 7.3.2.

SECTION 8. NORTH KONA DISTRICT

8.1 DISTRICT PROFILE

The North Kona district stretches from sea level along the island's west coastline, in a southeast direction up to the summit of Mauna Loa at 13,677 feet. The district contains 365,881 acres with Hualalai mountain rising to 8,271 feet at its western corner. **See Figure 1.2-1**, following page 1-2, for location of the district and its boundaries.

Rainfall averages in this district's coastal areas range from 9 inches a year in the dryer coastal areas and 50 inches annually at its upper regions along Mamalahoa Highway. A pocket area at about 3000 feet elevation in the Keauhou area registers a high of 79 inches a year. **See Figure 1.2-2**, following page 1-2, for rainfall map.

Average maximum and minimum temperatures at Kailua Village would be about 83°F and 67°F, respectively. In the upper areas along Mamalahoa Highway at Holualoa, the average maximum and minimum temperatures are 77°F and 60°F, respectively. The lowest average temperature, 45°F, is found at the summit of Mauna Loa.

North Kona is experiencing the fastest economic growth on the island. A growth spurred primarily by an expanding visitor industry. It is the major economic activity for the district. The more than 4,500 hotel and vacation condominium units in the district are forecasted to expand rapidly. The Keahole International Airport is located in this district. The airport plans include terminal and runway expansion. Also located in the same general area of the district are the State's Natural Energy Laboratory of Hawaii (NELH), the Hawaii Ocean Science and Technology (HOST) Park, and a small boat harbor at Honokahau. These facilities have great potential for further expansion.

Despite the dominance of tourism in the district's economy, diversified agriculture continues to develop. Raising of coffee, macadamia nut and avocado, and ranching are the major agricultural activities in North and South Kona. Other agricultural commodities include papaya, bananas, oranges, tangerines, beans, cucumbers, ginger roots, tomatoes, flowers, foliage, and nursery plants. Floriculture expansion is reflected in new nurseries specializing in orchids, anthuriums, and protea in the Kona area.

The Big Island is the sole producer of coffee grown in the U.S. The North and South Kona districts have experienced increases in the number of coffee farms located there. While the cost of producing Kona coffee is higher than other coffee producing areas of the world, Kona coffee is dependent on a gourmet market to reach a reasonable profit.

Timber harvesting and fishing are small industries in Kona. The Kailua Harbor is considered a major center for big game fishing and international tournaments are held annually. Other industrial activities include quarrying operations for building materials, construction, and printing.

The population of North Kona grew by 188% from 4,832 people in 1970 to 13,898 in 1980. It is estimated that by 1987, the district's population had grown 48% to about 20,500. By year 2010, the population is projected to reach 52,620 people, making up 26% of the island's total population at that time. The population distribution is estimated as follows:

Kukio Area	365	00.7%
Keahole-Kailua Development Area	14,674	27.9%
Kailua Village Area	21,881	41.6%
QLT-Holualoa-Kaloko Mauka Area	10,740	20.4%
Keauhou Area	3,660	07.0%
Kainaliu-Honalo Area	1,300	02.5%
	52,620	

The North and South Kona districts have a total of 2,420 acres zoned for single-family residential use. 1,554 acres or 64% is undeveloped. Unfavorable topographic conditions, inadequate roadway access and lack of infrastructure facilities are some reasons for the zoned lands not being developed. The 1985 land use inventory showed 4,697 single-family units to be in the district. The projection for year 2010, estimates that single family units will multiply more than two and half times to 12,800 units.

A total of 703 acres are zoned for multiple-family residential use in North and South Kona. Construction activities of multiple-family residential units in the Kona districts have been moving rapidly and are expected to continue because of the expansion of tourism. Some of the zoned areas lack the basic amenities, such as sewer, water and adequate roadways. The 1985 existing housing inventory showed 4,073 duplex, apartment and condominium units in the district. By year 2010, multi-family residential units are projected to reach about 7,550 units.

There are 280,937 acres of land designated as Agricultural District by the State Land Use Commission in North and South Kona. Of this total acreage, county zoning has designated 160,409 acres for agricultural use and 120,145 acres as unplanned. Although the district's climate is favorable for agriculture, soils and topography present limitations, particularly for mechanized farming. Land prices, pressures for urban development and land ownership by a few large landowners are other constraints on agriculture in the districts.

Commercial activity in North Kona is located in Kailua, in the Keauhou Resort area and in several rural village areas along Mamalahoa Highway in the mauka areas. Kailua's increased commercial activity has paralleled the growth of tourism and related population increase in the area. Commercial facilities consisting of office and shopping complexes, professional and financial service buildings, retail shops, and restaurants are located on Alii Drive and Kuakini Highway, mainly between Palani and Hualalai Roads. The Keauhou Resort shopping center is located at the south end of the Alii Drive and services residents and visitors. The commercial activities in the mauka areas are geared primarily toward meeting residents needs.

Most of Kona's industrial development is service oriented and located near Kailua Village. There are industrial parks just north of the Village and at Keahole near the airport. Industrial activities include warehousing, lumber storage yards, and service oriented businesses. The energy and aquaculture activities at Keahole have good potential for expansion and may become major employment generators in the future.

There are 328 acres zoned resort in the North Kona District with about 135 acres vacant. However, not all of the acreage zoned for resort are utilized for hotels. Other uses include multi-family residences along with some non-conforming residential and commercial uses. For every hotel unit in the district, there are almost two condominium units that are available for vacation rentals.

North Kona has historically been the focus of resort activity for the island of Hawaii. Initial development occurred in the Kailua Village area with a small number of visitor accommodations. Hotel facilities are now located in both Kailua and Keauhou areas with other visitor related uses such as condominiums, single-family dwellings, restaurants and retail shops sided between the two locations on Alii Drive.

Kamehameha Investment, the development arm of Bishop Estate, has created the Keauhou Resort into a resort-residential community offering the full range of amenities including golf, tennis, shopping, entertainment, and convention center facilities.

The coastal area north of Kailua to the Kona Village area is seen as the section in the district where large scale resort expansion is anticipated. Several resort proposals have been offered for the area.

Of the total land area in North Kona 213,414 acres or 59% are state lands. It is one of the four districts on the island where public lands constitute more than 50% of its total land mass.

Data from Hawaii County General Plan, 1989. **See FIGURE 1.5-6,** following page 11-2, for Land Use Map showing General Plan land use pattern for North Kona District.

Proposed Land Use Pattern Acreage Allocation

Residential	Commercial	Industrial	Resort	Total
25,066 ac.	2,507 ac.	5,068 ac.	1,160 ac.	30,801 ac.

Proposed Zoning Acreage Allocation

Residential	Commercial	Industrial	Resort	Total
10,027 ac.	100 ac.	2,027 ac.	733 ac.	12,887 ac.

Proposed Urban Expansion Areas

Keahole	Kailua
Honokahau	Keauhou

Land Use Goals and Policies and Water Utility Courses of Action:

The General Plan goals and policies relating to county economy and population, environmental quality, water, and land use are listed in **Appendix B** - County General Plan Goals and Policies.

The water utility courses of action proposed for the North and South Kona Districts are:

- Pursue groundwater source investigation, exploration and development in areas that would provide for anticipated growth and that would provide for efficient and economic system operation.
- Increase the capacity of the booster pump stations as required.
- Improve the system along Alii Drive. Reservoirs to serve this area should be balanced with the Kailua and Keauhou reservoirs.
- Increase capacity of the booster pump for the South Kona water system as the demand increases.
- Construct reservoirs as needed.

8.2 EXISTING WATER USE AND DEVELOPMENT

8.2.1 INVENTORY

An inventory of existing water uses and developments in Hawaii County is detailed by aquifer sectors in **Appendix C.** The inventory for the North Kona District is summarized by use categories in the following sections.

8.2.2 SUMMARY OF WATER USED, SYSTEM CAPACITY, AND WATER DRAW

Table 8.2-1, below, gives a summary of the average amount of water sold daily by the municipal systems or used by private systems, the surface flow or well pump capacity of the source, and the volume of water drawn from the source. Where recorded data was not available, estimates of water drawn were made based on information from system operators, well or stream diversion registration forms, and other available data.

Ground water was the only source of water used by all systems in North Kona. The County's North Kona System drew 7.69 mgd or 90% of the total. The Kahaluu well fields supplied all of the North Kona municipal requirement and a portion of the South Kona requirement. The balance of the total water used in the district were drawn from private well sources for resort and subdivision uses.

TABLE 8.2-1

SUMMARY OF WATER USED, SOURCE CAPACITY, AND WATER DRAW - N.KONA

System	Aquifer Code	Average Use mgd	Low Flow or Pump Capacity mgd	Ground Water Draw mgd	Surface Water Draw mgd
Muni/North Kona	80901	5.973	11.520	7.694	-
Priv/Domestic	80902		0.070	0.13	-
Priv/Commercial	80902		0.133	0.70	-

8.2.3 MUNICIPAL SYSTEMS

The County Water Supply Department has one major system in the district. It is the second largest system on the island with 5,237 service accounts. The average water consumption for 1987-88 was 5,973,000 gallons per day. The North Kona System depends fully on ground water sources for its water supply. The system currently has five deep wells and one inclined shaft sources in Kahaluu and Holualoa. See Figure 1.9-4 Regional Water Development Plan, following page 11-2. for general location of the system's service area.

The North Kona Water System extends from the Ke-ahole Airport south to the South Kona boundary where interconnection with the South Kona Water System is made. The Kona districts were without any County water systems until funds were provided by the Legislature in 1951. The first increment of the North Kona Water System was completed in 1953. Surface water from Waiaha Stream was diverted into large storage tanks located Waiaha above Mamalahoa Highway, filtered, then piped down to Kailua by a small transmission line to large tanks above Kailua Village. This provided the impetus for the resort development which occurred in subsequent years. Expansion of the system, mainly through legislative funds, continued for years. The small pipelines installed initially have been replaced with larger mains for the most part. The system expanded to Keauhou permitting the development of hotels along this coastline. Expansion to Ke-ahole Airport opened up a new area for development such as the Honokohau Small Boat Harbor. The expansion program did not neglect the existing farming community in the mauka areas as the system eventually serviced the North Kona District from Kalaoa Homesteads and continuing south to the South Kona boundary, a distance of over 18 miles.

The expansion and growth of the system were primarily due to the successful development of the deep wells at Kahaluu at elevation 832 feet, more or less. The spectacular economic growth of this district has required the drilling of additional wells to meet consumption demands. In recent years, a well has been drilled at Holualoa while the search for other productive areas continues.

A branch of the North Kona Water System serves the Kaloko Mauka Subdivision. This agricultural subdivision starts from Mamalahoa Highway at elevation 1400+ feet and, through a series of pumps and storage tanks, water is boosted up to a final elevation of 5106 feet. The high cost of pumping through seven lift stations necessitates a special water rate structure for this portion of the North Kona Water System. Several of the original 20-acre lots have been resubdivided into smaller 3-acre lots and at present, 56 metered services are in place.

8.2.4 AGRICULTURAL IRRIGATION SYSTEMS

The district does not have any agricultural irrigation system with its own source. Farmers rely on the municipal system or private catchment system for their irrigation water supply.

8.2.5 MILITARY SYSTEMS

The district does not have any military water system.

8.2.6 PRIVATE DOMESTIC, COMMERCIAL, AND INDUSTRIAL SYSTEMS

The district has one commercial system that services the Kona Village Resort at Kahuwai Bay and one domestic system that serves the Puuwaawaa Ranch Puu Lani subdivision.

The Kona Village resort facility started in the 1950's, as a small hideaway accessible by light planes on its own runway, has kept pace with visitor industry growth. Today, it is also accessible from the Queen Kaahumanu Highway. At present, 2 electro-dialysis plants provide the drinking water of 0.070 mgd. Brackish water is used for irrigation purposes.

The Puwaawaa Ranch drilled two extremely deep wells in the late '70s which are the source for a subdivision development. Puu Lani. on the slopes of Hualalai. These wells at an elevation of 2550 feet and 2313 feet, respectively, extend down 4,862 feet. The wells produce 50 gpm and 42 gpm; or 0.133 mgd, maximum.

The Kona Coast (Iuehue Ranch), as part of its development plans for its ranch holdings, drilled a test well and discovered potable water. This has led to plans for resort and residential development. No sustained use of the well is underway at this time.

8.2.7 NATIVE HAWAIIAN AUWAI SYSTEMS

Records indicate some native Hawaiian auwai systems in the district. However, little if any use is practiced today.

8.2.8 OTHER SYSTEMS

The district does not have any water systems in this category.

8.3 FUTURE WATER NEEDS

8.3.1 MUNICIPAL SYSTEMS

Municipal water supplies must keep pace with the rapid growth of the coastal areas of West Hawaii. The need for additional water sources, namely, more wells will be the priority. The permeability of the ground and the low hydraulic gradient of the basal water table does not permit wells with high yields. Past records indicate that over-pumping of wells producing over 2 mgd will result in increased salinity. Therefore, wells with smaller yields, 1 mgd or less, will be required. While hotel construction in North Kona has waned, condominiums and residential developments have blossomed. The State-owned Kealakehe tract is proposed for a huge housing development of 1500+ units. The area between Kailua and Ke-ahole Airport is under strong development pressures. State projects such as the Ke-ahole Agricultural Park, the Natural Energy Laboratory of Hawaii with its expanding facilities for aquaculture, mariculture and energy-related activities, and the new Hawaii Ocean Science and Technology Park (HOST Park) are dependent on the County water system.

The first large scale resort in Kona, the Bishop Estate's Keauhou Resort, still requires additional water to reach its goal of 3,000 hotel rooms and 3,000 residential units of apartments and single-family residences. To date, 3 hotels with a total of 1,286 rooms, and 967 residential units have been completed.

Based on current trend, the water usage could more than double within 15 to 20 years if present development proposals, government and private, are carried out. The additional water need of 22.0 mgd shown on the next page were estimated based on available information from various sources. Adding the present amount being drawn by the North Kona System would result in a total future need of about 29.7 mgd. The estimate of future need based on projected population and hotel-condo units for North Kona, as shown in **Appendix D** is 30.6 mgd.

Kohanaiki Project:	2.8	mgd
Ooama Project:	1.3	mgd
TSA International Project:	0.8	mgd
Kealakehe (State) Project:	4.7	mgd
Liliuokalani Trust Project:	3.4	mgd
Keauhou Resort:	3.0	mgd
Normal system increase - Kailua-Keauhou incl. mauka area:	3.0	mgd
State Projects:	3.0	mgd
Total	22.0	mgd

8.3.2 PRIVATE SYSTEMS

Private domestic, commercial and industrial water sources are being expanded or developed, including the following:

Huehue Ranch (Kukio), 675 acres:	3.5 mgd
Kaupulehu (Kona Village), 575 acres:	2.8 mgd
Puu Lani (Puuwaawaa)	0.1 mgd
Total:	6.4 mgd

These developers have indicated their intent to develop their own water sources, or to contribute financial aid (impact fees) for expanding the existing County system. Developments at Puuwaawaa Ranch, Kona Village, and Huehue have water sources that are in use and may possibly be expanded to handle additional water requirements.

The use of intermittent streams by the ranching community is expected to continue. Storage is essential to gain wider use of the erratic stream flows. The expansion of the County water system has benefited the ranchers and lessened their dependency on stream flows. Prior to the County water system, ranchers had to haul water great distances during the occasional dry spells typical of this region. However, the upper regions of Kona beyond the County service zone which is the primary grazing areas, still depend on stream flow storage.

The native auwai system is almost absent. This is not to mean that stream rights do not exist; rather, the traditional auwai system such for the growing of taro is of minor use in this region. Most of the kuleana rights are associated with brackish wells or ponds in the lower coastal areas.

TABLE 6.3-1

SUMMARY OF EXISTING AND FUTURE SYSTEM CAPACITIES

	Estimated	Required

System	Aquifer Code	Future Demand mgd	Existing Draw mgd	Existing Capacity mgd	Future Capacity mgd
Muni/North Kona Sys	80901	30.6	7.7	11.52	34.0 *
Priv/Dom-Comm	80902	-	0.83	0.20	6.4

* Includes backup well capacity

8.4 WATER PROBLEMS AND OPPORTUNITIES

The rapid growth of North Kona is related to the visitor industry. In the past, the lack of water had been the deterrent to growth. Since the first deep well at Kahaluu disclosed the existence of developable basal water, North Kona has proven to be a prime visitor destination area. However, developments have taken an accelerated pace and water has again become a critical factor. The Kahaluu shaft which was designed to produce over 10 mgd can only be counted for 6 mgd, more or less, to control the water quality. The chloride content originally 6 ppm has risen alarmingly to 200 ppm. The diminished quality of this source requires careful monitoring. Small clusters of wells spread out over a large area are needed rather than a concentration of many wells in a single location. This requires continuation of the State well drilling exploratory program. Such program could also provide information for private developers, thus lessening the burden of well drilling by government agencies. Further, the location of wells spread out over the district minimizes the risk of depending on a single source and precludes the necessity of large and long transmission lines. Since the area north of Kailua to the South Kohala boundary has been proposed for development, a better understanding of the basal water supply at Waikoloa, which stands higher than the adjacent Lalamilo wells, would be desirable. Should the Waikoloa water table extend south to State lands at Kiholo, a valuable source would be available.

The municipal water system will have to keep pace with the projected growth of North Kona. The location of new wells is critical for development to continue. The limits of mauka service area generally follow Mamalahoa Highway. The pressure to subdivide above the highway will only result in increase costs of operation due to high pumping charges. As most of the mauka lands are devoted to agriculture, subdividing the mauka lands should be controlled. This would be in line with the consensus for retaining an agricultural base in the Kona districts.

Developers of private systems in the area north of Kailua are still faced with locating suitable underground sources. Coordination and monitoring of these future sources must be exercised to ensure that the sustainable yield is not exceeded by any one to the detriment of the others and to prevent adverse impacts to the basal water table.

8.5 REGIONAL WATER DEVELOPMENT PLANS

8.5.1 MUNICIPAL PLANS

Wells: The exploration and drilling of deep wells throughout the North Kona district is required to maintain an orderly growth pattern. The need to develop a planned well field throughout the district remains a priority item. Some potential drill sites are located at Kiholo, Waiaha-Keopu sector, and south of Keauhou. Proposed well sites for which funds have been approved or

requested include: Kainaliu, Kalaoa and Hualalai. The existing Kahaluu well shaft will be improved while studies are conducted to reduce the increasing chloride content by use of a grout curtain.

Alii Drive Realignment Pipeline: The installation of a large diameter pipeline, 12-inch or larger, along the proposed route of the new Alii Drive linking Kailua and Keauhou is essential for efficient water service.

Kealakehe to Ke-ahole Water Improvements: The large scale housing development at Kealakehe, continuing development at Ke-ahole Airport, the proposed expansion of Honokohau Harbor, development of the Kealakehe makai lands for a golf course and related construction, and the HOST Park - all State projects; and the proposed development of private lands north of Kailua Village will require as much water as is currently available.

8.5.1.1 PROJECTED IMPACTS OF MUNICIPAL PLANS

Wells: Without the addition of new wells, the present water sources will be over-drawn resulting in long-term water quality problems. Growth will be stymied including the State's housing, agricultural and scientific programs. The visitor industry will be adversely impacted.

Alii Drive Realignment Pipeline: The new Alii Drive has been planned to alleviate the growing traffic problem along the present narrow coastal road. Without the new transmission pipeline, the development of the Kailua-Keauhou sector will not have an efficient water network to promote orderly growth.

Kealakehe to Ke-ahole Water Improvements: Without additional water sources and new and larger mains, the growth of the Kealakehe to Ke-ahole area will not be possible. Further, if continual high withdrawals are made of the Kahaluu source, water quality will be severely impacted. The State's plan for this sector is an inducement for private lands in the area to be developed in consonance with the State.

8.5.1.2 ESTIMATE OF MUNICIPAL DEVELOPMENT COSTS

The magnitude of cost estimates of the water developments proposed in the North Kohala District are as follows:

Wells: $2.792 million have been budgeted for this initial well development program. Additional funding for well development should continue at this pace until the required capacity of the municipal system is assured.

Alii Drive Realignment Pipeline: Depending the final size of the Alii Drive pipeline, the cost will range from $1.6 to $2.3 million.

Kealakehe to Ke-ahole Water Improvements: The estimated cost depends on the participation of the private developers. Impact fees (contributions in aid to construction) will supplement government expenditures. The initial water source development has been estimated at $12 million. The total water source development could reach $80 million.

8.5.2 PRIVATE PLANS

See comments in Section 8.3.2.

SECTION 9. SOUTH KONA DISTRICT

9.1 DISTRICT PROFILE

The South Kona district has 143,341 acres and occupies about 35 miles of the island's southwest shoreline. The land area runs from sea level to approximately 7,000 feet elevation along the southwestern slope of Mauna Loa. It is the second smallest district on the island in geographic size and population. **See Figure 1.2-1,** following page 1-2, for location of the district and its boundaries.

Rainfall in the lower coastal areas registers an average of 23 inches a year and at the upper reaches of the district at 7000 feet it averages 39 inches. There is a northern and southern high rain fall pocket between 2000 and 3000 feet elevations where it averages 78 inches a year. **See Figure 1.2-2,** following page 1-2, for rainfall map. Average temperature in this district ranges from 75°F to 85°F in the coastal areas and 50°F to 70°F at its upper elevations.

The primary economic activity of this district is agriculture. Coffee, macadamia nuts, and ranching are primary crops and activities. Coffee is both grown and processed in the district. Other district commodities include bananas, citrus, avocadoes, winter tomatoes, cattle, other truck crops and macadamia nuts. Macadamia nut orchards have increased significantly in acreage in recent years, and surpassed coffee as the top agricultural product of the district.

South Kona's population in 1980 stood at 5,809 people. By 1987, it is estimated that the population increased by 26% to 7,293 people. Projections to year 2010 indicate a population of 10,660 in South Kona, or an increase of 46%. The distribution of population is estimated to be about 8,580 people in the Captain Cook-Kealakekua area, and about 2,080 people in the Hookena-Milolii area. The population centers are at Captain Cook and Kealakekua with smaller settlements strung along the Mamalahoa Highway on relatively steep slopes at elevations of 500 to 1000 feet.

The North and South Kona districts have a total of 2,420 acres zoned for single-family residential use. 1,554 or 64% is undeveloped. Unfavorable topographic conditions, inadequate roadway access and lack of infrastructure facilities are some reasons for the zoned lands not being developed. The 1985 land use inventory showed 1,846 single-family units in the district. The district is projected to have about 2,970 single-family residential units by year 2010.

Although construction of multiple-family residential units in the Kona region has proceeded at a rapid rate, the vast majority of the units are located in North Kona. The North and South Kona districts have a total of 703 acres zoned for multiple-family residential use. Some of the zoned areas lack the basic amenities, such as sewer, water and adequate roadway systems which limit development for the intended use. The 1985 existing housing inventory showed 110 duplex, apartment and condominium units in the South Kona District. Very little increase is expected in the future. By year 2010, the multi-family residential units are projected at 122 units. Most of the units would be located in the Captain Cook-Kealakekua area.

There are 280,937 acres of land designated as agricultural district by the State Land Use Commission in the North and South Kona districts. Of this total acreage, county zoning has designated 160,409 acres for agricultural use and 120,145 acres as unplanned. Although climate is favorable for agriculture, soils and topography present limitations, particularly for mechanized farming. Land prices, pressures for urban development and land ownership by a few large landowners are other constraints on agriculture. Commercial activities are located in several village areas along the Mamalahoa Highway in the mauka area and are geared primarily towards the needs of the residents.

The major industrial activity is coffee and macadamia nut milling and roasting. Other activities include slaughterhouses, fish packing and processing and ancillary agricultural services. Service

related industrial uses such as warehousing, garages and auto body shops are located in pockets along the highway. The general lack of level land areas limits the development of industrial sites.

Although there are no resort zoned lands in the district there are lands allocated for resort in the General Plan. There are limited of visitor accommodations in the district.

There are 25,025 acres of state owned lands in South Kona.

Data from Hawaii County General, 1989. **See FIGURE 1.5-6**, following page 11-2, for Land Use Map showing General Plan land use pattern for South Kona District.

Proposed Land Use Pattern Acreage Allocation

Residential	Commercial	Industrial	Resort	Total
5,122 ac.	512 ac.	768 ac.	90 ac.	6,492 ac.

Proposed Zoning Acreage Allocation

Residential	Commercial	Industrial	Resort	Total
2,050 ac.	205 ac.	307 ac.	54 ac.	2,616 ac.

Proposed Urban Expansion Areas
Kealakekua

Land Use Goals and Policies and Water Utility Courses of Action:
The General Plan goals and policies relating to county economy and population, environmental quality, water, and land use are listed in **Appendix B** - County General Plan Goals and Policies.

The water utility courses of action proposed in the General Plan for the North and South Kona Districts are:

- Pursue groundwater source investigation, exploration and development in areas that would provide for anticipated growth and that would provide for efficient and economic system operation.
- Increase the capacity of the booster pump stations as required.
- Improve the systems along Alii Drive. Reservoirs to serve this area should be balanced with the Kailua and Keauhou reservoirs.
- Increase capacity of the booster pump for the South Kona water system as the demand increases.
- Construct reservoirs as needed.

9.2 EXISTING WATER USES AND DEVELOPMENTS

9.2.1 INVENTORY

An inventory of existing water uses and developments in Hawaii County is detailed by aquifer sectors in Appendix C. The inventory for the South Kona District is summarized by use categories in the following sections.

9.2.2 SUMMARY OF WATER USE, SYSTEM CAPACITY, AND DRAW

Table 9.2-1, below, gives a summary of the average amount of water sold daily by the municipal systems or used by private systems, the surface flow or well pump capacity of the source, and the volume of water drawn from the source. Where recorded data was not

available, estimates of water drawn were made based on information from system operators, well or stream diversion registration forms, and other available data.

TABLE 9.2-1

SUMMARY OF WATER USE, SOURCE CAPACITY, AND WATER DRAW - S.KONA

System	Aquifer Code	Average Use mgd	Low Flow or Pump Capacity mgd	Ground Water Draw mgd	Surface Water Draw mgd
Muni/South Kona	80603	0.867	1.584	0.755	-
Priv/Agr Irr	80602	-	1.14	0.274	-

9.2.3 MUNICIPAL SYSTEMS

The Hawaii County Department of Water Supply has one major system in the South Kona District. It had 1,379 service accounts with an average daily consumption of 867,000 gallons in 1987-88. The South Kona System utilizes ground water from a series of deep wells at its Keei well field. **See Figure 1.9-5** Regional Water Development Plan, following page 11-2, for general location the system's service area.

The South Kona System interconnects with the North Kona System a short distance from the district boundary (which is near the Kona Hospital) at Konawaena School. The principal source for the system is the Keei well field. This well field was first started in 1958. From this well field a network of pipelines emanates heading mauka, makai, and north and south along Mamalahoa Highway. Today, the system extends from the district boundary south to Hookena, a distance of 16 miles. Being a new system insofar as the Water Department is concerned, all the major pipelines are of ductile iron and most of the storage facilities are of reinforced concrete.

Major centers of interest served by this system include Pu'uhonua o Honaunau National Historical Park, Kealakekua Bay and its environs, coffee farms along the mauka highway and middle road, and schools at Hookena and Honaunau.

9.2.4 AGRICULTURAL IRRIGATION SYSTEMS

There is one agricultural irrigation system in the district for a macadamia nut orchard, MacFarms of Hawaii. Its 3,800 acres makes it the largest single macadamia nut orchard on the Big Island, and perhaps the world. The slightly brackish State well at Okoe is used for irrigation. Other small farmers rely on the municipal system or catchment system for their irrigation water supply. The well is only used as needed and approximately 100 million gallons is used annually.

9.2.5 MILITARY SYSTEMS

The district does not have any military water system.

9.2.6 PRIVATE DOMESTIC, COMMERCIAL, AND INDUSTRIAL SYSTEMS

The district does not have any water system in this category.

9.2.7 NATIVE HAWAIIAN AUWAI SYSTEMS

There are no known auwai systems used for irrigation at this time.

9.2.8 OTHER SYSTEMS

The district does not have any water systems in this category.

9.3 FUTURE WATER NEEDS

9.3.1 MUNICIPAL SYSTEMS

The municipal water system has been a positive factor for South Kona. Farms have sprouted along the County water system. Even those not served by the County and who rely on roof catchment have benefited. During drought periods, these residents had to go long distances to haul their emergency water supply or suffer great hardship in the past. While construction of dependable water system to serve these residents may not be justified from the revenues derived solely from such a water system, a more rational approach would be to evaluate their contribution to the economic and cultural aspects of the island. Based on such a viewpoint, it would seem that some form of rural system can be developed to improve the health and welfare of these residents who are making a significant contribution to the island farming and fishing industries, and the retention of our Hawaiian culture. A water system, in one or more increments, capable of furnishing 0.100 mgd would be desirable for areas beyond the scope of the present County water system at Hookena.

Since population projections for South Kona show an increase, additional sources of supplies are required. The primary growth will center around Kealakekua. This means that the Keei well field source must be supplemented by new wells. Another well, or wells, capable of supplying up to 1.0 mgd would be required.

9.3.2 PRIVATE SYSTEMS

Private domestic, commercial and industrial uses are expected to increase. A well has been drilled by MacFarms of Hawaii to increase their irrigation capability. This would expand the irrigated macadamia orchard acreage and increase crop yields. The new well still to be placed in use will also produce 1 mgd and indications are the chloride content is lower than the nearby State well at Okoe. Farms of Kapua, nearby, is still struggling with government approvals relating to land use. Its water requirements were estimated to be 7.4 mgd of brackish water suitable for irrigation; 0.01 mgd for livestock; and a potential use of 6 mgd for aquaculture facility should government land use approvals be obtained. Potable water is expected to be trucked in since no source is presently available for such use. This is estimated to be 3,200 gallon per day.

TABLE 9.3-1

SUMMARY OF EXISTING AND FUTURE SYSTEM CAPACITIES

System	Aquifer Code	Estimated Future Demand mgd	Existing Draw mgd	Existing Capacity mgd	Required Future Capacity mgd
Muni/South Kona	80603	1.41	0.76	1.58	2.7
Pri/Agr Irr	80603	-	-	-	2.1

9.4 WATER PROBLEMS AND OPPORTUNITIES

Municipal water uses must continue to expand to accommodate the population growth expected in South Kona. The relatively low rainfall and the permeable ground do not indicate a good basal water table. Exploratory wells are needed to assess the availability of groundwater. Such exploratory work could be coordinated with private developers seeking to expand the agricultural base of the district. The potential of additional macadamia, coffee and avocado orchards appears excellent in view of present market conditions. The expansion of municipal water system could support a higher farm working community.

Private developers require irrigation supplies to increase crop yields and to overcome the adverse impacts of prolong dry weather conditions. The test well at Okoe shows some promise with the somewhat brackish well water suitable for irrigation to some extent. Additional exploratory drilling is desirable.

9.5 REGIONAL WATER DEVELOPMENT PLANS

9.5.1 MUNICIPAL PLANS

New Water System - Milolii/Honomalino: Municipal water system expansion to serve a greater area in South Kona is desirable. This would improve the health and welfare of those residents still without the benefit of a County water system.

Keei Well: The present Keei well field has two wells with rather high chloride content. The newest well has a significantly lower salinity count and therefore, better quality water can be developed. Further, the present well field will not be able handle the population increase projected for the Kealakekua-Keei sector. Additional sources must be found and developed.

The general locations of the proposed developments are shown on **Figure 1.9-5** Regional Water Development Plan, following page 11-2.

9.5.1.1 PROJECTED IMPACTS OF MUNICIPAL PLANS

New Water System: Without the expansion of the water system, the health and welfare of the residents will be adversely affected. As an example, the current impact to roof catchment supplies due to prevailing volcanic conditions will be alleviated. In addition, the work force for the agriculture industry could expand as new homes could be built closer to the places of employment such as at Honomalino. Residents at Milolii and its vicinity could improve their livelihood by subsistence farming improving the economic status such persons.

9.5.1.2 ESTIMATE OF MUNICIPAL PLAN COSTS

The preliminary cost would be for well drilling. This would require $1 to $2 million. The next phase would be the installation of water mains. Another $1 to $2 million would be required depending on the location of the well sources in relation to the residences to be served.

9.5.2 PRIVATE PLANS

See comments in Section 9.3.2.

SECTION 10. KAU DISTRICT

10.1 DISTRICT PROFILE

The Kau District has the largest land area of all the island's districts with a total of 624,992 acres. It runs along 65 miles or almost two thirds of the island's southern shoreline. It is made up of barren lava fields, lush green acreage of sugar cane, large tracts of grazing lands, forest reserves and macadamia nut orchards. Land elevations reach from sea level to 13,677 feet at Mauna Loa's summit. **See Figure 1.2-1,** following page 1-2, for location of the district and its boundaries.

Average temperatures in coastal areas are 70°F to 85°F. Upper elevation temperatures range between 50°F to 75°F, dropping to 30°F at the summit. Coastal areas have an average rainfall of 20 inches to 50 inches a year while upper summit rainfall registers 24 inches a year. A pocket of heavier rainfall at 158 inches a year occurs at approximately 3000 feet between the coastal areas of Naalehu and Pahala. **See Figure 1.2-2,** following page 1-2, for rainfall map.

Agriculture is the economic mainstay of the Kau district. Sugar cane, cattle and macadamia nuts are the major activities. Kau Agribusiness Co., is the district's major employer. The macadamia nut and cattle industry do not require a large labor force. But both industries, along with sugar, play an important role in the district's land utilization. The visitor facilities at Punaluu include golf, tennis and conference facilities. Future plans call for expanded resort development.

The Kau District's population has remained fairly stable during the two decades prior to 1980. The population increased from about 3,700 people in 1980 to an estimated 4,700 people in 1987 for a 27% gain. By the year 2010, the district's population is expected to increase by 51% to 7,080 people and make up 2.6% of the island's population. Population centers are at Pahala and Naalehu.

The district has 799 acres of single-family and 106 acres of multi-family residential use zoned lands, mostly located in the towns of Naalehu and Pahala, and at Punaluu. The 1985 housing inventory showed 1,439 single-family units and 174 multi-family units in the district. By year 2010, they are projected to increase to about 2370 and 230 units, respectively.

Public lands make up 31% or 188,256 acres of the district area. Hawaiian Home Lands Department controls 10,989 acres of this total.

There are over 252,647 acres of agriculturally zoned land in the district. Over 70% is not being utilized for agricultural purposes. Sugar and macadamia nuts area the major crops grown in the Kau district. Other crops such as bananas, avocados, tomatoes, and carnations are grown on a limited scale. Ranching operations are also found throughout the district.

Commercial and industrial activities are concentrated in Pahala, Naalehu, Waiohinu, and in the area near Volcanoes National Park. Pahala is largest of these communities. The town was built around a sugar mill, the major employer of the area, and has a high school and hospital that services the district, convenience goods stores and services. Naalehu, with a larger service area than Pahala, has a small shopping center and other service facilities. Sugar processing and macadamia nut milling constitute the majority of industrial activity. Miscellaneous activities include County base yards, public utilities stations, and fish and meat processing.

Tourism activity is limited to Punaluu and the Volcano Park areas. The Punaluu resort has 33 condominium units, dining and retreat conference facilities, tennis courts and a golf course. Expansion of the resort is proposed. The 14 unit Shirakawa Motel serves mostly local guests. A 37 unit hotel in the Volcanos National Park caters to those wishing to explore the park. The military has a rest and recreation camp adjacent to the national park. There are about 27 acres zoned for resort use in the district of which 26 acres remain vacant.

Data from Hawaii County General Plan, 1989. **See FIGURE 1.5-7**, following page 11-2, for Land Use Map showing Kau District land use pattern.

Proposed Land Use Pattern Acreage Allocation:

Residential	Commercial	Industrial	Resort	Total
2,062 ac.	206 ac.	525 ac.	91 ac.	2,927

Proposed Zoning Acreage Allocation:

Residential	Commercial	Industrial	Resort	Total
930 ac.	93 ac.	210 ac.	64 ac.	1,297

Urban Expansion Location
Naalehu

Land Use Goals, Policies and Water Utility Courses of Action:
The goals and policies relating to county economy and population, environmental quality, water and land use are listed in **Appendix B** - County General Plan Goals and Policies.

The water utility courses of action proposed for Kau District are:

- Provide additional source and storage capacity for the currently serviced areas of Naalehu, Waiohinu and Pahala.
- Pursue groundwater source investigations, exploration and development.

10.2 EXISTING WATER USE AND DEVELOPMENT

10.2.1 INVENTORY

An inventory of existing water uses and developments in Hawaii County is detailed by aquifer sectors in **Appendix C.** The inventory for the Kau District is summarized by use categories in the following sections.

10.2.2 SUMMARY OF WATER USE, SYSTEM CAPACITY, AND WATER DRAW

Table 10.2-1, on the next page, gives a summary of the average amount of water sold daily by the municipal system or used by private systems, the surface flow or well pump capacity of the source, and the volume of water drawn from the source. Where recorded data was not available, estimates of water draw were made based on information from system operators, well or stream diversion registration forms, and other available data.

Ground water is the predominant source of water supply in the district. It accounted for 94.3% of the total 12.1 mgd of water drawn. More than 82% of the total were used for agricultural irrigation and industrial uses, mainly for macadamia nut orchids and sugar mill purpose. Although during the 1988 fiscal year, municipal systems benefited from abundant surface water and took 79% of its supply from the spring sources, the ratio can reverse during dry periods. Punaluu Resort utilizes about 1.2 mgd for its golf course, restaurant and condominium units.

TABLE 10.2-1

SUMMARY OF WATER USE, SYSTEM CAPACITY, AND WATER DRAW - KAU

System	Aquifer Code	Average Use mgd	Low Flow or Pump Capacity mgd	Ground Water Draw mgd	Surface Water Draw mgd
Mun/Pahala	80503	0.335	0.562	0.147	0.23
Mun/Waiohinu-Naalehu	80503	0.335	0.540	0.015	0.40
		0.670		0.162	0.63
Priv/Agri Irrigation	80804		4.176	3.60	-
Priv/Agri Irrigation	80503		2.74	2.74	-
Priv/Industrial	80504			-	0.10
Priv/Commercial	80503		3.00	1.1	-
Pri/Other	80503		7.488	3.7	-
				11.14	0.10
District Total				11.30	0.73

10.2.3 MUNICIPAL SYSTEMS

The Hawaii County Department of Water Supply has two systems in the Kau District. The general locations of the service areas and water sources for the systems are shown in **Figure 1.9-5 and 1.9-6,** Regional Water Development Plan - Kau, following page 11-2.

The Pahala System normally relies on the Alili Tunnel for its supply and supplements it with water from the Pahala Well during dry weather periods. The system has a relatively compact service area, with 461 accounts, in Pahala Village. Depending on the determination of the State Department of Health, the Alili Tunnel intake may require improvements or its use as a source may need to be evaluated.

The New Mountain House Tunnel and Haao Spring are the primary sources for the Waiohinu-Naalehu System. Naalehu Well supplements the tunnel and spring sources during dry weather. The supply from the tunnel and spring sources is piped to Waiohinu and distributed further to Naalehu and South Point. Both of these sources need to be evaluated in light of the testing and filtration requirements of the Safe Drinking Water Act. The pipeline from the tunnel source is an old plantation line that requires replacement. The spring source may require filtration. The Waiohinu-Naalehu System had 581 service accounts in 1988. The system is relatively widespread with low density of customers in areas such as South Point.

10.2.4 AGRICULTURAL IRRIGATION SYSTEMS

The two agricultural irrigation systems in the district both utilize deep wells for their sources and are used to irrigate macadamia nut orchards.

10.2.5 MILITARY SYSTEMS

The district has one military water system at the Kilauea Military Camp, a rest and recreational facility for military personnel. The military owns and operates an extensive catchment and storage for its water supply. The neighboring Volcano National Park has a similar type of system for the park facilities.

10.2.6 PRIVATE DOMESTIC, COMMERCIAL, AND INDUSTRIAL SYSTEMS

Some of the ranches in the district provides domestic water for their ranch houses. Since the amount is small, it is included in the ranch total under industrial. The Punaluu Resort utilizes two wells in Ninole for its source. About 0.90 mgd of the total 1.20 water drawn are used for irrigating the golf course. A small amount of effluent from the resort's wastewater treatment plant is sometimes blended with the ground water for the irrigation system. The balance of the water draw supplies water to the restaurant, meeting areas, and condominium units. The industrial systems listed in this category are for livestock and pasturage use by the ranches.

10.2.7 NATIVE HAWAIIAN AUWAI SYSTEMS

Several registration forms for uses of spring and stream waters in Kau have been filed with the State Commission on Water Resources Management. Further study is required to determine if there are any native Hawaiian auwai systems being used for irrigation at this time.

10.2.8 OTHER SYSTEMS

The sugar mill in Pahala Village has two deep wells that supply water for industrial cooling and wash water. One well pumps at capacity during the duration of mill operation. One well is kept as standby. There are no aquaculture or hydroelectric power systems.

10.3 FUTURE WATER NEEDS

10.3.1 MUNICIPAL SYSTEMS

Because of the unreliability of spring sources, and the federal water quality regulations, the trend will be to depend more on ground water for municipal water supply in the district. Fortunately, the aquifer underlying the Pahala and Naalehu areas has a high sustainable yield capacity (268 mgd) with a probable high percentage of potable water.

The district's population is projected to increase from the 4,700 estimated in 1987 to 7,080 by year 2010. Based on current usage, the amount of water needed to support the projected population and community infrastructure is estimated at 1.08 mgd. The calculations for this estimate may be found in **Appendix D.** The need is expected to be primarily satisfied through the municipal systems. Additional requirements from activities such as those discussed in the section below and major agricultural irrigation projects must be provided separately.

10.3.2 PRIVATE SYSTEMS

Currently, the major use of water in Kau is for agricultural irrigation of macadamia nut orchards and industrial cooling and sugar mill uses. The agricultural irrigation use is expected to continue. There is good possibility of expansion of macadamia nut and other orchard crops. The need for industrial use water in the future will depend largely on the stability of the sugar industry. The supplies for these major uses of water are provided by the private sector from their own sources.

Should expansion plans for the Punaluu Resort materialize for the presently designated resort lands, the resort's two existing deep wells with a combined capacity of 3.0 mgd together with

additional storage should satisfy the water requirements. Much water can be conserved by utilizing recycled effluent from the wastewater treatment plant for golf course and landscape irrigation.

The State has been making a strong effort to encourage the construction of a commercial satellite launching facility in the vicinity of Palima Point in Kau. Should the effort be successful, water would be required for the facility. Also, depending on the number of transient and permanent staff required for the facility, additional housing and water will be needed.

TABLE 10.3-1

SUMMARY OF EXISTING AND FUTURE SYSTEM CAPACITIES

System	Aquifer Code	Estimated Future Demand mgd	Existing Draw mgd	Existing Capacity mgd	Required Future Capacity * mgd
Mun/Pahala	80503	-	0.377	0.562	1.12
Mun/Waiohinu-Naalehu	80503	-	0.395	0.540	1.08
		1.08	0.772		2.20
Pri/Agr Irr	80804			3.6	3.6
Pri/Agr Irr	80503			2.74	2.7
Pri/Ind	80504				0.1
Pri/Com	80503			3.00	3.0
Pri/Oth	80503			7.48	7.5
					16.9
Total for District					19.1

* Includes backup well capacity

10.4 WATER PROBLEMS AND OPPORTUNITIES

Ground water sources do not appear to be a problem in terms of water developments to meet future needs. Experience indicates that ground water of good quality can be retrieved in the vicinity of Pahala and Naalehu where the majority of future water need is expected.

The existing Pahala and Waiohinu-Naalehu systems with additional storage can manage to satisfy the estimated future needs. However, a back-up well in each of the systems should be provided as a safety measure in case of operational emergency or prolonged repair of the existing well. This would be especially during dry weather periods when the spring sources run very low. A back-up well would also give the water department the option of abandoning the surface water sources if the cost is too high to improve and operate the sources in compliance with the Safe Drinking Water Act regulations.

System improvements, especially in the Waiohinu-Naalehu System, are badly needed to provide better service to the more sparsely settled service areas of the system. Most of the lines serving these areas are old and have inadequate capacity.

Future water needs generated by projects such as a satellite launching facility must be accommodated by the projects either through development of its own water system or payment of negotiated facilities development and operational charges.

10.5 REGIONAL WATER DEVELOPMENT PLANS

10.5.1 MUNICIPAL PLANS

The major development plans for the district are directed toward the development of one deep well for each for the Pahala and Waiohinu-Naalehu systems. As in other systems that utilize surface water sources the federal water quality regulation must be complied with. Both the Pahala and the Waiohinu-Naalehu systems will be affected. An assessment should be made to determine whether to maintain or abandon the existing surface water sources to assure timely compliance with the regulations. **See Figure 1.9-6** Regional Water Development Plan, following page 11-2, for general locations of proposed developments.

Waiohinu-Naalehu System. An exploratory well in the vicinity of the existing Pahala Well should be programmed, followed by a production well if the exploratory findings are acceptable. If it is determined that the system will be supplied primarily by the wells, storage capacity should be increased to optimize pumping time and provide for peak demand reserve.

As part of system upgrade, the 4" transmission line from Waiohinu to South Point should be given high priority for replacement, including new booster pumps and reservoirs, to provide sufficient capacity for the services in the South Point area. A connection from the Discovery Harbor line to the South Point line to form a loop would be desirable. Additional storage and booster stations should be part of the improvements.

Pahala System. An exploratory well in the vicinity of the existing Pahala Well should be programmed, followed by a production well if the exploratory findings are acceptable. Storage capacity should also be increased for the same reasons stated in the Waiohinu-Naalehu System.

10.5.1.1 PROJECTED IMPACTS OF MUNICIPAL PLANS

The proposed developments will assure that the water consumers within the service areas of the county system will have a reliable and high quality water supply, regardless of the weather conditions. It will also allow the county system to be in compliance with the federal Safe Drinking Water Act regulations.

10.5.1.2 ESTIMATE OF MUNICIPAL PLAN COSTS

The magnitude of cost estimates of the water development proposals for the Kau district total $ 4.5 million and include new wells and concrete reservoirs of various sizes, South Point sub-system improvements, and upgrading of system lines and appurtenances.

10.5.2 PRIVATE PLANS

See comments in Section 10.3.2.

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APPENDIX A

ADMINISTRATIVE RULES OF THE STATE WATER CODES

Subchapter 3 Water Use and Development Plan

§13-17-30 Responsibilities of counties. A water use and development plan shall be prepared by each separate county and adopted by ordinance, setting forth allocation of water to land use in that county.

§13-170-31 Contents of plan. Each county water use and development plan shall include, but not limited to:

(1) Status of county water and related land development including an inventory of existing water uses for domestic, municipal, and industrial users, agriculture, aquaculture, hydropower development, drainage, reuse, reclamation, recharge, and resulting problems and constraints;

(2) Future land uses and related water needs; and

(3) Regional plans for water developments including recommended and alternative plans for water developments including plans, and relationship to the water resource protection plan and water quality plan.

§13-17-32 Guidelines for preparation of the plan. (a) In preparing the water use and development plan and for purposes of consistency, the counties shall utilize information from the master water resource inventory identified within the water resource protection plan. The counties shall also utilize the hydrologic units designated statewide by the commission for the presentation of data and analysis.

(b) All water use and development plans shall be prepared in a manner consistent with the following conditions:

(1) Each water use and development plan shall be consistent with the water resource and protection plan and the water quality plan.

(2) Each water use and development plan and the state water projects plan shall be consistent with the respective county land use plans and policies, including general plan and zoning as determined by each respective county.

(3) Each water use and development plans shall consider a twenty-year projection period for analysis purposes.

(4) The water use and development plan for each county shall also be consistent with the state land use classification and policies.

(5) The cost of maintaining the water use and development plan shall be borne by the counties; state water capital improvement funds appropriated to the counties shall be deemed to satisfy Article VIII, section 5 of the State Constitution.

APPENDIX B

COUNTY GENERAL PLAN GOALS AND POLICIES

The following statements of goals and policies concerning the economy and population, environmental quality, water, and land use are set forth in the General Plan (Proposed General Plan Draft).

ECONOMIC ELEMENT GOALS (includes population):

- Provide residents with opportunities to improve their quality of life.
- Economic development and improvement shall be in balance with the physical and social environments of the island of Hawaii.
- The County of Hawaii shall strive for diversity and stability in its economic system.
- The County shall provide an economic environment which allows, new expanded, or improved economic opportunities that are compatible with the County's natural and social environments.

ECONOMIC ELEMENT POLICIES (includes population):

- The County of Hawaii shall assist the expansion of the agricultural industry, especially diversified agriculture, through the protection of important agricultural lands, capital improvements and other programs, and continued cooperation with appropriate State and Federal agencies.
- The County of Hawaii shall strive for an economic climate which provides its residents an opportunity for choice of occupation.
- The County of Hawaii shall continue to encourage the expansion of research and development industry by working with and supporting the university, private sector, and other agencies' programs developed to aid the County of Hawaii.
- The County of Hawaii shall encourage the development of the visitor industry which is consistent with the social, physical, and economic goals of the residents of the County.
- The County shall require a study of the significant social and physical impact of large developments prior to approval.
- The County of Hawaii shall strive for diversification of its economy by strengthening existing industries and attracting new endeavors.
- The County shall encourage the expansion of the fishing industry, various forms of aquaculture, and other fresh and ocean water-based activities.
- The County shall support all levels of educational opportunities and institutions for its residents.
- The County of Hawaii shall study the feasibility of establishing a business development loan program.

- The County's capital improvements program should improve the quality of existing commercial and industrial areas.

- The County of Hawaii's land, water, air, sea, and people shall be considered as essential economic resources for present and future generations and should be protected and enhanced through the use of economic incentives.

- The County of Hawaii shall encourage the research, development and implementation of advanced technologies and processes in existing and potential economic endeavors.

- The County shall conduct a re-evaluation of all economic goals and policies, particularly in the area of tourism, coincident with any County-initiated overall land use acreage allocation and General Plan review.

- The County shall identify and encourage primary industries that are consistent with the social, physical, and economic goals of the residents of the County.

- An active liaison between the County and the private sector should be encouraged with respect to the County's requirements for establishing business on the island.

- The County of Hawaii shall encourage the continuing development of the retirement industry.

ENVIRONMENTAL QUALITY ELEMENT GOAL:

- Maintain and, if feasible, improve the existing environmental quality of the island.

ENVIRONMENTAL QUALITY ELEMENT POLICIES:

- The County of Hawaii shall take positive action to further maintain the quality of the environment for residents both in the present and in the future.

- Minimum controls are established by the Federal and State governments; through its powers the County shall reinforce and strengthen established standards where it is necessary, principally by initiating, recommending, and adopting ordinances pertaining to the control of pollutants which affect the environment.

- The County should keep apprised of and advise the public of environmental conditions and research undertaken about the island's environment.

- Encourage the concept of recycling agricultural and municipal waste material.

- The County shall encourage the State to establish air and water quality monitoring stations in areas of existing and potential urban growth.

PUBLIC UTILITY ELEMENT GOALS:

- Ensure that adequate, efficient and dependable public utility services will be available to users.

- Maximize efficiency and economy in the provision of public utility services.

- To have public utility facilities which are designed to fit into their surroundings or concealed from public view.

PUBLIC UTILITY ELEMENT (WATER) POLICIES:

- Water system improvements and extensions shall promote the County's desired land use development pattern.
- All water system shall be designed and built to Department of Water Supply standards.
- Improve and replace inadequate systems.
- Water sources shall be adequately protected to prevent depletion and contamination from natural and man-made occurrences or events.
- Water system improvements should be first installed in areas which have established needs and characteristics, such as occupied dwellings and other uses, or in areas adjacent to them if there is need for urban expansion, or to further the expansion of the agricultural industry.
- A systematic program by the County, State, and private interest shall identify sources of supply to ensure the development of sufficient quantities of water for future needs of high growth areas.
- The fire protection systems shall be coordinated with the water distribution systems in order to ensure water supplies for fire protection purposes.
- The County shall consider the feasibility, desirability, and the attendant responsibilities of establishing standards for individual water catchment units.

LAND USE ELEMENT GOALS:

- Designate and allocate land uses in appropriate proportions and mix and in keeping with the social, cultural, and physical environment of the County.
- Protect and encourage the intensive utilization of the County's important agricultural lands.
- Protect and preserve forest, water, natural and scientific reserves and open areas.

LAND USE ELEMENT POLICIES:

- Zone urban and rural types of uses in areas with ease of access to community services and employment centers and with adequate public utilities and facilities.
- Promote and encourage the rehabilitation and use of urban and rural areas which are serviced by basic community facilities and utilities.

APPENDIX C
INVENTORY OF EXISTING WATER USES AND DEVELOPMENTS BY AQUIFER SECTOR

DEFINITION OF CATEGORIES OF WATER USE AND DEVELOPMENT

MUNICIPAL SYSTEMS - are water sources and/or developments controlled and operated by the Hawaii County Department of Water Supply for all categories of water uses.

AGRICULTURAL IRRIGATION SYSTEMS - are water sources and developments dedicated to irrigation of crop lands.

MILITARY SYSTEMS - are water sources and/or developments to provide water supply for military facilities.

PRIVATE DOMESTIC, COMMERCIAL, AND INDUSTRIAL SYSTEMS - are water sources and/or developments controlled by private sector for domestic uses, commercial uses such as in resort communities and related uses, and industrial uses such as in sugar mills, meat companies, construction products companies, and also for raising livestock.

NATIVE HAWAIIAN AUWAI SYSTEMS - are water sources and/or developments whose owners or operators were granted the rights to the use of the sources and/or facilities through traditional native Hawaiian grants.

OTHER SYSTEMS - includes water sources and/or developments for aquaculture uses, hydroelectric power production uses, geothermal power production and related uses, and industrial equipment cooling uses.

Ground water - is water from wells, tunnels, and shafts.

Surface water - is water from streams and springs.

Recycled water - includes sewage effluent, mill effluent, or other water that is reused.

APPENDIX C

INVENTORY OF EXISTING WATER USES AND DEVELOPMENTS BY AQUIFER SECTOR & SYSTEMS

AQUIFER SECTOR 801 - KOHALA

Name	Sys. Code	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max* Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
Aquifer System 80101 - Hawi											
Kaauhuhu System (DWS)				0.093	0.166	0.099	0.12			Mun	Tnl w/4"trans to 0.02mg tnk/6",4",3"distr/
Lindsey Tunnel	NKoha	7047-01	G,tnl	0.093	0.166		0.12				/services upper Kaauhuhu area only
Hawi-Kokoiki-Kynnersely-Kapaau System (DWS)				0.115	4.576	0.237	0.26			Mun	1-Well,pump/tnl w/4",5"trans to 0.20mg res/tnl w/6" trans to
Hawi Well	NKoha	7449-02	G,well		0.576		0.103	0.265	18		0.08mg res/1-0.05mg,1-0.10mg,1-0.25mg res/8",6",4" lines
Watt Tnl #1	NKoha	7148-04	G,tnl	0.07	2.50		0.16				
Kapahapai Tnl	NKoha	7248-03	G,tnl	0.045	1.5						
Halawa-Halaula System (DWS)				0.05	4.175	0.088	0.11			Mun	Tnl w/4"trans to 1-0.10mg tnk/8",6",4" lines/
Bond Tnl #1	NKoha	7247-01	G,tnl	0.05	4.175		0.11				/connected to Hawi Sys via 8" line
Makapala-Keokeo System (DWS)				0.03	0.250	0.027	0.03			Mun	Tnl w/2"trans to 0.050mg res/chlorinator, 8",6" lines
Murphy Tunnel	NKoha	7145-02	G,tnl	0.03	0.250		0.03				
Chalon International											Total of 42 wells, tunnels, shafts/ mean flow 23.2 mgd
Honokane Tnl	NKoha	6743-01	G,tnl							Irr	
Honokane Tnl 4	NKoha	6743.02	G,tnl							Unu	
Honokane Tnl 1	NKoha	6844-01	G,tnl							Unu	
Honokane Nui Tnl	NKoha	6843-01	G,tnl							Irr	
Honokane Nui Tnl	NKoha	6843-02	G,tnl							Irr	
Honokane Nui Tnl	NKoha	6843-03	G,tnl							Irr	
Honokane Tnl 2	NKoha	6843-04	G,tnl							Irr	
Honokane Tnl 3	NKoha	6843-05	G,tnl							Unu	
Lindsey Tnl	NKoha	7047-01	G,tnl							Unu	
Opaepilau Tnl 2	NKoha	7144-02	G,tnl							Irr	
Wakani Tnl	NKoha	7145-01	G,tnl							Unu	
Maulaua Tnl	NKoha	7245-01	G,tnl							Irr	
Murphy Tnl	NKoha	7145-02	G,tnl							Irr	
Puu Mini Tnl	NKoha	7145-03	G,tnl							Unu	
Paa Tnl	NKoha	7145-04	G,tnl							Irr	

* Avg Use = avg daily consumption 7/87-6/87; Avg Draw = avg G or S water draw '87-88 / Max Draw = high month G or S draw '83-88 / S water draw is estimated

AQUIFER SECTOR 801 - Continuation

Name	Sys. Code	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
Amau Tnl	NKoha	7145-05	G,tnl							Irr	
Waipunalau Tnl	NKoha	7146-01	G,tnl							Unu	
Halawa Tnl	NKoha	7246-01	G,tnl							Irr	
Kay Tnl	NKoha	7147-01	G,tnl							Irr	
JD Bond Tnl	NKoha	7147-05	G,tnl							Irr	
Watt Tnl 2	NKoha	7147-06	G,tnl							Irr	
Koelling Tnl	NKoha	7147-07	G,tnl							Unu	
Olding Tnl	NKoha	7148-05	G,tnl							Irr	
Cowpen 1 Tnl	NKoha	7148-01	G,tnl							Irr	
Cowpen 2 Tnl	NKoha	7148-02	G,tnl							Irr	
Cowpne 3 Tnl 1	NKoha	7148-03	G,tnl							Irr	
Pae Tnl	NKoha	7244-01	G,tnl							Irr	
Kaala Tnl	NKoha	7248-02	G,tnl							Irr	
Aamakoa Tnl 2	NKoha	7345-01	G,tnl							Unu	
Aamakoa Tnl 3	NKoha	7345-02	G,tnl							Unu	
Halala	NKoha	7347-02	G,well		1.73				43	Ird	
Kohala Sugar	NKoha	7348-01	G,well							Irr	
Kohala Shaft	Nkoha	7446-01	G,well		9.99					Irr	
Union Mill	NKoha	7448-01	G,well							Unu	
Gusman Tnl 5	NKoha	7448-03	G,well							Unu	
Union Mill 1	NKoha	7448-04	G,well		2.66				73	Ird	
Union Mill 2	NKoha	7448-05	G,well		2.66				129	Ird	
Alaalae Shaft	NKoha	7549-01	G,well							Unu	
Alaalae Tnl 7	NKoha	7549-02	G,well							Unu	
Upolu Tnl 6	NKoha	7552-01	G,well							Unu	
Hoea Shaft	NKoha	7650-01	G,well							Unu	
Waikane Shaft	NKoha	7652-01	G,well		3.00				601	Irr	
Kohala Ditch	NKoha	-		15.0	76.0					Irr/Oth	Irr=1 mgd/ aqua=0.10 mgd/ hydro=9.0 mgd
Kahua Ranch											
Puulaa Laau Tnl	NKoha	6745-01	G,well							Unu	
Waiakailio Tnl	NKoha	6451-01	G,well							Unu	
Kahua Waterhead	NKoha	-	S,div		15.0						
Kehena Ditch	NKoha	-	S,div		10.0						

AQUIFER SECTOR 801 - Continuation

Name	Sys. Code	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
Aquifer System 80102 - Waimanu											
Waimea-Puukapu-Nienie System (DWS)				0.38	4.911	0.725	1.621	2.190		Mun	3-50mg raw water res w/18"trans to Waimea treatment plant
Kohakohau Str	S.Koha	-	S,str	0	2.204						w/1-4.0mg treated water res/1-0.10mg res,2-boost pump/
Waikoloa Str	S.Koha	-	S,str	0.38	2.507						3-0.005mg res,1-0.025 RW tnk/1-0.02mg, 4-RW press brk tnks/
Waimea TP (meter)		-	-				1.621	2.190			/12",8",6",4" lines/ Waikoloa Avg=5.69mgd/Kohakohau Avg=5.48mgd
Notes: Treatment plant also provides portion of supply for Kawaihae-Hapuna-Puako and Ahualoa-Honokaa systems.											
(State) Waimea Irrigation System											
Total All Str	S.Koh		S,str	4.0	30.0		1.3			Irr	Serves 73 farmers, 478 acres cultivated area
Kawainui Str											1-60mg res,1-100mg res/series of str,tnls,ditches & flumes
Alakahi Str											
Kawaiki Str											
Koiawe Str											
Waima Str											
Ahualoa-Honokaa (Upper) (DWS)						0.241	0.241			Mun	
Waimea TP	S.Koh	-	S,str		see-->		0.241				Supply from Waimea TP via 8" line from Puukapu-Nienie
Lower Hamakua Ditch (HS Co)			S,str	18	60		22.2				
Portion of Flow	SKoh						12			Irr	
Portion of Flow	SKoh						0.2			Dom	Paauhau Camp/sand filter/chlorinator/2-stl tanks/4"line
Portion of Flow	SKoh						10			Ind	Ind cooling & mill use
Aquifer System 80103 - Mahukoha											
Kohala Estates and Ranches											
Kohala Rnch-1	N.Koh	6549-01	G,well		1.008				65	Dom	
Kohala Rnch-2	N.Koh	6549-02	G,well		1.008				65	Dom	
Sherrod M&D	N.Koh	6550-01	G,well								

APPENDIX C

INVENTORY OF EXISTING WATER USES AND DEVELOPMENTS BY AQUIFER SECTOR AND SYSTEMS

AQUIFER SECTOR 802 - EAST MAUNA KEA

Name	Sys. Code	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max* Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
Aquifer System 80201 - Honokaa											
Ahualoa-Honokaa (Lower) (DWS)					0.576	0.201	0.201			Mun	Area makai of hospital tank
Haina Well	Hama	6528-01	G,well		0.576		0.201	0.883	67		
Waimea TP	Hama	·	$,str		see-->		0				Supply from Waimea TP via 8" line from Puukapu-Nienie
Kukuihaele Water System (DWS)						0.040	0.04			Mun	
Kukuihaele Spr	Hama	6734-01	$,spr		0.25	0.040	0.04				Kaupulena Spr also used
Plantation Systems (Hamakua Sugar Co)											
Kukuihaele Spr 1	Hama	·	$,spr							Unu	
Kukuihaele Spr 2	Hama	·	$,spr							Unu	
Kukuihaele Spr 3	Hama	·	$,spr							Unu	
Kukuihaele Spr 4	Hama	·	$,spr							Unu	
Aquifer System 80202 - Paauilo											
Paauilo System (DWS)						0.031				Mun	
Paauilo Shaft	Hama	·	$,str		see-->	0.031	see-->				Supply purchased from Hamakua Sugar system
Ookala System (DWS)						0.009				Mun	DWS 4" distr line connected to plantation system
Ookala Shaft	Hama		see-->								Supply from Hamakua Sugar Ookala Shaft - draw included w/shaft
Plantation Systems (Hamakua Sugar Co)											
Paauilo Mill	Hama	6321-01	G,well							Unu	Supplies Paauilo, Kaohe Subd, Nahale Camp + County Sys
Paauilo Shaft	Hama	6321-02	G,well				0.12			Dom	1-intake/1-booster pump/2-0.01mg,4-0.03mg st tnks/
Paauilo	Hama	6322-01	G,well							Unu	/6",4" lines (200 homes)
Well #1	Hama	6323-01	G,well		1.296		1.3		191	Ind/Irr	1-well,pump/6-0.01mg FG tnk/6" PVC lines
Well #2	Hama	6424-01	G,well		2.592					Irr	1-well,pump/unu-testing

* Avg Use = avg daily consumption 7/87-68; Avg Draw = G or S water draw / Max Draw = high month G or S water draw '83-88

AQUIFER SECTOR 802 - Continuation

Name	Sys. Code	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max* Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
(Hamakua Sugar Co.) - Continuation											
Puumaile Str Tnl	Hama	6119-01	G,tnl							Unu	
Puumaile Str Tnl	Hama	6120-01	G,tnl							Unu	
Puumaile Str Tnl	Hama	6120-02	G,tnl							Unu	
Puumaile Str Tnl	Hama	6120-03	G,tnl							Unu	
Kawaili Str Tnl	Hama	6121-01	G,tnl							Unu	
Kanui Gul Tnl	Hama	6122-01	G,tnl							Unu	
Paauilo Gul Tnl	Hama	6122-02	G,tnl							Unu	
Paauilo Gul Tnl	Hama	6122-03	G,tnl							Unu	
Kuakaiau Gul Tnl	Hama	6220-01	G,tnl							Unu	
Manienie Gul Tnl	Hama	6222-01	G,tnl							Unu	
Paauilo Str Tnl 1	Hama	6222-02	G,tnl							Unu	
Paauilo Str Tnl 2	Hama	6222-03	G,tnl							Unu	
Paauilo Gul Spr	Hama	-	S,spr							Unu	
Kainehe Str Tnl	Hama	6121-02	G,tnl							Unu	
Waipunalei Spr	NHilo	-	S,spr							Unu	
Kaawili Tnl	NHilo	5816-02	G,tnl							Unu	
Kaawili Gul Tnl 1	NHilo	5816-02	G,tnl							Unu	
Kaawili Gul Tnl 2	NHilo	5816-02	G,tnl							Unu	
Kapili Str Tnl	NHilo	5716-01	G,tnl							Unu	
Humuula Tnl	NHilo	5917-01	G,tnl							Unu	
Kaula Gul Tnl 1	NHilo	6017-01	G,tnl							Unu	
Kaula Gul Tnl 2	NHilo	6017-02	G,tnl							Unu	
Kaula Gul Tnl 3	NHilo	6017-03	G,tnl							Unu	
Kaula Gul Tnl 4	NHilo	6017-04	G,tnl							Unu	
Ookala Shaft	NHilo	6117-01	G,well				0.04			Dom	Serves Ookala, Niu, Kukui, Milo, Akasaki camps + County system
Aquifer System 80203 - Hakalau											
Laupahoehoe System (DWS)					0.576	0.087	0.093	0.387		Mun	2-well,pumps/3-0.10mg,1-0.05mg conc res/1-boost pump/
Laupahoehoe #1	NHilo	5814-01	G,well		0.144		0.033	0.387	85		/8",6",4" lines
Laupahoehoe #2	NHilo	-	G,well		0.432		see->	see->	85		Volume of draw included w/well-1
Manowaiopae Spr	NHilo	-	S,spr	0.04	0.15		0.05				
Kihalani Spr	NHilo	-	S,spr	0	0.03		0.01				
Ninole System						0.017				Mun	2-boost pump at intake/1-0.05mg conc res/8",6",4" lines
Chaves Spring	NHilo	-	S,spr			0.017	0.02				

AQUIFER SECTOR 802 - Continuation

Name	Sys. Code	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max* Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
Plantation Systems (Hamakua Sugar Co)											
Huliilii Gul Spr	NHilo	-	S,spr							Unu	
Kaiaakea Spr	NHilo	-	S,spr				0.004			Dom	Kaiaakea/1-RW tnk/2"line
Kapehu Cp Spr	NHilo	-	S,spr							Unu	
Kaiwilahilahi Sp	NHilo	-	S,spr				0.024			Dom	Papaaloa, Keokeo camps/1-stl tnk/chlorinator/2"line
Kihalani Spr	NHilo	-	S,spr				0.004			Dom	Skill Camp/1-stl tnk/2"line
Plantation Systems (Mauna Kea Agribusiness Co)											
Umauma Spr	NHilo	-	S,spr							Unu	
Peleau Spr	NHilo	-	S,spr							Unu	
Opea Spr	NHilo	-	S,spr							Unu	
Nanue Mauka Spr	NHilo	-	S,spr							Unu	
Nanue Spr	NHilo	-	S,spr							Unu	
Waiehu Mauka Spr	NHilo	-	S,spr							Unu	
Waiehu Makai Spr	NHilo	-	S,spr							Unu	
F068 Spr	NHilo	-	S,spr				0.02			Irr	Div agr
Kauka Dam Int	SHilo	-	S,div							Unu	
Mauka Domestic	SHilo	5005-01	G,well		0.72		0.72		15	Ind	Mill boiler makeup water, office, garage
Makai Domestic	SHilo	5005-02	G,well		0.36		0.36		27	Ind	Mill use-same
Palau Spr	SHilo	-	S,spr				0.02			Irr	Div ag
Wailea Spr	SHilo	-	S,spr							Unu	
Makalau Spr	SHilo	-	S,spr							Unu	
Plantation System (Hilo Coast Processing Co)											
Cooling Well #1	SHilo	5005-03	G,well		7.49		7.49			Brack Oth	Ind. cooling
Cooling Well #2	SHilo	5005-04	G,well		7.49		7.49			Brack Oth	Ind. cooling
Cooling Well #2	SHilo	5005-05	G,well		7.49		7.49			Brack Oth	Ind. cooling
Honomu System					0.14	0.088				Mun	
Akaka Falls Spr	SHilo	-	S,spr		0.14		0.09				
Wailea-Makalau System					0.072	0.038	0.038	0.056		Mun	
Makalau School	SHilo	5307-01	G,well		0.072		0.038	0.056	14		
Aquifer System 80204 - Onomea											
Pepeekeo System					0.832	0.161	0.193			Mun	
Kulaimano	SHilo	5006-01	G,well		0.432		0.003	0.179	12		
Maukaloa Spr	SHilo	-	S,spr	0.03	0.40		0.19				

AQUIFER SECTOR 802 - Continuation

Name	Sys. Code	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max* Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
Papaikou System (DWS)				____	0.824	0.196	0.220			Mun	
Papaikou	SHilo	4706-01	G,well		0.504		0.180	0.527	15		
Upper Kaieie	SHilo		G,spr	0	0.02		0.010				
Kaieie Spr	SHilo		G,spr	0.10	0.30		0.030				
Plantation System (Mauna Kea Agribusiness)											
Pukihae Str	SHilo	-	S,str							Unu	
Nikai Flm Int	SHilo	-	S,str				0.02			Ind	Water standpipe for tankers
Honolii Spr	SHilo		S,spr							Unu	
Pahoehoe Str Tnl	SHilo	4607-01	G,tnl							Unu	
Kapue Str Tnl	SHilo	4708-01	G,tnl							Unu	
Kaieie Fl Int	SHilo	-	S,str							Unu	
Mokuoniki Spr	SHilo	-	S,spr				0.02			Irr	Div ag
Kawainui Str Tnl	SHilo	4906-01	G,tnl				0.02			Irr	div ag/livestock

APPENDIX C

INVENTORY OF EXISTING WATER USES AND DEVELOPMENTS BY AQUIFER SECTOR AND SYSTEMS

AQUIFER SECTOR 803 - WEST MAUNA KEA

Name	Sys. Code	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max* Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
Aquifer System 80301 - Waimea											
Kawaihae-Hapuna-Puako System (DWS)					3.896	1.840	1.849			Mun	Makai of Waiaka to Kawaihae: 3-0.02mg,1-0.037mg stl tnk/
					0.500						
Kawaihae #1	SKoha	6148-01	G,well		(0.216)		0	0.047	385		1-0.25 mg conc res/12",8",6"lines/2 wells-on standby.
Kawaihae #4	SKoha	6148-02	G,well		(0.648)		0		460		
Waimea TP	SKoha		see-->		0.500		0				Supply from Waimea TP via Waimea system and Kawaihae Rd line
					3.896		1.849				
Lalamilo A	SKoha	5946-01	G,well		1.008		0.376	0.909	106		From Queen K inter: 3-wells w/pumps, 1-well shaft only/1-1/0 mg,
Lalamilo B	SKoha	5946-02	G,well		1.444		1.237	1.490	54		1-0.10 mg,1-0.30 mg res/12",8",6" lines
Lalamilo C	SKoha	5946-03	G,well		1.444		0.236	1.495	95		
Lalamilo D	SKoha	5946-04	G,well		see-->		see-->		93		New well shaft, pump not installed
Mauna Kea Properties											
Duli A	SKoha	6049-05	G,well							Irr	
Duli B	SKoha	6048-03	G,well							Irr	
MKB Hotel Well	SKoha	6049-01	G,well						700	Irr	
MKB Hotel Well	SKoha	6048-02	G,well						750	Irr	
Signal Hawaii, Inc.											
Duli Well 1	SKoha	6046-01	G,well								
Mauna Lani Resort											
Well	SKoha	5750-03	G,well								
Nursery Well	SKoha	5750-02	G,well								
Puako Shaft	SKoha	5750-01	G,well								
Well	SKoha	5651-01	G,well								

* Avg Use = avg daily consumption 7/87-6/88; Avg Draw = avg G or S water draw '87-88 / Max Draw = high month G or S water draw '83-88

AQUIFER SECTOR 803 - Continuation

Name	Sys. Code	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max* Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
Waikoloa Water Company											
Waikoloa 1	SKoha	5745-03	G,well							unu	
Parker 1	SKoha	5548-01	G,well		1.01				600	irr	
Parker 4	SKoha	5745-01	G,well		1.01				30	dom	640 service connection
Parker 5	SKoha	5745-02	G,well		1.01				30	dom	See above line
Parker 2	SKoha	5648-01	G,well							unu	Test well
Waikoloa Resort											
Nursery Well	SKoha	-	G,well		1.30		1.224			irr	
Foot Well STP	SKoha	-	G,well		0.50		0.504		900	irr	
Resort Irr 1	SKoha	5452-01	G,well		0.50				720	irr	
Resort Irr 2	SKoha	-	G,well		1.01		1.008		720	irr	
Parker 6	SKoha	5553-01	G,well							unu	
Waikii Ranch											
Waikii 1	SKoha	5239-01	G,well				0.25		27	Ind	Portions used for domestic/construction/livestock
Waikii 2	SKoha	5239-02	G,well				0.17		27	Ind	Same
Pohakuloa Training Area (Military)											
Hopukani Spr	Hama	-	S,spr				0.03			Dom	Sources shared w/Pohakuloa State Park
Waihu Spr	Hama	-	S,spr				see->			Dom	Included w/Hopukani
Liloe Spr	Hama	-	S,spr				see->			Dom	Included w/Hopukani

APPENDIX C

INVENTORY OF EXISTING WATER USES AND DEVELOPMENTS BY AQUIFER SECTOR AND SYSTEMS

AQUIFER SECTOR 804 - NORTHEAST MAUNA LOA

Name	Sys. Code	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max* Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
Aquifer System 80401 - Hilo											
Hilo Water System-North (DWS)					5.616			Mun			
Piihonua A	SHilo	4306-01	G,well		3.024		0.916	2.782	2		
Piihonua B	SHilo	4306-02	G,well		3.024		see-->	see-->	2		Draw included w/well ALauoile Int 80401 -S,str 06.025.0
Wailuku-Hookelekele	SHilo		S,str	see-->	see-->		4.6				Used jointly w/Kaohama, normally draw Kaohama first, during dry
Kaohama Str Int	SHilo		S,str	see-->	see-->		see-->				draw varies between 0-5 mgd from Wailuku
Olaa Fl Spr	SHilo	4211-01	S,spr	0.050	3.0		0.100				Used jointly w/Lyman Spr, normally draws for upper Kaumana,
Lyman Spr	SHilo	4210-01	S,spr	see-->	see-->		see-->				draw varies 0-3.0 mgd depending on Piihonua need
James Glover Ltd											
Glover Quarry A	SHilo	4203-13	G,well		0.86	na	0.250		13	Ind	
Glover Quarry B	SHilo	4203-14	G,well		0.43	na	0.040		13	Ind	
Hawaii Electric Light Co.					61.49		39.1				
Puna Plant 1	SHilo	3802-03	G,well		4.03		11.5			Oth	Ind. cooling
Puna Plant 2	SHilo	3802-04	G,well		4.03				6	Oth	Ind. cooling /Volume of draw included w/well-1
Puna Plant 3	SHilo	3802-05	G,well		4.03				6	Oth	Ind. cooling /Volume of draw included w/well-1
Hill Unit 5A	SHilo	4203-05	G,well		6.48		12.2		28	Oth	Ind. cooling
Hill Unit 5B	SHilo	4202-06	G,well		6.48				24	Oth	Ind. cooling /Volume of draw included w/well-5A
Hill Unit 5C	SHilo	4202-07	G,well		6.48					Oth	Ind. cooling / Volume of draw included w/well-5A
Shipman Unit 1A	SHilo	4304-01	G,well		3.89		1.3			Oth	Ind. cooling
Shipman Unit 1B	SHilo	4304-02	G,well		3.89		1.3			Oth	Ind. cooling
Shipman Unit 2	SHilo	4304-03	G,well		ret					Unu	
Shipman Unit 3	SHilo	4304-04	G,well		9.50		6.4			Oth	Ind. cooling
Shipman Unit 4A	SHilo	4304-05	G,well		6.34		8.4			Oth	Ind. cooling
Shipman Unit 4B	SHilo	4304-06	G,well		6.34					Oth	Ind. cooling /Volume of draw included w/well-4a
Hawaii Electric Light Co.					——		31.9				
Puueo Intake	SHilo	4307-01	S,str				29.2		58	Oth	Hydroelectric, Wailuku River
Waiau Intake	SHilo	4308-01	S,str				2.7		6	Oth	Hydroelectric, Wailuku River
Wenko Energy											
Ainako-Kapaa St	SHilo		S,str							Oth	Hydroelectric, Ainako Stream

AQUIFER SECTOR 804 - Continuation

Name	Sys. Code	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max* Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
Aquifer System 80402 - Keaau											
Hilo Water System-South (DWS)						5.485	5.985			Mun	Includes avg use for Paukaa-Honolii Sys.
Hilo Airport	SHilo	4202-01	G,well		unu				186		
Panaewa #1	SHilo	4003-01	G,well		2.160		2.160	2.800	8		
Panaewa #2	SHilo	4003-02	G,well		3.168		2.761	3.960	3		
Panaewa #3	SHilo	4003-03	G,well		3.168		0.520	3.105	3		
Waikea-uka Tnl	SHilo	3809-01	G,tunl	0	see-->		see-->	see-->			Line merges-draw included w/tunnel 3809-02
Waikea-uka Tnl	SHilo	3809-02	G,tunl	0	0.720		0.544				
Keaau-Mountain View System (DWS)					2.340	0.489	0.729	1.369		Mun	2-wells,pumps/10-st tnk,conc res/7-boost pumps/
Keaau #1	Puna	3802-01	G,well		1.620		0.729	1.369	9		/12",8",6",4" lines
Keaau #2	Puna	3802-02	G,well		0.720		see-->	see-->	5		Volume of draw included w/well-1
New Well	Puna	--	G,well		unu						Proposed pump size - 2 mgd
Watamull Investment-King's Landing											
King's Landing 1	Puna	-	G,well							Unu	
King's Landing 2	Puna	4100-01	G,well						380	Unu	
King's Landing 3	Puna	-	G,well							Unu	
Mauna Loa Macadamia Nut Corp					1.22		0.38				
Keaau Orchid I	Puna	3900-01	G,well		0.50		0.19		92	Oth	Ind cooling/macnut factory
Keaau Orchid II	Puna	3900-02	G,well		0.72		0.19			Oth	Ind cooling/macnut factory
Hawaiian Host											
Keaau	Puna	4203-15	G,well		0.22		0.024		21	Ind	
Hawaiian Water Co.											
Keaau	Puna	3704-01	G,well		0.144					Com	
VH Shipman Ltd.											
Puu Oo	Puna	-	S,spr							Unu	
Keaau	Puna	-	G,well							Unu	
Keaau	Puna	3500-01	G,well							Unu	

* Avg Use = avg daily consumption 7/87-6/88; Avg Draw = avg G or S water draw '87-88 / Max Draw = high G or S water draw '83-88

APPENDIX C

INVENTORY OF EXISTING WATER USES AND DEVELOPMENTS BY AQUIFER SECTOR AND SYSTEMS

AQUIFER SECTOR 805 - SOUTHEAST MAUNA LOA

Name	Sys. Code	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max* Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
Aquifer System 80501 - Olaa											
No inventory in this system.											
Aquifer System 80502 - Kapalapala											
No inventory in this system.											
Aquifer System 80503 - Naalehu											
Pahala Water System (DWS)				0.03	1.312	0.335	0.38			Mun	1-well,pump/1-tnl intake, 4-PB tnks/1-chlor/1-0.50 conc res/
Pahala Well	Ka'u	1229-01	G,well		0.562		0.147	0.414	4		10",8",4" lines
Alili Tunnel	Ka'u	1331-01	G,tnl	0.03	0.75		0.23				
Waiohinu-Naalehu Water System (DWS)				0.09	8.810	0.335	0.42			Mun	1-well,pump/1-tunl int/1-spr int/1-0.04 mg,2-0.05mg,
Naalehu #1	Ka'u	0335-01	G,well		0.540		0.015	0.352	8		1-0.10mg res/12" trans fr Mt Hse Tnl to Haao Spr tnk/
New Mt Hse Tnl	Ka'u	0936-01	G,tnl	0.08	6.45		0.30				4" trans to S.Point & 8" line to Waiohinu-Naalehu area/
Haao Spr	Ka'u	0537-01	G,tnl	0.01	1.82		0.10				12",8",6",4" distr lines/
Plantation Systems (Ka'u Agribusiness Co)											
Kapuna Tnl	Ka'u	436-01	G,tnl							Irr	
Tanaka Tnl	Ka'u	436-02	G,tnl							Irr	
Honuapo Mill	Ka'u	533-01	G,tnl							Irr	
Honuapo 1	Ka'u	533-02	G,tnl							Irr	
Honuapo 3	Ka'u	533-03	G,tnl							Irr	
Kahilipali Tnl	Ka'u	536-01	G,tnl							Irr	
Haao Tnl	Ka'u	537-01	G,tnl							Irr	
Honuapo 2	Ka'u	632-01	G,tnl							Irr	
Ninole A	Ka'u	831-02	G,tnl		3.00				175	Irr	Punaluu Resort/2 wells,pumps/1-1.0 mg res/16",12" trans,distr ln
Ninole B	Ka'u	831-03	G,tnl		see-->					Irr	Included with above well
Old Mt Hse Tnl	Ka'u	836-01	G,tnl							Irr	

* Avg Use = avg daily consumption 7/87-6/88; Avg Draw = avg G or S water draw '87-88 / Max Draw = high month G or S water draw '83-88 / S water draw is estimated

AQUIFER SECTOR 805 - Continuation

Name	Sys. Code	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max* Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
Ninole-Wailau 3	Ka'u	1032-01	G,tnl							Irr	
Ninole	Ka'u	1033-01	G,tnl							Irr	
Ninole-Wailau 1	Ka'u	1033-02	G,tnl							Irr	
Vischer Tnl	Ka'u	1035-01	G,tnl							Irr	
Fact Tnl Well 2	Ka'u	1128-01	G,well		3.744		3.744	3.744	-	Ind	Mill operation
Fact Tnl Well 1	Ka'u	1128-01	G,well		3.744		-	-	-	Ind	Back-up well
Sisal	Ka'u	1129-01	G,well		2.74			2.74	48	Irr	
Plant N Spr Tnl	Ka'u	1136-01	G,tnl							Irr	
Kaumaikeohu Tnl 2	Ka'u	1332-01	G,tnl							Irr	
Moaula Gulch Tnl	Ka'u	1333-01	G,tnl							Irr	
Moaula Trib Tnl	Ka'u	1333-02	G,tnl							Irr	
Fukuda Tnl	Ka'u	1333-03	G,tnl							Irr	
Shirakura Tnl	Ka'u	1333-04	G,tnl							Irr	
Ipuu Ridge Tnl	Ka'u	1529-01	G,tnl							Irr	
Dble Arch Tnl	Ka'u	1530-01	G,tnl							Irr	
Mud Flow 3	Ka'u	1530-02	G,tnl							Irr	
Mud Flow Tnl	Ka'u	1530-03	G,tnl							Irr	
Kaalaala Gul Tnl	Ka'u	1530-04	G,tnl							Irr	
Weda 3 Tnl	Ka'u	1629-01	G,tnl							Irr	
Weda 1 Tnl	Ka'u	1630-01	G,tnl							Irr	
Weda 2 Tnl	Ka'u	1630-02	G,tnl							Irr	
Heio Tnl	Ka'u	1630-03	G,tnl							Irr	
Fault Tnl	Ka'u	1630-04	G,tnl							Irr	
Noguchi Tnl	Ka'u	1630-05	G,tnl							Irr	
Piikea Gul Tnl 1	Ka'u	1630-06	G,tnl							Irr	
Piikea Gul Tnl 2	Ka'u	1630-07	G,tnl							Irr	
Mudflow Tnl 2	Ka'u	1630-08	G,tnl							Irr	
Noguchi Mauka Tnl	Ka'u	1630-09	G,tnl							Irr	Also registered under Commune 1 - no data provided
Noguchi 2 Tnl	Ka'u	1630-10	G,tnl							Irr	Also registered under Kapapala Ranch - see below for data
Makakupu Tnl 1	Ka'u	1729-01	G,tnl							Irr	
Makakupu Tnl 2	Ka'u	1729-02	G,tnl							Irr	
Makua Ranch Tnl	Ka'u	1730-01	G,tnl							Irr	
Weda 2 Tnl 1	Ka'u	1730-02	G,tnl							Irr	
Horita Tnl	Ka'u	1730-03	G,tnl							Irr	
Plantation Spr	Ka'u	USGS141	S,spr							Irr	
Mt Hoode Spr	Ka'u	USGS142	S,spr							Irr	Also registered under Searle GI - no data provided
Makanau Ridg Spr	Ka'u	USGS143	S,spr							Irr	
West Hilea Spr	Ka'u	USGS144	S,spr							Irr	
Portuguese Spr	Ka'u	USGS145	S,spr							Irr	
Haao Spr	Ka'u	UGS146	S,spr							Irr	

AQUIFER SECTOR 805 - Continuation

Name	Sys. Code	State #	Source	Min Fl/Cap mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max* Draw mgd	Max Chl ppm	Use Cat.	facilities / Comments
Kawaa Spr	Ka'u	-	S,spr							Irr	
Waikapuna Spr	Ka'u	-	S,spr							Irr	
Ninole Spr	Ka'u	-	S,spr							Irr	
Moaula Gulch Spr	Ka'u	-	S,spr							Irr	
Punaluu Tnl 2	Ka'u	830-02	G,tnl							Irr	
Palima	Ka'u	1128-02	G,well		4.176		3.600		70	Irr	Also registered under IASCO Farms - see next page
IASCO Farms											
Palima	Ka'u	1128-02	G,well		4.176		3.600		70	Irr	
Kapapala Ranch											
Makakupu Tnl	Ka'u	1729-01	G,tnl				0.062	0.086		Oth	Mainly livestock / small amount domestic
Kawaihae Ranch											
Makanau Tnl 1	Ka'u	933-01								Ind	Livestock pasturage
Kauaikeohu Tnl 1	Ka'u	1232-01								Ind	Livestock pasturage
Moula Tnl	Ka'u									Ind	Livestock pasturage
Makano,Wahine	Ka'u									Ind	Livestock 5-30,000 gpd/Dom 15 units
Wood Valley	Ka'u									Ind/Dom	Livestock 40-60,000 gpd/Dom 10 units
Haao Spring	Ka'u									Mun	Whittington Beach Park
Mtn House	Ka'u									Ind/Dom	Livestock 10-35,000 gpd/Dom 5 units
Kaalualu Tnl 1	Ka'u	8836-01								Ind	Livestock pasturage
Kaalualu Tnl 2	Ka'u	8837-01								Ind	Livestock pasturage

APPENDIX C

INVENTORY OF EXISTING WATER USES AND DEVELOPMENTS BY AQUIFER SECTOR AND SYSTEMS

AQUIFER SECTOR 806 - SOUTHWEST MAUNA LOA

Name	Sys.	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max* Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
Aquifer System 80601 - Manuka											
No inventory in this system.											
Aquifer System 80602 - Kaapuna											
Mac Farms Hawaii											
Okoe	SKona	953-01	G,well		1.14					Irr	
Well 1	SKona	-	G,well								
Prod of Okoe											
SK Okoe Well	SKona	-	G,well			1.0				Irr	
Aquifer System 80603 - Kealakekua											
South Kona Water System					1.584	0.869	0.755			Mun	3 wells, pumps/
Keei A	SKona	2753-01	G,well		0.432		0.209	0.407	166		
Keei B	SKona	2753-02	G,well		0.432		0.120	0.424	173		
Keei C	SKona	2653-01	G,well		0.720		0.426	0.426	69		

* Interconnected with North Kona system, draws supply from N.Kona system as required.

* Avg Use = avg daily consumption 7/87-6/88; Avg Draw = avg G or S water draw '87-88 / Max Draw = high month G or S water draw '83-88

APPENDIX C

INVENTORY OF EXISTING WATER USES AND DEVELOPMENTS BY AQUIFER SECTOR

AQUIFER SECTOR 807 - NORTHWEST MAUNA LOA

Name	Dist.	State #	Source	Min Fl/Cap mgd	Max Fl/Cap mgd	Avg Use mgd	Avg Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments

NO INVENTORY IN THIS SECTOR.

APPENDIX C

INVENTORY OF EXISTING WATER USES AND DEVELOPMENTS BY AQUIFER SECTOR AND SYSTEMS

AQUIFER SECTOR 808 - KILAUEA

Name	Sys. Code	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max* Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
Aquifer System 80801 - Pahoa											
Watamull Investment-King's Landing											
Hawn Paradise Pk	Puna	-	G,well							Unu	
WH Shipman Ltd.											
Naena	Puna	-	S,spr							Oth	Aquaculture pond
Keaau-Pahoa (DWS)										Mun	
K-P Road Well	Puna	3389-01	G,well		unu				12		
Waipahoehoe Well	Puna	3500-01	G,well		unu						
Pahoa Water System (DWS)					1.872	0.294	0.426	0.824		Mun	3-wells,pumps/1-boost pump/1-0.50mg,1-0.30mg conc res/
Keonepoko Nui	Puna	3188-01	G,well		1.008		0.106	0.375	7		/12",8",6",4" lines
Pahoa Batt 2A	Puna	2986-01	G,well		0.360		0.320	0.449	6		
Pahoa Batt 2B	Puna	2986-02	G,well		0.504		see-->	see-->	7		Volume of draw included w/well 2A
Hawaiian Shores Community Assoc.											
Hwn Shores	Puna	3185.02	G,well		0.50		0.032			Dom	
Aquifer System 80802 - Kalapana											
Kapoho Water System (DWS)					0.144	0.057	0.065	0.155		Mun	1-well,pump/1-well-unu/1-0.10mg conc res/12",8" lines
Kapoho Crater	Puna	3080-01	G,tunl		0.144		0.065	0.155	190		
Kapoho	Puna	3081-01	G,tunl		unu				190		
Kalapana Water System (DWS)					0.878	0.071	0.086	0.529		Mun	2-wells,pumps/1-0.50mg, 1-0.10mg conc res/8",6" lines
Keauohana #1	Puna	2487-01	G,well		0.374		0.086	0.529	124		
Keauohana #2	Puna	2487-02	G,well		0.504		see-->	see-->	124		Volume of draw included w/well-1

* Avg Use = avg daily consumption 7/87-6/88; Avg Draw = avg G or S water draw '87-88 / Max Draw = high G or S water draw '83-88

AQUIFER SECTOR 808 - Continuation

Name	Sys. Code	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max* Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
State Natural Energy Lab											
HGP-A	Puna	2883.01	G,well							Oth	Geothermal well
Oneloa Co.											
Well	Puna	2881.01	G,well							Irr	

Aquifer System 80803 - Hilina

No inventory in this system.

Aquifer System 80804 - Keaiwa

Plantation Systems (Ka'u Agribusiness Co)											
Punaluu Tnl 2	Ka'u	830-02	G,tnl							Irr	
Palima	Ka'u	1128-02	G,well		4.176		3.600		70	Irr	Also registered under IASCO Farms - see next page
IASCO Farms											
Palima	Ka'u	1128-02	G,well		4.176		3.600		70	Irr	

APPENDIX C

INVENTORY OF EXISTING WATER USES AND DEVELOPMENTS AQUIFER SECTOR AND SYSTEMS

AQUIFER SECTOR 809 - HUALALAI

Name	Sys. Code	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max* Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
Aquifer System 80901 - Keauhou											
North Kona Water System (DWS)					11.52	5.989	7.694			Mun	8 wells,10 pumps/
Kailua Well	NKona	3758-01	G,well		unu				600		
Keauhou A	NKona	3457-02	G,well		unu						
Holualoa Well	NKona	3657-01	G,well		1.008		0	0.076	70		
Kahaluu A	NKona	3557-01	G,well		1.008		0.774	1.058	40		
Kahaluu B	NKona	3557-02	G,well		1.008		0.200	0.947	86		
Kahaluu C	NKona	3557-03	G,well		1.008		0.614	0.905	25		
Kahaluu D	NKona	3557-04	G,well		1.440		0.453	1.566	43		
Kahaluu Shaft	NKona	3557-05	G,well		6.048		5.653	6.585	200		Infiltration gallery
Note: System interconnected with South Kona System, feeds S.Kona system as required.											
TSA International											
Kaloko Irr 1	NKona	4160-01	G,well						959	Irr	
Kaloko Irr 2	NKona	4160-02	G,well							Irr	
Kona CC											
South Well	NKona	3357-02	G,well								
Fairway 7	NKona	-	G,well								
Lee Y	NKona	3485-01	G,well								

* Avg Use = avg daily consumption 7/87-6/88; Avg Draw = avg G or S water draw '87-88 / Max Draw = high month G or S water draw '83-88

AQUIFER SECTOR 809 - Continuation

Name	Sys. Code	State #	Source	Min Flow mgd	Max Fl/Cap mgd	Avg* Use mgd	Avg* Draw mgd	Max* Draw mgd	Max Chl ppm	Use Cat.	Facilities / Comments
Aquifer System 80902 - Kiholo											
PIA-Kona Ltd.											
K.Village 1	NKona	4858-01	G,well						410	Unu	For proposed golf course
K.Village 2	NKona	4858-02	G,well						420	Unu	For proposed golf course
K.Village 3	NKona	4858-03	G,well						830	Unu	For proposed golf course
Kaupulehu 1	NKona	4658-01	G,well							Unu	For future water use
Kaupulehu 2	NKona	4658-02	G,well							Unu	For future water use
Kaupulehu Development											
Kaupulehu 1	NKona	4658-01	G,well								
Kaupulehu 2	NKona	4658-02	G,well								
Puwaawaa Ranch					0.133						
Puwaawaa Ranch	NKona	4650-01	G,well		0.072					Dom	
Puu Lani	NKona	4850.01	G,well		0.061					Dom	
Huehue Ranch 1	NKona	4559-01	G,well								
Toyama Gard	NKona	4003-04	G,well								

APPENDIX D

FUTURE DEMAND CALCULATIONS

CALCULATIONS FOR ESTIMATE OF GROSS PER CAPITA CONSUMPTION - MUNICIPAL SYSTEM

	PUNA	S.HILO	N.HILO	HAMAKUA	N.KOHALA	S.KOHALA Makai	S.KOHALA Mauka	N.KONA	S.KONA	KA'U
Total Consumption	0.910	6.009	0.108	0.489	0.421	1.871	0.727	6.383	0.931	0.658
Less Hotel		0.268		0.006	0.004	0.485		0.630	0.007	0.002
Less Resort Condo *						0.160		0.642		
NET CONSUMPTION	0.910	5.741	0.108	0.483	0.417	1.226	0.727	5.061	0.924	0.656
1987 Population Est.	19003	45303	1495	5303	3602	2206	4891	20504	7293	4700
Less Pop.on Pri.Sys.**	300		300	800	92	1645				110
NET POPULATION	18703	45303	1195	4503	3510	561	4891	20504	7293	4590
Per Capita Consumption ***	49	127	90	108	119	2185	149	247	127	143
USE FOR ESTIMATE	**130**	**130**	**90**	**110**	**120**	**800**	**150**	**250**	**130**	**145**

* 0.160-Mauna Lani/ 0.642-Est. based on 50% being resort condo
** 240-Hawn Shores/ 300-Hamakua Sugar/ 800- Hamakua Sugar/ 92-Kohala Ranches/ 1645-Waikoloa Village/ 110-Ranches
*** Puna-PCC is low-large number of individual roof catchments-Use S.Hilo factor
S.Kohala-questionable correlation of population & usage-Use avg. of 4-MF projects in MKB & ML - 800 g/c/d

CALCULATIONS FOR ESTIMATES OF FUTURE AVERAGE DAILY DEMAND

	Res. Pop. c	Res. Demand mgd	Resort Condo. unit	Condo. Demand mgd	Hotel unit	Hotel Demand mgd	Total Demand mgd
PUNA DISTRICT		@130					
Keaau-Volcano	19650	2.554					2.555
Pahoa-Kalapana	19675	2.558					2.628
SUB-TOTAL	39325	5.112					5.183
Private System	540						
TOTAL	39865						
SOUTH HILO DISTRICT		@130		@400		@400	
Hilo	46023	5.983	154	0.062	1150	0.460	6.505
Papaikou-Hakalau	9497	1.235					1.235
TOTAL	55520	7.218	154	0.062	1150	0.460	7.740
NORTH HILO DISTRICT		@90					
TOTAL	1500	0.135					0.135
HAMAKUA DISTRICT		@110				@400	
Honokaa	5340	0.587			6	0.002	0.589
Pauuilo	1745	0.192					0.192
TOTAL	7085	0.779			6	0.002	0.781
NORTH KOHALA DISTRICT		@120				@400	
Municipal System	5380	0.646			10	0.004	0.650
Private System	3090						
TOTAL	8470						

CALCULATIONS FOR ESTIMATES OF FUTURE DEMAND (Continuation)

	Res. Pop. c	Res. Demand mgd	Resort Condo. unit	Condo. Demand mgd	Hotel unit	Hotel Demand mgd	Total Demand mgd
SOUTH KOHALA DISTRICT		@150		@400		@400	
Waimea	8352	1.253	2	0.001	39	0.016	1.270
Kawaihae (N of QK)	1644	0.247					0.247
SUB-TOTAL	9996	1.500	2	0.001	39	0.016	1.517
		@800		@2000		@800	
SKohala Resorts	3500	2.800	2538	5.076	2796	2.237	10.113
TOTAL	13496	4.300	2540	5.077	2835	2.253	11.630
Private Systems	8804						
TOTAL	22300						
NORTH KONA DISTRICT		@250		@2000		@800	
Kukio	365	0.091	2515	5.030	2040	1.632	6.753
Keahole-Kailua	14674	3.669	1329	2.658	1300	1.040	7.367*
SUB-TOTAL	15039	3.760	3844	7.688	3340	2.672	14.120
* At build out, the County's Keahole to Kailua Plan estimates 11.336 total.							
		@250		@800		@800	
Kailua Village	21881	5.470	1469	1.175	1268	1.014	7.659
QLT-Holualoa-Kalaoa	10740	2.685	10	0.008	11	0.009	2.702
Keauhou	3660	0.915	3078	2.462	3061	2.449	5.826
Kainaliu-Honalo	1300	0.325	-	-	-	-	-
SUB-TOTAL	37581	9.395	4557	3.645	4340	3.472	16.512
TOTAL	52620	13.155	8401	11.333	7680	6.144	30.632
SOUTH KONA DISTRICT		@130				@400	
Capt.Cook-Kealakekua	8583	1.116			64	0.026	1.142
Hookena-Miloli	2077	0.270	-	-	-	-	0.270
TOTAL	10660	1.386			64	0.026	1.412
KA'U DISTRICT		@145					
TOTAL	7080	1.027	-	-	126	0.050	1.077

TABLE 1.3-1

ESTIMATES OF SUSTAINABLE YIELDS BY AQUIFER SYSTEMS FOR HAWAII
(Source: Mink and Yuen, Inc. 6/8/89)

Aquifer Sector Name	Aquifer System Name	Aquifer Code	System Area sq.mi.	Sustainable Yield mgd
KOHALA	Hawi	80101	56.95	27
	Waimanu	80102	69.95	110
	Mahukona	80103	113.91	17
			240.81	154
EAST MAUNA KEA	Honokaa	80201	105.82	31
	Paauilo	80202	150.16	60
	Hakalau	80203	166.72	150
	Onomea	80204	180.53	147
			603.05	388
WEST MAUNA KEA	Waimea	80301	282.14	24
N.E. MAUNA LOA	Hilo	80401	193.73	347
	Keaau	80402	207.27	393
			401.00	740
S.E. MAUNA LOA	Olaa	80501	129.51	124
	Kapapala	80502	83.50	19
	Naalehu	80503	352.00	117
	Ka Lae	80504	134.77	31
			699.78	291
S.W. MAUNA LOA	Manuka	80601	167.26	42
	Kaapuna	80602	241.76	50
	Kealakekua	80603	226.75	38
			635.77	130
N.W. MAUNA LOA	Anaehoomalu	80701	291.01	30
KILAUEA	Pahoa	80801	222.0	435
	Kalapana	80802	193.36	157
	Hilina	80803	59.24	9
	Keaiwa	80804	89.99	17
			564.59	618
HUALALAI	Keauhou	80901	166.72	38
	Kiholo	80902	146.22	18
			312.94	56
TOTAL			4,031.09	2,431

TABLE 1.6-1
SUMMARY OF WATER DRAWN BY AQUIFER SECTORS & USE CATEGORIES
7/87 to 6/88

	Municipal mgd	Agri.Irr. mgd	Priv.D/C/I mgd	Others mgd	Military mgd	Total mgd
801-Kohala						
Grd Wtr	0.33		0.10			0.43
Suf Wtr	1.81	14.3	1.0	19.01		36.21
Total	2.14	14.3	1.10	19.01	-	36.64
802-E.Mauna Kea						
Grd Wtr	0.46	1.46	2.54	22.5		26.96
Suf Wtr	0.44	0.08	0.05		0.03	0.60
Total	0.90	1.54	2.59	22.5	0.03	27.56
803-W.Mauna Kea						
Grd Wtr	1.85		5.16			7.01
Suf Wtr			2.0			2.0
Total	1.85	-	7.16	-	-	9.01
804-N.E.Mauna Loa						
Grd Wtr	7.63		0.71	39.1		47.44
Suf Wtr	4.7			31.9		36.6
Total	12.33	-	0.71	71.0	-	84.04
805-S.E.Mauna Loa						
Grd Wtr	0.16	2.74	1.10	3.7		7.70
Suf Wtr	0.63		0.10			0.73
Total	0.79	2.74	1.20	3.7	-	8.43
806-S.W.Mauna Loa						
Grd Wtr	0.76	1.14				1.90
Suf Wtr						
Total	0.76	1.14	-	-	-	1.90
807-N.W.Mauna Loa						
	-	-	-	-	-	-
808-Kilauea						
Grd Wtr	0.58	3.60	0.03			4.21
Suf Wtr						
Total	0.58	3.60	0.03	-	-	4.21
809-Hualalai						
Grd Wtr	7.69		0.83			8.52
Suf Wtr						
Total	7.69	-	0.83	-	-	8.52
ALL SECTORS						
Grd Wtr	19.46	8.94	10.47	65.3		104.17
Suf Wtr	7.58	14.38	3.15	51.0	0.03	76.14
Total	27.04	23.32	13.62	116.3	0.03	180.31
	15.0%	12.9%	7.6%	64.5%	-	100.0%

TABLE 1.6-2
SUMMARY OF WATER DRAWN BY DISTRICTS & USE CATEGORIES
7/87 to 6/88

	Aquifer Sector	Average Sale or Use mgd	Ground Water Draw mgd	Surface Water Draw mgd	District Total mgd
PUNA DISTRICT					
Muni/Keaau-Mt. View	804	0.488	0.73	0	
Priv/D.C.I.	804		0.42	0	
Muni/Pahoa-Kapo-Kalapana	808	0.422	0.58	0	
Priv/D.C.I.	808		0.03	0	
			1.76		1.76
SOUTH HILO DISTRICT					
Muni/Hilo	804	5.485	6.90	4.7	
Priv/D.C.I.	804		0.29	0	
Priv/Oth	804		39.1	31.9	
Muni/Rural Hilo	802	0.483	0.22	0.32	
Priv/Agr Irr	802		0	0.06	
Priv/D.C.I.	802		1.08	0.01	
Priv/Oth	802		22.5	0	
			70.09	36.99	107.08
NORTH HILO DISTRICT					
Mun/3-Systems	802	0.113	0.04	0.08	
Priv/Agr Irr	802		0.04	0.02	
Priv/D.C.I.	802		0.04	0.04	
			0.12	0.14	0.26
HAMAKUA DISTRICT					
Muni/3-systems	802	0.513	0.20	0.28	
Priv/D.C.I.	802		1.42	0	
Priv/Agr Irr	802		1.42	0	
Priv/Agr Irr	801		0	12	
Priv/D.C.I.	801		0	0.20	
Priv/Oth	801		0	10.0	
Military	804		0	0.03	
			3.04	22.51	25.55
NORTH KOHALA DISTRICT					
Mun/4-Systems	801	0.451	0.33	0.19	
Priv/Agr Irr	801		0	1.0	
Priv/D.C.I.	801		0.10	0.8	
Priv/Oth	801		0	9.1	
			0.43	11.09	11.52
SOUTH KOHALA DISTRICT					
Mun/Waimea-Kawaihae	801	0.724	0	1.38	
State/Agr Irr	801		0	1.3	
Priv/Ind	801		0	2.0	
Mun/Puako-Hapuna-HHL	803	1.840	1.85	0	
Priv/D.C.I.	803		5.16	0	
			7.01	4.68	11.69

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TABLE 1.6-2 (Continuation)

	Aquifer Sector	Average Sale or Use mgd	Ground Water Draw mgd	Surface Water Draw mgd	District Total mgd
NORTH KONA DISTRICT					
Muni/North Kona Sys	809	5.973	7.69	0	
Priv/D.C.I.	809		0.83	0	
			8.52		8.52
SOUTH KONA DISTRICT					
Muni/South Kona Sys	806	0.867	0.76	0	
Priv/Agr Irr	806		1.14	0	
			1.90		1.90
KAU DISTRICT					
Muni/Pahala-Naalehu Sys	805	0.670	0.16	0.63	
Priv/Agr Irr	805		2.74	0	
Priv/D.C.I.	805		1.10	0.10	
Priv/Other	805		3.7	0	
Priv/Agr Irr	808		3.60	0	
			11.30	0.73	12.03
TOTAL FOR ALL DISTRICTS			104.17	76.14	180.31
			57.8%	42.2%	100.0%

TABLE 1.6-3 MUNICIPAL SYSTEMS

WATER SOLD, SOURCE CAPACITY, & WATER DRAW BY AQUIFER SECTOR

(Data Source: Hawaii County Water Department)

Aquifer Sector	Aquifer Code	Average Sold mgd	Low Flow or Pump Capacity mgd	Ave Grd Wtr Draw mgd	Est Srf Wtr Use mgd
801					
KOHALA	80101	0.451	0.691	0.333	0.19
	80102	0.997	(1)	(1)	1.62
		1.448	0.691	0.333	1.81
802					
EAST MAUNA KEA	80201	0.241	0.826	0.201	0.04
	80202	0.009	(2)	(2)	-
	80203	0.230	0.868	0.071	0.17
	80204	0.357	0.946	0.183	0.23
		0.837	2.640	0.455	0.44
803					
WEST MAUNA KEA	80301	1.840	4.752	1.849	-
804					
N.E. MAUNA LOA	80401	(3)	10.648	1.468	4.70
	80402	5.973	10.692	6.170	-
		5.973	21.340	7.630	4.70
805					
S.E. MAUNA LOA	80501	-			
	80502	-			
	80503	0.670	1.102	0.162	0.63
	80504	-			
806					
S.W. MAUNA LOA	80601	-			
	80602	-			
	80603	0.867	1.584	0.755	-
807					
N.W. MAUNA LOA	80701	-			
808					
KILAUEA	80801	0.294	1.872	0.426	-
	80802	0.128	1.022	0.151	-
		0.422	2.894	0.577	
809					
HUALALI	80901	5.973	11.520	7.694	-
	80902	-			
TOTAL ALL SYSTEMS		18.030	46.523	19.455	7.58
				72.0%	28.0%

NOTES:

The average daily volume pumped from the wells in a system is used as the average ground water draw.

(1) Included in Waimea TP; Paauilo capacity/draw included in HSCo Paauilo Well
(2) Ookala capacity/draw included in HSCo Ookala Well
(3) Consumption included in 80402

TABLE 1.7-1

REQUIRED FUTURE CAPACITIES BY AQUIFER SECTORS & USE CATEGORIES
TO YEAR 2010

	Municipal mgd	Agr.Irr. mgd	Priv.D/C/I mgd	Others mgd	Military mgd	Total mgd	
801-Kohala							
Grd Wtr	1.8		6.2			8.0	
Suf Wtr	6.0	23.0	2.3	19.0		50.3	
Total	7.8	23.0	8.5	19.0		58.3	18.8%
802-E.Mauna Kea							
Grd Wtr	5.2	2.6	2.4	22.5		32.7	
Suf Wtr							
Total	5.2	2.6	2.4	22.5		32.7	10.5%
803-W.Mauna Kea							
Grd Wtr	18.0		10.5			28.5	
Suf Wtr							
Total	18.0		10.5			28.5	9.2%
804-N.E.Mauna Loa							
Grd Wtr	24.0		3.3	61.5	1.2	90.0	
Suf Wtr				32.0		32.0	
Total	24.0		3.3	93.5	1.2	122.0	39.3%
805-S.E.Mauna Loa							
Grd Wtr	2.2	2.7	3.1	7.5		15.5	
Suf Wtr							
Total	2.2	2.7	3.1	7.5		15.5	5.0%
806-S.W.Mauna Loa							
Grd Wtr	2.7	2.0				4.7	
Suf Wtr							
Total	2.7	2.0				4.7	1.5%
807-N.W.Mauna Loa		NONE					
808-Kilauea							
Grd Wtr	4.0	3.6	1.0			8.6	
Suf Wtr							
Total	4.0	3.6	1.0			8.6	2.7%
809-Hualalai							
Grd Wtr	34.0		6.4			40.4	
Suf Wtr							
Total	34.0		6.4			40.4	13.0%
ALL SECTORS							
Grd Wtr	91.9	10.9	32.9	91.5	1.2	228.4	
Suf Wtr	6.0	0.3	2.3	51.0		82.3	
Total	97.9	33.9	35.2	142.5	1.2	310.7	100.0%
	31.5%	10.9%	11.3%	45.9%	0.4%	100.0%	

TABLE 1.7-2
REQUIRED FUTURE CAPACITIES BY DISTRICTS AND USE CATEGORIES
TO YEAR 2010

System	Aquifer Code	Future Demand	Existing Capacity	Required Capacity
PUNA DISTRICT				
Muni/Keaau-Mt.View	804	2.55 mgd	2.34 mgd	4.0 mgd
Priv/D.C.I.	804		1.58	2.0
Muni/Pahoa-Kapo-Kala	808	2.56	2.89	4.0
Priv/D.C.I.	808		0.70	1.0
				11.0-gw
SOUTH HILO DISTRICT				
Muni/Hilo	804	12.50	14.54	20.0
Priv/D.C.I.	804		1.3	1.3
Priv/Oth	804		61.5	61.5-gw/32.0-sw
Muni/Rural Hilo	802	1.30	1.0	2.5
Priv/D.C.I.	802		1.1	1.1
Priv/Oth	802		22.5	22.5
				108.9-gw/32.0-sw
NORTH HILO DISTRICT				
Muni/3-systems	802	0.14	0.58	0.9
				0.9-gw
HAMAKUA DISTRICT				
Muni/3-systems	802	0.93	0.58	1.8
Priv/D.C.I.	802		1.3	1.3
Priv/Agr Irr	802		2.6	2.6
Priv/Agr Irr	801			12.0-sw
Priv/Oth	801			10.0-sw
Military	804	0.60		1.2
				6.9-gw/22.0-sw
NORTH KOHALA DISTRICT				
Muni/4-systems	801	0.65	0.94	1.8
Priv/Agr Irr	801			6.0-sw
Priv/D.C.I.	801			6.2-gw/0.3-sw
Priv/Oth	801			9.0-sw
				8.0-gw/15.3-sw
SOUTH KOHALA DISTRICT				
Muni/Waimea-Kawaihae	801	1.52		6.0-sw
State/Agr Irr	801			5.0-sw
Priv/D.C.I.	801			2.0-sw
Muni/Puako-Hapuna-HHL	803	13.60	4.75	18.0
Priv/D.C.I.	803		6.72	10.5
				28.5-gw/13.0-sw
NORTH KONA DISTRICT				
Muni/North Kona	809	30.63	11.52	34.0
Priv/D.C.I.	809			6.4
				40.4-gw
SOUTH KONA DISTRICT				
Muni/South Kona	806	1.41	1.58	2.7
Priv/Agr Irr	806		1.14	2.0
				4.7-gw
KAU DISTRICT				
Muni/Pahala-Naalehu	805	1.08	1.10	2.2
Priv/Ag Irr	805		2.7	2.7
Priv/D.C.I.	805		3.1	3.1
Priv/Oth	805		7.5	7.5
Priv/Agr Irr	808		3.6	3.6
				19.1-gw
TOTAL FOR ALL DISTRICTS				310.7= 228.4-gw+82.3-sw