Water: the lifeline of our islands. It is our most precious resource here in Hawaii. Water is the driving force of our environment, our economy, and our Hawaiian Culture (Commission on Water Resource Management website message).

1 INTRODUCTION

1.1 BACKGROUND

1.1.1 State Water Code

In 1987, the State Legislature passed the State Water Code (Hawaii Revised Statutes, Chapter 174C) to protect Hawaii's surface and ground water resources. The State Water Code (the Code) called for the establishment of a Commission on Water Resource Management (CWRM) that would be responsible for administering the Code. Also, as part of the requirements set forth in the Code, was the formulation of a *Hawaii Water Plan* that would serve as a dynamic, long-range planning guide for the Commission. The Commission established the Hawaii Administrative Rules Chapter 13-170, *Hawaii Water Plan*, which specifies and clarifies definitions, procedures, requirements, etc., required by, but not specified in, the Code.

The *Hawaii Water Plan* consists of five parts: (1) the *Water Resource Protection Plan*, (2) the *Water Quality Plan*, (3) the *State Water Projects Plan*, (4) the *Agricultural Water Use and Development Plan* (AWUDP), and (5) the County Water Use and Development Plans (WUDP). A separate WUDP is to be prepared by each of the four Counties. The AWUDP was added to the *Hawaii Water Plan* by mandate under Act 101, Session Laws of Hawaii (SLH) 1998, by the State Legislature.

The original *Hawaii Water Plan* was completed and adopted by the Commission in July 1990. The Code calls for the *Hawaii Water Plan*, including all of its elements to be updated regularly to reflect the current needs of the State. Each of the Counties is responsible to update their respective WUDP as required. Updates of the various elements except the WQP and AWUDP were drafted in1992, but were not officially adopted by the CWRM.

1.1.2 History of Hawaii County Water Use and Development Plan

In compliance with the State Water Code, the County of Hawaii Department of Water Supply (DWS) was tasked with the responsibility to prepare the *County of Hawaii Water Use and Development Plan* in 1988. The WUDP serves as a continuing long-range guide for the water resource development in the County. Its objective is "to set forth the allocation of water to land use through the development of policies and strategies which shall guide the County in its planning, management, and development of water resources to meet projected demands." Section 13-170-31, Hawaii Administrative Rules states that the WUDP shall include but not be limited to:

> *(1) 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) Future land uses and related water needs; and

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

The original County of Hawaii WUDP was adopted by the County Council by ordinance and endorsed by Mayor Tanimoto on May 10, 1990. The WUDP was conditionally accepted by the State Commission on Water Resource Management for incorporation into the *Hawaii Water Plan* on June 27, 1990, with the provisions that the WUDP be reviewed and revised as necessary by the County to coincide with the review process of the *Hawaii Water Plan*.

Adoption of the County of Hawaii WUDP was executed by County of Hawaii Ordinance No. 90-60. The Ordinance requires that the County of Hawaii WUDP be updated every five years. The first update was drafted in 1992, but was not officially adopted by the CWRM. In 2003, the County of Hawaii Department of Water Supply produced the funding and initiated the update to the WUDP.

1.1.3 Statewide Framework for the Update of the Hawaii Water Plan

The *Statewide Framework for Updating the Hawaii Water Plan* (Framework) dated February 2000 was created by the Commission on Water Resource Management to facilitate coordination, integration, and consistency of the components of the *Hawaii Water Plan*. In addition, the framework is a guide for preparation of the WUDP to insure effective implementation by the County and utilization by the CWRM for resource management purposes.

The Framework requires data and analyses to be based on ground water and surface water hydrologic units designated by the CWRM. However, the surface water hydrologic units were only recently established and adopted in June 2005; and additional information on the surface water hydrologic units is extremely limited. Therefore, the Hawaii WUDP update is based on the ground water hydrologic units, and references the surface water hydrologic units as applicable.

1.1.3.1 Ground Water Hydrologic Units

The State, as part of its *Water Resource Protection Plan (WRPP)*, has established an aquifer classification and coding system to describe and identify 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 the largest component in the hierarchy, followed by Aquifer Sector Areas (ASEA), then Aquifer System Areas (ASYA) located within the Aquifer Sector Areas.

An Aquifer Sector Area reflects an area with broad hydrogeological (subsurface) similarities while maintaining traditional hydrographic (surface), topographic and historical boundaries

where possible. The Aquifer System Area is an area within an Aquifer Sector Area that is more specifically defined by hydrogeologic continuity among aquifers in the System. 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. A two-digit Sector number and a two-digit System number follow the island number. The Sector Areas and System Areas are also assigned geographic names. **Figure 1-1** shows the boundaries, codes and names of the Aquifer Sector Areas and System Areas on the island of Hawaii. A description of each Aquifer System Area may be found in the *Water Resource Protection Plan* component of the *Hawaii Water Plan.*

1.1.3.1.1 Sustainable Yield

Sustainable Yield (SY) is defined and described in the *Water Resource Protection Plan (WRPP)* as follows:

> *Sustainable yield refers to the forced withdrawal rate of groundwater that could be sustained indefinitely without affecting either the quality of the pumped water or the volume rate of pumping. It depends upon the head selected as the minimum allowable during continuous pumping. Head is the elevation* [or height] *of the unconfined water table above sea level. There is not a unique value for sustainable yield; the value depends on the head that will preserve the integrity of the groundwater resource at the level decided upon by the manager.*
>
> *Sustainable yield is equal to a fraction of the recharge. In a basal lens the fraction is usually more than half and sometimes greater than three fourths where initial heads are high. In high level aquifers about three fourths of the recharge can be taken as sustainable yield.*
> [Groundwater recharge is the process of adding water to the aquifer through the infiltration of precipitation on the land surface.]
>
> *The estimates of sustainable yield are not meant to be an exact number which could be used in final planning documents. The estimates are constrained not only by the scanty data base but also by the fact that they do not consider the feasibility of developing the groundwater. The estimates should not be equated to developable groundwater. In many regions, taking advantage of a high estimate would not be economically feasible.*

It should be noted that the Sustainable Yield value represents the sum of potable and non-potable ground water. It is stressed that the SY estimates reflect the average daily pumpage over an entire aquifer system area assuming wells are spaced optimally; and does not consider the feasibility of developing the groundwater; nor whether the groundwater is potable or brackish. Other hydrogeological studies have pointed to the uncertainty in the SY. The *Water Resources Protection Plan*, like the *Water Use and Development Plan*, is a dynamic document, and the SY estimates continue to be evaluated. Subsequent updates of the WRPP should provide updated

values of the SY. Therefore, caution should be exercised in comparing the Sustainable Yield to projected water demands. As stated in the WRPP, estimates of the Sustainable Yield should be used as a guide in planning rather than a definitive constraint.

Table 1-1 lists the geographical area of coverage and estimated sustainable yield in million gallons per day (mgd) published in the *Hawaii Water Resource Protection Plan* for the 9 aquifer sector areas on the island of Hawaii.

Table 1-1: Aquifer Sector Areas

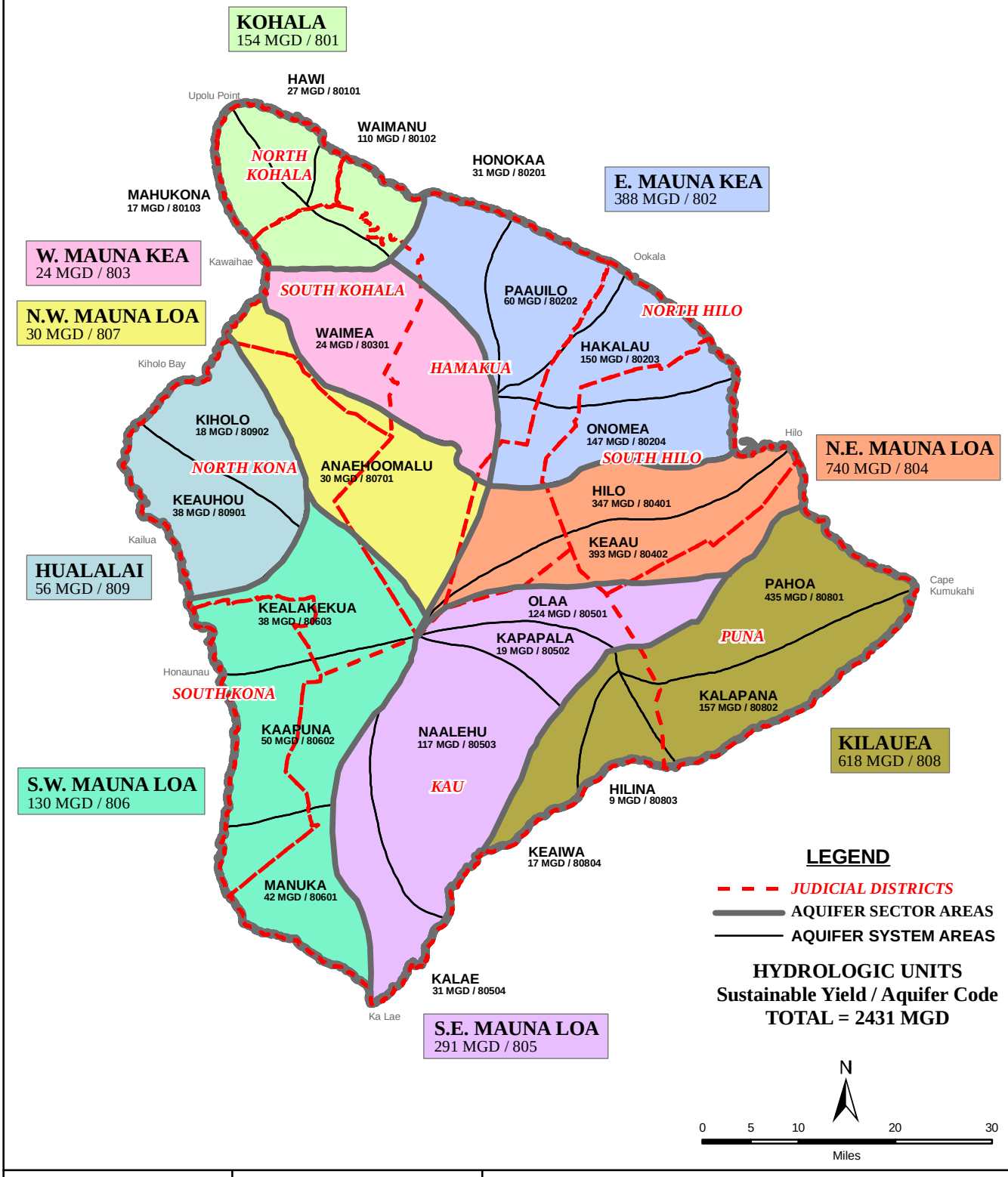
Sector Area Code	Sector Area	Area (Acres)	Sustainable Yield (MGD)
801	Kohala	154,118	154
802	E. Mauna Kea	385,952	388
803	W. Mauna Kea	180,570	24
804	N.E. Mauna Loa	256,640	740
805	S.E. Mauna Loa	447,859	291
806	S.W. Mauna Loa	406,893	130
807	N.W. Mauna Loa	186,246	30
808	Kilauea	361,338	618
809	Hualalai	200,282	56
Total for Island		2,579,898	2,431

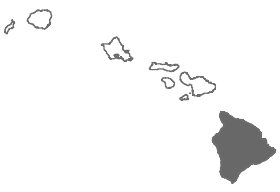
1990 State Water Resource Protection Plan

1.1.3.2 Surface Water Hydrologic Units

The CWRM recently established surface water hydrologic units and a coding system, and adopted the *CWRM Surface-Water Hydrologic Units: A Management Tool for Instream Flow Standards* report in June 2005. Key objectives of the CWRM surface water hydrologic units include the following:

1) *Define and delineate unique units that can accommodate the relational requirements in a database environment, while providing a system that can be easily understood by the general public.*
2) *Develop an information management system which utilizes the coding system to relate surface-water permits and other resource information to a given unit.*
3) *Define hydrologic units to be considered in the analysis and development of instream flow standards.*
4) *Provide a reference system that promotes better information management of other resource inventories.*
5) *Promote the sharing and collection of surface-water resource data between government agencies, the public, private entities, and community organizations.*
6) *Improve the overall coordination of monitoring, data collection, and field investigation efforts.*





Island of Hawaii

FIGURE 1-1

JUDICIAL DISTRICTS AND AQUIFER BOUNDARIES

Hawaii County
Department of Water Supply

DWS UPDATE TO THE WATER USE AND DEVELOPMENT PLAN

Job No. 2003-818

FUKUNAGA & ASSOCIATES, INC.
Consulting Engineers
1388 Kapiolani Boulevard, Honolulu, Hawaii 96814

A hydrologic unit is defined by the Code as "a surface drainage area or a ground water basin or a combination of the two." The majority of surface water hydrologic units have boundaries which closely match the drainage basins or watershed units. The CWRM defines a watershed unit in accordance with *the State Definition and Delineation of Watersheds* report as follows:

> *A watershed unit is comprised of a drainage basin (or basins) which include both stream and overland flow, whose runoff either enters the ocean along an identified segment of coastline (coastal segment) or enters an internal, landlocked drainage basin. The watershed units for an island are defined so that all segments of coastline are assigned to a unique watershed unit and so that all areas of an island are assigned to one, and only one, watershed unit.*

Similar to the aquifer code system, the surface water hydrologic unit 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. A three-digit System number follows the island number. The Systems are also assigned geographic names. **Figure 1-2** shows the boundaries of the 166 surface water hydrologic units and the 9 aquifer sector areas for comparison on the island of Hawaii. Information on each surface water hydrologic unit is extremely limited since the coding system is the first-step towards improving the organization and management of surface water information that CWRM collects and maintains.

1.1.4 The Hawaii Water Plan Update Status

As required by the Code, the *Hawaii Water Plan*, including all of its elements, must be updated regularly to reflect the current needs of the State. Currently, the update status of the various elements is as follows:

PLAN ELEMENT	STATUS
Water Resource Protection Plan	Second update in progress
Water Quality Plan	1990 – first update completed
State Water Projects Plan	2003 – Second update completed
Agricultural WUDP	Plan in development: Phase 1 – 2003 Phase 2 – 2004 Phase 3 – In progress
Hawaii County WUDP	2006 – Second update projected completion
Honolulu, Maui & Kauai WUDPs	Second update in progress

Act 101, SLH 1998 requires that the AWUDP should provide a master inventory of irrigation systems, identify the extent of repair and rehabilitation that would be required over a 5-year period, and provide a long-range management plan. The Framework further expands the scope to provide for the development of agricultural water demand projections, which is essential for the WUDP updates. The AWUDP, dated December 2003, and revised in December 2004, was

prepared to meet the mandate of Act 101, and to review and discuss the potential for transitioning from monocrop corporate farming into diversified crop farming, along with the potential opportunities available in the new diversified farming. However, due to funding and time constraints, a comprehensive plan has not yet been completed.

1.2 PHYSICAL SETTING

1.2.1 Location and Size

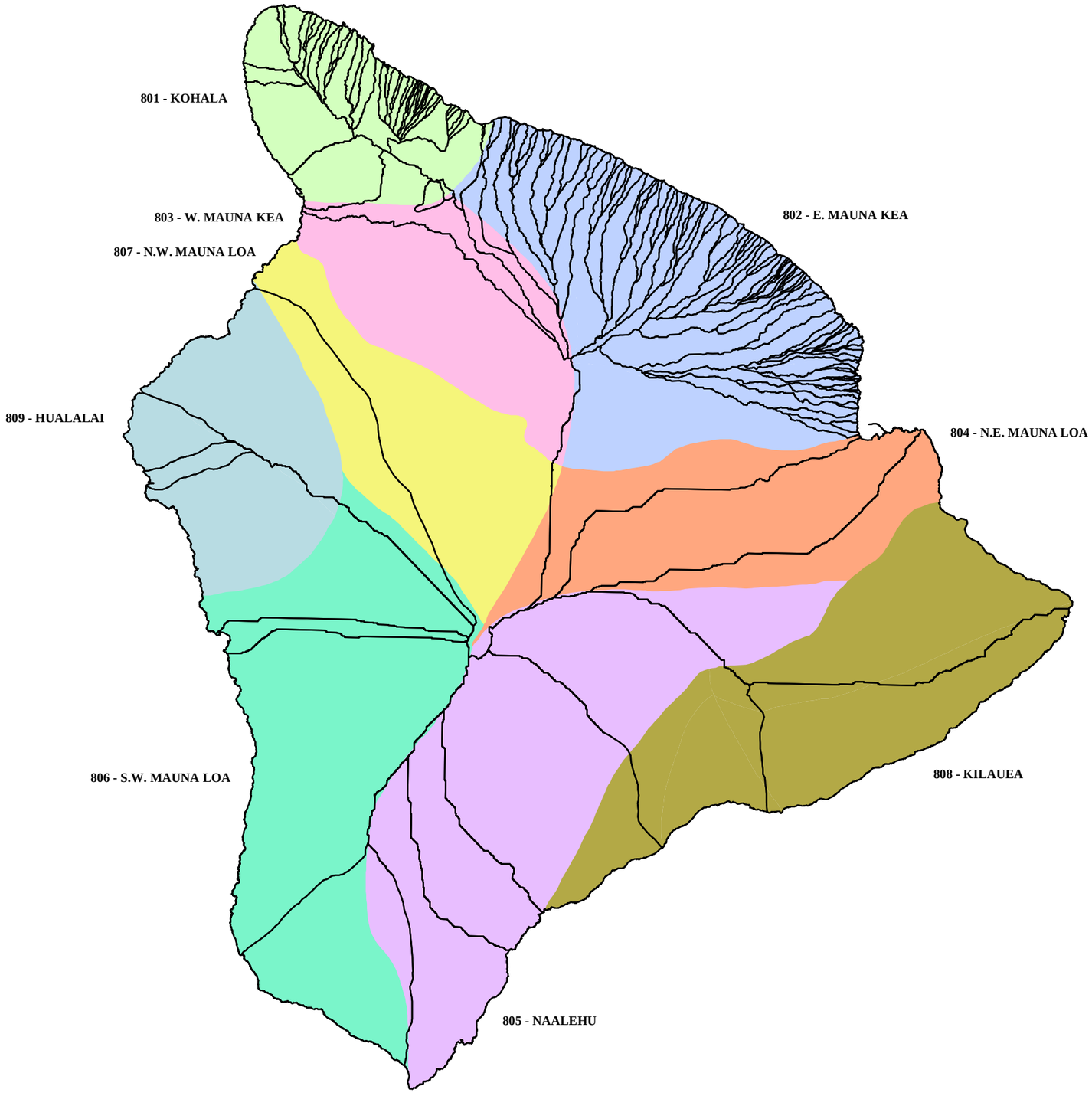
The County of Hawaii encompasses the island of Hawaii, the largest most southeastern island of the Hawaiian archipelago. The total area of the island is approximately 4,028 square miles. The island is divided into 9 judicial districts, and has 9 aquifer sector areas and 166 surface water hydrologic units, as previously shown on **Figures 1-1 and 1-2**. The 2000 U.S. Census reports the island's resident population to be 148,677 residents.

1.2.2 Climate

The size of the island and 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 or a rainfall pattern caused by the mountains, typical of the larger islands in the Hawaiian chain. Rainfall reaches a maximum intensity in areas 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 cool as they rise up the mountain slopes and lose much of their moisture as rain. The prevalence of trades throughout most 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 (southwest) slopes, the air becomes dryer and warmer. Rainfall declines accordingly, resulting in a 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 the summer, generates a moderate sea breeze circulation. This results in frequent and heavy showers, which produce a much higher mean rainfall than in other leeward areas. Generally, in areas where trade winds predominate, the dry months are from May through September. The wet months occur from October through April. In the Kona region, sheltered from the trades, summer rainfall predominates.

Under prevailing trade wind conditions, from 50 to 70 percent of the time, temperature inversion greatly influences moisture distribution in the air surrounding the island. 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 the inversion is roughly 70 to 80 percent in windward areas, and 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.



Hawaii County
Department of Water Supply

DWS UPDATE TO THE WATER USE AND DEVELOPMENT PLAN

Job No. 2003-818

LEGEND:

Surface Water Hydrologic Units Boundary

NORTH

0 2 4 8 12
Miles

INDEX MAP - Island of Hawaii

FIGURE 1-2

Surface Water Hydrologic Units

FUKUNAGA & ASSOCIATES, INC.
Consulting Engineers
1388 Kapiolani Boulevard, Honolulu, Hawaii 96814

Because of the consistently mild temperatures of the ocean waters surrounding the islands, temperatures in the air moving across the ocean and over the island are also mild and do not vary significantly. The warmest month is August and the coldest is February. Temperatures above 90°F are very unusual, except in the dry leeward area of South Kohala, where maximum temperatures in the low 90's are common. A temperature less than 55°F is uncommon, except at elevations above 2,500 feet. The summits of Mauna Kea and Mauna Loa frequently have snow in the 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. These winds combine with local winds on the mountain slopes and lowlands to form complex patterns. During the cooler winter months, southerly winds generally replace the trades. 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.

The Island of Hawaii recently experienced continuous drought conditions, lasting from 1998 through 2003, during which the County declared frequent drought emergencies. The County sustained water shortages and heavy damage to agriculture and the cattle industries.

1.2.3 Geology

The Hawaiian Islands are 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, with a total area that exceeds the rest of the other island areas combined. The island is the youngest from a geological viewpoint. Rocks from its earliest volcano indicate an age of about 700,000 years. In contrast, Kauai is over 5 million years old, and Oahu is over 2 million years old.

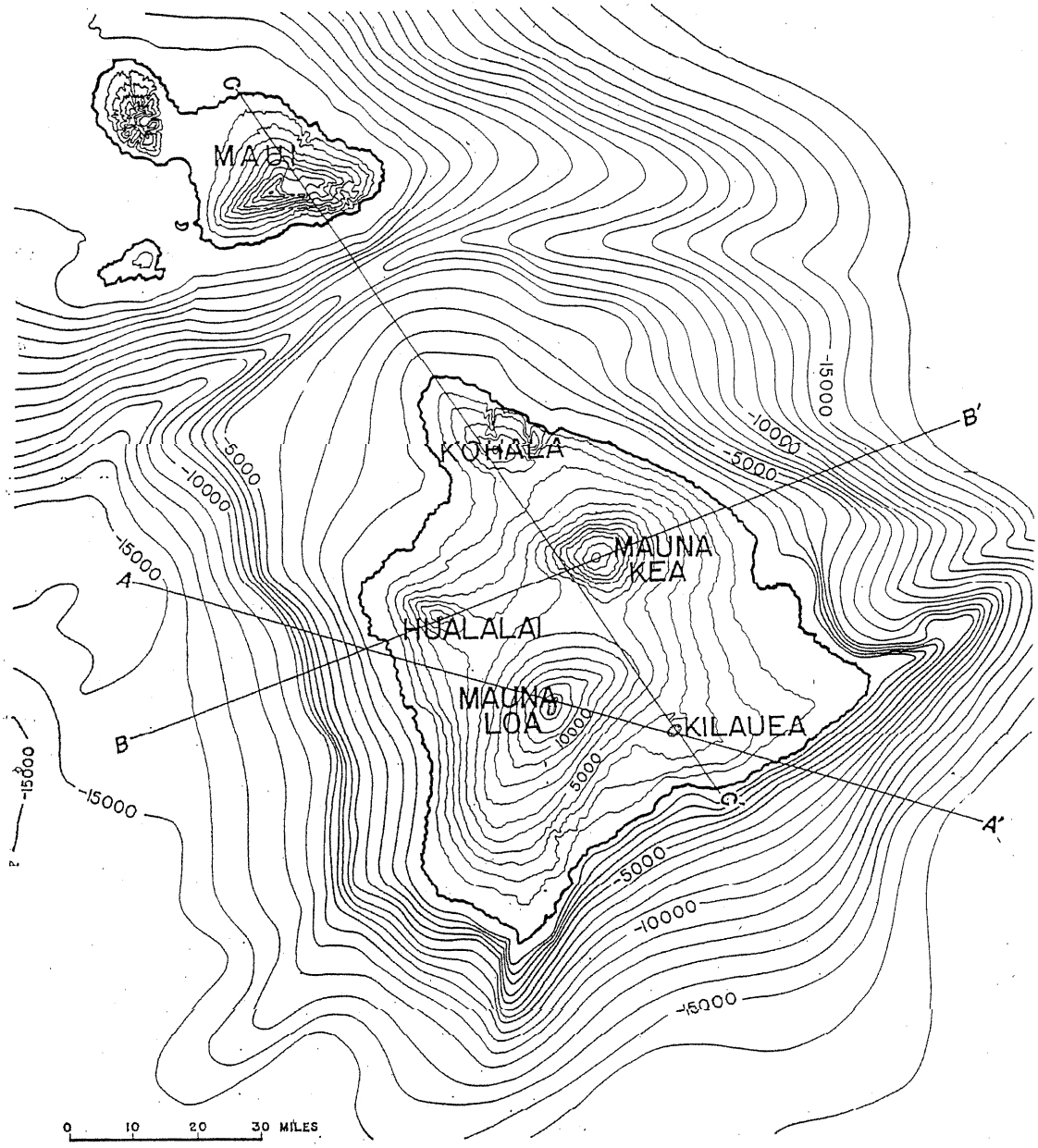
Five shield volcanoes formed the island of Hawaii: Kohala, Mauna Kea, Mauna Loa, Hualalai, and Kilauea. **Figure 1-3** shows the volcano locations. Kohala is considered extinct; Mauna Kea has not erupted for 4,500 years and is dormant; and Hualalai last erupted in 1801 and is considered dormant. Mauna Loa and Kilauea are active volcanoes. A sixth volcano, the Loihi Seamount, is active and forming on the seafloor south of Kilauea.

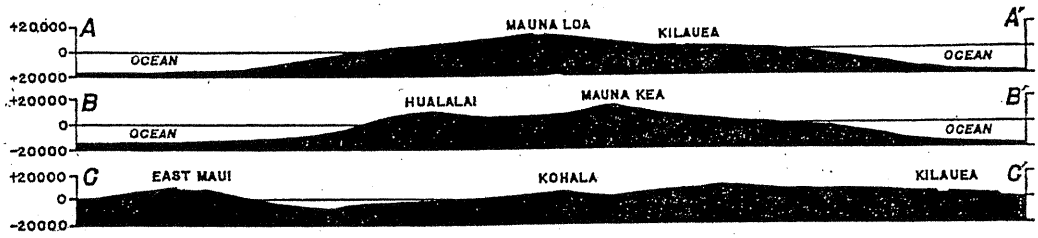
Each volcanic dome consists primarily of permeable thin-bedded basaltic lava flows. A veneer of andesitic lavas covers much of Mauna Kea; and one of andesite and trachyte covers part of the Kohala Mountain, attesting to the older age of the Kohala volcanic series. The andesitic and trachytic flows are mostly thick-bedded and are poorly permeable.

Numerous dikes have intruded lava flows in the rift zones. However, exposed dikes are found 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 deposits were 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. Because of the highly pervious nature of many of the surface rocks, the island has only a limited number of perennial streams. These streams are found on the eastern (or windward) slopes of Mauna Kea and Kohala Mountain. 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. As a result, sedimentary materials are sparse and scattered. They include alluvium, talus, dune and beach deposits, and glacial deposits on Mauna Kea. Due to the sparse distribution, sedimentary material has little impact on hydrology.

Figure 1-4 shows a geologic map of Hawaii Island. Accompanying the geologic map is **Table 1-2** showing the stratigraphic sequence of the volcanic rock units on Hawaii Island.





Source: GEOLOGY AND GROUND-WATER RESOURCES OF THE ISLAND OF HAWAII, H.T.Sterarns & G.A.MacDonald, Hawaii Division of Hydrography, 1946, p.35, Figure 4

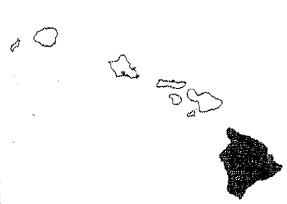


FIGURE 1-3

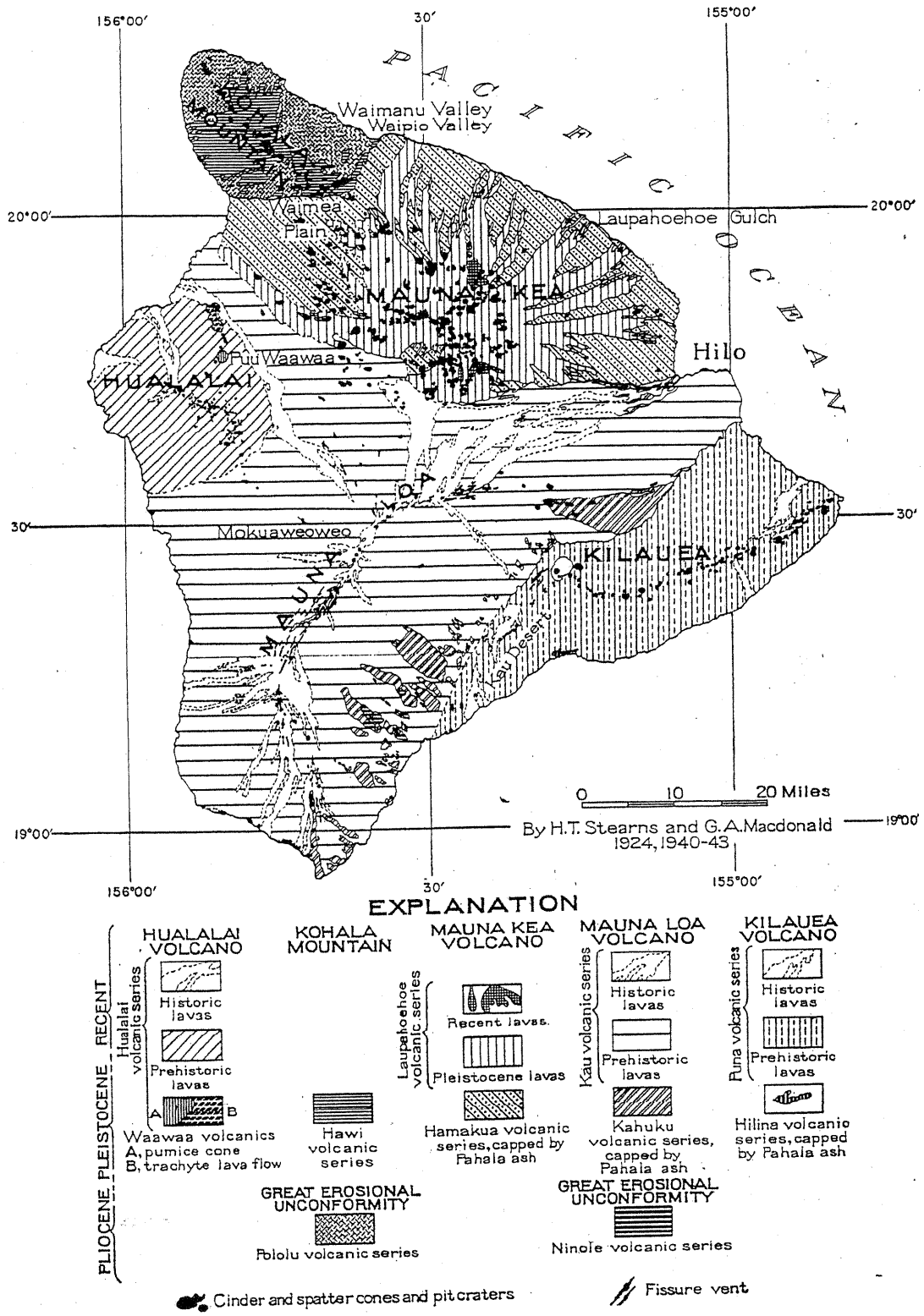
VOLCANOES

Hawaii County
Department of Water Supply

DWS UPDATE TO THE WATER USE AND DEVELOPMENT PLAN

Job No. 2003-818

FUKUNAGA & ASSOCIATES, INC.
Consulting Engineers
1388 Kapiolani Boulevard, Honolulu, Hawaii 96814



Source: GEOLOGY AND GROUND-WATER RESOURCES OF THE ISLAND OF HAWAII, H.T.Sterarns & G.A.MacDonald, Hawaii Division of Hydrography, 1946, p.102, Figure 17

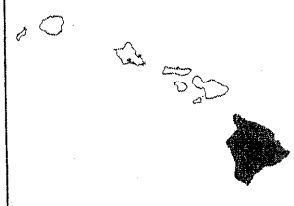


FIGURE 1-4

SIMPLIFIED GEOLOGIC MAP

Hawaii County
Department of Water Supply

DWS UPDATE TO THE WATER USE AND DEVELOPMENT PLAN

Job No. 2003-818

FUKUNAGA & ASSOCIATES, INC.
Consulting Engineers
1388 Kapiolani Boulevard, Honolulu, Hawaii 96814

Table 1-2: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)

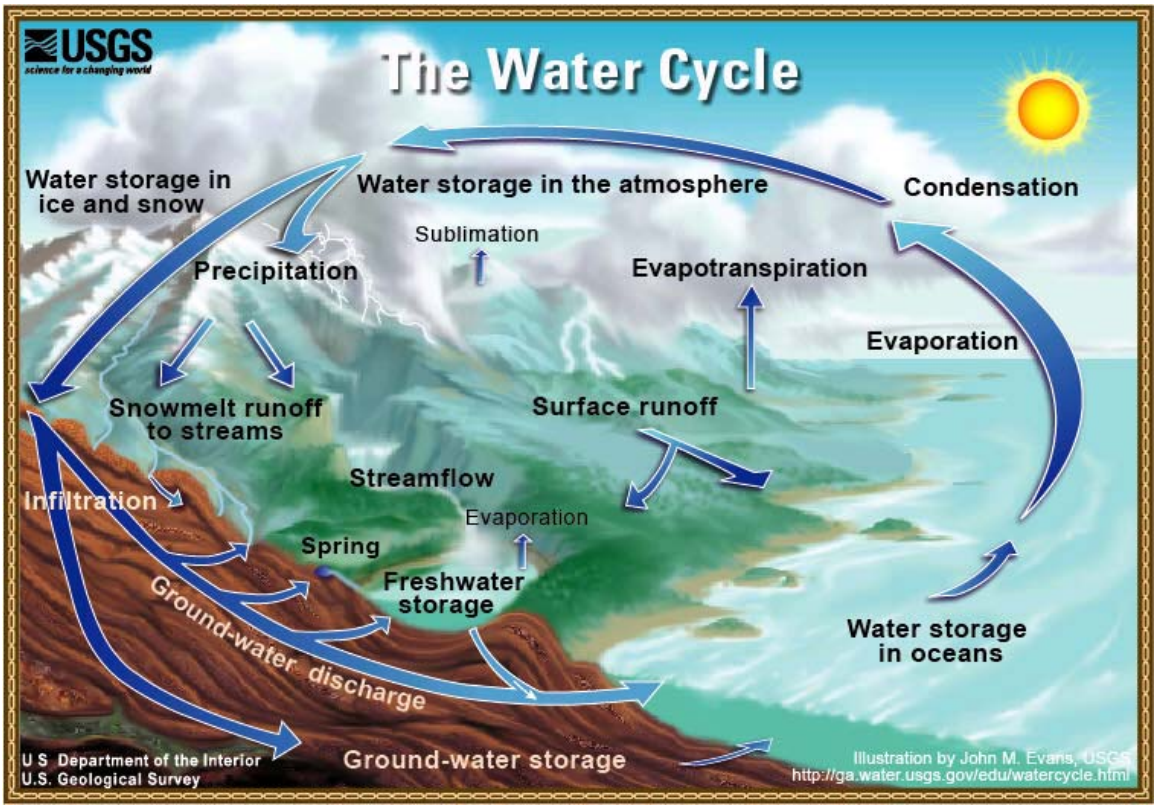
<table>
<tr><th>Age</th><th>Hualalai</th><th>Kohala Mountain</th><th colspan="2">Mauna Loa</th><th>Kilauea</th><th colspan="2">Mauna Kea</th></tr>
<tr><td>Historic</td><td>Historic member of Hualalai volcanic series (volcanics of 1801)</td><td rowspan="2">Unconsolidated alluvium, dunes and landslides</td><td>Historic member of Kau volcanic series (volcanics of 1832-1942)</td><td>Mud flow of 1868</td><td>Historic rocks of Puna volcanic series (volcanics of 1790-1934)</td><td></td><td rowspan="2">Ribbons of gravel and small alluvial fans</td></tr>
<tr><td>Recent</td><td rowspan="3">Exposed part of prehistoric member of the Hualalai volcanic series</td><td colspan="2">Dunes</td><td>Dunes</td><td>Upper member of Laupahoehoe volcanic series</td></tr>
<tr><td rowspan="2">Late Pleistocene</td><td rowspan="2">Fluvial conglomerates</td><td colspan="2" rowspan="2">Prehistoric member of Kau volcanic series</td><td rowspan="2">Prehistoric member of Puna volcanic series</td><td colspan="2">Glacial debris and fluvial conglomerates</td></tr>
<tr><td colspan="2">Lower member of Laupahoehoe volcanic series</td></tr>
<tr><td></td><td>Pahala ash (exposed on Waawaa volcanics only)</td><td>Pahala ash (not differentiated)</td><td colspan="2">Pahala ash</td><td>Pahala ash</td><td colspan="2">Pahala ash</td></tr>
<tr><td>Early and Middle Pleistocene</td><td rowspan="3">Waawaa volcanics and lower unexposed part of Hualalai volcanic series</td><td>Fluvial conglomerates</td><td colspan="2" rowspan="2">Kahuku volcanic series</td><td rowspan="3">Hilina volcanic series</td><td colspan="2" rowspan="3">Hamakua volcanic series</td></tr>
<tr><td>Pliocene</td><td>Hawi volcanic series</td></tr>
<tr><td></td><td colspan="3">Great erosional unconformity</td></tr>
<tr><td></td><td></td><td>Pololu volcanic series</td><td colspan="2">Ninole volcanic series</td><td></td><td colspan="2"></td></tr>
</table>

Source: GEOLOGY AND GROUND-WATER RESOURCES OF THE ISLAND OF HAWAII, H.T. Sterarns & G.A. MacDonald, Hawaii Division of Hydrography, 1946, p. 62`1

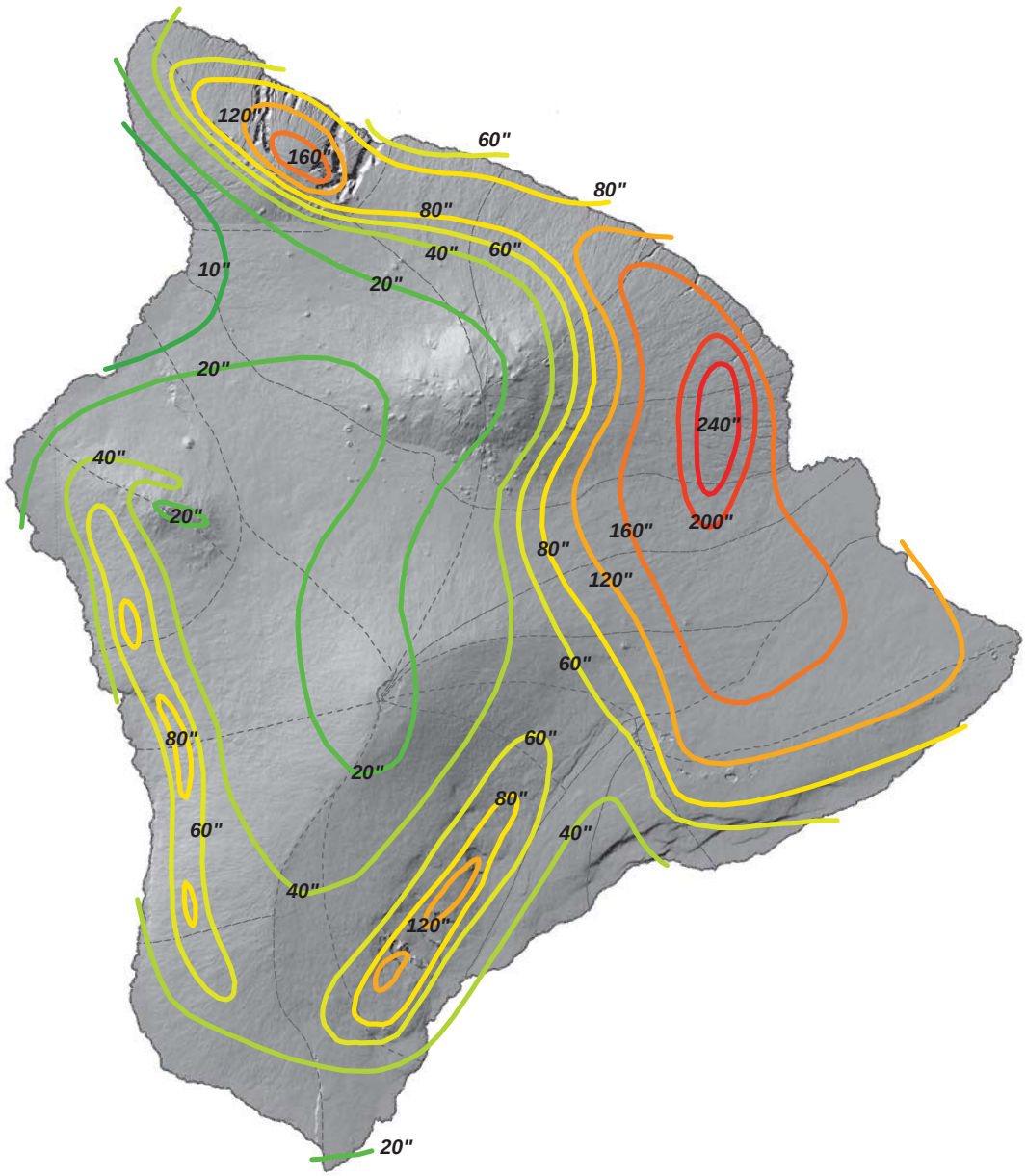
1.2.4 Hydrology

The hydrologic cycle or water cycle is the cyclical movement of water between the air, land and sea, as illustrated in **Figure 1-5**. Generally, it begins with evaporation of water from the ocean and returns to the ground as precipitation. Some of the precipitation or rainfall may be lost through evapo-transpiration; it may become surface runoff or runoff into streams and empty into the ocean; or it may infiltrate the ground to become soil moisture or collect as ground water and eventually escape to the sea. Water supply in the islands is dependent upon this cycle.

Figure 1-5: The Water Cycle



The island of Hawaii, which lies in the path of the prevailing northeast trade winds, has an orographic rainfall pattern. 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 rainfall averages 72 inches per year, equivalent to 13.82 billion gallons of water per day. As indicated by the isohyetal lines of the rainfall map shown in **Figure 1-6**, rainfall gradients are very steep. 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 can drastically fluctuate from year to year, and has often exceeded 300 percent fluctuation. The intensity of rainfall is also very high with 12

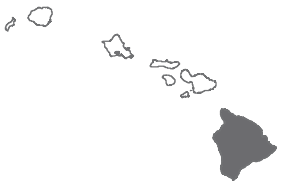


N

0 5 10 20 30

Miles

Source: (GIS Layer) Office of Planning, State of Hawaii, February 2004



Island of Hawaii

FIGURE 1-6

ANNUAL RAINFALL

Hawaii County

Department of Water Supply

DWS UPDATE TO THE WATER USE AND DEVELOPMENT PLAN

Job No. 2003-818

FUKUNAGA & ASSOCIATES, INC.
Consulting Engineers
1388 Kapiolani Boulevard, Honolulu, Hawaii 96814

inches or more of rain a day occurring at least once a year, and instances of over 30 inches of rain occurring within a 24-hour period.

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

Ground water is less susceptible to droughts and seasonal changes than surface water, and therefore is a more dependable water source. There are four different types of ground water on the island: 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. The greatest ground water reservoir is the basal water table near sea level, which is a fresh water lens that "floats" on sea water. This phenomenon is known as the Ghyben-Herzberg principle. Due to the difference in specific gravity of sea water and fresh water, theoretically 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, there is a zone of mixture or transition zone from sea water to fresh water.

The generalized maps in **Figures 1-7** and **1-8** show ground water areas on the island, and locations where ground water recovery by wells and tunnels is feasible. The maps, prepared by the U.S. Geological Survey in 1946, are still applicable today with a few modifications. One such modification is the high-level ground water encountered in the early 1990's within the Keauhou Aquifer System Area, which is within the Hualalai Aquifer Sector Area 809. Exploratory drilling at elevations above 1600 feet mean sea level (msl) encountered water elevations ranging from 25± feet msl to 460± feet msl. *A Study of the Ground-Water Conditions in North and South Kona and South Kohala Districts, Island of Hawaii, 1991-2002* published by CWRM in September 2003, was the culmination of efforts to collect and analyze ground water data from West Hawaii. The report recommends "that this monitoring work continue, and that new hydrological and geological information be analyzed and incorporated into current understanding of West Hawaii."

1.3 ECONOMY AND POPULATION

1.3.1 Economy

The economy of the County of Hawaii is supported by agriculture, tourism, the manufacturing of export products, and research and development. Support of research and development in emerging fields such as astronomy, high technology, renewable energy, health and wellness, agricultural and eco-tourism, diversified agriculture and aquaculture is an important economic force.

Tourism replaced the sugar industry as the primary economic generator in the mid-1980's, with the last sugar harvest on the island in 1997. Tourism related facilities and activities are primarily

on the west side of the island, with continued development concentrated in the Kohala and Kona Districts.

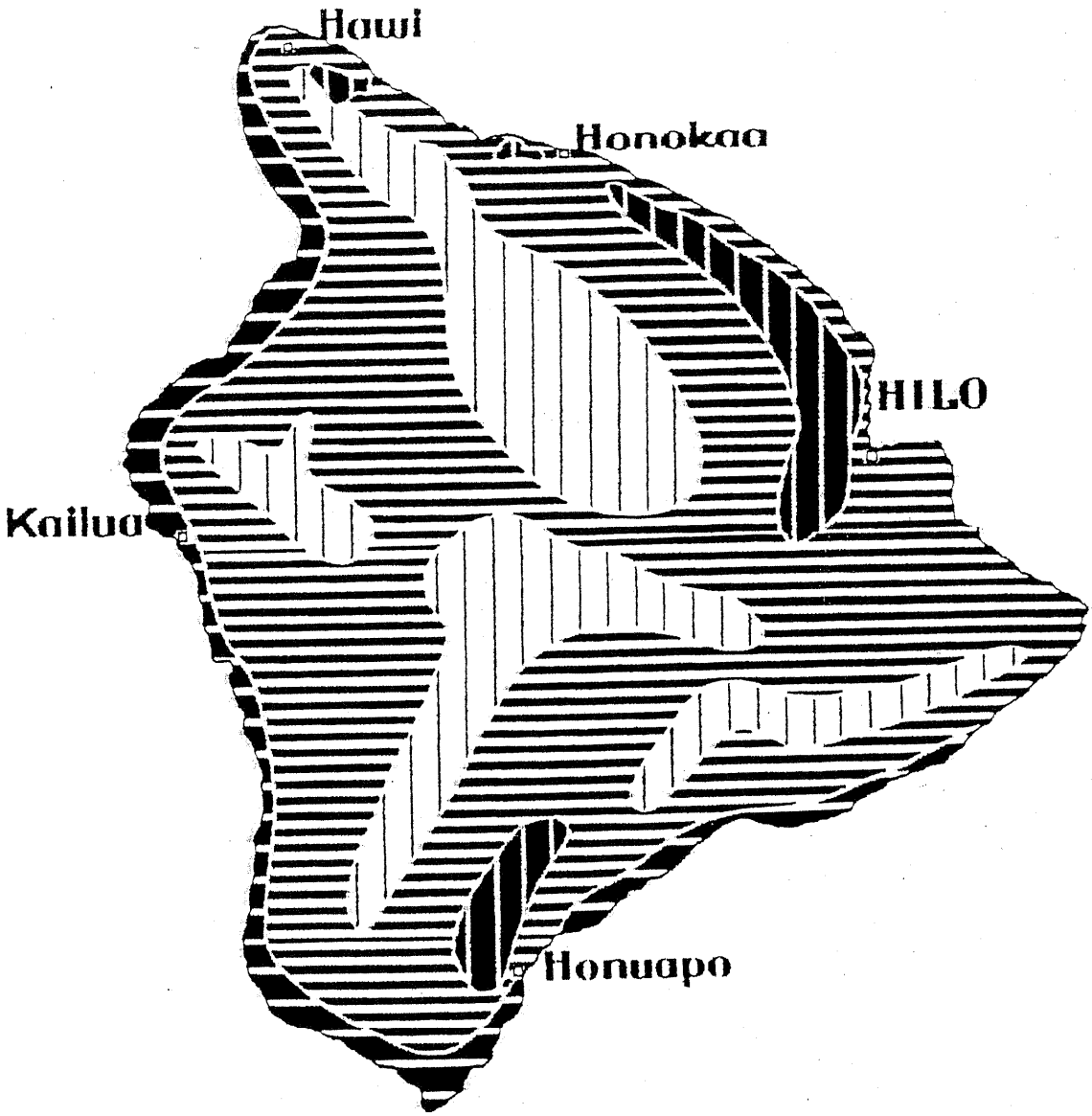
Agriculture continues to be a major economic generator, and includes raising cattle and other livestock, farming of coffee, macadamia nuts, papaya, flowers and nursery products, vegetables, aquaculture, forestry and several processing plants that utilize locally grown products. Livestock production has been declining steadily since the late 1980's primarily due to the high cost of importing feed which resulted in the closing of many feedlots within the State. The market for locally grown products with the growth of local demand and potential of increasing exports indicates promising opportunities for expansion of agriculture. Forestry is a promising industry with the excellent growing climate and the availability of former sugarcane lands, pasture and brush lands. Forest products such as eucalyptus and higher value hardwoods such as toon, maple, and koa are already being produced commercially on the island.

Aquaculture is also a promising industry. According to the County General Plan, "aquaculture operations County-wide have grown from eight operations in 1982 to forty-three in 1996. During this same period, annual revenues have grown from $90,600 to $13,200,000. The County accounts for 37 per cent of the total aquaculture operations within the State but accounts for over 80 per cent of the total production and over 84 per cent of the production value." The Natural Energy Laboratory of Hawaii Authority (NELHA) was first created in 1974 by the Hawaii State Legislature on 322 acres of land in Keahole, North Kona, and continues to be a State subsidized facility now encompassing 870 acres of land. The Pacific Aquaculture and Coastal Resource Center is now being developed on two sites in Hilo, and is funded by the County of Hawaii, State of Hawaii, the U.S. Economic Development Administration, and the University of Hawaii.

1.3.2 Population

The County population has increased at a rate of 23 percent between 1990 and 2000, as compared to 9 percent for the State. According to the County General Plan, "the district of Puna saw the largest increase at 51 per cent, followed by South Kohala (44 per cent), North Kohala (41 per cent), Kau (31 per cent), North Kona (28 per cent), South Kona (12 percent), North Hilo (12 per cent), Hamakua (10 per cent) and South Hilo (6 per cent)." The County General Plan projects that Puna will continue its strong population growth, while growth in North and South Kohala and North and South Kona will be closely associated with the growth of the visitor and agricultural industries in the districts.

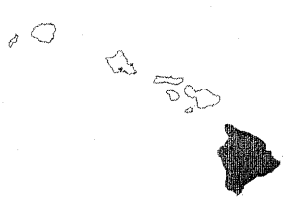
The County General Plan has three population projections for the island to the year 2020, as listed in **Table 1-3**. Series A is a conservative projection, Series B is a medium projection, and Series C projects more rapid growth. More detailed projections for each judicial district are presented in the General Plan.



EXPLANATION

- Brackish basal water
- Basal water floating on salt water
- Water confined by dikes and not floating on salt water
- Water perched on ash, soil or alluvium and underlain with basal water

Source: GEOLOGY AND GROUND-WATER RESOURCES OF THE ISLAND OF HAWAII, H.T.Stearns & G.A.MacDonald, Hawaii Division of Hydrography, 1946, p.35, Figure 4



Island of Hawaii

FIGURE 1-7

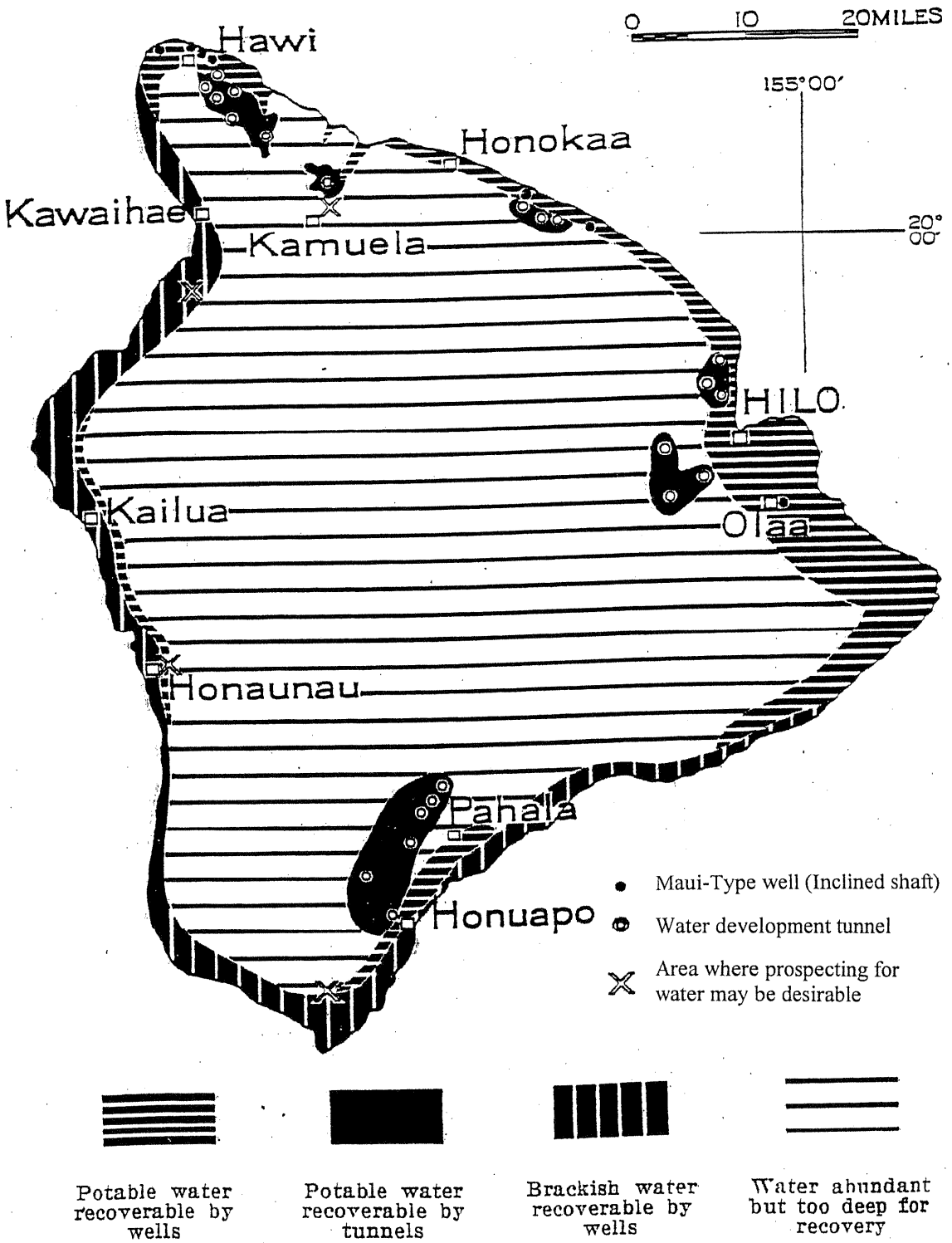
GROUNDWATER QUALITY & LOCATION

Hawaii County
Department of Water Supply

DWS UPDATE TO THE WATER USE AND DEVELOPMENT PLAN

Job No. 2003-818

FUKUNAGA & ASSOCIATES, INC.
Consulting Engineers
1388 Kapiolani Boulevard, Honolulu, Hawaii 96814



Source: GEOLOGY AND GROUND-WATER RESOURCES OF THE ISLAND OF HAWAII, H.T.Stearns & G.A.MacDonald, Hawaii Division of Hydrography, 1946, p.35, Figure 4

Island of Hawaii

FIGURE 1-8

RECOVERABLE GROUNDWATER BY WELLS & TUNNELS

Hawaii County
Department of Water Supply

DWS UPDATE TO THE WATER USE AND DEVELOPMENT PLAN

Job No. 2003-818

FUKUNAGA & ASSOCIATES, INC.
Consulting Engineers
1388 Kapiolani Boulevard, Honolulu, Hawaii 96814

Table 1-3: County General Plan Population Projection

GROWTH RATE	2000	2005	2010	2015	2020
A – Low	148,677	159,397	175,388	193,118	213,452
B – Medium	148,677	159,907	176,938	195,965	217,718
C - High	148,677	166,576	188,031	211,357	237,323

1.4 LAND USE

1.4.1 State Land Use

The State Land Use classification is very general with only four land use districts: Urban, Rural, Agriculture and Conservation. The County administers the local land use policy within the Urban, Rural and Agricultural districts, while the State of Hawaii Board of Land and Natural Resources regulates activities within the Conservation district. The County of Hawaii State Land Use acreage by classification is listed in **Table 1-4** and shown in **Figure 1-9**.

Table 1-4: State Land Use Classification

State Land Use	Acreage	% of Total
Urban	54,267	2
Rural	807	<1
Agricultural	1,184,599	46
Conservation	1,338,135	52
Total	2,577,808	100

General Plan, February 2005 (Data as of May 2000)
State of Hawaii, DBEDT, Office of Planning GIS Data
County of Hawaii Planning Department

1.4.2 County General Plan

The County of Hawaii General Plan is the policy document for long-range development, which establishes a balanced land use pattern to guide development based on long-term goals. The General Plan underwent a revision program beginning in 2001; and this program was finalized and adopted in February 2005. The General Plan goals and policies as applicable to the WUDP are listed in **Appendix A**.

The General Plan Land Use Pattern Allocation Guide (LUPAG) Map, indicates the general distribution of various land uses on the island. 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 land use designations and their associated acreage for the island are listed in **Table 1-5**:

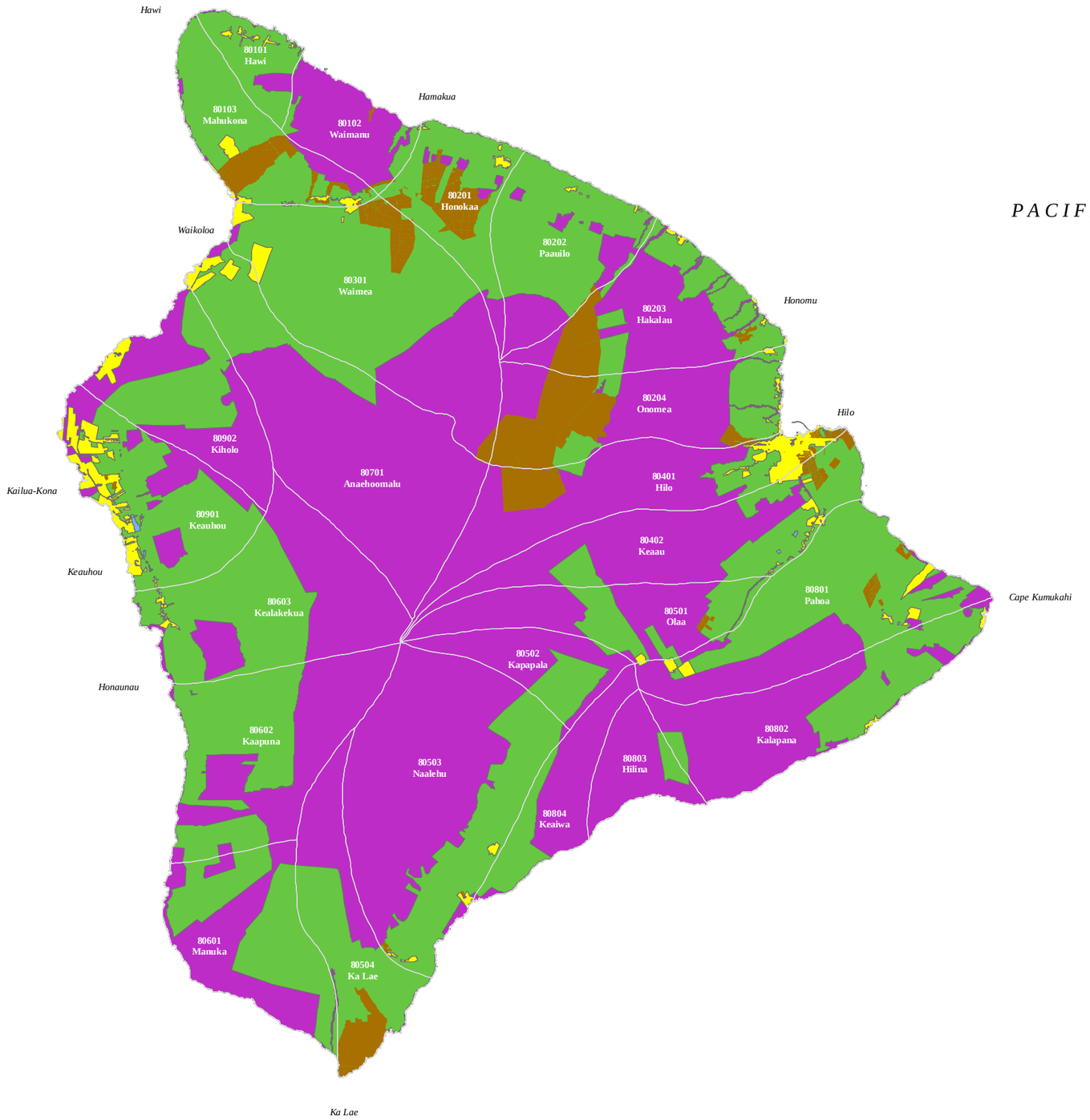
Table 1-5: General Plan Land Use Pattern Allocation Guide

LUPAG	Acreage*	% of Total
High Density Urban	1305	<<1
Medium Density Urban	5,947	<1
Low Density Urban	37,253	1
Industrial	10,977	<1
Important Agricultural Land	386,283	15
Extensive Agriculture	661,382	26
Orchard	1,603	<<1
Rural	47,996	2
Resort/Resort Node	5,676	<1
Open Area	35,696	1
Conservation Area	1,355,021	52
Urban Expansion Area	29,142	1
University Use	1,125	<<1
Total	2,584,274	100

*Planning Department Estimates – GIS Data

The General Plan water utility policies are as follows:

- ***(a)*** *Water system improvements shall correlate with the County's desired land use development pattern.*
- ***(b)*** *All water systems shall be designed and built to Department of Water Supply standards.*
- ***(c)*** *Improve and replace inadequate systems.*
- ***(d)*** *Water sources shall be adequately protected to prevent depletion and contamination from natural and man-made occurrences or events.*
- ***(e)*** *Water system improvements should be first installed in areas that have established needs and characteristics, such as occupied dwellings, agricultural operations and other uses, or in areas adjacent to them if there is need for urban expansion.*
- ***(f)*** *A coordinated effort by County, State and private interests shall be developed to identify sources of additional water supply and be implemented to ensure the development of sufficient quantities of water for existing and future needs of high growth areas and agricultural production.*
- ***(g)*** *The fire prevention systems shall be coordinated with water distribution systems in order to ensure water supplies for fire protection purposes.*
- ***(h)*** *Develop and adopt standards for individual water catchment units.*
- ***(i)*** *Cooperate with the State Department of Health to develop standards and/or guidelines for the construction and use of rainwater catchment systems to minimize the intrusion of any chemical and microbiological contaminants.*
- ***(j)*** *Cooperate with appropriate State and Federal agencies and the private sector to develop, improve and expand agricultural water systems in appropriate areas on the island.*
- ***(k)*** *Promote the use of ground water sources to meet State Department of Health water quality standards.*



Hawaii County

Department of Water Supply

DWS UPDATE TO THE WATER USE AND DEVELOPMENT PLAN

Job No. 2003-818

LEGEND:

State Land Use District Boundaries

- Hawaiian Home Lands
- Agricultural
- Conservation
- Rural
- Urban
- Aquifer System Boundaries

NORTH

0 2 4 8 12

Miles

INDEX MAP - Island of Hawaii

FIGURE 1-9

State Land Use District Boundaries (2004)

FUKUNAGA & ASSOCIATES, INC.
Consulting Engineers
1388 Kapiolani Boulevard, Honolulu, Hawaii 96814

(l) Continue to participate in the United States Geological Survey's exploratory well drilling program.
(m) Seek State and Federal funds to assist in financing projects to bring the County into compliance with the Safe Drinking Water Act.
(n) Develop and adopt a water master plan that will consider water yield, present and future demand, alternative sources of water, guidelines and policies for the issuing of water commitments.
(o) Expand programs to provide for agricultural irrigation water.

1.4.3 County Zoning

The Zoning Code is the County's legal instrument that regulates land development, and implements the General Plan policies; therefore, zoning must be consistent with the General Plan. The zoning districts with associated acreage for the island are listed in **Table 1-6**:

Table 1-6: County Zoning

County Zoning Districts	Acreage *	% of Total
Single-family residential	18,240	<1
Multi-family residential	3,318	<1
Resort	1,213	<1
Commercial	1,994	<1
Industrial	5,684	<1
Industrial-Commercial Mixed	269	<<1
Family Agriculture	332	<<1
Residential Agriculture	3,139	<1
Agriculture	1,243,350	48
Open	345,920	13
Project District	1,744	<1
Agricultural Project District	23	<<1
Lands not zoned (includes Forest Reserves and National Parks)	939,941	37
Total	2,565,167	100

** Estimate – GIS Data, 2004 Zoning*

County Zoning is more detailed than the General Plan, with zoning codes designated for virtually every parcel. The Residential, Resort, Commercial, and Industrial designations specify the required minimum building site area allowed for each unit.

1.4.4 Community Development Plans

The Community Development Plan (CDP) program was mandated by the 2005 General Plan to translate broad goals, objectives, and policies into implementation actions as they apply to specific geographical areas. The CDP are "intended to be a forum for community input into managing growth and coordinating the delivery of government services to the community." The

General Plan states that a CDP is not mandatory for every region on the island; however, the need for a CDP "for a particular area should be assessed considering a number of factors, including how much is public infrastructure challenged by recent or anticipated growth and whether there are significant efforts to change the zoning and land use in the area." Once finalized the CDP would be enacted by the County Council by ordinance.

CDP for North and South Kona, Puna, and North and South Kohala Districts have been initiated. North and South Kona CDP kick-off public information meetings started in September 2005, Puna meetings began in February 2006, North Kohala meetings began in November 2006, and South Kohala meetings began in September 2006. Planning efforts are in progress; final CDP should be considered in future WUDP updates.

1.5 EXISTING WATER RESOURCES

1.5.1 General

Water resources that are utilized currently on the island of Hawaii include ground water, surface water or stream diversions, rainwater catchment and reclaimed wastewater. Water quality varies with the source, and depending on the proposed use, treatment requirements also vary. Water quality protection is covered by the State's *Water Quality Plan*, which describes the Department of Health and other programs which protect existing and potential sources of drinking water. Current available information on water resources is limited, and records on individual rainwater catchment systems and stream diversions is extremely limited.

1.5.2 Ground Water

Ground water is the primary source of supply for the majority of water users on the island, for both county-owned and private water systems. **Figure 1-7,** shown previously, depicts ground water resource areas on the island. **Figure 1-8** shows areas where ground water recovery by wells is feasible. As can be seen from **Figure 1-7**, although there appears to be an abundant supply of basal water underlying the island, the high ground elevations and resulting depth to ground water sources makes it very expensive to recover the basal water in many parts of the island.

1.5.2.1 Wells

"Well" is defined by the Water Code as, "an artificial excavation or opening into the ground, or an artificial enlargement of a natural opening by which ground water is drawn or is or may be used or can be made usable to supply reasonable and beneficial uses within the State." The inventory of the wells or existing ground water sources was obtained from the CWRM database, which was developed with information received from the Well Registration program; and since 1988, has been supplemented with information obtained through the well construction/pump installation permitting process. The database is the best available information and was used to evaluate the existing ground water resources; however, it is not complete and lacks information pertinent to the WUDP for many of the wells, such as installed pump capacity and chloride concentration. The installed pump capacity is critical because it indicates the quantity of water

Figure 1-10: Registered Wells

MAP CURRENTLY NOT AVAILABLE ON-LINE

that may be pumped from each well. The chloride concentration is important because the potability of the water, i.e. potable, brackish or saltwater is not always evident and has varying impacts on the aquifer sustainable yield. The Water Code and Administrative Rules do not require well owners in non-designated water management areas to notify the CWRM of changes in ownership and type of use; however, the CWRM updates its records whenever it becomes aware of such changes. In July 2005, the CWRM began issuing certificates of well construction and pump installation completion that require landowners to notify the CWRM if the well operator or landowner changes.

Based on the CWRM well database and limited additional update information, the island of Hawaii has 355 well sources, which are shown on **Figure 1-10**. The pumping capacity of the well sources reporting pumpage to the CWRM is 274.2 MGD, as listed in **Table 1-7**.

Table 1-7: Summary of Installed Pumps in Existing Well Sources

Category	# of Wells	Capacity* (MGD)	% of Total Capacity
Municipal	97	91.6	33.4
Domestic	30	3.1	1.1
Irrigation	129	45.0	16.4
Industrial	39	102.2	37.3
Others	60	32.3	11.8
Total	355	274.2	100.0

* Capacity based on available installed pump capacity data; many well pump capacities are not listed in the database.

1.5.3 Surface Water

The *Hawaii Stream Assessment* (HSA) lists 376 perennial streams throughout the State. Of the 376 streams, 132 perennial streams are on the island of Hawaii as shown on **Figure 1-11**. The majority of the streams are in the windward areas of higher rainfall, and practically all are on the slopes of Kohala Mountain and Mauna Kea. In other areas, streams are intermittent or non-existent. The HSA notes that the over 100 streams located on the Kohala-Hamakua coast are difficult to access and very little information is available; therefore, the level of confidence of the attributes for most of these streams is low.

Table 1-8 is from the HSA, and lists the available gaging records for the island.

In accordance with the Code, the CWRM must establish and administer instream flow standards on a stream-by-stream basis as necessary to protect public interests. Instream flow standard is defined as, "a quantity or flow of water or depth of water which is required to be present at a specific location in a stream system at certain specified times of the year to protect fishery, wildlife, recreational, aesthetic, scenic, and other beneficial instream uses." According to Section 13-169-46, Hawaii Administrative Rules, "Interim Instream Flow Standard for all streams on Hawaii, as adopted by the commission on water resource management on June 15, 1988, shall be that amount of water flowing in each stream on the effective date of this standard,

Table 1-8: Gaging Records

CODE	Gage is associated with stream with this HSA code	QUAL DATA	USGS assessment of quality of records
NAME	USGS Station Name	DRAIN	Drainage area above gage (sq. mi.)
GAGE #	USGS number of gage station. If all zeros, median and average are calculated flows.	DIV	Diversions per USGS Y Diversion is present above gage N No diversion is present above gage D Gage is on a ditch
ACTIVE	A – Active in January, 1991		
MEDIAN	Flow at gaging station exceeded 50% of time in cubic feet/second (cfs)	TYPE DATA	Type of data collected C Continuous record E Extreme flows only, low and/or peak C-E Converted from continuous to extreme L Low flow P Peak flow new New gage 1988 – continuous record
AVERAGE	Average of yearly mean flow in cubic feet/second (cfs) at gaging station		
YRS REC	Years of record, 19..-19..		

Note: cfs x 0.646 = MGD

CODE	NAME	GAGE #	ACTIVE	MEDIAN	AVERAGE	YRS REC	QUAL DATA	DRAIN	DIV	TYPE DATA
8-1-07	Hapahapai Gulch at Kapaau	752600	A			62-			N	P
8-1-16	East branch Honokane nui Str nr Niulii	747500		21.0		63-69			Y	C
8-1-17	East Honokaa iki intake to Awini Ditch nr Niulii	744000		0.9	1.76	27-72				C
8-1-29	Kukui Str nr Waimanu	742000		0.9		39-66			N	C
8-1-30	Paopao Str nr Waimanu	741000		1.1	3.33	39-52			N	C
8-1-31	Waiaalala Str nr Waimanu	740000		0.6	1.10	39-52			N	C
8-1-32	Punalulu Str nr Waimanu	739000		2.4	6.53	39-52			N	C
8-1-33	Kaimu Str nr Waimanu	738000		3.2	8.68	39-52			N	C
8-1-35	Waiilikahi Str nr Waimanu	737000		4.3	10.00	39-60			N	C
8-1-44	Kawainui Str nr Kamuela	720000	A	4.3	14.80	64-	G	1.58	N	C
8-1-44	Alakahi Str nr Kamuela	725000	A	3.1	6.88	64-	G	0.87	Y	C
8-1-44	Wailoa Str nr Waipio	732200		51.0	75	01-69			Y	C
8-1-44	Kawaiki Str nr Kamuela	720300	A	1.7	4.27	68-	G	1.45	N	C
8-1-55	Honokaia Gulch tributary nr Honokaa	717950	A			62-			N	P
8-1-60	Ahualoa Gulch at Honokaa	717920	A			62-			N	P
8-1-87	Keehia Gulch nr Ookala	717850	A			62-			N	P
8-2-06	Manowaiopae Str nr Laupahoehoe	717820		3.4	8.42	65-71	G	1.04	Y	C
8-2-16	Pahokupuka Str nr Papaaloa	717800	A	7.7	27.10	62-	G	2.76	N	C-P
8-2-37	Kapehu Str nr Pepeekeo	717650	A			62-			N	P
8-2-37	Kapehu Str at Piihonua nr Hilo	709000			50.90	28-37		4.84	N	
8-2-39	Alia Str nr Hilo	717600	A	12.0		62-			N	C-P
8-2-47	Kalaoa Mauka Str nr Hilo	717400	A			62-			N	new
8-2-56	Honolii Str nr Hilo	716000		13.0	52.00	24-32			N	C
8-2-56	Honolii Str nr Papaikou	717000	A	38.0	125.00	11-	F	11.60	N	C
8-2-60	Wailuku R nr Pua Akala	701700				64-65			N	C
8-2-60	Wailuku R at Hilo	713000	A	160.0	386.00	77-	G	256.00	Y	C
8-2-60	Wailuku R nr Humuula	701750			2.82	65-	G	34.80	N	C
8-2-60	Wailuku R nr Kaumana	701800		2.9	27.60	66-	G	43.40	N	C
8-2-60	Wailuku R at Pukamaui nr Hilo	703000		26.7	93.30	23-40			Y	C

CODE	NAME	GAGE #	ACTIVE	MEDIAN	AVERAGE	YRS REC	QUAL DATA	DRAIN	DIV	TYPE DATA
8-2-60	Wailuku R nr Piihonua	704000	A	83.8	279.00	28-	F	230.00	Y	C
8-2-61	Waiakea Str nr Mountain View	700000	A	8.9	11.60	30-	G	17.40	N	C
8-2-61	Wailoa R at Hilo	701300	A			67-			Y	P
8-2-61	Wailoa R nr Hilo	701200				57-67			Y	C
8-3-01	Hilea Gulch tributary nr Honuapo	764000	A	1.2	7.47	66-	F	9.17	N	C
8-3-01	Hilea Gulch tributary no. 2 nr Honuapo	765000			3.00	66-	G	1.86	N	C
8-4-01	Kiilae Str nr Honaunau	759800			0.21	58-	G	0.67	N	C
8-4-02	Right branch Waiaha Str nr Holualoa	759200			0.31	60-	G	1.89	N	C
8-4-02	Waiaha Str nr Holualoa	759500				57-68			Y	C
8-4-02	Waiaha Str at Luawai nr Holualoa	759300	A			60-			Y	C-P
8-5-03	Waikoloa Str nr Kamuela	757000		4.0	7.21	47-71	G	0.78	N	C
8-5-03	Waikoloa at marine dam nr Kamuela	758000	A	4.2	9.00	47-	G	1.18	Y	C
8-5-03	Kohakohau Str nr Kamuela	756000	A	1.9	8.49	56-	G	2.51	Y	C
8-5-03	Hauani Gulch nr Kamuela	759000	A		1.61	56-	G	0.47	Y	C

Figure 1-11: Surface Water Resources

MAP CURRENTLY NOT AVAILABLE ON-LINE

and as that flow may naturally vary throughout the year and from year to year without further amounts of water being diverted offstream through new or expanded diversions, and under the stream conditions existing on the effective date of the standard, except as may be modified [by the commission]."

1.5.4 Rainwater Catchment

Rainwater catchment is the collection of rainwater from a roof or other surface before it reaches the ground. Rainwater is typically a pure and free source of water, and is dependent upon climate. As stated earlier, the island of Hawaii experienced drought conditions from 1998 through 2003. According to the *Kau and South Kona Water Master Plan*, rainfall in the Kau and South Kona region has decreased since 1983 when Kilauea Volcano began erupting. Accordingly, rainfall catchment systems were impacted significantly, and continue to be impacted by the decrease in rainfall. The volcanic activity also impacts rainwater quality in the vicinity of Kilauea, particularly due to the emission of sulfur dioxide which can combine with water forming sulfuric acid. Acid rain has resulted in pH levels of water in catchment tanks as low as pH 4 in the Kau and South Kona areas. The pH of pure water is pH 7.

1.5.5 Reclaimed Wastewater

Reclaimed wastewater potentially is a valuable resource, especially for irrigation purposes. Based on information from the Department of Health, Wastewater Branch, **Table 1-9** lists existing reclaimed water applications, classifications and capacities throughout the island.

Table 1-9: Reclaimed Wastewater Resources

Wastewater Reclamation Facility (WWRF)	Reclaimed Water Classification	WWRF Capacity (MGD)	Current Reuse Amount (MGD)	Irrigation Application
Heeia	R-2	1.8	0.5	Kona and Alii Country Club Golf Course
Waikoloa Beach Resort	R-2	1.3	0.5	Waikoloa Beach Resort Golf Course
Maunalani	R-2	0.75	0.25	Nursery and sod farm
South Kohala Resort	R-2	0.6	0.27	Mauna Kea Golf Course
Kealakehe	R-2	1.3	0.06	Swing Zone Driving Range
Kona International Airport	R-1	0.14	0.03	Landscape
Waimea	R-3	0.1	0.045	Parker Ranch pasture
Punaluu	R-2	0.125	0.012	Sea Mountain Golf Course

Sources: Department of Health, Wastewater Branch
Water Reuse Projects on Hawaii – List as of January 2005,
<http://www.hwea.org/watreuse/wrhawaii.htm>

1.6 EXISTING WATER USE

1.6.1 General

The CWRM staff is working towards establishing and drafting water use categories based on water system purveyance and primary use of the system for the purposes of water use permitting and reporting. Upon finalization of the categories, the CWRM staff will propose incorporation of the categories in the update of the Framework. Water use in this update report is categorized in accordance with the list and definitions to the extent possible. Future WUDP Updates should conform to the finalized water use categories to the extent possible.

- Domestic (Individual Household)
- Industrial (Fire Protection, Mining, Thermoelectric Cooling, Geothermal)
- Irrigation (Golf Course, Hotel, Landscape, Parks, School, Dust Control)
- Agriculture (Aquatic Plants & Animals, Crops/Processing, Livestock & Pasture, Ornamental/Nursery)
- Military
- Municipal (County, State, Private Public Water Systems [as defined by DOH])

Determination of existing water use is difficult due to the lack of detail in available metered water data, and is therefore based on the best available information. DWS meters customer water use and therefore has the most complete database on DWS purveyed water use. DWS metered water data from November 2004 to October 2005 are used in this update. The CWRM requires a monthly report of water use from wells and stream diversions, with exceptions discussed in detail in Section 1.6.8.1. CWRM data includes only that which is reported and therefore is not complete. However, it is the best available data, and data from the same time period, November 2004 through October 2005, also are used. In addition to the data obtained from DWS and the CWRM, Federal and State water system managers and private water system owners were queried on the existing populations served and water production capabilities of their systems, as well as future projections. Disclosed information is incorporated.

1.6.2 Domestic Use

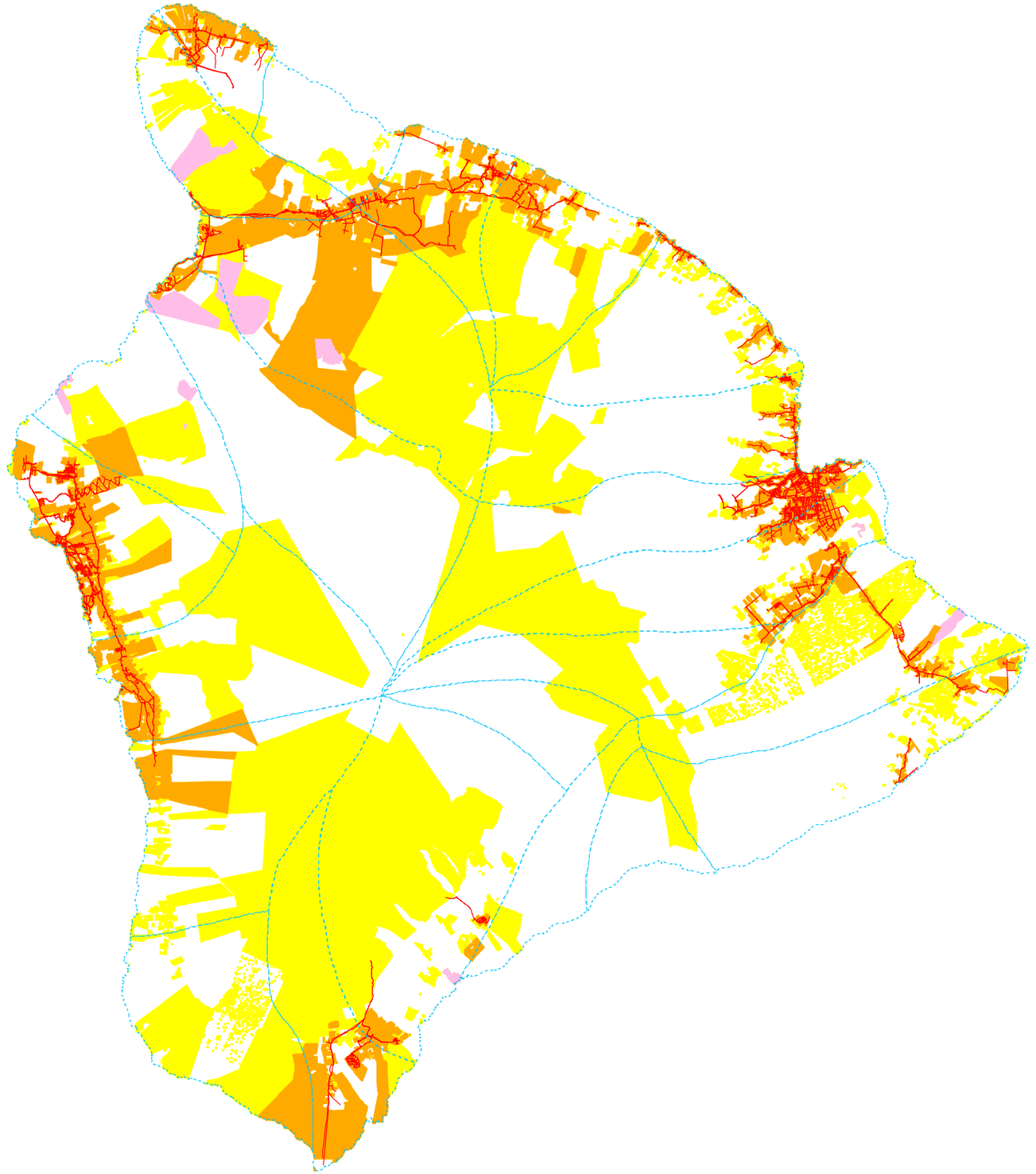
Domestic use is potable and non-potable water use by individual households. There is no government agency that oversees private individual systems. The owner is responsible for the water quantity, quality and maintenance of the system. Individual rainwater catchment systems and private wells for individual domestic use are in this category. Records and data on individual rainwater catchment systems are not readily available. Water use by individual catchment systems is determined by deduction, i.e. if a developed parcel is not served by DWS or other water system of record, then a catchment system is assumed. Developed areas possibly served by catchment systems are shown on **Figure 1-12**. Information on private wells includes details collected through the CWRM well construction/pump installation permitting process. Users are required to measure and report monthly usage in excess of 50,000 gallons to the CWRM.

Hawaii County

Department of Water Supply

DWS UPDATE TO THE WATER USE AND DEVELOPMENT PLAN

Job No. 2003-818



LEGEND:

- DWS Water System Service Area
- Possible Catchment Area (Building Value > $10000)
- Private Water System Service Area
- Aquifer Systems
- DWS Water System

NORTH

0 2 4 8 12

Miles

INDEX MAP - Island of Hawaii

FIGURE 1-12

Water System Service Area Map

FUKUNAGA & ASSOCIATES, INC.
Consulting Engineers
1388 Kapiolani Boulevard, Honolulu, Hawaii 96814

1.6.3 Industrial Use

Industrial use can be potable or non-potable water use for fire protection, mining, thermoelectric cooling, and geothermal uses. Most of the industrial use on the island is for thermoelectric cooling which can use non-potable water; therefore, it is assumed that industrial use is categorized as non-potable water use. Hawaiian Electric Light Company, Inc. (HELCO) reports pumpage from their wells to CWRM; therefore an estimate can be made on thermoelectric cooling by HELCO.

1.6.4 Irrigation Use

The irrigation use category as defined by the CWRM consists of non-potable water uses including irrigation for golf course, hotel, landscape, parks, school, and dust control. Irrigation use is determined from CWRM well pumpage data for irrigation wells.

1.6.5 Agricultural Use

Agricultural use includes water use for aquatic plants and animals, crops/processing, livestock and pasture, and ornamental/nursery, and this does not include water supplied by rainfall. Aquaculture and some agricultural uses are served by municipal systems.

There is great potential for non-potable agricultural irrigation systems as water sources. The major systems include the Waimea Irrigation System, Lower Hamakua Ditch System, Kohala Ditch System, and Kehena Ditch System. However, with the demise of the sugarcane industry in the late 1990's, many of the systems were abandoned and left to deteriorate. Current information on the condition of the systems is limited and typically is obtained by field verification. The current AWUDP is limited in scope and only discusses two of the systems which are owned and operated by the State of Hawaii, Department of Agriculture (DOA), Agricultural Resource Management Division (ARMD), the Waimea Irrigation System and Lower Hamakua Ditch System (Honokaa-Paauilo Irrigation System). According to the AWUDP, most irrigation systems built by the sugarcane and pineapple industries in Hawaii did not have any metering or monitoring of water use. As the industry shifts to diversified agriculture, the lack of water use data continues. However, the Lalamilo section of the Waimea Irrigation System is one of three DOA irrigation systems in the State with years of metered monthly diversified agriculture water use records, as well as acreage served.

The Waimea Irrigation System, Lower Hamakua Ditch System, and Kohala Ditch System are known to have sustained significant damage from the October 15, 2006 earthquake. The impacts of this recent event are not fully realized and are not reflected in this report. However, the earthquake has clearly demonstrated the vulnerability of the ditch systems, and the need for contingency plans to mitigate the impact of another event.

The United States Department of Agriculture, National Agricultural Statistics Service (USDA, NASS) collected and published data for the *2002 Census of Agriculture*. This was supplemented by the *2003 Farm and Ranch Irrigation Survey*. The census indicates that the County of Hawaii has 908 farms defined as, "any place from which $1,000 or more of agricultural products were produced and sold, or normally would have been sold, during the census year;" and also indicates that 9,041 acres of farmland are irrigated (2002 Census, Table 1). The 2003 Survey, Table 11, published the *Estimated Quantity of Water Applied by Source or Supplier: 2003 and 1998, for the State of Hawaii*. A more detailed breakdown of this data was requested from the USDA, NASS; however, the additional data obtained specific to the County of Hawaii indicates 498 farms and 6,284 acres irrigated with 6,106 acre-feet water (or 5.45 mgd). USDA, NASS stated that the discrepancy in the information is due to a difference in collecting and summarizing the data. Due to the discrepancy and uncertain accuracy and completeness of the survey data, and because more detailed breakdown of the data within the County was not available, only the *2002 Census of Agriculture* data are used.

Current agricultural water use is extremely difficult to determine due to the absence of comprehensive, island-wide data. Defining existing agricultural water demands is the objective of the AWUDP, which is a major effort; hence, the AWUDP is being developed in phases. The WUDP uses the best available information; therefore, agricultural water use considers lands classified as Important Agricultural Land in the General Plan and the *2002 Census of Agriculture* data. Important Agricultural Lands are defined as "those with better potential for sustained high agricultural yields because of soil type, climate, topography, or other factors" and have potential sources of irrigation within reasonable proximity if needed. Therefore, Important Agricultural Land is used as the primary basis for agricultural water demand. This is discussed further in detail in **Chapter 2, Technical Approach**. It is assumed that the 9,041 acres of farmland currently irrigated on the island are classified as Important Agricultural Land. Accordingly, the irrigated farmland is divided among each aquifer sector area based on the proportion of the island's Important Agricultural Land within each sector area.

1.6.6 Military Use

There are two potable water systems serving military use on the island. The Kilauea Military Camp, located in the Volcano National Park, relies on an extensive catchment and storage system. The Pohakuloa Training Area is in the saddle area between the slopes of Mauna Kea, Mauna Loa, and Hualalai, and is served by the State owned Mauna Kea State Park water system.

1.6.7 Municipal Use

Municipal use includes County, State and Federal water use served by potable water systems, and private public water systems, as defined by the State Department of Health (DOH). DOH defines "public water system" as "a system which provides water for human consumption, through pipes or other constructed conveyances if the system has at least fifteen service connections or regularly serves an average of at least twenty-five individuals daily at least sixty days out of the year." Refer to **Figure 1-12**, shown previously, for the general service area of the public water systems on the island. Municipal use is subcategorized into the other CWRM uses,

domestic, industrial, irrigation, agriculture and military uses, as data is available. DWS meter data is the most detailed, but cannot be precisely subcategorized for each use. Domestic use is based on residential meter data, and is the best defined. Industrial, irrigation and agriculture use can be identified to an extent. This leaves a considerable portion of water use that cannot be subcategorized because it is a mix of the subcategories for such users as schools, hotels, government facilities, etc., and therefore are indicated as "other municipal." These water systems are listed in **Table 1-10**.

Table 1-10: Water Systems

NAME	OWNER	POP**	SVC-CN*	SOURCE
Ninole	DWS Hawaii	146	51	Ground
Kalapana	DWS Hawaii	169	59	Ground
Makapala-Niulii	DWS Hawaii	226	79	Ground
Ookala	DWS Hawaii	229	80	Ground
Hakalau	DWS Hawaii	272	95	Ground
Kapoho	DWS Hawaii	283	99	Ground
Kukuihaele	DWS Hawaii	455	159	Ground
Halaula	DWS Hawaii	526	184	Ground
Honomu	DWS Hawaii	621	217	Ground
Paauilo	DWS Hawaii	704	246	Ground
Laupahoehoe	DWS Hawaii	1,150	402	Ground
Pahala	DWS Hawaii	1,316	460	Ground
Pepeeko	DWS Hawaii	1,359	475	Ground
Lalamilo	DWS Hawaii	1,499	524	Ground
Pahoa	DWS Hawaii	1,928	674	Ground
Papaikou	DWS Hawaii	2,219	776	Ground
Waiohinu-Naalehu	DWS Hawaii	2,225	778	Ground
South Kona	DWS Hawaii	2,774	970	Ground
Haina	DWS Hawaii	3,312	1,158	Ground
Hawi	DWS Hawaii	3,764	1,316	Ground
Olaa-Mountain View	DWS Hawaii	5,686	1,988	Ground
Waimea	DWS Hawaii	8,872	3,102	Surface
North Kona	DWS Hawaii	25,666	8,974	Ground
Hilo	DWS Hawaii	37,563	13,134	Ground
Mauna Kea State Park	DLNR State Parks	25	13	Surface
Kulani Correctional Facility	Department of Public Safety	281	16	Catchment
Kilauea Military Camp***	U.S. Army	220	85	Catchment
Hawaii Volcanoes National Park	U.S. Department of Interior	3,374	76	Catchment

Table 1-10: Water Systems (continued)

NAME	OWNER	POP**	SVC-CN*	SOURCE
Waikii Ranch	Waikii Ranch Homeowners	58	94	Ground
Napuu Water, Inc.	Napuu Water, Inc.	330	147	Ground
Mauna Loa Macadamia Nut	Mauna Loa Macadamia Nut	100	4	Ground
Punaluu	S.M. Investment Partners	200	21	Ground
Kukio Utility Company	WB Kukio Resorts, LLC	260	15	Ground
Kohala Ranch Water Co.	Kohala Ranch Water Co., LLC	575	250	Ground
Kaupulehu	Kaupulehu Water Co.	1,056	9	Ground
Hawaiian Shores	Hawaiian Shores Associates	1,132	283	Ground
Hawaiian Beaches	Miller & Lieb Water Co.	3,040	950	Ground
Waikoloa	West Hawaii Water Co.	8,500	1,436	Ground

*SVC-CN – number of service connections
**POP – population serviced
***Included under "Military Use"
Source: State Department of Health, Safe Drinking Water Branch

1.6.7.1 County Water Systems

The Hawaii County Water Department owns and operates 24 separate systems on the island. These systems are dispersed widely around the island and vary in size from the largest in Hilo with 13,134 services (in 2004), to the smallest in Ninole with 51 services. Several of the systems are interconnected to optimize use of resources. DWS metering data provides the most detailed water use for the island.

From November 2004 through October 2005, the systems accounted for 25.3 mgd. Descriptions of the individual water systems are covered in the pertinent aquifer sector sections of this plan.

1.6.7.2 State Water Systems

The State owns two public water systems, the Mauna Kea State Park Water System and the Kulani Correctional Center Water System. The Mauna Kea State Park WS is located on the southwestern side of Mauna Kea on Saddle Road. By agreement between the State of Hawaii Department of Land and Natural Resources (DLNR) and the U.S. Army Pohakuloa Training Area (PTA), PTA is served by the State owned Mauna Kea State Park WS in exchange for maintenance of the water system sources and transmission lines. The source for the water system is from springs. The Kulani Correctional Center Water System is located in Kulani, off Stainback Highway. The system is supplied by rainwater catchment.

1.6.7.3 Federal Water Systems

There is one Federal water system owned by the Department of the Interior serving the Hawaii Volcanoes National Park. The system includes extensive catchment and storage facilities.

1.6.7.4 Private Public Water Systems

There are ten private public water systems on the island of Hawaii. The largest private water purveyor on the island is the Waikoloa water system which serves the resort, commercial and residential properties in the Waikoloa Resort. There are several small systems serving subdivisions in west Hawaii. There are two small private systems that provide water for domestic use to the Hawaiian Shores and Hawaiian Beaches subdivisions in Puna. Mauna Loa Macadamia Nut has a water system south of Hilo, and there is one private system in Punaluu which serves a golf course, commercial, and residential properties. Some Private Public Water System water consumption data is available, but is typically difficult to obtain and not categorized by use. Therefore, water use for Private Public Water Systems is based primarily on well pumpage reported to CWRM.

1.6.8 Water Use by Resource

Existing water resources include ground water, surface water, rainwater, and reclaimed wastewater. Most of the available water consumption data are categorized by the type of resource. As discussed previously, ground water and surface water are described and identified by hydrologic unit classification and coding systems. Use of water resources from a hydrologic unit are not limited to use within that hydrologic unit, and may be used within other hydrologic units when water systems span more than one hydrologic unit.

1.6.8.1 Ground Water

The CWRM has data on well pumpage, which only includes wells for which data are reported. Consequently, this information is not complete in all areas. The following cases describe uses of water which are exempt from the requirements for measuring and reporting on a monthly basis (unless otherwise determined by the CWRM):

a) individual end uses of water on multi-user distribution systems where the end user does not control or operate the water supply source(s) to the system.
b) water uses from individual systems for average annual uses less than 1,700 gpd.
c) passive agricultural consumption, such as when crops are planted in or adjacent to springs and natural wetland areas.
d) livestock drinking from dug wells or stream channels;

The following cases allow modification of the monthly reporting requirement, to reporting on a quarterly, semi-annual, or annual basis:

a) water uses from individual systems for average annual uses equal to or greater than 1,700 gpd and less than 161,000 gpd.
b) salt water or brackish water sources
c) surface water sources

Water uses from gravity-flow, open ditch stream diversion works which are not already being measured and are not in designated surface water management areas are deferred until the CWRM adopts reasonable guidelines for such systems.

Many of the tunnel and spring sources may be ground water directly under the influence of surface water (GWUDI). DOH takes samples and performs particulate analysis to determine if these sources are GWUDI. DOH officials believe that most of the County springs are GWUDI; however, the only three that have been designated are the Alili Tunnel (DWS Pahala WS), the Kukuihaele Spring (DWS Kukuihaele WS), and the Olaa Flume (formerly used by the DWS Hilo WS, currently not in use). GWUDI is subject to the Surface Water Treatment Rule; however, DOH has granted the two designated GWUDI currently in use "interim disinfection requirement," which requires higher disinfection. It is anticipated that DWS will be replacing GWUDI sources or provide additional treatment

The CWRM database is the best available information and was used to evaluate the existing ground water resources.

Table 1-11 summarizes the current production, potential production (16 and 24 hour operation), sustainable yield (SY), and percentage of SY for the various productions calculated. Current production is represented by the highest 12-month moving average (MAV) calculated from the actual pumpage data reported for each aquifer system/sector area. Potential well production is based on installed pump capacities, and calculated for both 16 hours of operation a day (ideal operating condition) and 24 hours of operation a day. Data is based on pumpage data from January 2003 through October 2005 reported to CWRM. Many wells in use do not report to CWRM or are not required to report. Refer to **Appendix B** for the CWRM well database.

The CWRM well database and sustainable yield information indicate that under current installed conditions, only the West Mauna Kea Aquifer Sector Area (ASEA), and the Kiholo Aquifer System Area (ASYA) (within Hualalai ASEA) have the potential of exceeding the sustainable yield if the wells are operated 24 hours per day; all other sector areas have sufficient sustainable yield under current installed conditions. Based on the 12-month MAV, actual water withdrawn from the West Mauna Kea ASEA is 38.04 % of SY and water withdrawn from the Kiholo ASYA is 22.56% of SY, or 27.77% of SY for the Hualalai ASEA. For the other sector areas, the 12-month MAV is well under the SY.

Table 1-11: Well Production and Sustainable Yield

Aq Code	Sys Code	Sector Area	System Area	High 12-Month MAV (MGD)	Potential 16 -Hour Production (MGD)	Potential 24-Hour Production (MGD)	SY (MGD)	High 12-Month MAV SY (%)	Potential 16-Hour Production SY (%)	Potential 24-Hour Production SY (%)
801		**Kohala**		**1.44**	**17.66**	**26.49**	**154**	**0.94**	**11.47**	**17.20**
	80101		Hawi	0.65	15.23	22.84	27	2.41	56.40	84.59
	80102		Waimanu	0.10	0.96	1.44	110	0.09	0.87	1.31
	80103		Mahukona	0.69	1.47	2.21	17	4.06	8.67	13.00
802		**E. Mauna Kea**		**2.06**	**23.86**	**35.79**	**388**	**0.53**	**6.15**	**9.22**
	80201		Honkaa	1.41	2.31	3.46	31	4.55	7.44	11.16
	80202		Paauilo	0.14	4.51	6.77	60	0.23	7.52	11.28
	80203		Hakalau	0.13	16.17	24.25	150	0.09	10.78	16.17
	80204		Onomea	0.38	0.87	1.31	147	0.26	0.59	0.89
803		**W. Mauna Kea**		**9.13**	**17.56**	**26.34**	**24**	**38.04**	**73.17**	**109.75**
	80301		Waimea	9.13	17.56	26.34	24	38.04	73.17	109.75
804		**N.E. Mauna Loa**		**59.05**	**62.95**	**94.43**	**740**	**7.98**	**8.51**	**12.76**
	80401		Hilo	42.78	42.15	63.22	347	12.33	12.15	18.22
	80402		Keaau	16.27	20.81	31.21	393	4.14	5.29	7.94
805		**S.E. Mauna Loa**		**0.22**	**5.17**	**7.75**	**291**	**0.08**	**1.78**	**2.66**
	80501		Olaa	0.00	0.00	0.00	124	0.00	0.00	0.00
	80502		Kapapala	0.00	0.00	0.00	19	0.00	0.00	0.00
	80503		Naalehu	0.22	5.17	7.75	117	0.19	4.42	6.62
	80504		Ka Lae	0.00	0.00	0.00	31	0.00	0.00	0.00
806		**S.W. Mauna Loa**		**2.38**	**6.92**	**10.38**	**130**	**1.83**	**5.32**	**7.98**
	80601		Manuka	0.16	0.79	1.18	42	0.38	1.87	2.81
	80602		Kaapuna	0.01	0.40	0.60	50	0.02	0.80	1.20
	80603		Kealakekua	2.17	5.73	8.60	38	5.71	15.09	22.63
807		**N.W. Mauna Loa**		**4.13**	**10.61**	**15.91**	**30**	**13.77**	**35.36**	**53.03**
	80701		Anaehoomalu	4.13	10.61	15.91	30	13.77	35.36	53.03

Aq Code	Sys Code	Sector Area	System Area	High 12-Month MAV (MGD)	Potential 16 -Hour Production (MGD)	Potential 24-Hour Production (MGD)	SY (MGD)	High 12-Month MAV SY (%)	Potential 16-Hour Production SY (%)	Potential 24-Hour Production SY (%)
808		**Kilauea**		**1.53**	**5.53**	**8.29**	**618**	**0.25**	**0.89**	**1.34**
	80801		Pahoa	1.47	3.53	5.30	435	0.34	0.81	1.22
	80802		Kalapana	0.06	1.99	2.99	157	0.04	1.27	1.90
	80803		Hilina	0.00	0.00	0.00	9	0.00	0.00	0.00
	80804		Keaiwa	0.00	0.00	0.00	17	0.00	0.00	0.00
809		**Hualalai**		**15.55**	**32.79**	**49.18**	**56**	**27.77**	**58.55**	**87.82**
	80901		Keauhou	11.49	16.58	24.87	38	30.24	43.63	65.45
	80902		Kiholo	4.06	16.21	24.31	18	22.56	90.04	135.06
		Island of Hawaii	**Total**	**95.49**	**183.04**	**274.56**	**2431**	**3.93**	**7.53**	**11.29**

1.6.8.2 Surface Water

1.6.8.2.1 Stream Diversions

The inventory of the existing stream diversions was obtained from the CWRM database. The CWRM database has 197 declared stream diversions and 5 permitted stream diversions. **Figure 1-11** shown previously displays the locations and distribution.

In the past, the sugar plantations built several major ditch and flume systems to utilize surface water sources. According to the *Water Resource Protection Plan* with data based on information prior to 1990, approximately 76 mgd were diverted from streams primarily for irrigation and hydroelectric power serving the sugar industry. **Table 1-12** lists the major stream diversions or ditch systems and corresponding flows.

Table 1-12: Major Stream Diversions

Major Stream Diversion (Ditch System)	Flow (MGD)
Total	**76**
Kehena Ditch	7
Kohala Ditch	27
Upper Hamakua Ditch	10
Lower Hamakua Ditch	32

The sugar industry has declined steadily since 1983. The last sugarcane harvest on the island was in 1997, and many irrigation systems were abandoned and left to deteriorate. According to data published in the *State of Hawaii Data Book 2003, Table 5.22 – Fresh Water Use, By Type, By Counties: 2000 (Data compiled by Hawaii State Department of Business, Economic Development and Tourism from County of Hawaii Department of Water Supply),* surface water use in 2000 was 8.86 mgd. Surface water remains a significant potential source for irrigation and industrial uses.

1.6.8.2.2 Instream Use

Instream use is defined by the Code as, "beneficial uses of stream water for significant purposes which are located in the stream and which are achieved by leaving the water in the stream. Instream uses include, but are not limited to:

(1) Maintenance of fish and wildlife habitats;
(2) Outdoor recreational activities;
(3) Maintenance of ecosystems such as estuaries, wetlands, and stream vegetation;
(4) Aesthetic values such as waterfalls and scenic waterways;
(5) Navigation;
(6) Instream hydropower generation;
(7) Maintenance of water quality;

(8) The conveyance of irrigation and domestic water supplies to downstream points of diversion; and
(9) The protection of traditional and customary Hawaiian rights."

1.6.8.3 Rainwater Catchment

Rainwater catchment systems are typically located outside of the County water system service areas. There are three rainwater catchment public water systems regulated by the Department of Health, Safe Drinking Water Branch. These serve Kilauea Military Camp, Hawaii Volcanoes National Park and Kulani Correctional Facility. There is no government agency that oversees private individual systems. The owner is responsible for the water quantity, quality and maintenance of the system. There are no records or data on these systems. Therefore, information reflected in this report is based on deductions; i.e. if a developed parcel is not served by DWS or other water system of record, then a catchment system is assumed. Individual rainwater catchment systems are primarily in the Puna, Kau and Hamakua Districts.

Where a large number of private individual water catchments exist, the Civil Defense has established emergency spigots from the County water system to supplement those residents' needs during droughts. If the County decides to extend water service to these areas, then more water sources will be needed.

1.6.8.4 Reclaimed Wastewater

Reclaimed wastewater information was obtained from the Department of Health, Wastewater Branch, as previously listed in **Table 1-9**. Approximately 1.7 million gallons of reclaimed wastewater are used per day on the island, primarily for irrigation of agriculture, golf courses and landscaping.