RECEIVED
2019 MAR 22 AM 9:09
OFFICE OF THE MAYOR

MICHAEL P. VICTORINO
Mayor

JEFFREY T. PEARSON, P.E.
Director

HELENE KAU
Deputy Director

DEPARTMENT OF WATER SUPPLY
COUNTY OF MAUI
200 SOUTH HIGH STREET
WAILUKU, MAUI, HAWAI'I 96793
www.mauiwater.org

RECEIVED
2019 MAR 22 PM 2:39
OFFICE OF THE COUNTY CLERK

March 22, 2019

APPROVED FOR TRANSMITTAL

Michael P Victorino 3/22/19
Mayor Date

Honorable Michael P. Victorino
Mayor, County of Maui
200 S. High Street
Wailuku, Hi 96793

For Transmittal to:

Honorable Kelly T. King, Chair
Maui County Council
200 S. High Street
Wailuku, HI 96793

SUBJECT: **DRAFT MAUI ISLAND WATER USE AND DEVELOPMENT PLAN**

Attached please find a bill for an ordinance adopting an update to the Water Use and Development Plan (WUDP) for Maui Island. The final draft WUDP is attached as Exhibit A. The State Commission on Water Resource Management (CWRM) oversees the development of this plan under the State of Hawaii Water Code. Under the Maui County Code, the plan serves as the primary guide to the council, the department and all other agencies of the County:

1. In approving or recommending to other agencies the use or commitment of the water resources in the County; and
2. In using public funds to develop water resources to meet existing or projected future demands on the public water system as set forth in the plan.

We initiated a rigorous public process to update this plan in 2015. Our goal is to address the community's concerns and meet their planning objectives to the extent possible while ensuring long term sustainability in the face of population growth, climate change and other challenges. Major changes that impact water resources occurred throughout the development of this plan, including cessation of sugarcane cultivation, reopening of contested cases, and amendments to Instream Flow Standards. The decision and order issued June 20, 2018 for East Maui Streams Contested Case was incorporated into this update. On August 10, 2018, the Department of Water Supply submitted the final chapter of the WUDP Update to the Board of Water Supply and posted on line for public review. No data adjustments were made to account for events potentially impacting water resources that occurred after submittal of this draft to the Board of Water Supply.

COUNTY COMMUNICATION NO. 19-162

Per Maui County Code Chapter 14.02.040, the Board held public hearings on the proposed update and transmitted their findings and recommendations to the department on January 22, 2019, attached. The department has addressed the issues defined by the Board and made the revisions recommended by the Board and by the CWRM staff.

Per Maui County Code Chapter 14.02.040 the council shall pass the proposed update by ordinance within one hundred eighty days of receipt, unless extended by resolution. The plan is subsequently approved by CWRM and incorporated into the Hawaii Water Plan.

Thank you for your attention to this matter. Department staff will be available throughout the review of this plan update. Electronic copies are provided for your convenience. Should you have any questions, please contact me at Ext. 7834.

Sincerely,

JEFFREY T. PEARSON, P.E.
Director

Enclosures

ORDINANCE NO. ___________

BILL NO.________(2019)

A BILL FOR AN ORDINANCE ADOPTING AN UPDATE TO THE WATER USE AND DEVELOPMENT PLAN FOR THE ISLAND OF MAUI

BE IT ORDAINED BY THE PEOPLE OF THE COUNTY OF MAUI:

SECTION 1. Pursuant to sections 14.02.020 and 14.02.040 (3), Maui County Code, the document entitled "Maui Island Water Use and Development Plan Draft", dated March 19, 2019, which is attached hereto and made a part hereof as Exhibit "A", is hereby adopted as an update to the County of Maui's water use and development plan.

SECTION 2. This ordinance shall take effect upon its approval.

APPROVED AS TO FORM
AND LEGALITY:

____
EDWARD S. KUSHI, JR.
First Deputy Corporation Counsel
County of Maui

Maui Island Water Use and Development Plan

DRAFT

MARCH 2019

OLA NĀ MEA A PAU I KA WAI

By Water All Things Find Life

Prepared By:

Maui County Department of Water Supply

ACKNOWLEDGEMENTS

Michael P. Victorino, Mayor
Sandy Baz, Managing Director
Jeffrey T. Pearson, P.E., Water Director

DEPARTMENT OF WATER SUPPLY, WATER RESOURCES & PLANNING DIVISION
Eva Blumenstein, Planning Program Manager
Pam Townsend, Water Resource Planner
B. Alex Buttaro, Water Resource Planner
Alexander de Roode, Water Resource Planner
Lori Delbello, Secretary

Table of Contents

LIST OF TABLES

SECTION 14 WAILUKU ASEA LIST OF TABLES

SECTION 14 WAILUKU ASEA LIST OF TABLES

SECTION 15 CENTRAL ASEA LIST OF TABLES

SECTION 16 KO'OLAU ASEA LIST OF TABLES

SECTION 16 KO'OLAU ASEA LIST OF TABLES

SECTION 16 KO'OLAU ASEA LIST OF TABLES

SECTION 17 HANA ASEA LIST OF TABLES

SECTION 17 HANA ASEA LIST OF TABLES

SECTION 18 KAHIKINUI ASEA LIST OF TABLES

SECTION 18 KAHIKINUI ASEA LIST OF TABLES

SECTION 19 LAHAINA ASEA LIST OF TABLES

List of Figures

	SECTION 1 - 13 LIST OF FIGURES
FIGURE #	**FIGURE TITLE**
Figure 6–6	Maui Agricultural Water Resources
Figure 7–1	Urban Growth Boundary and Low Intensity Zoning Districts
Figure 7-2	Large Landowners, 2013
Figure 8–1	General Location of Public and Private Public Water Systems
Figure 8–2	MDWS Districts, Community Plan Boundaries, and Aquifer Sector Areas
Figure 8-3	MDWS Consumption by Billing Class, Maui Island 2014 (mgd)
Figure 8-4	MDWS Consumption by CWRM Categories, Maui Island 2014 (mgd)
Figure 8-5	MDWS Consumption by Aquifer Sector Area, Maui Island 2014 (mgd)
Figure 8-6	MDWS Consumption by Community Plan Area, Maui Island 2014 (mgd)
Figure 8-7	MDWS Production, Maui Island, 2014 Daily Average
Figure 8-8	MDWS Production by Resource and District 2014 (mgd)
Figure 8-9	MDWS 10-Year Historic Production (mgd)
Figure 8-10	Location of Registered Wells on Maui, 2014
Figure 8–11	Plantation Irrigation Ditch Systems
Figure 8-12	Patterns of Water Transfers for Municipal Use
Figure 8-13	Direct Potable Reuse (DPR) Water Purification Steps
Figure 9-1	2030 Projected Irrigation Demand
Figure 9-2	Projected Growth in Farm Irrigation Water Demand
Figure 9–3	Resident and Visitor Populations, Maui County, 1990 to 2040
Figure 9-4	Population Distribution on Maui, by Community Plan Area, 2010 – 2035
Figure 9-5	Population Growth and Water Demand with Margin of Error
Figure 9-6	Population Growth Based Demand by Community Plan Area, 2014- 2035 (mgd)
Figure 9-7	Population Growth Based Demand by Aquifer Sector Area, 2014- 2035 (mgd)
Figure 9-8	Maui Island Population Growth and Land Use Build-Out Based (Excluding AG) Projections
Figure 9–9	DHHL Projects
Figure 9-10	MDWS Consumption by Billing Class
Figure 9-11	MDWS Systems, Comparison of Base, High and Low Projections
Figure 9-12	Predicted Opportunities for Intensive Agriculture in Pre-contact Era
Figure 9–13a	Lahaina Aquifer Systems (Northern) Declarations of Water Use, Kuleana Parcels, and 2015 Ag Baseline
Figure 9–13b	Lahaina Aquifer Systems (Southern) Declarations of Water Use, Kuleana Parcels, and 2015 Ag Baseline
Figure 9-14	Important Agricultural Lands, Ditches, Service Areas, and Rainfall for HC&S Lands
Figure 10-1	Ka Pa`akai Analysis Process Simplified
Figure 11-1	Predicted Opportunities for Intensive Agriculture in Pre-contact Era
Figure 11.2	Assessed Resource Yield and Projected Demand
Figure 12-1	Priority Watershed Areas
Figure 12-2	Watershed Partnerships Maui Island
Figure 12-3	Ungulate Control Through Fencing in Pu`u Kukui
Figure 12-4	Forest Restoration and Exclusion of Grazing Animals
Figure 12-5	National Indoor Single Family Household Water Use
Figure 12-6	Maui Department of Water Supply Consumption Compared to Services, 1995-2015

	SECTION 1 - 13 LIST OF FIGURES
FIGURE #	**FIGURE TITLE**
Figure 12-7	Conservation Plan Relationships

LIST OF FIGURES--SECTION 14 WAILUKU ASEA

LIST OF FIGURES--SECTION 15 CENTRAL ASEA

LIST OF FIGURES--SECTION 15 CENTRAL ASEA

LIST OF FIGURES--SECTION 16 KO`OLAU ASEA	
FIGURE #	**FIGURE TITLE**
Figure 16-1	Average Mean Recharge under Average Climate and Drought Conditions by Aquifer System, Percent Recharge Reduction during Drought, and Sustainable Yield (mgd)
Figure 16-2	Ko`olau ASEA Relationship of Aquifer System Areas (ASYA) and Sustainable Yield to Maui Island Plan Growth Boundaries and Development Projects
Figure 16-3	Ko`olau ASEA Relationship of Aquifer System Areas, Watersheds, and Moku
Figure 16-4	Ko`olau ASEA Hydrological Units/Watersheds
Figure 16-5	Ko`olau ASEA Hydrologic Units/Watersheds (West Section of ASEA)
Figure 16-6	Ko`olau ASEA Perennial and Non-Perennial Streams
Figure 16-7	Traditional Moku of Ko`olau within the Ko`olau ASEA
Figure 16-8	Traditional Moku of Hāmākualoa within the Ko`olau ASEA
Figure 16-9	Estimated Native Hawaiian Pre-Contact Land Utilization and Kuleana Lands Compared to Growth Boundaries
Figure 16-10	Ko`olau ASEA Kuleana Lands
Figure 16-11	Directed Growth Plan: Ko`olau ASEA, Ha`ikū Planned Directed Growth Area
Figure 16-12	Directed Growth Plan Map, Ko`olau ASEA, Makawao/Pukalani Planned Directed Growth Area
Figure 16-13	Ko`olau ASEA County Zoning Districts
Figure 16-14	Ko`olau ASEA Department of Hawaiian Homelands
Figure 16-15	Pumpage by Well Type, Ko`olau ASEA, 2014
Figure 16-16	Pumpage by Well Type, Ko`olau ASYAs, 2014 (mgd)
Figure 16-17	Relationship of Kuleana Parcels and 2015 Statewide Agricultual Land Use Baseline
Figure 16-18	Opana/Awalau Source Existing Water Allocation
Figure 16-19	EMI Ditch System
Figure 16-20	Ko`olau ASEA Public Water Purveyors
Figure 16-21	Ko`olau ASEA General Location of Public Water Systems
Figure 16-22	Water Source by Aquifer Sector Area, 2014 (gpd)
Figure 16-23	Ko`olau ASEA Registered Surface Water Diversions
Figure 16-24	Ko`olau ASEA Department of Hawaiian Homelands Land Inventory
Figure 16-25	Full Build-Out Water Demand Projections by CWRM Use Type (including DHHL), Ko`olau ASEA
Figure 16-26	Ko`olau ASEA Planned Growth Areas, Makawao-Pukalani-Kula CP, Maui Island Plan Directed Growth Map U1: Makawao/Pukalani

LIST OF FIGURES--SECTION 16 KO`OLAU ASEA	
FIGURE #	**FIGURE TITLE**
Figure 16-27	Ko`olau ASEA Planned Growth Areas, Pā`ia-Ha`ikū CP, Maui Island Plan Directed Growth Map N2: Kū`au/Ha`ikū
Figure 16-28	Comparison of Growth Boundaries, 2016 Development Project List, Kuleana Parcels, Water Systems and Water Resources, Ko`olau ASEA.
Figure 16-29	Projected MDWS Consumption by CWRM Category, Ko`olau ASEA to 2035
Figure 16-30	East Maui Watershed Partnership
Figure 16-31	Streams in Ko`olau ASEA subject to Contested Case
Figure 16-32	Streams in Ko`olau ASEA Subject to Full Restoration
Figure 16-33	East Maui Irrigation System Service Areas
Figure 16-34	MDWS Upcountry Water System and Water Treatment Facilities

LIST OF FIGURES SECTION 17 HĀNA ASEA	
FIGURE #	**FIGURE TITLE**
Figure 17-1	Hāna ASEA Average Mean Recharge under Average Climate and Drought Conditions, Percent Recharge Reduction During Drought, and Sustainable Yield (mgd)
Figure 17-2	Hāna ASEA Relationship of Aquifer System Areas and Sustainable Yield to Maui Island Plan Growth Boundaries and Development Projects
Figure 17-3	Hāna ASEA Relationship of Aquifer System Areas, Watersheds, and Moku
Figure 17-4	Hāna ASEA Hydrological Units/Watersheds
Figure 17-5	Hāna ASEA Perennial and Non-Perennial Streams
Figure 17-6	Hāna Region and Hāna Aquifer Sector
Figure 17-7	Estimated Native Hawaiian Pre-Contact Land Utilization and Kuleana Lands Compared to Growth Boundaries
Figure 17-8	Hāna ASEA Kuleana Lands
Figure 17-9	Directed Growth Plan: Hāna Planned Rural Growth Area
Figure 17-10	Hāna ASEA Community Plan Boundaries and County Zoning Districts
Figure 17-11	Hāna ASEA Department of Hawaiian Homelands, Hāna ASEA Inventory
Figure 17-12	Pumpage by Well Type, Hāna ASEA, 2014
Figure 17-13	Pumpage by Well Type, Hāna ASYAs, 2014 (mgd)

LIST OF FIGURES SECTION 17 HĀNA ASEA	
FIGURE #	**FIGURE TITLE**
Figure 17-14	Relationship of Kuleana Parcels and 2015 Statewide Agricultual Land Use Baseline
Figure 17-15	Hāna ASEA Public Water Purveyors
Figure 17-16	Hāna ASEA General Location of Public Water Systems
Figure 17-17	Water Source by Aquifer System Area, 2014 (gpd)
Figure 17-18	Hāna ASEA Registered Surface Water Diversions
Figure 17-19	DHHL Wākiu Tract, Hāna ASEA
Figure 17-20	Full Build-Out Water Demand Projections by CWRM Use Type, Hāna ASEA
Figure 17-21	Hāna Planned Growth Areas, Maui Island Plan Directed Growth Map E1: Hāna Town to Hāna Airport
Figure 17-22	Pu`uiki Planned Growth Areas, Hāmoa to Kīpahulu
Figure 17-23	Comparison of Growth Boundaries, 2016 Development Project List, Kuleana Parcels, Water Systems and Water Resources
Figure 17-24	Projected MDWS Water Consumption by CWRM Category, Lāhaina ASEA to 2035
Figure 17-25	Hāna ASEA Projected Population Growth and Land Use Build-Out Based Water Demand, 2015-2035
Figure 17-26	Land Use Full Build-Out and Population Mid Growth Based Water Demand Projections, Hāna ASEA, 2035
Figure 17-27	Managed Lands and Forest Reserves Hāna ASEA
Figure 17-28	East Maui Watershed Partnership Major Land Holdings
Figure 17-29	East Maui Watershed Partnership
Figure 17-30	Hāna ASEA, Water Supply Drought Risk Area

LIST OF FIGURES SECTION 18 KAHIKINUI ASEA	
FIGURE #	**FIGURE TITLE**
Figure 18-1	Kahikinui ASEA: Average Mean Recharge under Average Climate and Drought Conditions by Aquifer System, % Recharge Reduction, and Sustainable Yield
Figure 18-2	Kahikinui ASEA: Distribution of Mean Annual Groundwater Recharge for Average Climate Conditions
Figure 18-3	Kahikinui ASEA: Relationship of Aquifer System Areas, Watersheds, Moku and Streams

LIST OF FIGURES SECTION 19 LAHAINA ASEA

Artist: Alyssa Ching

MAUI ISLAND WATER USE AND DEVELOPMENT PLAN DRAFT

EXECUTIVE SUMMARY

Table of Contents

ABBREVIATIONS

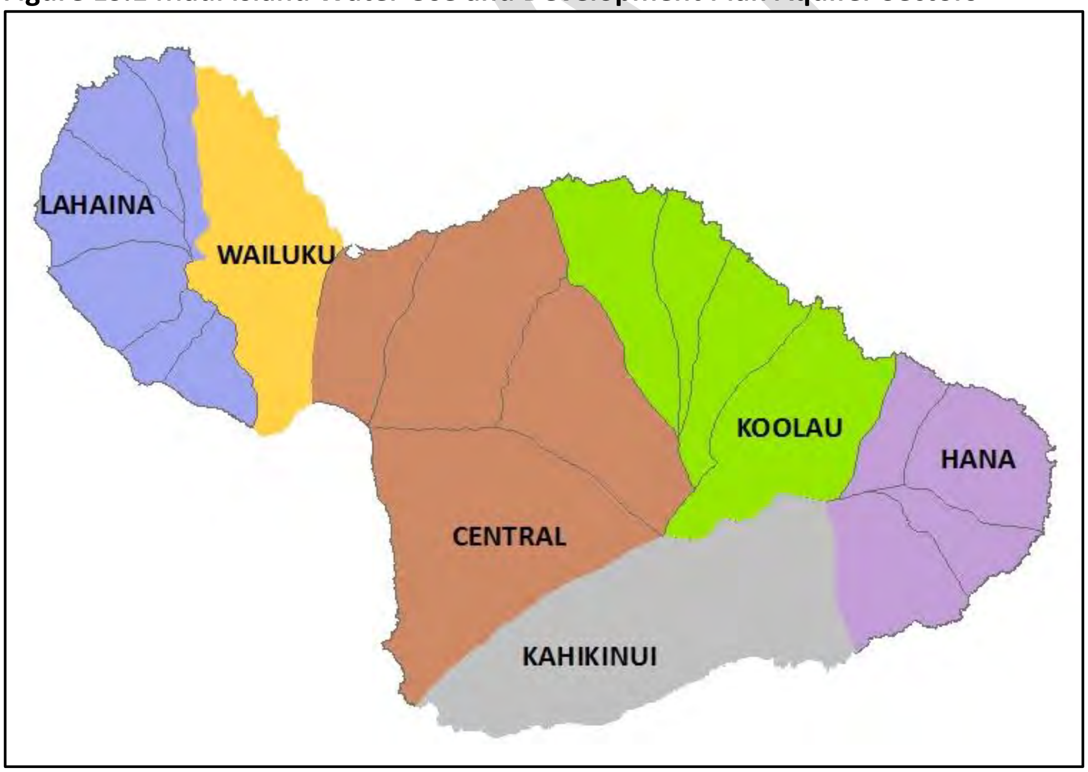
CWRM	Commission on Water Resource Management
DHHL	State Department of Hawaiian Homelands
GPD	Gallons per Day
HC&S	Hawaii Commercial and Sugar
IIFS	Interim Instream Flow Standards
MDWS	Maui County Department of Water Supply
MGD	Million Gallons per Day
MIP	Maui Island Plan
SY	Sustainable Yield
WUDP	Water Use and Development Plan

ES.1 THE MAUI ISLAND WATER USE AND DEVELOPMENT PLAN PURPOSE

The Maui Island Water Use and Development Plan (WUDP) is a long-range plan for the use, development, conservation, protection and management of the county's water resources. It is part of the *Hawai'i Water Plan* which serves as a comprehensive, long-range planning guide for use by the Commission on Water Resource Management (CWRM). Its objective to allocate water to land use through the development of policies and strategies will guide the County in its planning, management and development of water resources to meet projected demands. The planning period extends to 2035.

The plan was developed by the Maui County Department of Water Supply (MDWS) with community collaboration, reviewed by the Board of Water Supply and is being submitted to County Council for adoption by ordinance and to the CWRM for approval. The plan consists of six regional plans, based on Aquifer Sectors as hydrologic units. A brief synopsis of each Aquifer Sector is provided in this Executive Summary, including regional water resources, projected demand and water supply options.

Figure ES.1 Maui Island Water Use and Development Plan Aquifer Sectors



ES.2 REGULATORY FRAMEWORK

The State Water Code (Hawai'i Revised Statutes, Chapter 174-C) requires formulation of a Hawai'i Water Plan, which consists of the *Water Resource Protection Plan*, *Water Quality Plan*, *State Water Projects Plan*, *Agricultural Water Use and Development Plan*, and County Water Use and Development Plans prepared by each county and adopted by its county council and the CWRM. 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 *Statewide Framework*, 2000, provides guidance in updating WUDPs and includes recommended plan elements for the County WUDP update process.

At the County level, the plan serves as the primary guide to the County Council, MDWS, and all other agencies of the County in approving or recommending the use or commitment of water resources in the County, and in using public funds to develop water resources. (Maui County Code Chapter 14.02.)

The State Water Code and the Maui County Charter, Chapter 11, Section 8-11.2(3) mandate that County WUDPs be consistent with County land use plans and policies. The 2030 Maui County General Plan is comprised of the Countywide Policy Plan (2011), Maui Island Plan (MIP, 2012) and the Community Plans adopted in various years. The MIP provides direction for future growth, the economy, and social and environmental decisions through 2030 and establishes a Directed Growth Strategy. The WUDP does not propose alterations to proposed land use and development patterns established by the General Plan.

The original WUDP for Maui County was adopted by County ordinance and by CWRM in 1990. An update adopted by Maui County Council in 2010 was not approved by CWRM, primarily because it was limited in scope to the MDWS District rather than all water uses and needs. In August 2012, the CWRM accepted a revised Project Description to comprehensively address all water resources and needs for public and private water systems and public trust purposes. The Lana'i WUDP was updated in 2011 and the Moloka'i WUDP will be updated following adoption of this Maui Island WUDP.

ES.3 PLANNING FRAMEWORK

The CWRM Framework provides guidelines for applying an integrated resource planning process. In developing the Maui Island WUDP update, key components of this process were adopted, including defining multiple planning objectives as a basis for which resource scenarios are evaluated, and strong community involvement. Alternative planning scenarios and resource strategies are presented that consider cost, environmental impact, legal, regulatory, or practical constraints and uncertainties. Integrated planning assumes that trade-offs among conflicting planning objectives are necessary.

The integrated resource planning process involved people representing a broad range of community interests. Building upon the lengthy public process of the Maui Island Plan and early WUDP advisory committee meetings, an additional 20 community meetings were held from 2015 through 2017. Another 16 briefings and presentations were provided to policy bodies, including the Board of Water Supply, the CWRM, the County Council, the County Planning Department and the County Cultural Resources Commission.

The extensive public outreach identified **values, issues and objectives** to guide policies and strategies for the protection, planning, management, and development of water resources. The following overriding **values** were derived from community input:

'Wai' as a vital cultural and sustaining resource: Native Hawaiians and the Hawaiian culture value "wai" as a fundamental and necessary sacred element, and they continue to advocate for the rights to continuous flowing streams supported by healthy watersheds and nearshore environments.

Maui's natural beauty, native ecology and cultural heritage: Mauians are proud to reside in one of the most beautiful and distinctive places in the world. They value protection of Maui's native ecology as essential to preserving the island's beauty and cultural history, including its agrarian roots which support open spaces, native Hawaiian culture, and local self-reliance and independence.

Sustainable water resources: Maui is blessed with abundant groundwater, streams and ocean resources to serve its diverse needs. The native Hawaiians' mauka-to-makai ahupua'a management system safeguarded adequate stream flow necessary to sustain human settlements, cultural traditions and natural ecosystems from one generation to the next.

Abundant, high quality water for all needs: Mauians value the availability of high-quality water to support social and economic needs, as well as the aspirations of all people and cultures that reside here.

Area specific **issues** are addressed in each regional Aquifer Sector Report. This plan tries to tackle regional issues by articulating them and identifying viable solutions and strategies.

Planning **objectives** form the basis of evaluating resource strategies in the WUDP. Objectives were solicited through an iterative process. To ensure consistency with the Maui Island Plan and community plans, the planning objectives derived through the WUDP public process were compared to the goals, objectives and policies in the General Plan, Maui Island Plan (MIP) and community plans as shown in Appendix 2.

Photo credit: Pu`u Kukui Watershed Partnership

ES.4 METHODOLOGY

The WUDP is intended to allocate water to existing and planned land use. The WUDP and the MIP make up a framework to ensure that land use and infrastructure planning are integrated and provide guidance for resource use and infrastructure development. The following methodology was applied for each Aquifer Sector Area:

1. **Identify issues, concerns and objectives**
2. **Assess regional water resources**
3. **Identify settlement patterns and cultural resources**
4. **Identify existing and projected land use**
5. **Identify existing water use**

6. **Project future water needs**
7. **Analyze water source adequacy**
8. **Propose strategies to meet planning objectives**
9. **Define implementation process**

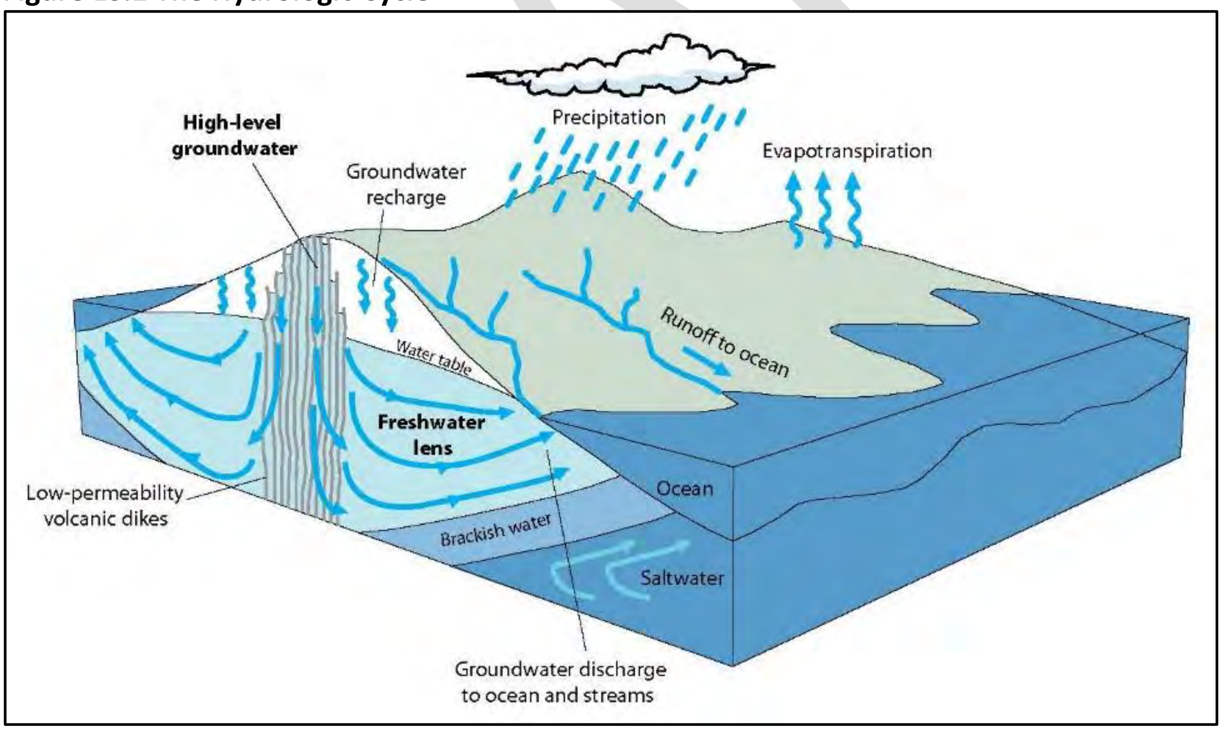
ES.4.1 Identify Issues, Concerns and Objectives

Region specific issues and concerns were documented in the public outreach process and also derived from the Maui Island Plan and the community plans. Planning objectives were likewise identified through the public process as well as from the regions' applicable community plans. Many broad objectives synthesized in the public process apply island wide. Region and inter-regional goals, objectives and policies make up the planning framework to assess and select water resource strategies to meet the region's water use demand over the planning period.

ES.4.2 Assess Regional Water Resources

The State Water Code requires that the County Water Use and Development Plans use hydrologic units designated statewide by CWRM. Groundwater and surface water resources interact through the hydrologic cycle and do not follow designated land use boundaries.

Figure ES.2 The Hydrologic Cycle



Hydrology of Ocean Islands, USGS Pacific Islands Water Science Center

Regional plans are based on Aquifer Sectors as designated by CWRM and consider natural and man-made interaction with water resources within and outside the region. For example, groundwater is generally the primary source of streamflow and therefore well pumpage may impact the recharge of stream flow. Vice versa, surface water that occurs above groundwater may contribute recharge of the groundwater so that surface water diversions can impact groundwater levels.

Inventoried water resources for each region include:

1. **Groundwater**
2. **Surface water**
3. **Rainwater catchment**
4. **Recycled wastewater**
5. **Stormwater reuse**

Uncertainties that impact resource availability are assessed, including climate change, droughts, legal constrains and data gaps.

ES.4.2.1 Groundwater

Groundwater is replenished by rainfall recharge. The amount of groundwater that can be developed is limited by the amount of natural recharge. Because some aquifer outflow or leakage must be maintained to prevent seawater intrusion or some perennial streamflow, the sustainable yield of an aquifer normally represents a percentage of the natural recharge. Sustainable yield is the legal limit for withdrawals from any individual aquifer as established by CWRM. Maximum available groundwater in each region is established sustainable yield, limited by any restrictions in groundwater management areas.

ES.4.2.2 Surface Water

The available flow of surface water for each region is much more difficult to quantify. Surface water is by nature highly variable. Stream flow during droughts and low flow conditions generally limit the amount of reliable flow for instream needs and off stream uses.

The amount available to divert from a stream is legally limited by established Instream Inflow Standards: "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." Of the total 90 streams on Maui, Interim Instream Flow Standards (IIFS) have been established for 25 streams in Ko`olau Aquifer Sector as of August 2018. Surface water diversions are also limited in designated Surface Water Management Areas, which includes four streams in Nā Wai `Ehā (Wailuku Aquifer Sector).

ES.4.2.3 Rainwater Catchment

Rainwater catchment is the collection of rainwater from a roof or other surface before it reaches the ground. Rainwater catchment systems are not regulated and its availability highly sensitive to regional rainfall conditions. No inventory of installed catchment systems throughout the island is available. The availability of rainfall catchment as a water resource is not quantified but considered as an alternative resource in regions with adequate rainfall.

ES.4.2.4 Recycled Wastewater

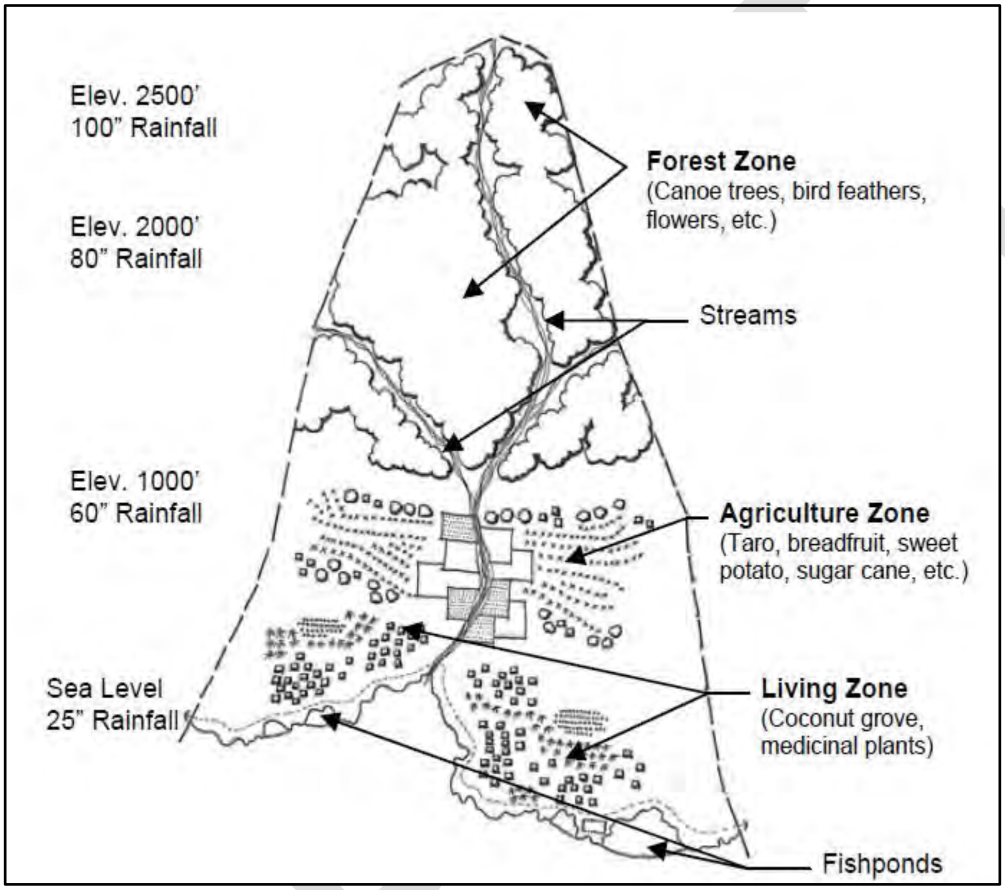
Reclaimed, or recycled wastewater can be used for non-potable purposes such as irrigation of agriculture, golf courses and landscape. Recycled wastewater treatment facilities are not located in all Aquifer Sectors as rural areas are often served by individual septic systems or cesspools. Recycled water treatment capacity, production and use are assessed for all regions with access or potential access to recycled wastewater.

ES.4.2.5 Stormwater Reuse

Stormwater reuse provides for capture and reuse of surface water runoff and can potentially provide water for non-potable water demand. There are a variety of stormwater technologies ranging from small rainwater catchment systems to reservoir storage systems. Stormwater reclamation and reuse opportunities are identified for each region as an alternative resource if available but generally difficult to quantify.

ES.4.3 Identify Settlement Patterns and Cultural Resources

Hydrologic and land use planning boundaries generally do not coincide with the traditional system of land and resource divisions. The traditional moku is comprised of many ahupua`a, where each unit extends from the upland mauka area to the sea. Through this indigenous land-management system based on the ecological interdependence of mauka and makai lands, the Hawaiians employed a complex system of sustainable agriculture and aquaculture practices that supported the inhabitants of the ahupua`a. Current land use patterns with population centers and extensive agriculture in dry regions have resulted in water transports from watersheds in wet areas.



Source: Maui Island Plan, 2012

Hawaiian history and cultural practices in the region inform resource management decisions and can identify any impact on Traditional and Customary practices. As directed by the Hawai`i Supreme Court ruling in *Ka Pa'akai O Ka `Aina v. Land Use Commission* (2000), a Ka Pa`akai preliminary analysis and consultation was conducted to identify and protect native Hawaiian cultural, historical and natural resources, as described in Chapter 10.2. A Ka Pa`akai analysis is generally performed for a site specific development project and should be continued as the WUDP policies and strategies are implemented to ensure resource development is pursued in a culturally appropriate way.

ES.4.4 Identify Existing and Projected Land Use

The WUDP must address future land uses and related water needs and be consistent with county land use plans and policies, including the general plan and zoning, as well as the state water projects plan. The WUDP identifies the following data that together direct future land use:

1. State Land Use designations
2. Community Plan designations
3. General Plan growth boundaries and planned growth areas
4. County Zoning designations
5. Department of Hawaiian Homeland island and regional plans

ES.4.5 Identify Existing Water Use

Existing water use by type and by resource is identified for all water uses and users in the region. Water systems often extend over multiple Aquifer Sectors and utilize water resources transported from multiple hydrologic units, such as aquifers or watersheds. For practical purposes existing water use is also analyzed for systems that share water resources from multiple hydrologic units. Water use ***by resource*** is analyzed for the categories defined under ES.4.2 above.

Water use ***by type*** are analyzed for the CWRM water use categories:

- 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 Department of Health)

ES.4.6 Project Future Water Needs

The Hawaii Administrative Rules 13-170-32 requires that the plan consider a twenty-year projection period for analysis purposes. Two alternative methods were used to project water demand to the year 2035: 1. Land use based water demand; and 2. Population growth based water demand.

ES.4.6.1 Land Use Based Demand Projections

Build-out of permitted land use based on County zoning and Department of Hawaiian Homelands' land use plans. Land use based water demand is based on water system standards. Applicable water use unit rates from the MDWS 2002 *Water System Standards*, Domestic Consumption Guidelines, are shown below. Adjusted water use rates especially for residential use are based on empirical consumption data.

Table ES.1 Water Use Rates for Land Use Based Demand Projections

USE CATEGORIES	2002 STANDARDS	ADJUSTED STANDARDS
Residential		
Single-Family or Duplex	600 gal/unit or 3000 gal/acre	South Shore: 1,000 gpd North Shore: 600 gpd
Multi-Family Low Rise	560 gal/unit or 5000 gal/acre	
Multi-Family High Rise	560 gal/unit	
Commercial		
Commercial Only	6000 gal/acre	
Commercial/Industrial Mix	140 gal/1000 sf	
Commercial/Residential Mix	140 gal/1000 sf	
Resort (includes hotel)	350 gal/unit or 17000 gal/acre	
Light Industrial	6000 gal/acre	
Schools, Parks	1700 gal/acre or 60 gal/student	
Agriculture	5000 gal/acre	3,400 gal/acre (AG WUDP)

MDWS 2002 Water System Standards. Adjusted standards based on empirical use or as stated.

Zoning designations are then aggregated to conform with CWRM water use categories, as defined under ES.4.5 above. Full build-out of land use classifications is not supported by the Socio-Economic Forecast and unlikely to occur over the 20-year planning period. County and state documents do not project active cultivation and pasture use throughout Agricultural zoned land.

Water use for State Department of Hawaiian Homelands (DHHL) are projected based on its Maui Island and regional land use plans, which are under its land use jurisdiction. Water use rates as defined by DHHL are applied per below.

Table ES.2 Water Use Rates for Department of Hawaiian Homelands Land Use Projections

CWRM Category	DHHL Land Use Category	Water Use Rate (gpd)
Domestic	Residential	600/unit
	Commercial	6,000/acre
Industrial	Industrial	6,000/acre
Agriculture	Agriculture	3,400/acre
Irrigated	N/A	0
Municipal	Community	1,700/acre
Military	N/A	0
N/A	Open Space	0

ES.4.6.2 Population Growth Based Demand Projections

Population growth rates based on 20-year population growth projections in the Socio-Economic Forecast Report (2014). Population based demand takes into account social and economic factors that are anticipated to drive growth over the planning period. Existing population and water use (2014) were calculated as the basis for water demand projections through 2035. Demand is projected annually 2015 – 2020 and in 5-year increments 2020 – 2035. Water use is projected for low, mid and high growth scenarios, based on Community Plan area growth rates established in the Maui Island Plan and 2014 Socio Economic Forecast. The mid growth scenario the selected method to project future water demand, with adjustment for water use not correlated to population growth described below. Water demand specified in the Department of Hawaiian Homelands and the State Water Projects Plan are added if not accounted for in existing population and water use for population growth based projections.

ES.4.6.3 Agricultural Demand Projections

Non-potable agricultural irrigation demand is not coordinated to population growth and represent additional demand. Agricultural projections differ significantly by region. Generally, agricultural use can be categorized into diversified agriculture and kalo cultivation, with the following water use rates:

Table ES.3 Water Use Rates for Diversified Agriculture and Lo'i Kalo

Agricultural Activity	Water Use Rate (gpd/acre)	Type of Water Coefficient
Diversified Agriculture	2,500 for wetter areas 3,400 for drier areas	Average per acre water use for Diversified Agriculture activities (Does not include irrigation system water losses)
Lo`i Kalo	100,000 to 300,000 15,000 to 40,000	Per acre water inflow into lo`i kalo system Consumptive use

Source: Diversified Agriculture – CWRM Waiahole Ditch Case, State Agricultural Water Use & Development Plan.
Lo`i Kalo - CWRM Na Wai 'Eha and East Maui Streams Contested Cases

ES.4.6.4 Irrigation Demand Projections

Landscape irrigation associated with single family homes and most commercial uses are generally provided through municipal potable systems and therefore factored into population growth based projections. Large landscaped areas for resorts and golf courses using untreated surface water, brackish groundwater and recycled water that are NOT supplied by municipal potable systems represent additional demand. Existing or estimated 2014 water use is projected to increase based on population growth over the planning period.

ES.4.7 Analyze Water Source Adequacy

Available water resources are compared to projected demand to determine if long term resource supply is adequate to meet future needs while maintaining watershed, stream and aquifer sustainability and replenishment. The analysis takes into account current and potential transport of groundwater and surface water from and to the region and whether alternative water resources such as recycled wastewater are available to meet non-potable water demand.

ES.4.8 Propose Strategies to Meet Planning Objectives

Multiple resource options to meet planning objectives and projected demand were reviewed and evaluated in regional public meetings and workshops to assess constraints, relative costs, implementation risk and viability. Selected strategies for each region are presented with a discussion of key issues and background. Life cycle costs are estimated for conventional (groundwater and surface water) and alternative (recycled water, stormwater, desalination) resource strategies where engineering studies and reports were available, including capital, operation and maintenance costs per 1,000 gallons water supply.

Recommended strategies include resource management as well as development of conventional and alternative resources. Resource management strategies support objectives related to stream restoration, water quality and watershed protection. Water conservation is a recommended strategy for all regions and defined in Chapter 12.2.

Selected water supply options to meet projected water demand through 2035 is summarized and differentiated into potable and non-potable supply and demand. The recommendations should guide resource use and infrastructure development over the 20-year planning period.

ES.4.9 Define Implementation Process

Estimated timeframes for implementation are indicated, allowing for flexibility to re-scope, prioritize and adjust to available funding. Recommended strategies in the WUDP does not legally bind the agencies and organizations to execute. The recommendations provide guidance for land use and infrastructure, including the county capital improvement programs over the planning period.

Timing and prioritizing of conventional and alternative resource strategies are tied to actual population growth and economic factors that drive individual development projects.

Artist: Jessica Mae Castillo

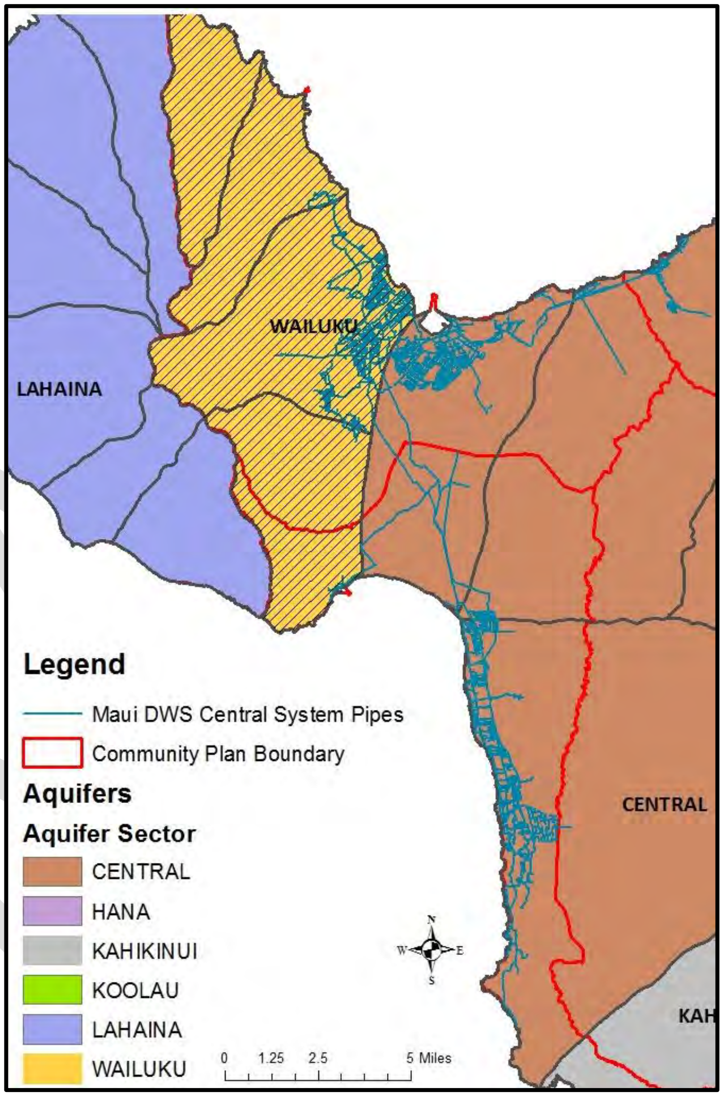
ES.5 AQUIFER SECTOR AREA REGIONAL PLANS

ES.5.1 Wailuku Aquifer Sector Synopsis

Groundwater and surface water resources from the region serve municipal needs within and outside the Aquifer Sector through the MDWS Central Maui System. The Wailuku, Central and Ko`olau hydrologic units are historically and currently closely entwined through water imports and exports. Land use planning based on community districts further links the Wailuku, Kahului and South Maui communities. Resource use and projected demand for the MDWS Central System as a whole is therefore used for practical planning purposes, in addition to agricultural and other non-potable needs.

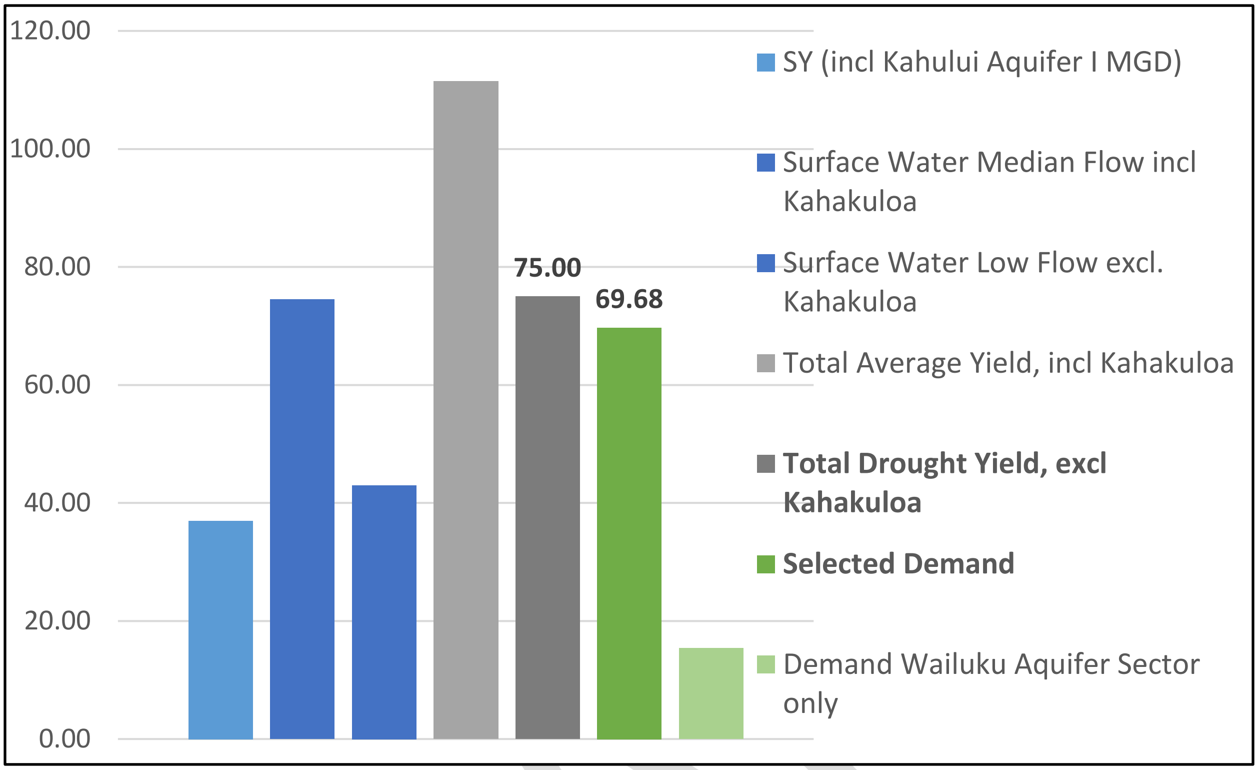
Transport of Wailuku groundwater is assumed to meet planned growth in directed growth areas throughout the Wailuku-Kahului Community Plan and the Kīhei-Mākena Community Plan districts, primarily served by the MDWS Central Maui System.

Figure ES.3 Wailuku and Central Aquifer Sectors, Maui Department of Water Supply Central Maui System



Groundwater resources include the Kahakuloa Aquifer with a sustainable yield of 5 million gallons per day (MGD). However, assuming that Kahakuloa groundwater and surface water will ***not*** be developed over the planning period, supplemental and alternative resources outside the Wailuku and Central Aquifer Sectors are needed to meet planned growth.

Figure ES.4 Wailuku Aquifer Sector Resources and 2035 Demand (MGD)



Additional groundwater source imports are proposed from Ko`olau Aquifer Sector, subject to comprehensive hydrologic studies.

Interim Instream Flow Standards (IIFS) are not yet adopted by CWRM to date but are expected to ensure restoration of mauka to makai stream flow and satisfy Native Hawaiian subsistence and cultural needs in the region. Agricultural needs on the Central isthmus that historically have relied on abundant stream flow from Nā Wai `Ehā will need to adapt to a lesser share, especially in dry season.

Reducing non-potable use of Wailuku Aquifer Sector basal and high level groundwater is desirable to prioritize high quality water for potable needs. Expansion of recycled water and brackish sources in the Central Aquifer Sector is proposed to meet future non-potable demands. Aggressive conservation measures to reduce water use per capita by 8 % over the planning period can delay but not replace groundwater source development needs.

Table ES.4 Selected Demand Scenario: Projected Water Demand and Supply Options Wailuku ASEA and MDWS Central System

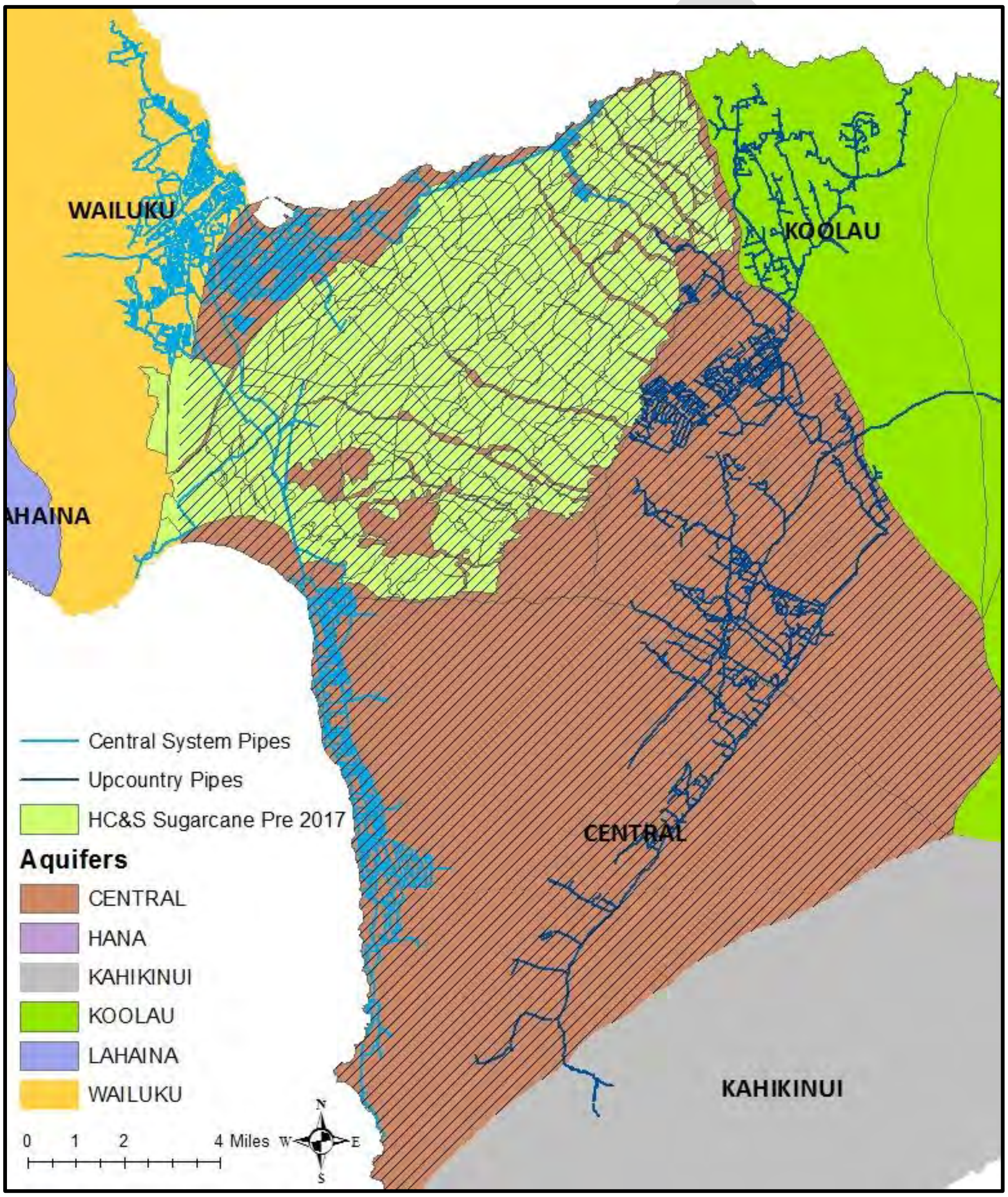
DEMAND (MGD)	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**
MDWS Potable Wailuku and Central ASEA*	22.274	22.699	27.685	30.602	34.005	37.174
MDWS Potable export to Central ASEA	17.664	17.990	22.838	25.592	28.874	31.868
MDWS Potable Wailuku ASEA only	*4.610*	*4.709*	*4.847*	*5.010*	*5.131*	*5.307*
Total Potable:	22.274	22.699	27.685	30.602	34.005	37.174
Non Potable (AG, IRR, DOM)**	33.911	33.911	33.856	33.919	33.993	34.061
Other, Non Potable (water losses)	2.730	2.730	2.730	2.730	2.730	2.730
Total Non-Potable	36.641	36.641	36.586	36.649	36.723	36.791
TOTAL DEMAND	**58.915**	**59.341**	**64.271**	**67.251**	**70.727**	**73.965**
SUPPLY (MGD)						
Potable Groundwater Wailuku ASEA	**20.353**	**19.909**	**22.142**	**23.701**	**21.570**	**19.119**
Potable Groundwater Central ASEA/Kahului Aquifer/Maui Lani Wells	0.930	1.090	1.090	1.090	1.090	1.090
Non Potable Groundwater	0.400	0.408	0.497	0.550	0.611	0.668
Potable surface water	0.990	1.700	3.200	3.200	3.200	3.200
Non Potable surface water	36.241	36.234	36.089	36.099	36.112	36.124
Recycled Water (South Maui MDWS Service Area)			0.500	0.700	0.700	0.700
Water Conservation (-8% per capita)	0.000		0.753	1.911	3.445	5.065
Potable Groundwater Import Ko`olau ASEA/Haiku Aquifer	0.000	0.000	0.000	0.000	4.000	8.000
TOTAL SUPPLY	**58.914**	**59.341**	**64.271**	**67.251**	**70.727**	**73.965**

*Includes MDWS wells in Kahului Aquifer
**Includes AG served by Na Wai Eha

ES.5.2 Central Aquifer Sector Synopsis

Water supply used in this region is primarily generated from outside the Aquifer Sector. Two of the Maui Department of Water Supply (MDWS) systems are partially located in this Aquifer Sector: The Central Maui System and the Upcountry System. The roughly 37,000 acre former Hawaii Commercial and Sugar (HC&S) plantation currently undergoes a transition to diversified agriculture. The figure below shows the MDWS systems and plantation lands overlying the three aquifer sectors.

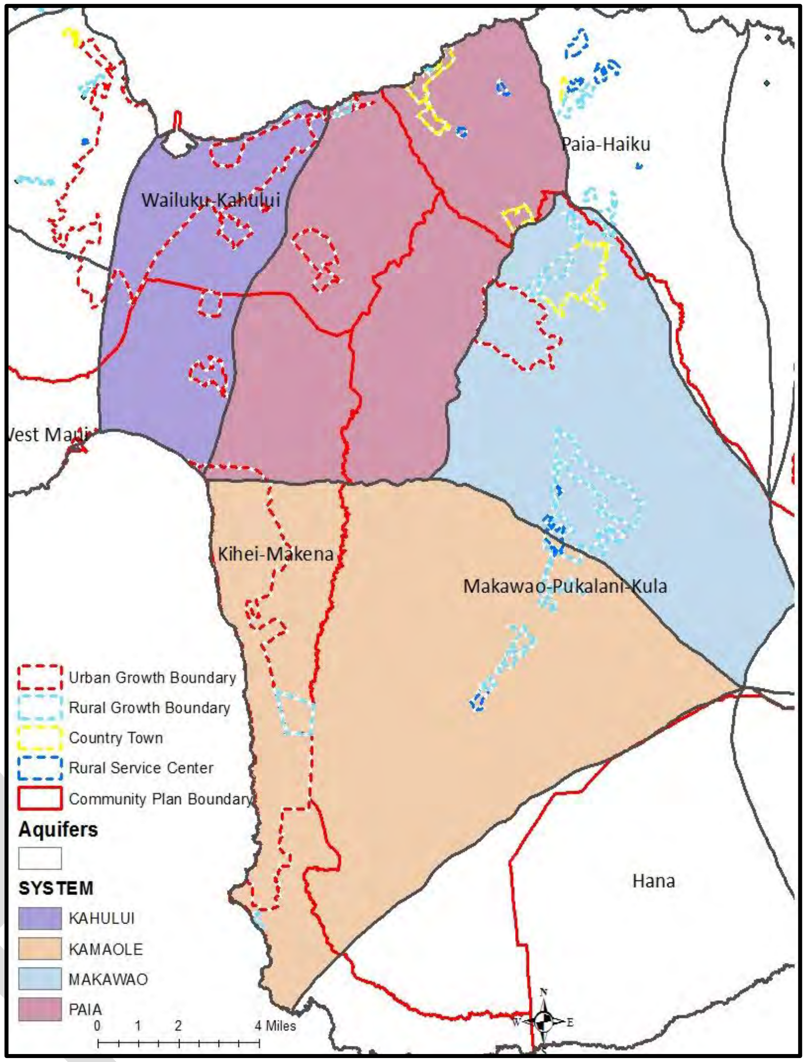
Figure ES.5 Wailuku, Central and Ko`olau Aquifer Sectors, HC&S Lands, Maui Department of Water Supply Central System and Upcountry System



Groundwater sustainable yield (SY) and surface water within the region is not sufficient to supply projected growth in the Wailuku-Kahului and Kīhei-Mākena Community Plan areas. The selected 20-year projected demand scenario is the mid growth population based projections, Department of Hawaiian Homeland planned growth and outstanding demand on the Upcountry Meter Priority List, totaling **128.1 mgd**. Including the MDWS Central System, projected demand totals 165 mgd. Resources in this Aquifer Sector is not anticipated to meet demand on the MDWS Central Maui System, which is addressed in the Wailuku Aquifer Sector.

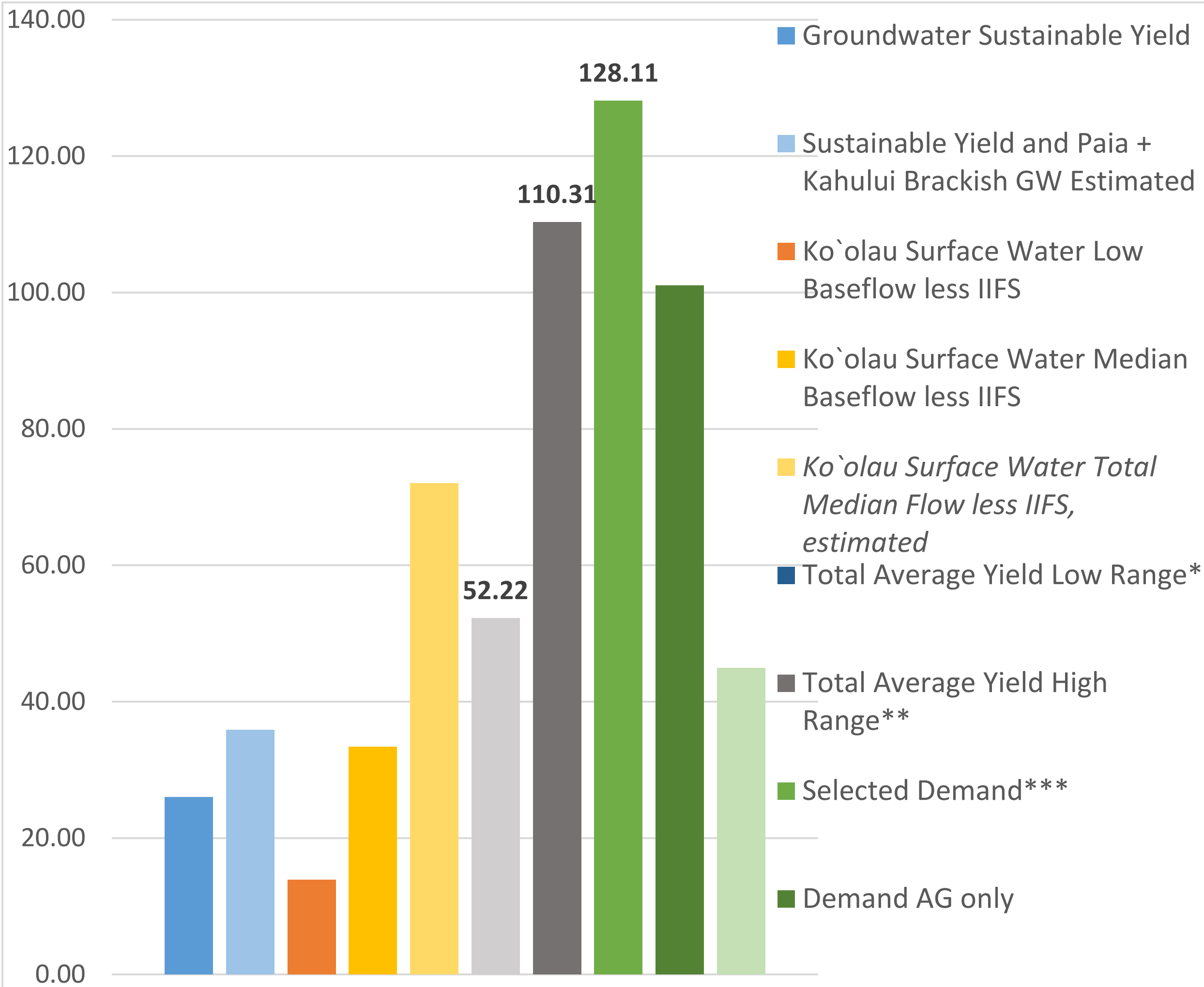
Projected population based growth will require groundwater development in Ko`olau Aquifer Sector.

Figure ES.4 Central Aquifer Sector, Community Plans and Directed Growth Areas



Irrigation demand for diversified agriculture on former sugarcane plantation lands is projected to range between a low 23 mgd to a high 89 mgd. Interim Instream Flow Standards established in 2018 for 25 East Maui streams will reduce surface water transport to Central Maui. The initial phase of transition can be satisfied under medium stream flow conditions. It's uncertain whether total available stream flow is sufficient to realize the full Diversified Agricultural Plan. The amount of available brackish groundwater from the Central Aquifer Sector is estimated to be higher than sustainable yield, but has not been quantified. Irrigation demand for agriculture outside the plantation, primarily Upcountry, is projected to range between 9.9 – 11.9 mgd.

Figure ES-5. Central Aquifer Sector Resources and 2035 Demand (MGD)



* Assessed brackish groundwater from Kahului and Paia aquifers (17.84) mgd, Stream median base flow, R-1 recycled water
** Assessed brackish groundwater from Kahului and Paia aquifers (17.84 mgd), Stream median total flow (72 mgd), less IIFS, R-1 recycled water
***Pop. Mid-Growth, incl. MDWS Upcountry System, Priority List, Land use based AG and DHHL (excl. MDWS Central System)

Groundwater development for potable needs in Haiku aquifer, Ko`olau Aquifer Sector, is subject to comprehensive hydrologic studies and the terms of the East Maui Consent Decree. Non potable irrigation and industrial demand can be met with brackish water resources within the Central ASEA. Agricultural water system water loss mitigation and stream flow duration analysis for raw water storage development are key to address reliability, climate adaption and to reduce drought impacts on the region's water supply.

Table ES.5 Selected Scenario Projected Water Demand and Supply Options Central ASEA and MDWS Upcountry System

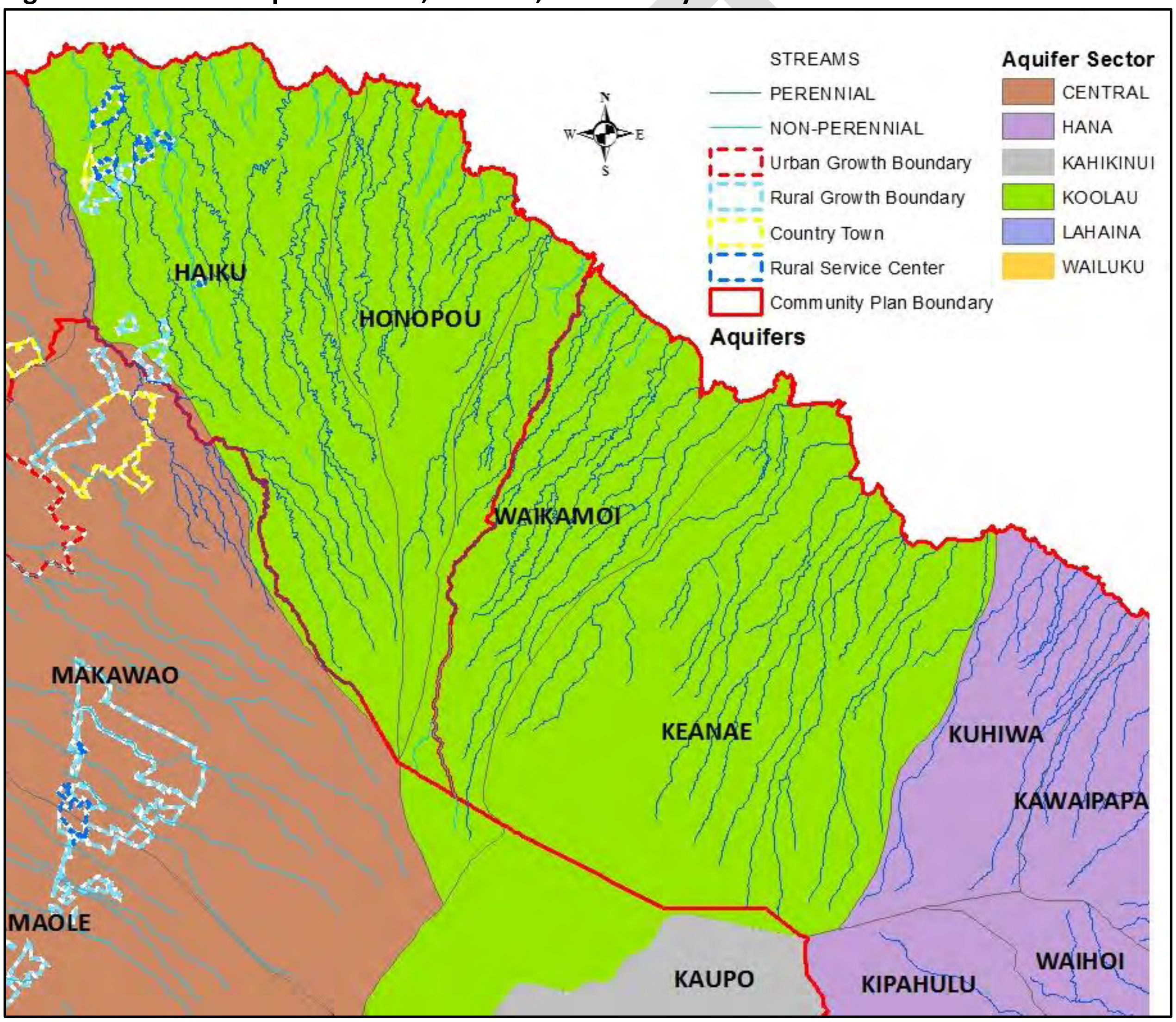
DEMAND (MGD)	2014	2015	2020	2025	2030	2035
MDWS Potable (Upcountry excl. Priority List)	7.610	7.693	8.155	8.292	8.432	8.530
Upcountry Meter Priority List	7.3	7.3	7.3	7.3	7.3	7.3
Municipal Private Potable	0.235	0.239	0.268	0.295	0.327	0.356
DHHL Potable Kahului Aquifer	0.000	0.000	1.734	1.734	1.734	1.734
DHHL Potable Kamaole Aquifer	0.000	0.000	0.349	0.349	0.810	0.813
TOTAL POTABLE DEMAND	**15.145**	**15.232**	**17.806**	**17.970**	**18.603**	**18.734**
Irrigation Non Potable	3.683	3.744	4.201	4.627	5.133	5.591
Agriculture, Non Potable	191.452	191.452	35.415	35.415	58.220	101.030
Industrial, Non Potable	0.208	0.211	0.237	0.261	0.290	0.316
DHHL, Non Potable	0.000	0.000	2.434	2.434	2.434	2.434
TOTAL NON-POTABLE DEMAND	**195.343**	**195.408**	**42.288**	**42.738**	**66.078**	**109.372**
TOTAL DEMAND	**210.487**	**210.640**	**60.094**	**60.708**	**84.681**	**128.105**
SUPPLY (MGD)						
Potable Groundwater Kahului Aquifer (serving MDWS Central System)*	*1.093*	*1.093*	*1.093*	*1.093*	*1.093*	*1.093*
Potable Groundwater Kahului Aquifer (non MDWS)**	0.161	0.161	1.895	1.895	1.895	1.895
Potable Groundwater Kamaole Aquifer	0.027	0.027	0.027	1.036	1.497	1.500
Potable Groundwater Paia Aquifer***	0.248	0.998	0.998	0.998	1.500	1.500
Potable Groundwater Makawao Aquifer	0.139	0.500	0.500	1.300	2.000	3.000
Potable Groundwater Ko`olau ASEA Haiku Aquifer	0.81	0.81	1.4	1.4	1.4	1.4
Potable Surface Water Ko`olau ASEA	6.460	7.700	7.700	7.700	11.700	11.700
Conservation (8% per capita)	0.000	0.000	0.519	1.195	1.989	2.676
TOTAL POTABLE SUPPLY	**7.845**	**10.196**	**13.039**	**13.629**	**20.086**	**21.776**
Unmet Potable Demand	-7.300	-5.036	-4.767	-4.341	1.483	3.043
Non Potable Groundwater Kahului Aquifer	28.906	28.906	2.169	2.169	10.776	10.776
Non Potable Groundwater Paia Aquifer	29.258	29.258	9.081	9.081	9.081	9.081
Non Potable Groundwater Kamaole Aquifer	2.826	2.888	3.345	3.991	4.277	4.735
Non Potable Groundwater Makawao Aquifer	0.220	0.220	0.220	0.220	0.220	0.220
Non potable Surface Water Ko`olau ASEA ****	134.133	134.133	27.473	27.277	35.000	35.000
Recycled Water (South Maui WWTF) Offset MDWS Central System*****	*2.280*	*2.280*	*2.280*	*2.280*	*2.280*	*2.280*
Recycled Water Kahului WWTF)******	0.000	0.000	*3.000*	*3.000*	*3.000*	*3.000*
Recycled Water Upcountry	0.19	0.19	0.19	0.19	0.19	0.19
TOTAL NON-POTABLE SUPPLY	**195.343**	**195.404**	**42.288**	**42.738**	**59.354**	**59.812**
Unmet Non-Potable Demand	0.000	-0.003	0.000	0.000	-6.724	-49.560
TOTAL SUPPLY	**203.187**	**205.600**	**55.327**	**56.367**	**79.440**	**81.588**

* and *****accounted for in Wailuku ASEA Supply
** May also supply Pulehunui Ind. Development +3.8 mgd, source adequacy TBD
***Includes Old Maui High School Project 0.75 mgd, source TBD
****28 mgd base flow, est. 35 mgd Total flow
******potential. alt source for Ag. Not counted as available supply

ES.5.3 Ko`olau Aquifer Sector Synopsis

The 2015 population of the Ko`olau ASEA was about 11,890 residents and projected to increase by 3.6 percent to 12,321 by 2035. Over 90% of the population is within the Pā`ia-Ha`ikū Community Plan area. Groundwater and surface water resources are abundant. Kalo cultivation is extensive and streamflow restoration at the heart of traditional and cultural Hawaiian practices in the region. Interim Instream Flow Standards (IIFS) were established for 25 streams in June 2018. The Draft Ko`olau Aquifer Sector Report submitted for Board of Water Supply Review on March 15, 2018 takes into account the Proposed IIFS dated August 2, 2017.

Figure ES.6 Ko`olau Aquifer Sector, Streams, Community Plan and Growth Boundaries



Current groundwater pumpage is about 0.5% of total 175 mgd sustainable yield. Projected population growth within the region can be met with available resources under normal and drought conditions. Groundwater transport of up to 9.4 mgd to meet population growth needs in the Central Aquifer Sector (MDWS Upcountry and MDWS Central Maui Systems) can be supported by sustainable yield, established at 27 mgd in 2008 and proposed at 24 mgd in 2019.

Figure ES.7 Ko`olau Aquifer Sector Resources and 2035 Demand (MGD)

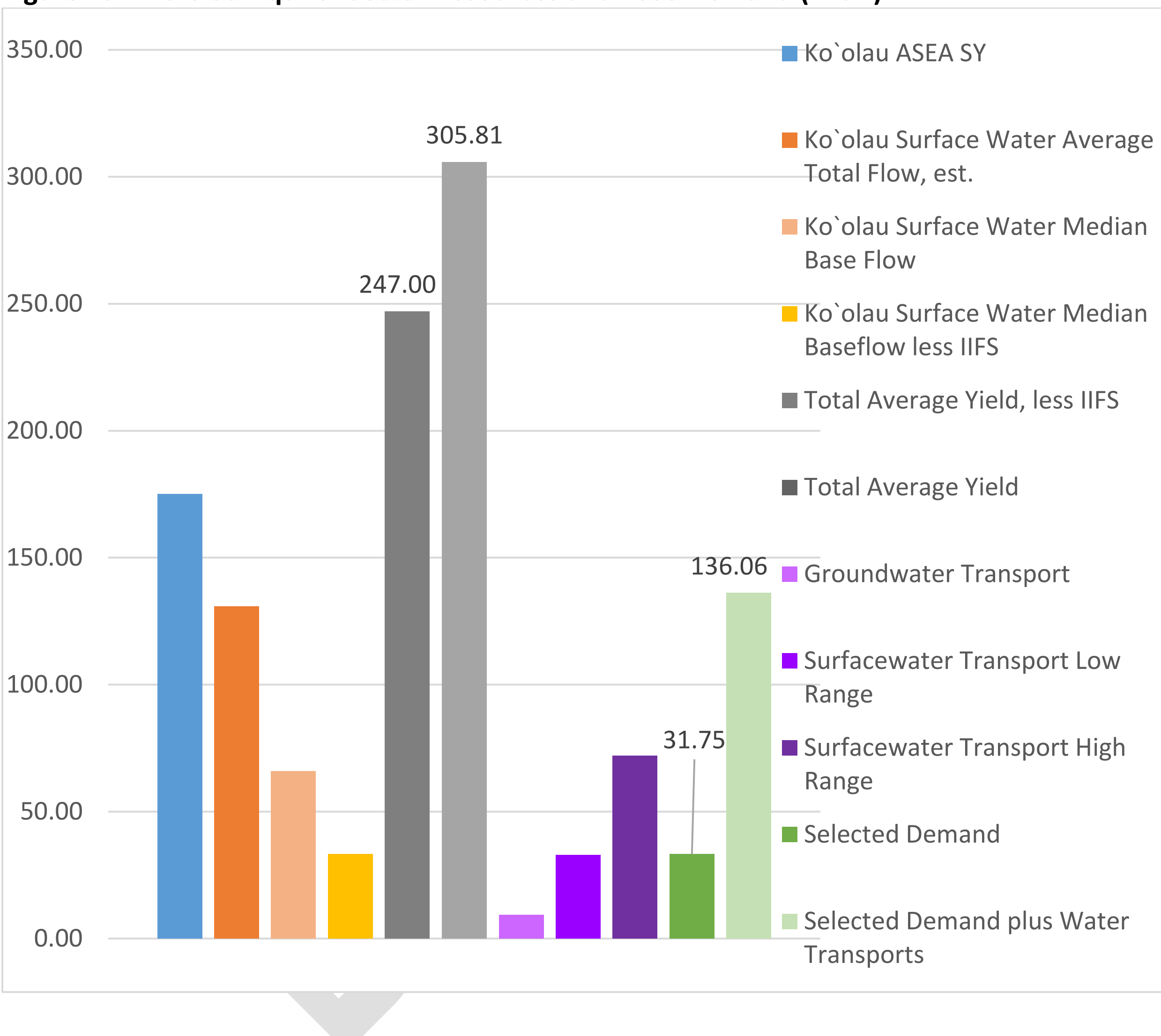


Table ES.6 Projected Water Demand and Supply Options Ko`olau Aquifer Sector (MGD)

DEMAND (MGD)	2015	2020	2025	2030	2035
MDWS Potable Groundwater for use Within Koolau ASEA*[1]	*0.82*	*0.831*	*0.839*	*0.846*	*0.849*
Other Potable Demand within Koolau ASEA	0.085	0.086	0.086	0.087	0.088
MDWS Potable Surfacewater for use Within Koolau ASEA[2]*	*0.104*	*0.105*	*0.106*	*0.107*	*0.107*
Potable Surface Water Ko`olau ASEA[1]*	*7.7*	*7.7*	*7.7*	*11.7*	*11.7*
Total Potable Demand (not including MDWS Upcountry System)	**0.085**	**0.086**	**0.086**	**0.087**	**0.088**
Non-Potable Demand within Koolau ASEA	21.08	22.064	23.093	24.17	25.297
DHHL Non-Potable Demand*[5]	0	6.375	6.375	6.375	6.375
Total Non-Potable Demand (Excluding Exports)	**21.08**	**28.439**	**29.468**	**30.545**	**31.672**
Total Demand (excluding exports)	**21.165**	**28.524**	**29.554**	**30.632**	**31.759**
SUPPLY (GPD)	**2015**	**2020**	**2025**	**2030**	**2035**
Haiku ASYA Potable GW*[1]	*0.83*	*0.831*	*0.839*	*0.846*	*0.849*
Other Potable Haiku ASYA	0.005	0.005	0.005	0.005	0.005
Other Potable Honopou ASYA	0.013	0.013	0.013	0.013	0.013
Other Potable Keanae ASYA	0.067	0.068	0.068	0.069	0.069
Potable Surface Water Ko`olau ASEA[2]*	*7.7*	*7.7*	*7.7*	*11.7*	*11.7*
Total Potable Supply (excluding exports)	**0.085**	**0.086**	**0.086**	**0.087**	**0.087**
Non-Potable Groundwater Haiku ASYA*[3]	0.017	0.025	0.037	0.054	0.081
Non-Potable Surface Water for Use Within Koolau ASEA	21.064	22.039	23.056	24.116	25.216
Non-Potable Surface Water for Export to Central ASEA[2] *[4]*	*134.133*	*27.473*	*27.277*	*28.5*	*28.5*
Non-Potable DHHL supply from Pi`ina`au Stream*[5]	0	4.275	4.275	4.275	4.275
Non-Potable DHHL supply from Waiokamilo Stream*[5]	0	2.1	2.1	2.1	2.1
Total Non-Potable Supply (excluding exports)	**21.08**	**28.439**	**29.468**	**30.545**	**31.673**
TOTAL SUPPLY (within Koolau ASEA, excluding exports)	**21.165**	**28.525**	**29.554**	**30.632**	**31.760**

*[1] MDWS Upcountry System demand and supply are accounted for in Table 15-38 of the Central ASEA chapter.

*[2] MDWS surface water exported to Kamole Weir and then used to serve Koolau MDWS customers.

*[3] Includes groundwater used within Koolau ASEA for irrigation and ag pumpage.

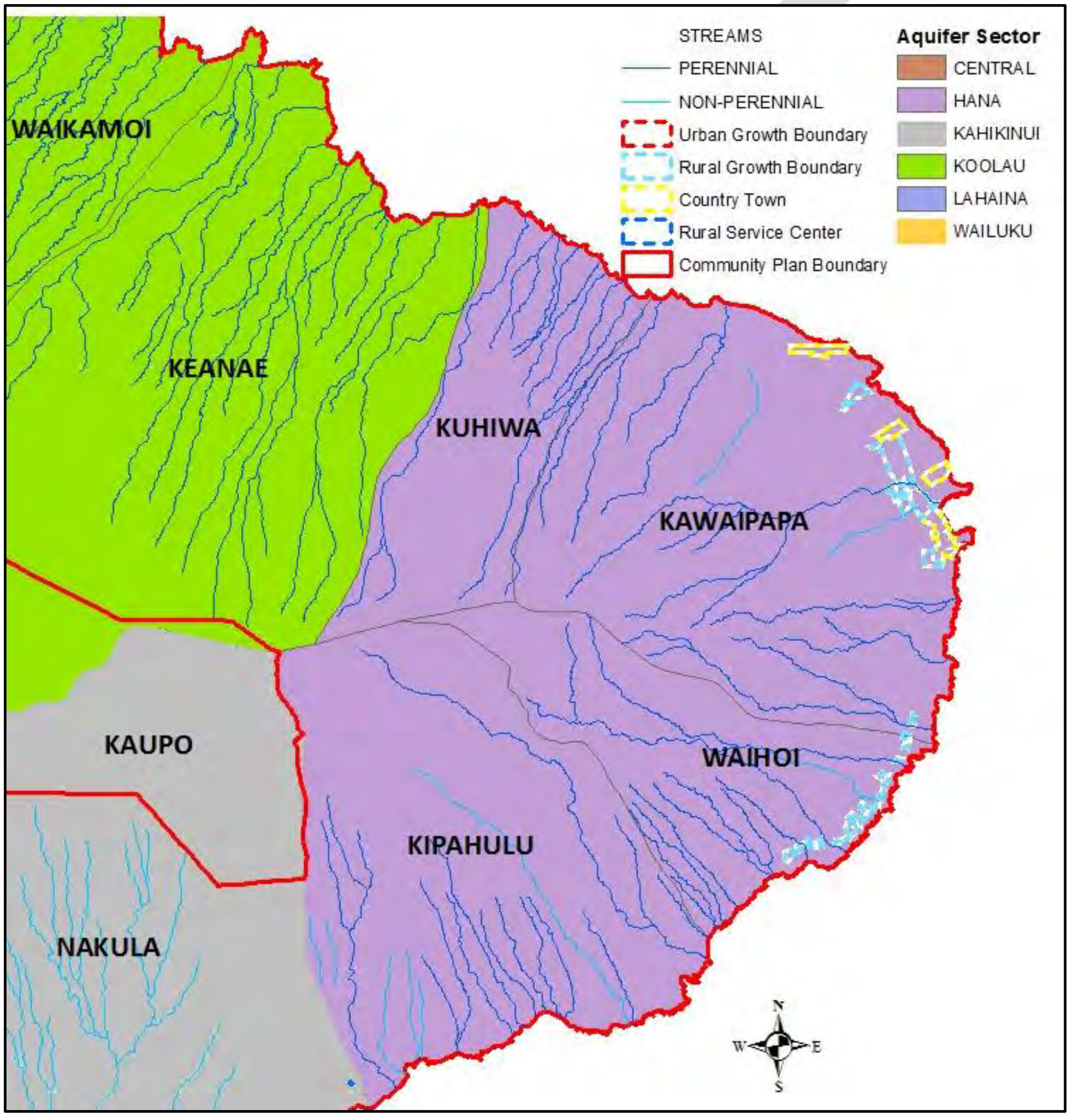
*[4] 28.5 mgd base flow. Available stream flow range from <28.5 mgd drought base flow to >78 mgd total flow.

*[5] Based on SWPP, 2017. Totals are entered in table to align with WUDP planning time increments.

ES.5.4 Hāna Aquifer Sector Synopsis

The Hāna Aquifer Sector encompasses the area east of Makapipi Stream and Ko`olau Aquifer Sector to Kaupo. Surface water from the 25 perennial streams are not exported out of the region. Natural streamflow data is unavailable for all but one stream. Reported groundwater pumpage is 0.5% of established 122 mgd sustainable yield (SY). The pending 2019 update of the State Water Resources Protection Plan will reduce the Aquifer Sector SY to 78 mgd.

Figure ES.8 Hāna Aquifer Sector, Streams, Community Plan and Growth Boundaries



Potable water demand based on population growth is projected to increase 22% from 0.75 mgd to 0.91 mgd by 2035. Agricultural irrigation needs including estimated consumptive use for kalo cultivation on kuleana parcels are assessed to 1.464 mgd by 2035. Department of

Hawaiian Homeland potable and non-potable demands of are considered additional to population growth based projections.

Figure ES.9 Hāna Aquifer Sector Resources and 2035 Demand (MGD)

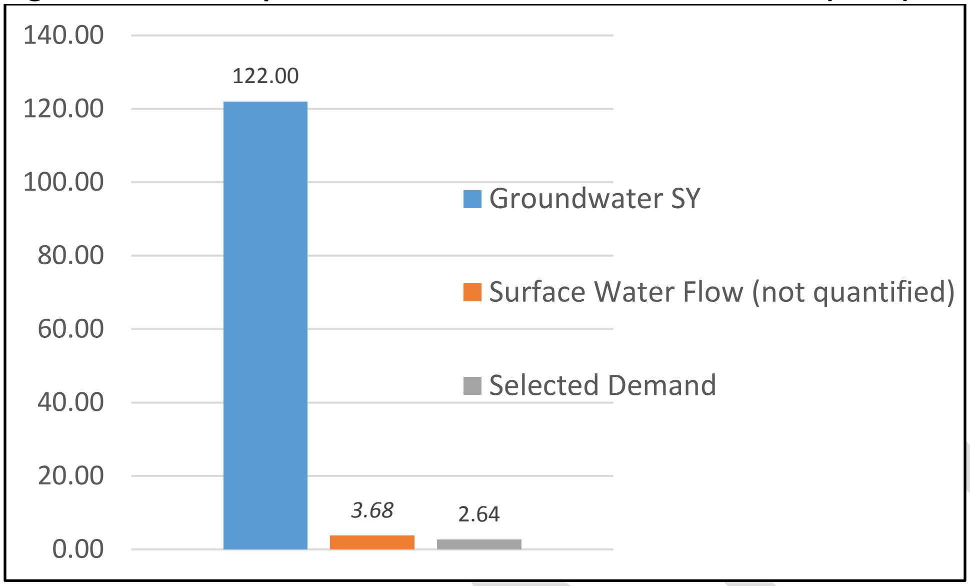


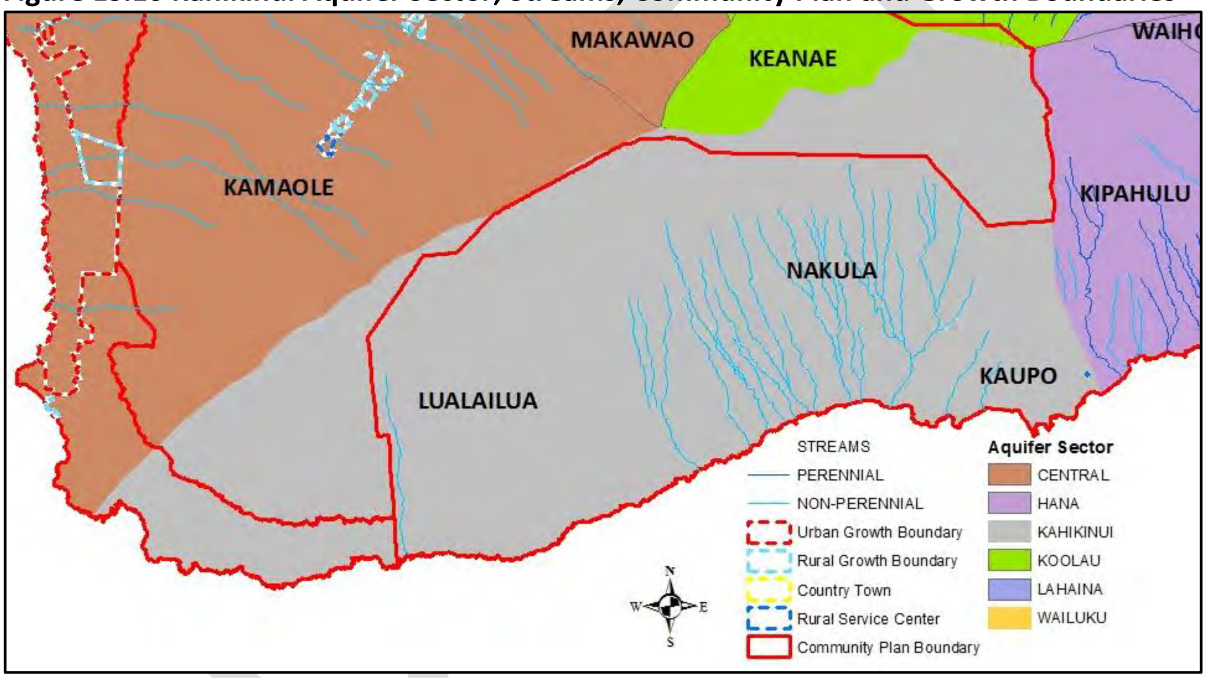
Table ES.7 Projected Water Demand and Supply Options Hāna Aquifer Sector (GPD)

DEMAND (GPD)	**2015**	**2020**	**2025**	**2030**	**2035**
MDWS Potable	448,920	472,202	495,483	518,765	542,047
Municipal Private Potable	157,860	166,047	174,234	182,421	190,608
DHHL Potable	0	0	51,700	105460	117,700
Domestic Potable	152,246	160,141	168,037	175,933	183,828
Total Potable:	**759,027**	**798,391**	**837,755**	**877,119**	**916,483**
Irrigation Non-Potable	1,328	1,390	1,453	1,515	1,578
Agriculture, Non-Potable	1,220,060	1,281,063	1,342,066	1,403,069	1,464,073
DHHL, Non-Potable	0	0	0	0	255,000
Total Non-Potable	**1,221,388**	**1,282,453**	**1,343,519**	**1,404,584**	**1,720,651**
TOTAL DEMAND	**1,980,415**	**2,080,844**	**2,181,274**	**2,281,703**	**2,637,134**
SUPPLY (GPD)					
Potable Groundwater	**759,027**	**798,391**	**837,755**	**877,119**	**916,483**
Non Potable Groundwater	1,328	1,390	1,453	1,515	1,578
Non potable surface water	1,220,060	1,281,063	1,342,066	1,403,069	1,464,073
Ambient rainfall	0	0	0	0	255,000
TOTAL SUPPLY	**1,980,415**	**2,080,844**	**2,181,274**	**2,281,703**	**2,382,134**

ES.5.5 Kahikinui Aquifer Sector Synopsis

The Kahikinui Aquifer Sector Area is mostly contained within the Hāna Community Plan District. Water resources and infrastructure are relatively undeveloped. Global climatic change and drought may cause future water availability conditions to dramatically decrease in this already dry area. A fraction of groundwater sustainable yield is developed. There are no perennial streams in the region. Maui Department of Water Supply (MDWS) Upcountry System serves 20 meters in Kanaio within this Aquifer Sector. The Kaupō Ranch/MDWS hybrid water system serves non-potable water to the Kaupō community. The constraints to supply the remote and sparsely populated region are primarily infrastructure costs and electric power supply. Department of Hawaiian Homelands (DHHL) Kahikinui homesteads rely on catchment and hauling water supply.

Figure ES.10 Kahikinui Aquifer Sector, Streams, Community Plan and Growth Boundaries



Water demand based on population growth will require less than 10,000 gallons per day (gpd) of additional supply. DHHL 22,860 acres represent an additional 76,500 gpd of future demand. Agricultural irrigation needs are difficult to assess but conservatively estimated at 180,000 gpd.

Figure ES.11 Kahikinui Aquifer Sector Resources and 2035 Demand (MGD)

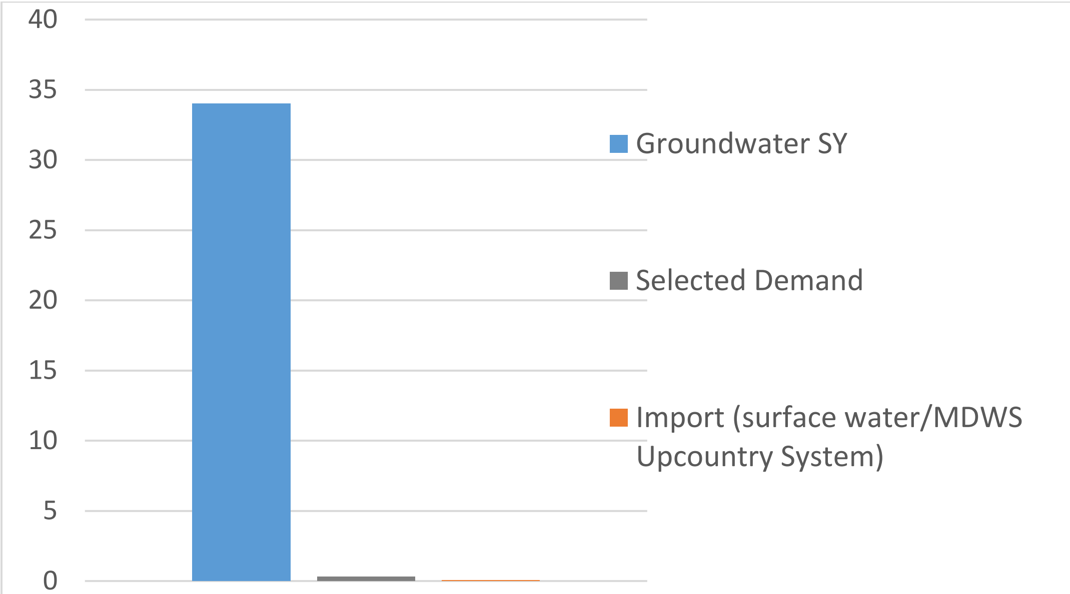


Table ES.8 Kahikinui Selected Demand Scenario and Supply Options

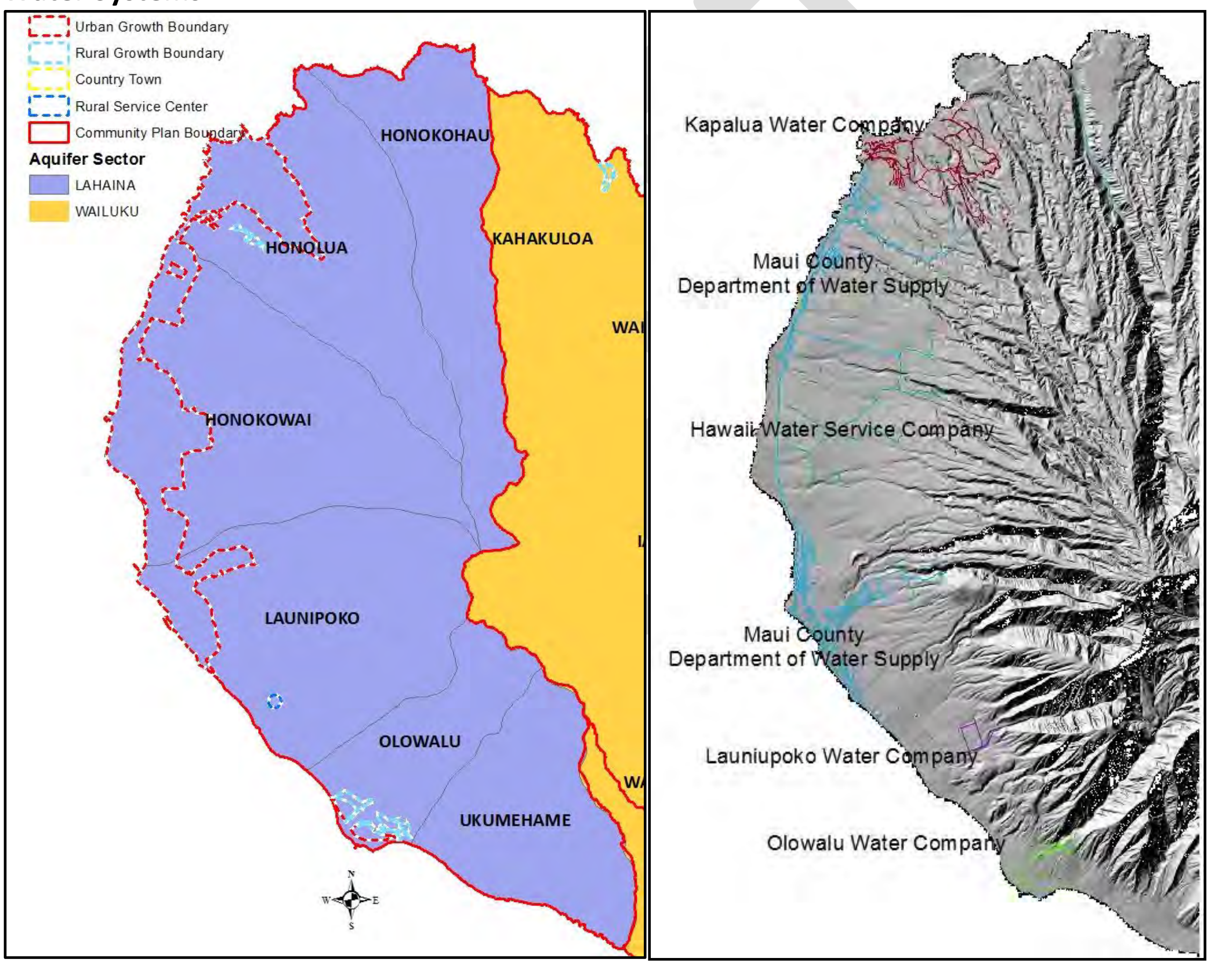
DEMAND (GPD)	2015	2020	2025	2030	2035
MDWS Potable*	35,575	37,392	39,298	41,293	43,405
DHHL Potable	0	63,000	63,000	63,000	63,000
Total Potable:	**35,575**	**100,392**	**102,298**	**104,293**	**106,405**
MDWS Non Potable**	5,274	5,544	5,826	6,122	6,435
DHHL Non Potable	0	13,500	13,500	13,500	13,500
Agriculture, Non Potable	180,000	180,000	180,000	180,000	180,000
Total Non-Potable	**185,274**	**199,044**	**199,326**	**199,622**	**199,935**
TOTAL DEMAND	**220,849**	**299,436**	**301,624**	**303,915**	**306,340**
SUPPLY (GPD)					
DHHL Fog Drip Catchment and Truck Haul		76,500	76,500	76,500	76,500
Potable surface water import Central/Ko`olau ASEAs***	35,575	37,392	39,298	41,293	43,405
Non-Potable Surface and Groundwater	**185,274**	**185,544**	**185,826**	**186,122**	**186,435**
TOTAL SUPPLY	**220,849**	**299,436**	**301,624**	**303,915**	**306,340**

*Kanaio
**Kaupō
*** Po`okela well in Central ASEA can backup Upper Kula System which receives Ko`olau ASEA surface water from Haipuaena, Waikamaoi, and Puohokamu streams.

ES.5.6 Lahainā Aquifer Sector Synopsis

The population of West Maui is projected by the Maui Island Plan to increase by 64% to 39,911 people by 2035. Population growth based demand would increase from about 9 mgd to 16 mgd, within a range of 14 – 17 mgd. All water supply used in the region, including groundwater and surface water, is generated within the Lahainā Aquifer Sector. While most public water supply on the island is provided by the Maui Department of Water Supply, the Lahainā region is also served by multiple privately owned water purveyors that provide potable and non-potable water.

Figure ES.12 Lahainā Aquifer Sector, Community Plan, Growth Boundaries and Municipal Water Systems



Groundwater sustainable yield (SY) of 34 mgd can satisfy projected population growth based demand by 2035. The growth in irrigation demand currently served by surface and recycled water is highly uncertain but assumed to increase at an equal rate as visitor units. With no significant anticipated increase in agricultural irrigation, total 2035 demand will be about 35 mgd. Interim Instream Flow Standards (IIFS) are addressed for a portion of the Lahainā streams in 2018. Increased reliance on groundwater to provide for future potable needs and a seasonal approach to surface and groundwater use is consistent with anticipated stream restoration in the region. About 2 mgd of recycled water, targeted conservation and committed watershed augmentation can sustainably diversify supply to address climatic changes and a potential decreased water supplies.

Figure ES.13 Lahainā Aquifer Sector Resources and 2035 Demand (MGD)

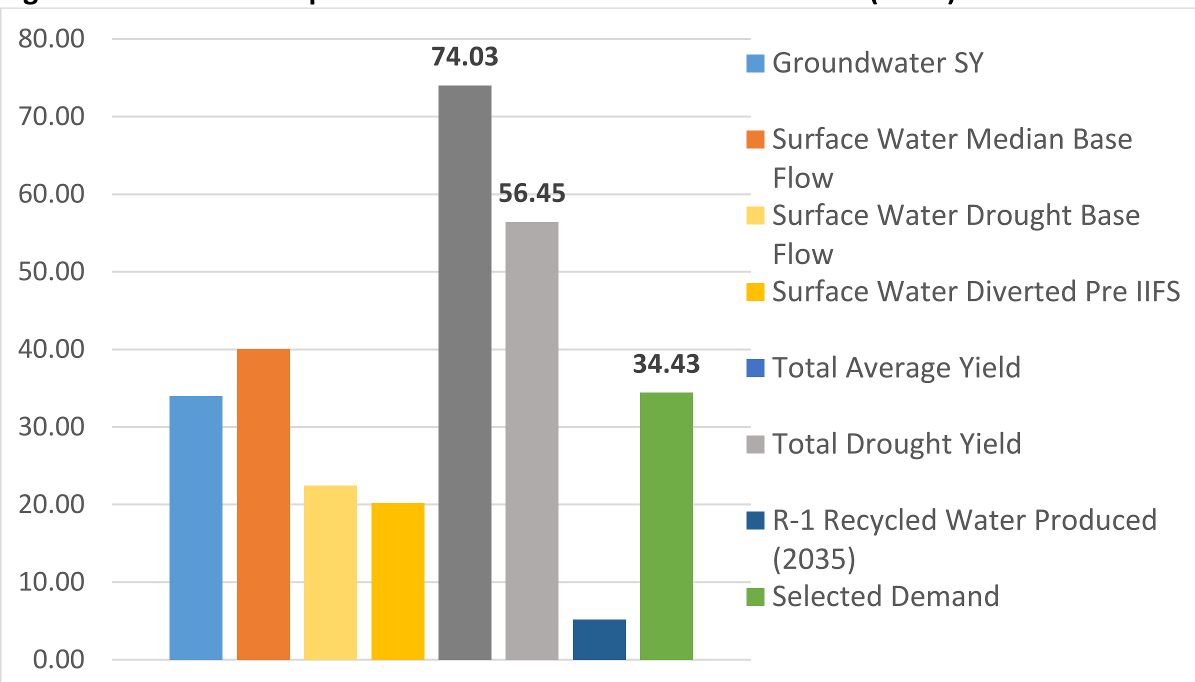


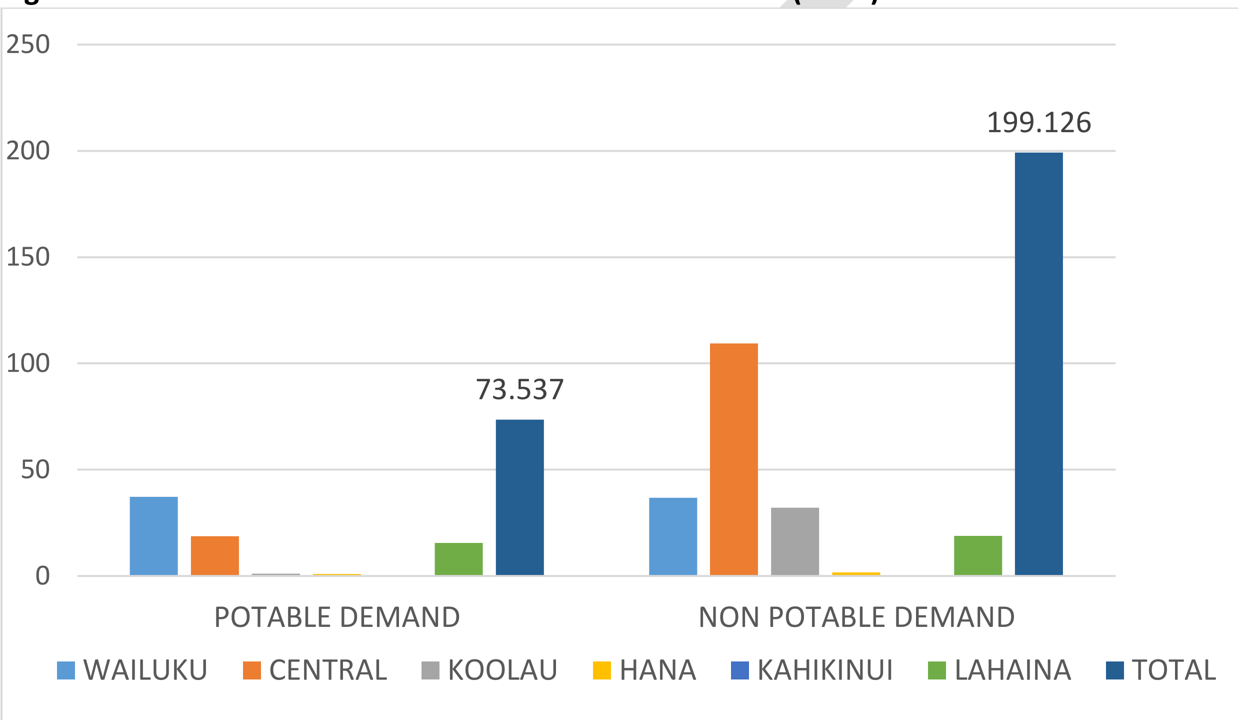
Table ES.9 Lahainā Selected Demand Scenario and Supply Options

DEMAND (MGD)	2014	2015	2020	2025	2030	2035
Domestic Potable	0.036	0.037	0.042	0.049	0.055	0.060
MDWS Potable	5.478	5.574	6.393	7.442	8.315	9.191
Municipal Private Potable	3.757	3.823	4.384	5.104	5.703	6.303
Total Potable Demand	**9.271**	**9.434**	**10.819**	**12.595**	**14.073**	**15.554**
Irrigation Non-Potable	13.000	13.065	13.392	13.720	14.178	14.876
Agriculture Non-Potable	4.000	4.000	4.000	4.000	4.000	4.000
Total Non-Potable Demand	**17.000**	**17.065**	**17.392**	**17.720**	**18.178**	**18.876**
TOTAL DEMAND	**26.271**	**26.499**	**28.211**	**30.315**	**32.251**	**34.430**
SUPPLY						
Potable Surface Water	3.300	3.300	3.300	2.500	2.500	2.500
Potable Groundwater	5.971	6.134	7.519	10.095	11.573	13.054
Total Potable Supply	**9.271**	**9.434**	**10.819**	**12.595**	**14.073**	**15.554**
Recycled R-1	1.330	1.330	2.000	3.000	5.230	5.230
Conservation 8% per capita	0.000	0.000	0.410	0.820	1.229	1.639
Non-Potable Supply (Brackish GW/Surface water subject to IIFS	**15.670**	**15.735**	**14.982**	**13.901**	**11.719**	**12.007**
TOTAL SUPPLY	**26.271**	**26.499**	**28.211**	**30.315**	**32.251**	**34.430**

ES.6 Island Wide Projected Water Demand and Supply

Population is projected to increase island-wide 31% from 157,087 to 207,000 in 2035. Based on the County General Plan and socio-economic forecast, Kīhei-Mākena and West Maui Community Plan areas will have increasing shares of the island population. 16.8 million visitors vacation on Maui each year, an estimated 46,000 visitors a day. The lion's share of projected water use is for non-potable needs, primarily agricultural irrigation. Total 2035 demand is projected to 272.66 million gallons per day (MGD).

Figure ES.14 Potable and Non Potable Demand Maui Island (MGD)



The selected population growth based demand scenario is compared to ultimate build-out of County zoning and Department of Hawaiian Homeland land use designations. Build-out, or full utilization of agricultural zoned land is not deemed realistic over the planning period and is highly variable depending on region, crops, ambient rainfall and other factors.

Table ES.9 Zoning Build-Out Based Water Demand, Maui Island (MGD)

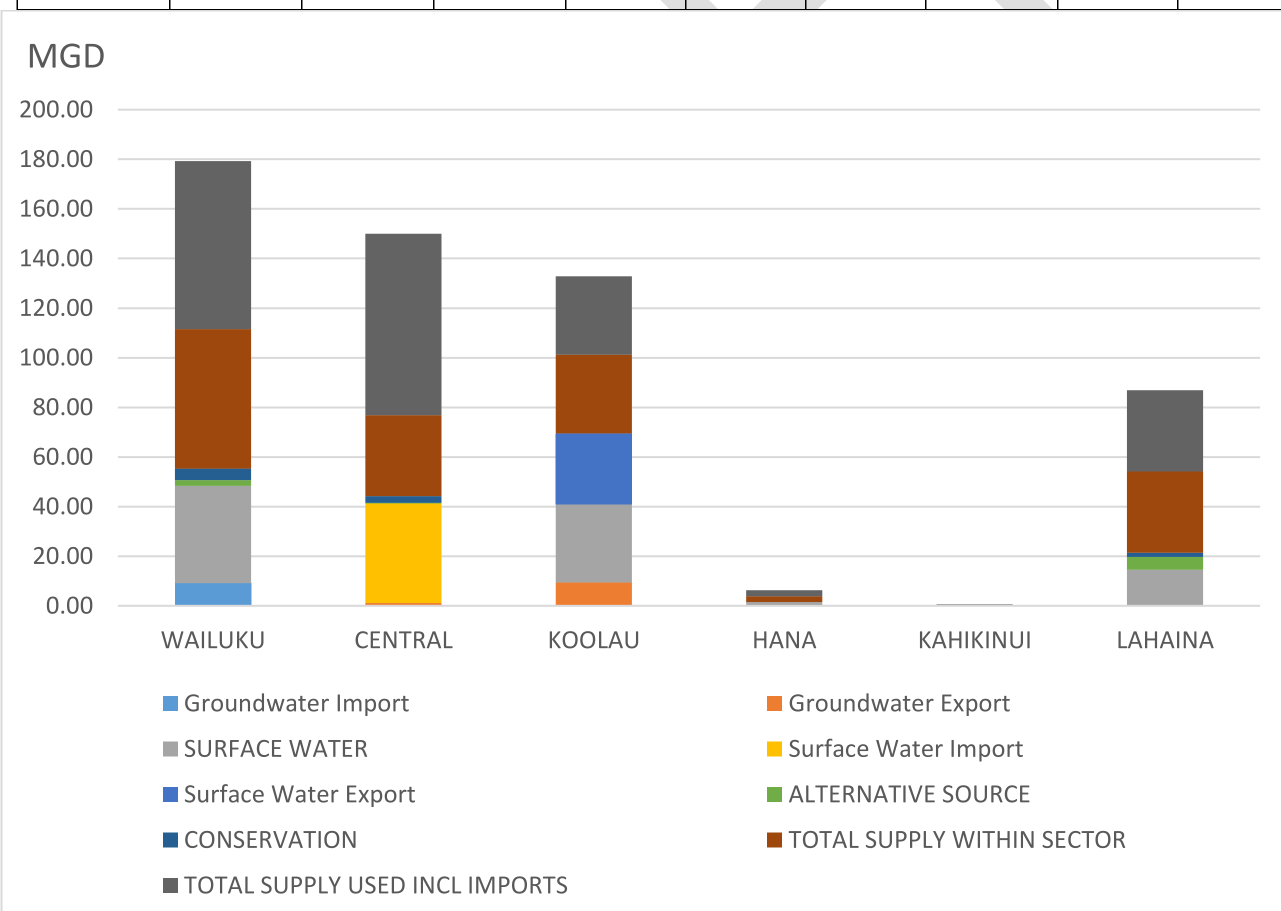
County Zoning Designations Excl. Agricultural	94.87
DHHL Land Use Based	51.51
County Zoning Excluding Agricultural, DHHL	**144.07**
Total Land Use Based, Incl. Agricultural	**1,007.08**

MDWS based on CWRM Reports, DHHL plans, Maui County Planning Department zoning.

Water resources to meet projected demand on an island wide basis are illustrated in the chart below. Conventional water resource transports are indicated, as well as alternative resources – recycled wastewater, fog drip and conservation.

Figure ES.15 Water Resource Supply Maui Island (MGD)

AQUIFER SECTOR	Ground-water in Aquifer Sector	Ground-water Import	Ground-water Export	Surface Water in Aquifer Sector	Surface Water Import	Surface Water Export	Altern-ative Source	Conser-vation	TOTAL SUPPLY
WAILUKU	17.11	9.09		39.23			2.28	4.65	67.71
CENTRAL	32.71		1.09		40.20		0.19	2.68	73.10
KOOLAU	0.09		9.40	31.59		28.50	0.00	0.00	31.68
HANA	0.92			1.46			0.00	0.00	2.38
KAHIKINUI	0.19			0.00	0.04		0.08	0.00	0.31
LAHAINA	13.05			14.51			5.23	1.64	32.79
TOTAL	**64.06**	**9.09**	**10.49**	**86.79**	**40.24**	**28.50**	**7.78**	**8.97**	**207.96**



ES.7 General Recommendations and Implementation

A combination of resource augmentation, developing and expanding the use of alternative resources and conservation measures can delay the need for source development and diversify our water supply to prepare us for climate change impacts. This update to the Water Use and Development attempts to address many questions and concerns that pertain to water resource use and management to help define responsibilities and needs. The recommended water resource allocations should guide and support planned growth consistent with the adopted General Plan and the Directed Growth Strategy. Together, the Water Use and Development Plan and the Maui Island Plan make up a framework to ensure that land use and infrastructure planning are integrated and provide guidance for resource use and infrastructure development.

Water Resource Sustainability is the foundation of responsible use and development of the island's water resources. Key strategies that address water quality, conservation, water resource protection and restoration apply island wide and reflect overall goals adopted in the Maui Island Plan. It is expected that the consultation process and *Ka Pa'akai* analysis initiated for this plan will continue in order to identify and protect native Hawaiian cultural, historical and natural resources and help ensure native Hawaiian customary and traditional rights.

Time frames for implementation, lead roles of agencies and organizations tasked with actions to implement the policies and strategies are identified but expected to be further defined. Actual implementation will depend on level of funding, detailed project design and planning, and other factors. The WUDP does not legally bind the agencies and organizations to implement adopted strategies and activities, rather the plan provides a guidance for land use and infrastructure, including the county capital improvement program, over the planning period.

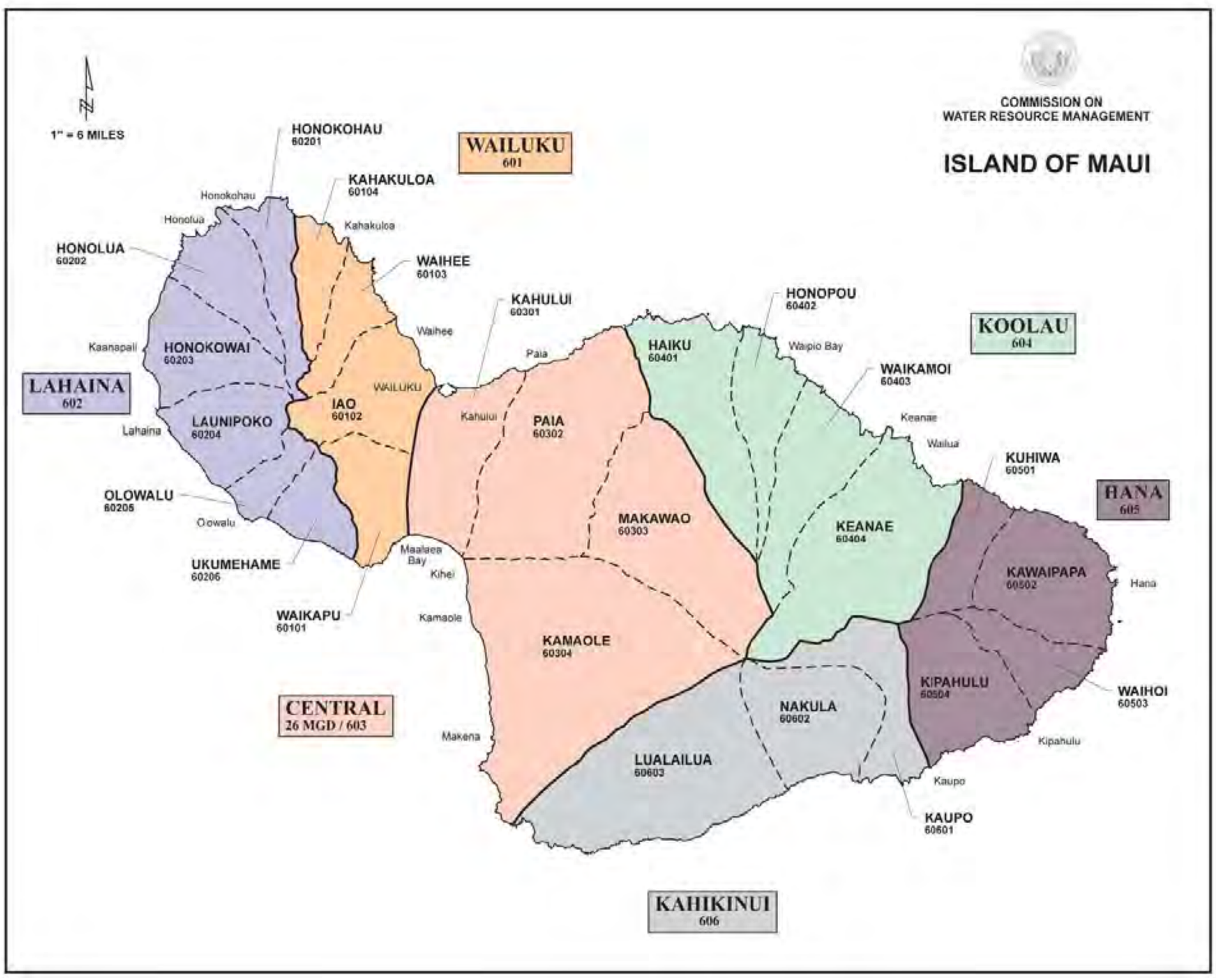
PART I

INTRODUCTION AND TECHNICAL APPROACH

INTRODUCTION

The Water Use and Development Plan (WUDP) is part of the *Hawai`i Water Plan* which serves as a comprehensive, long-range planning guide for use by the Commission on Water Resource Management (CWRM) for the protection, conservation, and management of Hawai`i's water resources. The WUDP aids CWRM and the County in the conservation, development, and use of the water resources of the County. The Maui County WUDP was adopted by Maui County ordinance and endorsed by the Mayor on October 19, 1990 and accepted by the CWRM on November 14, 1990 and is being incrementally updated for each island. This document is the Maui Island WUDP, a component of the Maui County WUDP. The plan is based on hydrologic units as required by the State Water Code and the planning period extends to 2035. There are six Aquifer Sector Areas with a total sustainable yield of 427 million gallons per day (mgd) of groundwater.

Figure 1-1 Commission on Water Resource Management Aquifer Management Sectors and Systems



Water Resources Protection Plan, 2008

1.0 REGULATORY FRAMEWORK

1.1 State Regulatory Framework

State Constitution

Under Article XI, Section 7, of the State Constitution, “The State has an obligation to protect, control, and regulate the use of Hawai`i's water resources for the benefit of its people.” This is the essence the Public Trust Doctrine which considers both the public's right to use and enjoy trust resources, and the private property rights that may exist in the use and possession of trust resources. However, the balancing of public and private interests begins with a presumption in favor of public use, access, and enjoyment.

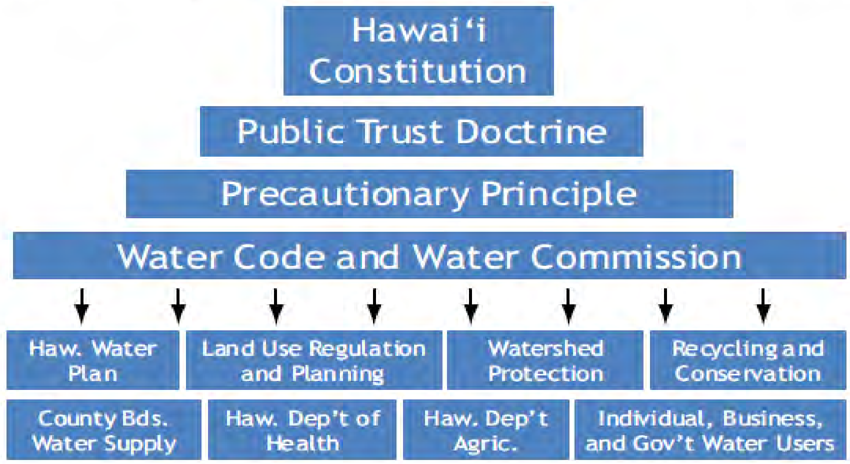
State Water Code

In 1987, the State Legislature passed the State Water Code (Hawai`i Revised Statutes, Chapter 174-C) to “protect, control, and regulate the use of Hawai`i’s water resources for the benefit of its People.” It provided for a Commission on Water Resource Management (CWRM) to administer the Water Code and protect and enhance the water resources of the state of Hawai`i through wise and responsible management.

HRS §174-C-2(c) specifies, “The State Water Code shall be liberally interpreted to obtain maximum beneficial use of the waters of the State for purposes such as domestic uses, aquaculture uses, irrigation and other agricultural uses, power development, and commercial and industrial uses. However, adequate provision shall be made for the protection of traditional and customary Hawaiian rights, the protection and procreation of fish and wildlife, the maintenance of proper ecological balance and scenic beauty, and the preservation and enhancement of waters of the State for municipal uses, public recreation, public water supply, agriculture, and navigation. Such objectives are declared to be in the public interest.” The CWRM is charged with balancing public trust purposes and other beneficial uses.

The Water Code required formulation of a Hawai`i Water Plan*,* which serves as a dynamic, long range planning guide for the Commission in its functions through an integrated program for the protection, conservation, and management of the waters of the State. The *Hawai`i Water Plan* consists of the *Water Resource Protection Plan*, *Water Quality Plan*, *State Water Projects Plan*, *Agricultural Water Use and Development Plan* (AWUDP), and County Water Use and Development Plans (WUDP) prepared by each county and adopted by its county council and the CWRM.

Figure 1-2 Law and Policy Framework for Water Resource Management in Hawai`i



Hawai`i Climate Change Adaptation Priority Guidelines, Figure 7, Law and Policy Framework for Water Resource Management in Hawai`i

Public Trust Doctrine

The Hawai`i Supreme Court has identified four trust purposes which are equally protected under the law, three found *In the Matter of Water Use Permit Applications, Petitions for Interim Instream Flow Standard Amendments, and Petitions for Water Reservations for the Waiahole Ditch Combined Contested Case Hearing*, and a fourth in its 2004 decision, *In the Matter of the Contested Case Hearing on Water Use, Well Construction, and Pump Installation Permit Applications,* filed by Waiola o Moloka'i, Inc. and Moloka'i Ranch, Limited.

- Maintenance of waters in their natural state;
- Domestic water use of the general public, particularly drinking water;
- The exercise of Native Hawaiian and traditional and customary rights, including appurtenant rights; and
- Reservations of water for Hawaiian Home Land allotments.

The Court also identified the following principles for the water resources trust, which apply to both surface and groundwater resources.

- The State has both the authority and duty to preserve the rights of present and future generations in the waters of the State;
- This authority empowers the State to revisit prior diversions and allocations, even those made with due consideration of their effect on the public trust;
- The State also bears the affirmative duty to take the public trust into account in the planning and allocation of water resources and to protect public trust uses whenever feasible;

- Competing public and private water uses must be weighed on a case-by-case basis, and any balancing between public and private purposes begins with a presumption in favor of public use, access, and enjoyment;
- There is a higher level of scrutiny for private commercial uses, with the burden ultimately lying with those seeking or approving such uses to justify them in light of the purposes protected by the trust; and
- Reason and necessity dictate that the public trust may have to accommodate uses inconsistent with the mandate of protection, to the unavoidable impairment of public instream uses and values. Offstream use is not precluded but requires that all uses, offstream or instream, public or private, promote the best economic and social interests of the people of the State.

The Precautionary Principle

The precautionary principle (or precautionary approach) states that if an action or policy has a suspected risk of causing harm to the public or to the environment, in the absence of a consensus on scientific evidence that the action or policy is not harmful, the burden of proof that it is *not* harmful falls on those taking an action that may or may not be a risk to public or environmental health. The principle is used by policy makers to justify discretionary decisions in situations where there is the possibility of harm from making a certain decision (e.g. taking a particular course of action) when extensive scientific knowledge on the matter is lacking. The principle implies that there is a social responsibility to protect the public from exposure to harm, when scientific investigation has found a plausible risk. These protections can be relaxed only if further scientific findings emerge that provide sound evidence that no harm will result. The Maui Island Plan (MIP) requires that Native Hawaiian water rights be incorporated into water planning.

According to the State of Hawai`i Water Plan, Water Resources Protection Plan, when scientific evidence is preliminary and not conclusive regarding the management of the water resources trust, it is prudent to adopt "precautionary principles." The Hawai`i Supreme Court's interpretation as explained in the Waiahole Water Case is as follows:

- As with any general principle, its meaning must vary according to the situation and can only develop over time. At a minimum, the absence of firm scientific proof should not tie the Water Commission's hands in adopting reasonable measures designed to further the public interest.

- The precautionary principle simply restates the commission's duties under the State Constitution and the State Code. The lack of full scientific certainty does not extinguish the presumption in favor of public trust purposes or vitiates the Water Commission's affirmative duty to protect such purposes wherever feasible. Nor does its present inability to fulfill the instream use protection framework render the statute's directives any less mandatory. In requiring the Water Commission to establish instream flow standards at an early planning stage, the State Water Code contemplates the designation of the standards based not only on scientifically proven facts, but also on future predictions, generalized assumptions, and policy judgments. Neither the State Constitution nor the State Water Code constrains the Water Commission to wait for full scientific certainty in fulfilling its duty toward the public interest in minimum instream flows.

The Court's linking of the Public Trust Doctrine to the precautionary principle offers significant guidance to water resource management. The tenets of the precautionary principle state that:

- There is a duty to take anticipatory action to prevent harm to public resources;
- There is an obligation to examine the full range of alternatives before starting a new activity and in using new technologies, processes, and chemicals; and
- Decisions should be open, informed, and democratic and include affected parties.

In this regard, "precautionary actions" may include:

- Anticipatory and preventive actions;
- Actions that increase rather than decrease options;
- Actions that can be monitored and reversed;
- Actions that increase resilience, health, and the integrity of the whole system; and
- Actions that enhance diversity.

The Public Trust Doctrine establishes a general duty to take precautionary actions and thus shifts the burden of proof to non-trust purposes and requires preventive action in the face of uncertainty.[1] Note that, while these principles are directed at surface water resources, they apply equally to groundwater resources.

Water Rights and Uses

The State Water Code[2] and the common law govern water rights and uses in Hawai`i. According to the State of Hawai`i Water Plan, Water Resource Protection Plan[3] the State Water Code preserved appurtenant rights but not correlative and riparian rights in designated water management areas. Thus, when a groundwater management area is designated, existing correlative uses within that area can be issued water use permits under the existing use provisions of the State Water Code, but unexercised correlative rights are extinguished. Similarly, when a surface water management area is designated, existing riparian uses within that area are eligible for water use permits as existing uses, but unexercised riparian rights are extinguished. Furthermore, the Hawai`i Supreme Court has ruled that when there is an undisputed, direct interrelationship between the surface and groundwaters, designation of a groundwater management area subjects both ground and surface water diversions from the

[1] State Water Resources Protection Plan, p 2-5.
[2] HRS 174C, §§ 174C-1 to 174C-101.
[3] State Water Resources Protection Plan, p 2-6.

designated area to the statutory permit requirement.[4] Presumably, permits would also be required for ground and surface water diversions when the interrelationship occurs in a surface water management area.

While water use permits are required only in designated water management areas and the common law on water rights and uses continue to apply in non-designated areas, other provisions of the State Water Code apply throughout the state. Thus, for example, well construction and pump installation permits are required for any new or modified groundwater use, and stream diversion and stream alteration permits are required for any new or modified surface water diversions. If the proposed stream diversion will affect the existing instream flow standard, a successful petition to amend the interim instream flow standard is also required.

Riparian Rights

Riparian rights are rights of land adjoining natural watercourses and are the surface water equivalent of correlative rights to groundwaters; i.e., the use has to be on the riparian lands, the use has to be reasonable, and the exercise of those rights cannot actually harm the reasonable use of those waters by other riparian landowners. The Court had originally stated that the right was to the natural flow of the stream without substantial diminution and in the shape and size given it by nature[5], but later concluded that the right should evolve in accordance with changing needs and circumstances. Thus, in order to maintain an action against a diversion which diminishes the quantity or flow of a natural watercourse, riparian owners must demonstrate actual harm to their own reasonable use of those waters.[6]

Correlative Rights

Under the common law, owners of land overlying a groundwater source have the right to use that water on the overlying land, as long as the use is reasonable and does not injure the rights of other overlying landholders.[7] When the amount of water is insufficient for all, each is limited to a reasonable share of the groundwater. Overlying landowners who have not exercised their correlative rights cannot prevent other landowners from using the water on the theory that they are using more than their reasonable share. They must suffer actual, not potential, harm. Only when landowners try to exercise their correlative rights and the remaining water is insufficient to meet their needs, can they take action to require existing users to reduce their uses.

---

[4] *In re Water Use Permit Applications*, 94 Haw. 97, at 173; 9 P3d 409, at 485 (2000).
[5] *McBryde v Robinson*, 54 Haw. 174, at 198; 504 P.2d 1330, at 1344 (1973); *aff'd on rehearing*, 55 Haw. 260; 517 P.2d 26 (1973); *appeal dismissed for want of jurisdiction and cert. denied*, 417 U.S. 962 (1974).
[6] *Reppun v Board of Water Supply*, 65 Haw. 531, at 553; 656 P.2d 57, at 72 (1982).
[7] *City Mill Co. v Hon. S. & W. Com.*, 30 Haw. 912 (1929).

Appurtenant Rights

Appurtenant water rights are rights to the use of water utilized by parcels of land at the time of their original conversion into fee simple lands i.e., when land allotted by the 1848 Māhele was confirmed to the awardee by the Land Commission and/or when the Royal Patent was issued based on such award, the conveyance of the parcel of land carried with it the appurtenant right to water[8]. The amount of water under an appurtenant right is the amount that was being used at the time of the Land Commission award and is established by cultivation methods that approximate the methods utilized at the time of the Māhele, for example, growing wetland taro[9]. Once established, future uses are not limited to the cultivation of traditional products approximating those utilized at the time of the Māhele,[10] as long as those uses are reasonable, and if in a water management area, meets the State Water Code's test of reasonable and beneficial use ("the use of water in such a quantity as is necessary for economic and efficient utilization, for a purpose, and in a manner which is both reasonable and consistent with the State and county land use plans and the public interest"). As mentioned earlier, appurtenant rights are preserved under the State Water Code, so even in designated water management areas, an unexercised appurtenant right is not extinguished and must be issued a water use permit when applied for, as long as the water use permit requirements are met.

The law with regards to appurtenant rights is not clear. The Supreme Court in Reppun[11] held that where a landowner attempted to reserve an appurtenant right while selling the underlying land, the reservation is not valid and the attempt to reserve extinguishes the appurtenant right. In doing so, the Court reasoned that there is nothing to prevent a transferor from effectively providing that the benefit of the appurtenant right not be passed to the transferee.[12] This difference is due to the Court's interpretation that riparian rights had been created by the 1850 statute, so any attempt by the grantor to reserve riparian water rights in the deed when riparian lands are sold is invalid. Presumably, the inconsistency could be cured by legislation providing a statutory basis for appurtenant rights. In fact, the Court in the Waiahole Water Case cited to the State Water Code's recognition of appurtenant rights and legislative comment to the effect that "[a]ppurtenant rights may not be lost."[13] However, the Court did not explicitly discuss its prior Reppun decision, so it is unclear whether its Waiahole decision overruled Reppun.

Appropriated Uses

Appropriated uses are uses of surface or groundwaters on non-riparian or no overlying lands. In the case of groundwater, "[P]arties transporting water to distant lands are deemed mere 'appropriators,' subordinate in right to overlying landowners …[T]he correlative rights rule

---

[8] 54 Haw. 174, at 188; 504 .2d 1330, at 1339.
[9] 65 Haw. 531, at 554; 656 P.2d 57, at 72.
[10] *Peck v Bailey*, 8 Haw. 658, at 665 (1867).
[11] 65 Haw. 531, at 552; 656 P.2d 57, at 71 (1982).
[12] Ibid.
[13] Ibid.

grants overlying landowners a right only to such water as necessary for reasonable use. Until overlying landowners develop an actual need to use groundwater, non-overlying parties may use any available 'surplus' (citations omitted)."[14] For surface waters, "the effect of permitting riparian owners to enjoin diversions beneficial to others in the absence of a demonstration of actual harm may occasionally lead to wasteful or even absurd results… The continuing use of the waters of the stream by the wrongful diversion should be contingent upon a demonstration that such use will not harm the established rights of others."[15] Thus, appropriated uses are not based on water rights but are allowed as long as they are reasonable and do not actually impinge on correlative and riparian rights. Note that appurtenant uses would be a type of appropriated uses if they were not based on appurtenant rights, and that in fact, the history of appurtenant uses in the Kingdom of Hawai`i has led to their establishment as water rights superior to riparian rights. Also note that when a water management area is designated, appropriated uses become superior to unexercised water rights, because appropriated uses become existing uses and are eligible for water use permits, while unexercised correlative and riparian rights are extinguished.

Obsolete Rights: Prescriptive and Konohiki Rights

Until 1973, surface waters were treated as private property and could be owned. Prescriptive water rights were the water equivalent of "adverse possession" in land ownership, where open and hostile occupation of another's private property for a specified number of years entitled the occupier to take legal ownership, because it raised the legal presumption of a grant. Prescriptive rights to water were exercisable only against the ownership of other private parties and not against the government. Thus, under prescriptive rights, appropriated uses could ripen into a prescriptive right superior to riparian rights. (Some early Court cases viewed appurtenant rights as a type of prescriptive right.) In 1973, the Court voided private ownership of water resources and prescriptive rights because of public ownership of all surface waters[16]. As for groundwater, two early cases (1884[17] and 1896[18]) reflected the then prevailing law on surface waters that water could be private property, but those cases also concluded that prescriptive rights cannot be exercised against subterranean waters that have no known or defined course, i.e., you could not adversely possess what you could not see. In 1929, the Court adopted the correlative rights rule[19], in which the overlying landowners could not use the water as they pleased, because it was a shared resource.

Until 1973, "konohiki lands," or lands whose title had passed from persons documented as konohiki, owned the "normal daily surplus water" in excess of waters reserved by appurtenant and prescriptive rights. (Despite a number of earlier cases, in 1930 the Court had concluded

[14] 94 Haw. 97, at 178; 9 P3d 409, at 490 (2000).
[15] 65 Haw. 531, at 553-554; 656 P.2d 57, at 72 (1982).
[16] 54 Haw. 174; 504 P.2d 1330 (1973);
[17] *Davis v Afong*, 5 Haw. 216 (1884).
[18] *Wong Leong v Irwin*, 10 Haw. 265 (1896).
[19] *City Mill Co. v Hon. S. & W. Com.*, 30 Haw. 912 (1929).

that riparian rights had never been the law in Hawai`i.[20] The 1973 Court, instead of overturning that decision, found a statutory basis for riparian rights in the 1850 statute.) In 1973, in addition to voiding any private property interest in water, the Court ruled that there can be no "normal daily surplus water," because the recognition of riparian rights entitled owners of riparian lands to have the flow of the watercourse in the shape and state given it by nature. [21]

Native Hawaiian Water Rights

The following provisions on Native Hawaiian water rights are outlined in the State Water Code, HRS §174C-101:

> *(a) Provisions of this chapter shall not be construed to amend or modify rights or entitlements to water as provided for by the Hawaiian Homes Commission Act, 1920, as amended, and by chapters 167 and 168, relating to the Moloka'i irrigation system. Decisions of the commission on water resource management relating to the planning for regulation, management, and conservation of water resources in the State shall, to the extent applicable and consistent with other legal requirements and authority, incorporate and protect adequate reserves of water for current and foreseeable development and use of Hawaiian home lands foreseeable development and use of Hawaiian home lands as set forth in section 221 of the Hawaiian Homes Commission Act.*
>
> *(b) No provision of this chapter shall diminish or extinguish trust revenues derived from existing water licenses unless compensation is made.*
>
> *(c) Traditional and customary rights of aupua`a tenants who are descendants of native Hawaiians who inhabited the Hawaiian Islands prior to 1778 shall not be abridged or denied by this chapter. Such traditional and customary rights shall include, but not be limited to, the cultivation or propagation of taro on one's own kuleana and the gathering of hihiwai, opae, o`opu, limu, thatch, ti leaf, aho cord, and medicinal plants for subsistence, cultural, and religious purposes.*
>
> *(d) The appurtenant water rights of kuleana and taro lands, along with those traditional and customary rights assured in this section, shall not be diminished or extinguished by a failure to apply for or to receive a permit under this chapter.*

Native Hawaiian Cultural Rights

The Hawai`i State Constitution was amended in 1978 to specifically recognize traditional and customary Hawaiian practices:

---

[20] *Territory v Gay*, 31 Haw. 376 (1930); *aff'd* 52 F.2d 356 (9th Cir. 1931); *cert. denied* 284 U.S. 677 (1931).
[21] 54 Haw. 174, at 198; 504 P.2d 1330, at 1344 (1973).

Article XII Section 7. The State reaffirms and shall protect all rights, customarily and traditionally exercised for subsistence, cultural and religious purposes and possessed by aupua`a tenants who are descendants of Native Hawaiians who inhabited the Hawaiian Islands prior to 1778, subject to the right of the State to regulate such rights.

Traditional and Customary Rights Clarified by the Hawai`i Supreme Court

The Hawai`i Supreme Court has recognized that H.R.S. section 7-1 specifically protects the right to gather, although that right is limited to the items listed in the statute. Broader protection for the exercise of traditional and customary practices is clarified in H.R.S. section 1-1, extending those rights to the gathering of materials that are otherwise essential to a tenants way of life, including medicinal plants and upland subsistence farming practiced other the ahupua`a where Native Hawaiians regularly resided. Article XII, section 7 of the Hawai`i Constitution has been interpreted by Hawai`i courts as protecting gathering rights exercised beyond the boundaries of the aupua`a of residence, and have held that "legitimate traditional and customary practices must be protected to the extent feasible." The state does not have the "unfettered discretion to regulate the rights of aupua`a tenants out of existence." The state can, however, permit private property owners to exclude persons "pursuing non-traditional practices or exercising otherwise valid customary rights in an unreasonable manner" or on private property that is "fully developed."

Rights of Ahupua`a Residents

Gathering rights are protected by three sources in Hawai`i law according to the Hawai`i Supreme Court: H.R.S. sections 7-1 and 1-1, and article XII, section 7 of the Hawai`i Constitution. The court held that residents of an aupua`a may—for the purpose of practicing Native Hawaiian customs and traditions—enter undeveloped lands within the aupua`a to gather the items listed in H.R.S. section 7-1: "firewood, house-timber, aho cord, thatch, or ti leaf." The court also ruled that pursuant to article XII, section 7, courts are obligated "to preserve and enforce such traditional rights." It further determined that H.R.S. section 1-1 ensures the continuation of Native Hawaiian customs and traditions *not* specifically enumerated in H.R.S. section 7-1, which may have been practiced in certain aupua`a "so long as no actual harm is done thereby." [22] The court eventually ruled against Kalipi, but the case is important because it was the first in which the Hawai`i Supreme Court recognized the modern legal bases of traditional and customary rights: H.R.S. sections 7-1 and 1-1, and article XII, section 7 of the Hawai`i Constitution.[23]

In summary, the court ruled that: (1) mere ownership of property within an aupua`a is not sufficient to justify the exercise of traditional and customary rights in that aupua`a; (2) H.R.S. section 7-1 permits only hoa`aina (native tenants) to gather in the aupua`a where they live; (3) H.R.S. section 7-1 permits only hoa'aina to gather the items enumerated in that statute; (4)

[22] Kalipi, 66 Haw. at 10, 656 P.2d at 751.

[23] Forman, David M., Susan K. Serrano. *Ho'ohana Aku, a Ho'ola Aku: A legal primer for Traditional and Customary Rights in Hawai`i, 2012*

H.R.S. section 7-1 permits only hoa'aina to enter undeveloped (rather than fully developed) lands for the purpose of exercising traditional and customary rights; (5) the interests of the property owner and hoa'aina must be balanced; and (6) H.R.S. section 1-1 protects other traditional and customary practices that have continued without harm to property owners.[24]

Rights of Residents Outside Ahupua`a Boundaries

The Hawai`i Supreme Court held that under article XII, section 7, traditional and customary rights could be exercised for subsistence, cultural, and religious purposes on undeveloped lands beyond the aupua`a of residence, provided that “such rights have been customarily and traditionally exercised in this manner.” [25]

In summary, the court held: (1) hoa'aina can gather beyond the aupua`a in which they live, where such rights have been customarily and traditionally exercised in this manner; (2) hoa'aina can gather what is needed for traditional and customary Hawaiian subsistence, cultural and religious purposes; (3) hoa'aina may enter undeveloped lands to reasonably exercise their traditional and customary practices; and (4) the interests of the property owner and hoa'aina must be balanced.

Rights Exercised on Less Than Fully Developed Land

The Hawai`i Supreme Court in *Public Access Shoreline Hawai`i v Hawai`i County Planning Commission (1995) ("PASH")* provided a doctrine to resolve disputes in which Native Hawaiians seek to practice traditional rituals and gather materials related to their cultural practices in a reasonable manner on land that is privately owned. This modern property law, which draws from both western law and Native Hawaiian custom and tradition, provides guidance on the rights and expectations of private parties, as well as on agencies.[26]

In summary, PASH/Kohanaiki meant that: (1) hoa'aina can gather anywhere that such rights have been customarily and traditionally exercised in that manner; (2) hoa'aina can gather what is needed for traditional and customary subsistence, cultural and religious purposes; (3) hoa'aina can gather on land that is less than fully developed; (4) the government cannot regulate traditional and customary rights out of existence; (5) the balance weighs in favor of the property owner against hoa'aina who exercise otherwise valid customary rights in an unreasonable manner.

Duty of State Agencies to Protect Native Hawaiian Traditional and Customary Rights

The Hawai`i Supreme Court in *Ka Pa`akai O Ka `Aina v. Land Use Commission* (2000) provided an analytical framework “to effectuate the State’s obligation to protect Native Hawaiian

[24] Forman, *Ho`ohana Aku, a Ho'ola Aku: A legal primer for Traditional and Customary Rights in Hawai`i, 12.*
[25] Pele I, 73 Haw. at 620, 837 P.2d at 1272.
[26] 79 *Hawai*`i 425, 903 P.2d 1246. [1995]

customary and traditional practices while reasonably accommodating competing private [property] interests."[27] The Court enumerated three tests for agencies to protect traditional and customary Hawaiian practices to the extent feasible. Under this framework, state and county agencies must independently assess the following when reviewing land use applications:

> (A) The identity and scope of valued cultural and historical or natural resources in the petition area including the extent to which traditional and customary Native Hawaiian rights are exercised in the petition area;
> (B) The extent to which those resources including traditional and customary Native rights will be affected or impaired by the proposed action; and
> (C) The feasible action, if any, to be taken by the state to reasonably protect Native Hawaiian rights if they are found to exist.

For the purposes of this plan, proposed uses of water resources should be accompanied by inquiries into the impacts on traditional and customary rights to ensure that proposed water resource uses are pursued in a culturally appropriate way.

Statewide Framework for Updating the Hawai`i Water Plan

The *Statewide Framework*, 2000, provides guidance in updating WUDPs to insure a consistent and coordinated plan for the protection, conservation and management of our water resources, effective implementation by the counties, and use by the CWRM for resource management purposes. The Statewide Framework includes the following recommended plan elements for the County WUDP update process:

- County-Specific WUDP Project Description
- Coordination with CWRM on Water Resource Management
- Stakeholder and Public Involvement
- Development of Policy Objectives and Evaluation Criteria
- Description of Water System Profiles
- Identification of Resource and Facility Options
- Development and Evaluation of Strategy Options
- Implementation Plan

A revised Project Description was accepted by the CWRM in 2012 and updates to the CWRM and consultation with Commission staff have been ongoing throughout the process. The WUDP has been prepared with credible public and stakeholder involvement as outlined in this Plan and Appendix 7. Policy objectives and evaluation criteria were developed through the lengthy public process and used to evaluate resource and facility options in order to develop a coherent and viable implementation plan. More information on the State Framework is provided in Appendix 1.

[27] 94 Hawai`i 31, 7 P3d 1087 (2000)

Consistency with Laws and Policies

The WUDP provides overall policies, strategies and implementation plans to guide the actions of Maui County and provide advice to CWRM regarding the planning, management, conservation, use, development, and allocation of limited surface water and groundwater resources to 2035. The WUDP is intended to be part of a comprehensive and integrated framework to achieve these objectives including consistency with the following state, federal, and county laws and policy documents:

- Federal Safe Drinking Water Act
- State Constitution and State Water Code
- Hawai`i Water Plan and Statewide Framework for Updating the Hawai`i Water Plan
- Hawai`i Supreme Court Decisions on the Waiahole Ditch, the Waiola O Moloka'i, the Ka Pa`akai O Ka`aina, and Nā Wai `Ehā and East Maui Streams contested cases
- State land use classifications and policies
- Maui County Code
- Maui County General Plan, Maui Island Plan, Community Plans, and Zoning Designations
- DHHL Regional and Community Plans, Land Use Designations and Water Reservations
- Other state plans or guidelines such as the Hawai`i Drought Plan, Hawai`i Water Conservation Plan and Climate Adaption Guidelines

1.2 County Regulatory Framework

Maui Island WUDP

The purpose of the WUDP is "to meet the mandate of the State Water Code relative to statewide water resources planning and aid the Commission and the County in the conservation, development, and use of the water resources of 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." It provides guidance to the CWRM for decision-making on water management area designation and water use and water reservation requests. At the County level, the plan serves as the primary guide to the County Council, Maui County Department of Water Supply (MDWS), and all other agencies of the County in approving or recommending the use or commitment of water resources in the County, and in using public funds to develop water resources. (Maui County Code Chapter 14.02.)

The WUDP meets the statutory requirements of HRS 174C-31 and HAR 13-7-170, the State Water Code (HRS, 174C), and Maui County Code Chapter 2.88A, and addresses the recommended elements in the Statewide Framework for updates of WUDPs. Section 13-170-31, HAR states that the WUDP shall include but not be limited to:

(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, re-use, reclamation, recharge and resulting problems and constraints;
(2) Future land uses and water related needs; and
(3) Regional plans for water development, including recommended and alternative plans, costs, adequacy of plans and relationship to Water Resources Protection and Water Quality Plans.

Additional guidelines for preparing the WUDPs are provided in Administrative Rule §13-170-32:

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

The WUDP is intended to be consistent with the other elements of the Hawai`i Water Plan, the state land use classifications and polices, and County zoning and land use policies. It must also recognize Department of Hawaiian Homelands' development needs. The WUDP must be periodically updated to remain consistent with these plans and policies.

The Maui County WUDP was adopted by County ordinance and by CWRM in 1990 and is being incrementally updated for each island. An update adopted by Maui County Council in 2010 was not approved by CWRM, primarily because it was limited in scope to the Maui Department of Water Supply's (DWS) Central Maui District rather than all public trust purposes. In August 2012, the CWRM accepted a revised Project Description to comprehensively address all water resources and needs for public and private water systems and public trust purposes based on the Maui Island Plan growth rate projections. This document comprises the Maui Island component of the Maui County WUDP. The Lāna`i WUDP was updated in 2011 and the Moloka'i WUDP will be updated following adoption of this Maui Island WUDP.

County of Maui General Plan

The State Water Code as well as the Maui County Charter, Chapter 11, Section 8-11.2(3) mandate that County WUDPs be consistent with County land use plans and policies. The Maui Island WUDP provides policies and strategies for the protection, planning, management, and development of water resources to meet land use and projected demand development set forth in the Maui Island Plan.

The 2030 Maui County General Plan is comprised of the Countywide Policy Plan (2011), Maui Island Plan (MIP, 2012) and the Community Plans adopted in various years. The Socio-Economic Forecast for the General Plan was updated in July 2014 and the MIP Implementation Plan was adopted in 2015. The MIP provides direction for future growth, the economy, and social and environmental decisions through 2030 based on a vision founded on core values, goals, objectives, policies and actions. The MIP establishes a Directed Growth Strategy which identifies areas appropriate for future urbanization and revitalization. The WUDP does not propose alterations to existing land use and development patterns or those proposed by the MIP or Community Plans. However, the WUDP may identify land use patterns or policy directions in the MIP that make it more difficult or inefficient to meet the multiple objectives of the WUDP.

The MIP is used by County policy boards, staff and the community as a policy document for decision-making on discretionary development proposals and for developing, implementing and applying land use policies and regulations. Formulation of the WUDP has included relevant data, technical reports and resources derived from the MIP process and coordination with the Maui County Planning Department's Long Range Planning Division, which is responsible for the preparation, adoption and implementation of the MIP. In turn, projections, policies and strategies in the WUDP can inform the Community Plan updates and future MIP amendments.

The WUDP is intended to allocate water to existing and planned land use. The WUDP and the MIP make up a framework to ensure that land use and infrastructure planning are integrated and provide guidance for resource use and infrastructure development.

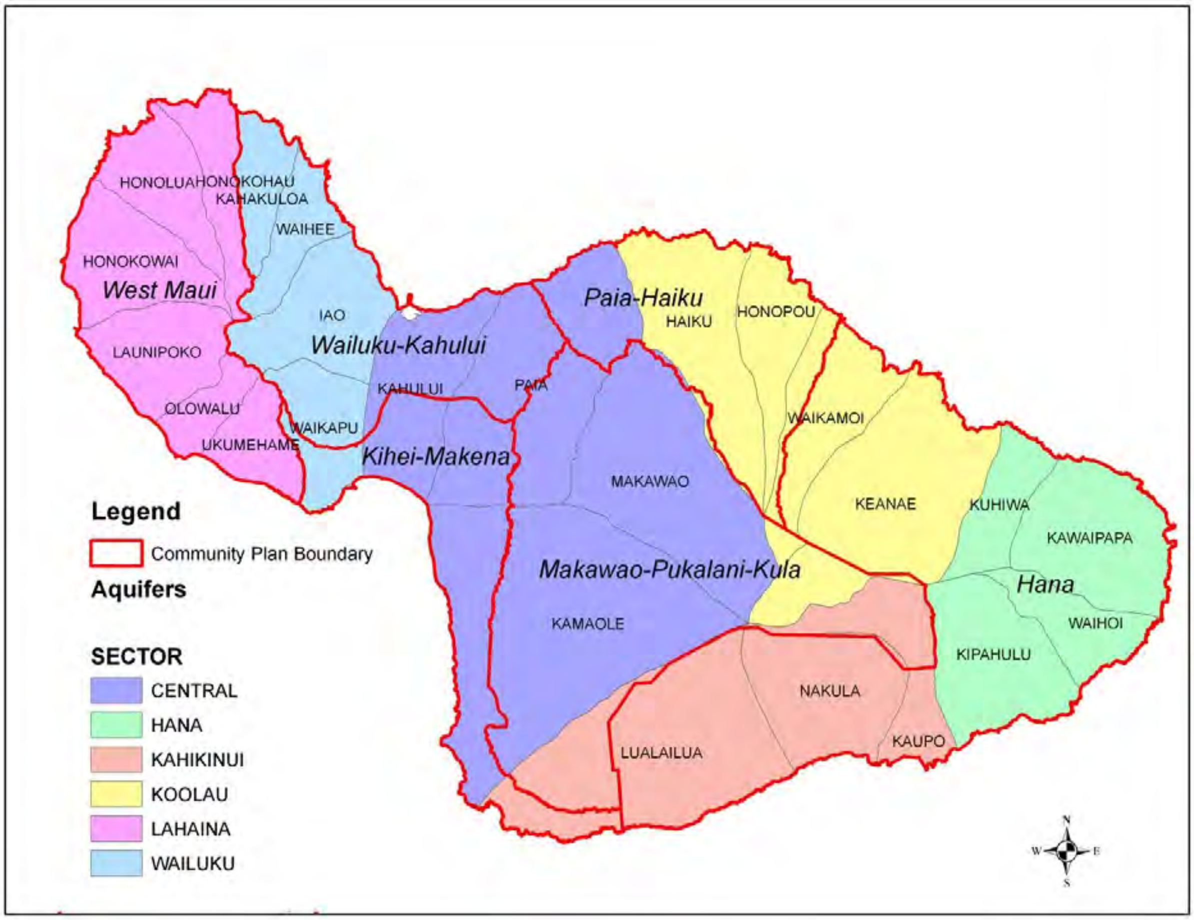
MIP policies applicable to the WUDP are listed in Appendix 2. The MIP water utility goal and objectives include:

Goal 6.3	Maui will have an environmentally sustainable, reliable, safe, and efficient water system.
Objective 6.3.1	More comprehensive approach to water resources planning to effectively protect, recharge, and manage water resources including watersheds, groundwater, streams, and aquifers.
Objective 6.3.2	Increase the efficiency and capacity of the water systems in striving to meet the needs and balance the island's water needs.
Objective 6.3.3	Improve water quality and the monitoring of public and private water.

Community Development Plans

Community Plans have been prepared for the Hāna, Pā`ia-Ha`ikū, West Maui, Makawao-Pukalani-Kula, Kīhei-Mākena and Wailuku-Kahului areas. They address a 20-year planning period and must be updated every 10 years per Maui County Code Chapter 2.08B. Each plan provides a land use map and addresses land use, density and design, transportation, cultural resources, community facilities and infrastructure in two-year increments, visitor accommodations, commercial and residential areas and other matters related to development of the planning area. With the exception of West Maui, community plan areas are not consistent with hydrologic units which are required to form the basis for water use planning in the WUDP as shown in the figure below.

Figure 1-3 Aquifers and Community Plan Areas

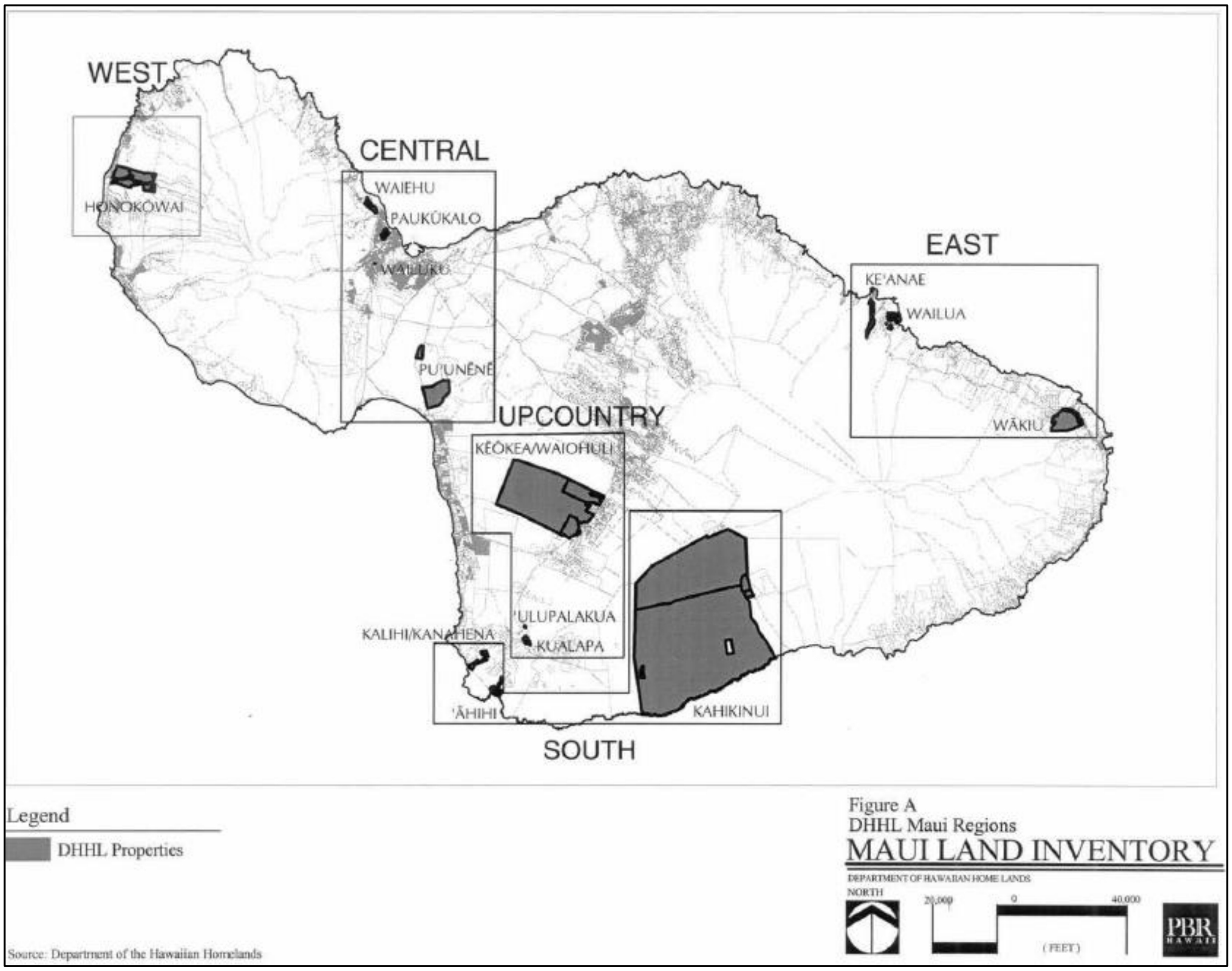


1.3 Other Policy Plans

State Department of Hawaiian Homelands (DHHL) Land Use Plans

The function of the Department of Hawaiian Home Lands (DHHL) is to serve Native Hawaiians and to administer its land trust throughout the State of Hawai`i. The primary method by which DHHL serves these beneficiaries is through 99-year homestead leases, which are land leases provided for residential, pastoral or agricultural use for the annual fee of one dollar. DHHL landholdings on Maui total more than 31,000 acres in five regions: Central Maui (Waiehu, Paukūkalo, and Pu'unēnē), West Maui (Honokōwai), Upcountry Maui (Kēōkea/Waiohuli, 'Ulupalakua, Kualapa), South Maui (Kahikinui, Kalihi/Kanahena, 'Āhihi), and East Maui (Ke`anae, Wailua, Wākiu).

Figure 1-4 DHHL Regions and Lands



DHHL developed a three-tier planning system to guide the development and use of Hawaiian homelands statewide. The Hawaiian Homes Commission adopted its Maui Island Plan as the overarching planning document in 2004. Subsequently the Kēōkea/Waiohuli, Kahikinui, Leiali`i-

Honokōwai and Waiehu Kou- Paukūkalo Regional Plans were adopted. A Water Policy Plan adopted in July 2014 (Appendix 3) states that the Hawaiian Homes Commission and DHHL's mission is to strive to ensure the availability of adequate, quality water by working cooperatively to:

- Understand our trust water assets;
- Plan for our water need;
- Aggressively understand, exercise and assert our kuleana as stewards of water;
- Develop and protect water sources; and
- Manage water systems.

Issues affecting DHHL and development projects proposed by DHHL within the next 20 years are incorporated into the land use based demand projections and the planning objectives and evaluation criteria. This will address reservations for water for Hawaiian Home Land allotments which is a public trust purpose.

Hawai`i Water Conservation Plan

The purpose of the *Hawai`i Water Conservation Plan*, 2013, is to identify and implement water use and delivery efficiency measures to conserve the fresh water resources of the state. The plan is intended to be a guiding document for the CWRM as they develop and implement water efficiency measures that can be implemented across the state by various water user groups.

Hawai`i Drought Plan

The purpose of the *Hawai`i Drought Plan*, 2017 Update, is to develop coordinated emergency response mechanisms and outline steps towards mitigating the effects of future drought occurrences. It provides a framework for integrating federal, State, County and private sector actions to reduce drought impacts. The Maui County Drought Committee participates in preparation of the County of Maui Drought Mitigation Strategy, which informs the County Multi-Hazard Mitigation Plan. The Maui Drought Committee is responsible for interfacing with agencies, stakeholders and the Hawai`i Drought Council, as well as monitoring groundwater, stream/ditch water, and reservoir conditions and the local impacts of drought.

Climate Change Adaptation Priority Guidelines

In 2012 the Hawai`i State legislature amended the Hawai`i State Planning Act, Chapter 226 HRS, by adding *Climate Change Adaptation Priority Guidelines* (Appendix 6). The Guidelines are intended to provide near-term implementation options to increase resilience and reduce vulnerability to risks related to climate change and a statewide strategy over the long-term. Under the Hawai`i State Planning Act, priority guidelines shall take precedence when addressing areas of concern such as County decision making and allocation of resources, county general plans and development plans, as well as capital improvement project appropriations and land use decision making.

The Guidelines states that climate change patterns already being seen in Hawai`i along with the forecast for increasing population and water demand underscore the need for “adaptive capacity” defined by laws and policies that require water management to be: (1) forward-looking—focused on both crisis avoidance and mitigation; (2) flexible—able to adjust to changing needs and conditions; (3) integrated—able to address climate-related impacts that cut across political and geographical boundaries; and (4) iterative—utilizing a continuous loop of monitoring, feedback and reevaluation. Potential adaptive tools that are not being implemented presently or are only partially implemented are provided in Appendix 6.

Hawaiʻi Fresh Water Initiative

The Hawai`i Fresh Water Initiative was launched in 2013 by the nonprofit Hawai`i Community Foundation to bring multiple, diverse parties including Hawai`i Fresh Water Council together to develop a forward-thinking and consensus-based strategy to increase water security for the Hawaiian Islands. The resulting report, “*A Blueprint for Action-Water Security for an Uncertain Future*” presents policy and decision makers with a state-wide goal of 100 mgd in additional fresh water capacity statewide and a set of solutions for adoption.[28] The report focuses on three aggressive water strategy areas and individual targets for the public and private to achieve by 2030:

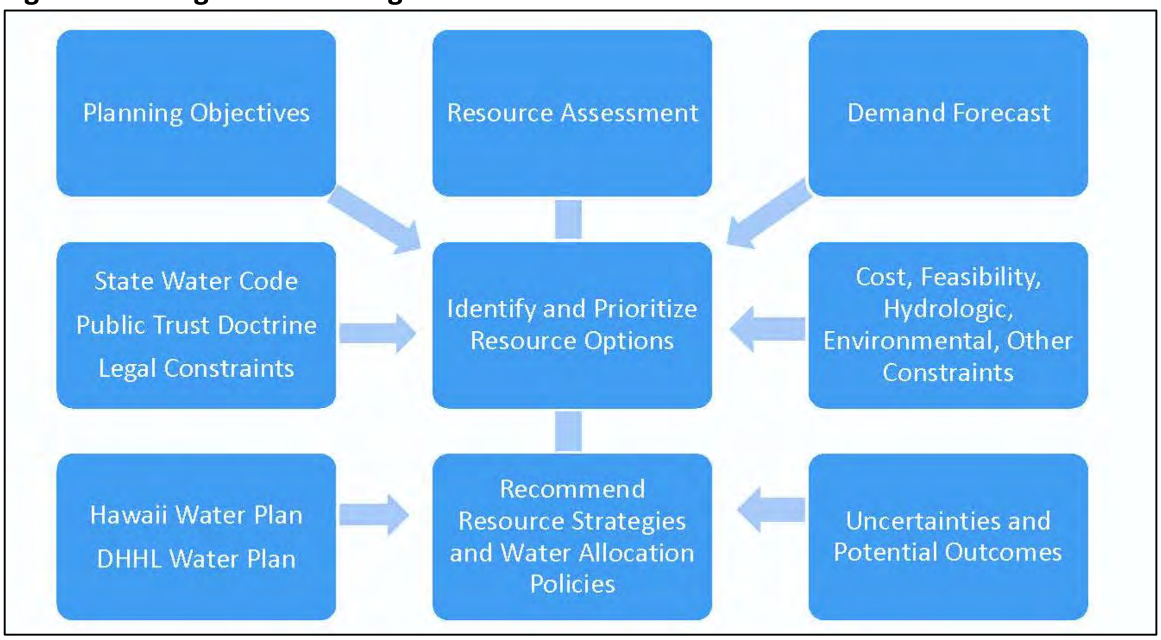
- **Conservation**: Improve the efficiency of the total underground aquifer water use rate by 8% from 330 gpd (statewide average) to 305 gpd per person. Target: 40 mgd in increased water availability by 2030.
- **Recharge**: Increase Hawai`i’s ability to capture rainwater in key aquifer sector areas by improving storm water capture and nearly doubling the size of our actively protected watershed areas. Target: 30 mgd in increased water availability by 2030.
- **Reuse**: More than double the amount of wastewater currently being reused in the Islands to 50 mgd. Target: 30 mgd in increased water availability by 2030.

[28] Hawaiʻi Community Foundation. 2015. *Hawaiʻi Fresh Water Initiative, A Blueprint for Action: Water Security for an Uncertain Future, 2016 – 2018*. http://www.Hawaiicommunityfoundation.org/strengthening/fresh-water

2.0 INTEGRATED PLANNING PROCESS

The CWRM Framework provides guidelines for applying an integrated resource planning process. Maui WUDP update adopts key components of this process, including definition of multiple planning objectives as a basis for criteria against which resource scenarios are evaluated, and strong community involvement. Alternative planning scenarios and resource strategies are presented that consider cost, benefits, social and environmental impacts. Integrated planning assumes that trade-offs among conflicting planning objectives are necessary. Informing decision-makers about legal, regulatory, or practical constraints and uncertainties are important in order to make difficult trade-offs. The components of this process is depicted in the figure below. It is noted that DHHL plans were also formulated through an interactive process as detailed in those plans.

Figure 2-1 Integrated Planning Process



Community Interests

Water planning, management, development and use affects and is important to virtually all people, segments of the population, and ecological systems on Maui. There are also stakeholders, interests, entities and communities who's engagement, cooperation and support will be important to the success of the WUDP and there are ways to categorize them. Some of the stakeholders and interests that were engaged during the WUDP process include:

Policy	Water Purposes / Needs
• CWRM, State Department of Health • Maui County Council, Council Water Resources Committee, Board of Water Supply	• Kuleana and Public Trust Doctrine uses • Holders of water rights, water use permits, reservations • Potable water users • Non-potable water users
Stakeholders and Target Interests	**Supporting Interests**
• Kuleana, Native Hawaiian community and beneficiaries • Business community • Agricultural community • Environmental community • Development community • Water purveyors • Landowners • Public agencies	• Public agencies • Scientific and educational community • Partnerships, program managers, organizations • Funding sources • Citizen scientists, advocates, volunteers

Community Participation Program

The public process included the following major components:

- The MIP was formulated through a lengthy and intensive public process and adopted in 2012. The Directed Growth Plan involved development of a set of Guiding Land Use Principles derived from the Focus Maui Nui WalkStory and PlanStory public outreach events and community workshops, planning literature and technical studies, followed by an iterative and integrated planning process in formulating and reviewing the plan components.
- The 1990 WUDP update process commenced in 2004 focusing on the MDWS Central Maui and Upcountry Districts, with community workshops and meetings, technical studies and policy board and CWRM input, culminating with adoption of the MDWS Central Maui District WUDP by the County Council; however, the CWRM declined to adopt this limited scope WUDP.
- A revised WUDP Project Description was submitted to and accepted by CWRM in 2012.
- Initial community meetings were held regionally in 2013/2014.
- Community meetings (12) were held regionally in 2016 in Central/South, West, Upcountry, and East Maui. The sets of meetings included Round 1 - Issue identification, Round 2 – Profiles, Objectives and Strategies, and Round 3 – Strategies to Address the Key Issues.
- Target interest group meetings were held in 2015 - 2017: Group of diverse interests (2), Aha Moku O Maui and regional moku (2), agricultural (2), realtors (1), Kaupō community (1), Maui County Cultural Resource Commission (2).
- Ka Pa`akai consultation process initiated in 2016.

- WUDP Survey distributed at meetings and online in 2016.
- Communications plan implemented in 2015/2016.
- All materials placed online.
- Progress reports provided 2016 through 2018 to the Board of Water Supply (8), the Council's Water Resources Committee (2), and CWRM (4).

3.0 MANAGEMENT FRAMEWORK

The WUDP is both a companion to and implementation component of the Maui Island Plan by allocating water to land use while protecting resources.

3.1 Issues and Concerns

The WUDP provides an opportunity to comprehensively plan for the management, development and use of our water resources consistent with the Statewide Framework, MIP and local planning objectives, as well as to tackle local issues, by articulating them, identifying solution and strategies, and working to resolve conflicts.

The WUDP is intended to allocate water to existing and planned land use. The MIP identifies the following challenges related to water systems:

- Native Hawaiian water rights must be incorporated into water planning.
- Lack of scientifically based interim instream flow standards which relate to water righrs and public trust purposes and planning for surface water resources.
- Future agricultural water use is uncertain.
- Comprehensive water resources planning and system control, while the County controls a relatively small percentage of the water on the island.
- MDWS budget constraints in the face of rising costs and infrastructure repair and replacement needs.
- Energy production and efficiency is a substantial component of MDWS costs.
- Private water systems and wells can undermine public systems or have the potential for contamination of water resources.

Many of the water system challenges identified in the MIP are specific to the MDWS water systems. The DHHL Water Policy addresses the need to ensure the availability of adequate, quality water to serve its beneficiaries and land uses. The WUDP addresses all water uses and users for which multiple issues were identified through the public process. Initial meetings with diverse community interests and stakeholders identified and provided feedback on key water issues not addressed in the MIP or through other venues.

During the community outreach process, tensions were identified involving water resource availability and management, diverse water uses and users, regionally based resources and uses, and water rights and priorities, among others. A synthesis of key issues for each region reflects these tensions:

East/Hāna: The impacts of water transport from East Maui streams on the ecosystem and public trust and other local uses. Relates to alternative ways to meet the future water needs of dependent regions.

West/Lahaina: Alternative ways to meet the future water needs of public trust and other local uses in the region given increased growth, climatic changes and potential decreased water supplies, while managing resources in a sustainable way.

Central/South: Alternative ways to meet the future water needs of all water uses and users in the region given increased growth especially in South Maui and reduced water transport from East Maui streams and Nā Wai `Ehā.

Upcountry: Alternative ways to provide reliable supply to the region including the potential for increased storage, given increased growth, climatic changes, and highly variable water supply in the face of reduced transport.

3.2 Values and Principles

While discussions during the WUDP community outreach process focused on water related issues and solutions, they also revealed aspects that Mauians value and treasure. The following overriding values are synthesized from input during the community outreach process.

'Wai' as a vital cultural and sustaining resource
Native Hawaiians and the Hawaiian culture value "wai" as a fundamental and necessary sacred element, and they continue to advocate for the rights to continuous flowing streams supported by healthy watersheds and nearshore environments.

Maui's natural beauty, native ecology and cultural heritage
Mauians are proud to reside in one of the most beautiful and distinctive places in the world. They value protection of Maui's native ecology as essential to preserving the island's beauty and cultural history, including its agrarian roots which support open spaces, Native Hawaiian culture, and local self-reliance and independence.

Sustainable water resources
Maui is blessed with abundant groundwater, streams and ocean resources to serve its diverse needs. The Native Hawaiians' mauka-to-makai aupua`a management system safeguarded adequate stream flow necessary to sustain human settlements, cultural traditions and natural ecosystems from one generation to the next.

Abundant, high quality water for all needs
Mauians value the availability of high-quality water to support social and economic needs, as well as the aspirations of all people and cultures that reside here.

The following principles capture values and beliefs prominently expressed by the community during public meetings as well as derived from the General Plan and other policy documents.[29]

[29] Many of the principles are stated in the Hawai`i Fresh Water Initiative's, "A Blueprint for Action, Water Security for an Uncertain Future, 2016-2018 which captures well the sentiments of the Maui community.

The principles were used to guide preparation of the WUDP in process and content, and can be consulted as 'things to keep in mind' as we implement the Plan and tackle future challenges.

- Respect the Public Trust doctrine and State Water Code as a foundation for water planning. The Native Hawaiian aupua`a system and cultural traditions can provide guidance on water stewardship.
- The 'water kuleana' of all Mauians creates responsibilities as well as rights. Be transparent and inclusive of all Mauians in all aspects of water planning and management.
- Recognize the complexity and interconnectedness of the hydrologic cycle, groundwater and surface water systems. Use the 'precautionary principle' in water planning, recognizing this era of climate unpredictability.
- Water resource management demands comprehensive and integrated policies and solutions. Consider both island-wide and regional effects and solutions to issues important to Mauians. Water resource planning and solutions should support ecological, social and financial sustainability.
- Create an actionable plan that provides water supplies for our diverse water uses. The options for solving water resource and supply issues will decrease and costs will increase with each year of delay.

These can be summarized as follows. The WUDP and planning objectives encompass these tenets.

- Ecologically holistic and sustainable
- Based on aupua`a management principles
- Legal, science and community-based
- Action-oriented

3.3 Planning Objectives

The Statewide Framework states that planning objectives form the basis of the evaluation of alternative resource strategies in the WUDP. The WUDP update process which commenced in 2004 and was originally focused on the MDWS Water System Districts generated a set of planning objectives based on input from the Water Advisory Committees through an iterative process. Suggestions for planning objectives were solicited, an extensive list of objectives, comments, policies and suggested resources was recorded, and these were sorted and grouped into a concise list of planning objectives.

Subsequently, in 2012 the scope of the WUDP update was broadened to include all water uses and users on Maui Island including cultural and environmental needs, and the planning objectives were again reviewed during community meetings held in 2012/13 and again during community, target interest, and policy board meetings in 2015/16. To ensure consistency with the MIP and community plans, the planning objectives derived through the WUDP public process were compared to the goals, objectives and policies in the General Plan, Maui Island Plan and Community Plans as shown in Appendix 2. Planning objectives and general descriptions are summarized in the table below.

Table 3-1 Planning Objectives and Description

Planning Objective	Description
Sustainability	Maintain Sustainable Resources
Resources	Protect Water Resources
Streams	Protect and Restore Streams
Environment	Minimize Adverse Environmental Impacts
Equity	Manage Water Equitably
DHHL	Provide for Department of Hawaiian Homelands Needs
Agriculture	Provide for Agricultural Needs
Culture	Protect Cultural Resources
Availability	Provide Adequate Volume of Water Supply
Quality	Maximize Water Quality
Reliability	Maximize Reliability of Water Service
Efficiency	Maximize Efficiency of Water Use
Cost	Minimize Cost of Water Supply
Viability	Establish Viable Plans
Conformity	Maintain Consistency with General and Community Plans

In order to measure the performance of resource options against the planning objectives, resource options and strategies are assessed and rated in terms of whether the strategy is likely to contribute to one or several planning objectives. A set of qualitative evaluation criteria or benchmarks are shown in the matrix below (Table 3-2) titled Planning Objectives Evaluation Criteria. Based on public input, a range of resource options were reviewed at public meetings in the four general regions East Maui (Hana), Central Maui (Wailuku/Kahului/Kihei), Upcountry and West Maui (Lahaina) to gague public acceptance and feedback. The assessment of preliminary strategies included a relative cost comparison and constraints that impact the viability of a specific resource or strategy, including legal constraints, practical constraints, and hydrologic constraints.

Table 3-2 Planning Objectives Evaluation Criteria

Criteria (Qualitative) Quantified Targets to be Developed as Applicable	**Planning Objectives**							
	Sustainability Resources Streams Environment	**Agriculture**	**Equity DHHL Culture**	**Availability**	**Quality**	**Reliability**	**Efficiency Cost**	**Plan Viability Conformity**
1. Groundwater sustainable yield levels are maintained over time	X			X				X
2. Streamflows restored to level to support stream ecosystems	X		X	X				X
3. Watersheds protected from invasive animals and plants	X			X				
4. Interim flow standards adopted for watersheds	X		X					
5. Scientific studies for aquifer systems complete (support science-based SY)	X							
6. Water resources and water system use consider aquifer recharge and streamflows under drought conditions	X		X		X	X		
7. Chloride levels in wells remain stable (salt water intrusion)	X	X		X	X	X	X	
8. Use of recycled water increased	X			X		X		
9. Greywater and catchment systems installed	X			X				
10. Infrastructure projects increase recycled water use and stormwater capture	X			X				
11. Watershed collaboration increased	X			X				X
12. Native Hawaiian community consultation process instituted			X					X
13. Per capita water use decreased	X			X		X	X	
14. MDWS prioritize DHHL needs over lower priority needs			X					

Criteria (Qualitative) Quantified Targets to be Developed as Applicable	**Planning Objectives**							
	Sustainability Resources Streams Environment	**Agriculture**	**Equity DHHL Culture**	**Availability**	**Quality**	**Reliability**	**Efficiency Cost**	**Plan Viability Conformity**
15. Potable and irrigation systems water loss decreased	X			X			X	
16. Potable water use for non-potable needs decreased	X							
17. Community water education increased	X						X	
18. Incentives for water conservation increased	X			X			X	
19. Drinking water standards met at all times				X	X	X		
20. Aquifer health maintained	X				X			
21. Public system water shortages to serve existing customers avoided				X		X		
22. Public water supply drought shortages avoided				X		X		
23. Contingencies in place to support water supply systems functions during emergency conditions				X		X		
24. Renewable energy use increased						X	X	
25. Water is available to timely serve development in MIP			X	X				X
26. Implementation plan for WUDP is incorporated into County budget and CIP planning						X		X
27. Strategies to meet all needs incorporated into WUDP			X					X

4.0 PLANNING SCENARIOS

The WUDP evaluates future water resources and demands for population growth and land use full build-out based scenarios as well as drought and climate change scenarios.

4.1 Population Growth- Based Water Demand Scenario

The future growth scenario for the Maui Island WUDP is the Population Based Water Demand Scenario, based on the population growth rates for each community plan area in the Maui Island Plan from 2015 to 2035. The base year is 2014. Growth rates were updated in the updated Socio-Economic Forecast, July 2014, prepared by the Maui County Planning Department, Long Range Planning Division based on Maui County totals provided by Department of Business, Economic Development and Tourism. This takes into account all water sectors excluding large agricultural demands which are not correlated with population growth. High and Low Cases are generated based on the 2014 Socio-Economic Forecast. Projected agricultural water demand over the 20-year period is then added as a separate component for a comprehensive assessment of water demands.

4.2 Land Use Full Build-Out Based Water Demand Scenario

An alternative Land Use Based Scenario projects water demand based on full development of the County General Plan, County Zoning and DHHL land use plans over an undetermined period.

4.3 Planning for Uncertainty

Water resource protection, development and use planning entails making assumptions about existing conditions and future scenarios. Identifying uncertainties and assumptions provides an opportunity to plan for a practical range of contingencies. This section highlights the major uncertainties and contingencies of this WUDP.

Drought and Climate Change

Data and research suggest that Hawai`i should be prepared for a future with a warmer climate, diminishing rainfall, declining stream base flows, decreasing groundwater recharge and storage, and increased coastal groundwater salinity, among other impacts associated with drought. Reductions in native species will also continue to affect watersheds. Statistical modeling is being improved but uncertainty remains in drought forecasting.[30] The limitations of downscaling climate models for local impacts, uncertainty about natural climate and weather patterns, and uncertainty about relationships among factors, make regional and long-term predictions very complex.[31] Conflicting or widely variable assessments of projected changes,

---

[30] WRPP, 2014 Draft, Section 8, Drought Planning

[31] Climate Change Impacts in Hawai`i - A summary of climate change and its impacts to Hawai`i's ecosystems and communities, 2014

along with long timescales affects the ability and urgency to incorporate specific actions into this WUDP. However, guidance in the *Climate Change Adaptation Priority Guidelines* and other efforts can be incorporated to increase resilience and reduce vulnerability to risks related to climate change.

Agricultural Water Demands

Predicting agricultural water demand is challenging due to uncertainty about the agricultural products market and regional crop water demand, the transition of lands used for sugarcane production to other crops, potential future agricultural use of kuleana lands, and associated legal issues relating to water rights and priorities of use. Regional crop types and locations, operational variables, and local climatic conditions also contribute to uncertainty.[32] Scenarios presented rely on stated assumptions and the best data available.

[32] *Ko`olau Poko Watershed Management Plan*, Honolulu Board of Water Supply, 2012

5.0 PHYSICAL SETTING

Maui, the second largest island of the Hawaiian archipelago, encompasses about 727.2 square miles. The island of Maui was formed by two shield volcanoes. The older West Maui Volcano is known as West Maui Mountain and may be extinct, while the younger East Maui Volcano known as Haleakalā is considered dormant. The island has six aquifer sector areas and 112 surface water hydrologic units. The 2010 U.S. Census reported Maui County population to be 154,834 while Maui Island's population was 144,444 people, 93 percent of the total. The population of Maui County was estimated by the U.S. Census Bureau to be 163,019 in 2014, with Maui Island estimated to have about 157,087 persons in 2015. Population is projected to increase island-wide by 31.7 percent from 157,087 in 2015 to 206,884 in 2035, compared to a 33.5 percent increase from 2000 to 2015.

5.1 Climate

The topography of Maui and the location of the north Pacific anticyclone relative to the island affect its climate which is characterized by mild and uniform temperatures, seasonal variation in rainfall, and great geographic variation in rainfall. During the warmer dry season (May to September) persistent northeasterly trade winds blow 80 to 95 percent of the time. During the cooler rainy season (October to April), migratory weather systems often travel past the Hawaiian Islands, resulting in less persistent trade winds that blow 50 to 80 percent of the time. Low-pressure systems and associated southerly winds can bring heavy rains to the island, and the dry coastal areas receive most of their rainfall from these systems.

The variation in mean annual rainfall with altitude is extreme on Maui, with differences of more than 130 inches within one mile of Pu'u Kukui in the West Maui Mountains, where average annual rainfall exceeds 355 inches per year. In contrast, mean annual rainfall at the coast in the dry leeward areas is less than 15 inches. At higher altitudes, precipitation is a combination of rainfall and fog drip where the montane forest canopy intercepts cloud water. The fog zone on the leeward slopes of Haleakalā extends from about 3,900 to 5,900 feet, with an estimated thicker fog zone at altitudes of 2,000 to 6,560 feet along windward slopes.[33]

Regular trade winds are key in generating rainfall which helps maintain Maui's water supply. However, a recent study showed that Hawai`i's trade winds have decreased in frequency by approximately thirty percent over the past 37 years, from 291 days per year in 1973 to 210 days per year in 2009.[34] The decrease in the trade winds could have serious implications for the Hawaiian Islands, including adversely impacting local agriculture, native ecosystems and endangered species, and the state's limited freshwater supply. Maui has experienced drought

---

[33] Gingerich, S.B., and Engott, J.A., 2012, Groundwater availability in the Lahaina District, west Maui, Hawai`i: U.S. Geological Survey Scientific Investigations Report 2012–5010, 90 p.

[34] Garza, J.A., P.-S. Chu, C.W. Norton, and T.A. Schroeder (2012) Changes of the prevailing trade winds over the islands of Hawaiʻi and the North Pacific. *Journal of Geophysical Research*, 117, D11109, doi:10.1029/2011JD016888

conditions in recent years. For example, based on the 1978–2007 monthly rainfall datasets, annual rainfall for the island was below average eight of the last 10 years (1998–2007).

5.2 Geology

Geology affects interactions between groundwater and surface water which may occur under the following conditions:

- High level water seeps into stream channels to provide base flow to streams
- Basal water in coastal areas flows into stream channels to provide base flow
- Stream water between marginal dike zones and coastal areas infiltrates into groundwater, as evidenced by losing stream reaches in these areas
- Basal water discharges through basal and/or caprock springs to provide water to wetlands and ponds

Basal occurrences of groundwater typically refer to a water table near sea level in high-permeability rocks. Groundwater in vertically extensive freshwater-lens systems can also be considered basal groundwater depending on the definition used.

West Maui Mountain and East Maui Volcano (Haleakalā) were built primarily by volcanic eruptions and layers of lava flows. The layers of lava flows were intruded in places by dikes, which consist of dense, low-permeability rock that formed when magma supplying lava flows solidified in narrow, near-vertical fissures below the ground surface. In the inland region of West Maui Mountain, near-vertical dikes radiating in all directions from the summit impound groundwater in compartments of volcanic rock in the caldera and permeable lava flows on the flanks. The water table of the dike-impounded groundwater systems in the West Maui Mountain interior may be more than 3,500 feet above sea level. Seaward of the dike-impounded systems, freshwater-lens groundwater systems exist in the dike-free high-permeability volcanic rocks and sedimentary deposits.

A freshwater-lens system consists of a lens-shaped freshwater body, an intermediate brackish-water transition zone, and underlying saltwater. Water levels of groundwater bodies in the dike-free volcanic rocks of West Maui Mountain are typically less than a few tens of feet above sea level. Fresh groundwater within the freshwater-lens system generally flows in a seaward direction from inland areas of West Maui Mountain toward the coast. Wedges of low-permeability sedimentary material referred to as caprock impede the seaward flow of fresh groundwater in freshwater-lens systems along parts of the northeast and southwest flanks of West Maui Mountain. Wedges of caprock between West Maui Mountain and Haleakalā also impede the flow of fresh groundwater between West Maui Mountain and the isthmus.

On northeast Haleakalā, in the area between Makawao and Ke`anae Valley, fresh saturated groundwater occurs as perched, high-level water held up by relatively low-permeability geologic layers above an unsaturated zone, and a freshwater-lens system underlain by seawater. The perched groundwater is several tens of feet below the ground surface within layers of thick lava flows, ash, weathered clinker beds, and soils. Collectively, this assemblage of layers has low permeability that impedes the downward movement of the perched, high-level groundwater. An unsaturated zone and a freshwater-lens system are beneath the high-level groundwater. The freshwater-lens system is located within high-permeability basalt lava flows and has a water table that is several feet above sea level. In the area between Ke`anae Valley and Nāhiku, the groundwater system appears to be saturated above sea level to altitudes greater than 2,000 feet. For southeast and southwest Haleakalā, information related to groundwater systems remains sparse although perched and freshwater-lens systems are expected to be present.[35]

5.3 Water Resources

The *State Water Resource Protection Plan* encourages effective ground and surface water management through the application of a hydrologic unit systems approach that focuses on the interaction and relationships between ground and surface water systems and water resource management. The hydrologic cycle describes the constant movement of water between the ocean, atmosphere, and Earth's surface, focused on precipitation, infiltration and recharge, runoff, and evapotranspiration. Agricultural and urban activities alter infiltration and runoff patterns, affecting the components of the hydrologic cycle.

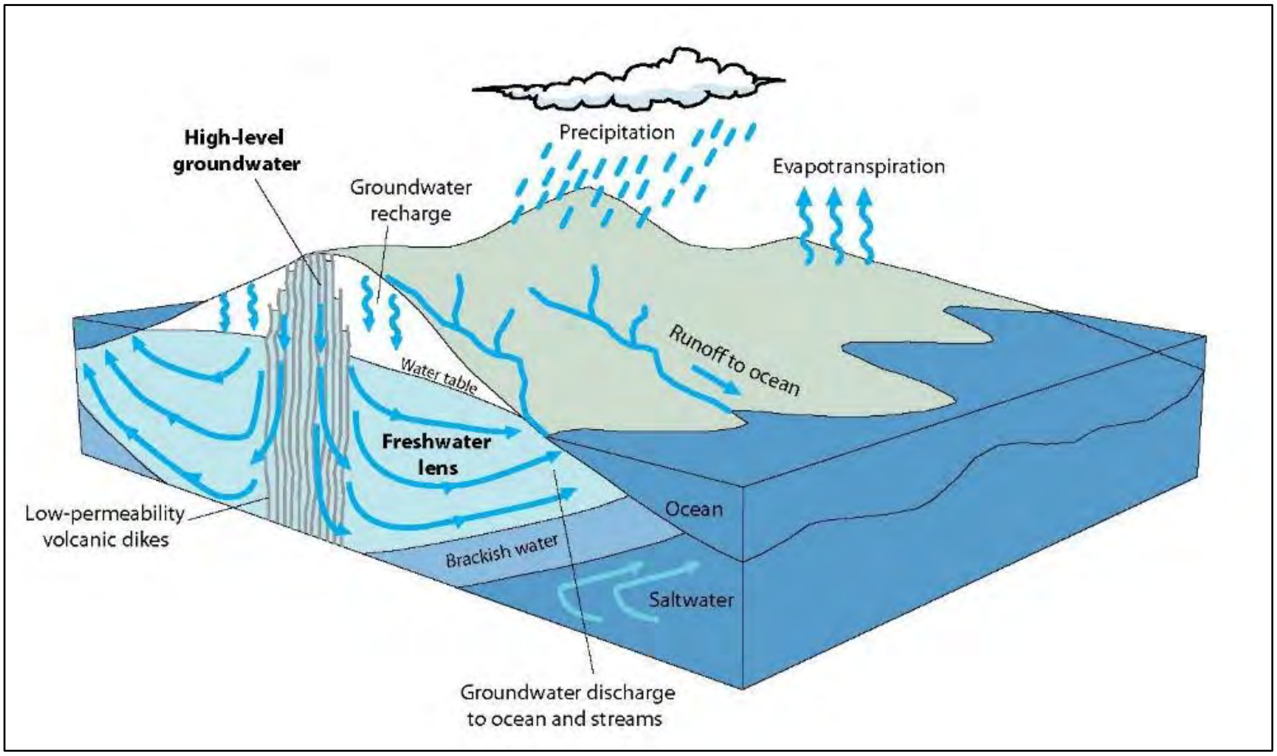
Hydrology

Hydrology is the scientific study of the occurrence, distribution, movement and properties of the waters of the earth and their relationship with the environment within each phase of the hydrologic cycle. The water cycle, or hydrologic cycle, is a continuous process by which water moves from the earth's surface (including the oceans) to the atmosphere and back to the land and oceans.[36] Climate, hydrology, geology and human activities affect the water cycle and the interconnected surface and groundwater systems. The figure below provides a generalized diagram of the hydrology of pacific islands.

[35] State Water Resources Protection Plan, 2008

[36] The USGS Water Science School, http://water.usgs.gov/edu/hydrology.html, retrieved August 1, 2016

Figure 5-1 Hydrology of Ocean Islands



Hydrology of Ocean Islands, USGS Pacific Islands Water Science Center

The State Water Code defines groundwater as “any water found beneath the surface of the earth, whether in perched supply, dike-confined, flowing, or percolating in underground channels or streams, under artesian pressure or not, or otherwise.” There are four different types of groundwater on Maui: 1) basal water floating on salt water; 2) dike confined water; 3) water perched on relatively impervious soil or rock formation; and 4) shallow groundwater. The greatest groundwater reservoir is the basal water table near sea level, which is a fresh water lens that “floats” on seawater. 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 from seawater to fresh water.[37]

Groundwater Recharge

Groundwater recharge is the replenishment of fresh groundwater and depends on many natural and human-related factors, such as precipitation, fog drip, irrigation, direct surface runoff, soil moisture storage, and evapotranspiration. An understanding of groundwater recharge informs water resource management. Under natural conditions, the aquifer is in a hydrologic balance such that the inflow of natural rainfall recharge equals the outflow or the

---

[37] State Water Resources Protection Plan, 2008

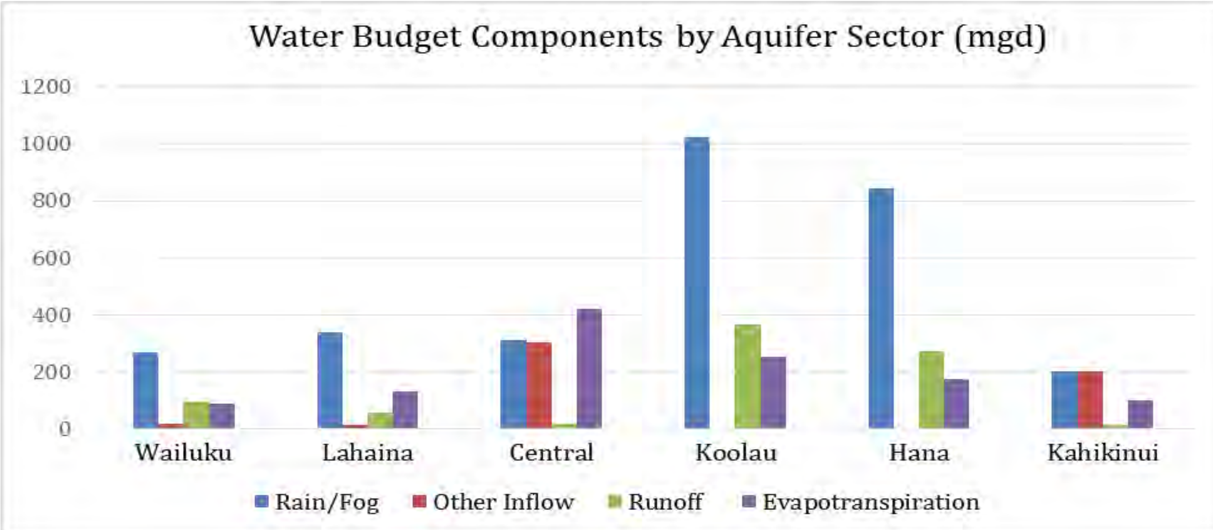
coastal leakage, and the volume of aquifer storage remains constant. Hydraulic head, the water level as it relates to water pressure, affects the speed of water movement and the storage of an aquifer. The hydraulic head of a basal aquifer is highest at its inland boundary and gradually reduces toward the coastline. This spatial variation of the hydraulic head induces groundwater flow from mountain areas toward the ocean. However, forced draft or pumping has disrupted the natural balance of Hawai`i aquifers.[38] Groundwater storage depletion as a result of groundwater withdrawal, evidenced by lowered water tables and a rise in the bottom of the freshwater lens (transition zone), as well as diminished streamflow, is a potential limitation to groundwater availability.[39]

The 2014 USGS study, *Spatially Distributed Groundwater Recharge Estimated Using a Water Budget Model for The Island of Maui, Hawai`i, 1978–2007*, concluded that the spatial distribution of rainfall is the primary factor determining spatially distributed recharge estimates for most areas on Maui. Estimated mean annual recharge on Maui is about 1,340 mgd for average climate conditions (1978–2007 rainfall and 2010 land cover).[40] Mean annual recharge of each of Maui's 25 aquifer system areas ranges from about 13 to 222 mgd for average climate conditions.[41] About 60 percent of recharge islandwide occurs in the Ko`olau and Hāna aquifer sector areas. Precipitation (rainfall and fog interception) comprises most of inflow (precipitation, irrigation, septic leachate, and direct recharge); on average about 45 percent of precipitation is recharged.[42] Irrigation in the Central aquifer sector area is substantial and constitutes about 43 percent of its total inflow.[43]

The figure below shows the water budget components for each aquifer sector area based on the 2014 USGS Study. As the study indicates, more accurate estimation of the rate of natural recharge requires an improved understanding of precipitation, including fog drip and rainwater, surface runoff, and evapotranspiration.

[38] State Water Resources Protection Plan, 2008.
[39] Volcanic Aquifers of Hawai`i—Hydrogeology, Water Budgets, and Conceptual Models
[40] Based on water budget area which more closely aligns with the 2008 WRPP average annual recharge is 1329 mgd.
[41] Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai`i, 1978–2007, Table 8, Water Budget Area A and B.
[42] Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai`i, 1978–2007
[43] Ibid, Table 8, Water Budget Area A.

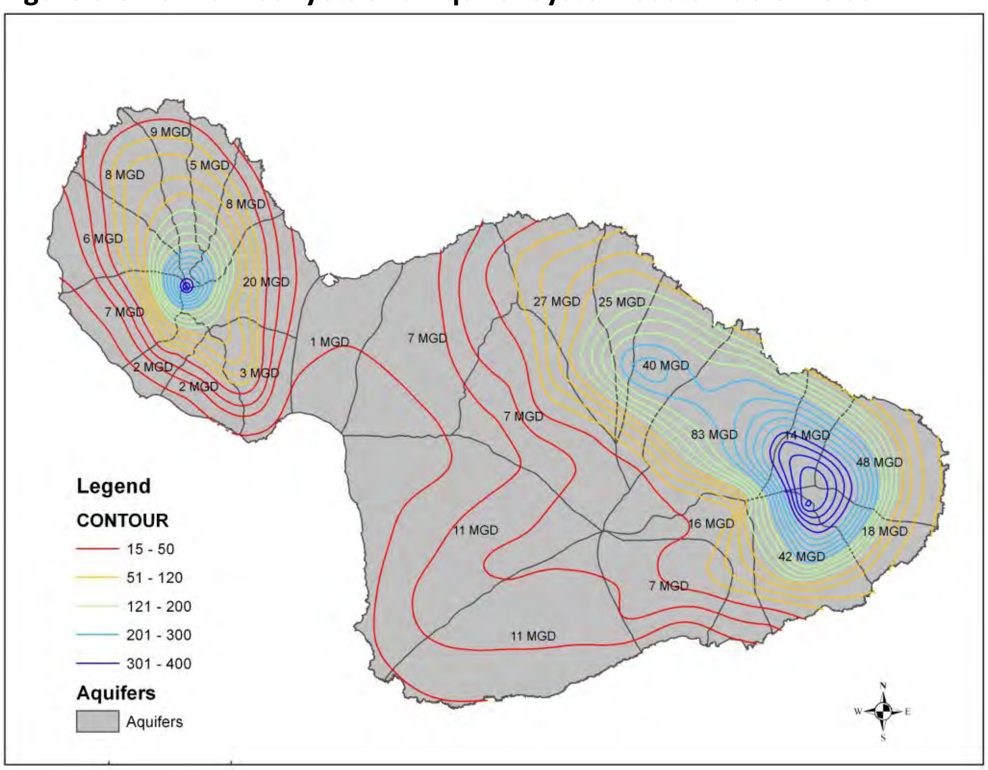
Figure 5-2 Water Budget Components by Aquifer Sector



MDWS Water Resources and Planning Division based on Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawai`i, 1978–2007, Table 8, Water budget area A, Average climate conditions, 1978–2007 rainfall and 2010 land cover. (Groundwater Recharge xlsx)

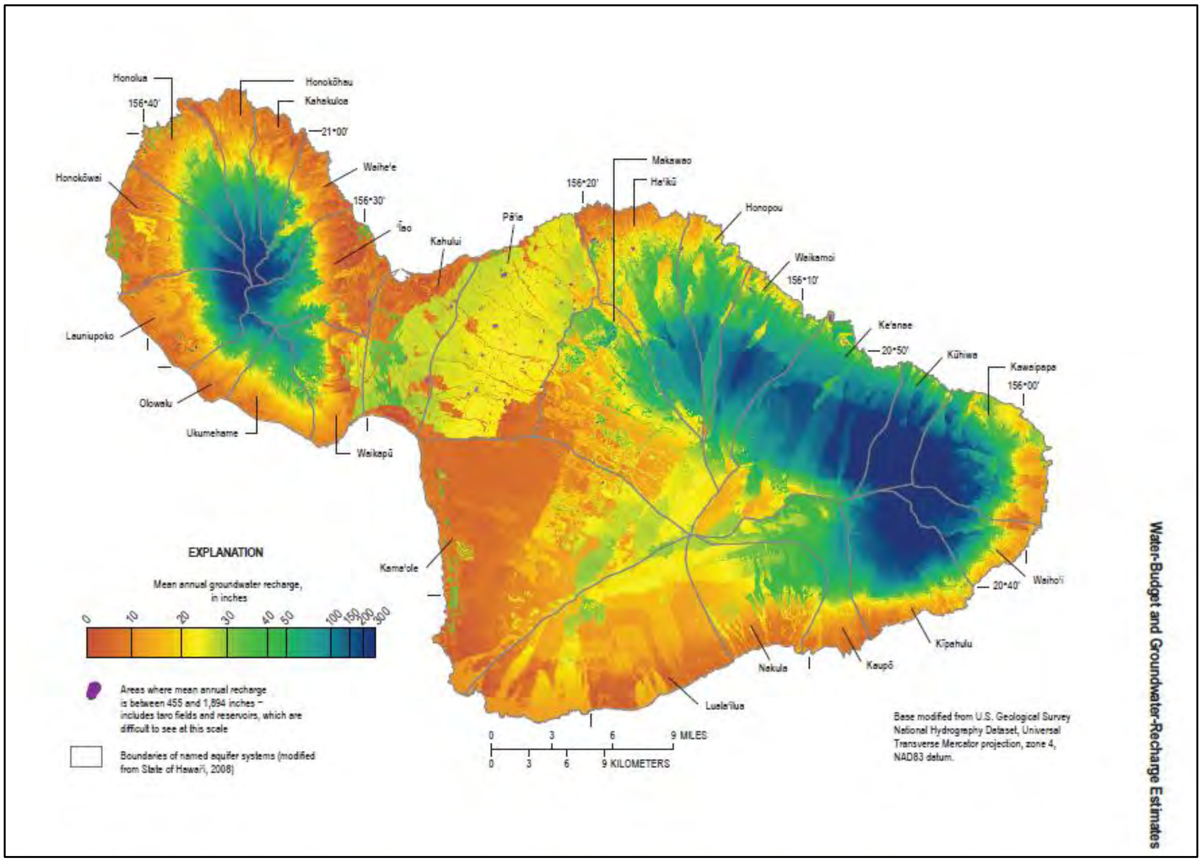
Figure 5-3 demonstrates a correlation between rainfall isohyets and sustainable yields. This is reflected in the distribution of mean annual groundwater recharge for average climate conditions in the subsequent figure.

Figure 5-3 Rainfall Isohyets and Aquifer System Sustainable Yields



2011 Rainfall Atlas of Hawai`i

Figure 5-4 Distribution of Mean Annual Groundwater Recharge for Average Climate Conditions



USGS, Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai`i, 1978–2007

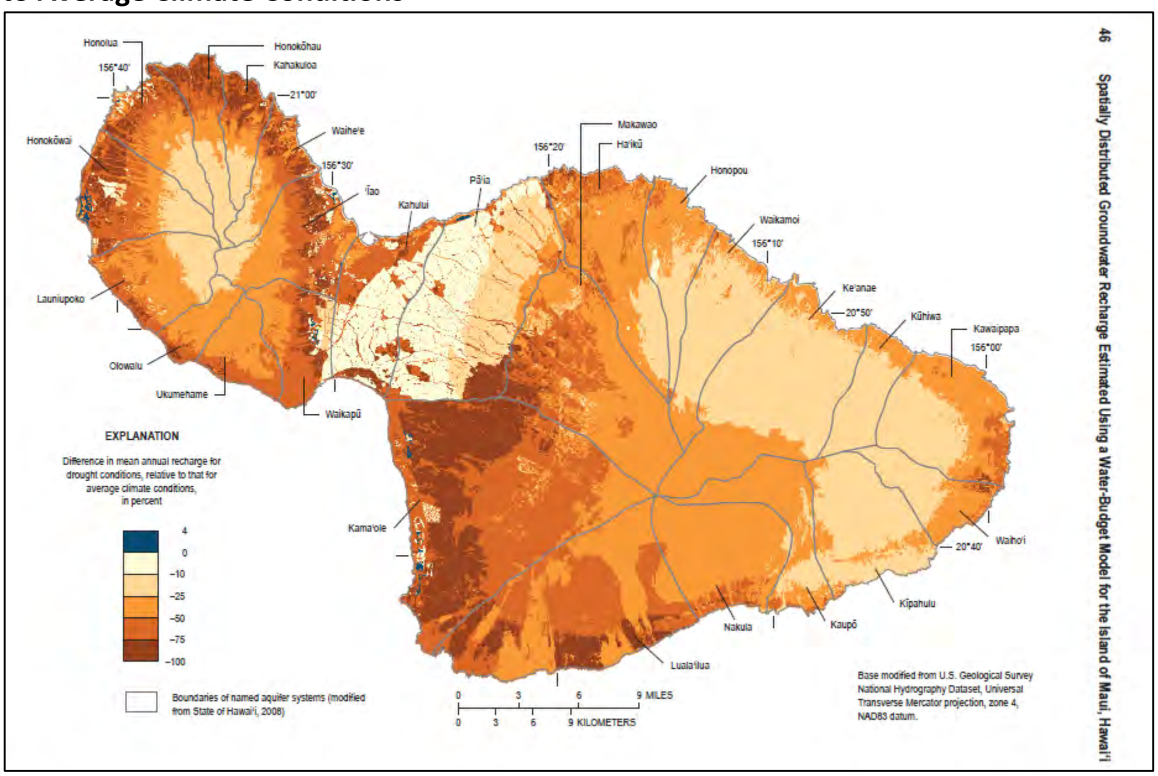
Drought Effects

Drought is a persistent and extended period of below normal precipitation. Meteorological drought is usually an expression of the precipitation level's departure from normal over some period of time and can be an early indicator of drought. Agricultural drought occurs when soil moisture is inadequate to meet the needs of a particular crop at a particular time. Hydrological drought refers to deficiencies in surface and subsurface water supplies, reflected in declining surface and groundwater levels. Due to lag time between a lack of rainfall and the observed decrease of water levels, hydrological drought will not be reflected until precipitation is deficient over an extended period of time. The drought from 1998 to 2003 had severe impacts throughout Hawai`i, including numerous wildland fires, record-low rainfall, and agricultural losses. Hawai`i has experienced D2 (severe) drought conditions somewhere in the state since June 2008 according to the U.S. Drought Monitor. The *Pacific Islands Regional Climate Assessment (2012*) reports an increase in average air temperature in the Hawaiian Islands from 1916-2006, and downward trend in rainfall across the state since the beginning of the 20th century and an even steeper decline since 1980 with the tendency for more prolonged dry periods, reduced stream base-flow, and a decrease in groundwater recharge and storage. A statistical downscaling model predicts decreasing wet-season rainfall and increasing dry-season rainfall, which seems to line up with a trend in increasing winter drought in Hawai`i since the 1950s.[44]

Estimates of groundwater recharge are necessary to evaluate availability of freshwater and are used by CWRM in setting sustainable yield. The report, *Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai`i, 1978–2007*, estimates that recharge could vary significantly under drought conditions (1998-2002 rainfall, 2010 land cover). Compared with average climate conditions, recharge is estimated to decrease under drought conditions as follows and as illustrated in the figures below:

- Aquifer system precipitation – decrease 12% to 37%
- Aquifer system recharge – decrease 8% to 51%
- Most upland areas in West Maui Mountain and windward Haleakalā – recharge decreases 10% to 50%
- Most lowland areas in West Maui Mountain and leeward Haleakalā – recharge decreases more than 50%

Figure 5-5 Percentage Difference in Mean Annual Groundwater Recharge for Drought Relative to Average Climate Conditions

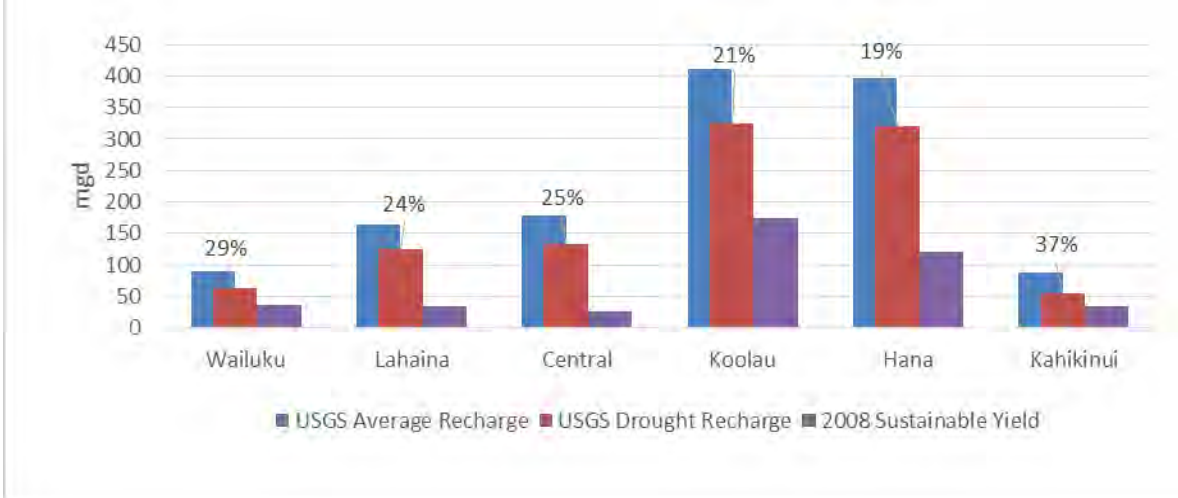


USGS, Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawai`i, Table 8. 2014; CWRM 2008 sustainable yield.

---

[44] State Water Resources Protection Plan Update, 2014

Figure 5-6 Average Mean Recharge Under Average and Drought Climate Conditions, Percent Recharge Reduction and Sustainable Yield



USGS, Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawai`i, Table 8. 2014; CWRM 2008 sustainable yield. USGS figures based on water-budget-area B (or A where there is no B), entire aquifer-system area, average climate. Average climate conditions are 1978–2007 rainfall and 2010 land cover. Drought conditions are 1998–2002 rainfall and 2010 land cover. (Groundwater recharge.xlxs)

In 2017, USGS discovered an error in data that affected published groundwater-recharge estimates for Maui and other islands. The recharge estimated for 1978 – 2007 rainfall and 2010 land-use conditions were revised and available on May 16, 2017 and are reflected in the table below. Recharge for drought conditions and associated reports and datasets were not available yet at the time of completing this WUDP draft. The percentage drought recharge reduction is assumed to not change significantly. The island wide impact in about a 2 percent decrease in recharge, with increases in certain aquifer systems and decreases in others, with a net decrease in all aquifer sectors except Wailuku. It is expected that the corrected data will be reflected in adjusted sustainable yield in CWRM's June 2017 update to the Water Resource Protection Plan.

Table 5-1 - Average Climate and Drought Climate Conditions by Aquifer Sectors (mgd)

Aquifer Sector Area	2008 WRPP Average Recharge	May 2017 Corrected Recharge	*USGS Average Recharge**	*USGS Drought Recharge**	% Drought Recharge Reduction (USGS)
Wailuku	60	92	*91*	*64*	29%
Lahaina	73	162	*163*	*125*	24%
Central	59	175	*179*	*134*	25%
Ko`olau	397	404	*411*	*325*	21%
Hāna	245	379	*397*	*322*	19%
Kahikinui	78	85	*88*	*56*	37%
Maui Island	912	1297	*1329*	*1025*	23%

*USGS, Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawai`i, 2014, Table 8. Report not yet reflecting corrected recharge numbers published 5/16/17
USGS figures based on water-budget-area A and water-budget-area B in Wailuku and Lahaina aquifer sectors, entire aquifer-system area, average climate. Average climate conditions are 1978–2007 rainfall and 2010 land cover. Drought conditions are 1998–2002 rainfall and 2010 land cover. WRPP- 1990, updated 2008 from CWRM where applicable, natural conditions are 1916–1983 mean rainfall and a uniform, unirrigated land cover. Scenario study areas may differ from the WRPP areas.

Sustainable Yield is determined by using recharge numbers determined over an extended time period which includes droughts. Sustainable yield is equal to a fraction of the recharge. In a basal lens the fraction is about half (46 %) for Maui Island.[45] In high level aquifers about three-fourths of the recharge can be taken as sustainable yield.[46] During a drought, sustainable yield would not necessarily change, but rather Water Reduction Plans or Drought Plans would be consulted.[47] Water availability during a future drought is better assessed by looking at pumping history to evaluate how and where chloride concentrations affected water availability during past droughts. To evaluate future droughts under different conditions, such as different drought lengths and magnitude or other hydrologic changes, the best tool would be the groundwater model.[48] While not purported to represent a recalculation of the State's sustainable yield, substituting the reduced recharge in their RAM groundwater flow and transport model may provide rough estimate too. This is a straightforward, but simplistic approach, and may provide an estimate of where and how much pumping needs to be reallocated during a drought. Although hypothetical, the effect of a direct relationship between drought recharge reduction and sustainable yield is shown in the following table (Table 5-2) as a possible benchmark or baseline for groundwater resources during drought conditions.

[45] Robert Chenet, Geologist, CWRM, personal communication 12/1/2016.
[46] State Water Resources Protection Plan, 2008.
[47] Robert Chenet, Geologist, CWRM, personal communication 12/1/2016.
[48] William R. Souza, Hydrologist, USGS Pacific Islands Water Science Center, personal communication 12/2/2016.

Table 5-2 Illustrative Example of Drought Recharge Reduction on Sustainable Yield (mgd)

Aquifer Sector	2008 SY	Drought Recharge Reduction (%)	Reduced SY (Hypothetical, 100% Drought Recharge Reduction)*
Wailuku	36	29%	25
Lahaina	34	24%	26
Central	26	25%	19
Ko`olau	175	21%	139
Hāna	122	19%	99
Kahikinui	34	37%	21
Total	427		329

*% Drought Recharge Reduction: USGS, Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawai`i, 2014, Table 8. Report not yet reflecting corrected recharge published 5/16/17
SY Reduction - assume SY is reduced by 100% of recharge. (Groundwater Recharge.xlsx)

Climate Change Effects

Climate change patterns already being seen in Hawai`i are projected to become increasingly serious before the middle of the 21st century, including (a) declining rainfall, (b) reduced stream flow, (c) increasing temperature, and (d) rising sea level. Each poses serious consequences for the replenishment and sustainability of groundwater and surface water resources. These trends are further compounded by potential changes in the trade wind regime, the intensity and frequency of drought and storm events, the El Nino-Southern Oscillation, and the Pacific Decadal Oscillation.[49]

The Pacific Regional Integrated Sciences and Assessments' (Pacific RISA) *Maui Groundwater Project* is an interdisciplinary research effort to inform decisions about the sustainability of groundwater resources on the island of Maui under future climate conditions. A new hydrologic model is being used to assess the impact of changing climate and land cover on groundwater recharge over the island. Preliminarily future climate projections for Maui island include: 1) temperature increases at all elevations; 2) wet areas get wetter; 3) dry regions are mixed (some wetter, some drier); 4) mean annual rainfall increases; seasonal patterns show May-September drying in Central Maui; 5) Mean annual reference evapotranspiration increases; and 6) little change in cloud-base elevation and trade-wind inversion height.[50]

---

[49] *Water Resources and Climate Change Adaptation in Hawai`i: Adaptive Tools in the Current Law and Policy Framework.*

[50] Pacific RISA. *Participatory Scenario Planning for Climate Change Adaption: Final Land Use Input, Pacific RISA, November, 2014*

The Hawaiian Islands Climate Synthesis Project which seeks to develop science-based syntheses of climate impacts and adaptation options for terrestrial and freshwater resources of the Hawaiian Islands indicates low or moderate confidence in predictions for most climate variables. Vulnerabilities and projected changes most relevant to water resource planning, some of which are already incrementally occurring on Maui, are summarized in the subsequent tables (Table 5-3 and Table 5-4).

Table 5-3 Climate Changes and Trends Relevant to Water Planning for Maui Island

Climate Variable	Trend	Relative Change by 2100	Confidence
Air Temperature	↑	High	High
Precipitation (amount and timing)	↑↓	Low to High	Low
Precipitation (extreme events)	↑↓	Low to Medium	Low
Drought	↑	Medium	Low
Streamflow	↓	Low to High	Low
Coastal flooding and saltwater intrusion	↑	High	Moderate
Species distribution (native and invasive plants)	↑↓	Medium to High	Moderate
Wildfire	↑	Unknown	**Low**

EcoAdapt. 2016. Climate Changes and Trends for Maui, Lāna`i, and Kaho`olawe. Prepared for the Hawaiian Islands Climate Synthesis Project, part of the Pacific Islands Climate Change Cooperative's Hawaiian Islands Terrestrial Adaptation Initiative.

Table 5-4 Projected Changes and Confidence Level for Climate Variables

Climate Variable	Projected Changed	Confidence (trend direction, magnitude)
Air Temperature	*Mean annual temperature* > By 2021---2050: increase of +1-2°F > By 2041---2070: increase of +1-3°F > By 2070---2100: increase of +2-5°F (up to +6.1-6.3°F in higher elevations, +3.6-4.5°F in lower elevations) *Heat waves* > Extreme heat days expected to become more frequent and more intense	**High** > High certainty that temperatures will increase > The amount of increase is somewhat uncertain due to climate model variables
Precipitation (amount and timing)	Multiple possibilities for precipitation differ in direction and magnitude of change: > Little to no change in precipitation by 2071-2099 *(Keener et al. 2013)* > Increased rainfall on windward slopes and decreased rainfall on leeward slopes by 2099 (Hamilton 2013) > Moderate to large decrease in precipitation *(Timm et al. 2015):* By 2041-2071: 16 to 18% (wet season), 24% to 32% (dry season)	**Low** > Precipitation highly variable depending on location > Studies disagree on direction and magnitude of change >Many variables affect climate models

Climate Variable	Projected Changed	Confidence (trend direction, magnitude)
	By 2071-2099: 17% to 25% (wet season), 29% to 46% (dry season)	
Precipitation (extreme events)	*Extreme precipitation events* At least two possibilities differ in direction and magnitude of change > Reduced frequency of extreme precipitation events by 2100, with greater reductions in dry areas *(Timm et al. 2011)* > Little change in frequency *(Takahashi et al. 2011)* *El Niño events* (by 2090) > Slight decrease in number of El Niño events (versus 1891---1990) > Extreme El Niño events twice as likely to occur (from one event every 20 years to one event every 10 years) > No change in spatial pattern of El Niño events *Tropical cyclones* > Increased frequency and strength around the Hawaiian Islands	**Low** > Climate models disagree whether extreme events will become more or less frequent/severe, but most models predict a decrease in frequency and an increase in intensity > Changes may vary by location and the type of event
Drought	By 2080-2100: > Increased risk in low- and mid-elevation leeward areas > Decreased risk on mid-elevation windward slopes of Haleakalā and summit of Mauna Kahalawai > No change in risk in other areas	**Low** > Drought predictions are closely related to precipitation, which are very uncertain > Few studies have projected drought risk
Streamflow	> No streamflow projections are available for the coming century. Mean annual rainfall decreases within a watershed are likely to result in: > Decreased low flows and streamflow/ base flow declines > Flows would become more variable and more unstable ('flashy'), especially in wet years	**Low** > Streamflow closely related to precipitation and temperature changes; also land cover, groundwater withdrawals, CO2 levels
Coastal flooding and saltwater intrusion	> Waiehu Deep Monitor Well (north Maui) 1985---1999, midpoint of transition zone between freshwater and sea water rose 2.2 m/year (i.e., freshwater lens became shallower) > Mahinahina Deep Monitor Well (West Maui) No change in midpoint of transition zone over time > No projections available for saltwater intrusion > Sea level rise will likely contribute to increased water salinity and higher water tables, especially during storms > Drought conditions increase groundwater salinity > Increased populations and water withdrawals will	**Moderate** > No downscaled sea level rise projections for this region > Saltwater intrusion is impacted by recharge rates and groundwater pumping/withdrawals (withdrawals likely play a larger role in saltwater intrusion than does sea level rise)

Climate Variable	Projected Changed	Confidence (trend direction, magnitude)
	contribute to saltwater intrusion into groundwater sources	
Species distribution (native and invasive plants)	*Native plant species* > Downslope contraction of cloud forest vegetation on Haleakalā if rainfall decreases > Upslope movements may be possible if rainfall increases, but habitat gains would be modest compared to the losses associated with drought *Native plant species (by 2100)* > 39% average reduction in climatically suitable habitat for native plants > 15% of modeled species will likely have no overlap between current and future suitable habitat > 5% of modeled species projected to lose >99% of their current climate envelope > Most vulnerable species include: single island endemics, species with a conservation listing *Invasive plant species (by 2100)* > ~11% increase in land area suitable for invasion > Invadable habitat will increase greatly on the leeward slopes of Maui > Most modeled species are projected to expand > Invasion risk increases at higher elevation locations	**Moderate** *Native plant species* > Modeled changes in plant distribution dependent on multiple factors > El Niño events can significantly affect vegetation distribution by altering patterns of precipitation and drought, but projected changes in these factors are poorly understood *Invasive plant species* > Models may under-represent invasive species distribution > Climatic tolerances of species reaction to changes not well understood
Wildfire	> No wildfire projections available > Wildfire will likely increase if drought events increase	**Low** > Wildfire strongly correlated with dry conditions; precipitation projections highly uncertain > Increasing temperatures likely to increase ET; may cause higher climatic water deficits even if precipitation increases slightly

Summarized from EcoAdapt. 2016. Climate Changes and Trends for Maui, Lāna'i, and Kaho'olawe. Prepared for the Hawaiian Islands Climate Synthesis Project.

Saltwater intrusion, the reduction of discharge to streams and the ocean, and lowering of water levels limit groundwater availability. When water is withdrawn from a freshwater-lens, the freshwater lens shrinks and saltwater or brackish water will intrude upward and landward into parts of the aquifer that formerly contained freshwater. The degree of saltwater intrusion depends on several factors, which include the hydraulic properties of the rocks, recharge rate, pumping rate, and well location. The effect of intrusion on a particular well depends on the vertical and lateral distance between the well and the transition zone. Wells completed in the freshwater lens near the coast are particularly likely to induce brackish water or saltwater movement into the well as pumping continues. Saltwater-water intrusion can be controlled by appropriately locating wells and controlling withdrawal rates. Groundwater withdrawal ultimately reduces the amount of discharge to springs, streams or the ocean; reduced flow can also lower water levels around the pumped well.[51] During an extended drought source water quality can be affected by sea water intrusion or upconing brackish water.[52]

Sea level rise and the associated coastal impacts have the potential to harm an array of infrastructure and environments including low lying coastal roads, water supply and wastewater systems. The University of Hawai`i Coastal Geology Group has predicted that conservatively sea level may rise up to one meter by 2100 affecting all coastlines and most severely affecting Mā`alaea, North Kīhei, Lahaina, Kā`anapali, and Kahului.[53] In many cases these impacts will stress an already ailing infrastructure. Water supply faces threats from both rising groundwater and saltwater intrusion in wells, as well as declining quality and quantity due to drought and downward trends in groundwater base flows. After considering climate change impacts and projected water demand increase, it is clear that careful water planning, stewardship, and climate adaptation are required.[54]

Surface Water Hydrology

Streamflow consists of "(1) direct runoff of rainfall, in the form of overland flow and subsurface storm flow that rapidly returns infiltrated water to the stream, (2) groundwater discharge, in the form of base flow, where the stream intersects the water table, (3) water returned from bank storage, (4) rain that falls directly on streams, and (5) any additional water, including excess irrigation water, discharged to the stream by humans."[55] The *Hawai`i Stream Assessment, 1990* lists 90 perennial streams on the island of Maui, which include streams flowing year-round and those which flow intermittently at lower elevations.[56] This information is now compiled as part of the *Atlas of Hawaiian Watersheds and Their Aquatic Resources* which is based on information in the Division of Aquatic Resources Aquatic Surveys Database.[57]

---

[51] Gingerich, S.B. and Oki, D.S., 2000, Ground Water in Hawai`i: U.S. Geological Survey, Fact Sheet 126-00

[52] Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai`i, 1978–2007

[53] Maui County Countywide Policy Plan, p 14.

[54] Water Resources and Climate Change Adaptation in Hawai`i: Adaptive Tools in the Current Law and Policy Framework

[55] Oki, D.S., 2003, Surface Water in Hawai`i: U.S. Geological Survey Fact Sheet 045-03, p. 6.

[56] Hawai`i Stream Assessment, Report R84, December 1990. http://files.Hawai`i.gov/dlnr/cwrm/publishedreports/R84_HSA.pdf

[57] Division of Aquatic Resources Aquatic Surveys Database http://www.Hawai`i.gov/dlnr/dar/streams/stream_data.htm

Streams on Maui generally originate in the wet uplands of Mount Kahalawai and Haleakalā and flow toward the coast. The upper reaches of some streams on Mount Kahalawai flow perennially and are fed by persistent rainfall and groundwater discharging from dike-impounded water bodies. During dry-weather conditions, lower reaches of some streams have reduced or no streamflow as a result of water captured by diversion systems and water infiltrating the subsurface where the water table is at a lower elevation than the streamflow level. Losing stream conditions can also occur where withdrawals at a well lowers the local water table and attracts the stream water towards the pumping well. Streams on windward Haleakalā are fed by abundant rainfall and groundwater discharge. In the area between Makawao and Ke`anae Valley, groundwater discharges to streams from a perched, high-level saturated groundwater system. East of Ke`anae Valley, groundwater discharges to streams from a vertically extensive freshwater-lens system. Water is diverted from many streams on windward Haleakalā and is mainly used to irrigate sugarcane in the isthmus. Stream reaches on leeward Haleakalā tend to be ephemeral.[58] The downward trend in rainfall across Hawai`i and on Maui since the beginning of the 20th century with steeper declines since 1980 has resulted in reduced base streamflow.[59]

Transfer of water between hydrologic units occurs in most sectors on Maui. An example is the East Maui Irrigation (EMI) System which transports surface water along 74 miles of aqueduct and tunnel system from the Ko`olau sector to the dry Central Sector for sugarcane irrigation. Irrigation creates an artificial relationship between Pā`ia and Kahului aquifers and the surface water from Ko`olau. There are cases where pumping wells located near streams have been determined not to affect proximal streamflow, such as when the streambed is higher than the groundwater table. For example, wells (e.g. Mokuhau wells) in Wailuku which pump groundwater from 10 feet above sea level do not impact the nearby `Īao Stream, which is located several hundred feet above sea level. A similar condition exists with the North Waihe'e Wells located in the neighboring Waihe'e Aquifer System Area where water levels are approximately eight feet above sea level and the Waihe'e River streambed invert elevation is much higher.

5.4 Groundwater Availability

Groundwater is the primary source of supply for the majority of water users on the island served by both county-owned and private public water systems. The WUDP uses hydrologic units designated by CWRM for presentation of data and analysis, along with the master water resources inventory in the State Water Resources Protection Plan (WRPP). Maui Island is divided into six regions called Aquifer Sector Areas that reflect broad hydrogeological similarities while maintaining hydrographic, topographic and historical boundaries where

[58] Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai`i, 1978–2007
[59] Water Resources Protection Plan Update, 2014.
http://files.Hawai`i.gov/dlnr/cwrm/planning/wrpp2014update/WRPP-2014Ch8SummaryDroughtPlanning.pdf

possible. Aquifer Sector Areas are divided into Aquifer System Areas based on hydraulic continuity and related characteristics. Because these delineations are based largely on observable surface conditions and only limited subsurface information, boundary lines should be recognized as management lines and not as hydrologic boundaries.

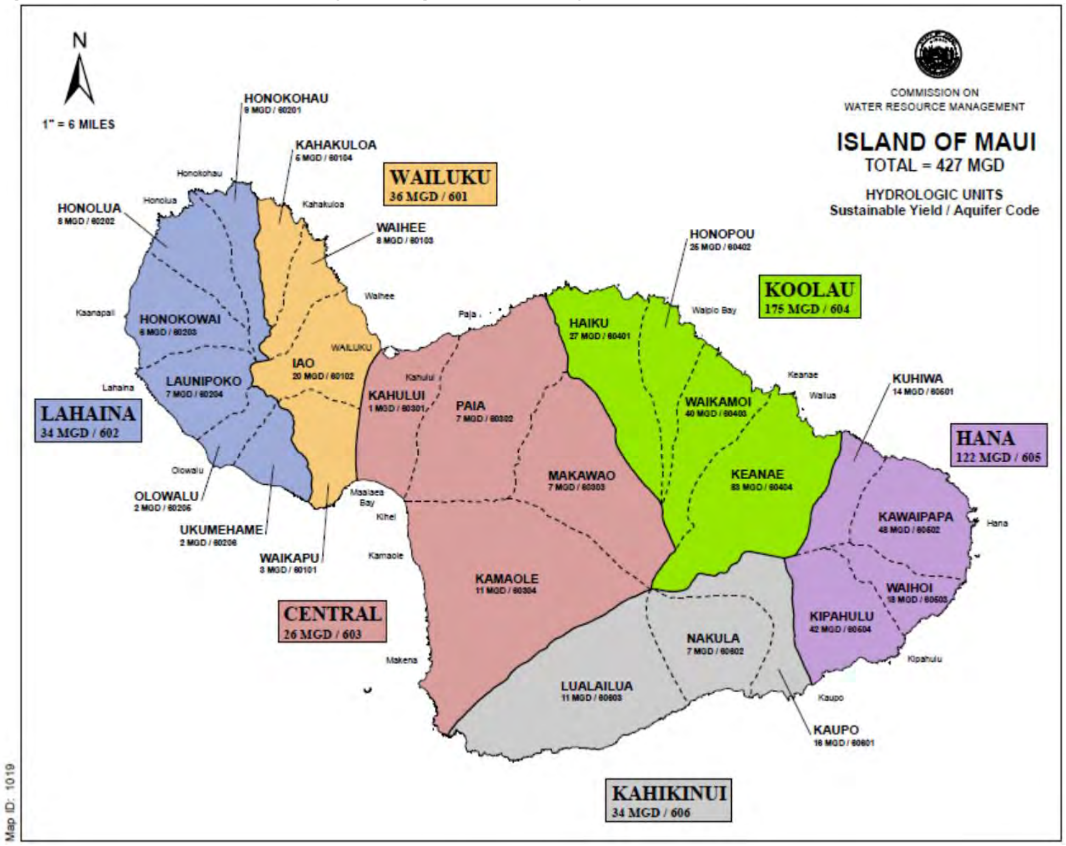
Sustainable Yield

Groundwater is replenished by rainfall recharge and classified as a renewable resource. The amount of groundwater that can be developed is limited by the amount of natural recharge. However, because some aquifer outflow or leakage must be maintained to prevent seawater intrusion or some perennial streamflow, the sustainable yield (SY) of an aquifer normally represents a percentage of the natural recharge. The CWRM has adopted SY for each aquifer system area to protect groundwater resources and regulate water use by water use permits. Sustainable Yield is defined as "the maximum rate at which water may be withdrawn from a water source without impairing the utility or quality of the water source as determined by the commission." (HRS §174C-3)[60] It is the legal limit for withdrawals from any individual aquifer. In setting SY, the CWRM assesses the quantity of groundwater recharge to the aquifer. 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 depends upon the head. Head is the elevation [or height] of the unconfined water table above sea level. There is not a unique value for SY; the value depends on the head that will preserve the integrity of the groundwater resource at the level decided upon by the manager.[61]

Established SY changes over time due to climatological trends, rates of recharge, interaction between streamflow and groundwater, land use and other factors. Insufficient hydrologic, geologic and meteorological data require the estimation of critical input parameters in SY models. As new and better data becomes available, the CWRM must periodically review and refine SY estimates. The United States Geological Survey (USGS) in particular continues to conduct scientific studies of groundwater recharge and availability on Maui which may support revised SY estimates in the future. Due to variables and inherent uncertainty in each prediction, CWRM applies the "precautionary principle" in adopting SY in the 2008 WRPP. The WUDP uses the established SY for an aquifer system as the basis for resource evaluation. Sustainable Yield for aquifer systems statewide is under review as part of the 2016 -2017 WRPP update.

[60] State Water Resources Protection Plan, 2008.
[61]State Water Resource Protection Plan, 2008

Figure 5-7 Groundwater Hydrologic Units, Aquifer Codes and Sustainable Yields



As shown in the table below (Table 5-5), the lowest predicted SY for each aquifer system area was selected as the 2008 sustainable yield, with exceptions to this rule for `Īao and Waihe'e Aquifer Systems. The SY for the `Īao Aquifer was maintained mid-range at 20 mgd as this is believed to be the best estimate to date based on numerical models, deep monitor well data, and historical pumpage records. For the Waihe'e Aquifer, the CWRM elected to maintain the SY at 8 mgd based on (1) current groundwater demands within the system, (2) 8 mgd falls within the predicted range of sustainable yields for the aquifer system area, (3) the presence of a deep monitor well within the system that will allow for long-term monitoring of the transition zone, and (4) groundwater studies support 8 mgd as a safe yield. Sustainable Yield ignores significant importation of surface water into Kahului and Pā`ia Aquifer System Areas, which supports the ability to withdraw fresh water from the basal aquifer at significantly higher rates than the SY without apparent negative impacts (i.e. rising chloride concentrations or decreasing water levels).[62]

The table below shows the 2008 SY, range and degree of confidence the CWRM places on the number, ranging from (1) most confident to (3) least confident directly related to the type, quality, and quantity of hydrologic data used in the SY determination.

[62] State Water Resources Protection Plan, 2008.

Table 5-5 Maui Island Aquifers Sustainable Yields, 2008

Aquifer Sector/System	Aquifer Code	Sustainable Yield Range (mgd)	Sustainable Yield (mgd)	Confidence Ranking
Wailuku	**601**		**36**	
Waikapū	60101	3-6	3	2
`Īao	60102	11-31	20	1
Waihe'e	60103	6-15	8	2
Kahakuloa	60104	5-8	5	2
Lahaina	**602**		**34**	
Honokōhau	60201	9-17	9	2
Honolua	60202	8-10	8	2
Honokōwai	60203	6-11	6	2
Launiupoko	60204	7-14	7	2
Olowalu	60205	2-7	2	2
Ukumehame	60206	2-6	2	2
Central	**603**		**26**	
Kahului	60301	1	1*	2
Pā`ia	60302	7-8	7*	2
Makawao	60303	7-20	7*	3
Kama`ole	60304	11-16	11	3
Ko`olau	**604**		**174**	
Ha`ikū	60401	27	27	2
Honopou	60402	25-26	25	3
Waikamoi	60403	40	40	3
Ke`anae	60404	83	83	3
Hāna	**605**		**122**	
Kuhiwa	60501	14	14	3
Kawaipapa	60502	48	48	3
Waihoi	60503	18-21	18	3
Kīpahulu	60504	42	42	3
Kahikinui	**606**		**34**	
Kaupō	60601	16	16	3
Nakula	60602	7	7	3
Lualailua	60603	11	11	3

Source: Hawai`i Water Resource Protection Plan, June 2008, Tables 3-10 and 3-11
* Only basal water

Groundwater Management Areas

The CWRM may designate an area as a water management area and limit the total quantity of water that can be withdrawn when the water resources of an area are determined to be threatened by existing or proposed withdrawals of water, current and subject future withdrawals to water use permit allocations. The State Water Code provides eight criteria for CWRM to consider in designating a groundwater management area, including the following:

- Whether an increase in water use or authorized planned use may cause the maximum rate of withdrawal from the groundwater source to reach 90 percent of the sustainable yield of the proposed groundwater management area;
- There is an actual or threatened water quality degradation as determined by the department of health;
- Whether regulation is necessary to preserve the diminishing groundwater supply for future needs, as evidenced by excessively declining groundwater levels;
- Whether the rates, times, spatial patterns, or depths of existing withdrawals of groundwater are endangering the stability or optimum development of the groundwater body due to upconing or encroachment of salt water;
- Whether the chloride contents of existing wells are increasing to levels which materially reduce the value of their existing uses;
- Whether excessive preventable waste of groundwater is occurring;
- Serious disputes respecting the use of groundwater resources are occurring; or
- Whether water development projects that have received any federal, state, or county approval.

The 90 percent of sustainable yield provides a regulatory buffer between SY and proposed withdrawals. The CWRM designated `Īao Aquifer System Area as a Groundwater Management area effective July 21, 2003, requiring water use permits for all non-individual domestic groundwater uses.[63] Water use permits issued as of August 2016 totaled 19.089 mgd with 0.911 mgd unallocated. The table in section 8.2.1 shows the sustainable yields adopted in 2008 by CWRM, 2014 pumpage, water use permits in groundwater management areas and pump capacity in other areas.

Developable Yield

Sustainable yield estimates adopted by the CWRM do not take into consideration a variety of factors that affect groundwater development. The sustainable yields provide an estimate for the entire aquifer system area assuming a single homogeneous geologic formation. The sustainable yield of basal aquifers represents the maximum aquifer pumping rate assuming optimal placement of wells and pump sizes. Groundwater may interact with streams due to dike influences. Development cost and risk also reduce the potential for full development of an aquifer system area.[64] While the sustainable yields adopted by the CWRM are conservative, input received from some community interests advocated an additional buffer to reflect these issues, especially where confidence ranking is low due to lack of hydrologic data. Groundwater

[63] State Water Resources Protection Plan. 2008

supply strategies of this WUDP therefore do not recommend development up to 100% of established sustainable yields.

5.5 Groundwater Quality

Groundwater is of high quality and is generally more reliable and less expensive to treat than surface water. The *Hawai`i Source Water Assessment Program (SWAP) Report* completed for Maui in 2004 assesses public drinking water sources for Potential Contaminating Activities (PCAs) to ground, surface and groundwater under the direct influence of surface water sources. The assessment delineates the area around a drinking water source through which contaminants may travel to the drinking water supply, inventories activities that may lead to the release of contaminants within the delineated area, and computes a susceptibility to contamination score for each drinking water source. This information supports the County's proposed wellhead protection ordinance which would impose land use regulations on high risk activities within wellhead capture zones.

The DOH Safe Drinking Water Branch's online Groundwater Contamination Viewer identifies detections of organic contaminants (which are generally a measure of human activity) detected by DOH and other reporting agencies and confirmed through repeat testing in drinking water wells, select non-potable wells and fresh water springs prior to treatment. Some contaminated wells may not be listed due to lack of reporting or testing, sources previously reported as contaminated whose latest test resulted in a "not detected" or "ND" report are no longer included, and some data are extremely old due to inability to retest. Detections on the Viewer in the figure below are identified within the Honokōwai, Honolua, Kahului, Pā`ia and Ha`ikū aquifer system areas are typically caused by herbicide applications including 1,2-Dibromo-3-Chloropropane (DBCP); Ethylene Dibromide (EDB); Atrazine and/or 1,2,3-Trichloropropane (TCP).

Figure 5-8 Groundwater Contamination Viewer Map for Maui Island

Groundwater Contamination Viewer, 09-23-2015, https://'Eha-cloud.doh.Hawai`i.gov

Changes in chloride concentration of pumped water over time can be a function of the pumping rate of a particular well, pumping at nearby wells, depth of the well, and recharge to the aquifer. Therefore, the evaluation of aquifer conditions based on chloride-concentration trends from the pumped wells has limitations.

The CWRM, USGS and others maintain or monitor deep monitoring wells which penetrate the freshwater basal aquifer into the underlying brackish and salt water and is used to estimate the thickness of the freshwater-lens and the freshwater-saltwater transition zone. The CWRM monitors four deep monitoring wells on Maui: at Mahinahina Deep Monitor Well in the Honokōwai Aquifer System Area near Lahaina, the Waiehu Deep Monitor Well and the `Īao Deep Monitoring Well in the `Īao Aquifer System Area, which is heavily pumped and may be showing signs of over pumpage, and the new Waihe'e Deep Monitor Well, located in the

Waihe'e Aquifer System Area, which is hydraulically connected to the `Īao Aquifer System Area.[65]

5.6 Surface Water Availability

There are 90 perennial streams in Maui, 82 of which have been diverted to some extent (Appendix 4). Streams provide riparian and instream habitats for many unique native species, support traditional and customary Hawaiian gathering rights and taro cultivation, provide recreational and aesthetic enjoyment, and affect the physical and chemical quality of receiving waters such as estuaries, bays, and nearshore waters. [66] Water from streams supplies a small proportion of drinking water island-wide but is a significant source of supply in West Maui and Upcountry.

The availability of surface water is uncertain due to multiple factors such as information about surface water resources and the effects of diversions on the ecosystem, as well as lack of numerical instream flow standards and legal issues. The main issues related to surface water in Hawai`i are: (1) streamflow availability; (2) the reduction of streamflow by surface diversions and, in some areas, ground-water withdrawals; (3) floods; (4) water-quality changes caused by human activities; and (5) erosion and sediment transport. The use of surface water in Hawai`i by agricultural and municipal water users and streamflow reduction caused by diversions often conflicts with traditional Hawaiian practices (taro cultivation and gathering of stream fauna), stream ecology, water quality, recreational activities, and aesthetics.[67]

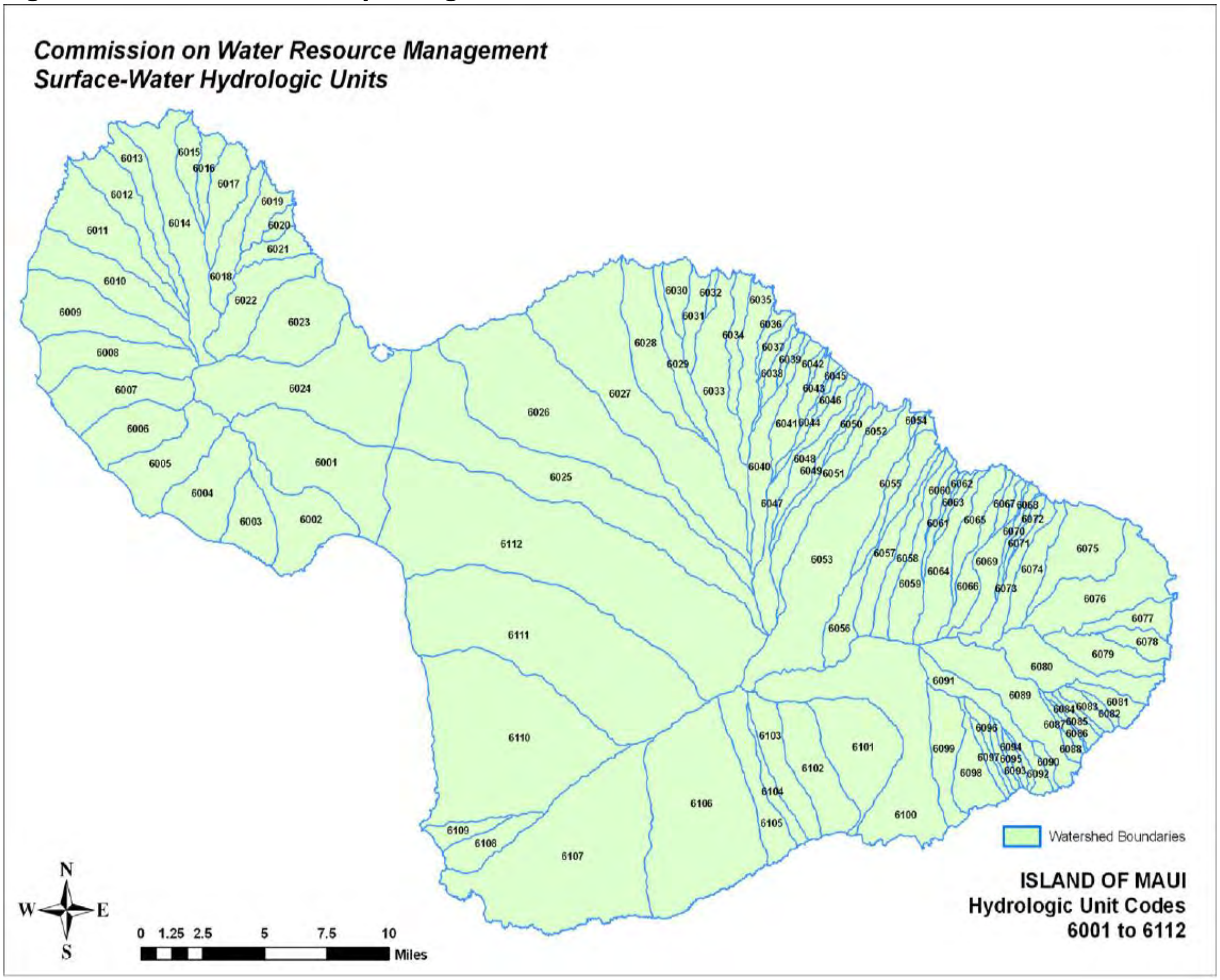
The drainage areas of surface water that are confined by topographic divides are generally referred to as watersheds. Surface water hydrologic units have been established by CWRM to provide a consistent basis for managing surface water resources. The watershed boundaries and hydrologic unit codes for Maui Island are shown in the figure below. While the WUDP is organized based on aquifer sector areas, surface water hydrologic units are referenced as relevant for watershed management, analysis of water transfers and resource use.

An inventory of streams on Maui is provided in Appendix 4.

---

[65] CWRM Monitoring Data, http://files.hawaii.gov/dlnr/cwrm/monitoringdata/dmw_infos.pdf, August 2, 2016.
[66] Cheng, C.L., 2016, Low-flow characteristics for streams on the Islands of Kaua'i, O'ahu, Moloka'i, Maui, and Hawai`i, State of Hawai`i: U.S. Geological Survey Scientific Investigations Report 2016-5103, 36 p. http://dx.doi.org/10.3133/sir20165103
[67] Surface Water in Hawai`i: U.S. Geological Survey Fact Sheet 045-03, Oki, D.S., 2003

Figure 5–9 Surface Water Hydrologic Units



Instream Flow Standards

In accordance with the Water Code, the CWRM establishes and administers instream flow standards on a stream-by-stream basis as necessary to protect the public interest. 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."

Section 174C-3, Hawai`i Revised Statutes, defines instream use 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."

The CWRM's mandate is to establish instream flow standards that will protect instream uses while allowing for reasonable and beneficial offstream use.

Interim instream flow standards (IIFS) were first adopted for both East and West Maui streams in 1988 (Sections 13-169-44 and 48, Hawai`i Administrative Rules). According to Section 13-169-46, Hawai`i Administrative Rules, "Interim Instream Flow Standard for all streams on Hawai`i, 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, 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]." Therefore, the IIFS established in 1988 are not based on scientific information but continue the "status quo" by setting the standard at the amount of water that was flowing in each stream on the date of adoption. For areas where measurable standards are not set, the CWRM basically regulates according to the users of surface water and groundwater which were required to register their uses with CWRM when the State Water Code was enacted. Any new diversions (unless deemed within the error of measurement) require an amendment to the IIFS. These standards will influence long-range planning instream and offstream uses.[68]

Instream flow standards need to consider the best available information in assessing the range of present or potential instream and non-instream uses. Surface water resources in an area must be quantified based on accurate long-term data before streamflow availability can be evaluated for existing and proposed uses. Balancing offstream and instream uses by the CWRM requires information on existing and future water use and quantified information on surface water availability, particularly natural flow during low-flow conditions, which has not always been available to set instream flow standards, support decision making and resolve litigation over rights to water between diverters and those desiring sufficient flow for instream uses as discussed below. The availability of streamflow during low-flow conditions is important to protect native stream animals, protect water quality and determine the total maximum daily load to characterize impaired waters, and to identify areas of groundwater discharge and assess the potential effect of groundwater withdrawal. [69]

[68] Maui Island Plan, Chapter 6 Infrastructure and Public Facilities
[69] Cheng, C.L., 2016, Low-flow characteristics for streams on the Islands of Kaua'i, O'ahu, Moloka'i, Maui, and Hawai`i, State of Hawai`i: U.S. Geological Survey Scientific Investigations Report 2016-5103, 36 p. http://dx.doi.org/10.3133/sir20165103

The annual mean "Qp" flow is the daily average flow equaled or exceeded "p" percent of the time during the year. Q_{50} is the median or natural base flow for a particular stream segment during a specified period. Base flow is dependent on groundwater discharge while total flow reflects base flow and rainfall runoff. [70] The base flow is a general guideline for the minimal amount of streamflow needed for fish habitat.[71] For perennial streams, the estimated long-term average base flow is 60 to 80 percent and thus 70 percent is used (Q_{70}). Flow exceeded 90% of time (Q_{90} flow) is commonly used to characterize low flows and flow exceeded 95 percent of the time Q_{95} represents extreme low-flow conditions.[72] The report, *Low-flow characteristics for streams on the Islands of Kaua'i, O'ahu, Moloka'i, Maui, and Hawai`i, State of Hawai`i: U.S. Geological Survey Scientific Investigations Report 2016-5103,* estimates natural streamflow under low-flow conditions using statistical models, where low-flow conditions are flow-duration discharges that are equaled or exceeded between 50 and 95 percent of the time during a 30-year base period 1984–2013. The study period is constrained by trends found in streamflow and base flow for long-term continuous-record stations; while USGS has operated many stream-gaging stations, data may be incomplete or nonexistent for some streams. The long-term downward base and low-flow trends from 1913 to 2008 reflect regional changes in climatic and land cover factors such as temperature and/or trade winds and reforestation, and decreases in groundwater storage and recharge which affect base flow.[73] The CWRM is funding the second phase of a cooperative study with USGS anticipated to be complete in 2021 to provide low flow duration discharges at existing measurement sites and develop methods to estimate selected natural low-flow duration discharges between the 50 and 90 flow-duration percentiles at ungagged sites where streamflow data is limited or unavailable on Maui and other islands using the StreamStat tool.[74]

In revising the IIFS, the CWRM defined minimum viable habitat flow (Hmin) for the maintenance of suitable instream habitat to support growth, reproduction, and recruitment of native stream animals in Nā Wai `Ehā and East Maui streams as 64% of Median Base Flow (0.64 x BFQ_{50}; also defined as H_{90} by USGS studies). For streams without measurable IFS, the IIFS generally reflects the diverted amounts existing when the status quo interim IFS were adopted, or as subsequently amended by CWRM. Low-flow conditions, or flow exceeded 90 percent of the time (Q_{90}), is therefore an appropriate starting point for considering additional offstream uses. Significant new stream diversions will require amendments to IIFS. [75] In revising the IIFS, the CWRM concluded that establishing continuous streamflow from mauka to

[70] Trends in Streamflow Characteristics at Long-Term Gaging Stations, Hawai`i. USGS SIR 2004-5080

[71] CWRM Staff Submittal, Steam Diversion Works Permit (SDWP.4175.6) Wailuku River, Maui, August 16, 2016

[72] Trends in Streamflow Characteristics at Long-Term Gaging Stations, Hawai`i. USGS SIR 2004-5080

[73] Cheng, C.L., 2016, Low-flow characteristics for streams on the Islands of Kaua'i, O'ahu, Moloka'i, Maui, and Hawai`i, State of Hawai`i: U.S. Geological Survey Scientific Investigations Report 2016-5103, 36 p. http://dx.doi.org/10.3133/sir20165103

[74] CWRM Staff Submittal regarding funding for Second Phase of Cooperative Study to Estimate Low-Flow Characteristics for Streams in Hawai`i, November 15, 2016. http://files.hawaii.gov/dlnr/cwrm/submittal/2016/sb20161115A2.pdf

[75] Cheng, C.L., 2016, Low-flow characteristics for streams on the Islands of Kaua'i, O'ahu, Moloka'i, Maui, and Hawai`i, State of Hawai`i: U.S. Geological Survey Scientific Investigations Report 2016-5103, 36 p.

makai provides the best conditions for re-establishing the ecological and biological health of the waters of Nā Wai `Ehā , and used the "Q_{90}" to establish IIFS.[76]

Instream Uses

There are essentially three areas on Maui where instream uses are at issue. The Nā Wai `Ehā contested case is within a surface water management area wherein CWRM determines the amount of water the end users are allowed to divert from the streams. The East Maui contested case addresses the instream flow standards and how much water must be left in the streams. In West Maui, CWRM is developing watershed assessments to support a determination of instream flow standards. These are summarized below.

<u>Nā Wai `Ehā</u>

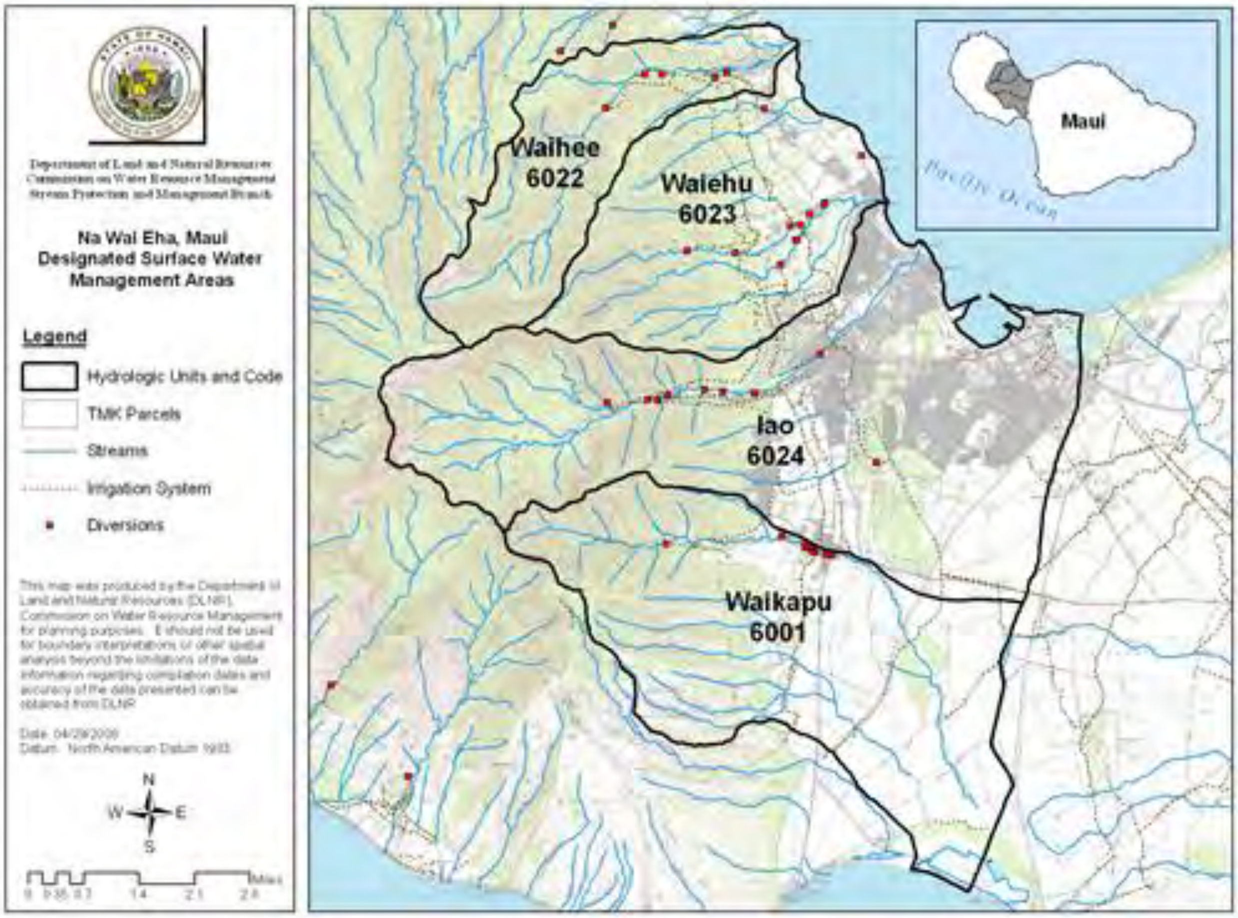
Nā Wai `Ehā, or "the four great waters of Maui," is the collective name for the Waihe'e River and the Waiehu, `Īao, and Waikapū Streams.

On June 25, 2004 Petitioners/Appellants Hui o Nā Wai `Ehā and Maui Tomorrow Foundation, Inc., through Earthjustice, filed a *Petition to Amend the Interim Instream Flow Standards for Waihe'e, North and South Waiehu, `Īao , and Waikapū Streams and Their Tributaries*, which had been in place since 1988. CWRM designated Nā Wai `Ehā as a surface water management area effective April 30, 2008 thereby assuming permit jurisdiction, excluding former domestic consumption of surface water by individual users, for users on any Maui Department of Water Supply water system, and for the use of rain catchment systems to gather water. A contested case addressing Instream Flow Standards (IFS), appurtenant rights and water use permits for Nā Wai `Ehā is still ongoing. The first proposed Findings of Fact (FOF), Conclusions of Law (COL), and Decision and Order (D&O) were issued by the Hearings Officer in April 2009. In June 2010, CWRM issued its FOF, COL and D&O, amending the IIFS for Waihe'e and Waiehu streams, while retaining the existing values for Wailuku River and Waikapū Stream. The decision to not amend IIFS values for Wailuku River and Waikapū Stream was appealed to the Hawai`i Supreme Court, which ruled that CWRM must consider ecosystem services, habitat for native biota, and traditional and customary practices in establishing IFS values. A mediated settlement of additional IFS values for the two streams was reached between the parties involved, which was approved by CWRM on April 17, 2014.[77] Under this agreement, more water will be returned to Nā Wai `Ehā, particularly to Wailuku River and Waikapū Stream.[78]

---

[76] CWRM's Findings of Fact, Conclusions of Law, and Decision and Order in the matter of the '`Īao Ground Water Management Area High-Level Source Water-Use Permit Applications and Petition to Amend Interim Instream Flow Standards of Waihe'e River and Waiehu, 'lao, and Waikapū Streams Contested Case Hearing, June 10, 2010 (CCH-MAO6-O1).
[77] http://files.hawaii.gov/dlnr/cwrm/cch/cchma0601/CCHMA0601-2-CWRM.pdf. http://files.hawaii.gov/dlnr/cwrm/cch/cchma0601/CCHMA0601-2-CWRM.pdf.
[78] State Department of Land and Natural Resources, *Maui Parties Reach Agreement In Nā Wai `Ehā Amended Interim Instream Flow Water Case*; Press Release, April 21, 2014. http://files.Hawai`i.gov/dlnr/cwrm/news/2014/nr20140421.pdf (May 2015)

Figure 5-10 Nā Wai `Ehā -Designated Surface Water Management Areas



On December 14, 2014 the CWRM issued a *Provisional Order on Claims That Particular Parcels Have Appurtenant Rights* (CCH-MA 13-02). The third stage of the contested case process is to determine surface water use permits and the integration of the IFS, appurtenant rights and surface water use permits. However, in response to the January 6, 2016 announcement by Alexander & Baldwin, Inc. that it would close HC&S by the end of 2016 and eventually transition to diversified agriculture, on March 9, 2016 the Parties filed and on July 7, 2016 the CWRM accepted a *Petition to Amend Upward the IIFS for Waihe'e, Waiehu, `Īao, and Waikapū Streams and Their Tributaries; and Motion to Consolidate or Consider in Parallel with Case CCH-MA 15-01.*[79]

In December 2017, the contested case hearing officer issued his proposed FOF, COL and D&O. The parties have filed their objections/exceptions in January of 2018 and at the time of this Draft, CWRM has yet to adopt the proposed FOF, COL and D&O.

[79] Staff Submittal to the CWRM, June 17, 2016.
http://files.hawaii.gov/dlnr/cwrm/submittal/2016/sb20160617C3.pdf

East Maui Streams

On May 24, 2001, the Native Hawaiian Legal Corporation (NHLC), on behalf of Na Moku ‘Aupuni o Ko`olau Hui (Na Moku), petitioned the CWRM to amend the Interim Instream Flow Standards (IIFS) for 27 East Maui streams. In 2008 and 2010, the CWRM approved amendments to the IIFS for about half the streams and establishing measurable IIFS of status quo conditions for the remaining streams; only six of the twenty-seven streams had flow restored. In June 2010, the County DWS and the NHLC, on behalf of Na Moku, filed petitions for a contested case hearing before the CWRM. On November 17, 2010, Na Moku appealed the CWRM’s decision contending that the CWRM erred in concluding that Na Moku had no right to contest the case hearing and in reaching its underlying decision regarding IIFS amendment for the nineteen streams. On November 30, 2012, the Intermediate Court of Appeals remanded to the CWRM and the contested case hearing began on March 3, 2015. The interest asserted by Na Moku was the right to sufficient streamflow to support the exercise of their traditional and customary Native Hawaiian rights to grow kalo and gather in, among, and around east Maui streams and estuaries and the exercise of other rights for religious, cultural, and subsistence purposes. The petition also alleges that the Commission had not carried out its obligations under public trust by failing to require HC&S and EMI to prove: 1) Their actual need; 2) that there are no feasible alternative sources of water to accommodate that need; and 3) the amount of water diverted to accommodate such need does not harm a public trust purpose or any potential harm does not rise to a level that would preclude a finding that the requested use is nevertheless reasonably-beneficial.

Subsequent to HC&S announcing cessation of sugarcane cultivation by the end of 2016, CWRM ordered re-opened hearings to address HC&S current and future use of surface water and the impact on the groundwater; the impact on MDWS’s use of surface water due to cessation of sugar operations; the County’s position on future use of sugarcane fields, and issues concerning management of the EMI ditch system. In the September Minute Order No. 21, the CWRM hearings officer reiterated the requirement that CWRM weigh competing instream and offstream uses, including economic impact on offstream uses, in amending the IIFS.

CWMR issued their decision on June 20, 2018 for East Maui Streams (see Chapter 15, Appendix 15A) and as of this WUDP Draft no appeals were filed.

A&B, Inc. and EMI currently hold revocable permits to take water from four license areas in East Maui. In December 2016 the Board of Land and Natural Resources approved holdover of four revocable permits on a month-to-month basis through December 31, 2017 with amendments capping A&B’s extraction of East Maui water at 80 million gallons per day, and ordered full restoration of seven East Maui streams used for taro farming. The Board added Honomanu Stream to the list of streams to be restored. The Board of Land and Natural Resources denied a contested case for A&B water leases in December 2018, allowing continued diversions at the time of this WUDP Draft.

West Maui

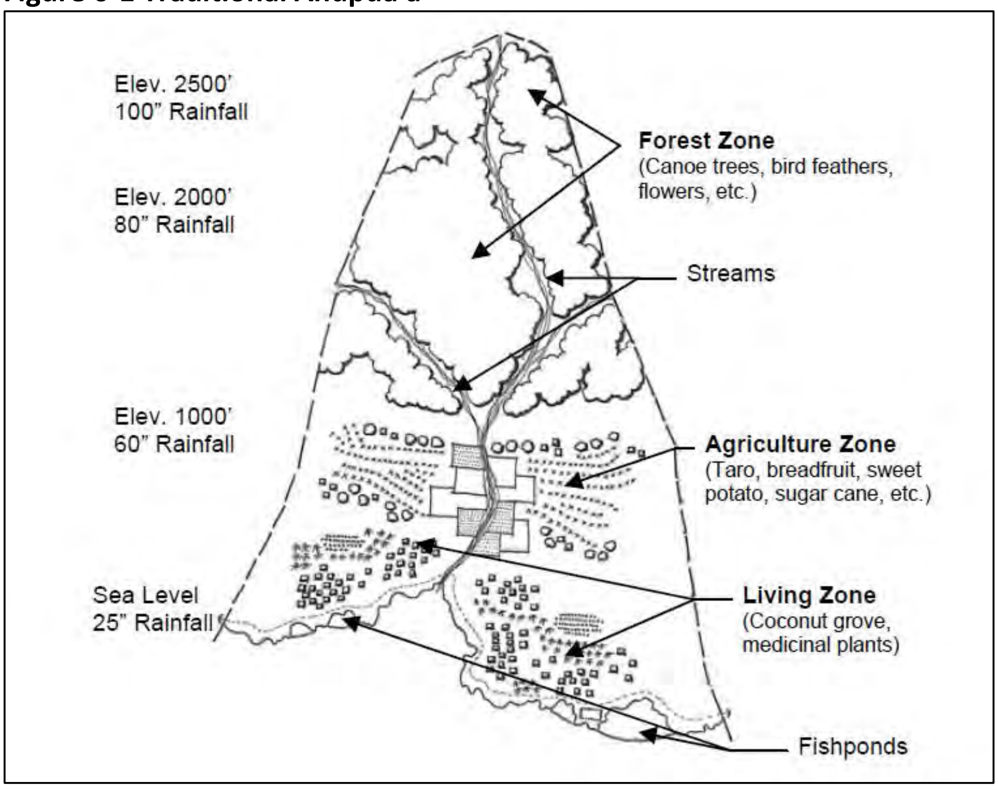
In August 2006 Maui Land & Pineapple Company (MLP) petitioned CWRM to establish amended instream flow standards for Honokōhau and Honolua Streams. In November 2008 the CWRM notified MLP that petitions would be delayed due to Nā Wai `Ehā contested case. In June 2011 the CWRM entered into an agreement with USGS to conduct a low-flow stream study for 10 streams in West Maui resulting in the report, *Low-Flow Characteristics of Streams in the Lahaina District, West Maui, Hawai`i: Scientific Investigation Report 2014–5087*. The CWRM is currently preparing instream flow assessments. In 2018, Interim Instream Flow Standards were proposed for the following streams: Ukumehame, Launiupoko, Olowalu, Kau`ula, Kahoma and Kahana streams. Stream assessments and proposed IIFS for all West Maui streams were underway at the time for this WUDP Draft.

6.0 SETTLEMENT PATTERNS AND CULTURAL RESOURCES

6.1 Overview of Moku and Ahupua'a

Maui County's original inhabitants developed a unique system of land and ocean tenure and use that divided land into large sections called moku. Each moku was comprised of many ahupua`a. An ahupua`a is a land division unit that extends from the upland mountain top to the sea, and usually includes the bounding ridges of a valley and the stream within. In 1853, there were at least 300 villages on the Island of Maui, located in 141 aupua`a in 12 districts or moku, shown in the figure below.[80] However, by 1853 Native Hawaiian populations had been decimated by disease. Ahupua'a were intended to support roughly equal numbers of people, but varied in size reflecting the availability of resources. Through this indigenous land-management system based upon the ecological interdependence of mauka and makai lands, the Hawaiians employed a complex system of sustainable agriculture and aquaculture practices including extensive auwai (irrigation systems) that were developed to water the lo`i kalo (taro fields).[81]

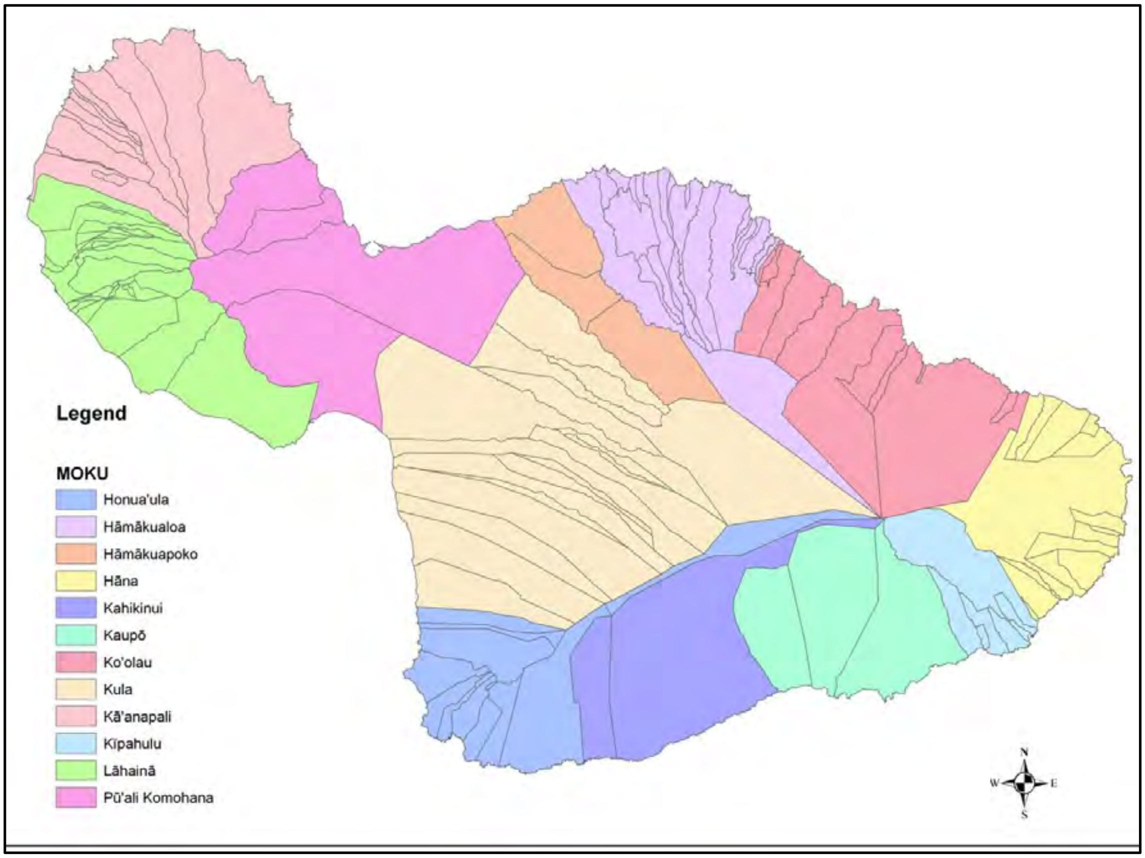
Figure 6-1 Traditional Ahupua'a



Source: Maui Island Plan, 2012

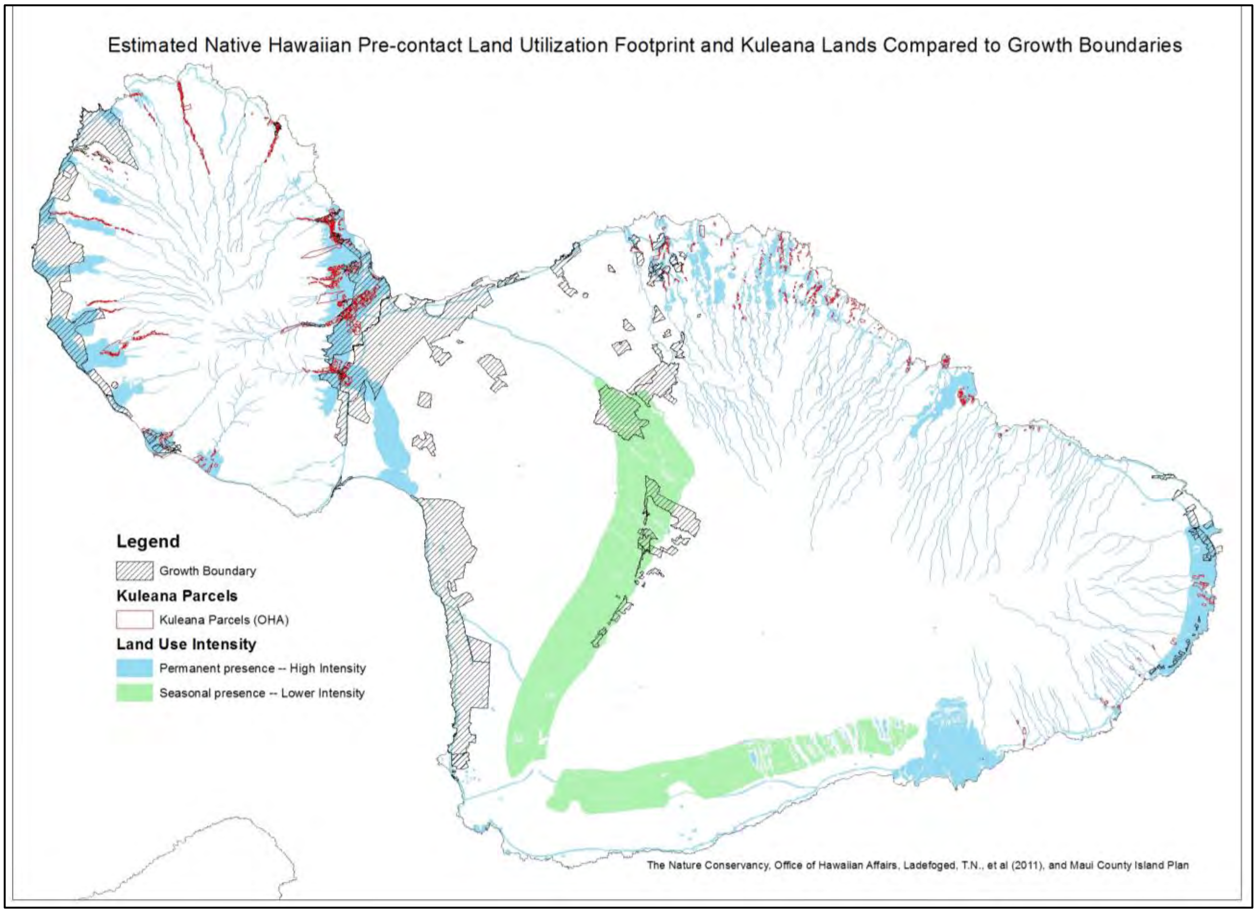
[80] There are 12 or 13 mokus on Maui Island depending on the historical representation; thus moku boundaries in this WUDP may vary depending on the reference.
[81] Mauka refers to lands toward the mountain or upland; makai refers to lands toward the ocean.

Figure 6-2 Moku and Ahupua'a



Land ownership as a concept was first introduced to Hawai`i by Westerners. In 1848, King Kamehameha III set into motion the Great Māhele which marked the establishment of Western land-management systems in Hawai`i, and included the practice of land division by survey and the privatization of land ownership resulting in a significant impact to the economic framework and cultural fabric of Hawaiian society. Following the events of the Great Māhele, Hawaiian land became widely available for private ownership and development which resulted in many Hawaiians being forced into urban centers and away from lands previous generations had cultivated for over a millennia. This relationship of estimated location of permanent and seasonal pre-contact land use utilization, in comparison to the urban centers represented by the Urban Growth Boundary in the Maui Island Plan, is shown in Figure 6-3. The figure also shows the correlation of pre-contact and kuleana lands compared to the urban centers.

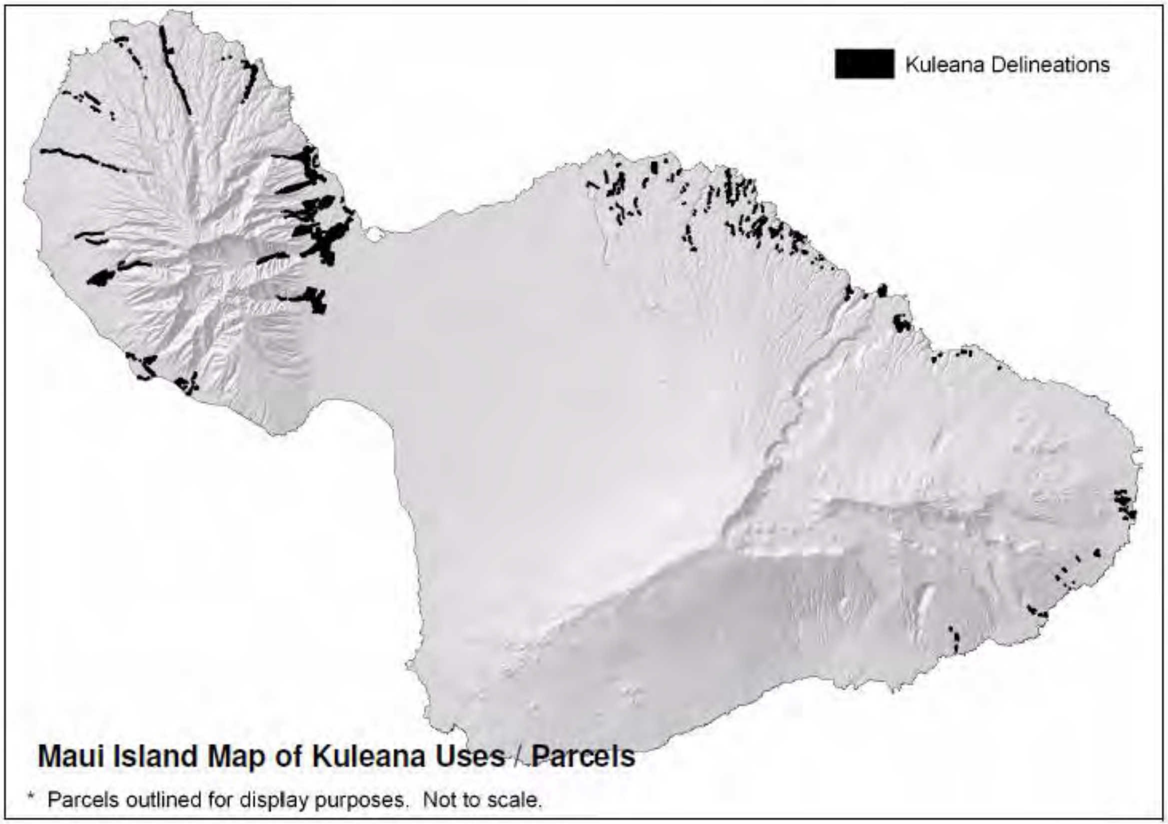
Figure 6-3 Estimated Native Hawaiian Pre-contact Land Utilization Footprint and Kuleana Lands Compared to Growth Boundaries



An understanding of Hawaiian customs, practices and indigenous rights in the context of the ahupua`a is required in the application of the water law in Hawai`i. Native Hawaiian water rights originate from kānāwai—traditional laws set forth by ali`i nui (ruling chiefs) for the management and use of fresh water—which were codified in early laws of the Hawaiian Kingdom. Native Hawaiian water rights are protected by the State Constitution and Water Code (HRS Chapter 174C). These water rights include current and future water use for Hawaiian Homelands, domestic water use for kuleana lands, and traditional and customary rights.

Water rights include "appurtenant or kuleana water rights" to use that amount of water from a water source (usually a stream) which was used at the time of the Māhele of 1848 on kuleana and taro lands for the cultivation of taro and other traditional crops and for domestic uses on that land, and "riparian rights" which protect the interests of people who live on land along the banks of rivers or streams to the reasonable use of water from that stream or river on the riparian land subject to other rights of greater value. These rights run with the land.[82, 83]

Figure 6–4 Kuleana Lands



Office of Hawaiian Affairs data

Traditional and Customary (T&C) Hawaiian practices are deeply intertwined with the geographical environment of the islands. Prior to the arrival of Westerners and the idea of private land ownership, Hawaiians communally managed, accessed and gathered the resources from the land and seas to fulfill their community responsibilities. Traditional and Customary Native Hawaiian rights are personal rights "customarily and traditionally" exercised for subsistence, cultural and religious purposes and possessed by ahupua`a tenants who are descendants of Native Hawaiians who inhabited the Hawaiian Islands prior to 1778, subject to the right of the State to regulate such rights. These rights remain in force today. In order to qualify as T&C Hawaiian rights, gathering of stream animals and the exercise of appurtenant rights must meet specified criteria. Not all appurtenant rightsholders have T&C Hawaiian rights because appurtenant rights are property rights held by any owner of the appurtenant lands, while T&C Hawaiian rights are personal rights. Traditional and Customary Native Hawaiian

[82] Haia, Moses. *Protecting and Preserving Native Hawaiian Water Rights.* http://www.Hawai`i.edu/ohelo/resources/AluLikeWorkbook/Chap7.pdf

[83] Ola I Ka Wai: A Legal Primer For Water Use And Management In Hawai`i

rights are exercised in the streams in the form of subsistence gathering of native fish, mollusks, and crustaceans, and stream flows are diverted for the cultivation of wetland taro, other agricultural uses, and domestic uses that can be traced back to the Māhele. The maintenance of fish and wildlife habitats to enable gathering of stream animals and increased flows to enable the exercise of appurtenant rights constitute the instream exercise of "traditional and customary" Hawaiian rights.[84]

6.2 Historical "Big Ag" Water Use

Large-scale agriculture, primarily sugarcane and pineapple, drove Maui's economy for over 90 years, with long-lasting impacts on the island's people, land, and water. Due to the 1876 signing of the Hawaiian Reciprocity Treaty allowing duty free admission of Hawaiian sugar to the mainland United States, sugarcane cultivation expanded from 5,080 acres in 1867 to 12,000 in 1880. The pineapple industry began on Maui in 1890 and expanded steadily to cover 28 percent of Maui's cultivated lands by 1930. After World War II, improved economic conditions and increased demand for housing resulted in marginal agricultural lands being converted into urban subdivisions.[85] Within the past two decades, Maui's pineapple has all but disappeared and has been replaced with seed and diversified crops or other land uses. In 2016 A&B Properties announced that HC&S would halt sugar production at the end of the year, expressing its commitment to future agricultural pursuits on a portion of the lands used for sugarcane production as discussed in section 9.3.

Plantation Irrigation Systems

A key factor to the boom of sugarcane and pineapple was the development of extensive surface water distribution systems in West and East Maui which diverted large quantities of surface water from perennial streams into transmission ditches and tunnels, moving water from the windward side of the islands to the leeward plains. Construction of the East Maui Irrigation (EMI) ditch system was started in 1898, immediately after Alexander & Baldwin acquired HC&S. EMI's water collection system begins in the Ko`olau range in Hāna and has a capacity of 450 mgd. The water source is primarily surface water runoff from streams in a 56,000 acre watershed area. EMI, which is owned by A&B Properties, currently leases 33,000 acres of watershed area from the State of Hawai`i. The ditch system in Nā Wai `Ehā consisted of two major ditches – Waihe'e and Spreckels ditches – and nine smaller ditches used by Wailuku Water Company (former Wailuku Sugar Company) and HC&S since the late 1800s. The total capacity of the major ditches of Nā Wai `Ehā is 100 mgd encompassing a 13,500 acre watershed area. The historical ditch systems are shown below.[86]

---

[84] CWRM East Maui Streams Hearing Officer's Recommended FOF, COL, and D&O, January 15, 2016. Contested Case No. CCH-MA 13-01 http://files.hawaii.gov/dlnr/cwrm/cch/cchma1301/CCHMA1301-20160115-HO-D&O.pdf

[85] Maui Island Plan, State Agricultural Water Use and Development Plan, 2004

[86] State Agricultural Water Use and Development Plan, 2004

Table 6-1 Historical Ditch Systems on Maui (mgd)

Plantation and Ditches	Date	Ave. Flow *	Capacity
East Maui Irrigation Co.		**160****	**440**
(Old) Hamakua Ditch	1878		
(Old) Ha`ikū (Spreckels) Ditch	1879	(4)	
Lowrie Ditch (Lowrie Canal)	1900	(37)	60
New Hamakua Ditch	1904	(84)	
Ko`olau Ditch	1905	(116)	85
New Ha`ikū Ditch	1914	25	100
Kauhikoa Ditch	1915	(22)	110
Wailoa Ditch	1923	(170)	160-195
Wailuku Sugar Co.		**30****	
Waihe'e (Spreckels) Ditch	1882	10-2	20
Waihe'e (Ditch) Canal	1907	27	
Nine other smaller ditches			
Honolua Ranch & Pioneer Mill Co.		**50****	
Honokōhau Ditch	1904	20	35
Honolua (Honokōhau) Ditch	1913	30-18	50-70
Honokōwai Ditch	1918	6	50
Kahoma Ditch		3	
Kanaha Ditch		3.8	
Kauaula Ditch		4.5	25.5
Launiupoko Ditch		0.8	
Olowalu Ditch		4	11
Ukumehame Ditch		3	15

AWUDP, 2004, Table 1, Modified after Wilcox, Carol, 1977.
* Average flows are based on the historical record except for those in parentheses, which are from USGS records.
**Estimated average total surface water diverted.

Agricultural Challenges

Prior to its planned demise in 2016, sugarcane cultivation in Central Maui has faced many challenges, including 1) court and regulatory rulings affecting continued access to surface water from East Maui watersheds through the EMI and the West Maui ditch systems; 2) lack of reliable and economically viable markets; and 3) inadequate labor supply. Irrigation demand for sugarcane crops averaged approximately around 160 mgd over the past decade.[87] Persistent droughts and low rainfall periods have adversely affected perennial streamflows and depleted high-level groundwater aquifers that supply Hawai`i's irrigation systems. A 2001 petition to amend the interim instream flow standard for 27 streams in East Maui and restore streamflow, along with the designation of Na Wai 'Ehā as a surface water management area in 2008, rendered the future use of surface water for large scale agriculture uncertain. However, House Bill 2501 enacted in June 2016, authorizes EMI to continue diversions by holdover lease until the pending application for the disposition of water rights if resolved, or no longer than three years, whichever occurs sooner.

[87] HC&S used about 30 mgd (WWC) and 126 mgd (EMI) per Nā Wai `Ehā and East Maui Streams Contested Cases.

Between 1980 and 2015, in the State of Hawai`i pasture land decreased by 31% from 1.1 million acres to 761,430 acres, and active agricultural cropland decreased by 57% from 350,830 acres to 151,830 acres. It is highly unlikely that that crop production will ever rebound to the 1980 level, although certain crops such as commercial forestry and seed crops have increased since 1980.[88] Still, according to the 2015 State of Hawai`i Data Book, Foreign Agricultural Exports on a per-farm-receipts-basis grew from $151.5 million in 2000 to $400.4 million in 2014. Although interest in food security, organic produce, farm-to-table dining, and community farmers markets is growing dramatically, Hawai`i's agricultural industry is dominated by export markets.

The agricultural lands in Central O`ahu have become a center for local food production serving both O'ahu and the neighboring islands, as well as providing a model for locally sourced products. Although opportunities may still exist for local exports to O'ahu, Maui and other islands are challenged by the efficiency of O`ahu's larger operations and greater transportation costs than borne by O`ahu's farmers. On Maui, many small farmers need to sell directly to consumers or capitalize on restaurant and resort markets in order to secure a sufficient profit margin. High land values in productive farm areas like Kula along with gentrification are resulting in decreasing farming activities.[89] Cultivating a continuing and new generation of farmers and labor force is an underlying problem, with first and second generation immigrant farmers generally acknowledged to be the cornerstone of virtually every crop Hawai`i produces.[90]

On Maui, agriculture consumed about 90 percent of total water use in 2014 and despite the projected decline in production with the close of HC&S is expected to remain a major user. Adequate quantity and low cost water supplies to meet agricultural demand are essential to support the agricultural industry. Maui's water supplies are becoming increasingly constrained due to changes in weather patterns and climate with increasing temperatures, decreasing rainfall and less predictability; population and economic growth; state and county laws, guidelines and their interpretation; stringent application of dam and safety regulations, increased federal farm food safety requirements and regulations requiring potable water to process vegetables; and legal rulings to protect water resources, comply with water rights and the public trust doctrine, and reduce water diversions from streams for both environmental and native cultural purposes (e.g., taro farming). Further, aging infrastructure and new water sources and technologies, such as more pipelines, groundwater wells, recycled water facilities and desalination of brackish sources, are constrained by the availability of capital. Many plantation irrigation systems across the state, including the Maui Land and Pineapple/Pioneer Mill Irrigation System (MLP/PMIS) in West Maui, have been partially abandoned and are deteriorating and rehabilitation will be extremely costly. The future of the EMI system also has many pending unresolved issues as sugarcane transitions to other crops or uses. Some small agricultural and kuleana users also use these systems for conveyance. These systems will

[88] Melrose, J., Perroy, R., and Cares, Sylvana, 2015. Statewide Agricultural Land Use Baseline 2015, HDOA, page 4.
[89] Ibid, pages 5-6.
[90] Ibid, page 6.

require strategic reinvestment, subsidies, and incentives in order to support existing and new farm growth.

Hawai`i Statewide Agricultural Land Use Baseline

The 2015 Hawai`i Statewide Agricultural Land Use Baseline provides a snapshot of contemporary commercial agricultural land use activity based on geospatial and other datasets verified by multiple means. It represents the best efforts to capture the scale and diversity of commercial agricultural activity in Hawai`i in 2015 and should be used for informational purposes only. Not all properties were mapped due to the small scale of some operations.

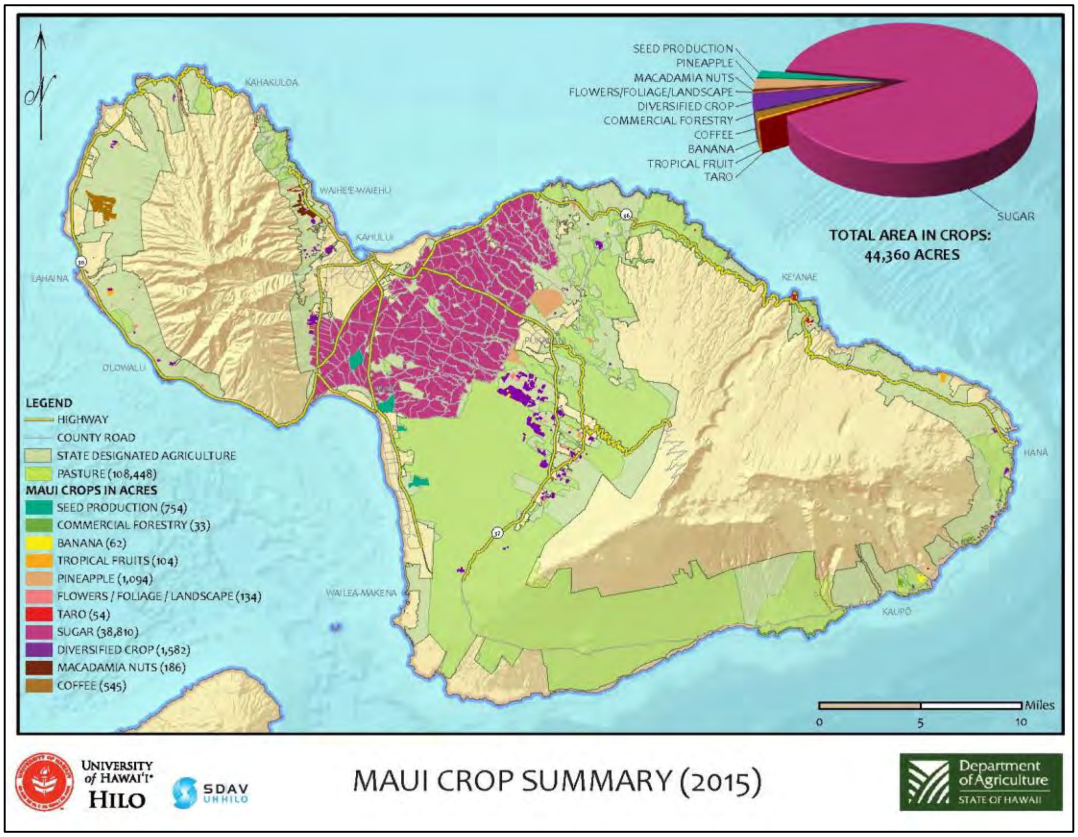
Table 6-2 Agricultural Crops and Acreage on Maui and Average Water Use Rates

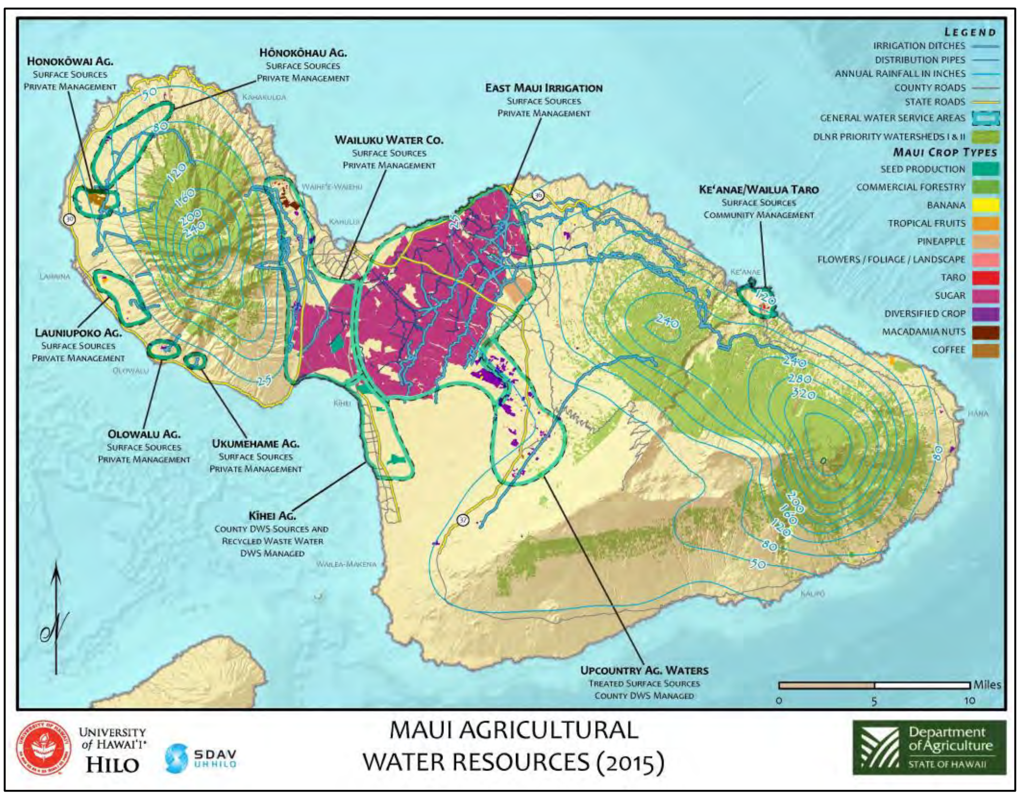
Crop	Acreage (2015)	Water Use Rate (gpd per acre)
Banana	62.38	
Coffee	545.35	2,900
Commercial Forestry	33.16	4,380
Diversified Crop	1,582.49	3,400 (2,500 wetter areas)
Flowers/Foliage/Landscape	134.28	4000 – 6000
Macadamia Nuts	186.33	4,400
Pasture	1,093.52	0 – 6700
Pineapple	1,093.52	1,350
Seed Production	754.41	6,700
Sugar	38,810.11	5,556
Taro	54.40	5,400 dryland 15,000-40,000 wetland (consumption)
Tropical Fruits	103.89	4,400 – 10,000
Total	**44,453.84**	

Water Use Rates - HDOA Guidelines; Coffee: 2004 AWUDP Kauai Irrigation System – 2,500 gpd; 2,900 gpd reported by plantation on O'ahu per Brian Kau, HDOA, personal communication 10/12/2016; Wetland taro: CWRM CC D&O, Nā Wai `Ehā and East Maui Streams, sugarcane: HC&S.

The 2015 Maui Crop Summary is shown in the figure below; small acreage operations such as taro production are difficult to see at this scale. The subsequent figure shows the location and sources of agricultural water resources.

Figure 6–5 Maui Crop Summary (2015) and Figure 6–6 Maui Agricultural Water Resources





Melrose, J., Perroy, R., and Cares, Sylvana, 2015. Statewide Agricultural Land Use Baseline 2015: HDOA, page 51.

7.0 EXISTING LAND USE

State land use districts, Department of Hawaiian Homelands (DHHL) land use boundaries, growth boundaries, community plan designations, and zoning districts work in concert to effectively manage land use. State law requires preparation of a WUDP that sets forth "the allocation of water to land use" in each county. Therefore an understanding of land use classifications and their future development potential is necessary.

7.1 State Land Use Plan

The State Land Use classification system provides a framework for county land use planning and local development. There are four land use districts: Urban, Rural, Agriculture and Conservation. The County administers local land use policy within all districts except within the Conservation district which is administered by the State of Hawai`i Board of Land and Natural Resources. The State land use category by acreage on Maui in the table below shows that Agricultural use comprises the largest category.

Table 7-1 State Land Use Category Acreage for Island of Maui

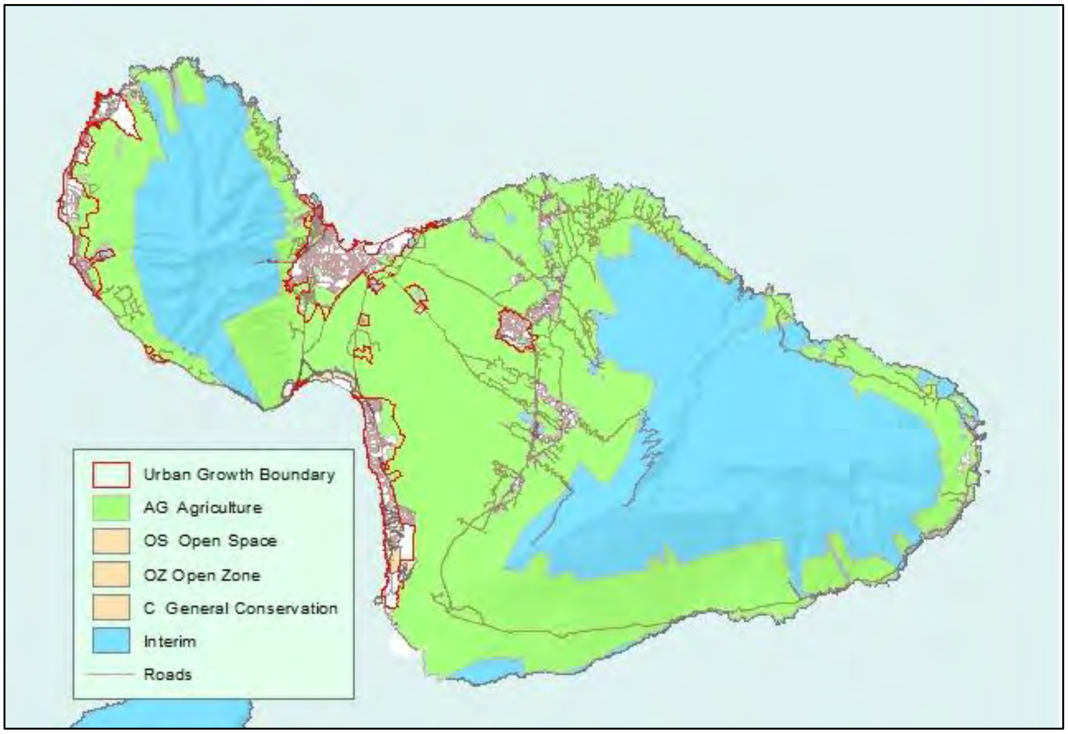
State Land Use Classification	Acreage	Percent of Total
Urban	24,191	5.2%
Rural	4,053	0.9%
Agricultural	242,720	52.1%
Conservation	194,836	41.8%
Total	465,800	100%

Hawai`i Data Book, DBEDT, 12/31/2014. Total differs from Census.

7.2 Maui Island Plan

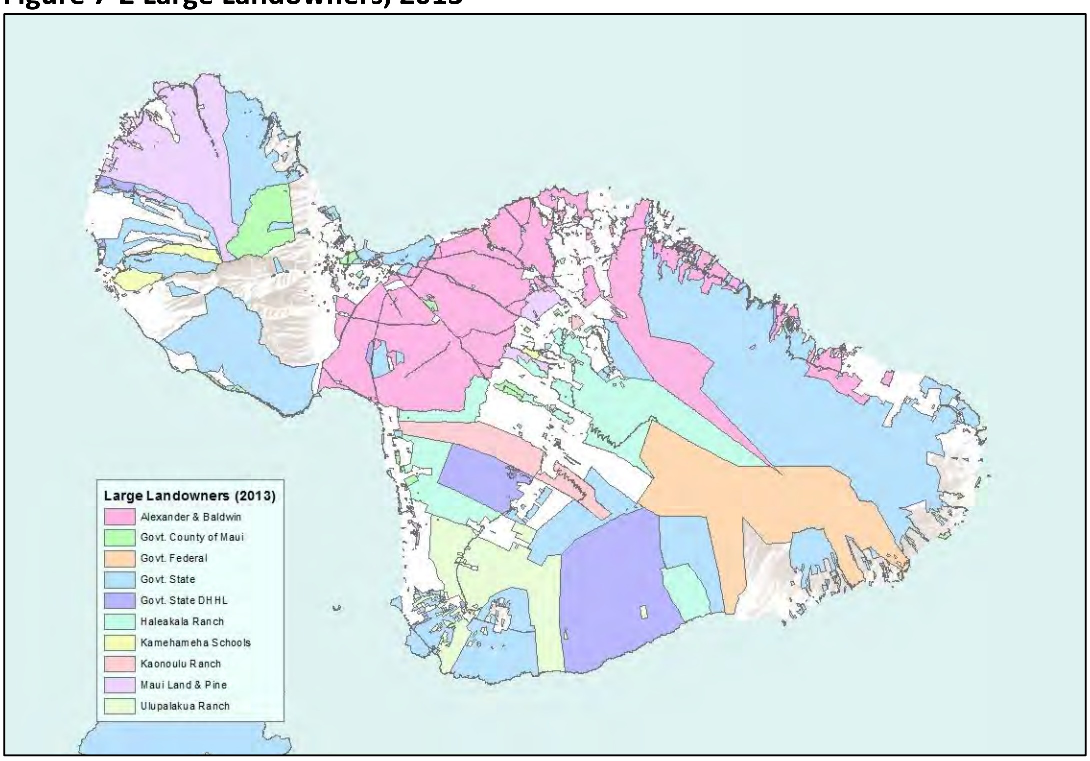
The Maui Island Plan is the guiding county land use plan for the purposes of the WUDP. The MIP establishes Urban, Small Town, and Rural Growth Boundaries (UGB, STB, and RGB) on the Directed Growth Maps. These boundaries encompass approximately 5,389 acres of new planned urban and small town growth areas through 2030. Planned growth is largely directed to Wailuku-Kahului, Kīhei and West Maui to protect the character of the existing small towns, rural areas, agricultural lands and open space, and to allow for more dynamic urban settlements with efficient public service delivery. The figure below (Figure 7-1) depicts the Urban Growth Boundary in relation to these low intensity use zoning districts. Most of the lands classified Conservation on the State Land Use Map are zoned Interim. About 5,640 acres of Agriculture zoned land is located within the Urban Growth Boundary.

Figure 7–1 Urban Growth Boundary and Low Intensity Zoning Districts



Government lands encompass about 40 percent of Maui Island, while major landowners account for approximately 70 percent.

Figure 7-2 Large Landowners, 2013



The Comprehensive Zoning Ordinance implements the MIP and sets forth permitted and conditional land uses which support the land use patterns in the MIP and provide a basis for calculating the land use based full build-out water demand projections in section 9.1. Lands within the County are divided into thirteen Use Zone Districts, with some subzones which further regulate land use. The MIP and Community Plans also provide guidance for the Project District zones where large development projects are anticipated. There is also an Interim District where the MIP and Community Plans provide guidance on future land uses; close to 90 percent of lands zoned Interim are essentially planned for open space uses.

7.3 State Department of Hawaiian Homelands (DHHL) Land Use Plans

The Hawaiian Homes Commission adopted its Maui Island Plan as the overarching planning document in 2004. Subsequently the Kēōkea-Waiohuli, Kahikinui, Leiali'i-Honokōwai and Waiehu Kou-Paukaukalo Regional Plans were adopted. DHHL owned 31,337 acres on Maui in 2013 within five planning regions (Hawai`i Data Book, 2014). Regional plans specify land uses and proposed development plans which are summarized in this plan to ensure water sources are adequate for future development.

Table 7-2 Maui Island Hawaiian Home Lands Inventory

TRACT	ACREAGE
West Maui	
Honokōwai	776.5
Central Maui	
Wailuku	0.2
Pu'unēnē	726.0
Waiehu	91.1
Paukūkalo	61.0
Upcountry Maui	
Kēōkea/Waiohuli	6,112.0
'Ulupalakua	2.0
Kualapa	40.9
East Maui	
Wākiu	743.0
Wailua	91.4
Ke'anae	150.9
South Maui	
Kahikinui	22,860.9
Kalihi/Kanahena	100.0
'Āhihi	75.0
Total	**31,830.9**

DHHL land use categories are summarized in the table below. About 5,000 acres are not assigned to a land use category because future plans are undetermined. Details are provided in the Aquifer Sector Area Reports. This information is used to prepare the land use based water demand projections in section 9.1.

Table 7-3 DHHL Lands Use and CWRM Categories

CWRM Category	DHHL Land Use Category	Acres	% of Total	Water Use Rates (gpd per Acre)
Domestic	Residential (2000.8 acres) Commercial (78.2 acres)	2,079.0 (3,850 Units)	12.7%	600 per unit 6000 per acre
Industrial	Industrial	218.0	1.3%	6000
Agriculture	Agriculture	14,017.5	85.5%	3400
Irrigation	N/A	N/A		
Municipal	Community	137.8	0.5%	1700
Military	N/A	N/A		
N/A	Open Space/Conservation	10,658.0		0
Total		27,110.0	0.05%	

MDWS, Water Resources & Planning Division, May 2015, based on DHHL Maui Island Plan and Regional Plans. Total Acres excludes 5062.5 acres because future land uses are unknown.

8.0 EXISTING WATER USE

8.1 Water Use by Type

The CWRM has established water use categories based on categories of water use for the purposes of water use permitting and reporting. State, MDWS (County), and private public water systems as defined by Department of Health are classified as Municipal. The MDWS billing classes are provided for comparison and reference.

Table 8-1 CWRM Water Use Categories, MDWS Billing Categories

Well Operator	CWRM Category	CWRM Sub-Category	MDWS Billing Classes
	Agriculture	• Aquatic plants and animals • Crops irrigation and processing • Livestock water, pasture irrigation, and processing • Ornamental and nursery plants • Taro • Other agricultural applications	Agricultural
Individual Operator	**Domestic** Residential Domestic, includes potable and non-potable water needs Nonresidential Domestic, includes potable (and non-potable) water needs	• Single and Multi-Family households, including noncommercial gardening • Commercial businesses, office buildings • Hotels • Schools • Religious facilities	• Single Family • Multi-Family • Multi-Family-Low Rise • Multi-Family High Rise, • Housing-County • Commercial • Religious • School-State/Private • Mixed Use • Hotel • Irrigation-Private
Individual Operator	**Industrial**	• Fire protection • Mining, dust control • Geothermal, thermoelectric cooling, power development, hydroelectric power • Other industrial applications	• Industrial
	Irrigation	• Golf course • Hotels • Landscape and water features • Parks • Schools • Habitat maintenance	•

Well Operator	CWRM Category	CWRM Sub-Category	MDWS Billing Classes
Agency Operator	**Military**	• All military use	• US Military Facility
	Municipal	• State • County • Private	• City Facility • State Facility • Parks-County/State • Irrigation-State/County • US Non-Military Facility

The CWRM requires a monthly report of water use from wells operators. CWRM data includes only reported data and therefore is not complete, but it is the best available. In 2014, 63 percent of pumpage was for agricultural use and 28 percent was for municipal use.

Table 8-2 Well Pumpage by CWRM Use Category, 2014 (mgd)

						Municipal		
Pumpage	**Domestic**	**Industrial**	**Agriculture**	**Irrigation**	**Municipal**	MDWS	Private Public	**Total**
Total	0.024	0.208	57.333	4.357	25.126	25.126	4.163	91.213
Percent	0.03%	0.23%	62.86%	4.78%	27.55%	27.55%	4.56%	100.00%

CWRM Well Database, 2014

Domestic Use

Domestic use includes potable and non-potable water use by individual households, commercial uses and quasi-public uses such as religious facilities or schools. These consist of use of individual wells or other sources, and include small water systems that fall outside the Department of Health definition of public water systems.[91] Owners and operators are responsible for water quality and maintenance of these systems. Information on private wells is collected through the CWRM well construction and pump installation permitting processes. The owner or operator of any well or stream diversion works is required to measure and report monthly usage to the CWRM. [92] It is likely that domestic use is underreported.

Industrial Use

Industrial use can be potable or non-potable water use for fire protection, mining, thermoelectric cooling, and geothermal uses. Industrial use accounts for less than five percent of total water use.

[91] A public water system is 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.
[92] HAR 13-168-7

Irrigation Use

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

Agricultural Use

Agricultural use includes water use for aquatic plants and animals, crops/processing, livestock and pasture, and ornamental/nursery. As used here, diversified agriculture encompasses all agricultural activities excluding sugarcane and pineapple. On Maui this includes harvesting vegetables, melons, fruits, taro, flowers and nursery products, seed crops, coffee, and macadamia nuts. Livestock and aquaculture also contribute to diversified agriculture on Maui. The majority of diversified agriculture is located within the MDWS Upcountry District and utilizes potable MDWS water.

The CWRM well database provides the following information on well pumpage and pump capacities for agricultural wells, with the preponderance of pumpage in Central Maui supporting sugar cane production.

Table 8-3 Pumpage and Pump Capacity of Reported Agriculture Wells (mgd)

Aquifer	Pumpage, 2014 Ave (mgd)	Pump Capacity				
		Total	Crops & Processing	Livestock & Processing, and Pasture	Ornamental & Nursery Plants	Aquatic Plants & Animals
Wailuku	0.001	1.036	0.172	0.864	0	0
Lahaina	0	19.886	19.829	0	0.057	0
Central	57.319	236.508	236.148	0	0	0.36
Ko`olau	0.014	8.858	8.019	0.036	0.681	0.122
Hāna	0	0.504	0.36	0.144	0	0
Kahikinui	0	0	0.036	0	0	0
Total	**57.333**	**266.792**	**264.564**	**1.044**	**0.738**	**0.482**

CWRM Well Database; pump capacity of AGR use types 5/29/2015; pumpage, 2014.
In the Ko`olau sector, 0.08 mgd of pump capacity listed as Agriculture has been allocated to crops and processing.

Military Use

According to the Hawai`i Military Land Use Master Plan, July 1995, on the island of Maui there are six acres of land owned by the Department of Defense and nine acres of secondary military use of non-DOD lands[93]. These lands are served by MDWS; billed consumption for 2014 was an average of 20,126 gallons per day.

[93] Office of Hawaiian Affairs, http://www.ohadatabook.com/T03-08-13.pdf (U.S. Department of Defense, Hawai`i Military Land Use Master Plan: July 1995 (Honolulu, 1995)) http://www.ohadatabook.com/T03-08-13.pdf

Municipal Use

Municipal use includes County, State and Federal water uses served by potable public water systems and privately owned public water systems (private public water systems). The State Department of Health (DOH) regulates public systems. Maui's ground and surface water sources must meet Federal Safe Drinking Water Act quality standards administered by the EPA through the DOH.

There are 16 public systems as shown in the table below. Most of these systems are community systems while five serve specific non-residential projects or facilities. As shown in the subsequent table, MDWS systems served 90% of the population. Maps in this WUDP generally display the general location of water systems or their facilities rather than service areas. Groundwater supplies most public water system customers, with the exception of MDWS which also treats surface water. The Haleakalā National Park relies entirely on catchment. The figure below provides the general locations of the public water systems on the island.

Table 8-4 Public Water Systems on Maui Island, 2013

PWS No.	Name	Owner	Type	Population Served	No. of Connections	Average Daily Flow (gpd)	Source
Wailuku Aquifer Sector Area							
212	Wailuku	MDWS	C	68,976	20,287	19,611,000	Ground/ Surface
215	Upper Kula	MDWS	C	7,038	2,346	1,231,000	Surface
240	Hawai`i Nature Center	Hawai`i Nature Center	NC	75	3	300	Ground
249	Kahakuloa	Kahakuloa Acres Water Co.	C	150	48	20,000	Ground
Lahaina Aquifer Sector Area							
204	Kapalua*	Kapalua Water Co., Ltd.	C	4,200	555	450,000	Ground
205	Kā`anapali*	Hawai`i Water Service Company	C	8,000	700	2,800,000	Ground
209	Olowalu*	Olowalu Elua Associates	C	100	38	52,000	Ground
214	Lahaina	MDWS	C	18,122	3,236	5,522,000	54% Surface 46% Ground

PWS No.	Name	Owner	Type	Population Served	No. of Connections	Average Daily Flow (gpd)	Source
218	Honokōhau	MDWS	C	42	15	13,000	Purchased Ground (PWS 204)
251	Mahānalua Nui Subdivison	Launiupoko Water Co., Inc.	C	587	275	100,000	Ground
Central Aquifer Sector Area							
247	Lower Kula	MDWS	C	3,192	1,064	3,431,000	Surface
254	Maunaolu Plantation	Maunaolu Plant HOA	C	100	37	19,000	Ground
255	Kula Nani	Kula Nani Estates Community Association	C	80	34	-	Purchased Surface (PWS 215)
256	Maui Highlands	Highland Services, LLC	C	26	53	10,000	Ground
258	Consolidated Baseyards	Consolidated Baseyards Association	NT	69	35	83,000	Ground
261	Maui Business Park Phase II	Maui Business Park Phase II Association	NT	65	1	5,000	Ground
213	Makawao**	MDWS	C	28,702	6,675	3,580,000	80% Surface/ 20% Ground
219	Ke`anae**	MDWS	C	270	90	44,000	Ground
Ko`olau Aquifer Sector Area							
203	Kailua	Ohanui Corporation	C	90	27	10,500	Ground
222	Haleakalā National Park	National Park Service	C	1,200	17	4,000	Catchment
252	West Kailua Meadows	W. Kuiaha Meadows HOA	C	45	15	6,000	Ground
Hāna Aquifer Sector Area							
217	Hāna	MDWS	C	1,101	367	319,000	Ground
201	Hāna Water Resources*	Hāna Ranch Partners, L.L.C.	C	816	81	120,000	Ground
220	Nāhiku	MDWS	C	107	43	41,000	Ground
243	Hāna Water Company*	Hāna Ranch Partners, L.L.C.	C	160	88	54,426	Ground
260	Kīpahulu	National Park Service	NC	2,000	4	3,000	Ground
				145,313	**36,134**	**37,529,226**	

Department of Health, Safe Drinking Water Branch, Sanitary Surveys, performed between 2013 and July 2015. Data supplied beginning in 2013. DHHL did not report Average Daily Flow.
(C) Community; (NT) Non-Transient, Non-Community; (NC) Non-community.
*Regulated by the PUC, Hawai`i PUC website, January 2016. **Extends into Ko`olau Aquifer sector area.

Table 8-5 Comparison of MDWS and Other Public Water Systems

System	Population Served	%	Service Connections	%	Average Daily Flow (mgd)	%
MDWS	127,550	88%	34,123	94.43	33.8	90%
Other	17,763	12%	2011	5.57	3.7	10%
Total	**145,313**	**100**	**36,134**	**100**	**37.5**	**100**
Community Systems only	141,804		36,074		37.4	

DOH, Safe Drinking Water Branch - July 2015. Haleakalā National Park is included in non-community total.

Figure 8–1 General Location of Public and Private Public Water Systems

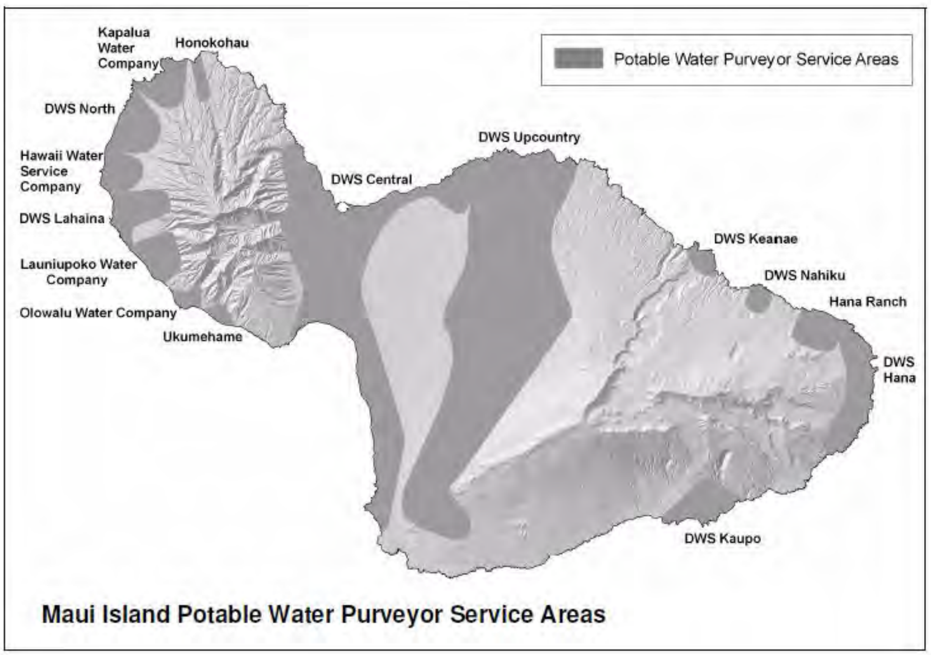


Table 8- 6 Consumption of Public Water Systems by Aquifer Sector on Maui Island, 2014 (gpd)

Aquifer Sector Areas	MDWS	Other Private Public Systems	*Other Non-Large Ag Pumpage*
Wailuku	4,202,663	0	*407,035*
Lahaina	5,388,402	3,757,309	*271,146*
Central	22,234,989	234,761	*3,898,093*
Ko`olau	995,203	14,908	*27,433*
Hāna	132,936	156,223	*0*
Kahikinui	5,222	0	*5,111*
Total	32,959,415	4,163,201	*4,608,818*

MDWS: billed consumption calendar year 2014. Other pumpage: CWRM Reports, Excluding Large Ag/Kula Ag

Federal Water Systems

The National Park Service owns the Haleakalā National Park system. The catchment system utilizes a 50,000 gallon water system tank and serves a population of about 1,200 people per day, including visitors.

State Water Systems

A State water system is defined as a water system owned and/or operated by the State that provides water service to State projects or facilities, provides source water and treatment of source water, stores water in storage reservoirs, provides booster pump capacity, conveys water through a distribution system, and distributes water to service connections. A State water system is also defined as when a County or private source supplies a State owned and/or operated water service serving State facilities.

On Maui, there are four state water systems owned and operated by the Department of Land and Natural Resources (DLNR), Division of State Parks. There were 23 State owned wells and four stream diversions including those in the table below and the Pokakaekane Stream diversion as of 2003.[94] The streamflows supplying the State Parks systems are not gauged or measured and they were not evaluated for surplus source capacity. Future demands were not reported in the State Water Projects Plan.

Table 8-7 State Owned and Operated Water Systems

System	Aquifer Sector/ System	Source	MGD	Use Type
Kaumahina State Wayside (DNLR)	Ko`olau/ Waikamoi	Haipuaena Stream diversion	0.008	Non-potable, comfort station
Polipoli Springs State Recreation Area	Central/ Kama`ole	Unnamed spring	0.002	Non-potable, park and campground
Pua`a Ka`a State Wayside (DNLR)	Ko`olau/ Ke`anae	Waiohue Stream diversion	0.006	Non-potable, comfort station (0.005 MG reservoir)
ʻĪao Valley State Park (DNLR)	Wailuku/ ʻĪao	ʻĪao Stream diversion	Not reported	Non-potable, 1500 sf taro patch irrigation (Potable supply- MDWS)

State Water Projects Plan, 2003
DNLR – Department of Land and Natural Resources

[94] State Water Projects Plan, 2003.

State Department of Hawaiian Home Lands Systems

DHHL does not own or operate any water supply systems on Maui.[95] Multiple DHHL properties are served by MDWS within the Central Maui, Upcountry and East Maui regions. Provision of reservations for water for Hawaiian Home Land allotments is a public trust purpose; however, the CWRM has not made any reservations per Section 174C-49(d) HRS on Maui as of 2016. MDWS executed a Water Credits Agreement MOU with DHHL dated December 8, 1997 for a reservation of 0.5 mgd for homesites within the MDWS Upcountry District (Kula and Kēōkea subdistricts) except during drought periods, with no time limit for DHHL to draw or use its reservation. Discussion is underway regarding a water credit agreement to supply the proposed Wākiu project in the Hāna District.

Maui County Department of Water Supply Systems

The Maui Department of Water Supply (MDWS) is responsible for the development, operation and maintenance of the municipal water system and supply. On Maui, MDWS manages nine public water systems as defined by DOH under the State Drinking Water Act, in four districts: Central Maui (Wailuku), West Maui (Lahaina), Upcountry (Makawao), and East Maui (Hāna); each district encompasses a number of subdistricts. The Central and West Maui districts and public water system boundaries are coterminous. The Upcountry district has four interconnected public water systems. The East Maui district has several unconnected public water systems.

The MDWS systems included 750 miles of water lines, 145 storage tanks with 295 million gallons of water storage capacity, six surface water treatment facilities, and 35 groundwater sources for 36,005 customers on Maui in FY 2014. Figure 8-2 below shows the MDWS water districts, community plan regions, and aquifer sectors.

[95] There are six nonproduction wells and two stream diversions used by individuals on DHHL lands.

Figure 8–2 MDWS Districts, Community Plan Boundaries, and Aquifer Sector Areas

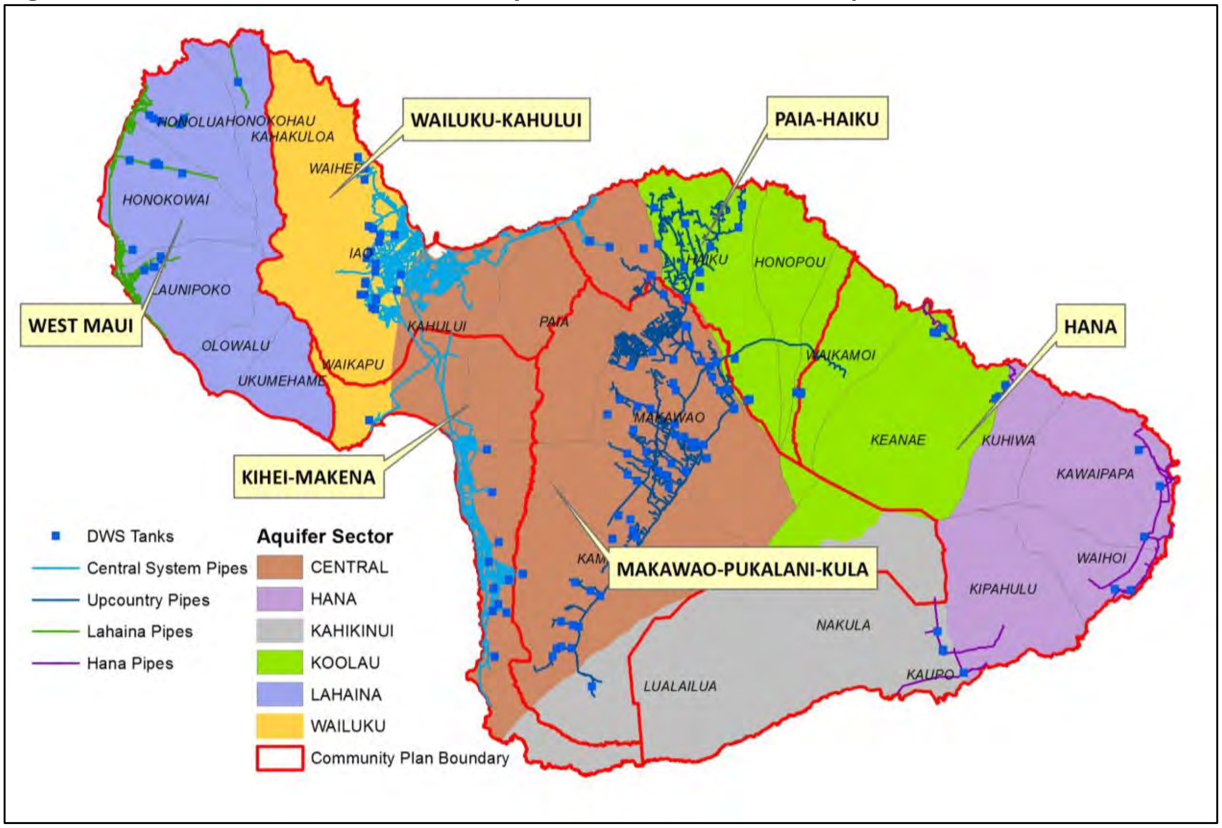


Table 8-8 County Water Systems and Areas Served

District	County Water Systems	Area Supplied	Major Facilities
Central Wailuku	Drinking Water: Central (Wailuku)	Wailuku, Waikapū, Waihe'e, Waiehu, Pu`unene, Sprecklesville, Pā`ia, Kū`au, Mā`alaea, Kīhei, Mākena	`Īao Water Treatment Facility, Wells
Upcountry Makawao	Drinking Water: Makawao , Lower Kula, Upper Kula Irrigation: Kula Agricultural Park, State/County System	Ha`ikū, Hali`imaile, Makawao, Pukalani, Kula, Ulupalakua, Kanaio	Pi`iholo, Olinda, Kamole Water Treatment Facilities, Wells
East Maui Hāna	Drinking Water: Ke`anae, Nāhiku, Hāna Non-potable- County/Private Shared: Kaupō/Kaupō Ranch	Ke`anae, Nāhiku, Hāna, Hamoa, Koali, Kaupō	Wells
West Maui Lahaina	Drinking Water: Lahaina, Honokōhau	Lahaina, Honokōwai, Alaeloa-Kahāna, Napili, Honokōhau, Kā`anapali region	Lahaina and Mahinahina Water Treatment Facilities, Wells

Consumption

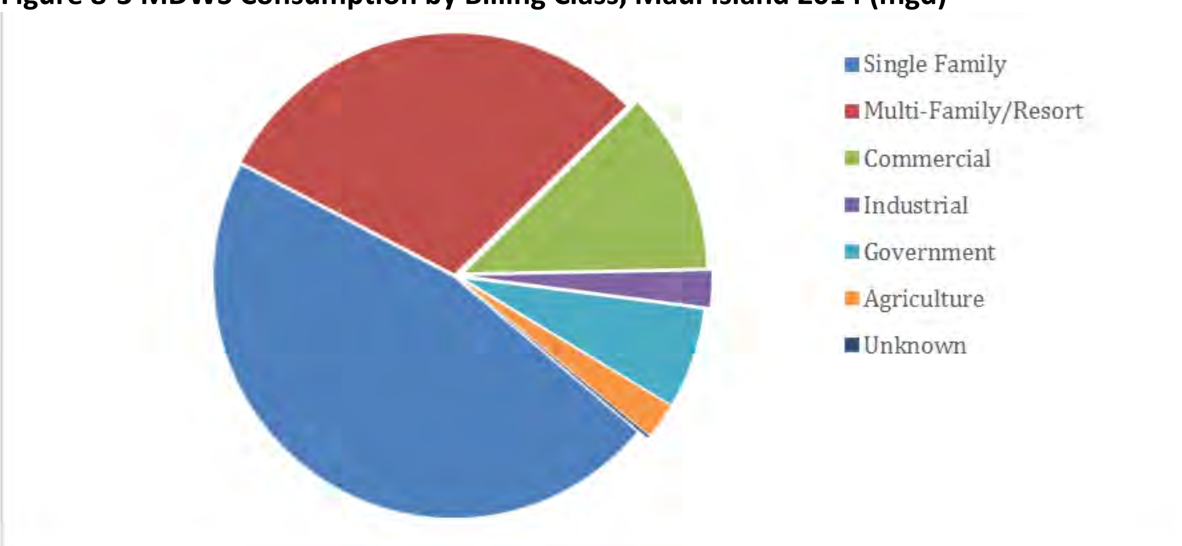
MDWS is a municipal use as classified by CWRM. MDWS categorizes water users and uses by customer class as Single Family, Multi-Family/Resort, Commercial, Industrial, Government, Agriculture and Unknown. The 2014 consumption billed for all MDWS systems on Maui Island totaled 33.081 mgd. Residential uses, particularly single family uses, generated the largest demand. Non-potable water billed for agricultural use was limited to an average of 0.12 mgd, within the Kula Agricultural Park subdistrict; excluding Kula Agricultural Park reduces the total billed to 32.959 mgd. All water supplied to the Kaupō subdistrict was billed as non-potable, consisting of 0.005 mgd for commercial and single-family use. Negligible volumes of water were also billed as non-potable to limited commercial or industrial accounts in the Kīhei, Lower Kula, Makawao and Lahaina subdistricts.

Table 8-9 MDWS Consumption by Class, Maui Island, 2014 (mgd)

Billing Class	Demand	Percent
Single Family	15.406	46.6%
Multi-Family/Resort	9.927	30.0%
Commercial	3.970	12.0%
Industrial	0.765	2.3%
Government	2.182	6.6%
Agriculture	0.778	2.4%
Unknown	0.053	0.2%
Total	33.081	100%

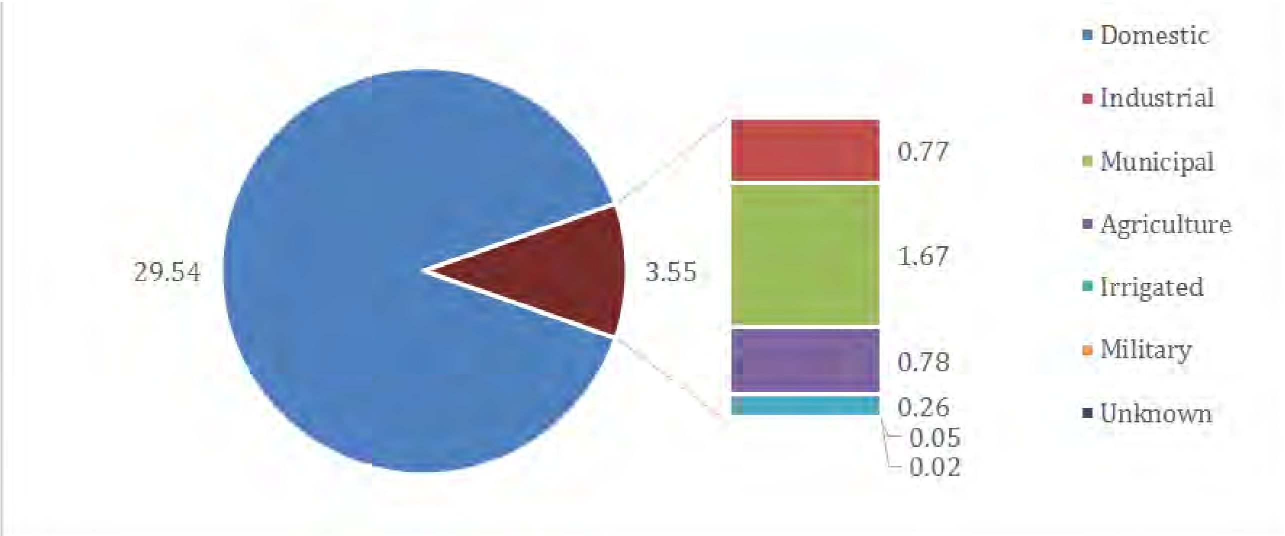
MDWS Metered Consumption, Cal Year 2014

Figure 8-3 MDWS Consumption by Billing Class, Maui Island 2014 (mgd)



Disaggregating MDWS consumption by CWRM categories, domestic uses constitute 89 percent of total demand.

Figure 8-4 MDWS Consumption by CWRM Categories, Maui Island 2014 (mgd)



The Kīhei-Mākena Community Plan district exhibited the largest demand, while the Central Aquifer Sector Area had the greatest demand as shown in the figure below. Community Plan and Aquifer Sector Areas boundaries are not coterminous except for West Maui/Lahaina.

Table 8-10 MDWS Consumption by Community Plan and Aquifer Sector Area, 2014 (mgd)

Community Plan	Consumption	Percent
Wailuku-Kahului	8.891	26.9
Kīhei-Mākena	12.462	37.7
Makawao-Pukalani-Kula	5.205	15.7
Pā`ia-Ha`ikū	0.979	3.0
Hāna	0.155	0.5
West	5.388	16.3
Total	**33.081**	

Aquifer Sector	Consumption	Percent
Wailuku	4.203	12.8
Central	22.235	67.5
Ko`olau	0.995	3.0
Hāna	0.133	0.4
Kahikinui	0.005	0
Lahaina	5.388	16.3
Total	**33.081**	

Figure 8-5 MDWS Consumption by Aquifer Sector Area, Maui Island 2014 (mgd)

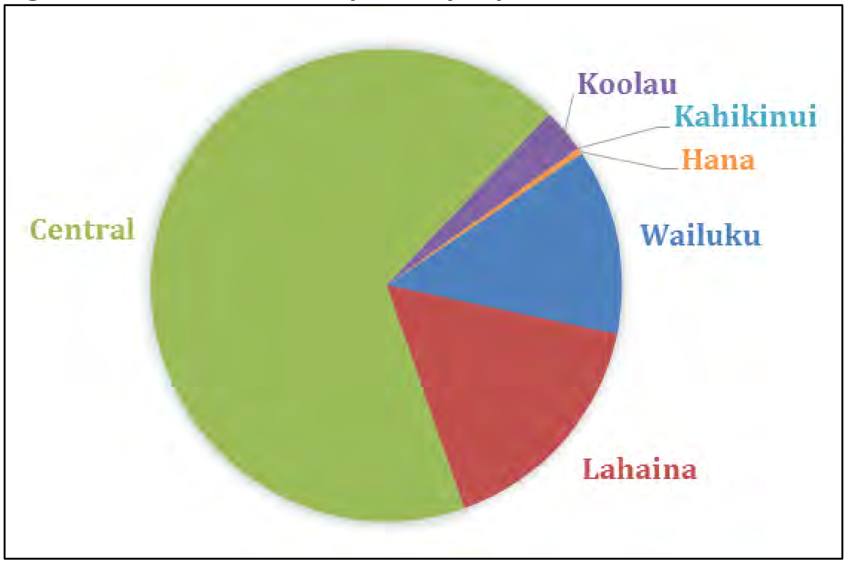
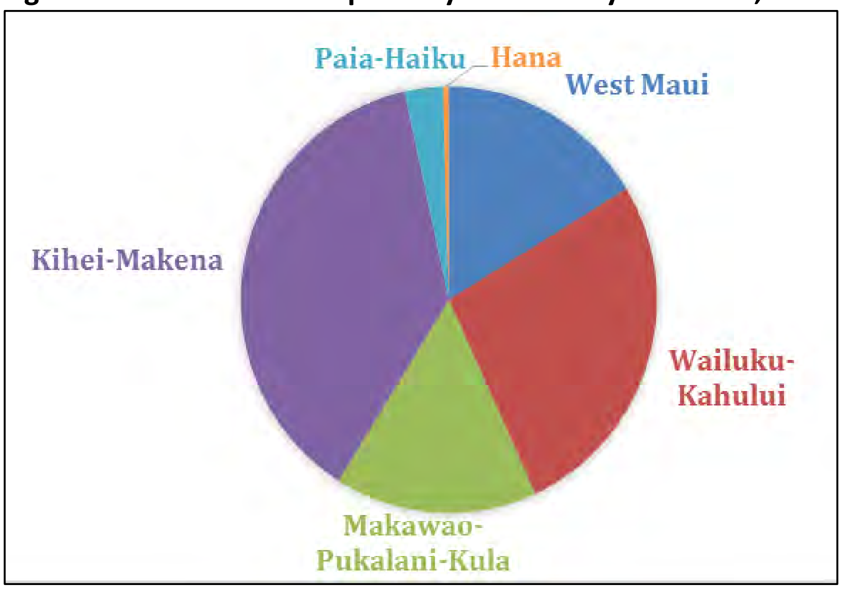


Figure 8-6 MDWS Consumption by Community Plan Area, Maui Island 2014 (mgd)



While the base year for this WUDP is 2014, alternative periods were reviewed to determine whether 2014—which exhibited a strong El Nino—is representative of consumption. The 10-year average was consistent with the 2014 average daily demand. Upcountry demand was about 14 percent lower than the 3-year and 10-year averages. While consumption in the Hāna District was comparatively low in 2014, the area does not face source challenges.

Table 8-11 Comparison of Consumption by MDWS District (mgd)

MDWS District	2014 Daily Ave	3-Yr Ave 2012-14	10-Yr Ave 2005-14	Variation 10-Yr Ave / 2014 Ave
Central Wailuku	21.154	21.299	21.288	1%
Upcountry Makawao	6.263	7.266	7.277	14%
West Lahaina	5.388	5.019	5.163	-4%
East Hāna	0.155	0.174	0.184	19%
Total	**32.959**	**33.753**	**33.911**	n/a

DWS Metered Consumption, 2014 is Calendar Year; other periods are fiscal year.
High year 2005-2014 ave = annual averages for 2012, 2013 and 2014. High year may vary by district.
10 year ave = annual averages, 2005-2014.

MDWS has maintained a priority list of applicants who have been denied water service within the Upcountry Water District pursuant to the Maui County Code, Title 16, and Chapter 106. Due to the insufficient water supply in the area, the Board of Water Supply on March 16, 1993 recognized a "shortage condition," and adopted a *Shortage Finding* stating that the Upcountry water systems did not have sufficient water supply to meet fire protection, domestic, and irrigation needs, and new meters could not be issued without detriment to the existing water services in the regulated area. The *Shortage Finding* affected Upper and Lower Kula, Makawao, Ha'ikū, and Pukalani subdistricts. Following the *Shortage Finding*, since November 2, 1994, MDWS has maintained a priority list of applicants who were denied water service; the list closed on December 31, 2012. As of June 30, 2014 there were 1,822 requests (excluding reservation offered but not accepted, reservation accepted, and meter installed) with an estimated demand of 7.284 mgd. It is estimated that about 50 percent of the requests may result in meters during the planning period for a projected demand of 3.64 mgd.[96] This issue is discussed in more detail under section 9.2 and in the Central Aquifer Sector Area Report.

Water consumption also varies seasonally, with the low demand months most significantly reflecting lower outdoor irrigation demands. System-wide consumption was about 44 percent higher in August than in March 2014, with the most significant increases in the dryer areas. The high and low months for 2011 to 2015 indicate significant differences in all regions; however, figures for East Maui are not thought to be well correlated with seasonal demand. Thus the large seasonal fluctuations indicate the potential for outdoor water conservation as well as ways to offset use of potable water for non-potable needs. These findings should also apply to the private public districts that serve community needs.

[96] MDWS, Maui Island Water Source Development Study, February 11, 2013

Table 8-12 Comparison of High and Low Month Consumption, by MDWS District, 2011 to 2015 (mgd)

District	High Month	Low Month	Variation	% Variation
Central/Wailuku	26.313	15.032	11.281	75%
Upcountry/Makawao	4.886	3.358	1.529	46%
West/Lahaina	5.627	4.209	1.419	34%
East/Hāna	0.188	0.117	0.071	61%
Total	**36.306**	**22.021**	**14.286**	**65%**

MDWS Billed Consumption (average mgd). High and low months, fiscal years 2011-2015 (mgd). Agricultural Services not included. The figures for the East district are provided but are not indicative of climate conditions.

Per capita consumption has shown a downward trend over time. Due to seasonal and annual variations, long term trends are most reliable. Specific use classes may also be evaluated to evaluate the results of water conservation programs. A per capita rate of 248 gpd is estimated based on average MDWS 2010-2014 FY billed consumption and interpolated population.

Table 8-13 MDWS Per Capita Consumption, 1990-2014

Year	Consumption (mgd)	Population (90% of Total)	Per Capita (gpd)
2014 Cal Yr	33.081	139,102	238
2014 Cal Yr, excluding Agricultural Services	*30.133*	139,102	*217*
2014 FY	31.761	139,102	**228**
2013 FY	35.501	136827	**259**
2012 FY	33.999	134551	**253**
2011 FY	33.119	132275	**250**
2010 FY	32.646	130,000	**251**
2000 FY	33.938	105,880	321
1990 FY	24.243	82,225	295

MDWS Annual Reports; 2014 Cal Year Consumption data

Production

Water produced is higher than water billed to consumer, due to water losses and other factors. MDWS produced an average of 35 mgd of water in 2014, consisting of 25.1 mgd of groundwater (71%) and 9.9 mgd of surface water. The six MDWS surface water treatment facilities produced over 3.6 billion gallons of water in 2014, representing a decline from 3.9 billion gallons in 2010. The Olinda facility was offline in the last quarter of 2014. The 2014 average daily production was 9.9 mgd; for comparison during the period 2012-2014 the high annual average was 11.677 mgd.

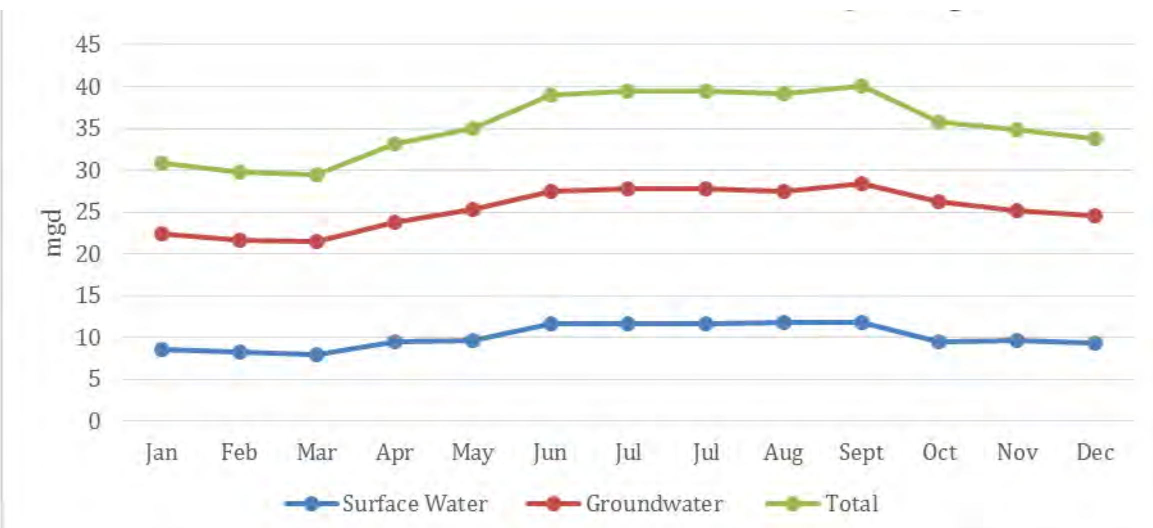
Table 8-14 MDWS Water Treatment Facilities, Annual and Average Daily Production (mg)

WTF	2014 YTD (1000 gal)	ADP (mg)	High YTD Production 2012-2014 (1000 gal)	High Month ADP 2012-2014 (mgd)	% Variation High Yr ADP 2012-2014/ 2014 ADP (mgd)
Lahaina	643.360	1.763	643.360	1.741	0.0%
Mahinahina	560.700	1.536	638.740	1.751	13.9%
West District	1,204.060	3.299	1,210.769	3.308	0.6%
`Īao Ditch	360.513	0.988	409.513	1.120	13.6%
Olinda*	336.690	0.922	546.770	1.494	62.4%
Pi'iholo*	1,044.967	2.863	1,265.306	3.457	21.1%
Kamole*	674.200	1.847	881.770	2.409	30.8%
**Upcountry*	*2,055.857*				
East District	2,416.370	6.620	3063.175	8.369	26.8%
Total	3,620.430	9.919	4273.944	11.677	18.1%

Source: MDWS. *Supplies Upcountry/Makawao system.
YTP= Year Total Production; ADP= Average Daily Production. Olinda was offline in the last quarter of 2014.
High ADP 2012-14 for the individual WTPs did not all occur in the same year.

Since water demand and production vary seasonally, high monthly production is a good indicator of predicted demand and storage capacity utilization. Production of both ground and surface water was highest in September, with an average of 40.2 mgd of water produced. The 10-year peak month production was 45.9 mgd in June 2007.

Figure 8-7 MDWS Production, Maui Island, 2014 Daily Average



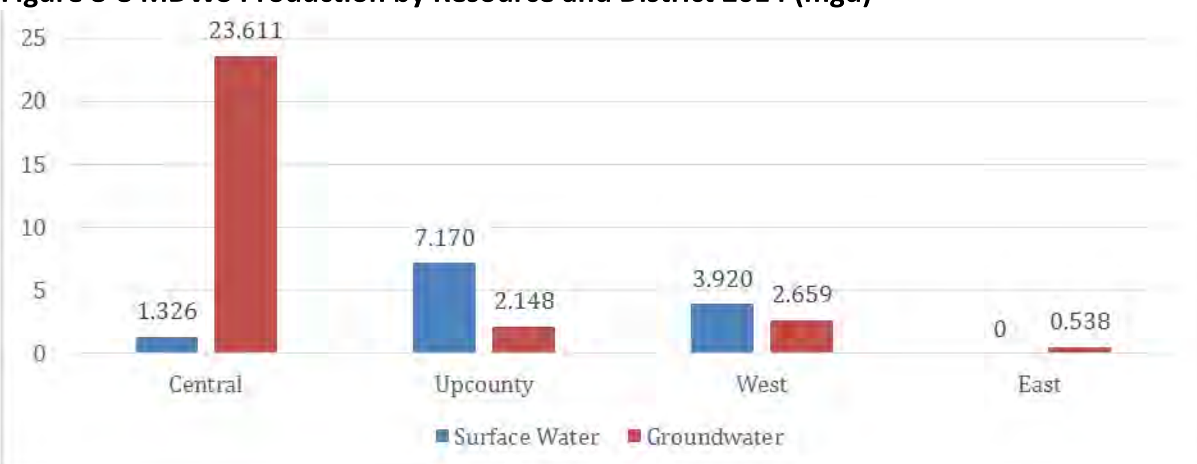
County of Maui DWS, Monthly Water Production, 2014

Table 8-15 MDWS Production by District, 2014 (mgd)

MDWS District	AD Production	High Month AD Surface Water	High Month AD Groundwater	Low Month AD Production	High Month AD Production	% Variation High/Low Month
Central/ Wailuku	22.262	1.326	23.611	20.949	24.937	19%
Upcountry/ Makawao	6.777	7.170	2.148	4.919	9.318	89%
West/ Lahaina	5.509	3.920	2.659	4.789	6.579	37%
East/ Hāna	0.504	0	0.538	0.464	0.538	16%
Total	**35.052**					

MDWS, 2014 Calendar Year. High month production varies by district. High month consumption is August 2014.

Figure 8-8 MDWS Production by Resource and District 2014 (mgd)



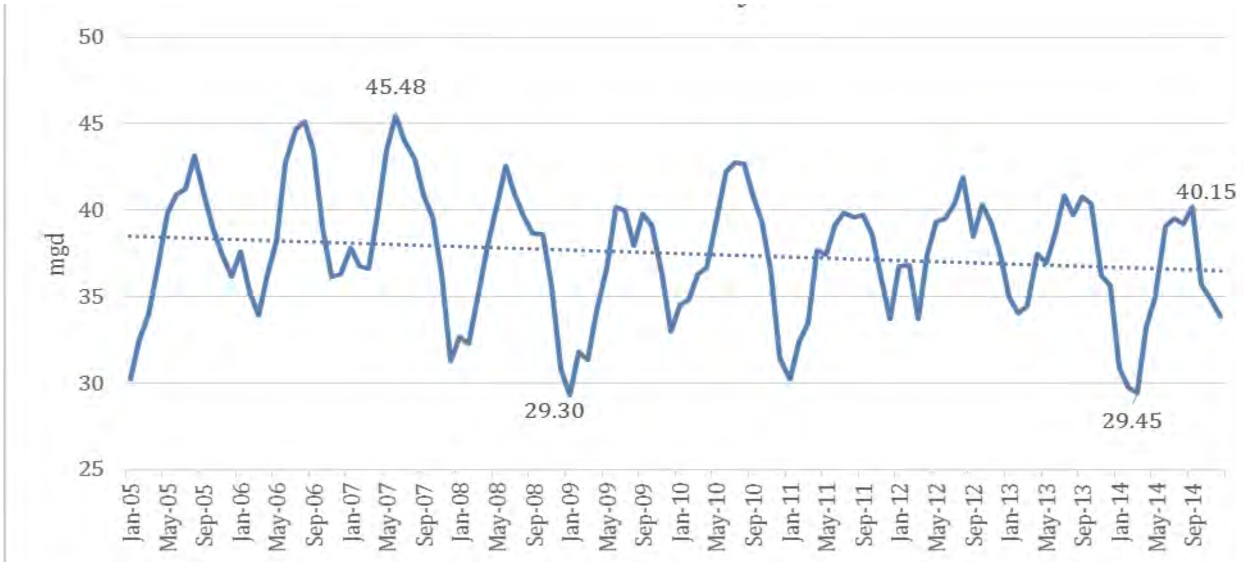
(DWS 2014 Ground and Surface Water.xlsx)

Table 8-16 MDWS Production, 10-Year Daily Average, 2005-2014 (mgd)

	Total Production			Groundwater			Surface Water		
District	Total Daily Ave	High Month Total	% High / Ave Month	Daily Ave	High Month	% High / Ave Month	Daily Ave	High Month	% High / Ave Month
Central/ Wailuku	24.06	28.38	18%	23.02	26.91	17%	1.07	1.73	63%
Upcountry/ Makawao	7.61	10.36	36%	1.23	2.06	68%	6.38	8.79	38%
West/ Lahaina	5.58	6.77	21%	2.35	3.30	41%	3.24	3.92	21%
East/Hāna	0.38	0.61	59%	0.38	0.61	59%	0.00	0.00	0%
Total	**37.66**	**46.12**	**22%**	**26.98**	**--**	**--**	**10.68**	**--**	**--**

MDWS production, 2005-2014 (mgd). Daily averages are over 10-year period. High month groundwater (GW) and surface water (SW) for the various districts are not totaled because they did not all occur in the same year. The figures for the East district are not indicative of climate conditions.

Figure 8-9 MDWS 10-Year Historic Production (mgd)



(DWS 2014 Ground and Surface Water.xlsx)

Water Losses

Total water loss is generally calculated as the difference between production at the source and billed consumption. MDWS average daily production in 2014 and on average over the past 10 years exceeded consumption by about 6% system-wide. While not directly comparable, the comparisons reflect operational and use efficiency. Water loss reduction through water audit, leak detection and other measures are addressed under the Conservation Section Chapter 12.

Privately Owned Public Water Systems

There are 16 privately owned public water systems on Maui. The largest private water purveyor is the Hawai`i Water Service Company which serves several large resorts, commercial and residential properties near Kā`anapali in West Maui. Private public water system data is based primarily on reported pumpage or average daily flow data derived from the Department of Health. More information is provided in the Aquifer Sector Area Reports. Water system operators were queried regarding existing conditions and future service projections; however, only limited data was received. Most data provided by private public water systems is not categorized by use.

Privately owned public water systems present an alternative to the MDWS systems when new developments are built outside MDWS service areas consistent with County land use policies and directed growth strategies. Issues of concern include management and monitoring of private water systems to ensure the long-term sustainability of the island's water resources, competition for water resources, proper well maintenance and abandonment as related to water quality.

Other Potable Water Use

An unknown number of persons are not served by any public water system. Some small developments or groups of development below the DOH threshold or individual households and uses may be served by domestic wells, catchment, streams or other sources. Estimated 'order of magnitude' demand for 2014 of 0.277 mgd was based 2010 Census Block population of about 1,190 persons that appeared to be outside public water system purveyor service areas based on general location of development and system pipes and an average MDWS per capita rate of 248 gpd.[97] Information on water demand for public systems and estimated unserved population is provided below.

Table 8-17 Summary of Potable Water Demand, 2014

User	2013 DOH	2014	2014 Notes
MDWS	32.792	32.959	Billed consumption (excludes Kula Ag Park- 0.12 mgd)
MDWS		*35.052*	*Production (Pumpage and WTF production – 25.126+9.919 =35.045)*
Private Public Systems	3.737	4.163	Pumpage
Public Water Systems	**37.529**	**37.122**	
Domestic Wells	**--**	**0.024**	Pumpage
Unserved Population	--	0.276	Estimate, excludes domestic well pumpage reported to CWRM
Total	**37.529**	**37.422**	

CWRM Reports, DOH, and MDWS Consumption Data.

8.2 Water Use by Resource

Existing water resources include groundwater, surface water, rainwater, reused rainwater (storm water, catchment), recycled wastewater and greywater, and desalinated water. Fresh water is defined as water that contains less than 1,000 milligrams per liter (mg/L) of dissolved solids. Maui has exhibited the highest freshwater use of the Hawaiian Islands.[98]

[97] 2010 Census Block Group population that appears to be outside public purveyor service areas – approx. 1190; apply average MDWS per capita rate of 248 gpd based on 2010-2014 consumption and interpolated population = 296,144 gpd. Excluding domestic well pumpage of 20,495 gpd results an estimated demand of 276,649 gpd.

[98] Volcanic Aquifers of Hawai`i—Hydrogeology, Water Budgets, and Conceptual Models, p 87.

Table 8-18 Fresh Water Use Maui Island (mgd)

	Maui Island	
Use	2014	% of Total
Groundwater	**91.21**	**25.20%**
Public supply	29.29	32.11%
Domestic	0.02	0.03%
Industrial	0.21	0.23%
Irrigation/Ag	60.17	65.96%
Livestock	1.04	1.14%
Aquaculture	0.48	0.53%
Surface Water	**270.70**	**70.00%**
Public supply	10.88	4.02%
Domestic		
Industrial	6.66	2.46%
Irrigation	253.16	93.52%
Total	**361.91**	**100.00%**

Source: CWRM Reports and characterization of HC&S water use, Petition to Amend the Interim Instream Flow Standards for East Maui Streams Contested Case, Hearing Officer's Proposed FOF, COL, D&O, January 15, 2015, page 135 (Resource Assessment.xlsx, Resource Use sheet)

8.2.1 GroundWater

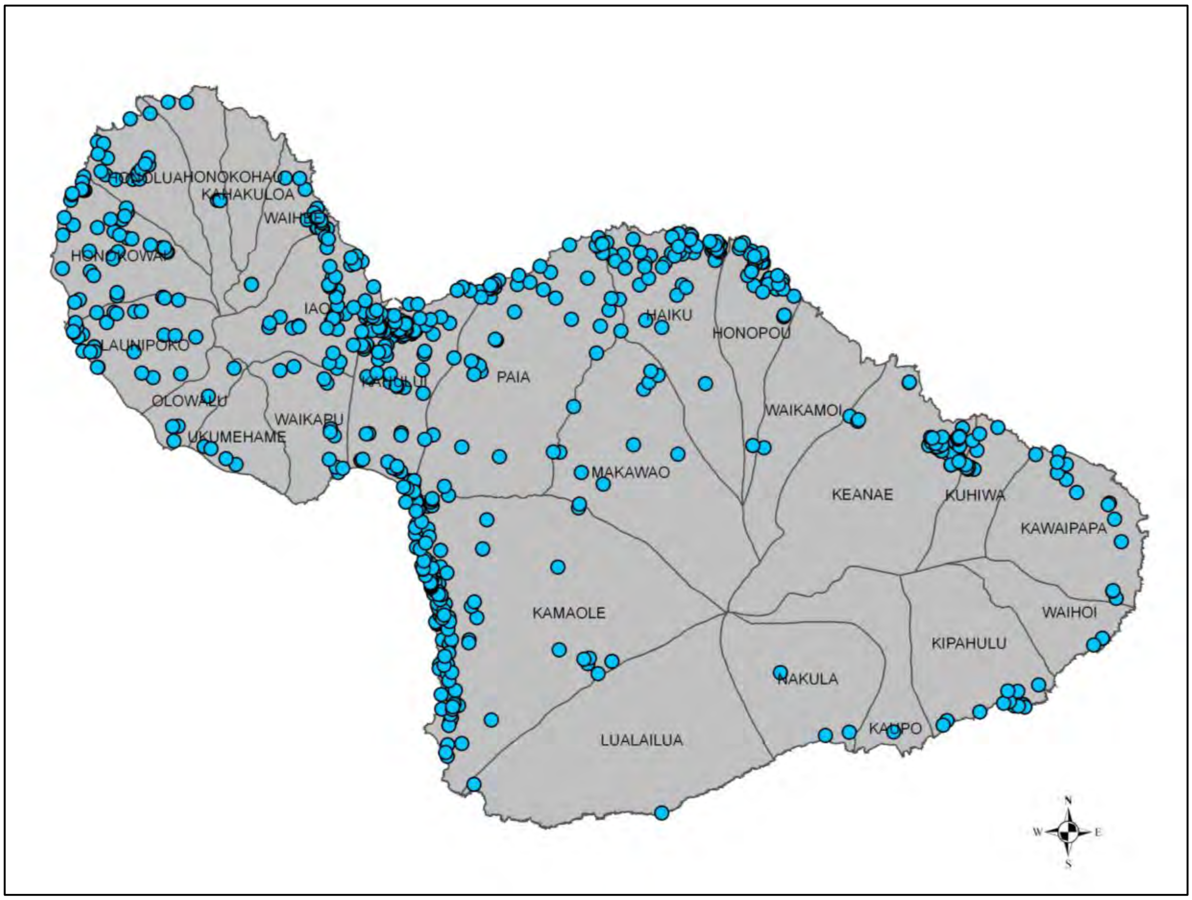
"Well" is defined by the Water Code as, "an artificial excavation or opening into the ground, or an artificial enlargement of a natural opening by which groundwater is drawn or is or may be used or can be made usable to supply reasonable and beneficial uses within the State. The inventory of wells was obtained from the CWRM database which was developed with information received from the Well Registration program and since 1988 has been supplemented with well construction and pump installation permitting information. The database is the best available information and was used to evaluate the existing groundwater resources. However, it is not complete and lacks information pertinent to the WUDP for many of the wells, such as installed pump capacity. On January 22, 2014, the Commission required all wells in the State of Hawai`i to report monthly groundwater use including quantity pumped, chloride (and/or conductivity) concentrations, temperature, and (pump off) water-level data. Continued exemptions include the following, "UNLESS the Commission determines a specific need for this data to resolve disputes, establish instream flow standards, or quantify the amount of water for a water use permit in a water management areas, or for similar needs:

(a) Passive agricultural consumption (e.g. when crops are planted in or adjacent to natural springs and natural wetland areas);
(b) Livestock drinking from dug wells or stream channels;
(c) In non-surface water management areas, individuals on multi-user ditch systems where IFS or water use permits are not an issue;

(d) Salt-water wells may continue to report monthly *estimates* of pumpage and monthly *actual measured* water-levels and salinity on an annual basis."[99]

In 2014 there were 832 registered wells on Maui Island, of which 528 were production wells assigned the CWRM use categories shown in the table below. The remainder were classified as observation, other, unused, abandoned or not specified. Non agricultural irrigation wells comprise the largest number of wells (249), predominately located within the Central Aquifer Sector Area. Reported pumpage is summarized below.

Figure 8-10 Location of Registered Wells on Maui, 2014



CWRM, GIS Well Database. Not all well locations are shown.

[99] CWRM Meeting, January 22, 2104. http://files.hawaii.gov/dlnr/cwrm/submittal/2014/sb201401D1.pdf

Table 8-19 Reported Pumpage by Well Use Type, Maui Island 2014 Daily Average (mgd)

Aquifer	Domestic	Industrial	Agriculture	Irrigation	Municipal	*Municipal*		Total
						MDWS	***Private Public***	
Wailuku	0.006	0	0.001	0.400	20.354	*20.354*	*0*	20.761
Lahaina	0	0	0	0.271	5.936	*2.179*	*3.757*	6.207
Central	0.007	0.208	57.319	3.683	1.507	*1.272*	*0.235*	62.724
Ko`olau	0.008	0	0.014	0.002	0.892	*0.877*	*0.015*	0.916
Hāna	0.004	0	0	0.001	0.6	*0.444*	*0.156*	0.606
Kahikinui	0	0	0	0	0	*0*	*0*	0
Total	**0.024**	**0.208**	**57.333**	**4.357**	**25.126**	***25.126***	***4.163***	**91.213**

Source: CWRM Well Database, 2014.

The table below (Table 8-20) compares pumpage and pump capacity to sustainable yield. Installed pump capacity indicates the maximum quantity of water that hypothetically could be drawn. Pumping capacity is available for only 318 of the 526 registered wells in use in the CWRM well database and totals 422 mgd. However, pump capacity exceeds sustainable yield for the Wailuku, Lahaina and Central Aquifer Sector Areas.

Table 8-20 Pump Capacity and Pumpage of Wells in Production Compared to Sustainable Yield (mgd)

Aquifer Sector	Pump Capacity	Pumpage (2014 Ave)	Sustainable Yield	% of Aquifer Pumped	% of Aquifer Potentially Pumped
Wailuku	70.812	20.761	36	58%	197%
Lahaina	53.181	6.207	34	18%	156%
Central	279.637	62.724	26	241%	1076%
Ko`olau	14.314	0.916	175	1%	8%
Hāna	3.717	0.606	122	0%	3%
Kahikinui	0.282	0	34	0%	1%
Total	**421.943**	**91.214**	**427**	**21%**	

CWRM Well Index 5/29/2015. Does not include unused, other, unspecified, abandoned or observation use wells.

At the aquifer system level, well permits have been issued allowing significantly higher pumpage than sustainable yield without apparent negative impacts due to agricultural irrigation return water. Pumpage exceeded sustainable yield in the Kahului and Pā`ia Aquifer System Areas by 3,000 percent and 422 percent respectively in 2014 due to agricultural demand. For the `Īao Aquifer System Area, which is a groundwater management area, 86% of the sustainable yield was pumped, primarily for municipal demand, while over 95% of the sustainable yield has been allocated by the CWRM.

Sustainable yield does not address whether groundwater is potable or brackish or includes agricultural return water, which supports pumping in excess of the sustainable yield within the

Kahului and Pā`ia Aquifer Systems. Termination of sugarcane operations in the Central region is likely to significantly reduce irrigation return water and affect groundwater availability and quality, but should not affect sustainable yield. The sustainable yield of the windward sides of the island, where growth is limited and not projected to substantially increase, greatly exceeds permitted and actual use.

8.2.2 Surface Water

Surface water use is difficult to quantify due to a lack of surface water use data and information on stream diversions, changes in water use by large-scale agricultural systems, and difficulties associated with measuring diverted flow. The major ditch and flume systems constructed by the historical plantations remain in use today, supplying agricultural, municipal and other uses, including kuleana uses. Due to increasing concern regarding surface water issues the CWRM on January 22, 2014 amended its policy allowing exemptions from the requirement to measure and report monthly water use to Stream Protection and Management Branch. Continued exemptions are the same as for groundwater described in the previous section.[100]

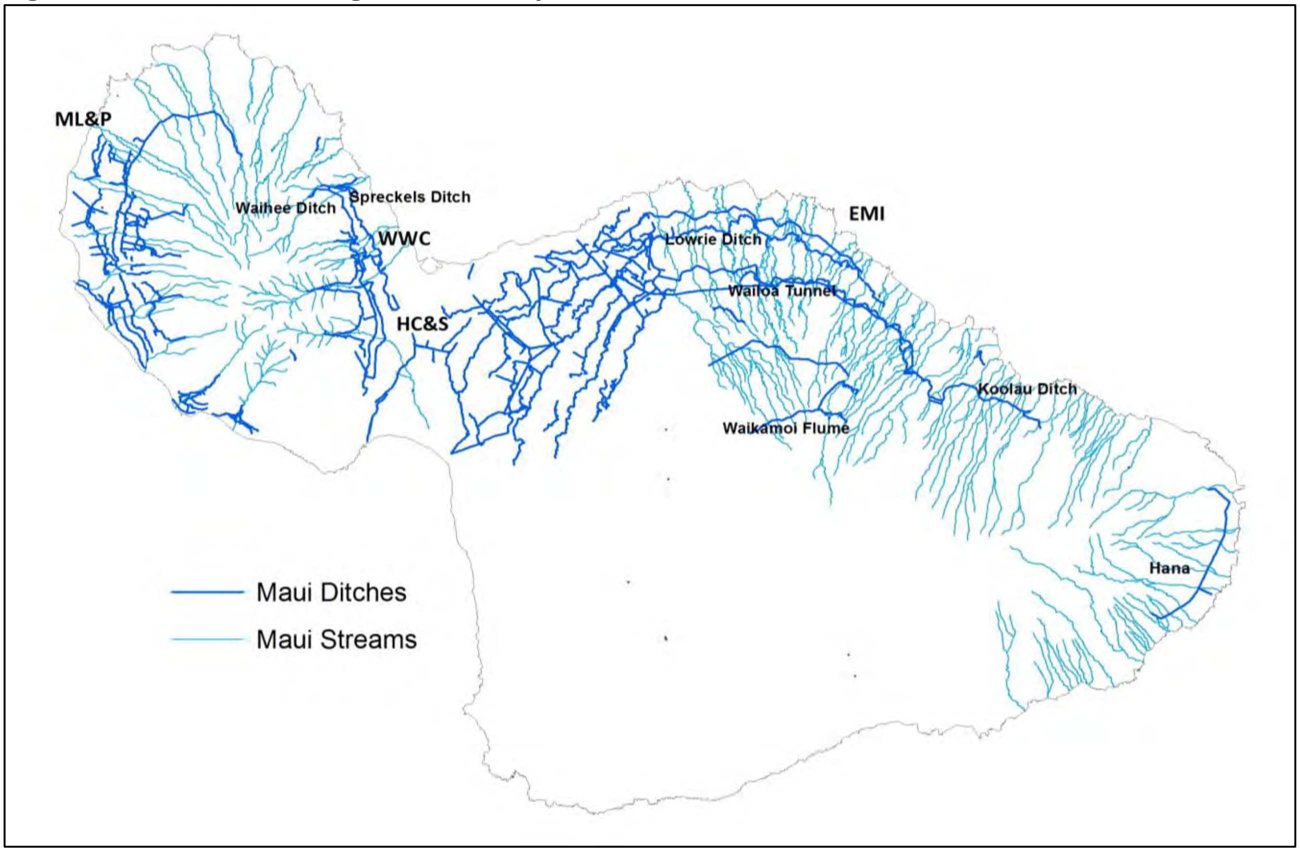
Stream Diversions

The major surface water systems included the East Maui Irrigation (EMI), Wailuku Water Company (WWC), and Maui Land and Pine (MLP) and Pioneer Mill systems, as shown on the following maps. The CWRM database lists 488 stream diversions and surface water gage records reported to CWRM indicate the average diverted flow was 407.5 mgd in 2014. Gages located at key locations along the length of the system may in some cases double count flow. Updated total flow for the EMI ditch in 2018 estimates average diverted water 2011 – 2015 to 123.6 mgd[101] for a total diverted flow of about 183 mgd island wide.

While historically plantation ditch operators maintained detailed records of rainfall conditions and diverted flows, different portions of some systems may now be under varying ownerships and flow monitoring gages may no longer exist or be useful for monitoring the total diverted flow. While the inventory of diversions is currently being updated and verified, much of the declared stream diversions and surface water use data is unverified, conflicting or incomplete, and is therefore of limited use. The locations and distribution of diversions and gages are listed in Appendix 4. On Maui, ground and surface water is transported to adjacent or distant aquifers by ditches or pipes for conveyance to uses in that area. Large-scale transport of surface water in particular is a significant legal, community, cultural and ecological issue. Water systems as well as recycled wastewater systems may also span more than one watershed or aquifer system area resulting in localized transport.

[100] CWRM Meeting, January 22, 2104. http://files.Hawai`i.gov/dlnr/cwrm/submittal/2014/sb201401D1.pdf
[101] December 2018 Diagram by Ayron Strauch, CWRM

Figure 8–11 Plantation Irrigation Ditch Systems



In 2014 agriculture continued to account for most of the surface water diverted from Nā Wai \`Ehā and East Maui streams. HC&S water use reports indicated 340 mgd was diverted in 2014, which is based on gages double counting flow in the same ditch. Updated total flow for the EMI ditch in 2018 estimates average diverted water 2011 – 2015 to 123.6 mgd.[102] The historic annual average flow for EMI was 160 mgd according to the 2004 AWUDP. As comparison, based on average water use rate of 5,555 mgd per acre for sugarcane stated by HC&S, irrigation need would be 194.5 mgd applied to the 35,000 acre holding.[103] In addition 2014 exhibited a strong El Nino with higher than normal rainfall in the dry season.

[102] December 2018 Diagram by Ayron Strauch, CWRM

[103] The HDOA Irrigation Water Use Guidelines water use rate for drip-irrigated sugarcane is 6,700 gpd/acre. HC&S-35,556 acres of sugarcane are drip irrigated (Maui County Data book, 2014 http://files.hawaii.gov/dbedt/economic/databook/db2014/section19.pdf). However, the rate used here is the water use rate stated by HC&S.

Table 8-21 Major Diverters, 2014 (mgd)

Diversion Owner	2014 Average Daily	Adjustments	Adjusted 2014
Wailuku Water Co	42.709		42.709
HC&S (EMI)	*123.6*	exclude 6.62 mgd to MDWS	*117**
Maui Land & Pine	13.262	exclude 3.299 mgd to MDWS	9.963
Other Irrigation	3.917	landscape and resorts	3.917
DWS Surface Water	9.919	surface water treatment (Kula Ag Park non-potable – 0.12 mgd)	9.919
Total	**193.41**		**183.508**

CWRM Monthly Use Reports 2014; MDWS 2014 production data. Numbers may not add due to rounding.
*Updated December 2018

Ground and Surface Water Use

Ground and surface water use on an island-wide basis is summarized in Table 8-22. Surface water diversions prior to 1990 were reported at 333 mgd island wide, and between 2009 – 2015 175 – 247 mgd. Average surface water use is less useful to determine resource adequacy as drought and storm flow are limiting factors for reliability and storage opportunities. The summary should be considered as estimates with high seasonal variation.

Table 8-22 Resource Availability and Use, 2014 (mgd)

Resource	Available	Used	Balance
GROUNDWATER	**427 SY**	**91**	**336**
Potable Uses		29	
Non-potable Uses		62	
SURFACE WATER	**Undetermined**	**183**	
Potable Uses		11	
Non-potable Uses		172	
ALTERNATIVE SOURCES	**26**	**3**	
Recycled	26	3	23
Other Non-potable			

Water Transport

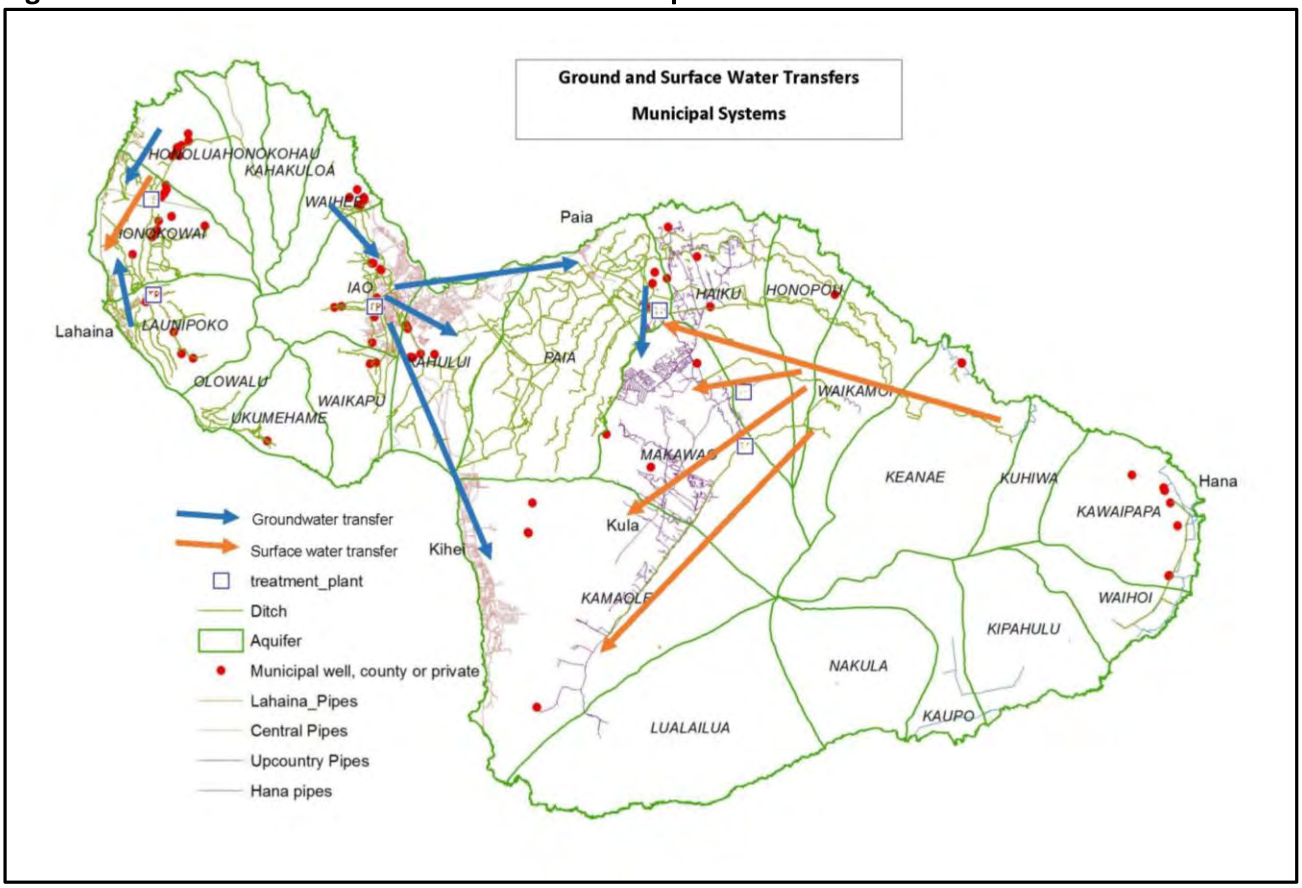
Water resources originating in high yield watersheds and aquifers are conveyed to dry regions where population centers and large scale agriculture are located. This export of water is the root to many conflicts, including the contested case over East Maui Streams and the streams in Nā Wai `Ehā . Generally, Ko`olau and Wailuku Aquifer Sector Areas are major source exports to the Central Aquifer Sector (ASEA). Water transport for agricultural irrigation changed drastically with the cessation of sugarcane cultivation in Central Maui. Water transport for potable municipal needs occur from Ko`olau ASEA to Upcountry Maui in the Central ASEA and from the

Wailuku ASEA to population centers from Pā`ia and Kahului in the north to Kīhei in the south within the Central ASEA. Water transport to the Maui Department of Water Supply (MDWS) Central and Upcountry Districts is shown in the table below (Table 8-23) and water transport patterns are shown in the figure below (Figure 8-11).

Table 8-23 Transport to MDWS Systems, 2014 (mgd)

Purveyor	2014 AD mgd	Aquifer Sector	To MDWS District	Notes
WWC	1.10	Wailuku to Central	Central	Surface water
MDWS	15.35	Wailuku to Central	Central	Groundwater
EMI	6.62	Upcountry	Upcountry	Surface water, potable and Kula Ag Park non-potable
Total	23.07			7.72 surface water 15.35 groundwater

Figure 8-12 Patterns of Water Transfers for Municipal Use



8.2.3 Recycled Wastewater

It is the policy of CWRM to promote the viable and appropriate use of recycled water in so far as it does not compromise beneficial uses of existing water resources. Recycled wastewater is a valuable resource, especially for irrigation purposes. Approximately 2.4 mgd of recycled wastewater is used on the island, primarily for irrigation of agriculture, golf courses and landscape.

On average, more than 12 mgd of recycled water is produced at treatment facilities on Maui, while the design capacity is twice that volume. The reuse of wastewater from the Central Maui, Kīhei, Lahaina, and other wastewater systems requires sufficient storage and distribution capability; otherwise, the excess is sent down injection wells. Community and agency concerns over effluent disposal continues to be a primary factor affecting the County of Maui, Wastewater Reclamation Division's (MWWRD) program since most of its wastewater reclamation facilities rely on injection wells.The County is in the process of obtaining NPDES (National Pollutant Discharge and Elimination System) permits to allow injection well discharges.

The State of Hawai`i defines R-1 water as the highest-quality recycled water; it has undergone filtration and disinfection to make it safe for use on lawns, golf courses, parks, and other areas used by people. R-2 recycled water can only be used under restricted circumstances where human contact is minimized. R-1 is primarily used in West and South Maui. R-2 is used in Kahului. The majority of the R-1 and R-2 water use is for irrigation. The Maui County Code was amended in 1996 requiring commercial properties (agricultural, commercial, public uses) within 100 feet of a Maui County R-1 water distribution system to connect within one year of recycled water availability and to utilize recycled water for irrigation purposes. The CWRM can also require dual water supply systems for new commercial and industrial developments in designated water management areas if a non-potable source of water (such as storm water) is available.

Table 8-24 Wastewater Reclamation Facility Capacity, Production and Use, 2014 (mgd)

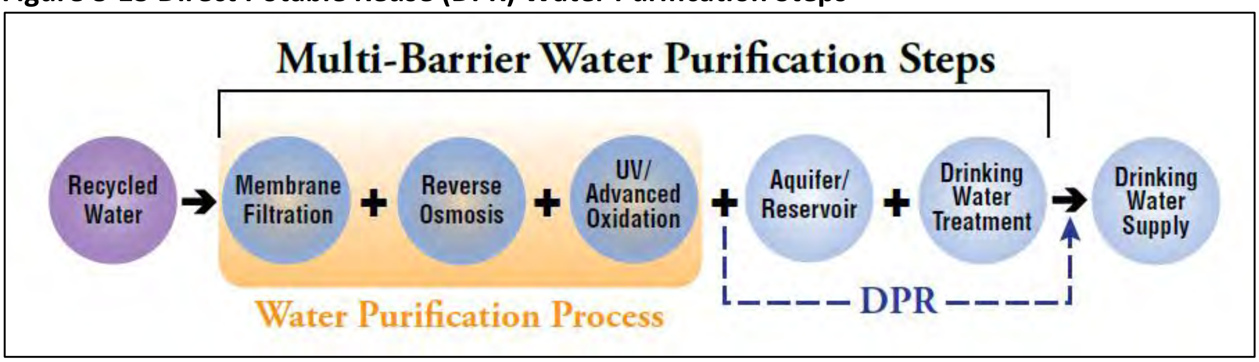
WWRF	Treatment Level	WWRF Design Capacity	Recycled Water Produced	Recycled Water Used	% of Total Produced Used	% of Design Capacity Used	Application
Wailuku-Kahului	R-2	7.9	4.7	0.25	5.3%	3.2%	None
Kīhei	R-1	8	3.6	1.5	41.5%	18.7%	Golf Course, Agriculture, Dust Control, Landscape, Fire Protection
Mākena (Private)	R-1	0.75	0.08	0.08	10.6%	10.6%	Golf Course

WWRF	Treatment Level	WWRF Design Capacity	Recycled Water Produced	Recycled Water Used	% of Total Produced Used	% of Design Capacity Used	Application
Pukalani (Private)	R-1	0.29	0.19	0.19	100%	65.5%	Landscape
Haleakalā (Private)		N/A	0.18	N/A	N/A	N/A	Closed loop system; Sanitary purposes
Lahaina	R-1	9	3.84	0.88	22.9%	9.8%	Golf Course, Landscape, Nursery, Agriculture
Subtotal		**24.9**	**12.1**	**2.38**			
Total		**25.9**	**12.6**	**2.65**			

Source: County systems: County of Maui Environmental Management Dept., Wastewater Reclamation Division, 2014 Average. Other systems, 2013 Update of the Hawai`i Water Reuse Survey and Report, State of Hawai`i, 2012 data.

Direct potable reuse is another method of using recycled water by introducing highly purified recycled water into the raw water supply immediately upstream of a water treatment plant, or into the distribution system downstream of a water treatment plant. In comparison, indirect potable reuse (IPR) first passes purified water through an environmental buffer such as a groundwater aquifer or reservoir. In all cases, water is treated to drinking water standards prior to distribution for potable use. Direct potable reuse projects in the U.S. typically blend about five to 50 percent or more purified recycled water with the raw water supply.[104]

Figure 8-13 Direct Potable Reuse (DPR) Water Purification Steps



Water Reuse California, Direct Potable Reuse, Winter 2015-California Legislative Update. DPR- Direct Potable Reuse.

[104] WateReuse California website. https://watereuse.org/sections/watereuse-california/
San Vicente Reservoir augmentation project:
https://www.sandiego.gov/sites/default/files/legacy/water/pdf/purewater/awwajournal_sept2013.pdf

Potential opportunities exist in locations where wastewater reclamation and water treatment facilities are in close proximity, such as in Lahaina or Kīhei.

Known constraints or uncertainties may generally include public acceptance, despite proven, existing technologies to treat recycled water to drinking water standards, which would require a robust education and outreach program. Department of Health regulations and rules to allow direct potable reuse are not in place. A County charter amendment to address organizational issues is likely necessary, along with other licensing and administrative issues. Potential modifications to wastewater reclamation facility and water treatment plant and distribution systems may be necessary to accommodate new source water, and back-up disposal for recycled water in the event of excess supply or contingencies would need to be maintained.

8.2.4 Rainwater Catchment

Rainwater catchment is the collection of rainwater from a roof or other surface before it reaches the ground. Rainwater catchment systems are not regulated by the Department of Health, making estimates difficult. Rainwater catchment is not as reliable as conventional water resources because it is extremely sensitive to the climate. Scattered use occurs throughout East Maui where consistent rainfall makes the systems feasible as a domestic source. The only public water system supplied by catchment is the Haleakalā National Park. Household demand unserved by public systems is grossly estimated at about 0.28 mgd including catchment, surface water, etc. No inventory of installed catchment systems throughout the island is available.

8.2.5 Stormwater Reuse

Stormwater reuse provides for capture and reuse of surface water runoff. Stormwater reclamation can potentially provide water for non-potable water demand such as irrigation and toilets. There are a variety of stormwater technologies as illustrated in the table below ranging from small rainwater catchment systems to reservoir storage systems. Due to contaminants picked up by storm water runoff, different levels of treatment may be necessary. Water-impounding reservoirs, which are regulated by DLNR's Dam Safety Program, include the Waikamoi and Olinda reservoirs which supply the MDWS Upcountry system. Stormwater reclamation methods that employ capture and storage technologies must be planned, constructed, and operated to ensure minimal impact to streams, riparian environments, conservation lands, water rights, cultural practices, and community lifestyles.

Reduced reliance on groundwater and surface water for landscape irrigation may be appropriate, especially when incorporated into the design of development projects to maximize water retention and minimize infrastructure costs. However, there is no code requirement for development projects to incorporate water retention or reclamation design features for the purpose of supplementing non-potable water supplies.

Table 8-25 Stormwater Reclamation Technologies

Technology	Description
Source Reuse	Use rain barrels or cisterns to collect precipitation or stormwater runoff at the source to provide water for a variety of non-potable purposes or, with treatment, potable water.
Small Lot Reuse	Manage precipitation or runoff as close to source as feasible. Examples: infiltration planter boxes, vegetated infiltration basins, eco roofs (vegetated roofs), porous pavements, depressed parking lot planter strips for biofiltration, narrowed street sections with parallel or pocket bioswales.
Stormwater Capture	Employ ditches, storm drainage system interception, dry wells, infiltration galleries, and injection wells to capture stormwater.
Stormwater Storage	Use aquifer storage and recovery, stream-bank storage, detention basins, and surface reservoirs to store stormwater.
Stormwater Distribution	Distribute stormwater via gravity ditch or pipe networks, operated/regulated ditch systems, pressure pipe networks, onsite wells.
Source: CH2MHill. *Hawaii Stormwater Reclamation Appraisal Report.* Prepared for the U.S. Bureau of Reclamation and the State of Hawaii Commission on Water Resource Management. July 2005	

8.2.6 Desalination

Desalination can remove salt and other dissolved minerals from the source water. Seawater, brackish water, or treated wastewater can be processed through several desalination methods: distillation, vacuum freezing, reverse osmosis and electrodialysis. Brine disposal and cost have posed significant impediments. Desalination is more costly than conventional water resources due to treatment and monitoring requirements, although costs have been decreasing. A cost evaluation for brackish water desalination in Central Maui region and aquifer sector was assessed by Brown & Caldwell in 2013. For an average increased production of 6.85 mgd, total net present value was assessed to about $9 per 1,000 gallons of desalinated water supply.The energy intensive technology currently available would add freshwater supplies but not provide other environmental co-benefits. Desalination of brackish water is generally more cost-effective and environmentally-friendly than use of sea water. Source water quality is an additional concern for desalinating brackish water. Trace amounts of pesticides have been found in some irrigation wells in the Kahului Aquifer and brackish wells may contain the same pesticides.

9.0 FUTURE WATER NEEDS

The characterization and projection of water demand includes the impacts of past water conservation programs and existing levels of recycled water use. Impacts of future programs and any increases in alternative source water use are not included in the water use projections. These future measures will be characterized and evaluated as potential resource options to meet the projections of water demand. Land use-based water demand is based on water system standards, while population based demand is projected based on actual demand. Applicable water use unit rates from the MDWS 2002 *Water System Standards*, Domestic Consumption Guidelines, are shown below. Adjusted water use rates especially for residential use are based on empirical consumption data.

Table 9-1 MDWS Water System Standards (Average Daily Demand)

Use Categories	2002 Standards	Adjusted Standards
Residential		
Single Family or Duplex	600 gal/unit or 3000 gal/acre	South Shore: 1,000 gpd North Shore: 600 gpd
Multi-Family Low Rise	560 gal/unit or 5000 gal/acre	
Multi-Family High Rise	560 gal/unit	
Commercial		
Commercial Only	6000 gal/acre	
Commercial/Ind Mix	140 gal/1000 sf	
Commercial/Res Mix	140 gal/1000 sf	
Resort (includes hotel)	350 gal/unit or 17000 gal/acre	
Light Industrial	6000 gal/acre	
Schools, Parks	1700 gal/acre or 60 gal/student	
Agriculture	5000 gal/acre	3,400 gal/acre (AG WUDP)

MDWS 2002 Water System Standards. Adjusted standards based on empirical use or as stated.

9.1 Land Use-Based Full Build-Out Water Demand Projections

Maui County Zoning

The Comprehensive Zoning Ordinance sets forth permitted and conditional land uses which support the land use patterns in the MIP and provides a basis for calculating the land use based water demand projections. The MIP and Community Plans also provide guidance for the Project District zones where large development projects are anticipated and for the Interim zone which is primarily planned for open space uses. The zones, acreage, and water use standards which are used as a basis for the land use based water demand projections are shown in the table below. The water use rates for the Project District and Interim zones were assigned based on the guidance in the MIP and Community Plans.

Table 9-2 Use Zone Districts and Water Use Rate, Excluding DHHL Lands

Use Zone Districts	Acres	% of Total	Water Use Rates (gpd per acre)
Single Family R-1, R-2, R-3, Duplex	7,618.33	1.6%	3000
Apartment A-1, A-2	1,209.26	0.3%	5000
Hotel H, H-1, H-M, H-2	804.84	0.2%	17000
Business B-1, B-2, B-3, BR, BCT, SBR	552.52	0.1%	6000
Industrial M-1, M-2, Kīhei R&T, Airport AP	3,074.54	0.7%	6000
Agriculture AG	247,590.82	53.4%	3400; sugarcane 5555
Rural 0.5, 1.0	2,794.15	0.6%	3000
Golf Course GC	422.78	0.1%	1700
Public/Quasi Public P, P-1	633.08	0.1%	1700
Park PK, PK-1, 2, 3, 4	2,479.50	0.5%	1700
Project District PD	4,397.75	0.9%	Per use type
Open Space OS, OS-2	1,815.54	0.4%	0
Interim I	190,689.30	41.1%	Per use type
Total	**464,082.39**	100%	

MDWS, Water Resources & Planning Division based on zoning supplied by Maui County Planning Department, Long Range Planning Division, May 2015. Sugarcane water use rate was 5,555 gpd per acre per information from HC&S.

Aggregating zoning consistent with the CWRM categories yields the totals in the table below. Interim and Project District zoned lands are assigned to CWRM categories based on guidance in the MIP and Community Plans and the list of major Development Projects maintained by the Planning Department representing projects that have come to their attention. Agriculture zoning occupies the largest area with approximately 5,640 acres located within the Urban Growth Boundary. Nearly half the land on Maui has an Open Space equivalent zoning with essentially no water demand as shown below.

Projected demand for full build-out of County zoning districts and DHHL plans is 144 mgd excluding agriculture, or 1,007 mgd including agriculture. DHHL demand is detailed in the next section.

Table 9-3 Projected Water Demand Based on Full Build-Out of Zoning Districts and DHHL Plans, by CWRM Category (mgd)

CWRM Categories	County Acres	County Water Demand	DHHL Acres	DHHL Water Demand	Total Demand
Domestic	16,928	67.02	2079 (3850 units)	2.31	69.33
Industrial	1,732	10.39	218.00	1.308	11.70
Municipal	3,943	15.74	137.80	0.234	15.97
Agriculture	230,844	860.70	14,017.00	47.66	908.36
Irrigated	1,644	1.72			1.72
Military	-	-	-	-	-
Total	**255,091**	**955.57**	**14,372.80**	**51.51**	**1,007.08**
Total excluding Agriculture zoning	24,247	94.87	2,434.8	3.85	144.07

Table prepared by DWS, Water Resources & Planning Division. Maui island zoning supplied by Maui County Planning Department, Long Range Planning Division, May 2015. DHHL acres/units based on DHHL Maui Island Plan and Regional Plans.

Water demand based on per acre standards except DHHL domestic based on residential units plus 0.2 acre commercial rate. Open Space zoning/land use not included due to lack of water demand. Irrigated includes Park-Golf Course and Golf Course zoning districts.

State Department of Hawaiian Home Lands (DHHL) Land Use Plans

DHHL projections based on its Maui Island and regional land use plans which are under its land use jurisdiction are summarized in the table below. About 5,000 acres were not assigned to a land use category because future plans are undetermined.

Table 9-4 DHHL Land Use – Maui Island and Regional Plans

CWRM Category	DHHL Land Use Category	Acres	Water Use Rate (gpd)	Projected Water Demand (mgd)
Domestic	Residential	2,000.8 (3,850 Units)	600/unit	2.31
	Commercial	78.2	6,000/acre	0.469
Industrial	Industrial	218	6,000/acre	1.308
Agriculture	Agriculture	14,017.5	3,400/acre	47.66
Irrigated	N/A	0	0	0
Municipal	Community	137.8	1,700/acre	0.234
Military	N/A	0	0	0
N/A	Open Space	10,658	0	0
Total		**27,110.30**		**51.51**

Source: DWS, Water Resources & Planning Division, May 2015, based on DHHL Maui Island Plan and Regional Plans.

Open Space DHHL Category includes conservation, cultural protection and similar types.Total Acres excludes 5062.5 acres because future land uses are unknown.

The State Water Projects Plan Update, DHHL, May 2017 Final Report proposes a project based demand of 31.078 mgd including anticipated demand after its planning period to 2031. Since this is less than the full build-out land use-based demand of 51.51 mgd and therefore, no adjustments to the full-build-out projection is necessary.

State Water Projects Plan

The land use based projections are compared to those in the State Water Projects Plan (SWPP), which projects future water demand to 2020. The SWPP states that, in general, new housing developments, agriculture irrigation projects, major facilities or major expansions were considered as having a significant impact on water resources. The SWPP was updated in 2017 for DHHL projects only, and therefore DHHL projects have been excluded from the table below.

Table 9-5 SWPP Projected Water Demands by Aquifer Sector (Excludes DHHL Projects) (mgd)

Aquifer Sector Area	2020 Potable Demand	2020 Non-potable Demand	2020 Total Demand	Unmet Needs to be Met by DWS	Projects with New State Water System	Non-potable Demand to be Met by Potable Sources
Wailuku	0.327	0.022	0.349	0.349	0	0.022
Lahaina	1.156	1.289	2.445	2.445	0	1.289
Central	0.812	9.947	10.759	4.759	6.000	0.034
Ko`olau	0.008	0.000	0.008	0.008	0	0
Hāna	0.006	0.000	0.006	0.006	0	0
Kahikinui	0.003	0.020	0.023	0.023	0	0
Total	**2.312**	**11.279**	**13.590**	**7.590**	**6.000**	**1.350**

State Water Projects Plan, Hawai`i Water Plan, Volume 4, SWPP for Islands of Lāna`i/Maui/Moloka'i, 2003. DHHL Water Demands totaling 6.4484 mgd are excluded. Projects with New State Water System- Lower Kula Watershed Project. (DHHL Maui Island Plan Development 07082015.xlsx)

Two major State projects (excluding DHHL projects) which lacked source strategies but planned to utilize County water systems are shown in Table 9-5a below.

Table 9-5a State Projects without Source Strategies Planning to use County Water Systems

Project	Demand (mgd)	Water Quality
Upcountry Maui Irrigation Project	3.61	Non-potable
Lahaina Master Plan	2.29	Potable

The SWPP states that the remaining balance of unmet potable and non-potable demands will be integrated into the County's overall water demand. Unmet demands of 1.0 mgd or greater, which are identified in the Lahaina and Central Aquifer Sector Areas, will be recommended for State source development if County water systems cannot meet projected demand. The land use based full build-out projections take into consideration projects in the SWPP and therefore no adjustments to the projected demand are necessary.

Agricultural Water Use and Development Plan (AWUDP)

The State Department of Agriculture (HDOA) oversees and promotes diversified agriculture and state-owned irrigation systems. The 2004 AWUDP projects demand to 2020 on lands served by major irrigation systems which include the East Maui, West Maui, Maui Land and Pineapple/Pioneer Mill, and Upcountry Maui Irrigation Systems. The AWUDP projected an increased water demand of 3 to 12 mgd on 891 to 3,544 acres of agricultural expansion based on a water use rate of 3,400 gpd per acre (which does not include irrigation system water losses). The projection was based upon population growth, partial replacement of imported produce with locally grown produce, and maintaining farm value growth in diversified agriculture.

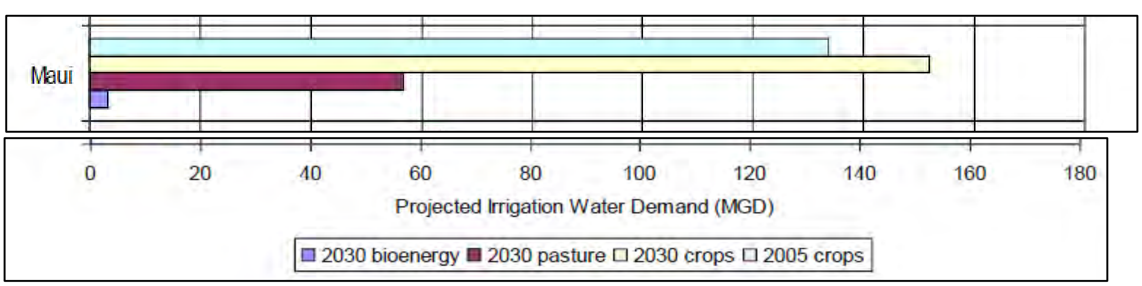
Table 9-6 AWUDP Water Demand Forecast for Diversified Agriculture, 2001-2021

Irrigation System	Total Acres	Acreage in Use		Unused Acreage Remaining Available	Acreage Forecast for Diversified Agriculture		Forecasted Water Demand (mgd)	
		Estimated Percent	Acres		Worst Case	Best Case	Worst Case	Best Case
Pioneer Mill*	3,533	30	1,060	2,473	422	1350	1.43	4.59
Upcountry	1,751	no data	no data	0	55	142	0.19	0.48
East Maui	33,026	70	23,118	9,908	200	1160	0.68	3.94
West Maui	5,400	60	3,240	2,160	214	892	0.73	3.03
Total	**43,710**		**26,358**	**14,541**	**891**	**5,544**	**3.03**	**12.05**

Compiled by MDWS based on AWUDP, 2003, revised 2004, Tables 6b and 7d. * Does not include Maui Land & Pineapple figures. Water use based on 3400 gpd per acre.

The Hawai`i Department of Agriculture is preparing an update to the AWUDP. Preliminary information provided in 2013 projected an irrigation water demand of an estimated 210 mgd by 2030, which is similar to 2014 demand, with increased demand by the Upcountry and West Maui (Wailuku) Irrigation Systems.[105] The demand forecast did not account for cessation of sugarcane cultivation on Maui.

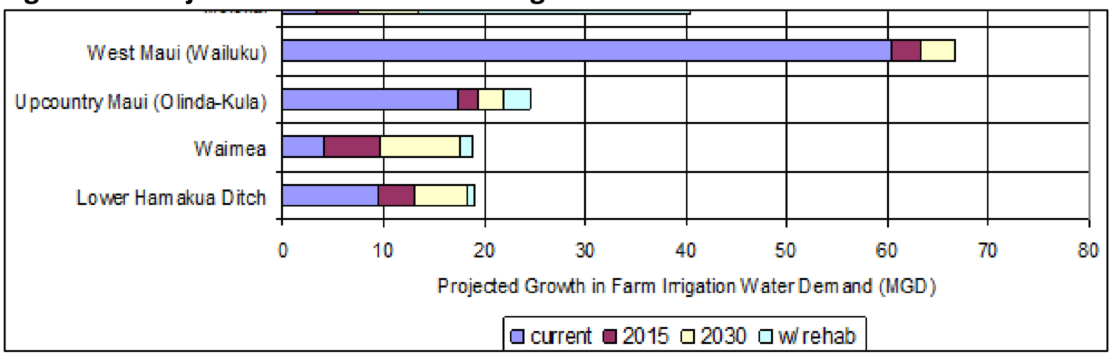
Figure 9-1 2030 Projected Irrigation Demand



Source: HDOA, AWUDP update presentation, October 23, 2013 HWWA Conference

[105] Hawai`i Department of Agriculture, AWUDP update presentation, October 23, 2013 Hawai`i Water Works Association Conference.

Figure 9-2 Projected Growth in Farm Irrigation Water Demand



HDOA, AWUDP update presentation, October 23, 2013 HWWA Conference

The land use full build-out based scenario includes projected water demand for all lands zoned Agriculture and this exceeds the 2004 AWUDP projections and preliminary information above. Therefore no adjustment to the land use based projection is necessary.

Important Agricultural Lands

The State Agricultural District encompasses 242,720 acres or 52% of Maui Island. The 2004 AWUDP indicates there were 67,900 acres of prime agricultural land, with 44,400 acres in monocrop, and 23,400 acres idle on Maui (2001 Statistics of Hawai`i Agriculture). The 2014 Hawai`i Data Book reported that there were 229,166 acres in farms (Maui County 2012) with 35,556 acres in sugar cane (2014). Important Agricultural Lands (IAL) designated by the State comprised 27,294 acres owned by Alexander & Baldwin predominately in sugarcane.[106] There were 149,242 acres of Agricultural Lands of Importance to the State of Hawai`i, ALISH, Prime, Unique, Other. The MIP is most protective of 82,592 acres of important agricultural lands identified by the University of Hawai`i Land Study Bureau, Detailed Land Classification System, LSB - A to C. Since the full-build scenario considers the water demands of land 247,590 acres zoned Agriculture, it encompasses the range of acreage of these land classification systems.

9.2 Population Growth Based Water Demand Projections (20-Year)

The 20-year population growth based demand projections are based on community plan growth rates in the Socio-Economic Forecast allocated to the Aquifer Sector Areas. Projected agricultural water demand is not correlated with population demand and is included as a separate component for a comprehensive assessment of water demands on Maui Island.

Population Forecasts and Water Demand

Population is projected to increase island-wide by 31.7 percent from 157,087 in 2015 to

[106] HDOA, 2/29/16. http://hdoa.Hawai`i.gov/wp-content/uploads/2013/02/IAL-voluntary-summary-e14_rev2-29-16.pdfhttp://hdoa.Hawai`i.gov/wp-content/uploads/2013/02/IAL-voluntary-summary-e14_rev2-29-16.pdf

206,884 in 2035, compared to a 33.5 percent increase from 2000 to 2015 according to the updated Socio-Economic Forecast, July 2014, prepared by the Maui County Planning Department, Long Range Planning Division. Population based water demand is projected to increase from an estimated 42.47 mgd in 2015 to 62.5 mgd in 2035, a 47% increase, based on Community Plan growth rates applied to existing demand. In addition to resident population, approximately 16.8 million visitors vacation on Maui each year, an estimated 46,000 visitors a day. The population is aging and household sizes are decreasing. Wailuku-Kahului is expected to remain the most populous Community Plan area, but both Kīhei-Mākena and West Maui Community Plan areas will have increasing shares of the island population by 2035. DHHL's Maui Island Plan also relies upon the County's growth projections.

The three primary urban centers on Maui, measured by the regional distribution of commercial jobs, are Wailuku-Kahului (44 percent), Kīhei-Mākena (18 percent), and West Maui (28 percent). Maui County has been dependent on agriculture and tourism, both of which are vulnerable to forces beyond the community's control, and with the cessation of now sugarcane production at the end of 2016, tourism will increase in importance. [107] Slow economic growth is predicted by the 2014 Socio-Economic Forecast which was prepared prior to A&B's announcement. The rates of increase in resident population, housing, and total employment are higher than the rate of growth for visitors. This means the Maui economy has diversified and is less driven by tourism than in the past. With high occupancy rates, construction of new units is expected to resume after 2020, and the supply of visitor units will likely grow at 0.9% or more annually from 2020 to 2040.[108]

Population growth rates were assigned to community plan areas by the Planning Department based on assessment of the location of new development projects and project build-out likelihood as an indicator of projected timing. Resident population growth and water demand do not have a direct relationship, but rather are co-related. Several growth related factors complicate predictions of water use, including an increase in the number of visitor accommodations, unoccupied second homes, and transient vacation rentals both legal and illegal in residential areas. Seasonal rainfall anomalies or drought conditions unrelated to population also affect demand.

While the number of residents and visitors (de facto population) in the County on any given day is higher than the number residents alone and more closely reflects water consumption than the number residents alone, resident population is used as the basis for projecting water demand for three major reasons: (1) existing water consumption which is used as a basis for demand projections includes water used by people and economic activities on any given day; (2) existing water consumption reflects the location of water use by occupied residences, visitor accommodations and economic activity on Maui; (3) resident and de facto population are projected to grow at similar rates, with the larger resident population growing at a higher rate in each area; (4) basing growth on resident population results in a slightly higher projected

[107] Maui County General Plan 2030 Countywide Policy Plan.
[108] Socio-Economic Forecast, July 2014

growth rate in nearly all cases, and , a considerably higher rate in some cases than using defacto population; and (5) the Maui Island Plan projects that the West Maui and Kīhei-Mākena areas, which have the greatest number of visitors, will continue to expand as visitor destinations, which is consistent with the high population growth rates for these regions. [109]

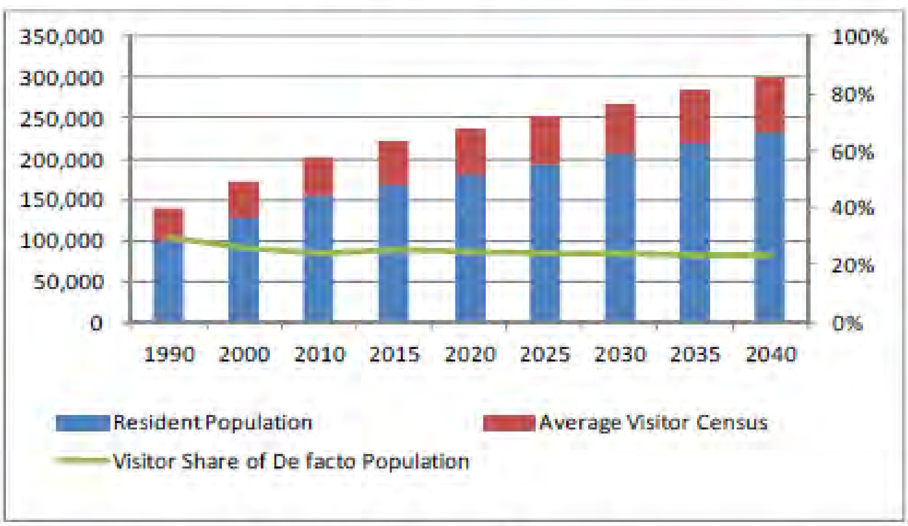
Table 9-7 Community Plan Area Population 1990 – 2035

Forecast Variables	Historical 1990	Historical 2000	Historical 2010	Projected 2015	2020	2025	2030	2035
Population by Region								
West Maui	14,574	17,967	22,156	24,373	27,762	32,318	36,110	39,911
Kihei-Mākena	15,374	22,870	27,244	29,599	34,757	39,975	46,370	52,044
Wailuku-Kahului	32,807	41,503	54,433	60,336	62,102	64,188	65,734	67,986
Makawao-Pukalani-Kula	18,923	21,571	25,198	26,551	28,438	28,949	29,482	29,852
Pa'ia-Ha'ikū	7,788	11,866	13,122	13,820	13,949	14,045	14,139	14,153
Hāna	1,895	1,867	2,291	2,408	2,531	2,660	2,795	2,938
Total	91,361	117,644	144,444	157,087	169,540	182,135	194,630	206,884

Source: Socio-Economic Forecast, 2014 (9/2014), Table R-1 (Refer to report for Table Notes)

Figure 9–3 Resident and Visitor Populations, Maui County, 1990 to 2040

FIGURE 1: RESIDENT AND VISITOR POPULATIONS, MAUI COUNTY, 1990 TO 2040

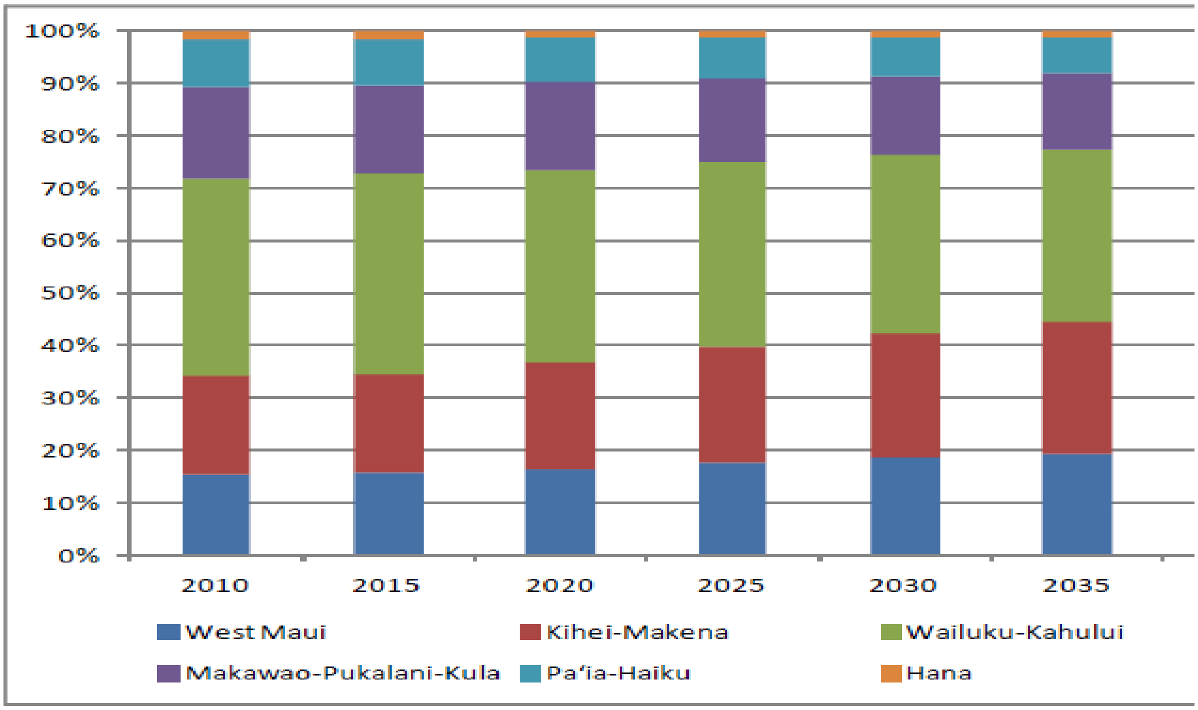


SOURCES: U.S. Census and Hawai'i Department of Business, Economic Development and Tourism. Projected De facto population calculated for this report.

Maui County Planning Department, Socio-Economic Forecast, 2014, Figure 1

[109] Maui County Planning Department, Socio-Economic Forecast, July 2014

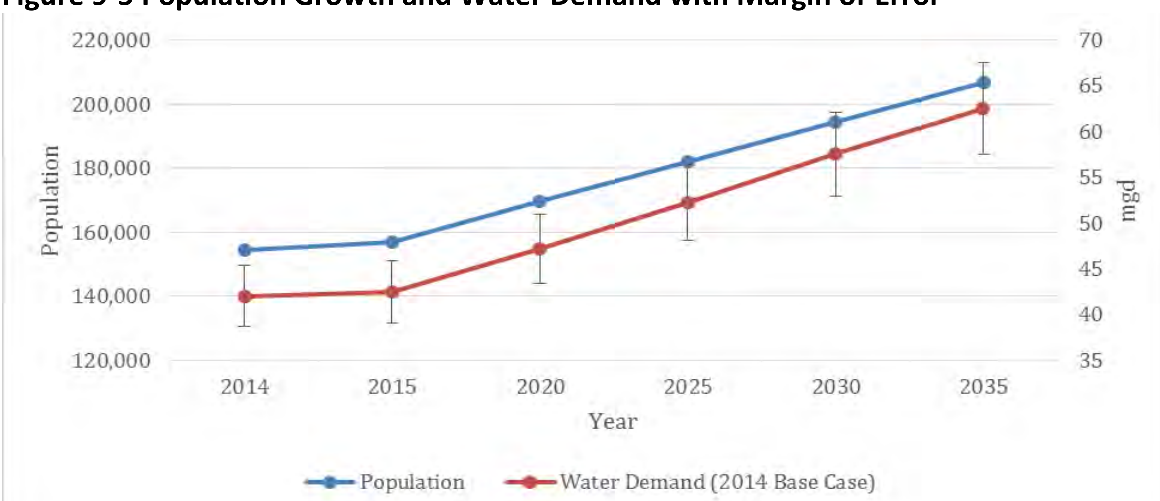
Figure 9-4 Population Distribution on Maui, by Community Plan Area, 2010 – 2035



Socio-Economic Forecast, July 2014

The Socio-Economic Forecast includes high and low population growth alternatives which reflect a margin of error close to 8% above and 8.5% below the base projection, based on the estimated increase from 1990 to 2010 compared to the actual population of the 2010 Census. The projected range of demand to provide a margin of error is about 57 to 68 mgd. The population growth projections and base water demand projection and margin of error is shown in the figure below. It is emphasized that projections should be thought of in terms of a range rather than a specific number.

Figure 9-5 Population Growth and Water Demand with Margin of Error



Population growth based water demand projections to the year 2035 are approximated by Community Plan area and Aquifer Sector Area in the figures below. The largest projected increases are within the Kīhei-Mākena Community Plan area and the Central Aquifer Sector Area reflecting higher growth rates in the Kīhei-Mākena area.

Figure 9-6 Population Growth Based Demand by Community Plan Area, 2014- 2035 (mgd)

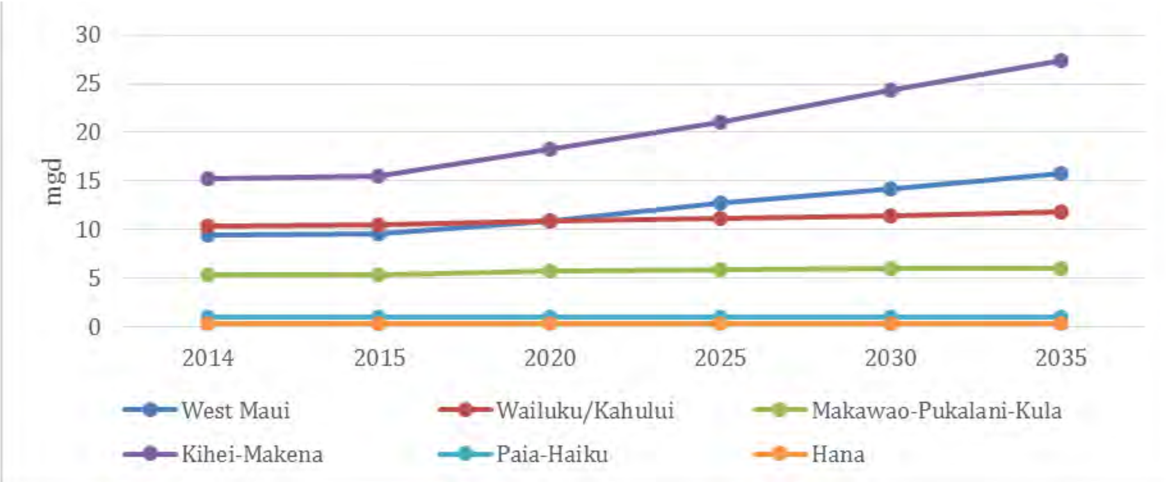
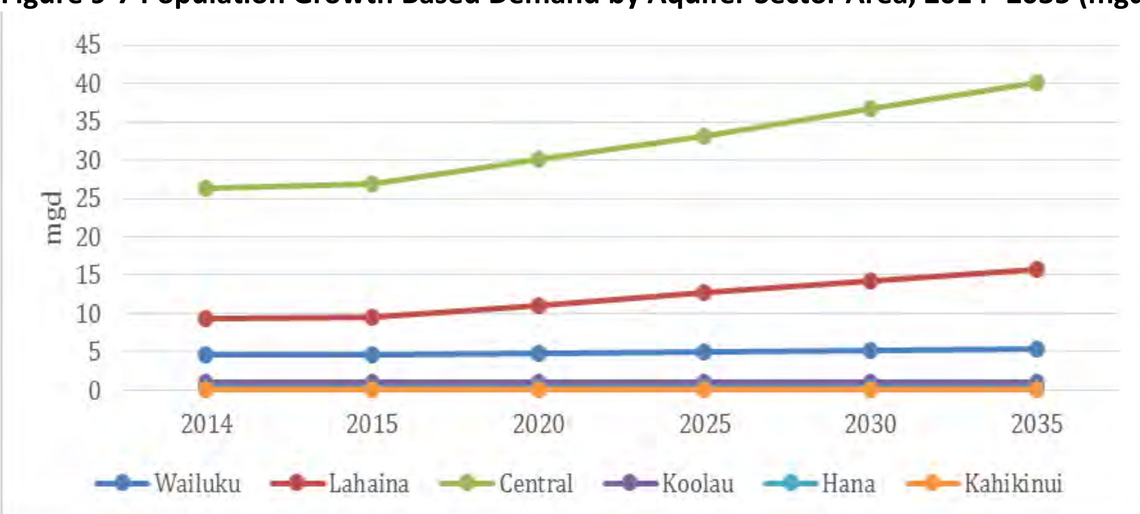


Figure 9-7 Population Growth Based Demand by Aquifer Sector Area, 2014- 2035 (mgd)



Since the population growth rates for community plan areas take into account potential development projects (May 2016) known to the Planning Department, potential water demand for listed projects is based on the water use rates for residential and resort unit demand. Total demand of all projects (excluding commercial, industrial, and public for which water demand would be minimal) is about 21.9 mgd. About 19.7 mgd of demand appears to be within the MDWS service areas, compared to a projected MDWS increase in demand of about 15.5 mgd from 2014 to 2035.[110] It is noted that not all projects may be approved, the number of units may be modified, timing is generally unknown, and it is possible that some projects would use a new private public entity. More information on development projects is provided in the Aquifer Sector Area Reports.

Population growth based demand is compared to the land use based full build-out scenario based on zoning and DHHL land use categories, with and without agriculture. Land use based demand is held constant throughout the planning period.

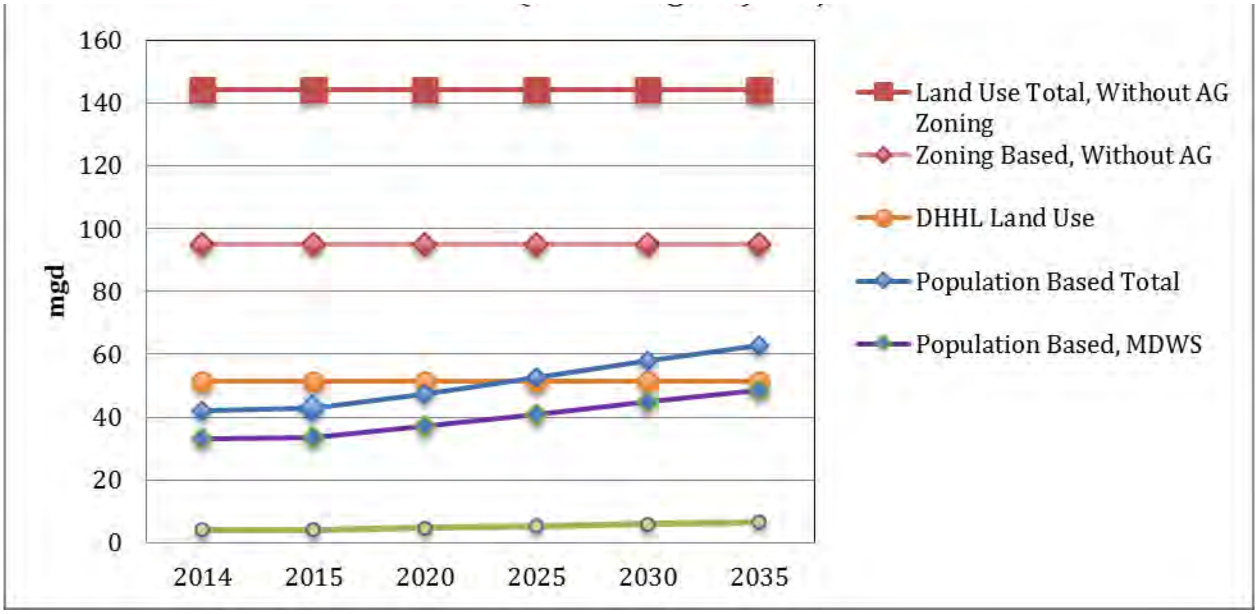
Table 9-8 Population Growth and Land Use Build-Out Based Water Demand, Maui Island (mgd)

Scenario	2015	2020	2025	2030	2035
Population Growth Based	**42.76**	**47.24**	**52.55**	**57.82**	**62.79**
All Public Systems	37.78	42.03	46.51	51.19	55.61
MDWS	33.54	37.16	40.89	44.80	48.50
Other Private Public Systems	4.24	4.79	5.42	6.05	6.65
Other (non-Large Ag)	4.97	5.57	6.24	6.97	7.64
Population Unserved by Public Systems (excludes domestic wells)	0.28	0.28	0.28	0.28	0.28
Land Use Based Without Agriculture Zoning	**144.07**	**144.07**	**144.07**	**144.07**	**144.07**
Zoning Based Without AG	94.87	94.87	94.87	94.87	94.87
DHHL Land Use Based	51.51	51.51	51.51	51.51	51.51
Land Use Based Total With AG	1,007.08	1007.08	1,007.08	1,007.08	1,007.08

MDWS based on CWRM Reports, DHHL plans, Maui County Planning Department zoning.

[110] The large DHHL projects cited in the 2017 SWPP are included on the development project list; Agricultural subdivisions may not be served by public districts.

Figure 9-8 Maui Island Population Growth and Land Use Build-Out Based (Excluding AG) Projections



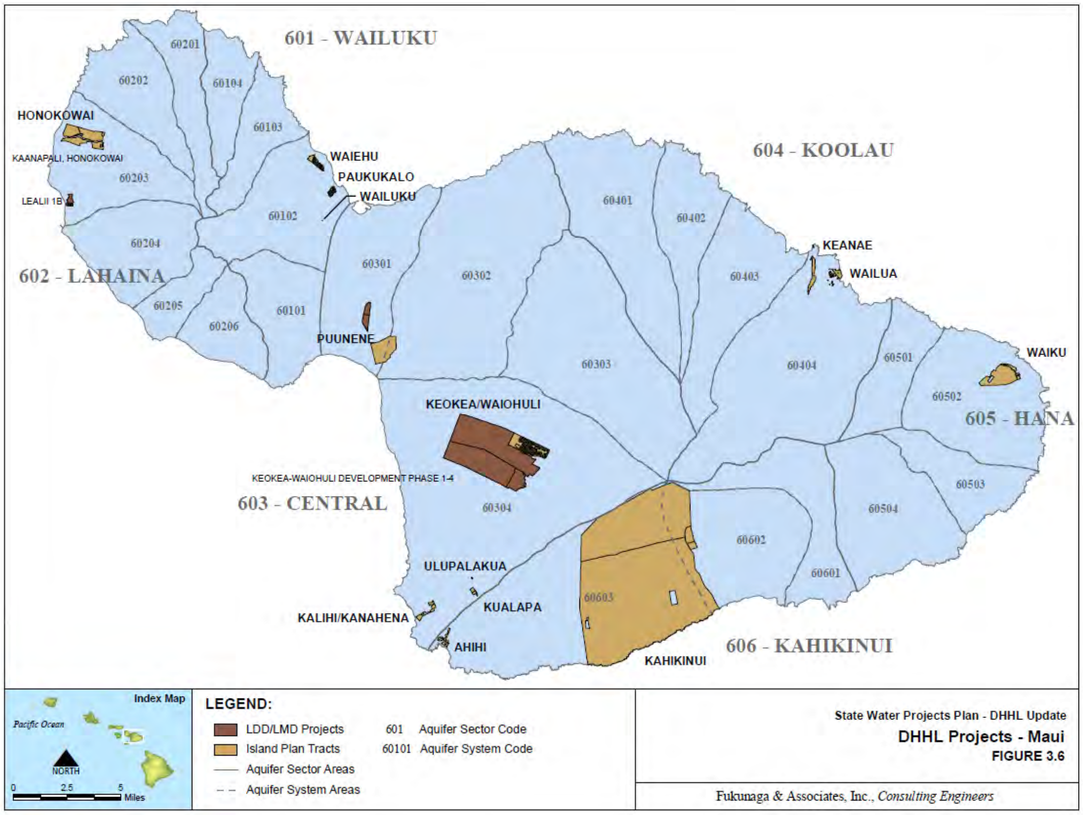
(Sum Maui MUN Pump 2014 Zoning.xlsx)

9.2.1 DHHL Water Demand Projections

The State Water Projects Plan Update, Hawai`i Water Plan, Department of Hawaiian Homelands, May 2017 Final Report provides water use requirement projections for projects shown on the map, planned to be developed below over the 20-year planning horizon from 2015 to 2031. A range of forecasts (high, medium and low) was developed based on prioritization of DHHL needs and uncertainties. Near term priority projects are 1-6 years (2015-2021) and Longer Term priority projects are 7-20 years (2022-2031). Project demands were based on the equivalent County Water System Standards unit rates.

All demands associated with the domestic component of homesteading and municipal use were considered to be potable. Agricultural non-potable demands were based on the diversified agricultural rate of 3,400 gal/acre/day with pastoral use at 20 gal/acre/day. Areas to be developed as lo`i kalo within the Ke`anae and Wailua projects are based on 150,000 gal/acre/day; water demand for lo`i kalo area is subject to change when quantity of available resources are determined. Most General Agriculture non-potable demands were not included in the non-potable demand used to develop strategies because these areas may serve as an interim use. Actual water use can vary considerably from planning estimates and strategies do not take into account potential alternate sources of potable and non-potable water. Additional information on DHHL water demands by hydrologic unit is presented in Appendix 5.

Figure 9–9 DHHL Projects



Projected demand for new projects is 15.173 mgd between 2015 and 2031, with potable demand at 3.551 mgd. An additional 27.557 mgd of non-potable demand is projected beyond the planning period, for a total of 31.078 mgd.

Table 9-9 Projected DHHL Demands by CWRM Category, 2031 (mgd)

Category	Potable	Non-potable	Total	Other Non-potable >2031
Domestic	0.063		0.063	
Industrial	1.824		1.824	
Irrigation			0	
Agriculture		11.652	11.652	27.557
Military			0	
Municipal	1.634		1.634	
Total	**3.521**	**11.652**	**15.173**	**27.557**

SWPP, May 2017 Final Report, Table 3.9.
Other non-potable is not expected to be developed by 2031 and strategies were not developed.

Projected demand and strategies to meet that demand are shown in the tables below. DHHL petitioned CWRM in 2015 to reserve groundwater in the Kama`ole (est. 1.722 mgd). However, according to the June 20, 2017 CWRM Bulletin, C. Petitions for Reservation of Water, Res - 719 “The State Department of Hawaiian Home Lands has filed an incomplete petition to reserve an estimated 1.772 mgd of groundwater from the Kama`ole Aquifer System Area"; Kawaipapa, (est. 0.03 mgd) and Honokōwai (est. 0.182 mgd) aquifer system areas.[111] If past practices continue, most DHHL projects would be serviced by MDWS systems. There is about 0.0837 mgd of unmet potable need for DHHL projects within or adjacent to the service area of a County water system but without a source option. It is proposed that DHHL would coordinate with Maui DWS to provide services. A large portion of the funding for these projects would be allocated to development of new sources and infrastructure, or towards payment of a proportional cost for new source development and infrastructure expansions and connection to County water systems.

Table 9-10 DHHL Potable and Non-potable Demand Projections for Maui Island, 2015 to 2031 (mgd)

Primary Use	2015	2016	2021	2026	2031
Potable	0	2.213	2.715	3.457	3.521
Potable Unmet Need-Coordinate with Maui DWS	*0*	*0.0204*	*0.0323*	*0.0323*	*0.0837*
Non-potable	0	1.87	11.397	11.397	11.652
Total	0	4.083	14.112	14.853	15.173
Other Non-potable (not expected to be developed by 2031)	0	1.87	11.397	11.397	27.557
Grand Total	**0**	**4.083**	**14.112**	**14.853**	**31.078**

State Water Projects Plan, May 2017 Final Report, Table 3.6. Cumulative Average Day Demand (MGD).

Table 9-11 Projected Water Demands and Strategies for DHHL Projects, Maui Island, 2035 (mgd)

Sector/ System	Project	Potable	Potable Strategy	Non-potable	Non-potable Strategy
Wailuku/ `Īao	Waiehu	0.017	Coordinate with MDWS (Central) – source not identified	0	
Wailuku/ `Īao	Paukukalo	0.0034	Coordinate with MDWS (Central) - source not identified	0	
Lahaina/ Honokōwai	Honokōwai/ Kā`anapali	0.6179	New and/or planned State wells	2.0808	MLP Irrigation System
Lahaina/ Honokōwai	Leali`i B	0.1517	New and/or planned State wells		
Central/ Kahului	Pu`unene	1.734	To be determined. Potential transport from Kamole to Kahului Aquifer	1.8564	To be determined

[111] CWRM Bulletin, May 2015, Petitions for Reservation of Water 719, 720 and 721.

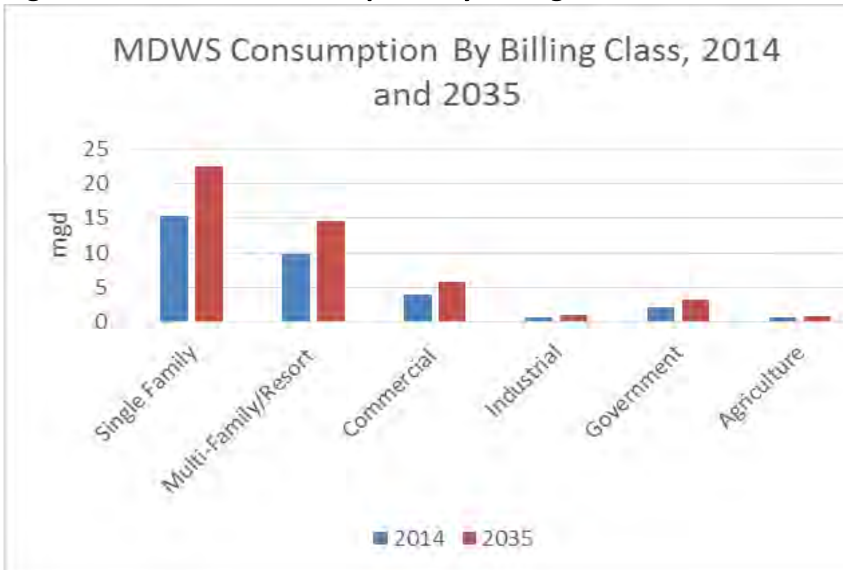
Sector/ System	Project	Potable	Potable Strategy	Non-potable	Non-potable Strategy
Central/ Kama`ole	Kēōkea/ Waiohuli	0.8097	Water Credit Agreement MDWS (0.2810) (Upcountry), New State System (0.5287)	0.578	Upcountry Maui Irrigation System
Central/ Kama`ole	`Ulupalakua	0.0034	Coordinate with MDWS (Upcountry) – source not identified	0	
Ko`olau/ Ke`anae	Ke`anae	0.0034	Coordinate with MDWS (Hāna) – source not identified	4.5878	Rainfall (0.3128), Pi‘inau‘u Stream (4.275)*
Ko`olau/ Ke`anae	Wailua	0		2.2802	Rainfall (0.1802), Waiokamilo Stream (2.100)*
Hāna/ Kawaipapa	Wākiu	0.1177	Water Credit Agreement MDWS (Hāna) (0.0612), coordinate with MDWS (Hāna) – source not identified (0.0565)	0.255	Rainfall
Kahikinui/ Lualailua	Kahikinui	0.063	Fog Drip Catchment, truck haul	0.0135	Fog Drip Catchment, truck haul
Total		**3.5212**		**11.6517**	

State Water Projects Plan, DHHL, May 2017 Final Report
*Part or all of water demand is based on estimated lo`i kalo area and is subject to change when quantity of available resources are determined

9.2.2 MDWS Water Demand Projections

MDWS projections are based on application of community plan population growth rates in the MIP to 2014 MDWS consumption figures. A 47 percent increase is projected from 2014 to 2035. Projected demand by billing class is shown in the following figure and table. It should be noted that to calculate source needs to meet demand, water produced rather than billed water consumption is used. Water production is higher than consumption due to water losses and other factors but can't be broken down by customer billing class.

Figure 9-10 MDWS Consumption by Billing Class



MDWS Billing Classes

Agricultural
Single-Family: Single-Family
Multi-Family/Resort: Multi-Family, Low Rise, High Rise; Housing-County
Mixed Use/Resort: Mixed Use, Hotel, Irrigation- Golf Course-Private
Commercial: Commercial, Religious, School-State/Private, Irrigation- Private
Industrial
Government: City Facility, State Facility, Parks-County/State, Irrigation-State/County, US Military Facility, US Non-Military Facility
Unknown

Table 9-12 MDWS Projected Consumption by Billing Class, 2010 to 2035 (mgd)

YEAR	2010	2014	2015	2020	2025	2030	2035
Maui Island Population	144,444	154558	157,087	169,540	182,135	194,630	206,884
Single Family	18.096	15.406	16.608	17.372	18.935	20.840	22.570
Multi-Family/Resort	7.784	9.927	10.701	11.194	12.313	13.552	14.677
Commercial	3.389	3.970	4.280	4.477	4.924	5.420	5.869
Industrial	0.994	0.765	0.825	0.863	0.949	1.045	1.131
Government	2.417	2.182	2.352	2.460	2.706	2.978	3.225
Agriculture	1.286	0.657	0.709	0.741	0.815	0.898	0.972
Unknown	0.065	0.052	0.056	0.059	0.065	0.071	0.077
TOTAL	34.031	32.959	33.539	37.160	40.850	44.795	48.503

Source: DWS Billing Data, Calendar Years 2010 and 2014. Maui County Population Projections, Projected Growth Rate from MIP 9-2014 Draft, applied to DWS Consumption figures. Agriculture excludes Kula Ag Park, 0.12 mgd in 2014.

Projected demand by MDWS district indicates the greatest increases will occur in the south (Kīhei-Mākena) and West Maui areas reflecting high Community Plan population growth rates for those leeward areas.

Table 9-13 MDWS Projected Consumption by District, 2014-2035 (mgd)

MDWS District	2014	2015	2020	2025	2030	2035	% Increase
Central/Wailuku	21.154	21.556	24.025	26.566	29.533	32.294	53%
Upcountry/Makawao	6.263	6.331	6.712	6.824	6.940	7.020	12%
West/Lahaina	5.388	5.496	6.260	7.287	8.141	8.999	67%
East/Hāna	0.155	0.156	0.164	0.172	0.181	0.191	23%
Total	**32.959**	**33.539**	**37.160**	**40.850**	**44.795**	**48.503**	47%

Upcountry Meter List

The Upcountry Meter List of requests for water meters represents a significant unsatisfied demand. As of June 30, 2014 there were 1,822 requests (excluding reservations offered but not accepted, reservations accepted, and meters installed) for an estimated total of 7,284,057 gpd. Historically, about 50 percent of the requests are withdrawn or denied. Projected demand to satisfy the Upcountry meter list is therefore estimated within the range of 3.6 to 7.3 mgd. About two-thirds of the requests are for development that would be located outside the Urban Growth Boundary, while policy in the Maui Island Plan directs urban services to areas within the growth boundaries. As shown below, development of half the meter list could result in a significantly higher water demand than otherwise projected. There remains uncertainty over the number and timing of new meters as well as occupancy (new population, relocation of existing population on Maui, use as vacation or part-time residences). This issue is discussed in more detail in the Central Aquifer Sector Area Report.

Table 9-14 Comparison of Upcountry District With and Without Meter List (mgd)

Criteria	**2014**	**2035**	**Increase (mgd)**
Upcountry/Makawao	6.2	7.0	0.7
Upcountry/Makawao + Meter List	6.2	9.9 – 13.5*	3.6 – 7.3

Assumes 50% - 100% of meter list requests are developed.

Base, Low and High Scenarios

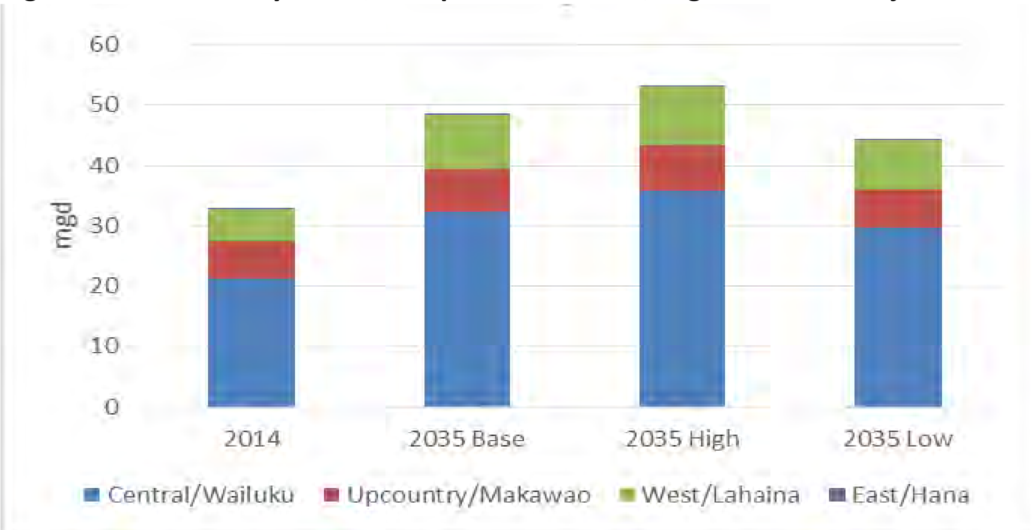
Projected consumption for the base, low and high scenarios indicates the range to be from 48.5 to 53.3 mgd, not taking into account the Upcountry meter list.

Table 9-15 Projected Consumption by MDWS District, Base, High and Low Scenarios (mgd)

District	**2014**	**2035 Base**	**2035 High**	**2035 Low**
Central/Wailuku	21.154	32.294	35.778	29.533
Upcountry/Makawao	6.263	7.020	7.573	6.420
West/Lahaina	5.388	8.999	9.708	8.229
East/Hāna	0.155	0.191	0.198	0.179
Total	**32.959**	**48.503**	**53.257**	**44.361**

Excludes Kula Ag Park

Figure 9-11 MDWS Systems, Comparison of Base, High and Low Projections



9.2.3 Privately Owned Public Water Systems Demand Projections

Projected demand is largely based on Community Plan population growth rates. Privately owned public water systems were also queried on the customers, water production capabilities, and future projections but information provided such as service projections were limited in many cases. Since many of the smaller private public systems serve specific development projects, significant increases would not be anticipated. Disclosed information is incorporated. Private public system demand comprises about 12% of the total population based demand.

Table 9-16 Public Water Systems, Population Growth Based Water Demand, Maui Island (mgd)

Purveyor	2015	2020	2025	2030	2035
MDWS	33.54	37.16	40.89	44.80	48.50
Other Private Public Systems	**4.24**	**4.79**	**5.42**	**6.05**	**6.65**

MDWS based on CWRM Reports.

9.2.4 Other Population Based Demand Projections

In addition to the public water systems, some persons are not served by public water systems and another component of water use is associated with population and economic demand. An unknown number of persons are not served by any public water system, but rather by wells, catchment and similar means; an estimated 'order of magnitude' demand for 2014 of 0.276

mgd was calculated and is projected to increase at a negligible rate.[112] Other population based demand includes persons using domestic wells as well as landscape irrigation and industrial wells which are not included within public system supplies. Rates of increase are based on the community plan growth rates.

Table 9-17 Other Population Growth Based Water Demand (mgd)

Criteria	2015	2020	2025	2030	2035
Other (non-Large Ag)	4.97	5.57	6.24	6.97	7.64
Population Unserved by Public Systems (excludes domestic wells)	0.28	0.28	0.28	0.28	0.28

MDWS, CWRM Reports.

9.3 Population Growth Based Demand - Agricultural Demand Projections

Agriculture and other large irrigation demands are not included in the population based demand figures above, but should be added to the population based demand figures to provide a complete picture of water use. Incidental gardening, landscape irrigation and small agricultural uses are included with municipal demand or may be represented in lower volume well reports that are incorporated into the demand above. About two percent of MDWS billed consumption is for agricultural use, excluding Kula Agricultural Park which receives non-potable water.[113]

The Hawai`i Department of Agriculture is preparing an update to the AWUDP. Preliminary information provided in 2013 projected an irrigation water demand of about 210 mgd by 2030, which is similar to 2014 demand, with increased demand by the Upcountry and West Maui (Wailuku) Irrigation Systems.[114] While future agricultural activity has the hypothetical potential to increase based on acreages of unutilized agricultural lands, the cessation of sugarcane production is expected to reduce irrigation demand. Despite the interest in food security and self-sufficiency and increasing exports, prospects for substantial increases in agricultural production in other locations are limited. In any case, projected agricultural water demands assume that future agricultural water demand cannot exceed potential agricultural water supply.

To project future water use for agriculture, agricultural activities can be categorized into diversified agriculture and wetland kalo cultivation.

---

[112] 2010 Census Block Group populations that appear to be outside public purveyor service areas – approx. 1,190; apply average MDWS per capita rate of 248 gpd based on 2010-2014 consumption and interpolated population = 296,144 gpd. Excluding domestic well pumpage of 243 gpd results an estimated demand of 275,649 gpd.

[113] Agricultural use based on billing categories or CWRM categories, which differs from 'Agricultural Services'.

[114] Hawai`i Department of Agriculture, AWUDP update presentation, October 23, 2013 Hawai`i Water Works Association Conference.

Table 9-18 Water Use Rates for Diversified Agriculture and Lo'i Kalo

Agricultural Activity	Water Use Rate (gpd/acre)	Type of Water Coefficient	Data Source
Diversified Agriculture	2,500 for wetter areas 3,400 for drier areas	Average per acre water use for Diversified Agriculture activities (Does not include irrigation system water losses)	Water demand factor used by the CWRM to calculate potential demand for diversified agriculture in the Waiāhole Ditch Case; the State AWUDP uses 3,400 gpd per acre
Lo`i Kalo	100,000 to 300,000 15,000 to 40,000	Per acre water inflow into lo`i kalo system Consumptive use	CWRM Nā Wai `Ehā and East Maui Streams Contested Cases

Lo'i Kalo Cultivation

The legal context for Native Hawaiian rights, including Traditional and Customary (T&C) uses, is provided under sections 1.3 and 6.2. Many lo`i kalo are also located in or directly adjacent to the stream, technically within the streambed or high-flow areas and virtually 100 percent of taro water is sourced from streams. However, due to the traditional landscape architecture of the lo`i systems, water utilized for taro is returned to the stream for downstream use with negligible loss. An exception to the downstream reuse of water principle rests in the extent to which other Native Hawaiian T&C crops are cultivated by way of irrigation water that is not returned to the stream. Therefore, consumptive use for lo`i taro in terms of unavailable downstream water lost is difficult to quantify but has been estimated at 15,000 to 40,000 gad, although the necessary flow is estimated to be 100,000 to 300,000 gad.

Several methods are used to characterize the potential for lo`i kalo cultivation as well as for vegetables, trees, and plants for subsistence and cultural purposes, as a basis for further discussion and evaluation. The primary data consulted are representations of historical agriculture, kuleana parcels (OHA), CWRM IIFS and contested case documents, the Declarations of Water Use (CWRM), and the 2015 Agricultural Baseline (HDOA). The 1992 Hawai`i Stream Assessment identified stream valley where taro was "truly a part of the large landscape" based on the CWRM Declaration of Water Use certification database, 1989, and adjusted and augmented by the Cultural Resource Committee that worked on the report.

Table 9-19 Landscapes with Significant Taro Cultivation

Streams	Characterization – acres per stream
Waihe'e, Waiehu, Pi`ina`au	> 50 acres
Honokōhau, Kahakuloa,`Īao, Honopou, Ho`olawa, Hanehoi, Waiokamio, Opelu	10-50
Kauaula, Waikapū, Nua`ailua, Ohia, Wailuanui, Kawaipapa, Opelu	Up to 10

Hawai`i Stream Assessment, A Preliminary Appraisal of Hawai`i's Stream Resources, 1992, Report R84, Table 32. Streams and acreages from Declaration of Water Use certification database, 1989 and adjusted and augmented by the Cultural Resource Committee for the report.

Pre-Contact Agriculture

Prediction of the suitability of lands for sustained intensive agriculture pre-contact can be useful to project opportunities for future wet and dryland agriculture. Community members have pointed to pre-contact settlement as an indicator of locations that can support increased population in harmony with local resources, as well as a predictor of future agricultural opportunities.

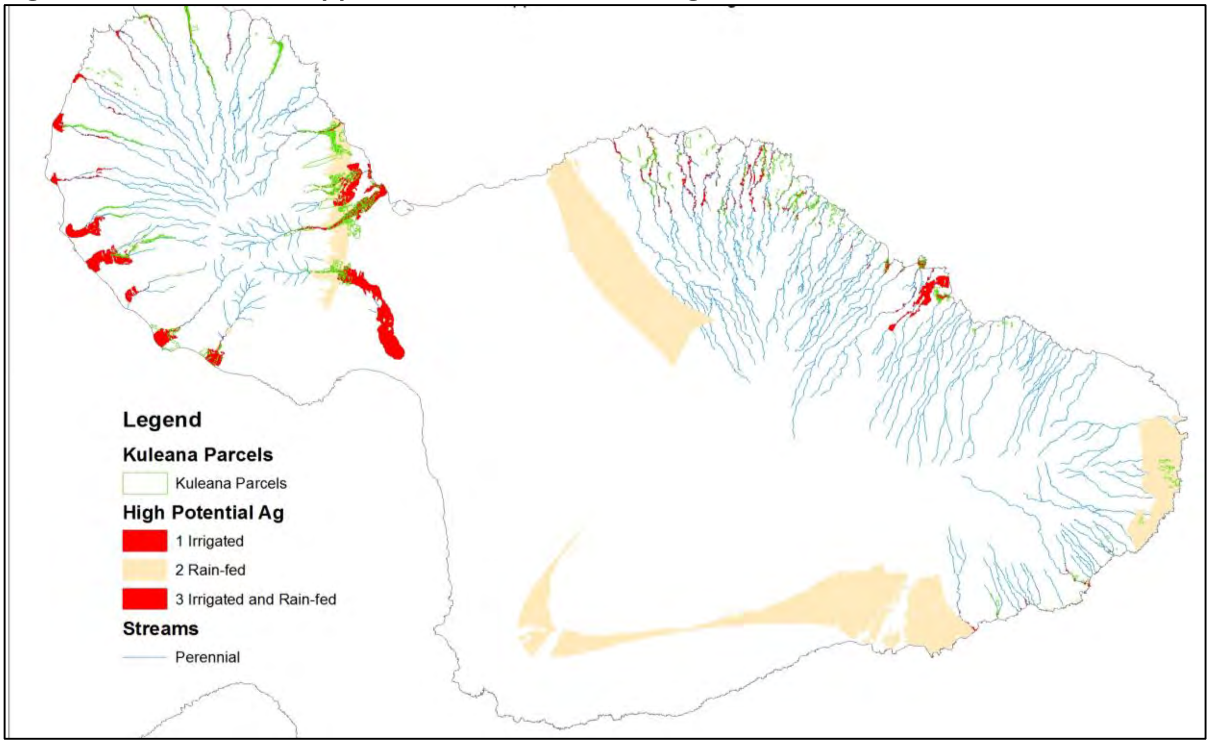
A 2009 study developed models for irrigated and rain-fed systems based on the environmental requirements of the primary crops and the previous archaeological research. The irrigated pondfield model is based on five major variables: water source, elevation, slope, gravitational flow, and geomorphology. The primary source of water for pondfields is continuous perennial streams, although springs and groundwater or stream re-emergence near the coast also supplied water. The GIS model included streams with at least 1 km in length above the 1500 mm rainfall isohyet, considered the minimum to supply a stream with sufficient streamflow to provide a reliable water source to potential pondfields and whether a stream extended to the 3000 mm isohyet, and assumed that the appropriate streams and stream segments could distribute water to areas extending up to 500 m from the stream. The rain-fed agriculture model is based on GIS-derived rainfall and elevation, as well as proxy measures of soil fertility. Predictions for Maui, assuming that all suitable areas cultivated at the end of the pre-contact era, are shown below and on the map (not all acreage is visible at the map scale).

Table 9-20 Predicted acreage of wetland and rain-fed field systems, Pre-Contact Maui Island (acres)

High potential for irrigated agriculture	High potential for rain-fed agriculture	High potential for irrigated and rain-fed agriculture	Total agriculture area
6,360.5	34,436.6	605.4	41,513.7

Ladefoged, T.N., et al., Opportunities and constraints for intensive agriculture in the Hawaiian archipelago prior to European contact, p 8.

Figure 9–12 Predicted Opportunities for Intensive Agriculture in Pre-contact Era



The Nature Conservancy, GIS data, Opportunities and constraints for intensive agriculture in the Hawaiian archipelago prior to European contact

Some of the areas of predicted opportunities for intensive agriculture areas in the Lahaina region are currently developed or within the Urban Growth Boundary. Although difficult to discern at the map scale above, kuleana parcels are often located upstream of the predicted opportunities for intensive agriculture. Two agricultural use scenarios for kuleana parcels by watershed scenarios were developed as shown in Appendix 8. Scenario 1 assumes that 25 or 50 percent of the total acreage of kuleana parcels by watershed would be cultivated for diversified agriculture. Scenario 2 assumes 25 or 50 percent of acreage cultivated for wetland taro calculating consumptive and streamflow needs. The table in Appendix 8 is summarized as follows.

Table 9-21 Scenarios: Potential Cultivation of Kuleana Parcels

Scenario	Standard (gpd/ac)	25% of acres cultivated (mgd)	50% of acres cultivated (mgd)
1: Diversified Ag	3,400	2.8	5.6
2: Wetland Taro - Consumptive Use	15,000-40,000	12.4 - 32.9	24.7 - 65.9
2: Wetland Taro - Streamflow	100,000 - 300,000	82.3 - 247.0	164.7 - 494.0

Kuleana Parcels: OHA data, 2009. MDWS: Calculations.

The results provide a range of potential with the lower end thought to be most realistic in terms of actual land use and availability of water. It is noted that calculating percentage on acreage by watershed overestimates water use compared to calculations on a per parcel basis.

Nā Wai `Ehā

Before the 1980s, delivery of water to most kuleana systems occurred only when water was delivered by Wailuku Water Company (WWC) for agricultural operations through the ditches and reservoirs to which the kuleana systems were connected; in the 1980's WWC replaced the ditches with pipes. There were 17 kuleana (or possibly) 18) ditch/pipe systems identified at the Nā Wai `Ehā Contested Case Hearing; 14 systems are connected to one of the primary distribution systems, and three divert water directly from a stream. In 2005 and 2006, 6.84 mgd was delivered to kuleana system users of Waihe'e, Waiehu, `Īao and Waikapū Streams. Nearly 50 persons testified at the Contested Case Hearing, involving approximately 135 acres, mostly comprised of small parcels, of which about 45 acres were or were intended to be cultivated, primarily in wetland kalo; but also for vegetables, trees, and plants for subsistence and cultural purposes. Persons who were receiving water testified that the amounts currently delivered were insufficient, especially for the purposes of lo`i kalo cultivation, and nearly all desired to increase their land under cultivation. Most of those not receiving water intended to resume or start cultivation of a portion of their lands. The number of future "kuleana" users beyond those identified at the Contested Case Hearing is unknown. The CWRM concluded that much of the water reported by WWC as being delivered to the kuleana lands is being lost between WWC's source and the kuleana ditches/pipes.

In setting the IIFS for Nā Wai `Ehā streams on June 10, 2010, the CWRM concluded that current kuleana lands receive more than 130,000 to 150,000 gad per acre for their kalo lo`i translating to about 260,000 to 300,000 gad when adjusted for the 50 percent of time that no water is needed to flow into the lo`i. These amounts would be sufficient for proper kalo cultivation and even meet *Reppun's* estimate of sufficient flow. Most of this water will flow through the lo`i and into other lo`i or back into the stream and will be available for other uses such as for downstream lo`i complexes and other agricultural uses, or for increased stream flow for improved stream animal habitat. Based on a reasonable consumptive use of 15,000 to 40,000 gad, the net consumptive use by the kalo lo`i would be on the order of 0.68 mgd to 1.71 mgd, with 1.71 mgd more than sufficient for kuleana landowners' kalo, domestic and other agricultural uses.

Table 9-22 Deliveries to Kuleana Systems and Consumptive Use, Nā Wai `Ehā 2006 (mgd)

Stream Source	**Delivery Amount**	**Current/Future Consumptive Use – Allowable Diversions**
Waihe'e*	5.42 (4.99 + 0.43)	All streams – 1.75 kuleana (Waihe'e – 2 Maui Coastal Land Trust; potential underlying basal aquifer alternative = 0)
North Waiehu	0.16	
South Waiehu*	0.25	
`Īao	0.13	
Waikapū	0.84	
`Īao /Waihe'e	0.04	
Total*	**6.84**	**1.71**

CWRM 2010 CCH-MA0601-02, Table 2, page 203.

*WWC stated 6.16 mgd delivered; Hui/MTF stated there is an additional 0.43 mgd sourced from Waihe'e Stream; HC&S stated South Waiehu Stream supplied an additional 0.25 mgd.
** 1.71 mgd plus 1.5-2.5 mgd (2 mgd average) for MCLT. Practical alternative for MCLT is underlying basal aquifer.

Because Nā Wai `Ehā kuleana users testified that their water deliveries were inadequate, and together with observations of numerous leakages from the ditches, the CWRM concluded that much of the water reported by WWC as being delivered to the kuleana lands is being lost between WWC's source and the kuleana ditches/pipes. Currently, kuleana users served by WWC's system are responsible for maintaining their kuleana system ditches and pipes which produces inconsistent results within different user-maintained systems. Water for lo`i kalo is a non-instream use and must show a lack of practicable mitigating measures for losses. While water must be provided for consumptive lo`i kalo use and flow-through for wetland kalo, there will be large amounts or waste if outflows are not returned downstream of the diversions, as well as disruption of stream flows and possible dewatering in the stretches between the diversion and return points. Even if access to stream water through an 'auwai is part of the customary Hawaiian practice of growing kalo on kuleana lands if practicable measures are available to prevent or minimize waste of the surface water resource, they should be utilized.[115] Thus, in order to prevent or minimize waste, kuleana ditches should be lined or enclosed pipes used in their place, absent a showing that it is unnecessary to prevent waste, or that it is not practical to do so.[116]

In a 2014 mediated agreement, restoring additional stream flow to Wailuku River and Waihe`e Stream was concluded to represent a reasonable and equitable resolution and balance between protecting instream uses and Native Hawaiian practices and accommodating reasonable and beneficial non instream uses, consistent with the public trust.[117] The contested case was subsequently reopened to address the cessation of sugarcane cultivation and change in irrigation demand as an offstream use. The hearing officer's proposed decision of the reopened case in November 2017 has yet to be adopted by CWRM and is discussed in the Wailuku Aquifer Sector Report.

East Maui Streams

The CWRM's May 25, 2010 Commission Order in re the East Maui Streams Contested Case identified the acreage of taro for each stream through the undocumented declarations of registered diverters, as a total of 1,006 acres plus water for domestic needs, but did not attempt to evaluate these claims nor relate these acres to the amount of water added to the streams in the revised IIFS. In amending the IIFS, the estimates of wetland taro and other agricultural requirements, including those that would also qualify for T&C Hawaiian

---

[115] Haw. Rev. Stat. § 1-1, Reppun, 65 Haw. at 539, 656 P.2d at 63
[116] CWRM's Findings of Fact, Conclusions of Law, and Decision and Order in re `Īao Ground Water Management Area High-Level Source Water-Use Permit Applications and Petition to Amend Interim Instream Flow Standards Nā Wai `Ehā Contested Case Hearing, June 10, 2010 (CCH-MAO6-O1).
http://files.hawaii.gov/dlnr/cwrm/cch/cchma1301/CCHMA1301-20160115-HO-D&O.pdf
[117] http://files.hawaii.gov/dlnr/cwrm/cch/cchma0601/CCHMA0601-2-CWRM.pdf

rights, were based on a subset of acreage that Na Moku claimed for appurtenant and riparian rights and demonstrated as suffering actual harm to their owners' reasonable use. In total, the acreage claimed by Na Moku as being either in taro or cultivable agriculture was 136.18 acres for Honopou, Palauhulu, Waiokamilo, and Wailuanui Streams, although Na Moku's expert witness conceded that these acreages are overstated by an unknown amount for taro cultivation and cultivable agriculture.

The CWRM used a water budget for taro of 130,000 to 150,000 gad which translates to an average of 260,000 to 300,000 gad during the time that water is needed to flow into the lo`i to maintain temperatures to prevent rot. Most of this water will flow through the lo`i, and into other lo`i or back into the stream where it will be available for other uses.[118]

Table 9-23 Water Requirements for Taro and Other Agriculture

Area	Stream	Taro Lo'i (acres)	Other Ag (acres)	Taro Lo'i Water Requirements (mgd)	Other Ag Water Requirements (gpd)
Ke`anae	Palauhulu	13.475	7.00	1.75 - 2.02	25,714- 28,571
Wailua	Waiokamilo & Wailuanui	30.160	28.096	3.92- 4.52	13,880 to 16,728
Honopou	Honopou	6.170	9.820	0.80 - 0.93	13,880 to 16,728
Hanehoi	Hanehoi & Puolua	2.300	?	0.30 - 0.35	
Makapipi	Makapipi	4.170	3.250	0.54 - 0.63	16,680 to 19,246
Total		**56.275**	**48.166**		

Taro represents appurtenant rights and other ag represents riparian rights. The water requirement for "other agriculture" was based on 10% of taro demand. http://files.hawaii.gov/dlnr/cwrm/cch/cchma1301/CCHMA1301-20160115-HO-D&O.pdf

In June 2018, CWRM adopted IIFS for all streams subject to the contested case. Restoration status and stream flow are discussed in the Central and Ko`olau Aquifer Sector Reports.

West Maui/Lahaina Region

Information about existing and potential lo`i kalo and other agricultural uses on kuleana parcels in the Lahaina region is not readily available. Information from the CWRM reports, 2015 Agricultural Land Use Baseline, 1989 Declarations of Water Use, and other sources were consulted.

The intersection of kuleana parcels and the 2015 Agricultural Baseline indicates that taro and diversified crops cultivated on or partially on kuleana parcels in the Lahaina aquifer sector area totaled about 7.7 acres as shown in the table below. However, given the purpose of the Baseline inventory to capture the scale and diversity of *commercial* agricultural activity in 2015, it is likely that most agriculture on kuleana parcels was not mapped. In the table below, taro is assumed

[118] Ibid.

to be wetland taro based on the proximity of the parcels to streams. The midpoint of the range for consumptive water use for wetland taro is used for Estimated Average Water Use. The low and high figures for consumptive water use and streamflow required for healthy plants are also provided.

Table 9-23a Estimated Water Use by Kuleana Parcels per 2015 Agricultural Baseline (gpd/acre)

Aquifer System	2015 Crop Category	Kuleana Parcels Acreage	Water Standard	Est. Ave. Water Use	Consumptive Use		Streamflow	
					Low 15,000	High 40,000	Low 100,000	High 300,000
Honokōhau	Taro	3.129	27,500	**86,045**	46,934	125,156	312,890	938,670
Launiupoko	Taro	0.191 (0.38*50%)	27,500	**5,253**	2,865	7,640	19,100	57,300
Olowalu	Diversified	4.21 (21.07*20%)	3,400	**14,314**	--	--	--	--

2015 Agricultural Baseline GIS, Kuleana parcels-OHA, 2009. Approx. ag acreages overlying kuleana parcels calculated by MDWS. Water Use Rates: Diversified Ag-HDOA Guidelines; Taro-CWRM Nā Wai `Ehā and East Maui Streams CCH. Due to proximity of parcels to stream, taro is assumed to be wetland taro. Water standard for taro is average consumptive range of 15,000 to 40,000.

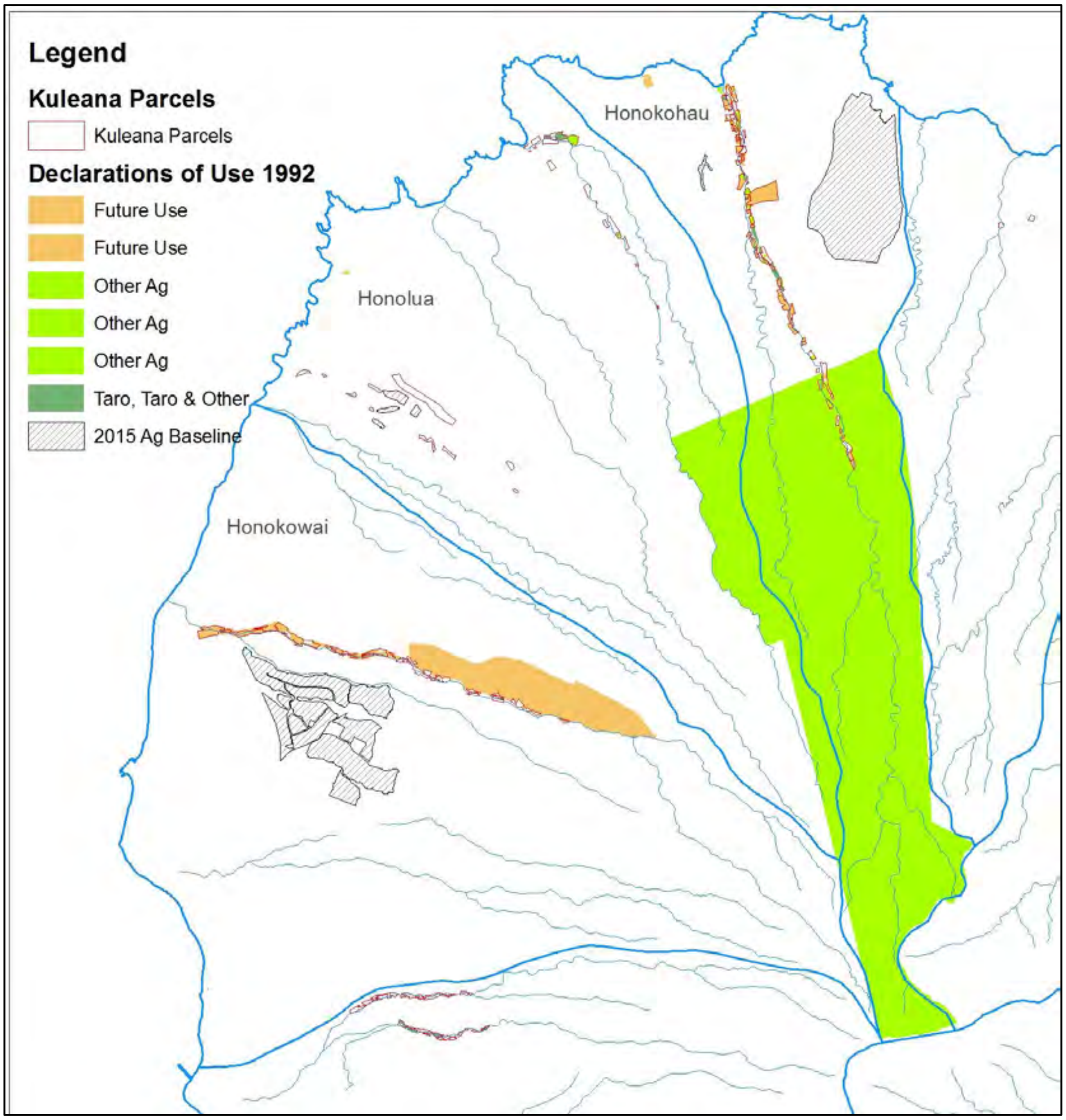
Section 19 provides details of watersheds and streams associated with kuleana parcels, declarations of water use correlated with CWRM diversions, the 2015 Agricultural Baseline, and Predicted Opportunities for Intensive Agriculture in the Pre-contact Era (1- Stream irrigated or 3- Rain and Stream irrigated) described earlier in this section.

The figures below show the relationship of agricultural use stated in the Declarations of Water Use to kuleana parcels. For this analysis, the stated existing uses were categorized as "taro, taro and other," "other agriculture" (excluding grazing), or "future use" including parcels with only rights claims or incomplete information regarding an existing use. Declarations are mapped by TMK, while declaration of use acreages in the table above are those stated in the declarations. Thus, the depictions of Declarations of Use on the following figures are often significantly larger than the acreage stated in the table.

While difficult to see at the scale of the figures below, a significant number of kuleana parcels exhibit a declaration of use for either an existing or future use. The identification of lands where declarants state a rights claim for a future use is provided solely to characterize the locations and scale of potential future uses, recognizing that identification in the plan does not create any legal basis for use or guarantee that a beneficial use will actually occur.

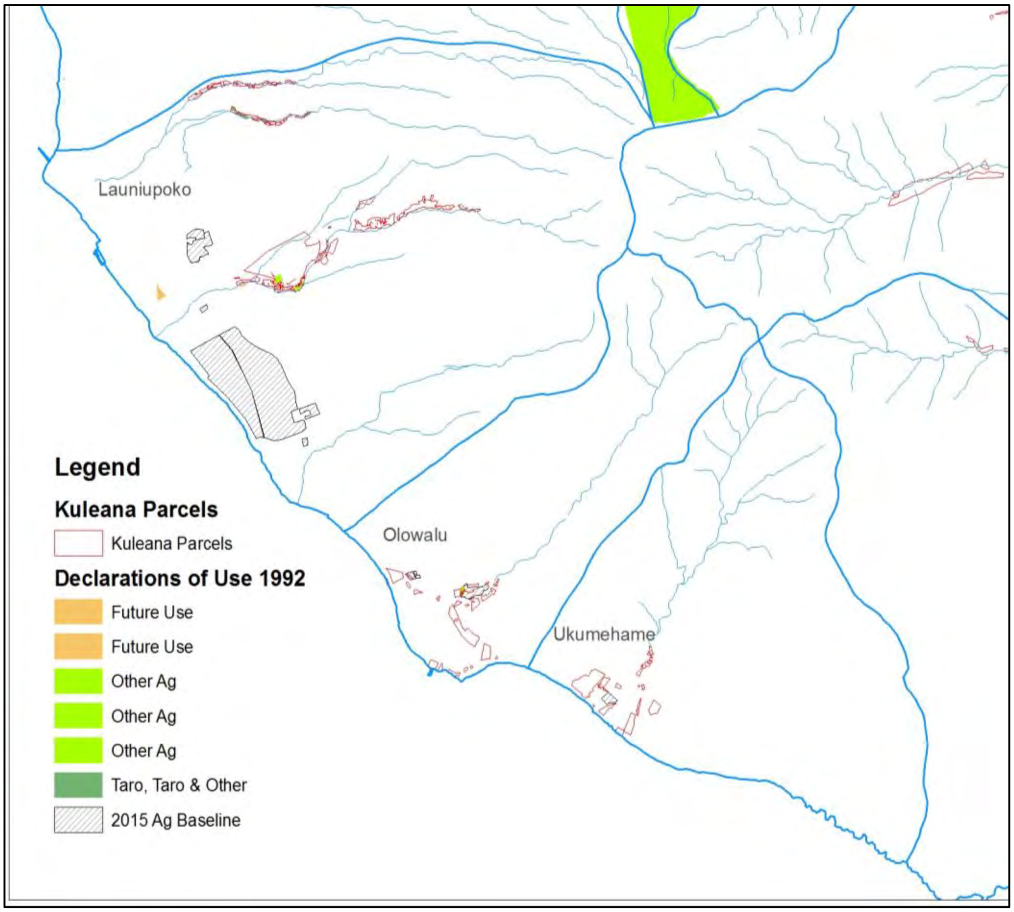
Applying standard water use rates, total demand for land uses in the Declarations of Water Use is close to 0.5 mgd based on the stated assumptions. Given that much of the 2015 Agricultural Baseline inventory is not coterminous with the declarations, the declarations appear to represent an additional increment of agricultural water use.

Figure 9–13a Lahaina Aquifer Systems (Northern) Declarations of Water Use, Kuleana Parcels, and 2015 Ag Baseline



Based on CWRM, Declarations of Water Use, Circular 123, Volumes 1 and 2, September 1992. Information is not verified. Note: Duplication of Future Use and Other Ag in the Legend has no meaning; 2015 Ag Baseline: HDOA

Figure 9–13b Lahaina Aquifer Systems (Southern) Declarations of Water Use, Kuleana Parcels, and 2015 Ag Baseline



Based on CWRM, Declarations of Water Use, Circular 123, Volumes 1 and 2, September 1992. Information is not verified. Note: Duplication of Future Use and Other Ag in the Legend has no meaning; 2015 Ag Baseline: HDOA

Irrigation water for commercial agriculture, excluding kuleana uses, is mainly supplied by surface water conveyed by the Maui Land & Pineapple (ML&P) and Pioneer Mill ditch systems, which is occasionally augmented with groundwater from wells. However, CWRM pumpage reports indicate there was essentially no water pumped by agricultural production wells in 2014.

Surface water diversion data reported to CWRM indicates that on average more than 18 mgd was diverted in recent years from streams in the Lahaina region. It is unknown how much of this water is used for agriculture, and not all diversions are reported. Surface water diverted by ML&P has been primarily used to irrigate small-scale diversified agricultural lots, for raising livestock, as well as for golf courses, domestic water supply, and supporting reforestation efforts. Discounting water used for municipal, landscape irrigation and similar uses, it is estimated that roughly 2 to 4 mgd may be used for agriculture. West Maui Land Co. indicates that about 1 mgd is released back to the streams for "cultural" uses.[119]

[119] Dave Minami, West Maui Land Co, personal communication, 2016.

Table 9-24 Surface Water Diversions (mgd)

Gage	Diversion	Period
19 Launiupoko	0.405	2011-2015
20 Kahoma	0.416	2011-2015
21 Kauaula	2.610	2011-2015, 4 mo no data
22 Olowalu	1.622	2011-2015, 7 mo no data
39 Kapalua Water Irrigation	**1.094*	2011-2013; no data 2014 -15
40 MLP Troon (Golf)	**0.914*	2011-Feb 2014, 3 mo no data
41 MLP Agricultural Irrigation	**0.425*	2011-Feb 2014, 3 mo no data
42 DWS Mahinahina	**1.718*	2011-Feb 2014, 3 mo no data
43 Kā`anapali Development Co.	**5.450*	2011-Feb 2014, 3 mo no data
82 MLP #1 Intake Honokōhau(MDWS Operator)	13.540	Mar 2014-Apr 2015
DWS Kanha Intake (Lahaina Treatment Plant)	1.6216	2011-2015
Total	**20.214**	

CWRM Reports.

*End use accounted for in 6-82: MLP #1. Not double counted in total.

The Statewide 2015 Agricultural Land Use Baseline indicates that coffee crops encompass 535 acres, or 82% of total West Maui cropland, while all other crops comprise only 116.5 acres. Pasture land totals an additional 1096.5 acres. Current water demand based on the stated water use standards in the table below is 2.3 mgd. Based on a hypothetical increase in acreage for the crops in the Crop Summary of one percent annually, agricultural water demand over the next 20 years equates to 2.8 mgd, an increase of less than 0.5 mgd over current estimated demand as shown below. While pasture land is not currently irrigated, it is possible that more intensive use such as for grass-fed livestock would merit irrigation. However due to the speculative nature, such demand is not included in the projection of water use.

Table 9-25 Estimated and Projected Agricultural Water Use, Lahaina Sector (mgd)

Aquifer System	Crop Category	Est. Acreage	Water Standard (gpd)	Est. Ave. Water Use	20% Increase In Water Demand
Honokōhau	Taro	3.13	27500 (15-40K)	0.0860	0.1033
Honokōhau	Diversified	6.41	3400	0.0218	0.0262
Honokōhau	Pasture	630.77	0 (0-7400)	0.0000	0.0000
Honokōhau		640.31		0.1078	0.1294
Honokōwai	Coffee	534.77	2900	1.5508	1.8610
Honolua	Diversified	19.33	3400	0.0657	0.0789
Honolua	Tropical Fruits	4.15	10000 (3700-10K)	0.0415	0.0498
Honolua		23.48		0.1072	0.1287

Aquifer System	Crop Category	Est. Acreage	Water Standard (gpd)	Est. Ave. Water Use	20% Increase In Water Demand
Launiupoko	FFL	13.88	6000 (4000-6000)	0.0833	0.0999
Launiupoko	Diversified	12.04	3400	0.0409	0.0491
Launiupoko	Taro	0.38	27500 (15-40K)	0.0105	0.0126
Launiupoko	Tropical Fruits	30.04	10000 (3700-10K)	0.3004	0.3605
Launiupoko	Pasture	465.72	0 (0-7400)	0.0000	0.0000
Launiupoko		522.07		0.4350	0.5220
Olowalu	Diversified	21.07	3400	0.0717	0.0860
Ukumehame	FFL	7.10	6000 (4000-6000)	0.0420	0.0504
Total		**1748.81**		**2.3154**	**2.7743**

2015 Ag Baseline GIS, acreages calculated by MDWS. It is not specified whether taro is dryland or wetland.
FFL=Flowers, Foliage, Landscape
Water Use Rates: HDOA Guidelines; Est Water Use for taro: average wetland taro consumptive rate.
Coffee: 2004 AWUDP Kaua'i Irrigation System- 2500 gpd; 2900 gpd reported by plantation on Oahu per Brian Kau, HDOA, personal communication 10/12/2016.

DHHL Lands

The State Water Projects Plan, DHHL, May 2017 Final Report indicates that non-potable water demand for agricultural uses for planned DHHL projects is projected at 11.652 mgd by 2031, with an additional demand exceeding 27 mgd in the longer term. Non-potable is proposed to be met by streamflow, rainfall, and the Upcountry and MLP irrigation systems.

Table 9-26 DHHL Potable and Non-potable Demand Projections, Maui Island, 2015 to 2031

Primary Use (mgd)	2015	2016	2021	2026	2031
Non-potable	0	1.87	11.397	11.397	11.652
Other Non-potable (not expected to be developed by 2031)	0	1.87	11.397	11.397	27.557
Grand Total	**0**	**4.083**	**14.112**	**14.853**	**31.078**

State Water Projects Plan, DHHL, May 2017 Final Report, Tables 3.6 and 4.7. Cumulative Average Day Demand (mgd).

HC&S Lands

The HC&S plantation consisted of over 43,000 acres of land, of which 35,000 acres were under cultivation in 2016. With the transition from sugarcane cultivation to alternative crops and uses, there are many uncertainties regarding the future of HC&S acreage, existing plantation irrigation systems and water rights. Legal conflicts are mainly focused on competing interests, including the current high demand for water from all types of users, the establishment of instream flow standards (IFS) and the growing concern over Native Hawaiian water rights.[120] Former HC&S lands are all located within the Central Sector, the majority of land overlying the Pā`ia aquifer. Surface water used for irrigation is imported from the Ko`olau sector. Yield from irrigation wells in Pā`ia and Kahului aquifers are heavily dependent on return flow from the imported surface water land application and reservoir leakage, although the additional recharge has not been quantified.

HC&S's conceptual "Diversified Agricultural Plan", dated March 2016, illustrates a mix of uses throughout the entire plantation envisioned by HC&S as sustainable and economically viable and takes into consideration soil types, rainfall, solar radiation and crop tolerance to brackish water irrigation.[121] The information provided in HC&S's plan is presented as planning Scenario 1 in the table below and compared to alternative possible scenarios that were developed with input from the Maui farming community, consulting the State Department of Agriculture, the Hawai`i Agriculture Research Center and island specific publications. On Maui, 27,294 acres were designated by the State and approved by the voters in 2009 as Important Agricultural Lands (IAL), comprised of lands owned by Alexander & Baldwin predominately in sugarcane.[122] Agricultural experts opine that replacement crops will most likely be confined to IAL lands.

An infinite range and combination of alternative crops is possible. For purposes of assessing potential water demand on HC&S lands, crops are grouped into five main categories: 1) Diversified crops; 2) Irrigated Pasture; 3) Biofuel; 4) Monocrops and 5) Forestry. Except for HC&S' Diversified Agriculture Plan (Alternative 1), no assumptions were made about locations for specific crops within the plantation. However, available acreage was considered for crops restricted by elevation, such as koa forestry, or rainfall. Irrigation needs are estimated based on available standards and studies. HC&S irrigation estimates account for site-specific information such as soils, elevation, ET loss and rainfall. Water demand varies significantly depending on cultivation methods. Water loss through various irrigation systems and other efficiencies are not included in this analysis but addressed under Agricultural Conservation Strategies Section 12.2 and water source adequacy for the Central ASEA Section 15.7.

As a baseline comparison, applying a sugarcane water use rate of 5,555 gpd per acre to 35,000 acres equals 194 mgd. Alternative crops and uses would generally represent a reduction in total water use for the plantation.

<u>Diversified Crops</u>: For planning purposes diversified crops is used here to mean farming a variety of crops, such as various orchards and vegetable crops, rather than a single commodity. Community and grassroots initiatives have advocated more opportunities for organic and regenerative farming and an increase in crops for local consumption, including the Shaka

---

[120] Maui Island Plan

[121] Case No. CCH-MA13-01 Hawaiian Commercial and Sugar Company's Opening Brief Regarding Re-Opened Evidentiary Hearing; Certificate of Service, October 17, 2016

[122] HDOA, 2/29/16. http://hdoa.hawaii.gov/wp-content/uploads/2013/02/IAL-voluntary-summary-e14_rev2-29-16.pdf

Movement, the Organic Farmland Initiative, the report *Malama Aina: A Conversation about Maui's Farming Future* among others. Based on consultation with the agricultural community and DOA, cultivation of diversified crops on 100% of IAL is unrealistic due to labor costs, foreign competition and local market penetration. Irrigation demand varies widely. A range of 2,500 for wetter areas to 5,387 gpd per acre for drier areas is used, which incorporates HC&S irrigation estimates for orchard crops. Average use for diversified crops according to the 2004 Agricultural Water Use and Development Plan is 3,400 gpd per acre.

<u>Pasture</u>: Conversion to irrigated and non-irrigated pastures for grass fed beef is currently being assessed on less than 400 acres. In the planning scenarios below 1000 – 3440 acres of irrigated pasture were considered and non-irrigated pastures in the Hāmākuapoko region of the plantation with more rainfall. Irrigated demand is estimated by HC&S at 1,992 gpd and as high as 2,651 gpd per acre in a study of 5,580 acres in Upcountry Maui.[123]

<u>Biofuel</u>: HC&S's Diversified Agriculture Plan calls for a mix of bioenergy crops that will be rotated over a few seasons. A variety of crops may include annual seed crops, such as soybean, safflower, sunflower and canola, perennial oil bearing trees, such as jatropha, kukui and pongamia; and tropical grasses, such as energy canes, banagrass, sorghum, hemp and new hybridized perennial tropical grasses. Anticipated focus for 3,650 acres that comprise the Waihe'e-Hopoi Fields are on tropical grasses. Exploratory sorghum plantings are currently underway. Crop and harvest trials on different varieties of energy crops and irrigation needs are tested on a 50-acre trial field planned to expand on an additional 500 acres in 2016. Estimated water requirements for tropical grasses, such as energycanes and banagrass were assessed as approximately 80 to 85% of irrigation needs for conventional sugarcane.
A 2011 paper exploring water for biomass-based energy on Maui estimated irrigation needs for jatropha, oil palm and banagrass ranging from 4.9 to 6.5 acre-feet, or 4,372 to 5,799 gpd per acre.[124] (HC&S field studies assess water needs for bioenergy tropical grasses at between 4,776 to 5,064 gpd per acre. The irrigation scenarios for sorghum in the 2013 study used 2,977 gpd per acre. For planning purposes, a range representing low irrigation demand sorghum to high water demanding banagrass is applied.

<u>Monocrops:</u> Monocrops are cultivated crops that do not rotate with other crops, such as the former sugarcane and pineapple plantations. Pineapple, coffee and seed production are the largest monocrops currently grown on Maui. Seed crops are currently grown on 754 acres island wide, a portion within IAL. Seed corn accounts for 95% of seed crop grown in the state. Seed crops are generally not land intensive but grown on plots of 1 to 5 acres at a time surrounded by a buffer zone. Expansion of seed crops would therefore not likely account for significant irrigation demand. Irrigation demands for pineapple and coffee range from 1,350 to 2,900 gpd per acre.

---

[123] Carey W. King, Ph. D., A Systems Approach for Investigating Water, Energy, and Food Scenarios in East -Central Maui. University of Texas at Austin, November 2013.
[124] Grubert, King and Webber, Water for Biomass-based Energy on Maui, Hawai`i, 2011, http://www.academia.edu/1645956/Water_for_Biomass-based_Energy_on_Maui_Hawai`i

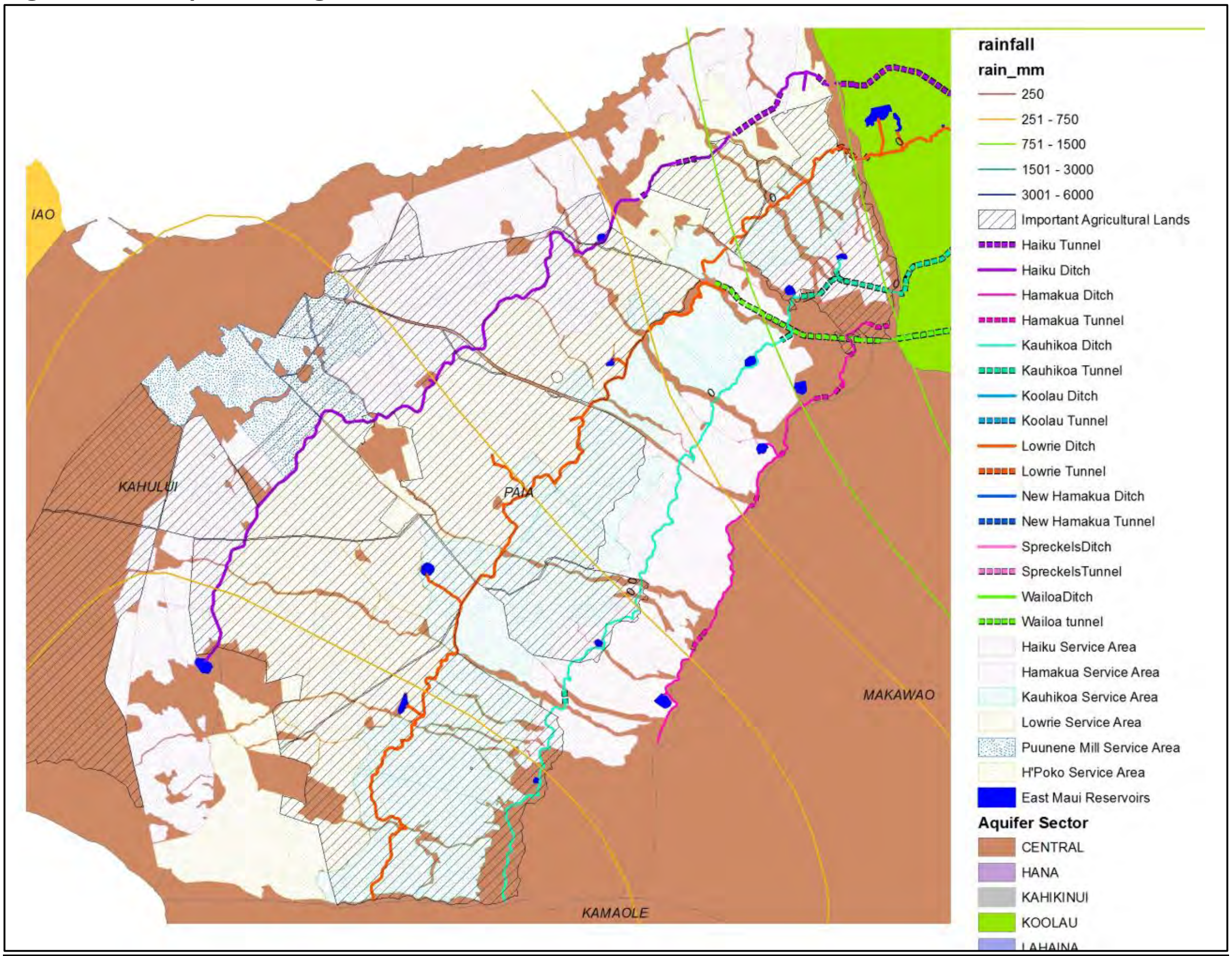
Forestry: Former sugarcane lands have been productive for koa forestry where koa seed stock has been selected for disease resistance and adapted to low-elevation sites from 500 feet. Successful forestation would require ripping to break hard pans and allow roots to penetrate. Water requirements estimated at 4,380 gpd per acre vary widely dependent on natural rainfall and growth. Other high value timber species, including milo, kamani and sandalwood could be considered for commercial plantings as well as windbreaks and habitat.

Table 9-27 Scenarios: Future of A&B Properties Lands

Crop	*SCENARIO 1: 100% of HC&S Lands Farmed, 10 Year Phase-In		SCENARIO 2: 100% of IAL Farmed, 10 Year Phase-In		SCENARIO 3: 50% of IAL Farmed, 10 Year Phase-In		SCENARIO 4: 25% of IAL Farmed, 20 Year Phase-In	
	Acres	**Irrigation Demand MGD**	**Acres**	**Irrigation Demand MGD**	**Acres**	**Irrigation Demand MGD**	**Acres**	**Irrigation Demand MGD**
Diversified Crops	6940	28.6	8,000	20 – 43.09	4,000	10 – 21.55	9,000	22.5 – 48.48
Biofuel	14,770	62.08	12,000	35.7 – 60.77	6,000	17.86 – 30.38		
Grazing	8540	17.07	4,000	7.9 – 10.60	2,000	3.98 – 5.3		
Monocrops			3,000	4.05 – 8.7	1,500	2.02 – 4.35		
Koa Forestry			294	1.28	294	1.28		
Fallow/ non-irrigated cover crops	4,650	0	7,606	0	21,106	0	25,900	
Total Plantation	**34,900**	**107.79**	**34,900**	**69.03 – 124.45**	**34,900**	**35.16 – 62.87**	**34,900**	**22.5 – 48.48**

*Scenario 1 is based on HC&S's conceptual "Diversified Agricultural Plan" dated March 2016.
IAL lands total 27,294 acres of A&B's 36,000 acre plantation

Figure 9-14 Important Agricultural Lands, Ditches, Service Areas, and Rainfall for HC&S Lands



Kula Agricultural Park

There are nearly 1,500 acres of diversified agriculture production in the Kula area. The largest and most consistently farmed is the Kula Agricultural Park managed by Maui County Office of Economic Development. The Park consists of 31 farm lots ranging from 10 to 30 acres for a total of 445 acres supporting 26 farmers. Crops being grown include vegetables, turf grass, landscape nursery products, flowers, bananas, and dryland taro.[125] Non-potable water is pumped from HC&S reservoirs to the Ag Park via the Upcountry Maui Irrigation System which supplies no potable water which bypasses the treated municipal supply with a parallel pipeline operated by the MDWS under agreements with EMI and County of Maui. An expansion of 373 acres is in progress, with 71 acres currently being farmed. There is 600,706.22 gpd from A&B Reservoir 40 available for the additional 302 acres of unused acreage under the Kula Agriculture Park Water Reservoir Agreement dated December 30, 2002. Water delivery infrastructure

[125] Maui County OED. http://www.co.maui.hi.us/621/Kula-Agricultural-Park accessed 8/31/16

funding will be sought from state and federal sources.[126] Because surface water sources are susceptible to droughts, additional storage capacity or alternate supplemental sources (recycled or storm water reuse), as well as the adequacy of the system's reservoir capacity especially along its downstream end, should be further studied.[127] Farming Upcountry outside the Kula Agriculture Park generally uses municipal potable water supply for all irrigation needs.

Given uncertainty over future agricultural scenarios it is probable that agricultural land use and water demand on Maui will decrease significantly as HC&S cease production and then increase slowly over the planning period as land is converted to a diversified model. Crops that have historically relied on affordable untreated surface water are becoming subject to the U.S. Food and Drug Administration (FDA) Food Safety Modernization Act's more stringent requirements for water quality. Depending on crop, an increased amount of diversified agriculture will likely require treated surface water or groundwater as part of production, with the assumption that the most affordable untreated surface water through plantation irrigation systems may no longer be relied upon as the primary source. Meanwhile, the potable municipal systems will unlikely have the capacity to serve agricultural demands island wide. Although the cessation of sugarcane cultivation is anticipated to free up surface water for more diverse agricultural demands, alternative and appropriate resource use needs to be further assessed.

9.4 Population Growth Based Demand - Drought Scenario

Water purveyors plan for seasonal water fluctuations, and in years when precipitation is lower than typical or supply issues occur, voluntary measures and regulatory controls can be implemented to reduce demand. Comparisons of seasonal and annual patterns provide an indication of these fluctuations. For the MDWS system, the highest month of production over the 10-year period 2002 to 2014 exceeded the 10-year average by about 22 percent. The Upcountry district exhibited the greatest variation, but all districts showed significant variation in high month versus 10-year average ground and surface water use. The highest average annual demand exceeded average annual demand for the same period by about 6 percent. Reliable peak month demand is not available for a comparable period. In all cases figures were not adjusted for climate or population variations. Peak demands typically represent increased outdoor use, most notably such as landscape irrigation, as well swimming pool evaporation and similar uses. Rather than projecting increased demand for drought conditions, such as applying a 20 percent drought increase, annual and seasonal fluctuations represent the range of conditions that should be mitigated through water resource and system management and operational measures, controls on water use, community education, strengthened partnerships, etc.

[126] Maui County Office of Economic Development presentation, Maui County Council Budget and Finance Committee, November 3, 2015.
[127] State AWUDO, 2004.

Drought mitigation on the supply side include diversifying sources to increase groundwater contingency to back up surface water, increase reliability through system connections and purveyor agreements.
On the demand side, efforts to reduce per capita demand by 8 percent over the planning period would have a significant effect on water demand.

Table 9-28 Water Conserved with 8% Reduction in Per Capita Water Use Rate, Public Water Systems (mgd)

Criteria	2015	2020	2025	2030	2035
Per capita rate target	240	237	232	226	221
Maui Island population	157,087	169,539	182,135	194,630	206,884
PWS demand	37.78	41.95	46.27	50.84	55.15
PWS demand, reduced per capita rate	37.78	40.18	42.25	43.96	45.70
PWS water conserved	0.00	1.77	4.13	6.96	9.57

MDWS. Cal Yr. Per capita rate incrementally reduced over 20 years.

Agricultural crops may exhibit increased ground and surface water demand during drought conditions. Long-term, it is likely that agriculturalists may modify crop types, irrigation methods and other factors to cost-effectively conform water demands and supply.

9.5 Population Growth Based Demand – Climate Change Scenario

For the purposes of this WUPD update the drought scenario provides the population based demand climate change scenario. Water demand may increase in some areas in response to increased temperatures, declining precipitation, and related conditions. Over a 20-year time frame, demand changes due to climate change cannot be reliably predicted. Climate change modeling for the next 20 years is uncertain while longer term models predict decreased precipitation and corresponding recharge in already dry regions. Because population centers and planned growth are focused to these regions over the 20 year planning period, it is prudent to anticipate and plan for demand adjustments and infrastructure needs now.

Supply side measures to address climate change and especially demand increases due to long term droughts are addressed under Strategies. Basic measures include diversifying supply, aggressive conservation efforts, watershed protection and augmentation and conducting vulnerability assessments to identify short and long term priority actions to address impacts on source and infrastructure.

PART II
WATER RESOURCE ADEQUACY, ISLAND WIDE STRATEGIES AND RECOMMENDATIONS

10.0 OVERVIEW

The Water Use and Development Plan (WUDP) must include regional water development plans, based on hydrologic units. At the same time the plan must also integrate the regional plans as water resources are shared between communities and hydrologic units. Issues and uncertainties relating to water resources and supply, such as climate change and water quality apply to all the island's water resources. Therefore, water supply sustainability is addressed for the island as a whole. Finally, strategies to meet identified planning objectives also apply island wide in many cases, including conservation, watershed and drought management and priority allocations for public trust purposes. These broad strategies are provided for here in Part II of the Maui Island WUDP. Strategies to meet region specific issues and objectives are addressed and refined in the respective regional plan for each of the six Aquifer Sector Areas in Part III.

10.1 RELATION TO MANAGEMENT FRAMEWORK

The following chapters present and discuss resource options and strategies that were considered in developing the WUDP and addressed in the public process, which commenced in 2004. Proposed strategies are broadly defined as any measure, program, policy or improvement that 1. Address identified issues and concerns, 2. Meet one or several established planning objectives and 3. Reflect the values and guiding principles distilled during the community outreach process. Following the Statewide Framework for preparing the WUDP, the planning objectives form the basis of the alternative resource strategies in this section. Planning objectives derived through the public process were compared to the goals, objectives and policies established in the General Plan, Maui Island Plan and Community Plans to ensure consistency and identify any conflicts.

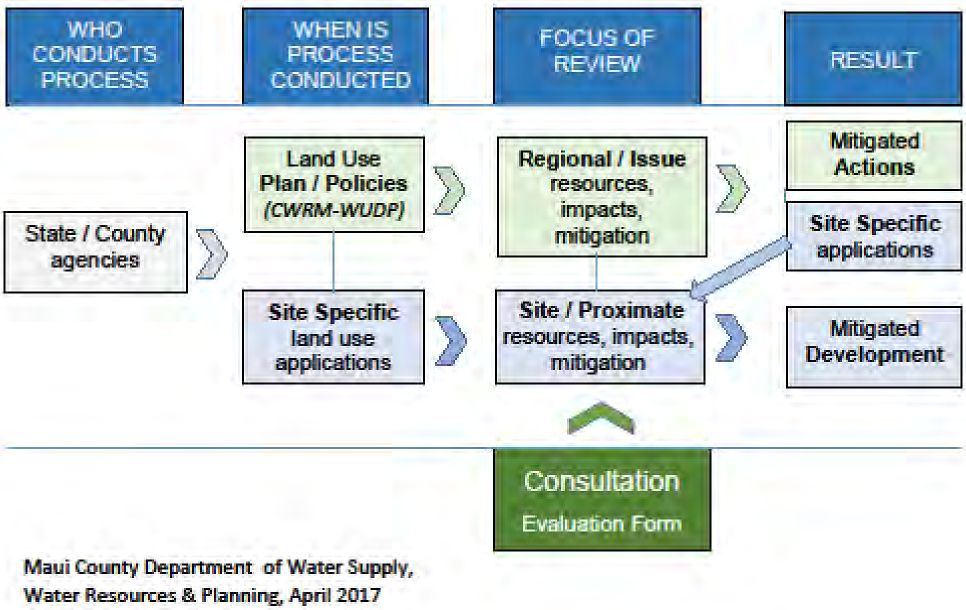
The tenets that guide development of the strategies and that should continue to permeate implementation of this plan can be summarized as follows:

- Ecologically holistic and sustainable
- Based on ahupua`a management principles
- Legal, science and community-based
- Action-oriented

10.2 KA PA`AKAI ANALYSIS

In order to identify and protect Native Hawaiian cultural, historical and natural resources and help ensure Native Hawaiian customary and traditional rights, a Ka Pa`akai analysis and consultation process has been conducted as directed by the Hawai`i Supreme Court ruling in *Ka Pa`akai O Ka `Aina v. Land Use Commission* (2000), which provided an analytical framework "to effectuate the State's obligation to protect Native Hawaiian customary and traditional practices while reasonably accommodating competing private [property] interests."[1] While a Ka Pa`akai analysis is generally performed for a site specific development project, it should also be applied at the planning stage if there are policies or strategies that may affect traditional and customary rights (e.g. water transfers) or if there are location-specific development proposals (e.g. new well construction, diversions, desalination, etc).

Figure 10-1 Ka Pa`akai Analysis Process Simplified



Preliminary Research

The following sources were consulted in order to gather pertinent Native Hawaiian information, catalog traditional and cultural resources, evaluate the impacts of the WUDP and protect native Hawaiian traditional and customary rights.

Community Meetings and Survey Data Capture: Native Hawaiian comments fielded in WUDP community meetings and surveys, and consultations were recorded or collected, taken into consideration during the WUDP process, and provided online as part of the public record.

OHA Native Hawaiian Databases: Kipuka and Papakilo databases developed by the Office of Hawaiian Affairs were consulted in order to gather pertinent Native Hawaiian information for use in the WUDP, identify traditional and cultural resources, anticipate impacts and protect Native Hawaiian rights.

[1] 94 Hawai`i 31, 7 P3d 1087 (2000)

State Inventory of Historic Places. The consultation notice was sent to the State Historic Preservation Division of DNLR, which maintains the official list of all known cultural and historic properties that have been discovered or recorded through survey work.

Environmental Impact Statements and Environmental Assessments: The list of EIS's and EA's for Maui maintained by the State Office of Environmental Quality Control was reviewed for information relevant to the Ka Pa`akai analysis, focusing on plan level documents as well as topical or locational documents of particular relevance (http://www.health.hawaii.gov/oeqc/).

Kuleana/Appurtenant Water Use: Another method used to identify traditional and cultural resources and anticipate impacts was to evaluate the GIS-based Office of Hawaiian Affairs (OHA) kuleana parcel data, along with the 1989 Declarations of Water Use, Hawai`i Stream Assessment, agricultural land use data, pre-contact settlement patterns, East Maui Streams and Nā Wai `Ehā Contested Case documents, and other data to assess present and potential future kuleana water needs.

Land Commission Awards (LCAs): The presence of LCAs is one indicator of Native Hawaiian activities or presence in the mid-to-later half of the nineteenth century.

Nā Wai `Ehā Contested Case documents, and other data to assess present and potential future kuleana water needs.

Sources: A list of sources consulted as a means of identifying resources, impacts and mitigations are provided in Appendix 9a.

Consultation

An initial consultation list was developed consisting of culturally-relevant individuals, organizations, and government agencies. The Native Hawaiian Organization Notification List, U.S. Department of the Interior, maintained and updated by the Office of Native Hawaiian Relations at https://www.doi.gov/hawaiian/NHOL was also consulted. A consultation packet was distributed to the various culturally-related entities: (1) explaining the process and project; (2) providing a matrix preliminarily analyzing resources, impacts and mitigations associated with preliminary strategies; and (3) providing an Evaluation Form for respondent use if desired requested information for the analysis; and (4) requesting names of any persons MDWS is advised to contact, and persons the respondent reached out to.

The Aha Moku o Maui Advisory Committee was contacted as an organization, its regional members were contacted, and Aha Moku O Maui was contacted as well. A meeting with Maui Aha Moku Advisory Committee was arranged in early 2017. A desired outcome of outreach to the Aha Moku committees was establishing a consultation procedure and to reach out to cultural practitioners. Input was also solicited from the Maui County Historic and Cultural Resources Commission.

Obtaining information on the significant Native Hawaiian traditional and customary rights areas may be difficult because: 1) practitioners may not be willing to share information about their practices because some of these practices are closely held family “secrets”; 2) the proposed strategies and actions in the WUDP are general in nature and not location specific; and 3) the practitioners are unlikely to know the impacts of these strategies on their specific practices. However, in order to mitigate these challenges, the outreach process included the following considerations:[2]

1. The consultation process was designed to place the burden of reaching out to practitioners and vetting Native Hawaiian traditional and customary rights issues and impacts on the County as the preparer of the WUDP. The consultation packet identified organizations contacted, and asked respondents to identify persons the County should contact.

2. Review of the federal Native Hawaiian Organizations' Notification List as a means to contact practitioners.

3. Provision of a matrix of preliminary analysis of potential resources, impacts and mitigations to a wide and diverse group of organizations as a starting point to assist in understanding the potential actions and to assist the process of addressing native Hawaiian traditional and customary rights issues.

4. The County`s outreach included a request for comments, including review of the process and project and consultation packet at a public meeting of County's Historical and Cultural Resources Commission public meetings, which elicited public comment along with Commissioner comments.

Consultation with Maui Aha Moku Advisory Committee

In order to identify traditional and cultural resources, anticipate impacts, and protect native Hawaiian rights, MDWS consulted the Maui Aha Moku Advisory Committee, which possesses knowledge of persons who may be consulted on these issues. The Maui Island Aha Moku (Moku O Pi`ilani) was also consulted and has been actively engaged in the WUDP process. In addition to the official representatives, Maui Aha Moku Advisory Committee and Aha Moku O Maui members were directly contacted.

The role of the Aha Moku Advisory Committee (AMAC) is to proactively advise the State of Hawai`i Department of Land and Natural Resources (DLNR) and its divisions, as well as collaborate with state, county, and federal agencies, and the state legislature on how to affirmatively protect and preserve Native Hawaiian rights, traditional and customary practices, and natural and cultural resources that are protected as part of the public trust.

[2] Adapted from Fukanaga & Associates, Inc., Hawai`i County Water Use an Development Plan Update, Keahou Aquifer System, Phase 2 (Pre-Release Review Draft Report), August 2016, Chapter 2.

The Committee, in its advisory role, reaffirms and shall protect all Native Hawaiian rights, customarily and traditionally exercised for subsistence, cultural and religious purposes. During meetings with the Water Committee of Moku O Pi`ilani and members of Wailuku, Kula, Honua`ula and other moku, strong support was voiced for initiating and implementing a Native Hawaiian consultation process for the WUDP. The recently adopted *Rules of Practice and Procedure* for the AMAC defines "collaborative governance" as a "governing arrangement wherein one or more public agencies such as the DLNR and its divisions, directly engage non-State stakeholders, such as the AMAC and island `aha moku councils, in a collective decision-making process that is *formal*, *consensus-oriented*, and *deliberative* and that aims to make or implement public policy or manage public programs or assets. Collaboration implies two-way communication and influence between agencies and stakeholders. Although ultimate authority lies with the department, stakeholders directly participate in the decision-making process". The rules also sets forth the communication process in advising agencies for those participating in the `aha moku system as well as a form for the island Po`o (representative) to use.

Community Outreach

In order to consult with a balanced and diverse expertise base within Maui`s Native Hawaiian community, the following organizations were contacted requesting their participation in order to gather the Ka Pa`akai analysis information used to catalog traditional and cultural resources, anticipate impacts and protect Native Hawaiian rights. The Native Hawaiian Organization Notification List, U.S. Department of the Interior, maintained and updated by the Office of Native Hawaiian Relations at https://www.doi.gov/hawaiian/NHOL was also consulted.

1. Department of Hawaiian Homelands (DHHL)
2. Office of Hawaiian Affairs (OHA)
3. State of Hawai`i Office of Historic Preservation
4. County of Maui Planning Department
5. County of Maui Historical and Cultural Resources Commission
6. State of Hawai`i Office of Planning
7. State of Hawai`i Commission on Water Resource Management
8. State of Hawai`i Historic Preservation Division
9. Native Hawaiian Legal Corporation
10. Maui Hawaiian Civic Clubs
11. Maui Aha Moku Advisory Committee
12. Aha Moku O Maui
13. Native Hawaiian Organizations Association
14. Earth Justice
15. Hui o Nā Wai `Ehā
16. Coalition to Protect East Maui Water Resources
17. Maui Tomorrow
18. Kamehameha Schools

19. University of Maui Hawaiian Studies Department
20. University of Hawai`i at Mānoa Hawaiian Studies Department
21. Ka Huli Ao Center for Excellence in Native Hawaiian Law at the University of Hawai`i's William S. Richardson School of Law
22. University of Hawai`i Environmental Center
23. Maui Aha Moku Advisory Committee
24. Ka Piko O Ka Na`auao, The Hawaiian Learning Center
    Luana Kawa`a, Kumu Hula & Cultural Specialist
25. Halau Hula Malani O Kapehe
26. Halau Hula Kauluokala
27. Halau Kekuaokala`au`ala`iliahi
28. Halau Na Lei Kaumaka O Uka
29. Hula Alapa`i – Malu Ulu `O Lele
30. Halau Ke`alaokamaile

Ka Pa`akai Analysis

(1) Identification and scope of "valued cultural, historical, or natural resources" in the impacted area, including the extent to which traditional and customary Native Hawaiian rights are exercised in the area.

<u>**Identification and Scope of Resources**</u>

Unfortunately, there is no "standard" source for planning documents, permit applicants or approving agencies to consult regarding valued cultural and historical or natural resources and potential Native Hawaiian traditional and customary practices. Through application of the Ka Pa`akai framework, analysis can be accomplished by gathering enough decision-making information to generate an accurate contextual analysis. Based upon consultations with knowledgeable individuals and organizations (including Native Hawaiian cultural organizations, and community leaders), Kama`āina expert testimony was sought-out to gather information for the WUDP. Through review of existing sources and studies, as well as Kama`āina experts, it appears that cultural practices within the context of the Maui Island WUDP include such broad categories as food, dance, physical practices, health, arts, flora, subsistence and religious practices and gathering places, cultural settings, and festivals and ceremonies.

The pre-contact Native Hawaiian population centers and the ahupua`a land management system were focused on the island's streams and nearshore resources, and contemporary cultural, historical and natural resources and traditional and customary Native Hawaiian rights are similarly focused in those areas. The WUDP encompasses all of Maui Island, and while the residential and commercial land uses and users of water on Maui are clustered within the developed areas; residents, commercial ventures and agriculture exist throughout the island. Ground, surface and alternative water resources and their associated ecosystems, and wells, stream diversions, and other water development systems and conveyances that support existing and future development are located both near and far from the uses they serve. Thus, while pre-contact population centers and cultural practices were focused in certain areas such as streams and nearshore waters, present cultural practices may be affected by distant and varied uses such as agriculture and population centers which transport water from culturally intensive and sensitive areas to those areas with less cultural usage intensity.

Community Meetings and Survey Data Capture

Responses to Consultation Notices: Two responses were received to the distribution of the consultation notice packet. 1) Kaniloa Kamaunu, Water Chair of Aha Moku O' Wailuku, and 2) The Hawai`i State Office of Planning.

OHA Native Hawaiian Databases: The Kipuka database was also examined but did not contain information concerning traditional and customary practices, groundwater uses or other public trust purposes, burials, traditional gathering places or information related to water use. The Kipuka database is not comprehensive and has not been updated since around 2005. This source should be consulted when a location specific implementation measure or activity is proposed. The Papakilo database consists of varied collections of data pertaining to historically and culturally significant places, events, and documents in Hawai`i`s history, including a historic sites database, Māhele awards, and place names.

State Inventory of Historic Places. The State Historic Preservation Division did not provide a response to the consultation notice. This is likely due to the general nature of the project and lack of identification of specific locations at which implementation activities may occur. This source should be consulted when a location specific implementation measure or project is proposed.

Environmental Impact Statements and Environmental Assessments: Environmental Assessments and Environmental Impact Statements filed since 1990, 20 of which were reviewed in greater detail, looking for content related to Native Hawaiian traditional and customary practices and groundwater withdrawal. Most of the cultural issues that were discussed in these documents dealt with archaeological sites or paths through development sites, and only one report addressed the types of strategies proposed in the WUDP, particularly ground and surface water development on traditional and customary practices and habitat concerns.

Land Commission Awards: This source of information was not beneficial due to the general nature of the project and lack of specific locations at which activities may occur. This source should be consulted when a location specific implementation measure or activity is proposed.

(2) The extent to which those resources—including traditional and customary Native Hawaiian rights—will be affected by the proposed actions; and (3) the feasible action, if any, to be taken to reasonably protect Native Hawaiian rights if they are found to exist.

The WUDP provides the comprehensive framework for the development and use of water resources on Maui for all land uses and water users. Identification of the nature and scope of cultural, historic, and natural resources, including traditional and customary rights that may exist, provides the basis for the evaluation of the extent to which these resources may be affected or impaired by the policies, strategies and actions proposed in the WUDP. Some methods and resources used in the identification of resources and practices will also be utilized to identify impacts and potential mitigations upon Native Hawaiian rights. While the WUDP policies, strategies and actions are typically not location specific, the WUDP provides the opportunity to holistically identify, evaluate and mitigate potential impacts at the earliest time possible. It also provides the opportunity to comprehensively address regional or island wide issues, such as watershed, groundwater or streamflow protection, that cannot be effectively addressed at the location specific project level. Therefore, conducting a thorough consultation and review process at this time is important.

WUDP Impacts and Mitigation

Preliminary strategies for the development and use of water resources on Maui have been identified through an assessment of water resources and needs over the next 20 years and community outreach has been incorporated as a tool to identify some of the strategies. A Matrix was prepared briefly assessing and summarizing how each preliminary strategy or measure may relate to protection of valued resources including traditional and customary Native Hawaiian rights, including mitigation measures considered for inclusion in the WUDP to reduce those impacts. The Matrix is attached as Appendix 10.

Future Implementation of WUDP and Ka Pa`akai Analysis

The future implementation of the policies, strategies and actions set forth in the WUDP will generally occur through a wide variety of activities over the 20-year planning period, including capital improvement plans, regulatory changes, development of water sources including alternative resources and water system infrastructure, watershed management and conservation activities, among others. Agencies responsible for protecting traditional and customary Native Hawaiian rights must conduct detailed inquiries into the impacts on those rights to ensure that proposed uses of land and water resources are pursued in a culturally appropriate way. While the WUDP process provides an opportunity to perform a high-level Ka Pa`akai analysis and integrate mitigation into the WUDP, or suggest mitigation to be applied at the implementation or development permit stage; some implementation measures or projects may require a future Ka Pa`akai analysis prior to being carried out. The table below attempts to broadly characterize the types of implementation that may be subject to a future Ka Pa`akai analysis, with the caveat that the table is strictly for informational purposes only and is not to be relied upon in determining whether to conduct a Pa Ka`akai analysis.

The CWRM staff advised the County of the need to include the Ka Pa`akai process as part of the development of the WUDP, and the CWRM staff is evaluating how to integrate the Ka Pa`akai process into its decision-making processes. These points of analysis could be added to CWRM applications for the applicant to address and for staff to vet. CWRM staff has identified the `Aha Moku Advisory Committee within the Department of Land and Natural Resources as a resource for examining traditional and customary rights. The `Aha Moku System includes several tiers from the individual Ahupua`a, which include traditional practitioners within an ahupua`a, to the statewide `Aha Moku Advisory Committee of traditional practitioners with one representative from each island. The potential role of the `Aha Moku in the CWRM process is under discussion.[3]

Table 10-1 Types of Implementation Activities Potentially Subject to Ka Pa`akai Analysis – Illustrative Only

Project Type	Action	Decision Making Agency
Groundwater development or monitoring	Groundwater use permits, well permits, petition to designate groundwater management area	CWRM
Surface water development or monitoring	Surface water use permits, stream channel alteration permits, stream diversion works permits, petitions to amend instream flow standards, petition to designate surface water management area	CWRM
Wastewater recycling, stormwater reuse, catchment, greywater, retention methods-	Discretionary development permits (subdivisions, large projects), capital improvement programs	Maui County Council, Planning Commission, County departments
Water systems- capital improvement programs	Discretionary development permits (subdivisions, large projects), capital improvement programs	Maui County Council, MDWS
Scientific, educational, technical investigations	Relevant permits for investigatory methods (monitoring wells, stream gages, etc.)	CWRM, County
Watershed management activities (fencing, species control, erosion control, etc.)	Funding decisions	County, DNLR
Regulatory changes	County or state code or rule changes	CWRM, County
Projects requiring an environmental impact report or environmental assessment	Various projects, projects in State Management Area	County, CWRM, DNLR

MDWS, WR&P, April 2017. This table is strictly for informational purposes only and is not to be relied upon in determining whether to conduct a Pa Ka`akai analysis.

[3] Adapted from Fukanaga & Associates, Inc., Hawai`i County Water Use and Development Plan Update, Keahou Aquifer System, Phase 2 Pre-Release Review Draft Report, August 2016, Chapter 2.

<u>Maui County Cultural Resources Commission Requested Additions</u>

A May 10, 2017 letter from the Maui County Department of Planning's Cultural Resources Commission requested: 1) A comprehensive list of all kuleana water users should be developed and incorporated…consider consulting with Aha Moku o Maui to see if they have a list available; 2) Incorporate the three different definitions of kuleana water users (allodial, purchase, and registered); 3) provide definitions for terms used throughout the plan, such as "cultural practitioner," "Hawaiian" and "Native Hawaiian"; 4) incorporate information about the seven realms of ahupua`a-based land management; 5) differentiate between `auwai and diversion ditch kuleana water users; and 6) provide information on the status of the evaluation forms that were sent out by the Department of Water Supply with the Ka Pa`akai Consultation request.

<u>Aha Moku Definitions of "Realms"</u>
Resource "realms" refer to the areas ancient 'aha councils considered when making decisions. One way the concepts of realms will be incorporated will be when discussing DWS strategies' possible impacts upon Native Hawaiian cultural practitioner access and mitigation strategies. The "realms" will be considered when considering access mitigations for Native Hawaiian cultural practitioners. However, due to time constraints and resource limitations, the "realms" paradigm may not be thoroughly integrated into the WUDP analysis: nevertheless, a summary explanation and definitions of the "realms" is incorporated as follows from the Final Rules of Practice and Procedure Department of Land and Natural Resources `Aha Moku Advisory Committee [Effective October 20, 2016]).

“Ka Lewalani” is a resource realm which encompasses everything above the land, the air, the sky, the clouds, the birds, the rainbows, etc.

“Kahakai Pepeiao” is a resource realm which begins where the high tide is to where the *lepo* (Dirt, earth, ground) starts. This is typically the splash zone where crab, limu, and `opihi may be located; sea cliffs; or a gentle shoreline dotted with a coastal strand of vegetation; sands where turtles and seabirds nest; extensive sand dune environs; and the like.

“Kanaka Hōnua” is a resource realm which includes the natural resources important to sustain people. However, care for these resources are based on their intrinsic value. Management is based on providing for the benefit of the resources themselves, rather than from the perspective of how these resources serve people.

“Ma Uka” is a resource realm which begins from the point where the lepo (soil) starts to the top of the mountain.

“Moana-Nui-Ākea” is a resource realm which is the farthest out to sea or along the ocean`s horizon one could perceive from atop the highest vantage point in one's area.

“Nā Muliwai” is a resource realm which comprises of all the sources of fresh water, ground or artesian water, rivers, streams, springs, including coastal springs that create brackish-water and contribute to healthy and productive estuarine environments.

“Wao Akua” means the sacred, montane cloud forest, core watershed, native plant community that is non-augmented and an area that was traditionally kapu (human access usually forbidden and prohibited).

“Wao Kele” is the saturated forest just below the clouds, the upland rainforest where human access is difficult and rare, and an area that is minimally augmented.

“Wao Nahele” is the remote forest that is highly inconvenient for human access; a primarily native plant community; minimally augmented; and utilized by early Hawaiians as a bird-catching zone.

“Wao Lā`au” is a zone of maximized biodiversity comprised of a highly augmented lowland forest due to integrated agroforestry of food and fuel trees, hardwood trees, construction supplies, medicine and dyes, and lei-making materials.

“Wao Kānaka” is where the early Hawaiians chiefly settled. These were the kula lands, the sloping terrain between the forest and the shore that were highly valued and most accessible to the people. These were the areas where families constructed their hale, cultivated the land, conducted aquaculture, and engaged in recreation. For coastal ahupua`a, Wao Kānaka also extended into the sea to include fishponds and fisheries.

Commonly Used Terms Defined

"Hawaiian": Merriam-Webster's Dictionary defines "Hawaiian" as a native or resident of Hawai`i; *especially* one of Polynesian ancestry.

“Kama`āina expert testimony” means testimony from a Native Hawaiian person who is familiar from childhood with a particular locality. Testimony from kama`āina is recognized as the appropriate method to determine the nature of Hawaiian traditional and customary practices in general, and also specifically in describing the customs exercised in a given area. (50 H. 452, 440 P.2d 76).

"Native Hawaiian”: "Native Hawaiian" is a statutory term that refers to any individual whose ancestors were natives of the area which consists of the Hawaiian Islands prior to 1778.

"Native Hawaiian" versus "Native Hawaiian": Whether the term "Native Hawaiian" uses an upper case "N" or lower case "n" for "native" depends on the context. Use of an upper case "N" is a legal term that strictly refers to any individual whose ancestors were natives of the area which consists of the Hawaiian Islands prior to 1778; while lower-case "n" refers to others that may not be lineal descendants of the 1778 pre-European contact population: for example, Hānai (adopted) Native Hawaiian cultural practitioners who are not related to a pre-1778 Hawaiian descendant, or practitioners who are not pre-1778 Hawaiian descendants, but who are part of a hui (cultural partnership, club, association, or organization). The PASH (Public Access Shoreline Hawai`i) court case leaves the door open for non-Native Hawaiians to participate in exercising Native Hawaiian cultural practices as Native Hawaiian practitioners, but it is likely that one would have to be part of a hui, `oHāna, or a non-Native Hawaiian "Hānai"(adopted) member of a Hawaiian family.

"Native Hawaiian Cultural Practitioner": A Native Hawaiian cultural practitioner is defined as one who practices Native Hawaiian cultural traditions of the natives of the area which consists of the Hawaiian Islands prior to 1778. This definition focuses on cultural practices and does not necessarily require that the practitioner's ancestors were natives of the area which consists of the Hawaiian Islands prior to 1778

Kuleana Parcels

Although kuleana parcels do exist, their accurate quantification can be difficult. Kuleana rights generally refer to water used at the time land title was initially conveyed to and recorded by the title recipient (a process that began in 1845 and theoretically continued until 1895) may rightfully be used in connection with the same land in exactly the same way it was used at the time of title conveyance. Broader interpretations vary in their view of the types of titles and conveyances involved; the types of water uses protected; the types of lands protected; transportability of the water to other lands and uses; and transferability and extinction of the rights. Most of the water covered by these rights was used for wetland taro cultivation. During the period of the privatization of land in Hawai`i (1840--1855), kuleana, usually translated as "native tenant rights," constituted both a right to, and responsibility over, land for Hawaiians. Kuleana rights arose in the mid-1800s and protected the entitlement of Hawaiian tenant farmers and their descendants to, among other things, access landlocked real estate parcels ([*"Ua Koe Ke Kuleana O Na Kanaka" [Reserving The Rights Of Native Tenants: Integrating Kuleana Rights And Land Trust Priorities In Hawai`i],* Harvard Law Review (2005*); Avoiding Trouble in Paradise,* Business Law Today *[December 2008]).*

The many varied definitions for "kuleana" water users include: 1) individuals who are descendants of those awarded land grants in the 1800s, but *are not* officially registered as having water rights with the State of Hawai`i, whose ancestors *were* natives of the area which consists of the Hawaiian Islands prior to 1778; 2) individuals who are descendants of those awarded land grants in the 1800s, but *are not* officially registered as having water rights with the State of Hawai`i, whose ancestors *were not* natives of the area which consists of the Hawaiian Islands prior to 1778; 3) individuals who are descendants of those awarded land grants in the 1800s, but *are* officially registered as having water rights with the State of Hawai`i, whose ancestors *were not* natives of the area which consists of the Hawaiian Islands prior to 1778; 4) individuals who are descendants of those awarded land grants in the 1800s, but *are* officially registered as having water rights with the State of Hawai`i, whose ancestors *were* natives of the area which consists of the Hawaiian Islands prior to 1778; 5) appurtenant rights holders who acquired their land and rights by way of land purchases after the Kuleana Act of

1850, granting allodial titles. The Kuleana Act of 1850, proposed by the King in Privy Council, passed by the Hawai`i legislature, created a system for private land ownership. (*Hawai`i State Archives, DLNR, 2–4. Hoakalei Cultural Foundation. Retrieved 2017-01-28. The Kuleana Act remains the foundation of law pertaining to native tenant right).* Kalo cultivators who do not fall under the above definitions also exist, but they are not "*kuleana*" growers, and they do not have the same rights as *kuleana* growers.

From a legal perspective, "Kuleana" rights are appurtenant water rights to the use of water utilized by parcels of land at the time of their original conversion into fee simple lands i.e., when land allotted by the 1848 Māhele was confirmed to the awardee by the Land Commission and/or when the Royal Patent was issued based on such award, the conveyance of the parcel of land carried with it the appurtenant right to water.

Comprehensive List of all Kuleana

A comprehensive list of all current kuleana users is very difficult to establish because the semantic variations of the definition include many users who are not officially registered with the State of Hawai`i; and families who hold Royal Patents do not necessarily identify with the State system. As appropriate, DWS could request the assistance of the Aha Moku o Maui in order to obtain a comprehensive list of all "kuleana" rights holders. Testimony submitted to the April 4, 2017 Maui Cultural Resources Commission meeting, suggested using the DLNR Aha Moku Maui Advisory Committee State of Hawai`i Aha Moku website to file a complaint with the Moku representative which would trigger the organization's procedures to have a list compiled.

10.3 WATER SUPPLY SUSTAINABILITY

Water Resource Sustainability is a foundation to the assessment and management of the island's water resources, as reflected in the plan's identified values and principles as well as the MIP goals, objectives and policies. Sustainable resources as a key planning objective relates to the use and management of groundwater, surface water as well as alternative water resources, to ensure its long-term health both in terms of quantity and quality. Uncertainties that can affect a sustainable water supply include climate change, current and future land uses that may contaminate water resources, and threats to our native forests that make up our watersheds, such as invasive plant and animal species. Proactive efforts to manage and protect watersheds, streams and aquifers are a prerequisite for further use and development of the island's water resources and are therefore considered resource strategies to meet future demand. Ensuring sustainably used water resources also requires consideration and use of alternative sources of water, such as recycled water, brackish water and storm water where reasonable and practicable. Sustainable water use means applying conservation measures both for existing users and for new developments. Aggressive conservation practices can include efficient irrigation practices, ultra-low-flow water fixtures, on site use of storm water and grey water and other innovative but cost effective measures.

10.4 WATER QUALITY

Generally, ground and surface waters on Maui are of excellent quality. However, legacy pesticides from historic agricultural land uses are still detected in certain aquifers and require expensive treatment to ensure contaminants are within safe levels for drinking water supply. A wide range of activities associated with urban and agricultural land uses pose a risk of contaminating underlying groundwater. Contamination impacts on surface water sources can occur within minutes or hours, depending on the distance from the contamination incident to the distribution point. Of particular concern is runoff from flood conditions, ditch maintenance activities and possible eradication efforts in the watershed.[4]

The State Department of Health Safe Drinking Water Branch (SDWB) primary mission is to safeguard public health by protecting Hawai`i's drinking water sources, including ground and surface waters, from contamination and assure that owners and operators of public water systems provide safe drinking water to the community. The Department administers the Underground Injection Control Program, The Groundwater Protection Program and the Drinking Water State Revolving Fund. The Federal Safe Drinking Water Act apply to all public water systems and sets requirements for drinking water standards, monitoring and reporting, treatment and enforcement.

[4] 2014 Department of Health Water Quality Plan Draft

11.0 WATER RESOURCE ADEQUACY

Comparing available resources to future demand and needs, long-term resource supply must be adequate to meet projected demand while maintaining watershed, stream and aquifer sustainability and replenishment. Resource adequacy means not just having enough water, but adequate quality of water for different types of needs, such as potable and irrigation uses.

11.1 CONVENTIONAL WATER SOURCE AVAILABILITY AND UNCERTAINTIES

Groundwater

Available groundwater is defined on a state level as sustainable yield and further restricted in groundwater management areas by water use permit limits. Except for the designated `Īao groundwater management area, few aquifers on the island are developed to more than a fraction of sustainable yield. As discussed under Chapter 8, groundwater pumpage exceeding sustainable yield in Pā`ia and Kahului aquifers of the Central Sector were a result of surface water import, both which significantly decreased with the cessation of sugarcane cultivation.

Table 11-1 Groundwater Yield and Pumpage

Aquifer Sector	Sustainable Yield	Pumpage (2014 Average)	% of Aquifer Pumped
Wailuku	36	20.761	58%
Lahaina	34	6.207	18%
Central	26	62.724	241%
Ko`olau	175	0.916	1%
Hāna	122	0.606	0%
Kahikinui	34	0	0%
Total	**427**	**91.214**	**21%**

Uncertainties related to groundwater resources include drought, climate change, water quality and water losses.

<u>Drought and Climate Change</u>
A hydrological drought refers to deficiencies in surface and subsurface water supplies, which are reflected in declining surface and groundwater levels when precipitation is deficient over an extended period of time. Source water quality can be affected by sea water intrusion or upconing brackish water.[5] Estimates of groundwater recharge are used to evaluate the availability of freshwater and are used by CWRM in setting sustainable yield. Island wide, mean annual recharge is reduced by about 23 percent under drought conditions compared to average

[5] WRPP, 2014, Drought Planning (Draft)

climate conditions, and is reduced about 19 to 37 percent by aquifer sector.[6] For all aquifer systems, the 2008 sustainable yield adopted by CWRM exceeds recharge under drought conditions; therefore sustainable yield can be used as the baseline for groundwater resources during drought conditions. Significant uncertainties remain in drought forecasting, both in terms of climate change and medium to long-term droughts. Climate change patterns already being seen in Hawai`i are projected to become increasingly serious before the middle of the 21st century, including (a) declining rainfall, (b) reduced stream flow, (c) increasing temperature, and (d) rising sea level. Each poses serious consequences for the replenishment and sustainability of groundwater and surface water resources. These trends are further compounded by potential changes in the trade wind regime, the intensity and frequency of drought and storm events, the El Nino-Southern Oscillation, and the Pacific Decadal Oscillation.[7] Sea level rise and the associated coastal impacts also have the potential to harm infrastructure and environments including low lying coastal roads, water supply and wastewater systems.[8] Water supply faces threats from both rising groundwater and saltwater intrusion in wells, as well as declining quality and quantity due to drought and downward trends in groundwater base flows.[9]

The Pacific Regional Integrated Sciences and Assessments' (Pacific RISA) *Maui Groundwater Project* is an interdisciplinary research effort to inform decisions about the sustainability of groundwater resources on the island of Maui under future climate conditions. A new hydrologic model is being used to assess the impact of changing climate and land cover on groundwater recharge over the island. Once results are available from this study, freshwater availability can be further evaluated and water management decisions adapted in planning for change. Preliminary predictions on future climate projections for Maui island include: 1) temperature increases at all elevations; 2) wet areas get wetter; 3) dry regions are mixed (some wetter, some drier); 4) mean annual rainfall increases (seasonal patterns show May-September drying in Central Maui); 5) Mean annual reference evapotranspiration increases; and 6) little change in cloud-base elevation and trade-wind inversion height.[10]

Acknowledging the limitations, potential reduction in available groundwater sources under drought conditions are assessed. A hypothetical "developable yield" is considered in response to community interests advocating an additional buffer to groundwater development, especially in aquifer systems where confidence ranking is low due to lack of hydrologic data. The hypothetical reduction in yield is based on current modeled reductions in recharge should be used as *guidance for pumpage levels and distribution*, not substituting sustainable yield as established by CWRM. Although impacts associated with climate change cannot be reliably

---

[6] Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai`i, 1978–2007
[7] Water Resources and Climate Change Adaptation in Hawai`i: Adaptive Tools in the Current Law and Policy Framework
[8] Maui County Countywide Policy Plan, p 14
[9] Water Resources and Climate Change Adaptation in Hawai`i: Adaptive Tools in the Current Law and Policy Framework
[10] Participatory Scenario Planning for Climate Change Adaption: Final Land Use Input, Pacific RISA, November, 2014

predicted over a 20-year time frame, vulnerabilities can be addressed through diversification and resource augmentation. Resource augmentation includes watershed protection to ensure healthy watersheds sustain freshwater supplies. Improving water resources to address climate change include reforestation to increase natural recharge and restore disturbed landscapes to original native forest. Diversifying water supplies increase reliability in long-term droughts. Other measures such as groundwater pumpage distribution mitigate anticipated decreased aquifer recharge. Specific strategies are discussed below in Chapter 12.

Table 11-2 Groundwater Availability and Drought Conditions

Aquifer Sector	Sustainable Yield (MGD)	Hypothetical Drought Yield (MGD)	Used (MGD)	Unused (MGD)
CENTRAL	26	19	62.72	36.72
KO`OLAU	175	139	0.92	174.08
LAHAINA	34	26	6.21	27.79
WAILUKU	36	25	20.76	15.24
HĀNA	122	99	0.61	121.39
KAHIKINUI	34	21	0	34
MAUI ISLAND	**427**	**329**	**91.21**	**333**

Water Quality

Most drinking water on the island is derived from the freshwater lens that sits above saline water. The salinity or chloride levels in fresh water are addressed in the establishment of sustainable yield: "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."[11] Chloride levels above 250 mg/L are not considered potable quality and are regulated as a secondary, non-enforceable drinking water standard. Chloride levels must be addressed both in determining appropriate use of groundwater supply and in managing groundwater resources to prevent overdraft and increasing chloride levels over time.

Water quality is also affected by potentially contaminating activities, including agricultural, commercial and industrial land uses. Most contaminants currently detected in Maui wells are derived from legacy pesticides applied decades ago. The Safe Drinking Water Act, amended in 1996, establishes primary drinking water standards, treatment technologies and monitoring schedules. Drinking water rules are reactive to existing contamination but does not protect or prevent future contamination of drinking water sources.   Avoiding contaminated aquifers or factoring in necessary treatment technologies and costs are limiting factors in groundwater development to meet potable needs. Ground and surface water supply must also be actively protected from future contamination on a state and local level to ensure sustainable water quality over time and to ensure consistency with the State Water Quality Plan prepared by the State Department of Health.

[11] State Water Resources Protection Plan, 2008

Water Loss and Other Uncertainties

Water losses due to leaks, seepage, evaporation and other inefficiencies range widely depending on storage and source transmission system age, length, type and many other factors. Water audits, improved irrigation methods and storage can mitigate but not eliminate water losses. To determine resource adequacy, demand factors are increased by 10 - 20% to account for water losses in water supply distribution and storage.

Other constraints on groundwater availability include access and cost. High yield aquifers in East Maui are located in remotely located watersheds in relation to growth areas where conveyance is difficult and transmission expensive. The Upcountry region is largely overlying the Makawao aquifer with relatively untapped yield. Elevations above 1200 feet would entail high pumping costs. To optimize pump distribution in partially developed aquifers, additional transmission to existing infrastructure may be warranted at additional cost.

Surface Water

There are 90 perennial streams on Maui, 82 of which have been diverted to some extent. Surface water supplies a relatively small proportion of drinking water island-wide but is a significant source of supply in West Maui and Upcountry. Absent established in-stream flow standards island wide, best estimates of available flow under various conditions were derived from CWRM contested case documents and stream assessments, from U.S. Geological Survey studies and from data reported by diverters to the CWRM.

Reported diversions of stream flow are often double counted as gages within a ditch measures continued flow from streams diverted along the same ditch. Q_{50}, the median or natural base flow for a particular stream segment during a specified period, can be used to assess potentially available surface water during normal conditions. Base flow is dependent on groundwater discharge while total flow reflects base flow and rainfall runoff. The base flow is a general guideline for the minimal amount of streamflow needed for fish habitat. For perennial streams, the estimated long-term average base flow is 60 to 80 percent and thus 70 percent is used (CWRM Staff Submittal, Steam Diversion Works Permit (SDWP.4175.6) Wailuku River, Maui, August 16, 2016)

Q_{90} flow is commonly used to characterize low-flows and flow exceeded 95 percent of the time Q_{95} represents extreme low-flow conditions. Pending outcomes of the East Maui and the Nā Wai `Ehā contested cases and established IFS, an assessment based on best available data is summarized below. The following limitations should be taken into account:

- Some streams (especially non-perennial streams) are not gaged and not diverted
- Many streams are diverted but not gaged or studied
- Historic diversions indicate higher uses as well as higher stream flow

Table 11-3 Surface Water Availability (MGD)

AQUIFER SECTOR	Median Flow/Q50	Low Q70	Drought Flow/Q90	Potential IFS	2009 – 2015 Average Diverted	1990 and Prior Diverted [a]
WAILUKU	67.83[b]	51.7 b	40.2 [b]	N/A	41-60	107.3
Nā Wai `Ehā (excluding Kahakuloa Stream)	62.66	48.69	37.34	24.5 [c]	41-60	107.3
KO`OLAU	59.7	35.72	20.23	N/A	114-167	169.6
East Maui Streams in Contested Case	44.17	25.17	14.45	16.8 [d]		N/A
LAHAINA	40	31	22.44	N/A	20.21	56.2
CENTRAL	N/A	N/A	N/A	N/A	N/A	N/A
HĀNA	N/A	N/A	N/A	N/A	N/A	0.1
KAHIKINUI	N/A	N/A	N/A	N/A	N/A	0.1
MAUI ISLAND	**169.18**	**119.74**	**84.24**		**175.21 - 247.21**	**333.3**

a) Department of Water Supply, Maui County Water Use and Development Plan, March 1990
b) USGS 2016-5103
c) CCHMA0601-2 CWRM Order Adopting 1) Hearing Officer's Recommendation on the Mediated Agreement Between the Parties; and 2) Stipulation Re Mediator's Report of Joint Proposed Findings of Fact, Conclusions of Law, Decision and Order, April 17, 2014
d) CWRM Decision 6/20/18

As discussed under section 5.6, the availability of surface water is uncertain due to multiple factors, including lack of measured flow data, pending instream flow standards and ongoing contested cases. Other threats to surface water resources are drought and climate change, invasive animal and plant species disrupting native ecosystems.

Drought and Climate Change

Decreasing rainfall, whether as a result of long-term droughts or climate change, has more immediate impacts on surface water flows making surface water vulnerable and generally less reliable over short-terms than groundwater. The Hawai`i Drought Plan, 2005 Update, identifies water supply vulnerability areas, including most of Upcountry Maui. A hydrological drought refers to deficiencies in surface and subsurface water supplies, which are reflected in declining surface and groundwater levels when precipitation is deficient over an extended period of time.[12] For the drought scenario, stream flow-duration discharges that are equaled 95 percent of the time (Q_{95} flow; or Q_{90} if Q_{95} flow not determined) are considered in evaluating surface water availability. Outdoor demand is assumed to increase, especially in agricultural vulnerability areas, but mitigated by continued and more aggressive conservation initiatives such as promoting the use of high-efficiency drip irrigation and drought tolerant crops and landscaping. Proposed demand and supply side conservation strategies for agricultural and non-agricultural uses are provided in Chapter 12.2 below.

[12] WRPP, 2014, Drought Planning (Draft)

Water Quality

Land disturbance and erosion cause sedimentation and turbidity in streams, which indirectly increase filtration treatment costs. Surface water for potable use is subject to the Surface Water Treatment Rule of the SDWA as amended. The primary threats to the watershed as a whole is invasive plant and animal species that outcompete the native ecosystem, potentially impacting recharge and exacerbate erosion. Few streams traverse agricultural and urban areas but ditch conveyance systems above ground from stream intakes can introduce agricultural pesticides and urban chemicals. EPA rules establish required treatment technologies, disinfection and monitoring schedules to address microbial contaminants typically associated with surface water, including Total Coliform *(E.coli) Legionella*, *Cryptosporidium*, and *Giardia lamblia*. The presence of organic matter in surface water adds another challenge in drinking water treatment. Organic materials react with disinfectants to form disinfection byproducts (DBP) in the distribution system. Additional carbon filtration technologies may be warranted in addition to conventional filtration systems. The U.S. EPA promulgated the Disinfection Byproduct Rule to provide more consistent protection from DBPs across the entire distribution system and by focusing on the reduction of DBP peaks.

Water Loss and Other Uncertainties

Water losses from open unlined ditches and raw water reservoirs are generally higher than from groundwater sources. Raw water storage in plantation and municipal reservoirs are subject to state rules established by the State Department of Land and Natural Resources and stricter insurance requirements. The liability and associated costs may impede construction or refurbishment of existing privately owned raw water reservoirs.

Due to the interconnectedness of groundwater and surface water in terms of high level or basal groundwater recharge to streams and stream seepage to groundwater, future development of groundwater sources in certain areas may potentially impact stream flow. The CWRM has jurisdiction over well drilling and any potential impacts on stream flow. However, where hydrologic data is scarce, additional hydrologic studies may be warranted to assess impact of major groundwater developments.

11.2 ALTERNATIVE WATER SOURCE AVAILABILITY AND UNCERTAINTIES

Developing and promoting alternative supplies to ground and surface water furthers diversification of supplies, conserve water resources and hedge against droughts and climate change. Alternative supply are generally not cost efficient per se, but can be important in areas where potable water is not available in sufficient quantities or areas lacking municipal infrastructure.

Recycled Wastewater

The Department of Environmental Management (DEM) administers and operates the county wastewater treatment plants and recycled water distribution system. As urban growth areas are developed in Central, South and West Maui, additional recycled water will become available at the same time as non-potable demand increase. The table below summarizes potentially available recycled capacity based on Verification Studies for the county facilities and current customer services and project improvements. DEM must fulfill obligations to serve projects that are in close proximity to the existing distribution system and will be connecting in the near future. The cumulative peak demand from these projects combined with existing demand cannot exceed recycled water produced. When demand is low, generally in the wet winter months, the excess wastewater must still be disposed of. Full utilization of recycled water production will supplement demand in West and South Maui and mitigate effluent disposal to injection wells. However, planned expansion of distribution from the Wailuku-Kahului facility has by far the greatest potential to offset potable water resources while reducing effluent discharge to injection wells and preserving brackish water resources. Plans for a distribution line build-out to HC&S lands east of Kuihelani Highway could offset irrigation demand on portions of the 1,951 acres of HC&S lands currently slated for "Large Diversified Farm Leases". The Central Maui recycled water distribution system has not been developed to date because the majority of candidate commercial properties currently utilize inexpensive brackish or ditch water.[13]

Table 11-4 Summary of Recycled Water Available Capacity

WWRF	Aquifer Sector	Treatment Level	Design Capacity (MGD)	Recycled Water Produced (MGD)	Recycled Water Sold (MGD)	Cumulative Peak Demand, Current and Committed Projects	Remain Available
Kīhei WWRF	Central	R-1	8	3.65	1.25	2.4	0.77
Lahaina WWRF	Lahaina	R-1/R-2	9	3.84	0.88	1.97	1.86
Mākena WWRF (Private)	Central	R-1	0.75	0.08	0.08	0.08	0
Pukalani WWRF (Private)	Central	R-1	0.285	0.19	0.19	0.19	0
Wailuku-Kahului WWRF	Central/ Wailuku	R-2	7.9	0.25	0.00	0.25	4.2
Haleakalā closed-loop system (and rain water)	Central			0.185		N/A	N/A
Total			26.33	8.19		4.89	6.83

[13] 2010 Central Maui Reycled Water Verification Study

Rainwater Catchment

Catchment systems on island are generally individual households using rain barrels or other devices to collect rainwater from a roof. Rain catchment systems are not regulated by the Department of Health and water quality can be an issue. The DOH Safe Drinking Water Branch publishes guidelines on how to design, construct and maintain home systems safe for domestic use. Scattered use occurs primarily in East Maui where there sufficient rainfall make catchment systems feasible. Impacts from seasonal droughts and climate change are unknown. However, households served solely by catchment systems may require back up sources, such as shared domestic wells.

Determining appropriate system sizing requires an accurate analysis of water demand relative to precipitation patterns.[14] The feasibility of using catchment for domestic use depends on demand, catchment area such as roof area, rainfall patterns and storage capacity. Scenarios presented below include an average demand of 100 and 200 gallons per household per day, or about 3,000 and 6,000 gallons per month. This is compared to the 600 gallon per day (18,000 gallons per month) single-family standard for public water systems which would be adequate for incidental outdoor irrigation. Finally, an agricultural scenario consisting of 0.5 acre of diversified crops is provided. To ensure a year-round water supply for domestic use, the catchment area and storage capacity must be sized to meet water demand through the longest expected interval without rain. In some areas on Maui historic intervals without rain have exceeded three months. Designing for this interval means that storage should meet average quarterly demand, although this approach may result in a more expensive system due to higher storage costs.[15]

Reducing demand along with water hauling could offset lack of supply during dry periods. The scenarios below show how much rainfall would be collected based on catchment area and rainfall, storage required to meet monthly demand, and then the amount required to meet a 90 day demand. Rainfall (low to high) is similar to averages for the Kahului, Pukalani and Haiku areas, respectively. Catchment in areas with higher rainfall continuing eastward of Ha`ikū should increase in viability. Water needs for diversified agriculture provide a rough sense of potential requirements based on the limited assumptions presented, and do not take into account the effects of irregular rainfall, the need for large and reliable volumes of water at the time needed, market conditions, etc.

[14] US EPA. *Rainwater Harvesting- Conservation, Credit, Codes, and Cost Literature Review and Case Studies,* January 2013, pp. 3-4.

[15] Texas Water Development Board. *The Texas Manual on Rainwater Harvesting*. Third Edition 2005, pp. 31-32. Median rainfall is more conservative and provides higher reliability than average rainfall because large rainfall events tend to drive the average value higher.

Table 11-5 Rainwater Catchment Scenarios

Scenarios	Demand (gpd)	Demand (gal/ month)	Catchment Area (sf)	Rainfall (monthly average)	Rainfall Collected	Storage Required (30 day)	Storage Required (90 day)
25 gpd, 4 people	100	3,000	2,500	1.5	1,986	5,000	10,000
25 gpd, 4 people	100	3,000	2,500	4.0	5,296	5,000	10,000
50 gpd, 4 people	200	6,000	2,500	4.0	5,296	10,000	20,000
600 gpd/residential unit	600	18,000	2,500	6.0	7,943	20,000	55,000
Accessory ag, 0.5 acre, 3400 gpa	**1,700**	**51,850**	**10,000**	**6.0**	**31,773**	**60,000**	**160,000**

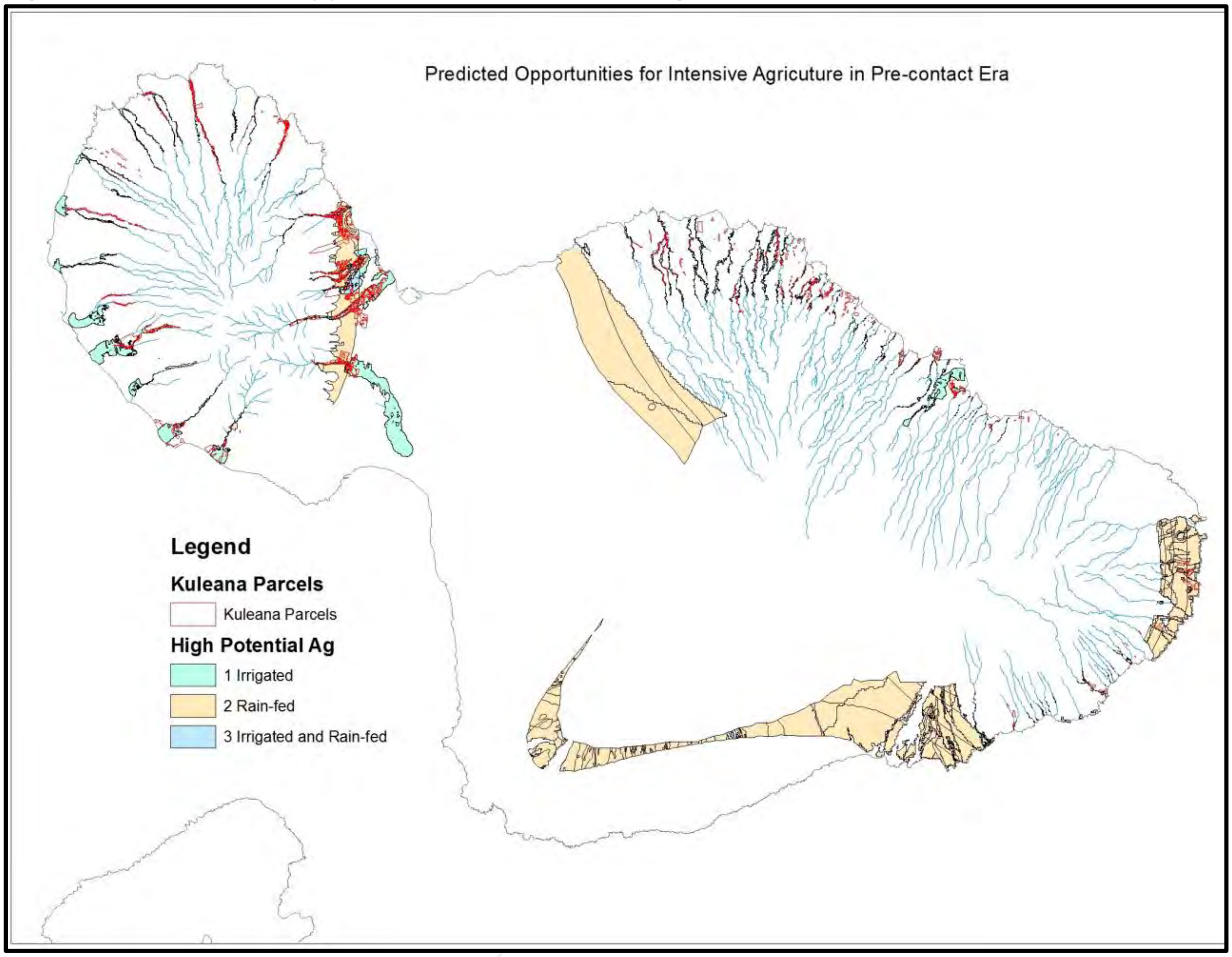
Storage is rounded up to the nearest 5000 gallon volume.
Rainfall (inches) x catchment area x 0.623 gal/sq ft. /in. rain x 85% collection efficiency

Agricultural crops have different requirements for water quality. Support for increased adaptation to natural ambient rainfall and climate adapted crops is consistent with the objective to use appropriate water quality for appropriate uses. To reduce demand for off-stream uses of surface water, rainwater catchment for diversified agriculture could potentially increase. Where ambient rainfall can adequately satisfy agricultural demand during normal rainfall conditions, conventional resource use including surface and groundwater can be used solely as contingency.

Drawing from history, indigenous Hawaiians were highly effective cultivators. A study of the suitability of tropical lands for sustained intensive pre-European contact agriculture modeled the distribution of irrigated taro pondfields and rain-fed dryland systems (largely sweet potato and to a lesser extent dryland taro, yams, banana, sugar cane, and other crops) based on climate, hydrology, topography, substrate age, and soil fertility, and comparison with archaeological evidence. Focusing here on rain-fed dryland systems which are more constrained, annual rainfall for optimum intensive rain-fed sweet potato production was defined in the study as a 30 inches per year, with 20 inches in the growing season being a minimum.[16] (pp. 1-3) For Maui Island, the model predicts four major zones of high potential for rain-fed field systems, and these are verified by other information.[17]

[16] Ladefoged, T.N., et al., *Opportunities and constraints for intensive agriculture in the Hawaiian archipelago prior to European contact*, J. Archaeol. Sci. (2009), doi:10.1016/j.jas.2009.06.030, pp. 1-3.
[17] Ladefoged, T.N., et al., *Opportunities and constraints for intensive agriculture in the Hawaiian archipelago prior to European contact*, J. Archaeol. Sci. (2009), doi:10.1016/j.jas.2009.06.030, pp. 8-9.

Figure 11-1 Predicted Opportunities for Intensive Agriculture in Pre-contact Era



Stormwater Reuse

Development that increases the amount of impervious surface in stormwater catchment areas decreases infiltration and thereby groundwater recharge. Green stormwater infrastructure can remove harmful pollutants in stormwater through filtration, biological uptake and breakdown while retaining stormwater volumes. Stormwater reuse provides for capture and reuse of surface water runoff. Due to contaminants picked up by stormwater runoff, different levels of treatment may be necessary. Stormwater can carry sediment, nitrogen, phosphorus, metals and pesticides that impact streams and near-shore coastal waters. Reliability is an issue as the supply does not match demand. Stormwater is not managed by water utilities but are generally funded through county general funds to ensure regulatory compliance. Regulations primarily address pollutants in stormwater runoff. Maui County Code Title 15 governs the design of storm drainage facilities and best management practices. Low Impact Design techniques that mimic predevelopment hydrology can be included in site design to satisfy water quality for stormwater runoff. However, reuse as the next step in stormwater management is not implemented to a great extent despite its multiple benefits. Four stormwater reclamation opportunities for agricultural irrigation end uses on Maui were appraised in a statewide study: Waiale Road Stormwater Drainage to collect stormwater from an urban area including an large detention pond; Kahoma Stream Flood Control to collect stormwater from a drainage channel; Kahului Flood Control Channel to collect stormwater from drainage channels; and Lahaina Flood Control to collect stormwater from a drainage channel and detention pond. [18] None of the stormwater reclamation projects are currently implemented.

The most effective stormwater management techniques are practiced at the source of runoff. "Clean catchment" is where velocities are the lowest, quantities is the smallest, and quality is the least impaired. The table below presents typical domestic water uses that could potentially be supplied from reclaimed stormwater. [19]

Table 11-6 Stormwater Applications for Domestic Uses

Water Use	Rate	Number of Events*	Total Usage, Gallons/year
Car washing	116 gallons/wash	90 washes	10,440
Lawn watering	180 gallons/application	58 waterings	10,440
Toilet flushing	**4 – 7 gallons/flush****		**6,000 – 10,500**

*Based on Lahaina which represents the lowest rainfall capture potential
**Assuming non-water conserving toilet using 7 gallons per flush

Desalination

Desalination of brackish water is generally more cost-effective and environmentally-friendly than use of sea water. The effects on groundwater resources and chlorides due to anticipated reduced irrigation association with the cessation of sugarcane production are issues. Salinity would slowly increase with time if recharge from surface water irrigation ceases. A reasonable estimate for the isthmus for planning purposes is less than 100% (from current average of about 400-500 mg/l to 800-1000 mg/ chloride) over a time period of 5 to 10 years. The most critical recovery-limiting constituents are silica, calcium and barium, pH, alkalinity and temperature. A broad range of other constituents affect processing. Trace amounts of pesticides have been found in some irrigation wells in the Kahului Aquifer and brackish wells may contain the same pesticides that would potentially require activated carbon filtration and add to treatment costs.

Treatment technologies for both brackish and sea water desalination were evaluated for Central and South Maui. Feasibility of a disposal option depends on many factors including

[18] U.S. Department of the Interior, Bureau of Reclamation: An Appraisal of Stormwater Reclamation and Reuse Opportunities in Hawai`i, 2008
[19] Commission On Water Resource Management, A Handbook for Stormwater Reclamation and Reuse Best Management Practices in Hawai`i, December 2008

climate, land availability, hydrogeology, regulations, public perception, and other. The primary environmental concern is impacting waters suitable for use as potable source water, and wastewater disposal injection wells are continuously an issue on Maui. The central Maui area where possible desalination plant sites are located fall within this area where the underlying aquifer is not considered a drinking water source. Drilling the wells deep enough should avoid challenges with future more stringent regulations for injection wells.

If seawater desalination were used, deep well intake sites for sea water desalination are preferred over coastal subsurface and surface ocean intake alternatives, with conveyance of the concentrate (brine) to an ocean outfall system. However, the high salinity (71,000 mg/L) of the brine raises environmental concerns with the effect of salinity on marine organisms.

11.3 LAND USE-BASED FULL BUILD-OUT DEMAND PROJECTIONS

Water resource adequacy is evaluated for each aquifer sector area in the six regional reports. Below is an overview comparing the alternative and the selected demand projections to available resources island wide.

Full build-out under County Zoning and DHHL land use plans would result in a hypothetical maximum demand of 931 mgd. The full-build-out scenario would exceed the island sustainable yield and assessed available surface water if demand was supplied entirely by conventional water resources. The land use based full build-out scenario is considered unrealistic because it is not coordinated with population projections which also take into account forecasted economic conditions over the planning period. Ultimate build out of Agricultural zoned land also does not accurately reflect anticipated use and water demand for Agricultural lands. Refined projections that account for historic and current agricultural use and crop specific water rates probably result in more realistic water demand. For example, 71% of all land currently in agricultural use island-wide, are unirrigated pasture, relying on natural rainfall. About 27,000 acres, or less than 18% of all land currently in agricultural use, is designated as Important Agricultural Lands (IAL). The potential for increased agricultural demand also appears to be unsupported by market trends, as well as the legal environment which constrains availability of surface water resources. Demand resulting from build-out of farm dwellings on Agricultural zoned land is more accurately represented by projected population growth over the 20-year time horizon of this plan.

11.4 POPULATION GROWTH-BASED WATER DEMAND PROJECTIONS (20-YEAR)

Projecting water demand for population growth is inherently uncertain. Economic markets and housing influence water system growth. Water use does not strictly correlate to population growth but largely depends on household size and water use behavior. Between 2015 and 2035, population based demand is projected to increase from about 42 mgd to approximately 63 mgd, a projected increase of about 53% based on Community Plan growth rates applied to

2014 potable water use. The population growth based projection does not account for the Upcountry Meter Priority List (which is not associated with population growth or accounted for in the 2014 Socio-Economic Forecast). The List represents an additional demand of 7.3 mgd for a total potable demand of 70.5 mgd. A low to high range demand of 57.8 – 68.1 mgd is projected consistent with low to high population growth established in the Maui Island Plan and the Socio-Economic Forecast. Potable demand for State Projects and Department of Hawaiian Homelands were added unless clearly accounted for in the socio-economic forecast and therefore projected population growth.

11.5 AGRICULTURAL DEMAND PROJECTIONS

Non-potable agricultural irrigation demand is not coordinated to population growth and represent additional demand as discussed under the Alternative Agricultural Scenario. The selected demand scenario combining 20 year population growth, Department of Hawaiian Homelands non-potable uses, non-potable needs for kuleana and lo`i kalo, projected diversified agricultural use on HC&S lands, and projected agricultural use outside the HC&S plantation are summarized below. The intensity of use and timing of new crops on HC&S lands has by far the largest variation potential as economic markets, the availability of surface water and pilot testing of economically viable crops directly impact irrigation needs.

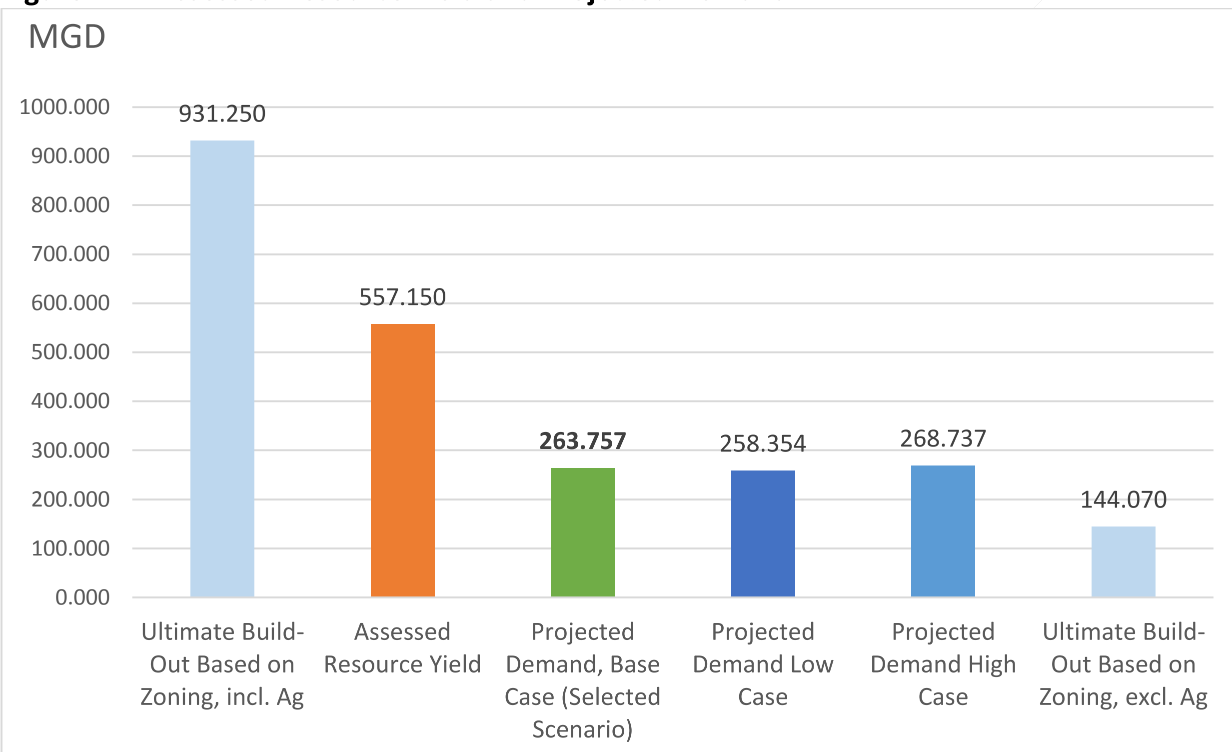
Table 11-7 Summary of Demand Projections

DEMAND	2015	2035
Population growth based, Base Case	41.2	63.2
Population growth based, 8% per capita conservation target	41.2	49.9
Population growth based, Low	41.2	57.7
Population growth based, High	41.2	68.2
Non-potable demand:		
Kuleana and kalo lo’i	10.9	15.5
Department of Hawaiian Homelands	1.8	11.6
HC&S lands Diversified Agriculture	191	116
Diversified Agriculture, outside HC&S plantation	20.9	25
TOTAL RANGE:	**265.8**	**231.3**

The assessment of available resources and analysis of projected demand confirm that there is sufficient water island wide to meet 20-year projected growth, including the estimated range of agricultural irrigation demand, under normal and drought conditions. Full build-out based on current zoning including Agricultural zoned land, is not expected to be fully utilized or irrigated, and highly unlikely over a 20 year time frame. However, entitlements and proposed projects are instructive as to location and planning for water sources. Department of Hawaiian Homelands projected demands should be considered in terms of resource use and transport.

Water resources are shared both naturally as hydrogeological units cross community plan boundaries, and mechanically where resources are transported between hydrologic and community plan regions. Demand and resource use in Central, Ko`olau and Wailuku regions impact each other as water is transferred from where it is generated to where it is needed. Domestic water supply systems are primarily supplied by groundwater to meet future demand. Agricultural demand has solely relied on surface water supplies, now subject to Instream Flow Standards to satisfy instream, including kuleana, needs. Agricultural uses must diversify supplies and improve efficiencies to reduce water losses. On an island wide basis, about 47% of available conventional water resources could meet 2035 base case demand under average/normal conditions.

Figure 11.2 Assessed Resource Yield and Projected Demand



In regional reports for each aquifer sector, water demand based on full build-out of zoning designations and 5-year incremental demand based on population growth are compared to the available conventional and alternative water resources. Available water resources include groundwater, surface water, rainwater, reused rainwater (stormwater, catchment), recycled wastewater and greywater, and desalinated water. The availability of each resource is contingent on several factors and uncertainties addressed in Section 12 Strategies below.

11.6 DROUGHT SCENARIO DEMAND PROJECTIONS

The Hawai`i Drought Plan, 2005 Update, identifies water supply vulnerability areas including Upcountry, Kēōkea and Kahikinui, and agricultural vulnerability areas as Kula, `Ulupalakua, Lahaina, Central Maui, and Kahikinui. The Maui Drought Committee identifies Upcountry (Kula, Makawao, and Pukalani to Kaupō) as particularly at risk for drought. Historically, agricultural demand and landscape irrigation increase by about 20% during drought conditions. Island wide, water resources during drought conditions can meet a hypothetical 20% increase in demand, even under the high growth scenario. However, to adequately address water supply vulnerability areas such as Upcountry, a diversified supply, creative storage and targeted conservation are needed to provide consistently reliable supply.

11.7 SOURCE CAPACITY PROJECTIONS

To meet projected demand in each region and aquifer sector, source development, whether conventional or alternative, must consider peak water use and water distribution losses including unauthorized use and unmetered use. Water production data, including treatment plant production and well pumpage are higher than billed consumption data. Optimization studies completed in 2013 for the MDWS Central Maui System, the Upcountry System and the Lahaina System based source development needs on the peak month production for each system. For the Central-South MDWS system, source development needs accounted for an additional 20 percent to projected base water use. For the Upcountry system the average and peak demand are much more volatile with peak daily demand 58 percent higher than average production over a ten year period. The source development needs considered low rainfall periods. A 100 day drought occurrence in 2006 increased demand 31.5 percent over the year's average. A 31.5 percent adjustment was used in the engineering study to project source need for Upcountry. For the Lahaina MDWS system, 29 percent was added to projected base water use to account for peak production of ground and surface water supply.[20] For other MDWS and public water systems, twenty percent added capacity to population growth based water use demand can represent peak seasonal use for conventional resource development.

The water losses (the difference between the total water produced and total water consumed within a system) vary for MDWS systems and is unknown for other public water systems. The average water loss for MDWS systems is about 13 percent and considered included in peak production data. Strategies for surface water conveyance through unlined plantation ditches and reservoirs are higher with 20 to 22 percent losses considered reasonable for plantation systems in the East Maui Streams and Nā Wai `Ehā contested cases.

[20] Water Source Development Options Report for the South-Central Maui and the Upcountry Maui Areas, County of Maui Department of Water Supply, 2013

12.0 STRATEGIES

In this section, recommended strategies were selected from preliminary strategies considered in developing the WUDP and vetted throughout the public process. These include measures, programs, policies and improvements that, 1. Address identified issues and concerns; 2. Meet one or several established planning objectives; and, 3. Reflect the values and guiding principles distilled during the community outreach process. The strategies are consistent with the overall goals and objectives defined in the Maui Island Plan. The overall goals related to water resource use and management adopted in the Maui Island Plan are:

- Healthy watersheds, streams, and riparian environments.
- Maui will have an environmentally sustainable, reliable, safe and efficient water system

The planning objectives adopted in the Maui Island Plan and the community plans and further defined in the WUDP update process form the basis for identified and selected resource strategies. Many of the issues and challenges related to water resource and supply in the Maui Island Plan are specific to the County Department of Water Supply systems. Some preliminary strategies were mutually exclusive, or complementary to meet projected demand and multiple planning objectives. Through community meetings and consultations with stakeholders and government agencies, region specific issues were further defined and preliminary strategies to address the issues were suggested. The Regional Plans articulate region specific sub-objectives to address such issues.

Comparative costs over a 20 year life cycle are assessed or estimated in order to compare and roughly characterize conceptual resource strategies. Accurate determination of cost would require more precise information on timing, site location, specific circumstances and operations. For example, the cost of developing, pumping and distributing water from a well site is highly dependent on the well depth and wellhead elevation, the water quality encountered and related treatment, the end use service area location and elevation and other factors.

A combination of several preliminary strategies were selected that align with planning objectives, are feasible considering hydrologic and legal constraints, cost effective to adequately meet projected demand while balancing the needs of the community. Resource management and water supply development strategies can represent existing programs or concepts to be further assessed and developed.

The overall Planning Objectives listed below can also be qualified using the criteria or benchmarks provided in section XX to measure accomplished targets in plan implementation.

1. Maintain sustainable resources
2. Protect water resources
3. Protect and restore streams
4. Minimize adverse environmental impacts
5. Manage water equitably

6. Provide for Department of Hawaiian Homelands needs
7. Provide for agricultural needs
8. Protect cultural resources
9. Maximize water quality
10. Maximize reliability of water service
11. Maximize efficiency of water use
12. Minimize cost of water supply
13. Establish viable plans
14. Maintain consistency with General and Community Plan

12.1 RESOURCE MANAGEMENT

An important purpose of this document is to provide a viable plan to equitably meet the water needs of all users on Maui Island in a sustainable way consistent with state and county laws, policy and the planning objectives of this plan, which reflect local issues and principles. Resource management is a key component of these objectives, focusing on both water sources (supply side) and their use (demand side).

Management Lessons from History

The ancient Hawaiians understood that every element within the ahupua`a was related to each another. Through the sharing of resources and working within the rhythms of their natural environment, the ancient Hawaiians were able to sustain large numbers of people, estimated to have numbered approximately one million inhabitants prior to European contact. The ahupua`a system reserved valley floors, where the most fertile soil is located, for communal food production. Hawaiians developed agroforestry systems that minimized soil erosion, facilitated the emergence of water springs, and maintained high species diversity. Population pressure and immigration continue to change both Hawaiian ways and the island environment. The ahupua`a system supports ecosystem health and sustainability, as well as ecosystem resilience which is important to tackling challenges such as changing climate and effects on ground and surface water systems in the face of increasing demands on water resources.

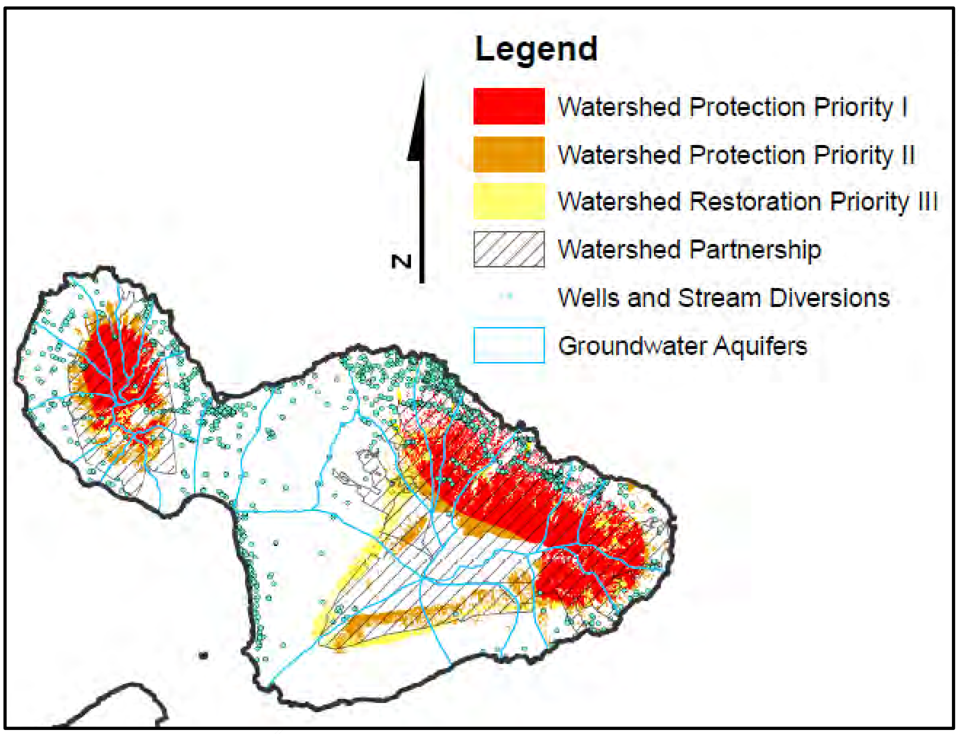
The cultural ahupua`a system is perpetuated through the modern principle of sustainability and ecosystem-based stewardship. The cultural concept of malama `aina—or caring for the land—can be facilitated by integration of traditional ahupua`a district planning with modern watershed and ecological planning, as well as fostering community responsibility to participate in planning and management efforts. The terms “ecosystem approach” and “watershed approach” have become synonymous with ahupua`a approach in the literature and programs addressing watershed protection.[21]

[21] Atlas of Hawaiian Watersheds and Their Aquatic Resources. http://Hawai'iwatershedatlas.com/intro_watersheds.html

Watershed Management

In 2011 the DNLR introduced "The Rain Follows the Forest" watershed initiative which aims to preserve and protect Hawai`i's mauka watersheds as a source of fresh water and a home to Native Hawaiian species focused on removing invasive plant and animal species and in some cases building protective fences. The DLNR has identified "Priority Watershed Areas" which are areas of highest rainfall and resupply, based on climatic conditions that provide high recharge and fog capture as shown in Figure 11-2. The State and County as well as various other entities have initiated or continued a variety of watershed based programs, increasingly focused on partnerships.

Figure 12-1 Priority Watershed Areas



The Rain Follows the Forest, DNLR, 201

<u>Watershed Related Issues</u>

The foundation for sustainable water resources is a healthy watershed that supports groundwater recharge, stream flow and healthy coastal and near shore waters for future generations. The observed trends of increasing temperatures, decreasing rainfall and declining streamflow have implications for watersheds and forests, water supply and quality, and dependent uses. Forested watersheds recharge groundwater supply, infiltrate rainfall and slow down runoff, mitigating flooding, control erosion and runoff to the ocean, protecting coral reefs and fisheries. Native forests provide habitat for unique plant and animal species and supply culturally important plants and animals. Constant threats of invasive and ecosystem modifying animal and plant species necessitate active management of native forested watersheds to maintain a functioning water collection system and important ecosystem services. Invasive plants and feral ungulates are considered the most damaging threats. Cattle, pigs, goats, sheep and deer destroy forest vegetation leaving grounds bare and soils exposed. Invasive weed species can take over a native forest and negatively impact: 1. the forest's ability to collect water; 2. wildfire danger; and 3. forest pests and disease.[22] Invasive species in the streams also out compete and impact native aquatic species. Wildfires contribute to degradation of the forested watershed if invasive species are allowed to re-vegetate burnt areas. Watershed management is largely focused to the high elevation forested areas. Management using traditional ahupua`a, or ridge to reef approach is hampered by urbanization, agricultural lands and fragmented ownership.

Objectives

a. Maintain Sustainable Resources, Protect and Restore Streams and Cultural Resources
b. More comprehensive approach to water resources planning to effectively protect, recharge, and manage water resources including watersheds, groundwater, streams, and aquifers.

A key value distilled through community input and participation is that water resource planning and solutions should support ecological, social and financial sustainability. Watershed protection generally strives to prevent the creation of new contaminant sources or threats to source waters while watershed management generally aims at reducing or eliminating contamination sources or threats. Watershed management is a first line of defense or protection barrier to the potential transmission of contaminants to water supply, with treatment a secondary or complementary action to ensure safe drinking water. As surface water is inextricably linked to groundwater, resource management on a watershed or ahupua`a level, provides a holistic approach to address and ensure long-term viable water quality.

General Plan Policies

a. Perpetuate Native Hawaiian biodiversity by preventing the introduction of invasive species, containing or eliminating existing noxious pests, and protecting critical habitat areas.
b. Restore and protect forests, wetlands, watersheds, and stream flows, and guard against wildfires, flooding, and erosion.
c. Protect baseline stream flows for perennial streams, and support policies that ensure adequate stream flow to support Native Hawaiian aquatic species, traditional kalo cultivation, and self-sustaining ahupua`a.
d. Restore watersheds and aquifer-recharge areas to healthy and productive status, and increase public knowledge about the importance of watershed stewardship, water conservation, and groundwater protection.
e. Promote the use of ahupua`a and moku management practices.

[22] http://hawp.org/why-watersheds-matter/

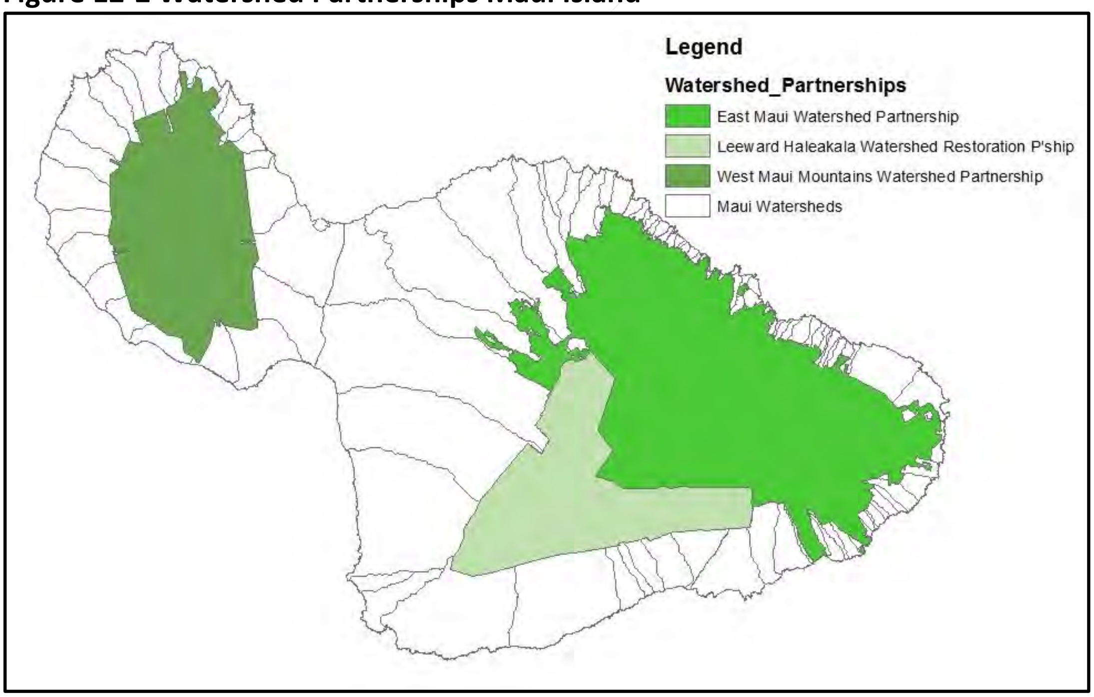
Recommended Strategies

a. Continue Maui County financial support for watershed management partnerships' fencing and weed eradication efforts.

The County's watershed protection approach provides a strategy for effectively protecting and restoring the resilience of natural aquatic ecosystems and thereby protecting ground and surface water resources and a range of ecosystem services. The approach is based on the premise that many water quality and ecosystem problems are best solved at the watershed level, rather than at the individual body of water or point of discharge. The watershed management approach fosters partnerships that involve the people most affected by allowing them to participate in key management decisions. This ensures that environmental objectives are well integrated with cultural, social and economic goals.[23]

Maui County has taken a lead role state wide in prioritizing and funding watershed protection efforts. Water rate funded financial support through the Maui DWS to watershed partnerships since the mid-1990s addresses the primary threats to a viable fresh water supply: feral ungulates and invasive weeds. Today seven partnerships and non-profit organizations manage and monitor 346,000 acres of critical watersheds throughout Maui and Moloka`i. Watershed management plans are developed for priority watersheds and implemented by the following partnerships and non-profit organizations on Maui:

Figure 12-2 Watershed Partnerships Maui Island



[23] Water Resources Protection Plan, 2008.

East Maui Watershed Partnership
The East Maui Watershed consists of approximately 120,000 acres and provides the largest harvested source of surface water in the state. Ongoing efforts to protect the watershed include fencing, ungulate control, invertebrate and small mammal control, weed management, rare species protection, removal of invasive species, monitoring, education, public outreach and volunteer recruitment to repair and install fencing, and plant native species.

The Nature Conservancy: Waikamoi Preserve and Kapunakea Preserve
The Kapunakea Preserve in West Maui is home to Kapaloa and Honokōwai streams and the pristine headwaters of the Honokōwai and Wahikuli watersheds. These watersheds have been identified as focal priority watersheds by the Hawai`i DOH, EPA and NOA. Management activities include fence maintenance, ungulate and weed control, monitoring and research for the Kapunakea Preserve. The Waikamoi Preserve contains large native-dominated areas that are free of habitat modifying weeds. The Nature Conservancy not manages significant new portions of the Upper Kula water system drainage area, This project not only benefits 1,000 new acres being fenced and managed for the first time but also the entire 12,000 acre core East Maui watershed and water collection area. The 3,721 acre parcel became legally protected under a new perpetual Conservation Easement between East Maui Irrigation Co., Ltd (EMI) and TNC in April 2014.

West Maui Mountains Watershed Partnership
Over 47,321 acres of the West Maui Mountains is being protected and preserved. This watershed is a key water recharge area that provides potable water to West and Central Maui residents. The major threats to this watershed are feral ungulates, invasive weeds, human disturbances and wildfires. Ongoing efforts include ungulate control through fence construction, retrofitting and regular trap checks weed management, planting and enclosures, monitoring, and human activities management through outreach, education and curbing use of area.

Leeward Haleakalā Watershed Restoration Partnership:
The partnership protects and restores dry forest lands on Leeward Haleakalā. Ongoing efforts include to preserve and provide a reserve from which certain important forest species can recover, install fencing, increase productive vegetation using native species, broadcast seed, conduct biological survey, and recruit volunteers to help with an intensive labor effort.

Auwahi Forest Restoration Project
This initiative actively restores dry forest lands on Leeward Haleakalā through excluding grazing animals, control of non-native kikuyu grass, and planting closely spaced, and rapidly growing native shrubs. Efforts support hydrological research to assess the effects of native forest restoration on soil moisture dynamics and potential aquifer recharge.

Pu`u Kukui Watershed Preserve

Over 8,600 acres of Pu`u Kukui Watershed Preserve is being protected and preserved. Ongoing efforts include ungulate control through fencing, trapping and surveying on foot, invasive plant control, rare species protection research and water quality testing.

Figure 12-3 Ungulate Control Through Fencing in Pu`u Kukui

Photo Credit: Pu'u Kukui Watershed Partnership

Maui Invasive Species Committee

Support efforts to monitor and remove the spread of miconia through repeated removal, treatments of existing areas of growth and prevention of seed dispersal. Similarly, manage other target weeds, including pampas grass, fountain grass, ivy gourd, giant reed, rubber vine, Jerusalem thorn, *malabar malestome,* downy rose myrtle, ruby salt bush and others. Seek to detect, identify and control potential problem weeds before they become difficult to control

b. Promote increased distribution of funding for watershed protection and active reforestation to reflect multiple values and ecosystem services.

A strong and consistent funding mechanism on state and county level would allow expanded efforts in disturbed watershed areas and address invasive threats before they become established and more difficult and expensive to combat. Water rate funded support is based on the scientific and economic underpinnings of groundwater recharge and a viable freshwater system. However, watersheds are critical infrastructure that provides a myriad of other ecosystem services, environmental and economic benefits to all citizens which warrant additional funding. Watershed restoration through reforestation of a damaged and disturbed landscape has proven successful on a small scale and is strongly supported based on community feedback in the WUDP public process. The collaboration between watershed managers, landowners and public volunteers to restore native habitat at Auwahi is a role model statewide.

Figure 12-4 Forest Restoration and Exclusion of Grazing Animals

Auwahi Reforestation Project

c. Expand watershed protection to incorporate the ahupua`a as a whole and utilize ahupua`a resource management practices.

Ahupua`a management complement existing watershed protection efforts to include the low elevation lands, coastal zone, near shore waters and coral reefs. Traditional resource management concentrates on the perpetuation of water, agriculture, aquaculture, near-shore and ocean practices that focuses on the sustainability of the resource. [24] Initiating and promoting collaboration between county and state agencies and the Native Hawaiian communities, organized in moku, can further the practices and applications of ancient knowledge and traditions in resource management. Traditional resource management translates to adaptive management where policies are designed and implemented

[24] Excerpt from the "Final Report of the Aha Ki`ole Advisory Committee, Best practices and specific structure for the cultural management of natural resources in Hawai`i, December, 2008)

incrementally to respond to new information and the behavior of natural systems. As vital information on the impacts of resource management and use are still lacking in many areas, the WUDP strategies should be assessed and adjusted as warranted as additional traditional knowledge and data are garnered.

New partnerships and collaborative efforts can be modeled upon the West Maui “Ridge to Reef” Initiative. The Initiative encompassing 24,000 acres from Kā`anapali northward to Honolua and from the summit of Pu`u Kukui to the outer reef seeks to restore and enhance the health and resiliency of West Maui coral reefs and near-shore waters through the reduction of land-based pollution threats, guided by the values and traditions of West Maui. In July 2008 the U.S. Army Corps of Engineers (USACE) expressed interest in developing a West Maui Watershed Plan with the assistance of the DLNR, DOH and various other federal agencies. The Hawai`i Coral Reef Strategy identified the coral reef ecosystem along the West Maui region as a priority management area. In April 2015, West Maui was designated as a Resilient Land and Waters Initiative site by the Department of the Interior, the Environmental Protection Agency and the National Oceanic and Atmospheric Administration. The Watershed Management Plan for Wahikuli and Honokōwai was completed in 2012 and the plan for Kahāna, Honokahua and Honolua Watersheds will be completed in 2016. http://www.westmauir2r.com/

d. Support stream restoration and increased use of *kalo* lands.

Stream restoration as both an objective and result of establishing numeric Instream Flow Standards, will increase and enhance opportunities for food production and cultural water uses. Although the authority and responsibility for assessing resources and establishing Instream Flow Standards lie with the State CWRM, input from the Native Hawaiian community indicate that grassroots efforts are ongoing and there is community interest to collaborate with state and county agencies. The roles and work efforts should be identified to propel assessment of stream resources and ensure restoration projects come to fruition.

e. Enable and assist in providing for Native Hawaiian water rights and cultural and traditional uses through active consultation and participation.

Native Hawaiian water rights are specifically protected in the State Constitution, Section 221 of the Hawaiian Homes Commission Act and the State Water Code, Section 174C-101, providing for the needs of Department of Hawaiian Home Lands; traditional and customary gathering rights; and appurtenant water rights of kuleana and kalo lands. Protecting Native Hawaiian rights must be accomplished through establishing instream flow standards. CWRM must balance in-stream uses, domestic uses, Native Hawaiian and traditional and customary uses with reasonable and beneficial off-stream uses. Active engagement between state and county agencies and the Native Hawaiian community is needed to ensure water rights are safeguarded and to inform public policy decision makers.

The Aha Moku System can serve to provide advice on integration of Native Hawaiian resource management practices with western practices in each moku and identify a comprehensive set of Native Hawaiian practices for natural resource management. [25]In meeting with the water committee of Moku O Pi'ilani and members of Wailuku, Kula, Honua'ula and other moku, support was voiced for initiating and implementing a consultation process for MDWS's water resource plans and management. The recently adopted Rules of Practice and Procedure for the DLNR 'Aha Moku Advisory Committee (AMAC) defines "Collaborative governance" as a "governing arrangement wherein one or more public agencies such as the department of land and natural resources and its divisions, directly engage non-state stakeholders, such as the 'aha moku advisory committee and island 'aha moku councils, in a collective decision-making process that is *formal*, *consensus-oriented*, and *deliberative* and that aims to make or implement public policy or manage public programs or assets. Collaboration implies two-way communication and influence between agencies and stakeholders. Although ultimate authority lies with the department, stakeholders directly participate in the decision-making process." The rules also sets forth the communication process in advising agencies for those participating in the 'aha moku system as well as a form for the island Po'o (representative) to use.

Maui DWS should collaborate with the established 'Aha Moku Advisory Committee and Moku O Pi'ilani and consult with designated AMAC representative(s) in developing and implementing public policy and managing public programs as it relates to regional resource development.

Water Quality Management

<u>Groundwater Quality Issues</u>
We are fortunate to be endowed with generally excellent ground and surface water quality throughout Maui. Groundwater can become contaminated from a range of land uses, including agricultural pest control, industrial activities, leaks and spills from chemical storage. Once chemicals infiltrate soil and reach the aquifer, contamination can linger for decades due to persistence. Pesticides applied decades ago remain in Maui aquifers and requires costly treatment where detections exceed acceptable levels. Microbial contamination at the source (which is different from pathogens that can occur within the distribution system) can result from cesspools, sewage sludge disposal, reclaimed water irrigation and other activities. Multiple studies have shown that protection at the source outweigh treatment costs. Remediating contaminated groundwater can be 40 times more expensive than taking steps to protect the source. For small community sources, this ratio can be as high as 200:1.[26] Water quality that not only meets, but exceeds federal and state drinking water standards protects public health and improves the community's confidence in municipal and private water utilities.

[25] Leimana DaMate, Status Report on Aha Moku to the Commission on Water Resource Management in Regards to Water Use in the Kona District Moku O Keawe (Hawai`i Island), May 19, 2016
[26] AWWA Manual M50 Water Resources Planning, 2001

The Safe Drinking Water Act, amended in 1996, establishes primary drinking water standards, treatment technologies and monitoring schedules. The Act mandated a statewide Source Water Assessment of all public water systems to be completed by the SDWB. The assessment delineated areas where potential contaminating activities may impact the water source, inventoried potentially contaminating activities and ranked the susceptibility of ground and surface water sources to contamination. The assessment laid the framework for protection measures on a local level. Drinking water regulations address existing contamination but does not prevent future contamination of drinking water sources. The State Wellhead Protection Program, established by the Safe Drinking Water Act, provides guidance to communities in developing protective measures on a local level. Proactive measures are needed to minimize threats to drinking water sources from current and future potential sources of contamination.

Emerging water quality issues are anticipated as new chemicals are introduced into water supply. Contaminants that are subject to potential regulation include those on the U.S. EPA's Contaminant Candidate List. As additional contaminants are assessed and analytical methods improve, new and more stringent drinking water regulations are expected.

<u>Objectives</u>

a. Protect and maintain the quality of water resources and delivery systems.

<u>General Plan Policies</u>

a. Improve water quality and the monitoring of public and private water systems.
b. Protect and maintain water delivery systems.

<u>Recommended Strategies</u>

a. Implement well siting criteria to avoid contaminated groundwater supplies and unnecessary risks to public health.

Well development in areas with current or historic contaminating activities unnecessarily subjects the public to contaminants and often necessitates reliance on costly treatment. Policy and procedure for siting new wells should apply to wells developed by MDWS or wells to be dedicated to MDWS. Well siting criteria to avoid contaminated water supply should be considered to the extent feasible by all public water systems. This strategy implements the MIP action item to "develop, adopt, and implement water source development siting standards that implement the MIP Directed Growth Plan and the WUDP, and protect water quality for existing and future consumers."

b. Adopt wellhead protection measures for potable wells.

Establish protective measures and acceptable land uses within potable well capture zones. A wellhead protection strategy for MDWS wells was developed with significant public participation, resulting in a draft ordinance. The strategy and ordinance builds upon the State Source Water Assessment Program and established best management practices to prevent contamination from potentially contaminating land uses and restricts high risk activities in capture zones of MDWS wells. Adoption of the draft ordinance has strong support from the community, the State DOH, and state experts in the water resource and hydrology field. [27] This strategy supports the WUDP objective of maximizing water quality and ensures consistency with the State Water Quality Plan prepared by the State Department of Health.

c. Support increased monitoring of groundwater sources and update assessment of potential contaminating activities around drinking water supply.

Source water monitoring schedules are established in primary drinking water standards. Sampling frequency varies by regulated contaminant and detections. Improved monitoring of existing wells that have history of contamination or that is ranked as highly susceptible to contamination in the State Source Water Assessment, reduces the risk to public health. The need and cost of increased sampling frequency should be weighed against history and type of contaminants on a case by case basis. Public water systems that have multiple contaminants detected in one source at concentrations close to, but below Maximum Contaminant Levels may benefit from additional sampling to identify spikes in concentrations and to determine whether and when treatment is warranted.

The 2007 Source Water Assessment of public water systems on Maui has not been updated to reflect new land use activities or new developed groundwater sources. Public water systems should take advantage of the technical assistance available from the SDWB and update assessment of activities in capture zones. As new groundwater sources are developed, capture zones should be delineated and potential contaminating activities assessed. Inventoried data related to activities that are deemed to pose a risk to groundwater supply should be made available to public water system customers.

Surface Water Quality Issues

Streams are subject to sediment build up, erosion, nutrients and turbidity that can impact in stream uses and require additional treatment for off stream uses. The State Department of Health Clean Water Branch monitors activities and report on impairments of waters, including Total Maximum Daily Loads (TMDL). The 2012 Integrated Report on impaired inland waters, found that the most common occurrences of pollutants not meeting state water quality criteria were turbidity, followed by Nitrate+Nitrite Nitrogen.[28] TMDL priority, low to high, was assigned for initiating TMDL development. Four Maui streams were assessed as “Medium” TMDL Priority: Honokōwai Stream, `Īao Stream/Wailuku River, KaHāna Stream, and Kahoma Stream. No Maui streams were assigned categories representing “impaired” waters. No other pollutants were identified in Maui streams, except for “trash” in Wailuku River and Ohia Stream. The updated 2014 assessment did not address any Maui inland freshwater bodies. Maui agriculture is heavily dependent on surface water as irrigation supply. This use comes with a responsibility to protect streams from agricultural pollutants and practices. Agriculture is the

[27] Testimony by State of Hawai`i Department of Health, 1/13 2014 and 8/20 2015; Testimony by Dr. Donald Thomas, 10/15 2015; Testimony by Dr. Daniel Amato, 10/15 2015; Testimony by Dr. Nicole Lautze, 10/19 2015

[28] 2012 State of Hawai`i Water Quality Monitoring and Assessment Report

nations' leading source of pollution for ground, surface and coastal waters. [29] Livestock and crop farming practices can contribute sediments, nutrients from fertilizers and animal waste, agricultural chemicals and bacteria from animal waste. Sediment and pollutants in raw water increases needs and costs of surface water treatment. Sediment buildup in reservoirs can decrease storage volume and delivery efficiency.

The primary water quality challenges using surface water for potable supply include mitigating disinfection byproducts and lead and copper levels in public water supply. Organic matter in raw water when combined with chlorine form disinfection byproducts, some of which pose public health risks. Permitted levels are regulated under the Stage 1 Disinfectant/ Disinfection Byproducts Rule (D/DBPR) and Stage 2 D/DBPR, established under the Safe Drinking Water Act. The chemistry of certain surface water supply is corrosive which can cause lead and copper in older household plumbing to leach into drinking water at the tap. The Lead and Copper Rule (LCR) promulgated by the U.S. EPA sets action levels, that if exceeded requires corrosion control measures and other mitigating actions. MDWS is in full compliance with D/DBPR and LCR and continuously assesses treatment technologies to maintain and improve drinking water supply quality. However, emerging disinfection byproducts are being discovered and future additional regulations of those disinfection byproducts that pose a risk to human health can be anticipated.

<u>Objectives</u>

a. Improve water quality and the monitoring of public and private water systems.

<u>General Plan Policies</u>

a. Protect and maintain water delivery systems.

<u>Recommended Strategies</u>

a. Educate the farming community in sustainable farming practices to reduce impact from agricultural practices on water resources.

Sustainable farming practices include development of a conservation plan to address runoff; waste management to prevent animal wastes to contaminate water supply; fertilizer, and pesticides and herbicides management to mitigate over application and to ensure proper storage and disposal. [30] Workshops and education outreach are sponsored by MDWS, Hawai`i Rural Water Association and DOH. Continued outreach should encourage farmers to take advantage of existing programs and technical assistance through the Soil and Water Conservation Districts, the State Department of Agriculture and DOH.

b. Support and fund capital and process improvements and monitoring of surface water systems to ensure compliance with drinking water standards.

---

[29] https://archive.epa.gov/region9/strategicplan/web/html/index.html

[30] http://health.hawaii.gov/cwb/site-map/clean-water-branch-home-page/polluted-runoff-control-program/prc-hawaiis-implementation-plan/agriculture/

Water quality challenges related to corrosion and water chemistry have primarily been limited to the MDWS Upcountry system. Except for MDWS, no other public water systems rely on surface water as potable supply. Process improvements and monitoring for the Upcountry system is addressed under Section 15.8.

12.2 CONSERVATION

The protection of water resources and the wise and sensitive use of water resources can be advanced though a robust water conservation program that reduces consumption of water, reduces water loss and increases efficiency of water systems and use. Conserving water and avoiding water loss is important for long-term sustainability and benefits the community, environment and water suppliers even in times of abundant rainfall. Reductions in water use though conservation and improved efficiency broadly decrease impacts on ecological systems, and on cultural practices that depend upon these systems. Reducing existing and future demands on water resources can delay the need to develop new sources of water, delay or avoid additional capital infrastructure, decrease operating costs, reduce energy use, and decrease environmental degradation and water use conflicts.

Conservation can be characterized as **demand side strategies** that generally promote reduction in water use, and **supply side strategies** that focus on water system efficiency and loss control from source to end use. Demand-side management options are usually programs undertaken by a water utility to encourage the use of efficient fixtures and appliances or practices by its customers, or to encourage customers to shift their time of use. Such programs often provide for direct installation or incentives such as rebates to encourage purchase of efficient fixtures or appliances. Other components focus on regulatory controls and educational programs to instill a conservation mindset and support other programs. Supply side measures include water audit/non-revenue water analysis, leak detection and meter maintenance and replacement.
Conservation programs can be implemented by water purveyors of all sizes. While this section of the WUDP focuses on conservation of ground and surface water sources, measures can also be applied to alternative water resources to improve efficiency and reduce costs.

Conservation Issues and Opportunities for Non Agricultural Uses

Maui has historically had the highest water consumption of all the Hawaiian Islands primarily due to streamflow diverted for plantation irrigation. While the diversion and transport of water for agriculture has already decreased with the curtailment of HC&S operations, demands for new agricultural pursuits, population increase and new development will continue to put pressure on Maui's water resources. Issues and opportunities specifically related to agricultural irrigation is discussed under Section 12.2.5 below. In developing the WUPD, a broad range of concerns were expressed through the community outreach process:

- Satisfaction of kuleana and public trust uses, and the balancing of public trust and other beneficial uses such as agriculture when conflicts occur.
- The effect of water diversion and transport on kuleana and public trust uses and local ecosystems.
- Protection of freshwater quantity and quality.
- Water resource sustainability during drought and with changing climate conditions.
- Promote a culture of living within our means, with design and use more commensurate with the water resources of the local area, particularly for landscape, resort and agricultural needs.
- Align the level of water with the type of use. Maximize use of alternative water resources, such as recycled, greywater, catchment and stormwater.
- Increase surface water system and use efficiency, and decrease water loss.
- Increase capacity and reliability of water systems to meet challenges in a cost-efficient manner.
- Use a varied regulatory, incentive, educational and rate-based approach, addressing all existing and future use types.
- Create a community conservation mindset through education and government leading by example.

The development and implementation of water conservation strategies and programs should carefully consider these issues. Reducing consumption particularly for landscape uses in dry areas is of particular interest to community members. In general, an effective water conservation and loss control program can reduce the demand on freshwater resources through reduced consumption, offsetting use with alternative resources, and reducing loss of water and leaks during conveyance and by the end user. A robust conservation and efficiency program will help address surface water diversion and water transport issues and support protection of kuleana and public trust uses. A conservation program of specific actions can entrust citizens as well as entities with responsibility and accountability for efficient water use thereby building a culture of water management responsibility. The program should consider how regional differences in water resources and uses can be engaged through conservation efforts. The WUDP Planning Objectives are all directly or indirectly relevant to water conservation as discussed in connection with proposed strategies and measures.

State Planning

The *State Water Code's* directive to "protect, control, and regulate the use of Hawai`i's water resources for the benefit of its People" authorized the CWRM to protect and enhance the water resources of the state of Hawai`i through wise and responsible management.

The *Hawai`i Water Plan, Water Resource Protection Plan* addresses the conservation of water resources. In carrying out its responsibilities, such as establishment of protection of aquifer and instream flow standards and issuance of water use permits, the CWRM has evaluated efficiency and loss of water conveyed by delivery systems from source to end uses, and as relevant applied conditions to address those concerns. Conservation supports the *Water Quality Plan* by

reducing pressures on freshwater resources, which may otherwise exacerbate salinity and other water quality issues.
The *Hawaiian Homes Commission Water Plan Policy* calls for water stewardship in a manner that balances cost, efficiency measures and Public Trust uses in the short and long-term.

The *Hawai`i 2050 Sustainability Plan* states that per capita water consumption reflecting conservation and renewable energy use are leading indicators of a 'sustainability ethic', which is a priority action of the *Plan.*

The Hawai`i Fresh Water Initiative's report, *A Blueprint for Action-Water Security for an Uncertain Future*, calls for improving the efficiency of the total underground aquifer water use rate by eight percent from 330 gpd per person (statewide average) to 305 gpd per person, in order to increase water availability by 40 mgd by 2030. The key strategies are to reduce potable water use on landscape areas, encourage audits and leak detection which also increase water security, and improve agricultural water efficiency.

The purpose of the *Hawai`i Water Conservation Plan* (2013) is to identify and implement water use and delivery efficiency measures to conserve the fresh water resources of the state. The plan focuses on demand side conservation and is intended to be a guiding document for the CWRM as it develops and implements water conservation measures that can be implemented across the state by public water suppliers, agricultural, and other water users.

The *Hawai`i Drought Plan, 2017 Update* states that an aggressive water conservation program is an essential component of drought mitigation. Water conservation should be promoted statewide and practiced within all water use sectors. A recommended priority action is to support water conservation, reuse, and recharge measures as part of increasing freshwater security.

The *Hawai`i Climate Change Adaptation Priority Guidelines* states that water conservation is a critical component of climate adaptation and can increase resilience to declining water supply or more frequent or longer droughts. The Priority Guidelines Tools focus on avoiding over-allocation of groundwater, such as demand-side conservation, mandatory water conservation and recycling plans, and incorporating water conserving design and use efficiency into new development and redevelopment supported by incentives.

Goals, Objectives and General Plan Policies

The Goals, Objectives and Policies established in the County's *General Plan 2030* and *Maui Island Plan* relating to water conservation are water shown in the table below. General guidance provided in the Community Plans is reflected in the MIP.

Table 12-1 Maui Island Plan and General Plan Goals, Objectives and Policies Related to Conservation

County Planning Policy/Measures	Plan
Goal: Restore watersheds and aquifer-recharge areas to healthy and productive status, and increase public knowledge about the importance of watershed stewardship, water conservation, and groundwater protection.	GP
Objective 6.3.2 - Increase the efficiency and capacity of the water systems.	MIP
Policy 6.3.2.a - Ensure the efficiency of all water system elements including well and stream intakes, water catchment, transmission lines, reservoirs, and all other system infrastructure.	MIP
Policy 6.3.2.e - Ensure water conservation through education, incentives, and regulations.	MIP,CP
Action 1 - Develop programs to increase the efficiency of all water system elements.	MIP
Action 3 - Revise County regulations to require high-efficiency, low-flow plumbing fixtures in all new construction.	MIP
Action 6 - Develop a water rate structure that encourages conservation and discourages the excessive use of water.	MIP
Provide incentives for water conservation practices.	MIP,CP
Action 7 - Develop a comprehensive water conservation ordinance to include xeriscaping regulations to promote water conservation.	MIP
Incorporate drought-tolerant plant species and xeriscaping in future landscape planting.	CP
Encourage use of non-potable water for irrigation purposes and water features. Kīhei-Mākena: Prohibit use of potable water in large water features or require substantial mitigation fees.	CP

Abbreviations: GP- General Plan 2030, MIP- Maui Island Plan, CP-Community Plan.

Maui County has adopted the following regulations that support water conservation generally:

- Maximum flow rate standards for plumbing fixtures sold by local distributors (Maui County Code, Chapter 16.20B)
- Plumbing code regulations that require low-flow fixtures in new development (Maui County Code, Chapter 16.20B)
- Education and incentives. MDWS shall promote water conservation education; as reasonable provide water-efficient faucet, shower fixtures, and outdoor hose nozzles to consumers upon request at no charge; and implement an incentive program to encourage consumers to replace old toilets and water fixtures with water-efficient fixtures. (Maui County Code, Chapter 14.06A)
- Leak detection. MDWS to monitor water consumption and issue high-consumption notices to consumers when warranted, prioritize the replacement of old and leak-prone water mains, as reasonable distribute toilet tank leak detection tablets or other methods

to consumer upon request, and encourage the public to report water leaks. (Maui County Code, Chapter 14.06A)

- MDWS may discontinue water service where negligent or wasteful use of water exists on any premises. (MDWS Rules and Regulations, Section 3-10)
- Control of water usage during a drought. MDWS "may declare a water shortage whenever the water supply becomes inadequate in any area in the County or County water system because of a period of drought, an infrastructure or mechanical malfunction, natural disaster, or other event causing a water shortage." The director may prohibit water usage during certain hours or days of the week; prohibit the use of water for irrigation, lawns, personal washing of vehicles, construction, subdivision, or other types of activity involving the use of water; and institute water shortage water rates. (Maui County Code, Chapter 14.06A, MDWS Rules and Regulations, Section 4-1)
- Grey water systems: The Department of Environmental Management may permit irrigation methods that discharge gray water in a manner that ensures that the gray water does not surface. In addition to specified irrigation systems, collection and distribution systems such as laundry-only gray water systems may be approved. (Maui County Code, Chapter 16.20B)
- New golf courses shall not use any amount of potable water for irrigation and other nondomestic uses (other than drinking, bathing, heating, cooking, and sanitation). (Maui County Code, Chapter 14.08)
- Recycled water. Improved commercial property must connect to an available recycled water distribution main within 100 feet of the property line within one year of service availability for an existing irrigation system, or at the time a new irrigation system is constructed.[31] (Maui County Code, Chapter 20.30)

Conservation Related to Population Based Demand

Conservation associated with population based demand, excluding large agricultural and irrigation uses, is addressed in this section. This demand is largely comprised of potable water served by public water systems, with about 90 percent supplied by MDWS on Maui Island. A per capita rate of 248 gpd is estimated based on average MDWS 2010-2014 FY billed consumption and interpolated population. (Please refer to Table 8-13). Existing water consumption figures incorporate conservation measures that are currently in use, such as high-efficiency fixtures, rainwater catchment, and use of recycled water, and it is assumed the savings produced by those measures will continue to be embedded in future consumption rates.

<u>Potable Demand – Residential Uses</u>

Residential uses comprise the largest consumer for most public water systems; residential uses consumed about 64 percent of water supplied by MDWS in 2014. Significant factors influencing indoor use include number of people per dwelling, housing type, fixture efficiency, water use

[31] Improved commercial property also includes golf courses, landscaping and agricultural uses, except properties used for single-family or duplex purposes. The Code refers to reclaimed water; for consistency throughout this document the term recycled water is used.

behavior, and water rates. Number of people per household is strongly correlated with indoor water use per dwelling. Household use rates are about 10 percent lower than per capita rates due to efficiencies of scale, and multi-family units use about 10 percent less water than single-family units due to fewer dishwashers, clothing washers and leaks. Per capita indoor water use should not significantly vary by region and therefore region specific indoor conservation programs are not indicated.

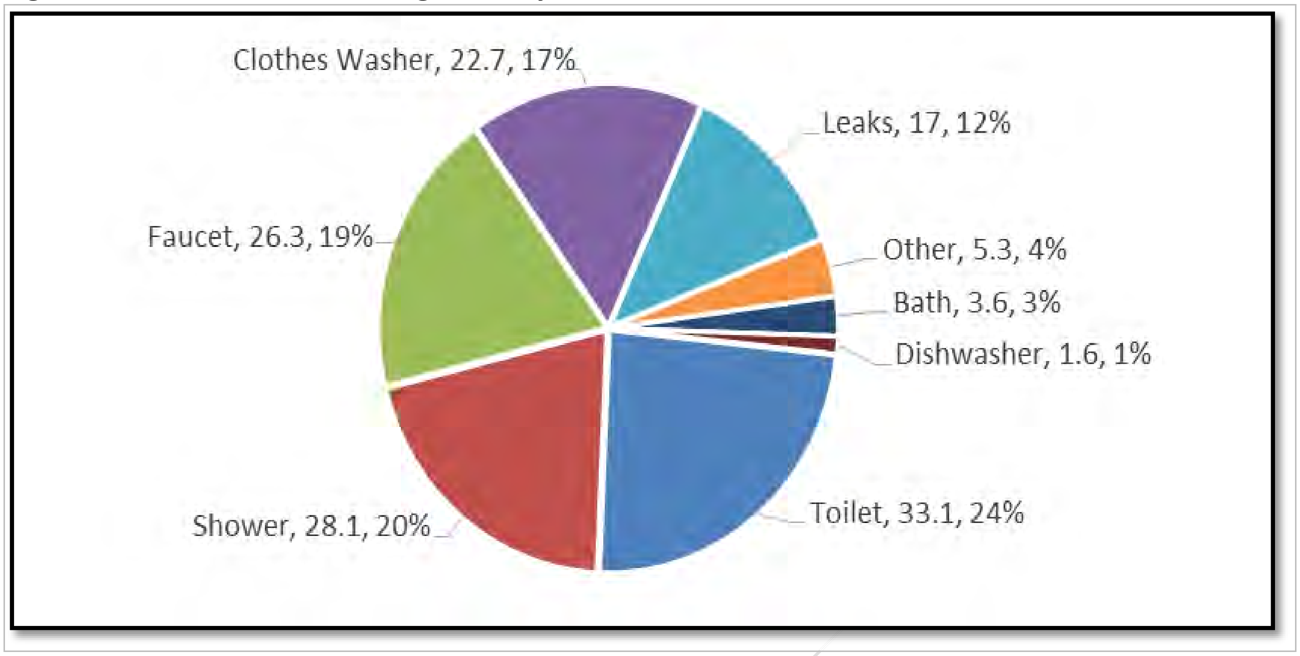
Indoor water use rates derived from various sources range from about 120 to 140 gallons per household per day (gpd). The 16-year study, *Insights into declining single-family residential water demands (2012*) states that agencies should be planning for per capita demands of around 40 gpd or less for a family of three, and household use of 120 gpd. An adjusted average water-efficient household rate for Maui Island equates to about 150 gpd for single-family units and 135 gpd for multi-family units.[32] The 2002 Water System Standard of 600 and 540 gallons per unit for single and multi-family units respectively includes accessory outdoor uses. There are few recent empirical examples of restricted indoor water use per unit or lot, with a separate system supplying non-potable needs; Wailuku Country Estates exhibited an average of 255 gpd per lot of potable water in 2014, with the higher demand likely attributed to lots with accessory units. Residential uses served by MDWS had an average per capita rate of 156 gpd in 2014; for purposes of analysis indoor use was estimated at 70 gpd per capita with the remainder attributed to outdoor use.

Water use rates have changed over time with the greatest savings from toilets and clothes washers. *The Residential End Uses of Water (REU2016)* found average indoor water use among utility customers studied was 138 gpd compared to 177 gpd in the 1999REU study.[33] The figure below compares use by fixture for single-family homes in the *REU2016* study. Toilet flushing was the largest indoor use, followed by showers, kitchen and bathroom faucets, clothes washers, and leaks in the *REU2016*.

[32] 138 gpcd is 89 percent of a per-capita-based household rate for Maui Island based on 2015 household water use.

[33] The participating utilities in the 1999 and 2016 Residential End Uses of Water studies differed. In the 1999REU most were in the west and southwest US, while they were more distributed throughout the US in the 2016REU. The 2016 study used 2010-2013 data.

Figure 12-5 National Indoor Single Family Household Water Use



The Residential End Uses of Water (2016)

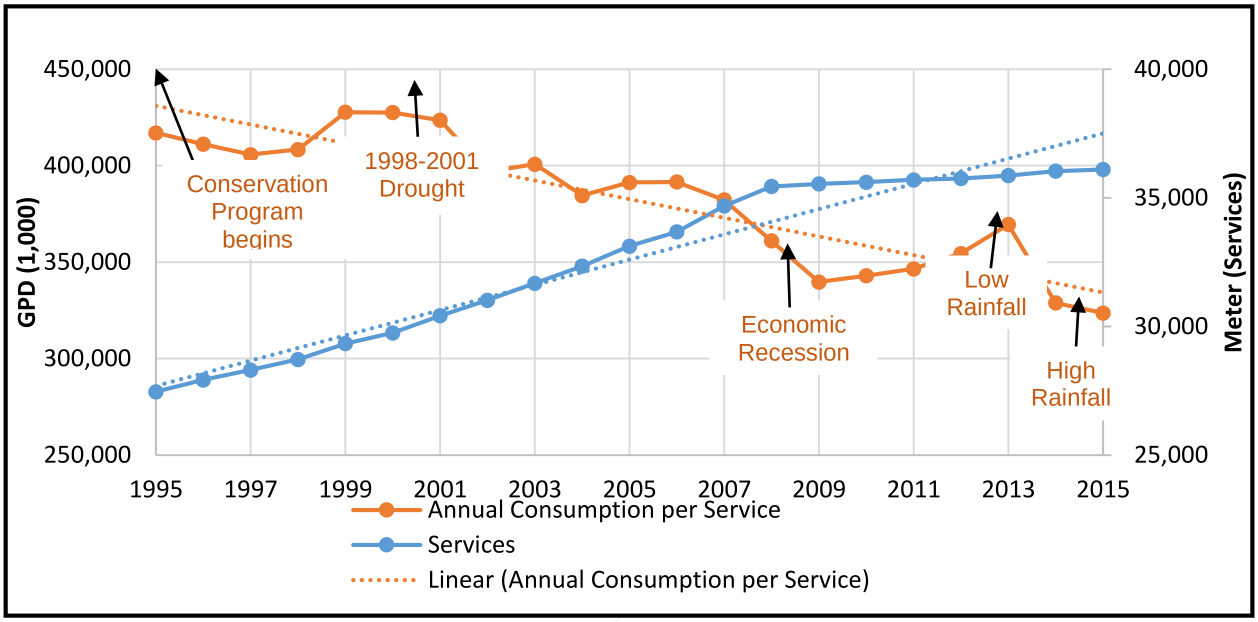
Water demand per service has been decreasing as a result of water efficiency regulations supporting water efficient products and development and supporting programs. Maui County Code, Chapter 16.20, effective December 31, 1992, which affects all development in Maui County regardless of purveyor, established a maximum rate of water flow or discharge for plumbing fixtures and devices in order to promote water conservation. MDWS also launched its water conservation program in the mid-1990s by providing low-flow devices and toilet leak detection tablets to its customers.

Table 12-2 Fixture Flow Rates

Devices	Maui County Code, 1993 and Later	MDWS Customer Giveaway Program
Kitchen faucets	2.2 gpm	1.5 gpm aerators
Bathroom faucet	2.2 gpm	1.0-1.5 gpm aerators
Showerheads	2.5 gpm	1.25-1.5 gpm
Toilets	1.6 gpf	0.8 gpf savings
Urinals	1.0 gpm	n/a
Hose nozzles	3.0 gpm	2.4 gpm maximum

Tiered water rates (water rates that increase with increased use) and other programs such as community education are also contributing factors that may be beneficial. From 1995 to 2015 the number of MDWS services (meters) increased over 30 percent while demand increased by about two percent, for an average decline of 22 percent per meter (see Figure 12-6 below).[34]

Figure 12-6 Maui Department of Water Supply Consumption Compared to Services, 1995-2015



MDWS, includes all services for Maui County including agricultural services.

A considerable amount of water could be saved by retrofitting older dwellings and using water-efficient appliances. The *2016REU* study found only 37 percent of residences met an efficiency level of less than 2.0 gal. per flush and 46 percent had clothes washer with less than 30 gal. per load, while 80 percent exhibited less than 2.5 gal. per minute for showers. While new residential units are required to conform to plumbing codes, adopting more restrictive codes than required by state law can further increase water savings in future development and retrofits. Since age of housing stock and remodeling and useful life of fixtures and appliances affect water conservation and efficiency, a robust water conservation program can increase adoption of more water-efficient devices, fixtures, appliances and behaviors.[35]

In the *2016REU* study, about 50 percent of water use was assumed to be attributed to outdoor uses such as landscape irrigation, water used through hose bibs, swimming pool related, washing pavement and cars, etc.[36] MDWS in 2016 and 2017 surveyed people about watering their yards at several events and other places where high-efficiency water fixtures were given out; of 802 responses 60 percent prefer hand watering, 27 percent use sprinklers, 12 percent

[34] Includes all MDWS systems serving Maui County; includes agricultural services. Decline was on average about 1100 to 900 gpd per service.

[35] *The Residential End Uses of Water, Executive Report, Version 2, 2016*.

[36] *The Residential End Uses of Water, Executive Report, Version 2, 2016*.

use drip irrigation systems, and 2 percent use other methods such as rainwater catchment, greywater from washing machines, and natural springs.[37]

Water savings of 20 percent or more can be estimated using mild to aggressive landscape water conservation programs. Pricing programs, water-conserving landscape, and reduction in planting areas may achieve outdoor demand reductions beyond efficiency measures.[38] The effect of a hypothetical 20 percent reduction in residential sector outdoor use is shown in Figure 12-7.

Potable Demand – Nonresidential Uses

The major end uses associated with commercial and institutional facilities include domestic and restroom uses, kitchen, heating and cooling, and landscaping according to *WaterSense at Work* (EPA, 2009). Commercial and government use comprises about 30 percent of MDWS consumption. Water-efficient products can deliver increased savings; for example, WaterSense labeled products are certified to use at least 20 percent less water than standard models. While water use fixtures for office and retail uses are similar to residential uses, programs targeted to locally prominent uses, such as hotels and restaurants, can be effective. Outdoor water for a variety of purposes can account for five to 30 percent of a facility's total water use. Proper landscape design, landscape systems, and regionally appropriate plant choices and pool practices can significantly reduce water use:

- Drip irrigation on plant beds instead of traditional sprinklers: 20-50%
- More efficient sprinkler heads: 30%
- Smart irrigation controllers: 15%
- Pool covers: 30-50% of evaporation [39]

Conservation Targets

Population based demand projections incorporate past conservation but do not take into account future conservation potential. The 2035 projected potable demand could be theoretically reduced based on an 8 percent reduction in per capita demand. After review by CWRM staff of this draft chapter, conservation demand targets were substituted for conservation supply targets. However, consistent with the Freshwater Initiative, reduction in MDWS residential demand of 8 percent per capita has the potential to offset up to 9 mgd of municipal potable source and delay source development over the 20-year planning period.

Conservation strategies are categories into demand side measures – on the consumer/end user side; and supply side measures – on the water purveyor/provider side. Examples of demand side measures include installation of water-efficient fixtures in new development; retrofit of

[37] MDWS High Efficiency Fixtures Distribution Results, FY 2017.
[38] *The Residential End Uses of Water, Executive Report, Version 2, 2016*.
[39] US EPA, WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities, October 2012.

existing development proactively, as fixtures wear out, or units are remodeled or replaced; and through water-efficient outdoor controls and practices. Examples of supply side measures include water loss control, leak detection, and improving water distribution and storage efficiencies.

Conservation Strategies

Water use conservation through improved efficiency and regionally climate adapted irrigation, coupled with increased use of alternative resources to offset potable supply, can significantly and cost-effectively reduce freshwater water and increase resource sustainability.

Public input at more than 20 community, target group and policy board meetings in 2015 and 2016, and via several surveys administered by MDWS show support for a variety of approaches to increase conservation as indicated below. There was much less agreement with behavioral controls, such as restrictions on time of day or days per week for watering residential landscaping.

Community members said …

- *Exercise control over water use and efficiency at the design phase rather than using behavioral controls*
- *Increasing water cost is the only effective way to produce conservation*
- *We have been talking to our kids about trade-offs - coaching them on how they shower and brush their teeth, that we can catch rain water to nourish the garden and fill the pool*

Survey of Potential Water Conservation Strategies and Measures - Over 75% Agreement

- ✓ Existing and new development equally bear responsibility for water conservation
- ✓ More aggressive conservation in new development in all areas
- ✓ More aggressive conservation in dry than wet areas (esp. large commercial landscaping)
- ✓ Adopt a restrictive water conservation standard for new development
- ✓ Require low-flow fixtures and water-conserving landscape in new development
- ✓ Implement a program to retrofit toilets in existing development
- ✓ Require all new landscape irrigation systems to be water-efficient
- ✓ Require existing large commercial users to reduce landscape water use
- ✓ Increase water conserving landscape requirements for resorts, golf courses, public facilities
- ✓ Maximize recycled wastewater use for irrigation uses
- ✓ Adopt grey water system programs for small residential and commercial irrigation
- ✓ Provide incentives for residential and small commercial catchment systems

The cost-effectiveness of conservation strategies is an important consideration in developing and sustaining a conservation program. Cost-effectiveness compares the costs of a portfolio of programs to promote water savings with the costs the utility and its customers would otherwise incur. In evaluating cost-effectiveness, MDWS compared the costs to develop and deliver new sources of water to meet future demand with the savings attributed to conservation. Cost savings, which vary with the portfolio of conservation programs selected, market penetration, timeframe and other assumptions, could be demonstrated for both basic and aggressive programs assisted by the economies of scale MDWS enjoys as the largest purveyor. For example, a five-year conservation program for the MDWS Central District with 45 percent penetration at an expenditure of $5M would reduce costs by $9.4M,[40] and a 10-year program with 45 percent penetration at an expenditure of $3.6M would reduce costs by $4.0M.[41] In both cases, operating cost reductions exceeded capital cost reductions. The potential for a net savings is also expected for the West Maui/Lahaina MDWS system due to the need for new source development.

There are several issues associated with a conservation program. Mandatory codes and regulations (e.g., requiring installation of fixtures that are more efficient than existing standards or that restrict some types of water use) are generally more effective and less expensive to implement than incentive programs. Adoption of "green" plumbing codes will automatically (at almost no cost) force anyone buying plumbing fixtures (i.e., toilets, shower heads, etc.) to meet maximum flow limits. Lead time must be given to plumbing retailers and supply houses to sell off inventory, but consumers and contractors would not be able to purchase illegal plumbing fixtures locally. Building inspectors will ensure compliance in new construction.

Regulating behavior, such as watering schedules, require some enforcement measures to be effective. “Policing” conservation measures is resource intensive and not supported by the community. Lastly, while programs may reduce customer bills due to less consumption, rates are not likely to be reduced due to fixed utility costs.[42] While it is beyond the scope of this WUDP to provide a programmatic plan for each public water system, the WUDP provides a framework for programs that can be evaluated and implemented to sustainably and cost-effectively manage the county's water resources.

<u>MDWS Conservation Program</u>

MDWS is preparing a Water Conservation Plan modeled after the *Hawai`i Water Conservation Plan*. While the WUDP provides long-term guidance and programs for all water uses and users of Maui, the water conservation plan focuses on specific short-term measures administered by MDWS within a longer-term framework as shown in the figure below.

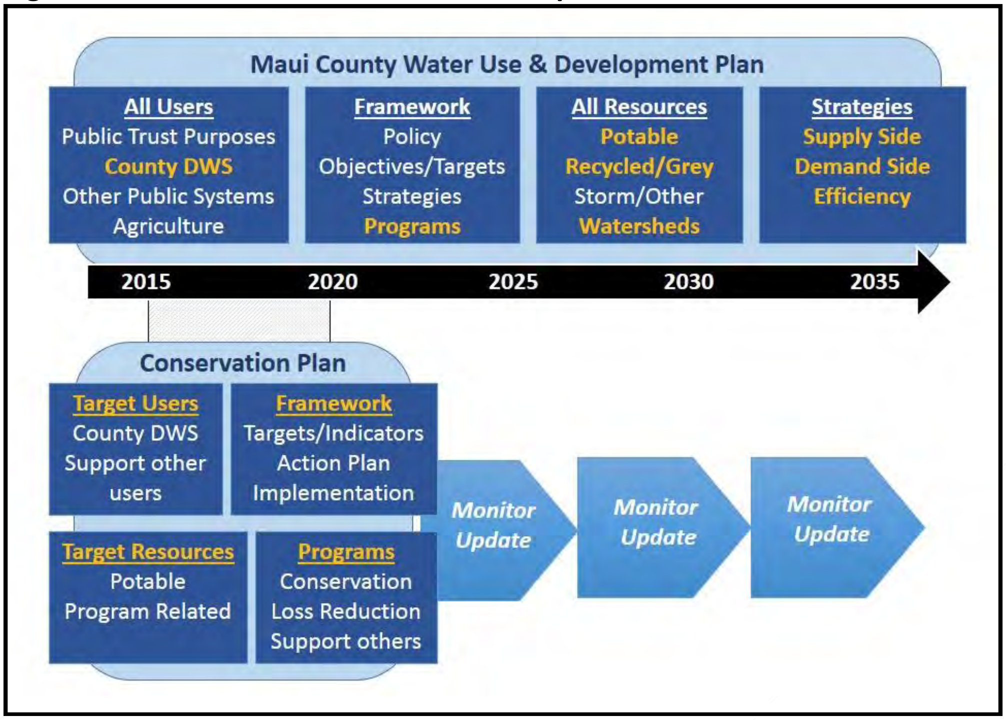
---

[40] Freedman, Carl, Haiku Design and Analysis. Maui County Water Use and Development Plan, Central DWS District Update, Nov. 16, 2010, p. 21.; $4.2M/5.2M capital/operating cost reduction.

[41] Freedman, Carl, Haiku Design and Analysis. Maui County Water Use and Development Plan, Upcountry Final Candidate Strategies WAC Draft, July 27, 2009, p. 18; $1.5M/$2.5M capital/operating cost reduction)

[42] Freedman, Carl, Haiku Design and Analysis. Maui County Water Use and Development Plan, Central DWS District Update, Nov. 16, 2010, p. 22.

Figure 12-7 Conservation Plan Relationships



The water conservation plan will implement County policy, protect water supplies, and reduce water use by reducing waste and increasing efficiency, allowing MDWS to meet existing and future demand in a more efficient, economic and sustainable manner. The plan will provide programs and measures to reduce consumption by MDWS customers and target groups, as well as promote water conservation measures that can be used by the community at large. The water conservation plan will accomplish a measurable and significant reduction over time resulting in:

- Reduced average daily water demands
- Lower peak season water use
- Deferment of new water source development

The plan will help to substantially reduce water consumption and raise conservation awareness through best management practices (BMPs) and incentives that foster participation and self-initiative by Maui communities and businesses. Some of the considerations in evaluating and ranking BMPs include:

- Cost-effectiveness
- Technology/market maturity
- Service area match
- Customer acceptance/equity
- Is there a better measure available?

- Strength, Weaknesses, Opportunities, and Threats (SWOT) analysis. Some of the considerations include:
  - Contribution of existing water conservation projects and programs
  - Political support, public acceptance, equity, regulatory issues
  - Development and operational costs
  - Funding sources, revenue replacement
  - Ongoing and future infrastructure investment priorities
  - Coordination, partnership, cost-share opportunities
  - Data and technical resources
  - Reduced operating costs

MDWS's long-term planning efforts have considered implementation of extensive water conservation measures as a strategy to meet future needs. Some water conservation measures (e.g., fixture replacement, leak repair) will result in tangible source water savings that can be reliably allocated to new users, while other types of measures rely on customer behavioral changes that may not be lasting. Behavioral savings are not treated as equivalent to new source until the water agency is comfortable that the resulting savings are permanent. By helping to extend the life of existing facilities and postponing new source development and capital improvement projects, water conservation has a high benefit-cost ratio.

MDWS Conservation Program Costs

Water conservation programs are expressed as a percentage of the "technical potential" for savings by implementing water conservation measures and practices. The Maui County WUDP Central DWS District Update (2010) and Upcountry District Final Candidate Strategies Report Draft (2009) evaluated the cost-effectiveness of various conservation program portfolios. Life cycle costs were estimated by Haiku Design & Analysis for 10 to 15 years of conservation measure life. All candidate measures, with the exception for greywater pilot program, targeted by MDWS have current life cycle costs of $3 per 1000 gallons and below. [43] Evaluating attainment of alternative levels of technical potential (30%, 45%, 60% and 75%) within various timeframes (7, 10, 12, 15 years) under certain assumptions indicated that achievement of 45 percent of the technical potential would yield the best economic returns. Depending upon the circumstances and needs of each water system, the duration and intensity of program implementation may be more cost effective, but only to a point of diminishing returns. A domestic base indoor program portfolio, including direct retrofit of *all* toilets, showerheads and sink faucet restrictors to current code standards, and 35 percent reduction of outdoor irrigation use would cost-effectively attain 15 percent of the technical potential after five years of implementation, as well as over longer timeframes. The recommended portfolio of demand-

[43] Haiku Design & Analysis Maui County Water Use and Development Plan Resource Options Draft, May 15, 2007. (Life cycle costs adjusted to 2016 assuming a 3 % inflation rate)

side conservation measures are all incorporated into the WUDP:[44] Costs and potential savings of the MDWS portfolio are further analyzed in development of the department's Conservation Plan.

MDWS Demand Side Conservation Strategies

MDWS' comprehensive program that includes ongoing demand-side elements and expansions as recommended in the WUDP are summarized in the table below.

Table 12-3 MDWS Demand Side Conservation Strategies and Programs

Existing Use and Facility Audits and Retrofits	**Distribution of water-efficient fixtures and retrofit/direct installation programs. Targeted audits and public facility water-efficient devices, fixtures and appliances programs**
Agricultural Programs	• Irrigation efficiency – technical assistance and rebates. Audits of irrigation system equipment and practices and recommendations to customer to improve efficiency. • Agricultural working group workshops – knowledge sharing about irrigation issues and solutions
Public Information and Education	• Establish a sustainability working group to teach and educate stakeholders about the interdependence of the social, environmental, economic and technological dimensions • Develop technology/innovation transfer programs with universities and schools. • Create a water conservation recognition program to reward entities, organizations, and individuals who innovate ways and means to increase water conservation. • Invigorate effective, fun, and engaging public events and contests to educate our youth and all those institutions, families, friends, and businesses who participate • Participate in recognized conservation programs which provide ideas, templates, materials and support for conservation programs, such as WaterSense, a US EPA partnership program. MDWS is a member. • Public advertising and community events • Agricultural users group • Building Manager User Group and Services • Permit review targeted recommendations
Landscaping	• Landscaping guidelines • Landscape ordinance under development • Landscape audit and retrofit program and small demonstration projects.
Rebates and Incentives	• High efficiency washing machines

[44] Maui County WUDP Central DWS District Update (November 16, 2010) and Upcountry District Final Candidate Strategies Report (July 27, 2009 Upcountry Water Advisory Committee Review Draft), Appendix A – Analysis of Demand Side Management (Conservation) Program Portfolios.

Existing Use and Facility Audits and Retrofits	**Distribution of water-efficient fixtures and retrofit/direct installation programs. Targeted audits and public facility water-efficient devices, fixtures and appliances programs**
	• High efficiency toilets and waterless urinals • Hotel Awards Program • High Efficiency Fixture Rebates
Regulatory	Revise county code to require high efficiency fixtures in all new construction. Develop a comprehensive water conservation ordinance to include xeriscaping regulations.
Water Use Rates	MDWS currently has a tiered rate structure (higher use results in higher rates) to encourage conservation (County Code Chapter 14.10). Data improvements underway could enable the Department to move toward a more aggressive tier structure.

While many programs are applicable to all public water systems, the economies of scale and customer diversity of MDWS allows it to provide a wide range of programs to its customers; as a department of the County, MDWS is positioned to provide education and outreach to the community at large. Still, various conservation measures should be evaluated to determine whether it would be feasible to apply them to a larger population base through methods such as:

- Adoption of regulations applicable to specified classes of uses, development types, geographic areas, or other categories, regardless of service provider. Examples are requirements for new development or that commercial uses replace specified appliances or fixtures with water-efficient ones within stated timeframes.
- Partnerships to administer, cost-share, or otherwise increase feasibility for smaller water providers, increase adoption rates, etc.

<u>Other Public Water Systems Demand Side Conservation Strategies</u>

Water conservation is applicable to water systems of all sizes, and programs can be tailored to the resources and uses served by the purveyor. The following WUDP policies are derived from and consistent with the goals and objectives established in the General Plan, Maui Island Plan and the WUDP public process to apply island wide:

a. Reduce the demand of existing uses.
b. Require aggressive conservation in new development in all areas.
c. Align the level of conservation with availability of local water resources.
d. Employ more aggressive landscape water conservation measures in dry areas than wet areas to mitigate water transport.
e. Instill a conservation mindset through community education, 'lead by example,' incentive programs, and conservation pricing.
f. The quality of the water supply should be matched to the quality of water needed, with the highest quality water allocated for the highest uses.

Theses general policies reflect the following strategies, programs and measures summarized in Table 12-4 below.

Table 12-4 Recommended Demand Side Conservation Strategies and Programs for MDWS, Public Water Systems and Non-Agricultural Irrigation

Strategies	Uses	Strategy Applicability
Smart meters retrofits	All	MDWS targeted rollout All water systems
Targeted water audits/direct install and sub-metering of multi-unit buildings	Residential Commercial	MDWS large users Public Water Systems
Residential low-flow devices incentives	Residential	MDWS customers All - public events
Residential and commercial water-efficient appliance and toilets incentives and rebates	Residential Commercial	MDWS customers
Targeted public facility water-efficient devices, fixtures and appliances programs	Public	MDWS County parks and facilities retrofits and partnerships
Landscaping and irrigation system incentives, targeting dry areas	Residential Commercial Public	MDWS County parks pilot program
Greywater incentives	Residential Commercial	MDWS pilot program
Rainwater catchment for irrigation	Residential Commercial	Educational - all
Water-efficient standards for fixtures, devices, and systems in new development (such as WaterSense or equivalent)	All	County Code amendment-all development
Water conserving design and landscaping in new development (xeriscaping targets dry areas)	All	County Code amendment-all development
Water-efficient irrigation systems	All	County Code amendment-all development
Water-efficient building design integrating alternative sources (grey water, catchment)	Large users Commercial Multi-family	Incentives or County Code amendment-target development
Low-impact development site design (integrate percolation, retention, capture)	Large users Commercial Multi-family Subdivisions	County Code amendment-target development
Restrict outdoor water waste (no runoff, water wasting, hose nozzles)	Outdoor water use	MDWS, drought rules
Targeted conservation programs in dry areas and drought conditions	Target users	MDWS water shortage rule
Educational, informational and other programs for community at large	All	MDWS
Water conserving landscaping guidelines	All	MDWS

Strategies	Uses	Strategy Applicability
Alternative source guidelines (grey water, rain harvesting, green sites, etc.)	All	MDWS
Market/customer surveys	All	MDWS
Water rates to incentivize conservation	All	MDWS tiered water rates
"Lead by Example" conservation and efficiency projects	All	County Parks Dept./MDWS-fixtures and landscaping programs at County parks and facilities

New development typically includes redevelopment or major improvements that relate to the subject element.

MDWS Supply Side Conservation Strategies

The sustainable and efficient use of water resources, as well as the capacity and integrity of water systems, can be improved by accounting for water as it moves through the system and taking actions to ensure that water loss is prevented and reduced to the extent feasible in accordance with accepted targets.

a. Perform annual comprehensive water audits

A comprehensive water audit program provides a foundation for improving system efficiency and loss control. A water audit provides a data driven analysis of water flowing through a water system from source to customer point-of-service and is the critical first step in determining water supply efficiency and responsible actions to manage and reduce water loss consistent with available source, operational and financial resources.[45] Some of the benefits of water audits include; increased water flow accountability and loss control; deferred source development; guiding leak detection and repair which result in energy and operational savings; and recover lost revenue from unauthorized or unmetered use. [46]

Act 169, Session Laws of Hawai`i, 2016, implements the *Hawai`i Water Conservation Plan* by requiring county-owned public water systems including MDWS to submit annual water audits to the CWRM beginning July 1, 2018. Act 169 specifies that audits use the American Water Works Association's *Water Audits and Loss Control Programs, Manual of Water Supply Practices M36* and its *Free Water Audit* software. The software produces financial and operational efficiency outputs and prioritized actions that can be taken to reduce system losses and improve data validity consistent with acceptable levels of water loss for each water system.[47]

---

[45] USEPA. Using Water Audits to Understand Water Loss. A Joint Presentation of the USEPA Office of Groundwater and Drinking Water and the American Water Works Association, 1/26/2012. https://www3.epa.gov/.../waterinfrastructure/docs/water-audits_presentation_01-2012.pdf *Accessed March 29, 2017.*

[46] Fujii, Neal, Commission on Water Resource Management. DWSR Providing Funding for AWWA Water Audits Coming to a Utility Near You. DOH, The Water Spot, DOH, Volume 20, Issue 4, October 2016. http://health.hawaii.gov/sdwb/files/2016/09/Water_Spot_Volume20_Issue4.pdf Accessed March 24, 2017.

[47] US EPA, Water Audits and Water Loss Control for Public Water Systems https://www.epa.gov/sites/production/files/2015-04/documents/epa816f13002.pdf Accessed March 24, 2017.

b. Fund and implement a continuous leak detection program

Monitoring and repair of identified leaks in water mains and laterals are guided by water audit data. Due to limited resources MDWS must prioritize leak repair. Lack of meters or access along water mains in undeveloped or agricultural areas can problematic in assessing leaks. Improved technologies such as District Metering Areas (DMAs), drone surveying and permanent leak detection on major distribution lines using the appropriate cost-effective technology would be beneficial and should be further explored.

Public Water Systems Supply Side Conservation Strategies

This section focuses on public water systems that primarily supply potable water, but the strategies can to varying degrees be applied to other systems.

a. Perform annual comprehensive water audits

Public water systems serving a population of 1,000 or more and those within water management areas regardless of population served are required to submit annual water audits beginning July 1, 2020. This includes the Kapalua Water Company, Kā`anapali Water System, Haleakalā and Kīpahulu National Park systems, as well as the Hawai`i Nature Center which is within the ``Īao water management area. Regardless of size, water systems should evaluate the system production data against metered or billed end uses to identify potential water losses. AWWA's *Free Water Audit* software required by Act 169 identifies thresholds to assist water system operators in determining acceptable levels of water loss for their systems. The average water loss for public water systems in the United States is 16 percent, with up to 75 percent of that loss able to be recovered.[48]

b. Maintain and operate the water system to minimize the sources of water loss

Preventive measures extending from design standards to effective maintenance can help ensure systems operate at optimal performance throughout their useful life and that repairs are made proactively. Leaks and water loss may occur at the water meter, in laterals or distribution lines, at source or treatment facilities, or other points in the system. Leak detection is used to locate and verify problematic leak areas in addition to ongoing repair and maintenance operations. Metering, monitoring and analysis of performance indicators can assist in identifying and prioritizing actions ranging from replacement or rehabilitation to preventative maintenance of meters, lines and equipment. In addition to a comprehensive leak detection program, a program for response and repair to large and small leaks, generally identified by the public, is necessary. Concerns were raised in the WUDP public process that

[48] US EPA, Water Audits and Water Loss Control for Public Water Systems https://www.epa.gov/sites/production/files/2015-04/documents/epa816f13002.pdf Accessed March 24, 2017.

irrigation in the rain, broken sprinkler heads and overspray are not addressed at county parks and facilities. The county needs to lead by example.

Conservation Issues and Opportunities for Agricultural Uses

Irrigated agriculture is facing challenges due to limited water supplies, competing uses and the threat of water quality degradation, along with market conditions that require irrigation water users to increase efficiency.[49] Sustainable agriculture and self-sufficiency goals can also be supported by resource conservation and efficiency. Most landscape irrigation is included within the population based demand projections.

Agricultural irrigation water use has been predominately supplied by surface water conveyed by the East Maui Irrigation Company (EMI), Wailuku Water Company, Maui Land & Pineapple Company, former Pioneer Mill and West Maui Water Company irrigation systems to local users and systems including `auwai. MDWS, Kā`anapali Coffee and various land owners are also identified as agricultural water managers in the 2015 State Agricultural Land Use Baseline. MDWS supplies non-potable surface water through EMI's ditch to the Kula Agricultural Park. Creative solutions are needed in order to implement county policies to support agriculture and provide adequate irrigation supply while surface water sources are constrained by higher priority protected public trust needs.

Demand-side management focus on crop and irrigation water use efficiencies and conservation, while supply-side measures focuses on irrigation system efficiencies and alternative supplies.

<u>Crop Demands</u>
Focusing agricultural production on crops adapted to local climate conditions was called for during community meetings on the WUDP in order to reduce irrigation requirements and water transport. Optimal crop yield requires balancing soil-water content between an upper limit at which leaching becomes excessive and a lower point at which crops are stressed.[50] Maximizing capture and use of precipitation can reduce irrigation needs and support sustainability. Regenerative agriculture can hold water in the soil restore the watershed by building healthy soil to improve carrying capacity, planting windbreaks, rotational planting, planting climate adapted crops, efficient irrigation methods, and capturing and storing rainwater.[51]

a. Inform and support less water consumptive crops, climate adapted crops and appropriate water duty.

Analysis to decrease crop consumptive use and increase crop efficiencies should be provided in the Agricultural Water Use & Development Plan. Provide guidance on appropriate crops by

---

[49] USDA-NRCS, *National Engineering Handbook*, Part 623, Irrigation, Chapter 2, Irrigation Water Requirements, 1993, p. 2-1.
[50] USDA-NRCS, *National Engineering Handbook*, Part 623, Irrigation, Chapter 2, Irrigation Water Requirements, 1993, p. 2-1.
[51] Maui Tomorrow, *Malama `Aina: A Conversation About Maui's Future*, March 8, 2016, p. 23.

climate zone, along with pertinent information on industry organizations and technical partners, federal and state support. Utilize available numerical models for estimating crop irrigation requirements, such as the ArcGIS based numerical simulation model IWREDSS 2.0 that account for water budget, water duty per acre, rain, runoff, evapotranspiration, drainage, irrigation application systems and other factors.[52]

Irrigation Management

Gains in water conservation may be most successful in the area of water use efficiency due to greater control and lower sensitivity to market forces.[53]

- Minimize losses during conveyance to and distribution onsite – diversion, conveyance and delivery losses, seepage and ET loss
- Minimize losses during application to crops – efficient irrigation methods, time planting to take advantage of precipitation, reduce evaporation in field, schedule irrigation based on soil moisture and plant needs, control weeds
- Apply only the amount of water the crop needs
- Apply new technologies for water management

An estimated one-third to one-half of water diverted for irrigation is lost between the source and the point of use in the western US.[54] Irrigation efficiency is an index used to quantify the beneficial use of water diverted for irrigation purposes to the end use, and includes irrigation water management and losses in providing the water to the area irrigated. Water management decisions strongly influence irrigation efficiency for surface water systems, while physical site conditions and irrigation facilities are more important in sprinkler, micro, and subsurface systems. [55] Conveyance system losses result from seepage from the irrigation system, leakage around diversion and other structures and operational spills. Losses up to 50 percent of a diversion can generally be maintained below 10 percent with a carefully managed manually operated system, or reduced even lower with automation technology. At the farm level, field distribution efficiency by the end user is affected by size of irrigated area, water delivery schedule, crops types, ditch lining, and water supplier capabilities.[56]

---

[52] Fares, Ali, Ph.D., CTAHR, UHM. Irrigation Water Requirement Estimation Decision Support System (IWREDSS) to Estimate Crop Irrigation Requirements for Consumptive Use in Hawai`i, Final Report prepared for CWRM, August 2013

[53] Adapted from Bellows, Barbara. Irrigation (PPT). National Sustainable Agriculture Information Service, 2004. https://attra.ncat.org/downloads/water_quality/irrigation.pdf This reference is also the source for many of the listed best management practices.

[54] USDA-NRCS, *National Engineering Handbook*, Part 623, Irrigation, Chapter 2, Irrigation Water Requirements, p. 2-181.

[55] NEH, p. 2-164. Irrigation efficiency is the ratio of the average depth of irrigation water beneficially used to the average depth applied, expressed as a percentage.

[56] USDA-NRCS, National Engineering Handbook, Part 623, Irrigation, Chapter 2, Irrigation Water Requirements, 1993, pp. 2-181 to 2-185.

Table 12-5 Conveyance and Field Distribution System Efficiencies

Project characteristics	**Conveyance efficiency**
• Continuous supply with no substantial change in flow	90%
• Rotational supply, depending on project characteristics	65 – 80%
Irrigation field characteristics	**Field efficiency**
• Irrigated fields >50 acres, unlined / lined ditch or pipeline	80 / 90%
• Irrigated fields <50 acres, unlined / lined ditch or pipeline	70 / 80%

USDA-NRCS National Engineering Handbook, Part 623, Irrigation, Chapter 2, Irrigation Water Requirements, Table 2–53, p. 2-185.

The Nā Wai `Ehā and East Maui Streams Contested Cases provide guidance on water losses for purposes of the restoration of stream flows under an amended IIFS. In both Contested Cases CWRM used an irrigation efficiency factor of 85 percent. In the East Maui Contested Case, EMI's irrigation reasonable and beneficial losses were calculated at 22.7 percent of total water uses including all HC&S uses, deliveries to MDWS and other uses. Of 22.7 percent, about 10 percent was attributed to system losses of water to irrigate HC&S fields (seepage, transportation and storage ET, reporting and system inefficiencies).[57] In the Nā Wai `Ehā Contested Case, Wailuku Water Company's reasonable system losses were five percent (2.73 mgd) and WWC estimated that lining the unlined portions of the ditches could further reduce system losses by about 29 percent;[58] HC&C's reasonable losses were 2.15 to 4.20 mgd (HC&S indicated an approximately 20 percent loss rate is 4 to 5 mgd).[59]

Political and legal questions are raised where those that benefit from conservation are not responsible for the cost. For example, while improvement of an irrigation system to reduce the amount of water diverted would provide more water for downstream users, the upstream user would not benefit and may not be incentivized to improve efficiency.[60] Establishment of an IFS and water use permits provide a foundation for addressing this issue. Case law (Wai`ahole II) establishes that "[o]ffstream users have the burden to prove that any system losses are reasonable beneficial by establishing the lack of practicable mitigation measures, including repairs, maintenance, and lining of ditches and reservoirs. … Whether or not a permit is

[57] CWRM Hearing Officer's draft January 15, 2016 Minute Order, East Maui Streams Contested Case (CCH-MA13-01), pp. 60, 72-74. Total water uses characterized by HC&S as surface water delivered and groundwater pumped. 85% consistent with industry standard and minimum drip irrigation efficiency design and consistency with the Irrigation Water Requirement Estimation Decision Support System estimating crop water requirements for consumptive use permitting in Hawai`i. The USGS study, "Measurements of Seepage Losses and Gains, East Maui Irrigation Diversion System, Maui, Hawai`i" determined it is not clear whether net seepage losses occur in the EMI diversion system.
[58] Calculation of 29%: WWC estimated a reduction of about 800,000 gpd from lining unlined ditches at approx. cost of $5,026,000; (800,000 gpd of 2.73 mgd = 29%). Stipulation Re Mediator's Report of Joint Proposed Findings of Fact, Conclusions of Law, Decision and Order in re Petition to Amend Interim Instream Flow Standards of Nā Wai `Ehā Contested Case Hearing (CCH-MAO6-O1), April 4, 2014, Finds of Fact, p. 17.
[59] Stipulation Re Mediator's Report of Joint Proposed Findings of Fact, Conclusions of Law, Decision and Order in re Petition to Amend Interim Instream Flow Standards of Nā Wai `Ehā Contested Case Hearing (CCH-MAO6-O1), April 4, 2014, Finds of Fact, pp. 14-18.
[60] USDA-NRCS, *National Engineering Handbook*, Part 623, Irrigation, Chapter 2, Irrigation Water Requirements, 1993, p. 2-225.

required for system losses, off-stream users, and ultimately the Commission, must account for water lost or missing by adopting "provisions that encourage system repairs and limit losses."[61]

Many intake systems were designed to take the entire base flow and discharge excess further down the ditch system, impacting natural flows and protection of native stream biota and appurtenant rights of taro growers downstream. New intakes and automated management systems may be helpful.[62] The CWRM determined that lo'i consume 15,000 to 40,000 gad and leakage from the inflow and outflow ditches must be reduced as much as practically possible.[63] Irrigation efficiencies of commonly grown crops with typically used irrigation systems indicate many crops typically use drip systems.[64] With proper irrigation method, crop and site conditions, and a high level of management, the efficiency of any irrigation system can be increased to the low to mid 90's.[65] Irrigation efficiency can be increased by about 15 percent by converting from sprinkler to drip irrigation.

Table 12-6 Common Crops, Typical Irrigation Systems, and Irrigation Efficiencies (%)

Crop	Irrigation	Efficiency	Crop	Irrigation	Efficiency
Avocado	Drip	85	Melons	Drip	85
Banana	Micro-spray	80	Pineapple	Drip	85
Breadfruit	Drip	85	Papaya	Drip	85
Cabbage	Drip	85	Seed Corn	Drip	85
Coconut palms	Drip	85	Sweet potato	Drip	85
Coffee	Micro-spray	80	Sugarcane	Drip	85
Domestic garden	Sprinkler	75	Taro (dry)	Drip	85
Koa	Micro-spray	80	Taro (wet)	Flood	50
Lettuce	Sprinkler	70	Turf, golf	Sprinkler	75
Macadamia nut	Micro-spray	80	Turf, Landscape	Sprinkler	75

Fares, Ali, Ph.D., CTAHR, UH-M. Irrigation Water Requirement Estimation Decision Support System (IWREDSS) to Estimate Crop Irrigation Requirements for Consumptive Use in Hawai`i, Final Report, August 2013, Tables 1 and 2, pp. 6-7.

a. Improve irrigation management and efficiency.

Promote education and resources to farmers and private water purveyors to increase adoption of cost effective conservation methods. Catalyze and support efforts to enhance agricultural

---

[61] CWRM's Findings of Fact, Conclusions of Law, and Decision and Order in re Petition to Amend Interim Instream Flow Standards Nā Wai `Ehā Contested Case Hearing, June 10, 2010 (CCH-MAO6-O1), p. 131-132. [Waiãhole I, 94 Raw. at 172-73, 9 P.3d 29 at 484-85; Waiãhole II, 105 Raw. at 27, 93 P.3d at 669]

[62] 2015 State Agricultural Land Use Baseline, pp. 84-85.

[63] CWRM's Findings of Fact, Conclusions of Law, and Decision and Order in re Petition to Amend Interim Instream Flow Standards Nā Wai `Ehā Contested Case Hearing, June 10, 2010 (CCH-MAO6-O1), p. 168.

[64] Fares, Ali, Ph.D., CTAHR, UH-M. Irrigation Water Requirement Estimation Decision Support System (IWREDSS) to Estimate Crop Irrigation Requirements for Consumptive Use in Hawai`i, Final Report prepared for CWRM, August 2013.

[65] USDA-NRCS, *National Engineering Handbook*, Part 623, Irrigation, Chapter 2, Irrigation Water Requirements, 1993, p. 2-164.

sustainability and self-sufficiency consistent with county policy using industry organizations and technical partners such as University of Hawai`i College of Tropical Agriculture and Human Resources, US Department of Agriculture, Soil and Water Conservation District, Hawai`i Agriculture and Education Departments; Hawai`i Farm Bureau Federation, and Hawai`i Organic Farmers Association.

b. Maintain the integrity of plantation irrigation systems including reservoirs

Explore funding and support maintenance and improvements to Maui's plantation conveyance systems to mitigate losses. A cost benefit analysis is warranted to assess how system improvements to reduce losses can offset groundwater development and compare to alternative resources. A strategy to preserve existing reservoirs at risk of decommissioning is needed to continue and expand raw water storage, which is key to managing drought conditions, taking advantage of periodic flows, and planning for climate change.

<u>Water Supply Management</u>

The use of surface and groundwater supplies can be reduced or optimized through increased storage, reuse and use of alternative sources. Capture of rainfall and runoff along with retention of surface water delivered and storage in ponds or reservoirs can reduce the need for other water resources. MDWS may also be called on to increase delivery of potable water for agricultural needs as the Food Safety Modernization Act requires use of treated water to wash crops and prepare them for market

Increased use of alternative sources such as recycled water and stormwater reuse is consistent with County policy and community sentiment expressed to reduce transport and align water quality levels with use. While the Food Safety Modernization Act poses challenges, increased use of recycled water can offset irrigation needs for some crops in some areas, with the potential to reduce injection of unused recycled water. Reuse of irrigation water prior to discharge where feasible can increase irrigation efficiency and reduce runoff or disposal of drainage containing elevated chlorides, agricultural chemicals, or sediments. County plan policy supports maximizing the use of alternative supplies to serve non-potable needs.

a. Augment agricultural water supplies with alternative resources.

Maximize the use of alternative resources for agriculture and irrigation, even if not the lower cost option. Support implementation of stormwater capture for agricultural end uses. This strategy is further discussed under Section 12.4.3

The table below (Table 12-7) summarizes conservation strategies related to agricultural irrigation.

Table 12-7 Recommended Conservation Strategies and Programs for Agricultural Uses

Strategies	Applicability
Research, support and use of less water consumptive crops and climate adapted crops	State Department of Agriculture, Industry/technical groups supported by state/federal policy
Improve irrigation management and efficiency	Industry/technical groups supported by state/federal policy
Maintain the integrity of plantation irrigation systems including reservoirs	Public-private partnerships: East Maui Irrigation Co, Wailuku Water Co, West Maui Land, Maui County, State Dept. of Land & Natural Resources, State Dept. of Agriculture
Augment agricultural water supplies with alternative resources	County Dept. of Public Works, State Dept. of Land & Natural Resources, State Department of Agriculture

Drought and Climate Change Scenarios

An aggressive water conservation program is a critical component of drought mitigation, especially during the dry and/or summer months. Conservation can address climate change by increasing resilience to declining water supply or more frequent or longer droughts and their related effects. A priority action recommended in the *Hawai`i Drought Plan 2017 Update* is to "Support water conservation, reuse, and recharge measures in Hawai`i as part of increasing freshwater security."[66] The summary of conservation and reuse strategies for the State of Hawai`i are similar to those recommended in this WUDP chapter:[67]

- Continue to implement the Hawai`i Water Conservation Plan.
- Encourage the county water departments to develop their own water conservation plan.
- All levels of government, the private sector, and stakeholders should be involved in conservation activities and should actively develop new water conservation programs where needed.
- Development of coordinated plans to implement water restriction practices, voluntary and mandatory, if a drought is either imminent or exists. Establish regional water shortage provisions and policy for guidance and drought-related emergencies.
- Dissemination of information to the public about water conservation measures.
- Continued development of media campaigns to solicit public support and cooperation for the effective and prudent use of water.
- Development of incentive programs or tax credits for installing water saving fixtures.

[66] Hawai`i Drought Plan 2017 Update (January 2017 Draft), prepared by One World One Water for CWRM, p. 91.
[67] Hawai`i Drought Plan 2017 Update (January 2017 Draft), prepared by One World One Water for CWRM, p. 83.

- Offer free inspections to identify leaking toilets and plumbing fixtures.
- Continue implementation of the Hawai`i Water Audit Validation Effort.
- Support and encourage water-conserving irrigation systems, irrigation management practices, and water conservation practices, such as windbreaks and cover crops.
- Encourage use of rainwater catchment for outdoor water uses and irrigation.
- Continue to encourage source water use reporting and end use metering.
- Support use of reuse, greywater and dual water systems, and stormwater utilities.
- Increase water reuse for large landscaped areas.

The strategies and programs in this chapter also support the *Hawai`i Climate Change Adaptation Priority Guidelines Tools* for local government:

- Identify potential steps and barriers for avoiding over-allocation of groundwater, such as implementing demand-side conservation measures
- Prepare and implement mandatory water conservation and recycling plans
- Increase resilience to declining water supply or more frequent drought by implementing mandatory water conservation and recycling
- Incorporate water-conserving infrastructure and practices into new development and redevelopment
- Enhance "green-building" efforts with county rebates and utility credits directed at conservation

Conservation and Efficiency Related to Energy (Demand/Supply Side Management)

<u>Issues and Opportunities</u>
The cost of energy is the largest cost of water production. Water conservation programs applied to potable and alternative water sources reduce the costs of developing, moving, storing and treating water, thereby conserving energy and reducing cost. Water utilities have an opportunity to improve energy efficiency and load management and generate and use renewable energy. Benefits include lower costs, increased sustainability, energy independence and security, reduced environmental degradation and health impacts, and other benefits associated with climate change mitigation and adaptation.

The State goal to generate 100 percent of the state's electricity with renewables by 2045 (HB 623, June 8, 2015) will be implemented by the energy utilities and drive policy at all levels of government. MECO's updated Power Supply Improvement Plan calls for 100 percent renewable energy by 2040 and MIP Energy Objective 6.10.1 proposes to reduce fossil fuel consumption by 30 percent from 2010 to 2030.

MDWS Energy Efficiency and Production

MDWS is the largest single consumer of electricity on Maui and participates in MECO demand response programs which incentivize energy users through agreements to alter the timing, level of instantaneous demand, or the total electricity consumption.

Opportunities to increase energy efficiency, manage electrical loads and generate electrical energy provide benefits to the County, MDWS customers and MECO. Most energy consumed is used to operate motors for pumps that lift water to storage tanks and reservoirs. This is most significant for the Upcountry System where water from the basal aquifer near sea level is conveyed to elevations ranging from 1,000 to 4,000 feet; electrical costs for pumping water 1,000 feet is roughly $1.50 per 1,000 gal water. When pumped to MDWS distribution at an elevation of 4,000 feet, the pumpage cost far exceeds the average customer water rate charge of about $4 per 1,000 gallons of water.

The MDWS system has the capability to provide short-term "stabilizing" load management to accommodate MECOs growing proportion of variable renewable energy sources, which could benefit both MECO and MDWS customers.[68]

Renewable energy production opportunities are site specific due to the nature and availability of renewable energy sources and proximity to MDWS system electrical loads. MDWS facilities have limited land area necessitating access to land for power generating installations.[69] MDWS has opportunities to produce renewable energy to offset its own while reducing system costs. Options identified to date include using water from high-level tunnels to produce hydroelectric power, wind generation to support the Upcountry system, photovoltaic installations through third parties; and an inline hydroelectric project at the Mahinahina WTF are under evaluation.

Other Public Water Systems

There are a wide range of opportunities to improve efficiency and increase the use of alternative energy resources, albeit at a smaller scale than is possible for MDWS, through an audit of existing facilities, equipment and vehicles and systematic planning and purchasing for future system, operations and maintenance. Coordination and partnerships with industry groups such as Hawai`i Waterworks Association, MDWS and MECO can help mitigate limited resources.

Objectives

a. Energy efficiency and production measures advance several of the WUDP planning objectives including: Cost, Efficiency, Environment, and Sustainability.

---

[68] Freedman, Carl, Haiku Design and Analysis. Maui County Water Use and Development Plan, Central DWS District Update, Nov. 16, 2010, p. 23.

[69] Freedman, Carl, Haiku Design and Analysis. Maui County Water Use and Development Plan, Central DWS District Update, Nov. 16, 2010, p. 110.

General Plan Policies

a. Support energy efficient systems, processes, and methods in public and private operations, buildings, and facilities.
b. Support the establishment of new renewable energy facilities at appropriate locations provided that environmental, view plane, and cultural impacts are addressed.
c. Encourage all new County facilities completed after January 1, 2015, to produce at least 15 percent of their projected electricity needs with onsite renewable energy.

Recommended Strategies

a. Pursue comprehensive energy management

Similar to water audits, energy audits should be used as a basis for identifying energy inefficiencies and opportunities. Programmatic coordination is needed between the water purveyor, Maui Electric Company, the County Energy Management Program, the State and utility sector programs.

b. Increase energy efficiency and improve load management

The greatest energy reduction opportunities are the result of water conservation and efficiency. Investing in high efficiency equipment where cost-effective, establishing system operation protocols that consider energy efficiency and participating in load management incentive programs should be considered by all water purveyors.

c. Increase alternative energy generation and use

Reduction in the use of fossil fuels by facilities, equipment, vehicles, and operations through energy efficiency and conversion to other technologies contributes to State and MIP objectives. The MIP calls for increases in renewable energy production and working with the Energy Management Program in their efforts to produce an energy audit of County facilities, operations, and equipment; develop programs and projects to achieve greater energy efficiency and reduction in fossil fuel use; and phase out of inefficient fossil-fueled vehicles. Water purveyors should monitor and implement cost-effective alternative energy generation opportunities.

12.3 CONVENTIONAL WATER SOURCE STRATEGIES

Between the two mountain ranges on Maui, Mauna Kahalawai and Haleakalā, naturally occurring water sources can be broadly described as East Maui groundwater, East Maui surface water, West Maui groundwater and West Maui surface water. These are considered conventional water sources. Conservation and efficiency measures can reduce the utilization of water and delay source development.

Groundwater Development

Island wide, groundwater supplies about 70% of drinking water needs. Aquifers on the wet windward side are sustained by high rainfall with 60% of the island's recharge occurring in Ko`olau and Hāna aquifer sectors. To support current population centers, groundwater is moved from sources to where it's needed. Sources in the Wailuku Sector provides most of the freshwater supply for communities spanning from Waihe`e to Pā`ia on the north shore, Kahului, Waikapū and transmitted across the Central isthmus to the Kīhei-Mākena region. The Maui Island Plan explicitly directs growth to areas where there is available infrastructure capacity. A recurring concern raised in the WUDP public process to reduce water transport needs to be balanced with the need to support planned growth areas with reliable water supply.

Groundwater Availability Issues

The amount of groundwater that can be developed is limited by the amount of natural recharge and aquifer outflow that contribute to streamflow and to prevent seawater intrusion, established as sustainable yield. Because delineation of aquifer sectors and systems in some cases are based on limited hydrologic information, areas for potential groundwater development must be assessed on its own merits to determine any additional needs for hydrologic studies and interaction with surface water and other sources.

Understanding potential impact of climate change adds to uncertainty in long-term groundwater availability. The primary responsibility to determine potential impacts on water resource availability lies with the State CWRM who in turn relies on studies and predictions by the scientific community and other agencies. Water purveyors need guidance how to mitigate and adjust to potential changes in groundwater availability.

Other constraints on groundwater availability include access and cost. Conveyance from high yield aquifers in remotely located watersheds to growth areas can be difficult and expensive due to topography and distance. Basal well development at high elevations, such as Makawao aquifer above 1200 feet would result in high pumping costs, just in terms of pumping water from the water table to ground elevation.

Adding wells in already developed aquifers must also consider distribution of pumpage. Development adjacent to existing infrastructure is preferred from a cost perspective, but adding transmission to distribute wells further throughout an aquifer system may be warranted to optimize pumpage and mitigate aquifer impact.

State CWRM designation of groundwater management areas provides more oversight by the CWRM in accordance with the State Water Code Section 174-C-41. It does not change established sustainable yield or pumpage distribution but allocates water use by permit within sustainable yield. Water use permits for the `Īao Aquifer, designated a groundwater management area in 2003, exceed 95% of sustainable yield.

Water availability has been a much debated issue since the adoption of the County Availability Rule, codified in Maui County Code Section 14.12. The rule applies to the MDWS systems and only addresses residential developments. The current rule does not clearly distinguish between long-term water supply available by infrastructure, including developed source capacity, or long-term water supply in terms of resource limits, defined as sustainable yield and in-stream flow standards. Community concerns raised with regards to the current policy range from excessive burden on private developers to supply water source; a convoluted process that impedes development of much needed housing; lack of expertise by MDWS to complete the rigorous assessment mandated in the rule; loop holes that exempt commercial development and non-county water systems from the rule; proliferation of small private water systems around the island versus a cohesive government-managed water system; and inadequate protection of the resource. The rule has been largely blamed for blocking small to medium-scaling housing from being built. [70]

Objectives

a. Provide adequate volume of water to timely serve planned growth in MIP
b. Increase capacity of water systems in striving to meet the needs and balance the island's water needs
c. More comprehensive approach to water resource planning to effectively protect, recharge and manage water resources
d. Ensure stable chloride levels in developed wells

General Plan Policies

d. Acquire and develop additional sources of potable water.
e. Seek reliable long-term sources of water to serve developments that achieve consistency with the appropriate Community Plans.
f. Capitalize on existing infrastructure capacity as a priority over infrastructure expansion.
g. Ensure that MDWS actions reflect its public trust responsibilities toward water.
h. Ensure that the WUDP implements the State Water Code and MIP's goals, objectives, and policies.
i. Ensure that the County's CIP for water source development is consistent with the WUDP and MIP.
j. Ensure that adequate supplies of water are available prior to approval of subdivision or construction documents.

Recommended Strategies

a. Support collaborative hydrogeological studies to inform impact from climate change and future well development on groundwater health.

Potential effects of groundwater development on streamflow and on the quality of water pumped from existing wells in a region can be evaluated by robust hydrologic studies and models. Joint funding and collaboration between the municipal and private

[70] Public Testimony, Maui County Council Water Resources Committee meeting January 6, 2016

purveyors, CWRM and the U.S. Geological Survey would focus studies to maximize benefits and prevent conflicts in water development and designation. The strategy urges the CWRM to prioritize hydrological studies and groundwater modeling in regions of planned well development. Study and modeling results should guide individual well development that mitigates salt water intrusion and impacts to adjacent sources and surface water, optimizes pumpage of existing wells to avoid negative impacts and assist CWRM in assessment and updates of sustainable yield.

b. Develop groundwater to provide sufficient supply for growth, maintaining a buffer to sustainable yield in order to conservatively account for potential future drought impact and prospective adjustments in aquifers lacking hydrologic studies.

Groundwater sources remain a cornerstone in serving reliable and adequate volume to current and new customers for municipal and privately owned systems in the long-term. While other strategies such as conservation and alternative resources can alleviate and delay development of new groundwater sources, carefully planned well development is required in all aquifer sectors to meet anticipated growth. Limiting well development in any aquifer system to below sustainable yield addresses community concerns for an additional resource buffer, especially in aquifer systems where confidence ranking of sustainable yield is low due to lack of hydrologic data. The strategy would inform CWRM decisions in their administration of well construction and pump installation permits in aquifers where pumpage approaches sustainable yield. Although changes in recharge and yield due to climate change cannot be reliably predicted over the 20 year time frame, a prudent approach is to distribute well development and pumpage throughout and between aquifer sectors rather than maximizing pumpage up to individual aquifer systems' sustainable yield. Limited groundwater transport in conjunction with aggressive conservation can alleviate stress on aquifer systems underlying infrastructure and growth areas, even though regional resource use is generally more economic. For instance, growth areas in dry Central and South Maui are supported by infrastructure but lack sufficient regional water resources to supply population growth. Withdrawals in Waikapū aquifer to the north-west and Haiku aquifer system to the east are negligible with about 29 mgd of sustainable yield undeveloped. Conservative buffers can be maintained well below sustainable yields. Well development by municipal and private purveyors should be guided by hydrogeological studies as defined in the preceding strategy to identify any impact on surface waters.

c. Promote the highest quality water for the highest end use.

Groundwater on Maui is generally of excellent quality, requiring minimum treatment. Especially high level groundwater, available in some areas as tunnel or spring water, is of pure quality and does not necessitate pumping from sea level to area of service. Prioritizing high level and good quality groundwater for potable needs and using brackish, semi-brackish and otherwise compromised quality water for non-potable uses can be achieved through collaborative agreements between water purveyors, dual distribution systems and increased use of alternative resources for non-potable demand. Dike confined high level water, available through tunnels or springs, generally contributes to base flow. High level tunnels and springs are addressed by CWRM for the designated surface water management area of Nā Wai `Ehā. Withdrawals from tunnels or high level wells in Ko`olau ASEA have historically contributed to the EMI ditch flow but is not specifically addressed in the East Maui streams contested case. Contribution from high level tunnels in the Lahaina ASEA to regional stream flow should be further explored by CWRM in assessment and establishment of Instream Flow Standards.

d. Protect and prioritize public trust uses in allocating groundwater in regions of limited resources and conflicting needs.

The Hawai`i Supreme Court has identified four trust purposes, which are equally protected under the law:

- Maintenance of waters in their natural state;
- Domestic water use of the general public, particularly drinking water;
- The exercise of Native Hawaiian and traditional and customary rights, including appurtenant rights; and
- Reservations of water for Hawaiian Home Land allotments.

In accordance with the principles for the water resources trust identified by the Court, the State and the County should in planning and allocating groundwater resources protect public trust uses whenever feasible; weigh competing public and private water uses on a case-by-case basis, with a presumption in favor of public use, but also accommodate non-public trust uses to promote the best economic and social interests of the people of the State. The State CWRM has an additional duty, set forth in the State Water Code 174C-101, to protect adequate reserves of water for foreseeable needs of Hawaiian Homelands.

As illustrated under Resource Adequacy in section 11, demand based on population growth can be met by available groundwater yield, even under drought conditions. The full build-out of County Zoning scenario, where demand would exceed the island conventional water resources, is considered unrealistic because it is not coordinated with population projections, or taking into account forecasted economic conditions over the planning period. Agricultural demand has by far the greatest potential for fluctuation in estimated demand over the planning period. Where affordable untreated surface water use for agricultural irrigation is constrained by the current legal environment and stricter Food and Drug Administration (FDA) standards, demand for groundwater as an irrigation source could increase.

Projected water use is difficult to break down between public trust and non-public trust categories. While agricultural irrigation is not a recognized public trust purpose, the Maui Island Plan objectives and policies support reliable and affordable water supply for agriculture.

Municipal use can be generally categorized as serving a public trust purpose, or at the very least include a public trust purpose. The State Water Code defines municipal use as “domestic, industrial, and commercial use of water through public services available to persons of a county

for the promotion and protection of their health, comfort, and safety, for the protection of property from fire, and for the purposes listed under the term 'domestic use'." Non-potable needs for outdoor residential irrigation can be estimated but not quantified without dual irrigation meters.
This strategy promotes the use of non-potable water in place of groundwater whenever feasible for non-public trust uses. Groundwater should be prioritized for municipal and domestic uses consistent with MIP growth strategies; Department of Hawaiian Homeland needs as assessed in DHHL regional plans. Groundwater should be provided for agricultural irrigation as contingency where other water supply sources are not feasible. Development of groundwater must consider any impact on the exercise of Native Hawaiian and traditional and customary rights, further described in the Ka Pa`akai analysis, Appendix 9. County policy and code can prioritize developed groundwater source capacity for domestic and municipal development that is consistent with the MIP directed growth and for DHHL needs. Regional groundwater development strategies are defined for each Aquifer Sector.

e. Increase monitoring of groundwater sources to assess water and chloride levels in potable and non-potable wells throughout developed aquifers.

Monitoring wells provide information on changes in water levels and chlorides over time. This data is crucial to track overall aquifer impact and potential impact on stream resources within the aquifer system. Continuous data help assess the status and trends of groundwater resources and to make adjustments to pump rates and distributions. Monitoring wells are present in Wailuku aquifer sector but lacking in most other groundwater regions.

f. Promote well siting and distribution strategies for all public water systems to ensure optimal spacing and withdrawals for aquifer health and equitable use.

Equitable resource use includes access to available resource at reasonable cost. Cost is directly related to the elevation and proximity to infrastructure while access is closely tied to land ownership. Traditionally, well development in the state is on a first come first serve basis that results in the cheapest source being developed first. As demand requires new source development, existing well fields that originated decades ago have expanded piecemeal, largely driven by the underlying land ownership and cost. Collaboration, rather than competition between water purveyors is needed to achieve "smart" source development that ensures:

1. Optimized distribution of withdrawals based on hydrologic models and studies
2. Potable water quality that is protected from existing and future contamination sources
3. Wells that serve development in compliance with the Maui Island Plan growth strategies
4. Regional resource preservation to meet future demand for public trust uses

Well siting standards that distribute well development spatially and avoid areas of potential contamination, agreements to preserve resources for public trust uses can be attained by County wide policy and public-private partnerships. This strategy should guide land use developments to diversify water supply and collaborate on source development that distributes withdrawals for aquifer health.

g. Formalize demand response plans for water purveyors that address water shortage and aquifer changes.

Except for designated water management areas, purveyors are not required to have response plans in place that address water shortage due to increased demand, drought or the impact to chloride content of individual wells. Reporting by water purveyors to the CWRM does not necessarily trigger improved management of individual water systems or well fields. This strategy promotes formalizing action plans and alternative pump rate scenarios for all wells in response to declining water levels, increases in chlorides or escalated pumpage to protect aquifer health. Purveyors should develop critical chloride and pump level thresholds for representative wells in each developed aquifer region or wellfield, and define response actions. Thresholds should trigger actions to mitigate impacts on aquifers, such as reduced pumpage in combination with alternative resource use and conservation measures.

h. Develop a water availability rule to provide certainty in land use planning and ensure that reliable source and infrastructure capacity is provided within reasonable time for planned growth.

Water availability has been a much debated issue since the adoption of the County Availability Rule, codified in Maui County Code Section 14.12. The rule applies to the MDWS systems and only addresses residential developments. To address community concerns and uncertainties of the current county Availability Rule, at the onset we need to distinguish resource availability from infrastructure availability. Availability rules should clearly define whether limitations apply to system infrastructure, including developed source capacity, or resource availability defined as sustainable yield and in-stream flow standards. Resource adequacy is the fundamental basis in planning development of new water supply sources. The pace of developing water supply should ideally correspond to and precede anticipated demand based on planned growth in the Maui Island Plan. Municipal source development generally occurs on a 5 – 10 year basis subject to capital improvement budget approved annually by council. Reliable and sufficient level of funding is necessary for timely development of needed source and related infrastructure, such as transmission.

<u>Groundwater Reliability and Efficiency Issues</u>

Efficiency measures in water supply and demand side are addressed under Section 12.2 Conservation. Efficient use of infrastructure entails source development that implements the MIP Directed Growth Plan and capitalizing on available infrastructure capacity. Reliability generally means adequate water quantity and quality, pressure and response. Groundwater is considered more reliable supply than surface water, recycled water, storm water reuse and catchment and is the corner-stone for backup source to surface water and alternative water resources in short and long-term droughts.

In Central Maui, less than 5 % of drinking water supply is surface water. In West Maui the ratio is roughly 50/50 and Upcountry 80% surface water/20% groundwater. Anticipated growth in designated growth areas can be met with a portfolio of resources to ensure sufficient, reliable, long-term supply. Although planned growth in Upcountry would require less than 1 MGD of additional supply, the demand estimated to satisfy the Upcountry Meter List will require up to 7.5 MGD of additional supply by 2035.

Objectives

- **a.** Increase the efficiency and capacity of the water systems in striving to meet the needs and balance the island's water needs
- **b.** Direct growth in a way that makes efficient use of existing infrastructure and to areas where there is available infrastructure capacity

General Plan Policies

a. Ensure the efficiency of all water system elements including well and stream intakes, water catchment, transmission lines, reservoirs and all other system infrastructure
b. Work with appropriate State and County agencies to achieve a balance in resolving the needs of water users in keeping with the water allocation priorities of the MIP
c. Acquire and develop additional sources of potable water
d. Ensure a reliable and affordable supply of water for productive agricultural uses
e. Capitalize on existing infrastructure capacity as a priority over infrastructure expansion
f. Develop and fund improved water-delivery systems

Recommended Strategies

a. Increase system flexibility so that regional sources can be moved to support areas of need, both within the municipal systems and between regional public water systems.

Interconnection between separate but adjacent water systems provides an added amount of redundancy of source, production equipment and electrical power to ensure reliable service. Constraints include mixing of supply sources with potential impact on water quality. Introduction and blending of supply sources require Department of Health approval. Economic benefits would result from interconnection when abundant less expensive surface water is available in wet season to supplement areas regularly served by groundwater supply. Reducing withdrawals of aquifers allows displaced groundwater resources to recharge.

b. Ensure that public/private groundwater development agreements reflect the public trust needs and are in keeping with the water allocation priorities of the MIP.

County Code currently requires water source development agreements between the county and private entities to be approved by resolution. In compliance with the directed growth strategy adopted in the MIP, such agreements should ensure that source provides for development of appropriate locations and uses. For example, irrigation needs for new commercial or resort development, not a protected public trust use, should to the extent feasible be met by non-potable sources.

c. Develop groundwater to maximize reliability of potable supply and as contingency in areas currently dependent on surface water.

Upcountry Maui (Kula, Makawao and Pukalani to Kaupō) are particularly at risk to drought and its' impact on water supply. The vulnerability to drought is highly dependent on the source of water supply. Although technically feasible, development of sufficient new basal wells to meet 100% of projected demand in the MDWS Upcountry system along with booster pumps, the high capital and pumping costs makes this option economically less desirable. A preferred option is to operate ground and surface water resources in the most economical manner during normal conditions with sufficient groundwater contingency source to supplement available surface water during droughts. This strategy is consistent with measures recommended for Upcountry by the Maui Drought Committee.[71] Haiku and Makawao aquifer sectors are preferred options based on available yield, elevation and connection to the existing distribution system, further discussed under Section 15 Central ASEA.

d. Diversify supply for agricultural use to increase reliability.

Agricultural irrigation has historically relied on affordable untreated surface water in West Maui, Central and Upcountry regions and plantation distribution systems. Affordable and reliable water supply to support agriculture is consistent with general plan policies and community plan objectives. In balancing competing water needs, agricultural irrigation is not a protected public trust use and should be rigorously scrutinized in terms of efficiency and needs. Based on public input efficiency should increasingly consider ambient rainfall and climate appropriate crops. A diversified supply is needed that combines sufficient reservoir storage to take advantage of high stream flows in wet season and to capture stormwater and regional rainfall, with non-potable groundwater as contingency in long-term drought periods. It would be cost prohibitive to develop municipal potable groundwater and infrastructure capacity as contingency for agricultural zoned land. Expansion of cultivated agricultural land cannot be serviced by municipal potable supply but should identify alternative contingency sources.

Surface Water Development

There are essentially three areas on Maui where competing instream and off stream use of surface water are at issue. The Nā Wai `Ehā contested case is within a surface water management area wherein CWRM determines the amount of water the end users are allowed to divert from the streams. The East Maui contested case addressed the instream flow standards and how much water must be left in the streams. In West Maui, CWRM is developing watershed assessments to support a determination of instream flow standards.

A key concern derived from community workshops and meetings is the impacts of transport and off stream uses of streams on the ecosystem, public trust and other local uses. Discussions centered around alternative ways to meet future water needs of dependent regions. These

[71] Wilson Okamoto Corporation, County of Maui Drought Mitigation Strategies, 2012 Update

concerns are reflected in the Public Trust Doctrine and the protections provided by the State Constitution (Article XI, Section 7) and the State Water Code (Hawai`i Revised Statutes, Chapter 174-C). HRS §174-C-2(c) specifies, "The state water code shall be liberally interpreted to obtain maximum beneficial use of the waters of the State for purposes such as domestic uses, aquaculture uses, irrigation and other agricultural uses, power development, and commercial and industrial uses. However, adequate provision shall be made for the protection of traditional and customary Hawaiian rights, the protection and procreation of fish and wildlife, the maintenance of proper ecological balance and scenic beauty, and the preservation and enhancement of waters of the State for municipal uses, public recreation, public water supply, agriculture, and navigation. Such objectives are declared to be in the public interest."

The four public trust purposes identified by the Hawai`i Supreme Court as equally protected under the law are also subject to the following principles for the water resources trust identified by the court in the Waiahole and the Wai`ola o Moloka`i cases discussed under Section 1.1.

- The State has both the authority and duty to preserve the rights of present and future generations in the waters of the State;
- This authority empowers the State to revisit prior diversions and allocations, even those made with due consideration of their effect on the public trust;
- The State also bears the affirmative duty to take the public trust into account in the planning and allocation of water resources and to protect public trust uses whenever feasible;
- Competing public and private water uses must be weighed on a case-by-case basis, and any balancing between public and private purposes begins with a presumption in favor of public use, access, and enjoyment;
- There is a higher level of scrutiny for private commercial uses, with the burden ultimately lying with those seeking or approving such uses to justify them in light of the purposes protected by the trust; and
- Reason and necessity dictate that the public trust may have to accommodate uses inconsistent with the mandate of protection, to the unavoidable impairment of public instream uses and values. Offstream use is not precluded but requires that all uses, offstream or instream, public or private, promote the best economic and social interests of the people of the State.

Because the CWRM is charged with balancing public trust purposes and other beneficial uses, it is assumed that final IFS will adequately provide for kuleana and taro water requirements and other in-stream uses. In revising the IIFS, the CWRM concluded that establishing continuous stream flow from mauka to makai provides the best conditions for re-establishing the ecological and biological health of stream waters.

Surface Water Availability Issues

There is no standard flow that is deemed adequate to meet instream needs. However, base flow is a general guideline for the minimal amount of streamflow needed for fish habitat.[72] Conflicting instream and off stream uses become particularly apparent during dry conditions. Flow exceeded 90% of the time (Q_{90} flow) is commonly used to characterize low-flows.

Mediated agreement on needed instream flows in Nā Wai `Ehā contested case were revisited in response to the January 6, 2016 announcement by Alexander & Baldwin, Inc. that it would close HC&S by the end of 2016. The parties to the contested case filed and CWRM accepted a *Petition to Amend Upward the IIFS for Waihe`e, Waiehu, `Īao, and Waikapū Streams and Their Tributaries; and Motion to Consolidate or Consider in Parallel with Case CCH-MA 15-01.*[73] The third stage of the contested case process is to determine surface water use permits and the integration of the IFS, appurtenant rights and surface water use permits. The hearing officer's November 2017 recommended decision had to the date of this WUDP Draft yet to be adopted.

The June 20, 2018 CWRM decision for East Maui Streams (see Chapter 15, Appendix 15A) established IIFS for the petitioned streams. The results and data from this decision is now incorporated into this Draft WUDP.

Plausible scenarios of available stream water for off stream uses were assessed with input from the Aha Moku, the agricultural community and the general public. IFS does not quantify off-stream uses. Offstream uses allocated through water use permits are found only in the designated surface water management area Nā Wai `Ehā. In West Maui, assessments and establishment of measurable IFS were underway in 2018. The results will be incorporated into this WUDP or subsequent update as needed.

Objectives

a. Greater protection and enhancement of watersheds, streams, and riparian environments
b. Enhance the vitality and functioning of streams, while balancing the multiple needs of the community

General Plan Policies

a. Encourage the State to mandate instream assessment to provide adequate water for native species.
b. Maui will protect all watersheds and streams in a manner that guarantees a healthy, sustainable riparian environment.
c. Work with appropriate agencies to establish minimum stream flow levels and ensure adequate stream flow to sustain riparian ecosystems, traditional kalo cultivation, and self-sustaining ahupua`a.

---

[72] Trends in Streamflow Characteristics at Long-Term Gaging Stations, Hawai`i. USGS SIR 2004-5080

[73] Staff Submittal to the CWRM, June 17, 2016. http://files.hawaii.gov/dlnr/cwrm/submittal/2016/sb20160617C3.pdf

d. Respect and participate in the resolution of Native Hawaiian residual land and water rights issues (kuleana lands, ceded lands, and historic agricultural and gathering rights).
e. Work with appropriate agencies and stakeholders to establish minimum stream flow levels, promote actions to support riparian habitat and the use of available lo`i, and maintain adequate flows for the production of healthy kalo crops.

Recommended Strategies

a. Encourage CWRM to prioritize establishing IFS for diverted streams with potential conflicting uses.

Diversions can and have historically impacted kuleana and appurtenant rights, traditional and customary practices, stream ecology and water quality. In West Maui, diversion data is incomplete and information about existing and potential lo`i kalo and other kuleana needs are not readily available. Community concerns include inadequate stream flow mauka to makai, lack of access to kuleana lands and degraded near-shore water quality. CWRM should focus resources to establish IFS for diverted streams in order to properly assess and balance in and off stream uses. At the time of revisions to this chapter, assessment and establishment of IIFS for four West Maui streams were underway. The strategy is therefore already being implemented.

b. In the absence of established IFS, consider drought conditions as baseline to determine available stream flow for instream and off stream needs.

Healthy streams that support native stream fauna and satisfy water quality and quantity needs for kalo and other cultural uses should be protected. Drought conditions can stress kalo crops that need continuous cool water flow. Where drought flow data is available, drought flow (Q_{90} flow) can guide the assessment of available stream flow for off stream uses, until measureable IFS are established.

c. Defer any new surface water diversions to meet projected future demand.

Surface water will remain a contentious resource with potential for significant impact from climate change and drought. To ensure that kuleana and instream needs are protected, no *new* diversions should be supported to meet projected off stream use demand until numerical instream flow standards are established. This strategy is aligned with the planning objective of stream restoration. Maximizing efficiency in distribution and end use of existing diversions can provide additional supply for off stream uses. Leakage reduction in transmission, climate appropriate crop selection and efficient irrigation techniques can continually support the use of untreated surface water for agricultural irrigation. Out of region transfers of surface water has more community support when end uses support sustainability goals with efficient irrigation, increased renewable energy and local food production.

d. Balance existing diversions with alternative sources for agriculture to mitigate low-flow stream conditions.

The estimated range in IFS for East Maui Streams and Nā Wai `Ehā indicate that sufficient surface water could be diverted to meet most projected agricultural demand under normal, or Q_{70} conditions, but not under Q_{90} flow. Under drought conditions, alternative sources are needed to support reliable agricultural supply without compromising in-stream needs. The farming community has expressed the necessity of affordable water to sustain economically viable farming, but likewise the importance of reliable supply for most crops and livestock. Surface water, whether transported from other hydrologic sectors or regionally available, continues to be the most affordable source for farmers to irrigate crops. A diversified supply is needed that combines sufficient reservoir storage to utilize high stream flows in wet season and to capture stormwater and regional rainfall, with non-potable groundwater or alternative sources as contingency. Additional recycled water will become available from the Kahului Wastewater Facility to supplement irrigation needs on the Central isthmus. Stormwater reclamation for agricultural irrigation is assessed for West Maui and discussed under section 12.4. The Agricultural Water Use & Development Plan should address and coordinate with industry stakeholders alternative sources of irrigation water including wastewater reuse, recycled stormwater runoff, and brackish well water.

<u>Surface Water Reliability and Efficiency Issues</u>

Potable and non-potable systems that rely on surface water are highly vulnerable to short and long-term drought conditions. Stream flow fluctuates widely by nature as it consists of direct rainfall and runoff of rainfall, water returned from bank storage, and groundwater discharge in the form of base flow. Direct rainfall and runoff from rainfall creates flashy and turbulent conditions, bringing sediment into conveyance and treatment systems. Sediments from high stream and ditch flows impede treatment processes and impact the water quality. On the other hand, low ditch flows create stagnant water conditions and bacteria growth can cause potable water quality problems. Redundant volume and fluctuations in quantity are main reliability concerns for the MDWS surface water systems.

The infrastructure that conveys and stores surface water often consists of open ditches and large uncovered reservoirs that generate water losses from evaporation and leaks. To improve water efficiency, strategies should target supply side infrastructure as well as the end uses of limited surface water resources.

Despite water quality and quantity challenges, surface water transmitted by gravity to existing reservoirs is by far the least costly source for potable and non-potable uses. Energy intensities would decline significantly if surface water becomes available for rate paying municipal customers as surface water is transported from higher elevation streams to lower elevation population centers largely by gravity. Plantation irrigation systems require substantial maintenance. The East Maui Irrigation Company and Wailuku Water Company control and maintain their irrigation systems while former plantation systems such as Pioneer Mill in West

Maui is broken up among multiple owners. Significant investments are needed to increase the efficiency of these systems and keep ditches and reservoirs functional.

Objectives

a. Increase the efficiency and capacity of the water systems
b. Provide for agricultural needs

General Plan Policies

a. Ensure the efficiency of all water system elements including well and stream intakes, water catchment, transmission lines, reservoirs, and all other system infrastructure.
b. Acquire and develop additional sources of potable water.
c. Support plans and programs to develop additional sources of water for irrigation purposes.
d. Support the recommendations, policies, and actions contained within the Maui Agricultural Development Plan, July 2009, when consistent with the MIP.
e. Give priority in delivery and use of agricultural water and agricultural land within County agricultural parks to cultivation of food crops for local consumption.

Recommended Strategies

a. Maximize efficiencies in surface water transmission, distribution and storage.

Surface water, whether transported from other hydrologic sectors or regionally available, continues to be the most affordable source for farmers to irrigate crops. Proactive maintenance and improvements in system transmission, distribution and storage should be implemented where feasible to reduce water losses. Water audits are recommended for *all* purveyors to identify and target system inefficiencies from source to point of service. Preventive measures and effective maintenance help extend the useful life of transmission, distribution and storage and ensure timely repairs. Leak detection should be considered to locate and verify system losses and schedule repairs. Covered storage reduces evaporation. Improvements to reduce losses may also extend to kuleana ditches, absent a showing that it is unnecessary to prevent waste, or that it is not practical to do so.[74]

b. Add raw water storage to increase reliable supply.

Additional reservoir storage capacity increases the drought period reliable yield of surface water collection, storage and treatment systems. Reservoirs of various capacities were analyzed for the MDWS Kamole, Olinda and Pi`iholo Water Treatment Facilities (WTF) in the Upcountry Water Advisory Committee Review Draft prepared by Haiku Design and Analysis. A 2015 preliminary engineering report evaluated raw water storage near the Kamole WTF to reduce

[74] CWRM's Findings of Fact, Conclusions of Law, and Decision and Order in the matter of the `Īao Ground Water Management Area High-Level Source Water-Use Permit Applications and Petition to Amend Interim Instream Flow Standards of Waihe`e River and Waiehu, `Īao, & Waikapū Streams Contested Case Hearing, June 10, 2010 (CCH-MAO6-O1).

the effects of low-flows in the Wailoa Ditch.[75] This option is a recommended strategy further discussed under the Central ASEA Section 15. Refurbishing and maintaining plantation reservoirs in West Maui for agricultural irrigation is discussed under the Lahaina ASEA Section 19. Storage options for Nā Wai `Ehā are discussed under Wailuku ASEA in Section 14. The optimal capacity of raw water storage is a function of the amount of water and the streamflow characteristics of the streams that feed the reservoirs, the capacities of the stream diversions and transmission from diversion to the reservoir. Additional storage would aid in balancing seasonal use of stream and groundwater to reduce conflicting stream uses in dry season and recharge aquifer in wet season (increase surface water use in wet season and develop groundwater to reduce reliance on streams in dry season). Because of the extensive capital cost, raw water storage sizing should be guided by final IFS. Financing is another issue in developing large raw water reservoirs. The Hawai`i Drinking Water Revolving Funds, a low-interest funding option available to public water systems for large capital improvements, can currently not be utilized for reservoirs. However, reservoir construction is eligible to receive Clean Water State Revolving Fund monies, which could be explored further.[76]

c. Increase treatment plan capacity at water treatment plant facilities to accommodate additional treatment in wet season.

Expanding capacity to treat additional ditch flow can provide additional redundancy and economic benefit to take advantage of times when stream and ditch flows are high in wet season. The amount of water available is directly related to IFS. For the Kamole, Pi`iholo and Olinda WTFs serving the MDWS Upcountry system any off stream uses are guided by IFS. Additional ditch flow through Wailoa ditch also requires an agreement with EMI and consideration of additional untreated water needs at the expanded Kula Ag Park. For the MDWS `Īao Water Treatment Facility, the amount of water available from Nā Wai `Ehā for off stream uses is allocated by water use permits. In West Maui, potential expansion of the two existing treatment plants should not be addressed until CWRM establishes IFS to ensure kuleana and instream uses are sufficiently protected.

d. Support plans and programs to develop additional sources of water for irrigation purposes.

Strategies to mitigate drought impact on agriculture were recommended by the Maui Drought Committee. Much of the recommendations are focused on the Upcountry region. Mitigation projects include development of groundwater sources in Kula to supplement the surface water system during drought and extending the current Upper Kula water system or develop a well in Kahikinui. High-priority projects that would potentially add source for agricultural irrigation include: implementing the Kula Stormwater Reclamation and Reuse Study; improving surface

[75] Austin, Tsutsumi & Associates, Inc. Preliminary Engineering Report for Kamole Water Treatment Plan Raw Water Reservoir(s), May 2015
[76] Northbridge Environmental Management Consultants, Hawai`i SRF Management Study for the CWSRF and DWSRF Programs, 2014

water sources in Upcountry Maui, which would include adding and improving intakes; and installation of the “dual Agricultural line”, a separate agricultural water distribution system to supply untreated water for farmers in the Upper Kula area from the Kahakapao reservoir.[77] Adding new intakes is not compatible with objectives to curb new diversions and prioritize public trust uses. The “dual Agricultural line” would not generate new source but compete with existing uses of the Upper Kula municipal system. Groundwater development and implementation of stormwater reclamation and reuse would supplement raw water storage and efficiency measures to provide new agricultural irrigation supply. These strategies should be further analyzed in in the statewide Agricultural Water Use and Development Plan (AWUDP) update. The AWUDP should identify and prioritize infrastructure requirements needed to accommodate non-potable water for irrigation. Site selection studies for water storage and supply facilities are needed for Central, Wailuku and Lahaina ASEAs.

e. Prioritize delivery and use of agricultural water within County agricultural parks to cultivation of food crops for local consumption.

The Hawai`i Department of Agriculture, through its Agricultural Resource Management Division operates ten agricultural parks throughout the state, none of them on Maui. For consistency with General Plan Policies, this strategy specifically addresses the Kula Agricultural Park managed by the County of Maui. The park was created to promote diversification of agriculture in Upcountry Maui on 346 acres. Irrigation to the park is currently supplied by pumping water from the Hāmakua Ditch, which is owned by EMI to two storage reservoirs located in the park. The reservoirs are uncovered and have a capacity of approximately 5.4 mgd. Much of the original improvements are still in use. Replacement of reservoir liners was completed in 2011.[78] Various options to provide more reliable supply of irrigation water to the park were investigated in a Preliminary Engineering Report prepared by Fukunaga & Associates, Inc. dated November 2006. Because the Kula region is generally dry and ranked at high risk to drought, the drought tolerance of crops, efficient irrigation techniques and back up sources are all of paramount importance.

The County has right to withdraw up to 1.5 mgd from Reservoir 40. The agreement could potentially satisfy current irrigation needs ranging from 0.5 to 0.6 mgd; additional entitlements from Hāmakua ditch of 0.351 mgd for Kula 1800 Subdivision and irrigation needs for a 373 acre planned expansion. However, this assumes sufficient ditch flow is available to maintain required volume in Reservoir 40. The park is located at higher elevation than any designated Important Agricultural Lands (IAL). Groundwater as contingency supply is therefore more expensive to develop and pump compared to all other IAL lands historically served by the EMI system. Once IFS are established for the East Maui streams that supply the Hāmakua ditch, the county should work with A&B Properties and EMI to ensure priority for Kula Agricultural Park irrigation demand in relation to makai irrigation needs during low-flows. Water source

---

[77] Wilson Okamoto Corporation, County of Maui Drought Mitigation Strategies, October 2004 (Updated June 2012)
[78] Fukunaga and Associates, Inc. Kula Agricultural Park Financial Analysis of the Water System, August 2013 (Revised may 2014)

agreements with the county should be based on a water audit to ensure reasonable irrigation needs and efficient irrigation techniques. This is consistent with the objective to support food crop cultivation in the park while scrutinizing agricultural irrigation needs, which are not a protected public trust use.

12.4 Alternative Water Source Strategies

Alternative water sources allowed by existing technologies include recycled wastewater, desalination, rainwater catchment and stormwater reuse. Conservation strategies are addressed separately in Chapter 12.2 above.

Reclaimed Wastewater

In the WUDP public process, strong community support was voiced for expanding reclaimed/recycled water distribution to offset potable supply for irrigation uses, especially in dry areas.

<u>Issues and Opportunities</u>
Increased of reclaimed wastewater is a feasible method of supplying non-potable needs such as landscape irrigation. The State Water Code HAR174C-31 as amended in 2016 adds as an objective of the Hawai`i Water Plan, "The utilization of reclaimed water for uses other than drinking and for potable water needs in one hundred percent of state and county facilities by December 31, 2045." However, the Food Safety Modernization Act restricts uses or reclaimed water on crops. Application of recycled water over potable aquifers also raise concerns in terms of contaminants that are not removed by sewage treatment technologies and that could potentially pose a risk to drinking water quality. Another challenge is the general public's acceptance of reuse of water.

Like sewer rates, reclaimed water rates need to reflect more of the actual cost of delivering this resource to users. Significant expansion of reclaimed water would require a considerable increase in rates to debt service and pumping costs. This cost may actually be more than what is would cost to deliver potable water for non-potable uses, but does not factor in the external benefits associated with water conservation and reducing the island's reliance on injection wells. Water recycling and water reuse projects that replace potable sources with non-potable sources are eligible for funding through the Drinking Water State Revolving Fund (DWSRF), including greywater, condensate, and wastewater effluent reuse systems, as well as extra treatment costs and distribution pipes associated with water reuse.[79] DWSRF funds may be under-utilized in county initiated expansion of recycled water use.

[79] 2010 Clean Water and Drinking Water State Revolving Fund 20% Green Project Reserve: Guidance for Determining Project Eligibility, Part B – DWSRF GPR SPECIFIC GUIDANCE; Northbridge Environmental Management Consultants, Hawai`i SRF Management Study for the CWSRF and DWSRF Programs, 2014.

Maui County Reclaimed Water Program

The County of Maui Department of Environmental Management administers the reclaimed wastewater program. Wastewater disposal via injection wells continue to be a concern. Sewer user fees are the primary source of funds for the production and delivery of reclaimed water. While this strategy was effective in the early stages of the program begun in 1990, more recently the County has delayed the implementation of planned reclaimed water projects due to higher-priority sewer improvement projects, which has slowed the development of infrastructure necessary to increase water reuse from County facilities.

The 2013 Update of the Hawai`i Water Reuse Survey and Report identifies short-term potential water reuse opportunities for County and private facilities. Information has been updated for County facilities resulting in the following projections. Proposed use is for generally for landscape and golf course irrigation. Details are provided in the Sector Reports.

Table 12-8 Short-Term Projected Recycled Water Use

WWRF	WWRF Design Capacity (MGD)	Projected Recycled Water Use (Ave. MGD)	% of Design Capacity Used
Wailuku-Kahului	7.9	2.25	28.5%
Kīhei	8	2.2	27.5%
Lahaina	9	1.84	20.4%
County WWRF Total	**24.9**	**6.29**	
Existing Private	1.23	0.45	36.2%
Proposed Private*	--	1.7	--
Private Total	**--**	**2.15**	**--**
Total		**8.44**	

Update of the Hawai`i Water Reuse Survey and Report, July 2013. http://files.Hawai`i.gov/dlnr/cwrm/planning/hwrsr2013.pdf. County of Maui Environmental Management Dept, Wastewater Reclamation Division, September 28, 2015.

* Some projects have not reported recycled water use projections and it is uncertain whether some projects would be served by County or private WWRFs.

Objectives

- Increase the efficiency and capacity of the water systems in striving to meet the needs and balance the island's water needs

General Plan Policies

a. Maximize the efficient use of reclaimed wastewater to serve non-potable needs
b. Promote the reclamation of gray water, and enable the use of recycled, gray, and brackish water for activities that do not require potable water.
c. Explore and promote alternative water-source-development methods.

Recommended Strategies

a. Expand requirement for new development to connect to recycled water infrastructure if practical.

Maui County Code, Chapter 20.30 requires commercial properties within 100 feet of the county's reclaimed water system to connect and use R-1 water for landscape irrigation. Expanding distribution and use of recycled water can be achieved through mandatory or incentivized hook up for particular properties and uses. A code amendment can increase the spatial requirement for connection, or allow a determination by the County Department of Environmental Management (MDEM) when reclaimed water can be feasibly provided in lieu of potable water for specific projects and uses.

b. Promote closer collaboration between MDWS and MDEM to master plan and utilize DWSRF funding to maximize recycled water use.

Demand and conservation of potable water determines wastewater treatment capacities and available recycled wastewater. Wastewater discharge through injection wells directly impacts groundwater recharge and quality. The nexus between recycling wastewater and reducing demand for drinking water treatment should be addressed collaboratively in long-term resource planning. MDWS services sewer billing but has no further role in management of recycled wastewater. Collaboration in water management and creative funding with support from the State Department of Health Safe Drinking Water Branch could optimize distribution and end uses for recycled wastewater to offset potable water use.

c. Explore expansion of "scalping plants" (small-scale membrane filter systems that put effluent closer to reuse locations) in designated growth areas.

Increasing costs associated with operating and maintaining large distribution systems make small-scale treatment close to wastewater generation more feasible. Decentralized wastewater treatment in dry growth areas would avoid costly transmission and provides an alternative source of irrigation supply on site. Scalping plants can withdraw wastewater and treat it to a specific limit depending on the end use. The county should support small scale on site treatment where feasible to maximize recycled water use for irrigation in new development.

Rainwater Catchment Systems

Issues and Opportunities

Rainwater catchment is not as reliable as conventional water resources because it is extremely sensitive to the climate. Catchment for agricultural irrigation should be further explored where consistent rainfall makes the systems feasible.

Objectives

a. Increase the efficiency and capacity of the water systems in striving to meet the needs and balance the island's water needs

General Plan Policies

a. Ensure the efficiency of all water system elements including well and stream intakes, water catchment, transmission lines, reservoirs and all other system infrastructure
b. Encourage increased education about and use of private catchment systems where practicable for non-potable uses

Recommended Strategies

a. Inform and educate the residential and commercial community of easy, affordable rainfall catchment for recharge and garden use

Rainfall catchment stored in a tank or underground storage system can be used for landscape irrigation to offset potable supply. Water quality can be an issue and there is currently no state or county oversight regulating household catchment systems. The State Department of Health and County of Maui agencies should further community outreach targeting households in areas not served by any public water system and promote catchment as a water conservation strategy for new commercial landscaping with potential incentives.

b. Provide incentives for residential rainwater catchment systems

A rainwater harvesting pilot program for residential irrigation uses is considered in the MDWS conservation program portfolio.

Stormwater Reuse

Issues and Opportunities
Capture and reuse of stormwater runoff is an under-utilized water resource that provides an opportunity to reduce reliance on groundwater and surface water for landscape irrigation, especially when incorporated into the design of development projects in order to minimize infrastructure costs. The *Hawai`i Stormwater Reclamation Appraisal Report, 2005, and Study Element 3: An Appraisal of Stormwater Reclamation and Reuse Opportunities in Hawai`i*, September 2008, screened and identified four projects on Maui within the final ranking, which might provide opportunities to augment agricultural irrigation water that is diverted currently from Maui streams, in addition to providing other benefits:[80]

- Waiale Road Stormwater Drainage: This opportunity uses an existing stormwater drainage channel and detention pond located along Waiale Road to capture and convey stormwater into the Waihe'e and Spreckels Irrigation Ditch Systems for agricultural irrigation to the south and east. The pressure to reduce stream diversions associated

[80] Hawai`i Stormwater Reclamation Appraisal Report, 2005, and Study Element 3: An Appraisal of Stormwater Reclamation and Reuse Opportunities in Hawai`i, September 2008.
http://files.Hawai`i.gov/dlnr/cwrm/planning/hsrar_element3.pdf

with Spreckels and Waihe'e Ditches puts increased pressure on agricultural water demands for Central Maui. The decline in agriculture in Central Maui has resulted in a significant decline in return irrigation recharge of the aquifers.

- Kahului Flood Control Channels: This opportunity uses an existing stormwater drainage channel in urban Kahului Town to collect stormwater for agricultural irrigation to the south of Kahului Town.
- Kahoma Stream Flood Control: This opportunity uses an existing stormwater drainage channel (Kahoma Stream) to collect and convey stormwater for agricultural use to the north.
- Lahaina Flood Control: This opportunity uses an existing stormwater drainage channel and detention pond located adjacent to the Lahaina Wastewater Reclamation Facility (WWRF) to collect stormwater for conveyance to agricultural areas to the north, south, and east.

Recommended Strategies

a. Explore and promote opportunities for large volume stormwater runoff for agricultural irrigation.

Incentives for landowners and agricultural users are needed that mitigate pollutant loads and take advantage of filtered runoff for non-potable end uses. Creative funding for large volume reuse projects is key. Future potential grant opportunities may become available through state legislative initiatives such as the CWRM Water Security grant funds. Recent legislation requires the CWRM to include plans for storm water management, reuse, reclamation and remediation in the Water Resources Protection Plan.

Desalination

Issues and Opportunities

Desalination is more costly than conventional water resources due to treatment and monitoring requirements, although costs have been decreasing. The energy intensive technology currently available would add freshwater supplies but not provide other environmental co-benefits. Supplying 10% of Maui's current municipal demand with brackish desalinated water would require an estimated 14% of MDWS current energy demand. The energy demand for the same amount of seawater desalination would be about 45% of current MDWS energy demand. [81]

Brackish groundwater is likely to the preferred resource for desalination to meet potable water quality because monitoring requirements are not as stringent as they are for surface water sources. In addition, desalination of brackish water is generally more cost-effective and environmentally-friendly than use of sea water. Effects on groundwater resources and chlorides

[81] E.A. Grubert and M.E. Webber, Energy for water and water for energy on Maui Island, Hawai`i, April 2015

due to anticipated reduced irrigation association with the cessation of sugarcane production are issues, along with impacts on source water quality, and wastewater disposal injection wells. However, since brackish groundwater contributes toward the sustainable yield of the aquifer, desalination of sea water can be advantageous because it is not a limited resource.[82] Overall, desalination may have potential within the 20-year planning horizon but does not warrant a recommended strategy aside from continued monitoring of progress in technology and energy use.

12.5 Land Use Controls

The Maui Island Plan Directed Growth Plan and designation of Urban and Rural Growth Boundaries ensures an adequate supply of land is available for future growth, while limiting sprawl and focusing infrastructure investment to areas within the growth boundaries. Development through planned urban infill and redevelopment also increases population density and prevents expansion of non-agricultural irrigated acreage. Maui County has zoning jurisdiction of land designated for Urban within the State Land Use District. Zoning provides density controls through housing unit and acreage controls. The WUDP complements the Directed Growth Plan by allocating conventional and alternative resources to planned growth, coupled with aggressive conservation to reduce per capita demand.

Maui County has approximately 244,000 acres of land designated for agricultural use within the State Land Use District. [83] The state and county have enacted zoning laws to protect agricultural resources and promote agricultural activities. The Agricultural Zoning District provides for distribution of minimum lot sizes to decrease the fragmentation of agricultural lands. This approach also ensures green and scenic open space. Transfer and purchase of development rights and conservation subdivision design are other tools that can protect important agricultural lands and direct development to areas suitable for development. [84]However, this approach does not consider the associated irrigation needs or location of water resources. Agricultural water use represents about 63 percent of groundwater pumpage and about 90 percent of surface water resources. Concentrating farm land as agricultural parks, considering irrigation needs, optimally based on natural rainfall, could capitalize on collective non-potable and alternative water supply and infrastructure. Agricultural parks as both a resource and land use control could be further explored to protect and sustain the island's commercial agriculture while alleviating future demand on potable water supply and infrastructure.

[82] WRPP, 2008
[83] State of Hawai`i DBEDT (2008). The State of Hawai`i Data Book
[84] Maui Island Plan, 2012, page 7-5

13.0 SUMMARY OF RECOMMENDATIONS

Recommendations described in Table 13-1 summarize the strategies discussed throughout Chapter 12 and how they relate to planning objectives. The planning objectives were developed through an extensive public process that incorporates input from advisory groups that addressed the Central and Upcountry MDWS systems only prior to 2010, stakeholder meetings, open public meetings and workshops held throughout 2015 and 2016. Values and principles derived from this process provide the overall guidance to define strategies. Specific recommendations for each aquifer sector area are presented in Section III. However, general recommendations and policies summarized below are applicable island-wide. Recommendations include policies and actions that on a county level should provide the foundation and guidance for MDWS capital improvement program and budget, public/private partnerships, studies and land use decisions. On a state level, recommendations should provide guidance to the CWRM in their decisions regarding pumping permits, stream withdrawals, water reservations and other matters.

13.1 Planning Objective Conflicts and Recommended Tradeoffs

When MDWS reignited the WUDP public process at the end of 2015, the approach was to create an actionable plan with no further delays while striving to address long-standing conflicts and concerns related to water resource management and use on Maui. The WUDP is intended to allocate water to existing and planned land use. The following challenges related to water systems were identified in the MIP and echoed in the WUDP public process:

- Native Hawaiian water rights must be incorporated into water planning.
- Lack of scientifically based interim flow standards which relate to water rights and public trust purposes and planning for surface-water resources.
- Future agricultural water use is uncertain.
- Comprehensive water resources planning and system control, while the County controls a relatively small percentage of the water on the island.
- MDWS budget constraints in the face of rising costs and infrastructure repair and replacement needs.
- Energy production and efficiency is a substantial component of MDWS costs.
- Private water systems and wells can undermine public systems or have the potential for contamination of water resources.

Objectives are generally complementary but in some cases conflicting. A predominant example is transport of surface and groundwater from resource abundant wet areas to dry growth areas versus reliance on regional resources. In each regional aquifer sector plan, strategies strive to provide a balance among conflicting objectives under the guidance of overall values and principles.

13.2 Implementation and Funding

Implementation Process

Formulation of the WUDP has included relevant data, technical reports and resources derived from the MIP process and coordination with the Maui County Planning Department's Long Range Planning Division, which is responsible for the preparation, adoption and implementation of the MIP. In turn, projections, policies and strategies in the WUDP can inform the Community Plan updates and future MIP amendments. The WUDP and the MIP make up a framework to ensure that land use and infrastructure planning are integrated and provide guidance for resource use and infrastructure development. In consistency with the Maui County Code Title 14, the plan shall serve as the primary guide to the council, the department, and all other agencies of the county in approving or recommending to other agencies the use or commitment of the water resources in the county; and in using public funds to develop water resources to meet existing or projected future demands on the MDWS system.

Upon County Council adoption and CWRM approval of the WUDP, implementing actions to effectuate the intent of the policies and strategies should be developed over the twenty-year planning period. Agencies and organizations tasked with scoping and refining strategies into projects are identified, with the expectation that lead roles and additional parties be further determined over the planning period. Estimated timeframes for implementation are indicated allowing for flexibility to re-scope, prioritize and adjust to available funding. Actual implementation will depend on level of capital funding, conclusion of contested cases and other CWRM actions, detailed design and planning, and other factors. Implementation timeframe is broken down into near term (next one to three years) and long-term (three to twenty years).

Funding

Funding to address island wide and region specific strategies is primarily shared between state and county agencies, with the greatest burden on MDWS. Funding sources for county infrastructure is summarized in Chapter 10 of the MIP Implementation Program.[85] Sources of revenues for MDWS are monthly water service fees: water system development (impact) fees, bond financing and State Revolving Fund loans.

Water service fees are charged to all customers, which make the distribution of such costs equitable throughout the community. Monthly water service charges are the primary revenue source for operations, maintenance and upgrades to existing systems.

Costs associated with facility expansion, including new source should be borne primarily by new development to ensure that costs are distributed equitably to uses benefitting from the

[85] Ordinance No. 4126, Bill No. 29 (2014) A Bill for An Ordinance Adopting the Maui Island Plan Implementation Program, May 29, 2014. Page 10-6

improvements. The water system development fee includes source, storage and transmission fees for capital Investments and are charged by meter size. The source portion of the fee should provide for adequate source to meet peak use for the water service.

Life cycle costs for the twenty-year planning period were assessed for most region specific conventional and alternative resources in Part III Regional Sectors. Life cycle costs include capital, operational and maintenance costs and include inflationary effects. Costs are estimated for each 1000 gallons of water provided or offset for comparative planning purposes. Major capital improvements for conventional resource strategies under the jurisdiction of MDWS were roughly assessed in the MIP to meet projected demand to year 2030. The overall description and estimated costs for the four MDWS systems on Maui have not changed significantly:

1. Central Maui Water System: Source development depending on the combination of new sources pursued: $100 million
2. West Maui Water System: Source development depending on the combination of new sources pursued. Costs do not include the development of raw water storage: $100 million
3. Upcountry Water System: Source development costs are based on satisfying a significant portion of the upcountry water meter list. This demand is far in excess of demand projected in the Maui Island Plan: $100 million
4. East Maui System: Various combinations of source, storage and transmission improvements: $10 million

Rate studies are continuously undertaken to ensure that water rate structures and amounts provide sufficient revenue for system services. Future rate studies will incorporate the adopted WUDP to secure revenues for priority needs. However, it’s not feasible to establish water rates and fees to reflect all strategies over the twenty year planning period, due to the many uncertainties and the anticipated need for adjustments. Instead, as the WUDP strategies are refined into county CIP projects and programs, water rate and fees should be evaluated and aligned to match priority needs. When major investments are made infrequently and the true cost of services are underfunded, catching up can be cumbersome and negatively perceived. Based on a historical lag in rate and water system development fee increases to reflect actual needs, water rate and fee increases by more than 50% between 2015 and 2030 would be needed to adequately fund maintenance of the current infrastructure and capital improvement projects to meet projected demand.

Some strategies rely on funding by private water purveyors, non-government organizations and public-private partnerships that will require detailed planning and alternative funding solutions. In consistency with the MIP, identification of strategies in the WUDP does not legally bind the agencies and organizations to implement the project and activities, rather the plan provides a guidance for land use and infrastructure, including the county CIP program, over the planning period.

Table 13-1 Summary of Recommended Strategies

	STRATEGY	PLANNING OBJECTIVES	ESTIMATED COST	IMPLEMENTATION 1: Short-term 1 – 5 years 2: Long-term 5 – 20 years	
				AGENCY *	TIME-FRAME**
RESOURCE MANAGEMENT					
Watershed Management					
1.	Continue Maui County financial support for watershed management partnerships' fencing and weed eradication efforts.	Maintain sustainable resources Protect water resources Protect and restore streams	$2 million per year/$8 per watershed acre (249,362 ac)	MDWS Maui County	1
2.	Promote increased distribution of funding for watershed protection and active reforestation to reflect multiple values and ecosystem services.	Maintain sustainable resources Protect water resources Protect and restore streams	N/A	Private water purveyors Land owners DLNR	1
3.	Expand watershed protection to incorporate the ahupua`a as a whole and utilize ahupua`a resource management practices.	Maintain sustainable resources Protect water resources Protect and restore streams Protect cultural resources	N/A	Public-private partnerships Aha Moku DLNR Maui County	1
4.	Support stream restoration and increased use of *kalo* lands.	Maintain sustainable resources Protect water resources Protect and restore streams Protect cultural resources	N/A Lo`i restoration projects can start from $50,000. Site specific	CWRM Aha Moku Community grassroots Maui County	1
5.	Enable and assist in providing for Native Hawaiian water rights and cultural and traditional uses through active consultation and participation.	Protect and restore streams Protect cultural resources	N/A	CWRM Maui County Aha Moku	1
Water Quality Management					
6.	Implement well siting criteria to avoid contaminated groundwater supplies and unnecessary risks to public health.	Maximize water quality	Potentially increased pumping costs for higher elevation wells, site specific	MDWS Public Water Systems	1
7.	Adopt wellhead protection measures for potable wells.	Protect water resources Maximize water quality	DOH grant funded public outreach and	MDWS Maui County	1

			research completed		
8.	Educate the farming community in sustainable farming practices to reduce impact from agricultural practices on water resources.	Protect water resources Maximize water quality	Outreach within multiple agency budgets. From $5,000 annually	DOA DOH MDWS HRWA SWCD	1
9.	Update assessment of potential contaminating activities around drinking water supply and support increased monitoring of potable wells as needed.	Maximize water quality	$10,000 - $20,000, five year updates	Maui County MDWS	1
	Conservation – Demand Side				
10.	Retrofits/direct installation and sub-metering programs, distribution of water-efficient fixtures and retrofits for existing users and facilities	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply	MDWS ongoing and pilot programs $108,000 year 1 - 3	MDWS	1
11.	Smart meters retrofits	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply	Depends on existing meters and model, conversion from $150/meter	Private water purveyors MDWS	2
12.	Landscaping and irrigation system incentives, targeting dry areas.	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply Manage water equitably	$245,000 annually (xeriscaping improvements rebate, irrigation controllers, residential greywater program)	Maui County Parks Dept. MDWS	2
13.	Public information and education: sustainability working group; technology/innovation transfer programs; recognition program; public events; participation in recognized federal and industry programs (WaterSense); advertising	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply	MDWS ongoing programs $50,000 annually	MDWS HRWA Public Water Systems	1
14.	Landscaping guidelines, audit and retrofit, landscape ordinance.	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply	Staff time. Retrofit depends on audit	MDWS	1

15.	Market/customer surveys followed by rebates and incentives: high efficiency fixtures, washing machines, toilets and urinals; hotel awards program	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply	$70,000 annually (excl. outdoor incentives)	MDWS	1
16.	Revise county code to require high efficiency fixtures in all new construction. Develop a comprehensive water conservation ordinance to include xeriscaping regulations.	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply Manage water equitably	Water efficient home, est. added construction cost $25K (6% increase in property value) LEED certified home, est. added construction cost $86K (18% increase in property value)	Maui County	2
17.	Aggressive tiered rate structure based on audit and rate study.	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply Manage water equitably	N/A	Maui County MDWS	1
18.	Agricultural programs: Irrigation efficiency audits, technical assistance and rebates. Ag technical working groups.	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply Provide for agricultural needs	Outreach within multiple agency budgets. From $10,000 annually	DOA DOH MDWS HRWA SWCD	1
19.	Greywater incentives	Maintain sustainable resources Maximize efficiency of water use	MDWS 2 year pilot program $80,000	Maui County MDWS	1
20.	Rainwater catchment for irrigation – educational.	Maintain sustainable resources Maximize efficiency of water use	N/A	DOH Private water purveyors Maui County	2
21.	Revise County Code and/or incentives: water conserving design and landscaping in new development (xeriscaping targets dry areas), water efficient irrigation systems	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply Manage water equitably	N/A	Maui County	1
22.	Revise County Code and/or incentives: Water-efficient building design integrating	Maintain sustainable resources Maximize efficiency of water use	N/A	Maui County	2

	alternative sources (grey water, catchment).	Minimize cost of water supply Manage water equitably			
23.	Restrict outdoor water waste (no runoff, water wasting, and hose nozzles).	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply	N/A	Maui County MDWS drought rules	2
24.	Targeted conservation programs in dry areas and drought conditions.	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply Manage water equitably	N/A	Maui County MDWS water shortage rules	
25.	"Lead by Example" conservation and efficiency projects.	Maintain sustainable resources Maximize efficiency of water use Minimize cost of water supply Manage water equitably	N/A	MDWS Maui County Parks Dept.	2
Conservation – Supply Side					
26.	Perform annual comprehensive water audits.	Maximize efficiency of water use Minimize cost of water supply	Staff costs only, free software and training	MDWS Public Water Systems	
27.	Fund and implement a continuous leak detection program.	Maximize efficiency of water use Minimize cost of water supply	From $100,000 annually	MDWS Large Public Water Systems	
28.	Maintain and operate the water system to minimize the sources of water loss.	Maximize efficiency of water use Minimize cost of water supply	N/A	MDSWS Private water purveyors	
Conservation – Agricultural Uses					
29.	Research, support and use of less water consumptive crops and climate adapted crops.	Maintain sustainable resources Maximize efficiency of water use Manage water equitably	N/A	DOA	
30.	Improve irrigation management and efficiency.	Maintain sustainable resources Maximize efficiency of water use Manage water equitably	N/A	UH CTAHR USDA SWCD Hawai`i Farm Bureau Hawai`i Organic Farmers Association	

31.	Maintain the integrity of plantation irrigation systems including reservoirs.	Maximize efficiency of water use Provide for agricultural needs	N/A	Public-private partnerships (EMI, MLP, WWC, West Maui Land) Maui County DLNR DOA	
32.	Augment agricultural water supplies with alternative resources.	Maintain sustainable resources Manage water equitably Provide for agricultural needs		Maui Dept. of Public Works DLNR	
Conservation – Energy					
33.	Pursue comprehensive energy management.	Minimize adverse environmental impacts Minimize cost of water supply	N/A	MDSWS Public Water Systems Maui County Energy Management Program	
34.	Increase energy efficiency and improve load management.	Minimize adverse environmental impacts Minimize cost of water supply	Being assessed	MDSWS Public Water Systems Maui County Energy Management Program	2
35.	Increase alternative energy generation and use.	Minimize adverse environmental impacts	N/A	MDSWS Public Water Systems Maui County Energy Management Program	2
CONVENTIONAL WATER SOURCE					
36.	Support collaborative hydrogeological studies to inform impact from climate change and future well development on groundwater health.	Maintain sustainable resources Protect water resources	From $600,000, joint funding. Site and resource specific	CWRM MDWS Public Water Systems USGS	1
37.	Develop groundwater within sustainable yield to provide sufficient supply for growth, maintaining a buffer to account for potential future drought impact and prospective adjustments in aquifers lacking hydrologic studies.	Maintain sustainable resources Maximize reliability of water service	Site specific, see regional sectors	CWRM MDWS Private water purveyors	1
38.	Promote the highest quality water for the highest end use	Manage water equitably	N/A	CWRM MDWS	1

				Private water purveyors	
39.	Protect and prioritize public trust uses in allocating groundwater in regions of limited resources and conflicting needs.	Manage water equitably Provide for Department of Hawaiian Homelands needs	N/A	CWRM MDWS DHHL	1
40.	Increase monitoring of groundwater sources to assess water and chloride levels in potable and non-potable wells throughout developed aquifers.	Maintain sustainable resources	From $50,000 annually monitoring, site specific	CWRM USGS	2
41.	Promote well siting and distribution strategies for all public water systems to ensure optimal spacing and withdrawals for aquifer health and equitable use.	Maintain sustainable resources Manage water equitably	N/A	CWRM Maui County MDWS Private water purveyors	2
42.	Formalize demand response plans for water purveyors that address water shortage and aquifer changes.	Maintain sustainable resources Maximize reliability of water service	None	CWRM MDWS Private water purveyors	2
43.	Develop a water availability rule to provide certainty in land use planning and ensure that reliable source and infrastructure capacity is provided within reasonable time for planned growth.	Maximize reliability of water service Maintain consistency with General and Community Plans	None	Maui County MDWS	2
44.	Increase system flexibility so that regional sources can be moved to support areas of need, both within the municipal systems and between regional public water systems.	Maximize reliability of water service Maximize efficiency of water use	See regional sectors	MDWS	2
45.	Ensure that public/private groundwater development agreements reflect the public trust needs and are in keeping with the water allocation priorities of the MIP.	Maximize reliability of water service Manage water equitably Maintain consistency with General and Community Plans	N/A	Maui County MDWS Public Water Systems	2
46.	Develop groundwater to maximize reliability of potable supply and as contingency in areas currently dependent on surface water.	Maximize reliability of water service	See regional sectors	MDWS Public Water Systems	2
47.	Diversify supply for agricultural use to increase reliability	Provide for agricultural needs Maximize reliability of water service	See regional sectors	DOA Maui County Private water purveyors	2

*Abbreviations:

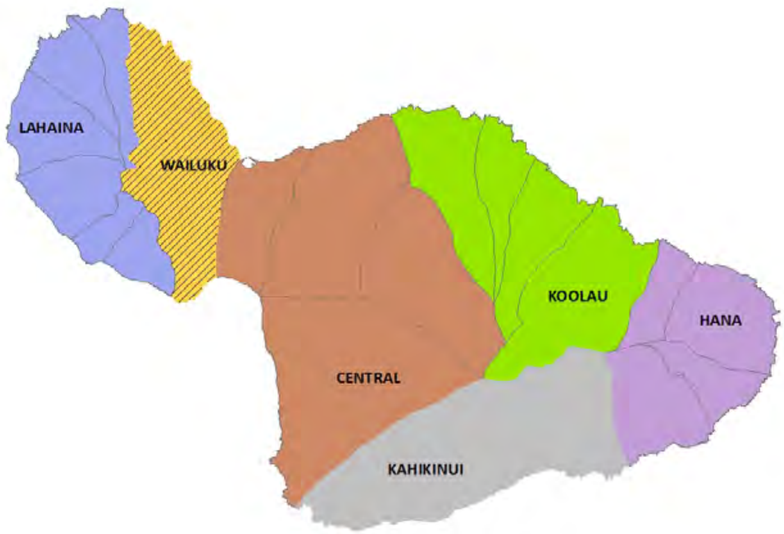
48.	Encourage CWRM to prioritize establishing IFS for diverted streams with potential conflicting uses.	Protect and restore streams Minimize adverse environmental impacts Manage water equitably Protect cultural resources	N/A	CWRM	2
49.	Defer any new surface water diversions to meet new projected demand.	Protect and restore streams Protect cultural resources	N/A	CWRM Maui County	1
50.	Balance existing diversions with alternative sources for agriculture to mitigate low-flow stream conditions.	Provide for agricultural needs Maximize reliability of water service	N/A	DOA Maui County Private water purveyors	2
51.	Maximize efficiencies in surface water transmission, distribution and storage.	Maximize efficiency of water use	N/A	Private water purveyors (EMI, MLP, WWC, West Maui Land)	2
52.	Add raw water storage to increase reliable supply once instream flow standards are established.	Maximize reliability of water service	See regional sectors	MDWS	2
53.	Increase treatment plan capacity at water treatment plant facilities to accommodate additional treatment in wet season.	Maximize reliability of water service Minimize cost of water supply	See regional sectors	MDWS	2
54.	Support plans and programs to develop additional sources of water for irrigation purposes.	Provide for agricultural needs Maximize reliability of water service	See regional sectors	DOA Maui County Private water purveyors	1
55.	Prioritize delivery and use of agricultural water within County agricultural parks to cultivation of food crops for local consumption.	Provide for agricultural needs Maximize reliability of water service	N/A	Maui County EMI MDWS	2
ALTERNATIVE WATER SOURCE					
56.	Expand requirement for new development to connect to recycled water infrastructure if practical.	Protect water resources Maintain consistency with General and Community Plans	N/A	Maui County	2
57.	Promote closer collaboration between MDWS and MDEM to master plan and utilize DWSRF funding to maximize recycled water use.	Maximize efficiency of water use, Maintain consistency with General and Community Plans	N/A	Maui County MDEM MDWS	2
58.	Explore expansion of "scalping plants" (small-scale membrane filter systems that put effluent closer to reuse locations) in designated growth areas.	Maximize efficiency of water use, Maintain consistency with General and Community Plans	N/A	MDEM	2

59.	Inform and educate the residential and commercial community of easy, affordable rainfall catchment for recharge and garden use	Protect water resources Maintain consistency with General and Community Plans	Outreach within multiple agency budgets. From $5,000 annually	DOH MDWS	2
60.	Provide incentives for residential rainwater catchment systems.	Protect water resources Maintain consistency with General and Community Plans	MDWS pilot program $45,000 over 2 years	MDWS	2
61.	Explore and promote opportunities for large volume stormwater runoff for agricultural irrigation.	Provide for agricultural needs	N/A	DLNR DOA MDPW	2

CWRM	Commission on Water Resource Management
DHHL	State of Hawai`i Department of Hawaiian Home Lands
DLNR	State of Hawai`i Department of Land and Natural Resources
DOA	State of Hawai`i Department of Agriculture
DOH	State of Hawai`i Department of Health
EMI	East Maui Irrigation Company
HRWA	Hawai'i Rural Water Association
Maui County	Maui County Administration and Maui County Council
MDEM	Maui County Department of Environmental Management
MDPW	Maui County Department of Public Works
MDWS	Maui County Department of Water Supply
MLP	Maui Land and Pineapple Company
SWCD	Soil and Water Conservation District
UH CTAHR	University of Hawai`i College of Tropical Agriculture and Human Resources
USDA	U.S. Department of Agriculture
USGS	U.S. Department of the Interior, U.S. Geological Survey
WWC	Wailuku Water Company

**Implementation Timeframe
1: Short-term 1 – 5 years
2: Long-term 5 – 20 years

III. Sector Area Reports



WAILUKU AQUIFER SECTOR AREA

MAUI ISLAND WATER USE AND DEVELOPMENT PLAN DRAFT

PART III REGIONAL PLANS

Table of Contents

List of Tables

List of Figures

WAILUKU AQUIFER SECTOR

Figure #	Figure Title
Figure 14-7	Nā Wai `Ehā -Designated Surface Water Management Areas
Figure 14-8	Wailuku Region and Wailuku Aquifer Sector
Figure 14-9	Kuleana Lands, Office of Hawaiian Affairs Data
Figure 14-10	Wailuku Aquifer Sector, Community Plans and Directed Growth Boundaries
Figure 14-11	Wailuku ASEA County Zoning Districts
Figure 14-12	DHHL Lands, Wailuku ASEA
Figure 14-13	Reported Pumpage by Well Type, Wailuku ASEA, 2014
Figure 14-14	Reported Pumpage by Well Type and Aquifer System, Wailuku ASEA, 2014 (mgd)
Figure 14-15	Reported Diversions by Use Type, Wailuku ASEA, 2011 - 2015
Figure 14-16	Wailuku ASEA Historic and Current Agricultural Land Use
Figure 14-17	West Maui Irrigation System/Wailuku Water Company
Figure 14-18	MDWS Central System
Figure 14-19	Groundwater Level Relative to Mean Sea Level, `Īao Aquifer Monitoring Well 2008 - 2017
Figure 14-20	Kahului Wastewater Reclamation Facility
Figure 14-21	Kīhei Wastewater Reclamation Facility
Figure 14-22	Wailuku-Kahului Planned Growth Areas
Figure 14-23	Wailuku-Kahului Planned Protected Areas and Sensitive Lands
Figure 14-24	Kīhei- Mākena Planned Growth Areas
Figure 14-25	Pulehunui Planned Growth Areas
Figure 14-26	Kīhei – Mākena – Planned Protected Areas
Figure 14-27	Comparison of Growth Boundaries, 2016 Development Project List, Water Systems and Water Resources, and Wailuku Water Company Ditch System
Figure 14-28	Projected Consumption by CWRM Category, MDWS Central System to 2035 (GPD)
Figure 14-29	Projected Water Use by CWRM Category to 2035, Population Growth Based (Low, Medium, High) Wailuku ASEA + MDWS Central System; Wailuku ASEA only (medium) Land Use Full Build-Out Wailuku ASEA only (mgd)
Figure 14-30	Population Mid-Growth Based 20-Year Water Demand Projections and Available Resources, Wailuku ASEA and Kahului Aquifer (mgd)
Figure 14-31	Population Mid-Growth Based 20-Year Water Demand Projections and Available Conventional and Alternative Resources, Wailuku ASEA and Kahului Aquifer in Central ASEA (mgd)
Figure 14-32	West Maui Mountains Watershed Protection Priority Areas, Elevation, Fog Zone and Rainfall

LIST OF ABBREVIATIONS:

CWRM	Commission on Water Resource Management
DHHL	State of Hawai'i Department of Hawaiian Home Lands
DLNR	State of Hawai'i Department of Land and Natural Resources
DOA	State of Hawai'i Department of Agriculture
DOH	State of Hawai'i Department of Health
HRWA	Hawai'i Rural Water Association
Maui County	Maui County Administration and Maui County Council
MDEM	Maui County Department of Environmental Management
MDP	Maui County Department of Planning
MDPW	Maui County Department of Public Works
MDWS	Maui County Department of Water Supply
SWCD	Soil and Water Conservation District
UH CTAHR	University of Hawaii College of Tropical Agriculture and Human Resources
USDA	U.S. Department of Agriculture
USGS	U.S. Department of the Interior, U.S. Geological Survey
WWC	Wailuku Water Company

14.0 WAILUKU AQUIFER SECTOR AREA

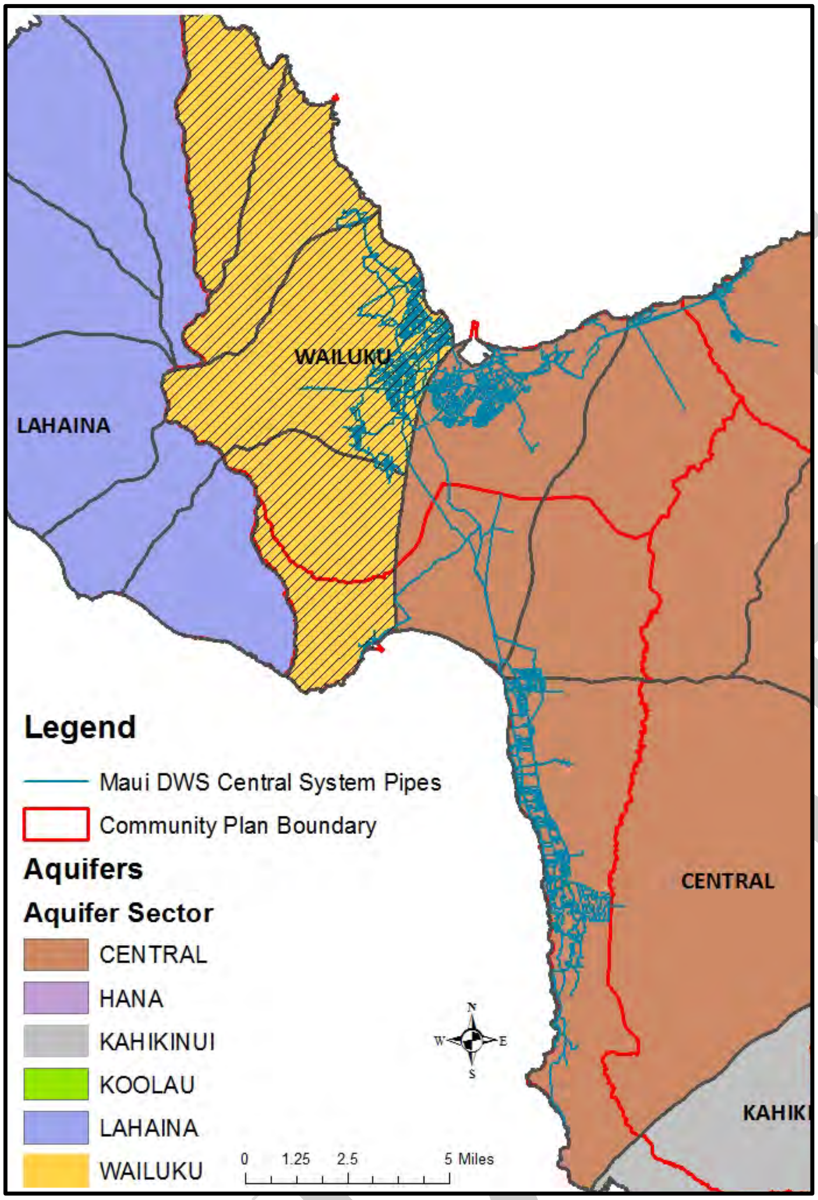
The Wailuku Aquifer Sector Area (ASEA) encompasses approximately 66 square miles, including four groundwater aquifer system areas underlying the eastern flank of West Maui Mountain. Pu`u Kukui summit rises 5,788 feet above sea level.

The population of the Wailuku ASEA includes shares of resident population from the Kīhei-Mākena and Wailuku-Kahului Community Plan areas. Almost 90% of the Wailuku ASEA is within the western portion of the Wailuku-Kahului Community Plan district. About 10% of the ASEA is within the western portion of the Kīhei-Mākena Community Plan district. The population of the Wailuku-Kahului Community Plan Area was estimated to be 60,336 in 2015 and is projected to increase by approximately 13% to 67,986 by 2035. The area remains the economic and population center of the island. In the 1990s, this area saw significant increases in trade, transportation, communications and utilities, and government jobs. Kahului harbor is the port through which most cruise ship visitors reach Maui. The 2030 Socio-Economic Forecast suggests the Wailuku-Kahului Community Plan Area will grow faster than other parts of Maui, as former sugar lands are developed into residential subdivisions. Wailuku-Kahului is expected to maintain its status as home to more than a third of Maui's households.

Most of the public water supply is from a freshwater lens in Wailuku ASEA. A considerable amount of water supply derived from aquifers and streams in the ASEA are transported for use in adjacent regions, primarily to the Central ASEA. The Water Use and Development Plan (WUDP) uses various definitions of hydrologic units for presentation and analysis consistent with The State Commission on Water Resources Management (CWRM) requirements for updating the Plan. The boundaries of hydrologic units and water distribution systems can be confusing. The State Water Code (Code), Chapter 174C, Hawai`i Revised Statutes (HRS), defines a hydrologic unit as "A surface drainage area or a groundwater basin or a combination of the two."[1] The 1990 Water Resources Protection Plan (WRPP) established Aquifer Sectors (ASEAs) as the largest aquifer units, and they are composed of smaller Aquifer Systems (ASYAs), which are composed of even smaller hydrologic units of streams and the surface areas surrounding them that gather and channel water into the streams. The figure below illustrates the Wailuku and Central Aquifer Sectors and the Maui Department of Water Supply (MDWS) "Central Maui System." The MDWS "systems" are not based on CWRMs Aquifer System hydrologic units, but instead, is an interconnected infrastructure of wells, pipes, and treatment and storage facilities. This MDWS system serves municipal needs on the north shore from Waihe`e to Pā`ia/Kū`au; the communities on the Central Isthmus: Kahului, Wailuku and Waikapū; and the south shore from Mā`alaea to Mākena.

[1] State of Hawai`i Commission on Water Resource Management (CWRM) Surface Water Hydrologic Units: A Management Tool for Instream Flow Standards (PR-2005-01), June 2005, page 1.

Figure 14-1 Wailuku and Central Aquifer Sectors, Maui Department of Water Supply Central Maui System



The Wailuku ASEA spans multiple moku that are generally more aligned with watershed boundaries than aquifer sectors. The majority of the Wailuku ASEA lies within the Pu`ali Komohana Moku, with sections also found within the Lahaina Moku to the South and Kā`anapali Moku to the North.

14.1 Planning Framework

14.1.1 Key Issues

Issues Raised in the Water Use and Development Plan Public Process

Initial efforts to update the 1990 WUDP focused on the MDWS Central Maui District. The MDWS and the consultant Ha`ikū Design and Analysis held stakeholder meetings with the Central District Water Advisory Committee from about 2005 through 2009. The committee identified issues, objectives, policies and suggested resources for this MDWS system. The WUDP Draft Update for the MDWS Central system was adopted by County Council but not approved by the Commission on Water Resource Management (CWRM). However, all issues and planning objectives were incorporated into the current update and summarized below.

Table 14-1 Central District Water Advisory Committee Planning Objectives

Availability	Provide Adequate Volume of Water Supply
DHHL	Provide For Department of Hawaiian Homelands Needs
Agriculture	Provide For Agricultural Needs
Cost	Minimize Cost of Water Supply
Efficiency	Maximize Efficiency of Water Use
Environment	Minimize Adverse Environmental Impacts
Resources	Protect Water Resources
Streams	Protect and Restore Streams
Culture	Protect Cultural Resources
Quality	Maximize Water Quality
Reliability	Maximize Reliability of Water Service
Equity	Manage Water Equitably
Sustainability	Maintain Sustainable Resources
Conformity	Maintain Consistency with General and Community Plans
Viability	Establish Viable Plans

The WUDP update was reignited at the end of 2015 and Department staff subsequently held several rounds of open public meetings, workshops and focus meetings for various stakeholder and special interest groups during 2016 that identified key issues and concerns for each region. Because the overlap between the MDWS water systems and hydrologic boundaries can be confusing, meetings held in Wailuku focused both on the resources within the Wailuku Aquifer Sector and the MDWS Central Maui System, which extends throughout large portions of the Central Aquifer Sector (ASEA).

In addition to input at meetings, the Department conducted manual and on-line surveys to poll residents on water issues and solutions for their regions. Generally, Central Maui is strongly concerned with the return of streamflow, prioritizing affordable housing before permits for new development are issued, and the status of Maui aquifers—more specifically, how aquifer pumpage relates to sustainable yield, water quality, and overall sustainability. Residents support the expanded use of greywater toilets and landscaping, cultural use of stream waters, and allowing neighbors to join together to share costs of public line extensions. South Maui residents voiced concerns about groundwater resource contamination and water use by HC&S.

Key issues and concerns can be categorized within the following interests, which overlap with the original planning objectives above:

- **Streamflow Protection and Native Hawaiian Rights and Uses**
- **Environmental Protection**
- **Alternative Water Sources**
- **Water Availability**
- **Availability at Development Stage/Meters**
- **Costs**
- **WUDP Process**

Streamflow Protection and Native Hawaiian Rights and Uses

- Community members have stated that kuleana tenants have absolute rights over stream resources, and they have called for restoring 100% of streamflow, before planning and allocating streamflow for other water uses and development.
- Concerns were expressed that the Maui County government administration supports extension of HC&S's revocable permits.

Environmental Protection

- Concerns were expressed about the lack of aquifer information in regions that are not designated groundwater management areas.
- Saltwater intrusion is viewed as environmental contamination of groundwater resources.

Alternative Water Sources

- Residents want to maximize use of alternative sources of water (R-1 wastewater, rainwater, greywater, etc.) while minimizing well and surface water use. There was also a desire to live within the limits of local water resources rather than transporting water.
- Desalination is viewed by some as energy intensive and potentially impacting natural nearshore ecosystems.

Water Availability

- Residents want the WUDP to ensure that water resources will be utilized in a way that ensures long-term sustainability.
- Central Maui residents are concerned with the health of our aquifers; the lack of reporting of private wells and the lack of data impact on establishing sustainable yields. Residents believe a water availability rule ("Show Me the Water") is critical to maintaining water availability in a sustainable fashion.

Availability at Development Stage/Meters

Concerns with water meter availability at the development stage are an extension of concerns over water availability. The MDWS Upcountry system was the primary target of most concerns regarding meters for single home residential and agricultural plots, along with proposed Hawaiian Homelands development, which are perceived to have come to a virtual standstill while large developers appear to be fast-tracked through the metering process.

Costs

Cost factors into a variety of questions and issues raised at the community meetings.

- Residents asked whether South Maui development should pay extra for the transport of water from Wailuku and stated that MDWS development fees are inadequate to cover costs.
- Residents want information about the proposed costs of options in the WUDP.
- There are concerns over how to ensure water for affordable housing is being provided.

WUDP Process and Development

Residents in Central Maui want clarification on the use and meaning of the word **"***stakeholder*" in relation to the WUDP and whether the Native Hawaiian community is being adequately consulted on water resource management.

14.1.2 Plans, Goals, Objectives and Policies

The WUDP implements the Maui County General Plan and is subject to the plans, goals, policies and objectives discussed in Chapter 3 of the WUDP. The Maui Island Plan (MIP), adopted in 2012, identified challenges and opportunities for the MDWS systems. Issues addressed in the MIP are not specific to the Wailuku Aquifer Sector (ASEA) or the MDWS Central Maui system that is partially located within the Wailuku ASEA, but they apply island-wide, and are summarized below:

- Comprehensive water resources planning and system control: continual assessment of the current and future adequacy of water supplies in a holistic way, including the establishment of appropriate principles and standards; determining the capital improvements that would be required to treat and deliver the needed water, and the best ways to pay for these improvements. Some members of the community expressed concerns that the County controls a relatively small percentage of the water on the island.

- The MDWS has budget constraints: the current budget is inadequate to cover costs for long overdue replacement and repairs for all water systems.

- Stream protection and Instream Flow Standards: Interim Instream Flow Standards (IIFS) in place are not based on scientific information but simply continue the status quo. Numerical standards will impact MDWS' long-range planning for surface water resources.

- Native Hawaiian water rights: concerns over water rights include current and future water use for Hawaiian Homelands, domestic water use for kuleana lands, and traditional and customary rights. The ahupua`a systems that exist should be maintained and enhanced.

- Energy production and efficiency measures: energy use is a substantial component of MDWS costs, increasing energy efficiency is a key element of reducing long-term water service costs. Multiple energy production and efficiency options exist, including hydroelectric generation, wind power for water pumping, and system operation efficiency improvements.

- Wastewater reuse: wastewater reuse for agricultural, golf course, landscape, and other irrigation needs extends the life of used water and conserves freshwater sources. The feasibility of treating and utilizing wastewater depends on many factors: the location of the wastewater facility and the proposed service area are key considerations for wastewater reuse.

- Private water systems: when new developments are built beyond water service areas, private water source development should implement, rather than undermine, County land use policies and directed growth strategies that seek to direct future growth to the most appropriate locations and communities. The Wailuku-Kahului Community Plan adopted in 2002 addresses regional issues and remains in effect. Relevant goals and policies of the community plan are summarized below.

Water Resources

- Protect water resources in the region from contamination, including protecting groundwater recharge areas, and wellhead protection areas within a 1.25-mile radius from the wells.
- Protect cultural and archaeological sites: `Īao Stream, taro lo`i terraces in `Īao Valley, Nā Wai `Ehā.
- Promote and implement programs for groundwater and wellhead protection.

Water Availability and Use

- Coordinate water system improvement plans with growth areas to ensure adequate supply and a program to replace deteriorating portions of the distribution system. Future growth should be phased to be in concert with the service capacity of the water system.
- Improve the quality of potable water.
- Coordinate the construction of all water and public roadway and utility improvements to minimize construction impacts and inconveniences to the public.
- Coordinate expansion of and improvements to the water system to coincide with the development of residential expansion areas.
- Preserve agricultural lands as a major element of the open space setting bordering various communities.
- Preserve and protect Native Hawaiian rights and practices customarily and traditionally exercised for subsistence, cultural and religious purposes.
- Encourage traditional Hawaiian agriculture, such as taro cultivation, within the agricultural district, in areas which have been historically associated with this cultural practice.

Supply Augmentation/Demand Controls

- Promote conservation of potable water through use of treated wastewater effluent for irrigation.
- Reuse treated effluent from the County's wastewater treatment system for irrigation and other suitable purposes in a manner that is environmentally sound.
- Provide incentives for water and energy conservation practices.
- Promote energy conservation and renewable energy.
- Incorporate drought-tolerant plant species and xeriscaping in future landscape planting.

14.2 Physical Setting

14.2.1 Climate and Geology

Climate

West Maui Volcano rises to 5,788 feet above sea level at Pu`u Kukui summit. The topography of Maui and the location of the North Pacific anticyclone relative to the island affect its climate, which is characterized by mild and uniform temperatures, seasonal variation in rainfall, and great geographic variation in rainfall.[2] Average temperature in Wailuku, near the coast, is 75º F. During the warmer dry season (May–September), the stability of the North Pacific anticyclone produces persistent northeasterly winds, known locally as trade winds, which blow 80–95 percent of the time. During the cooler rainy season (October–April), migratory weather systems often travel past the Hawaiian Islands, resulting in less persistent trade winds that blow 50–80 percent of the time. Low-pressure systems and associated southerly winds can bring heavy rains to the island, and the dry coastal areas can receive most of their rainfall from these systems. Mean annual rainfall at the coast in the dry leeward areas is less than 15 inches. At higher altitudes, precipitation is a combination of rainfall and fog drip where the montane forest canopy intercepts cloud water. Giambelluca and Nullet (1991) defined the fog zone on the leeward slopes of Haleakalā as extending from altitudes of about 3,900 to 5,900 ft. and estimated a thicker fog zone, at altitudes of 2,000 to 6,560 ft., along windward slopes. The variation in rainfall varies from approximately 355 inches per year at the summits of Pu`u Kukui to 20 inches per year on the lower slopes and isthmus of Waikapū *(Gingerich, S.B., 2008).* Precipitation is supplemented by an unknown amount of fog drip, which is fog and precipitation (not measured by rain gages) that is intercepted by vegetation and that subsequently drips to the ground surface.[3]

Geology

The West Maui Volcano, or Mauna Kahālāwai, "holding house of water," has a central caldera and two main rift zones that trend in northwesterly and southeasterly directions from the caldera. Thousands of dikes exist within the rift zones, with the number of dikes increasing toward the caldera and with depth. Additional dikes exist outside the trends of the rift zones, creating a radial pattern of dikes emanating from the caldera. The rocks of West Maui Volcano consist of the mostly shield-stage Wailuku Basalt, which is overlain by the postshield-stage Honolua Volcanics and rejuvenated-stage Lahaina Volcanics. Sedimentary deposits throughout Maui have been divided into consolidated earthy deposits, calcareous sand dunes, and unconsolidated deposits. The consolidated earthy deposits are primarily older alluvium, which

[2] Blumenstock, D.I. and Price, S. (1967) Climate of Hawai`i. In: Climates of the States, No. 60-51, Climatography of the United States, US Department of Commerce, Washington DC.
[3] William Meyer and Todd K. Presley. U.S. GEOLOGICAL SURVEY Water-Resources Investigations Report 00-4223. 2001. The Response of the ``Īao Aquifer to Ground-Water Development, Rainfall, and Land-Use Practices, Maui, Hawai`i

forms the bulk of the alluvial plains stretching from the mountains of West Maui Volcano to the coast. The older alluvium primarily consists of poorly sorted conglomerates. The older alluvium has been partly eroded by Waikapū Stream, the Wailuku River and Waihe`e River. Calcareous sand dunes are found seaward of the exposed older alluvium. Unconsolidated deposits are found in streambeds and in the coastal areas, and primarily consist of younger, poorly sorted alluvium. [4]

Dikes are intrusive volcanic rocks which formed by magma that cooled below the ground surface. Dikes associated with the rift zones of the West Maui Volcano are significant because of their low permeability and their impounding effect on groundwater. Groundwater levels in the interior of the West Maui Volcano may be as high as 3,000 feet above sea level, as evidenced by water tunnels tapping dike compartments. [5]

14.2.2 Water Resources

Most of the public water supply for the island is from a freshwater lens in the Wailuku Aquifer Sector Area (ASEA). The `Īao Aquifer provides most of the groundwater supply and has been extensively studied. The main groundwater system in this area consists of a freshwater lens system in dike-free volcanic rocks. Features that form boundaries of the freshwater lens system include dikes in the interior of West Maui Mountains. Sedimentary caprock with lower permeability between West Maui Volcano and Haleakalā impedes groundwater flow between Wailuku and the Central isthmus, as well as groundwater discharge to the coast. The water table in the dike-free volcanic rocks is less than a few tens of feet above sea level. In general, the water table altitude is lowest near the coast and increases landward at a rate of about 1 foot per mile.

Groundwater and Surface Water Recharge

A water budget includes water input and output and is modeled based on best available hydrologic, geologic and land use data. Groundwater recharge replenishes aquifers and is fed mainly by precipitation and irrigation that infiltrates the ground surface and percolates beyond the root zone in the soil. Recharge is greatest in the inland mountainous regions. Dike impounded groundwater discharges to streams, representing the continuous base flow. Where the groundwater table is below the streambed, seepage from streambeds generally recharges groundwater. Fresh groundwater that does not discharge to streams or tunnels, or is not withdrawn from wells in the dike-impounded system, flows to downgradient areas in the freshwater lens system. [6]

---

[4] Gingrich, S. 2008 U.S. GEOLOGICAL SURVEY. Ground-Water Availability in the Wailuku Area, Maui, Hawai`i Scientific Investigations Report 2008-5236

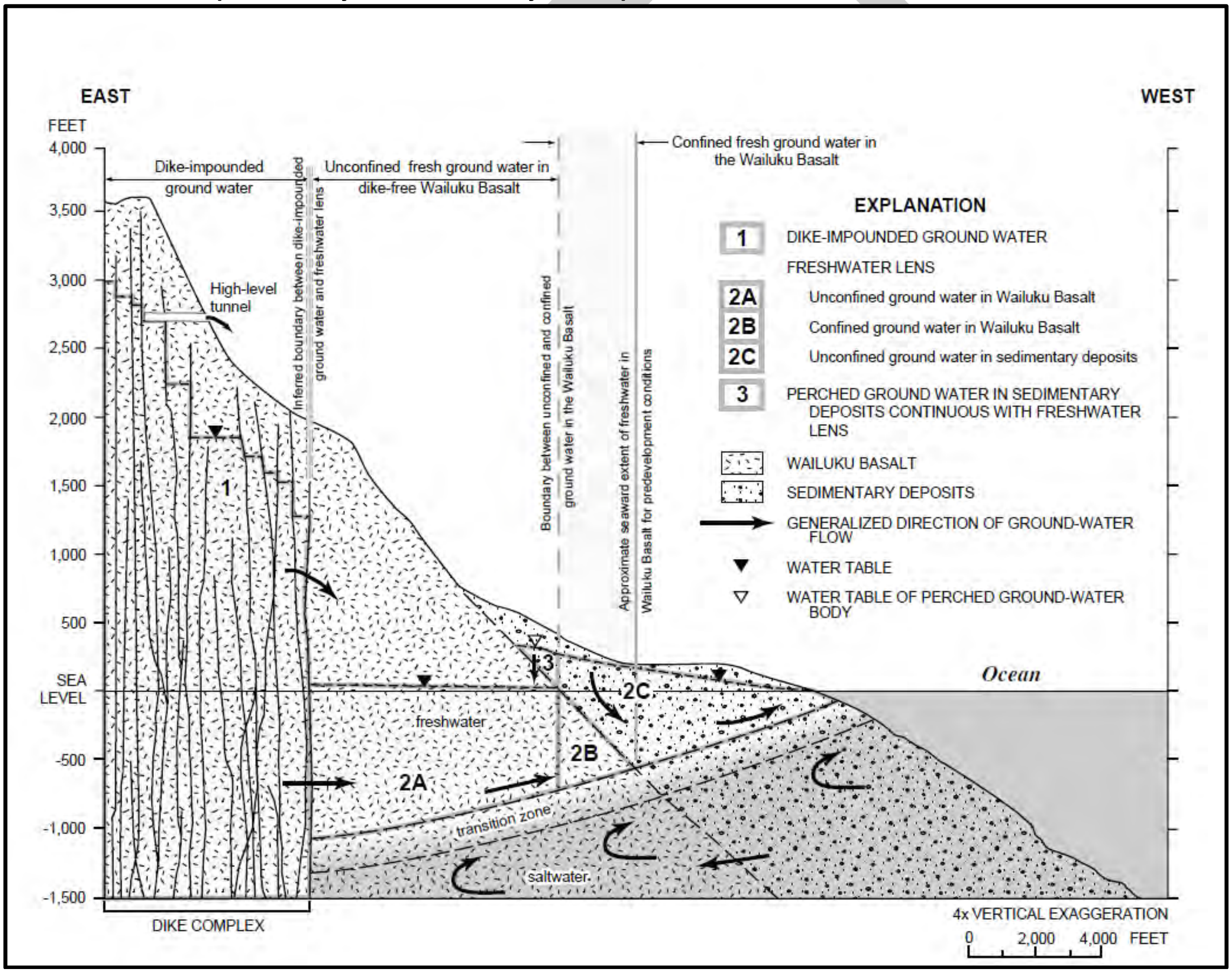
[5] Ibid.

[6] Ibid.

Downstream from the area of dike-impounded water, where the water table of the freshwater lens system is below the streambed, potential exists for streamflow infiltration to recharge the basal freshwater system.

Caprock water refers to water confined in sedimentary caprock, commonly along the shoreline, that is recharged from surface flows, local rainfall, return irrigation water, and leakage from confined basal water. It's generally limited to non-potable uses due to its saline quality.[7]
The figure below illustrates the types of groundwater occurrence and movement of the `Īao Aquifer.

Figure 14-2 Geologic Cross Section of the `Īao Aquifer Area, Showing Groundwater Occurrence and Movement (from Meyer and Presley, 2001)



Source: Gingrich, S. 2008 U.S. GEOLOGICAL SURVEY. Ground-Water Availability in the Wailuku Area, Maui, Hawai`i Scientific Investigations Report 2008-5236

[7] CWRM Water Resources Protection Plan, 2008 p 3-11

Before the cessation of Hawaiian Commercial & Sugar Company, most water diverted from Waikapū Stream, Waiehu Stream, and Waihe`e and Wailuku Rivers was transported to the isthmus (the strip of land in the center of the island between Haleakalā and Mauna Kahālāwai) and used for irrigation outside the area contributing recharge to the Wailuku ASEA. The amount and location of recharge has been profoundly affected by plantation-scale sugarcane cultivation (and, to lesser degrees, pineapple and macadamia nuts) in agricultural areas. Since the early 20th century, about 100 billion gallons of surface water has been diverted each year from island streams for crop irrigation. More than half of this diverted water, about 59 billion gallons per year, originated outside the Wailuku region in East Maui. Under natural conditions, most stream water would flow to the ocean. Instead, stream water diverted for irrigation is applied to the plant-soil system, creating an artificial increase in groundwater recharge of the underlying aquifer systems (Kahului and Pā`ia Aquifers). The export caused a net decrease in recharge to the Wailuku ASEA. [8] Since sugarcane irrigation ceased in 2016, the impact on natural and artificial recharge has not been quantified; however, in the past, the transition from ditch/furrow irrigation to drip irrigation systems has shown to significantly decrease the amount of artificial recharge.

The interaction between the Wailuku ASEA and Central ASEA hydrologic units are important to assess the viability of sources that are impacted by natural and artificial changes in recharge. The Maui Lani wells drilled within the Kahului aquifer just eastward of the `Īao Aquifer boundary are believed to be impacted by recharge from `Īao Aquifer, leaching from unlined reservoirs fed by Nā Wai `Ehā surface water, as well as irrigation return recharge within the Kahului aquifer.

Irrigation rates in the Wailuku and Central Maui regions have been steadily decreasing since the 1970s. This decrease coincided with periods of below-average rainfall, leading to substantially reduced recharge rates. Estimated recharge for Central and West Maui declined 44 percent during the period 1926 – 2004. To aid in prudent management of groundwater resources and plan for sustainable growth on the Island, MDWS entered into a cooperative agreement in 2003 with the U.S Geological Survey (USGS) to conduct a study of the groundwater availability in Central and West Maui. The 2008 USGS study, *Ground-Water Availability in the Wailuku Area*, assessed recharge during average and drought conditions and used a numerical groundwater flow and transport model to estimate the effects of various withdrawal and recharge scenarios on water levels and on the transition zone between fresh water and ocean water. Since then, recharge estimates have been updated and new wells were drilled, which can be measured to provide new water level information. Therefore MDWS entered into a new cooperative agreement with USGS in 2015 to update the groundwater-flow model (Gingerich, 2008) to evaluate effects of planned wells on the salinity and transition zone of the `Īao, Waihe`e and Waikapū aquifers. Revised recharge estimates during average climate conditions and drought conditions were available in 2017. A drought scenario based on rainfall during the 1998–2002 period yielded a 29 percent reduction in recharge compared to average climate conditions.

[8] Ibid.

Table 14-2: Wailuku ASEA Groundwater Recharge Estimates Drought and Average Conditions

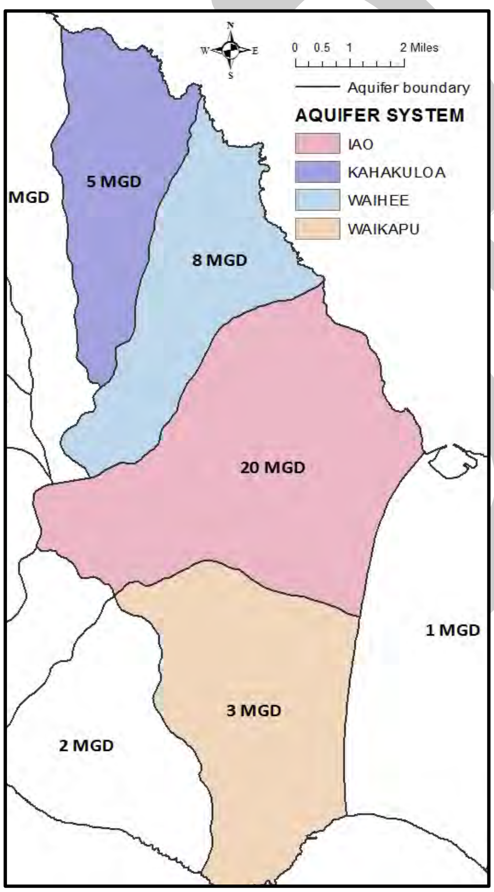
Recharge Average Climate Conditions *	Recharge Drought Climate Conditions *	Decrease Drought Climate Conditions
92 mgd	65 mgd	29%

*Non-caprock area delineated by Johnson and others (2014). USGS, Revised (May 2017) recharge estimates for Maui, Hawai`i for 1978–2007 rainfall and 2010 land-use conditions. Revised (2017) recharge estimates for Maui, Hawai`i for drought conditions (1998–2002 rainfall and 2010 land-use conditions).

Groundwater Availability

The Wailuku ASEA spans the eastern half of the West Maui Mountains, Mauna Kahālāwai from the north to the south shore with an altitude from 5,788 ft. at the summit of the West Maui Volcano to sea level at the Central Isthmus. The moku of Wailuku includes Nā Wai `Ehā, the four waters Waikapū Stream, Wailuku River, Waihe`e River, and Waiehu Stream. The Wailuku ASEA includes four aquifer systems: Waikapū, `Īao, Waihe`e, and Kahakuloa. The `Īao and Waihe`e aquifer systems on the eastern side of West Maui Mountain are the principal sources of domestic water supply for the island of Maui. The total sustainable yield of the Wailuku ASEA is 36 mgd, as established by the Commission on Water Resource Management (CWRM) in 2008.

Figure 14-3 Wailuku Sector Aquifer Systems and Sustainable Yield



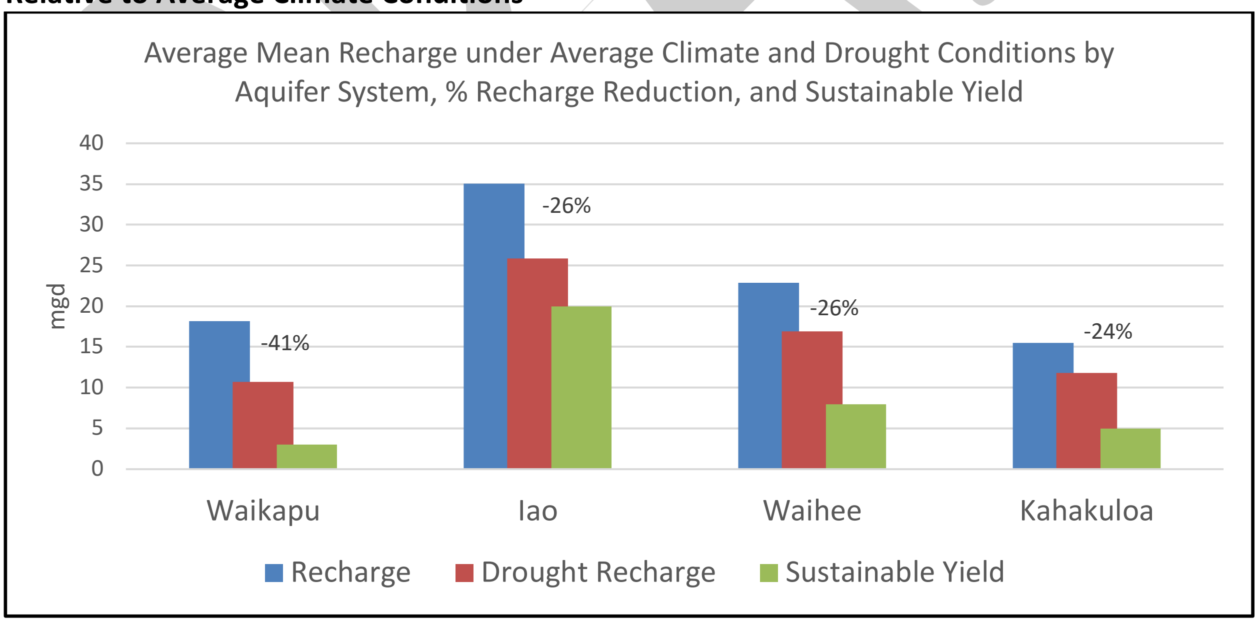
Aquifer System	Aquifer Code	Sustainable Yield Range (mgd)	Sustainable Yield (mgd)
Waikapū	60101	3-6	3
`Īao	60102	11-31	20
Waihe`e	60103	6-15	8
Kahakuloa	60104	5-8	5

Source: Hawai`i Water Resource Protection Plan, June 2008.

The groundwater sustainable yield (SY) is the maximum rate that groundwater can be withdrawn without impairing the water source as determined by the CWRM. Sustainable yield (SY) does not account for water transfers, such as irrigation return flow that percolates back into the aquifer to be potentially re-pumped, and SY accounts for basal, perched, and high-level water. Sustainable yield accounts only for basal groundwater and equals a fraction of estimated recharge. In a basal lens, the fraction is usually more than half of the total groundwater recharge. According to the State Water Resources Protection Plan, 2008, about three-fourths of the recharge of high-level aquifers can be taken as sustainable yield. SY is believed to be the best estimate based on available hydrologic data. The CWRM ranks confidence in SY data dependent on available hydrologic studies, deep monitoring wells and established pumping records. The CWRM is moderately confident in SY for Waikapū, Waihe`e and Kahakuloa aquifers, as sufficient data and studies are available to indicate that the adopted SY is not over-estimated. `Īao Aquifer is ranked most confident based on deep monitor well data and comprehensive hydrologic studies and groundwater models. `Īao Aquifer is a designated Groundwater Management Area, requiring the CWRM to allocate water use permits for all potable and non-potable uses.

Hypothetically, the drought recharge reduction can be applied to SY for planning purposes that consider long-term hydrologic drought. However, the WUDP updates will monitor continuous SY updates by CWRM and adjust accordingly. Recharge compared to sustainable yield for this aquifer sector is illustrated in the figure below.

Figure 14-4: Percentage Difference in Mean Annual Groundwater Recharge for Drought Relative to Average Climate Conditions



Source: CWRM 2008 Sustainable Yield. USGS, Revised (May 2017) recharge estimates for Maui, Hawai`i for 1978–2007 rainfall and 2010 land-use conditions. Revised (2017) recharge estimates for Maui, Hawai`i for drought conditions (1998–2002 rainfall and 2010 land-use conditions).

Two ongoing USGS studies initiated in 2015 assess the impact of land-cover changes on past and future groundwater recharge on Maui, and they also assess the hydrologic impact from native versus alien forested watersheds. Study results and improved methods of estimating fog interception, including forest canopy interception and the differentiation of native and alien forests could potentially affect future estimates of sustainable yield.

Groundwater Management Area Designation

In response to a 2001 petition and concerns of rising water levels and chlorides in the `Īao  and Waihe`e aquifers, the CWRM initiated designation procedures and issued their findings of fact in 2002. CWRM found that 2 of the 8 criteria cited in HRS §174C-44 for designation were met for `Īao Aquifer and designated the aquifer a Groundwater Management Area (GWMA) in 2003:

1. §174C-44(1) Whether an increase in water use or authorized planned use may cause the maximum rate of withdrawal from the groundwater source to reach ninety percent of the sustainable yield of the proposed water management area
2. §174C-44 (4) Whether rates, times, spatial patterns, or depths of existing withdrawals of ground-water are endangering the stability of optimum development of the ground-water body due to upconing or encroachment of salt water.

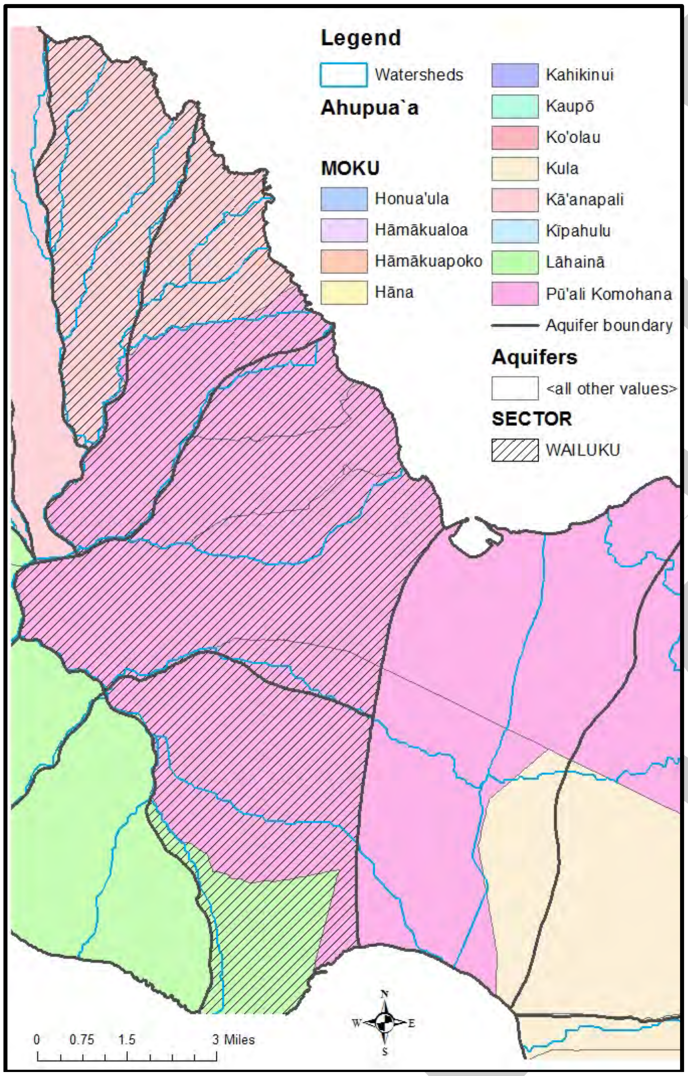
Upconing was deemed to occur at the Mokuhau and Waiehu Heights well fields. These are deep wells with large pumps that are closely spaced. Over the last decade, DWS has distributed pumpage through development of new wells within the aquifer and chlorides have remained stable. Authorized planned use is defined in §174C-3 as "the use of or projected use of water by a development that has received the proper state land use designation and county development plan/community plan approvals". The 2002 projected use from the MDWS Central System was estimated to 29 mgd. Although current pumpage from the designated aquifer has not approached 90 percent, or 18 mgd over the last few years, CWRM has issued water use permits totaling 19.795 mgd, representing 98.9 percent of SY, for the `Īao Aquifer GWMA.

For the adjacent Waihe`e aquifer, CWRM found that while groundwater designation criterion §174C-44(1) was met, MDWS source development would spread pumpage and help avoid other designation criteria. CWRM recommended that pumping from existing wells within the southern portion of the Waihe`e aquifer be limited to 4.0 mgd. The MDWS has maintained pumpage to below 4.0 mgd over the last decade and water levels have recovered to safer levels.

Moku and Watersheds

A moku, typically consisting of multiple ahupua`a, generally aligns more with watershed boundaries than aquifer sectors. The majority of the Wailuku ASEA lies within the Pu`ali Komohana Moku, with sections also found within the Lahaina Moku to the south and Kā`anapali Moku to the north.

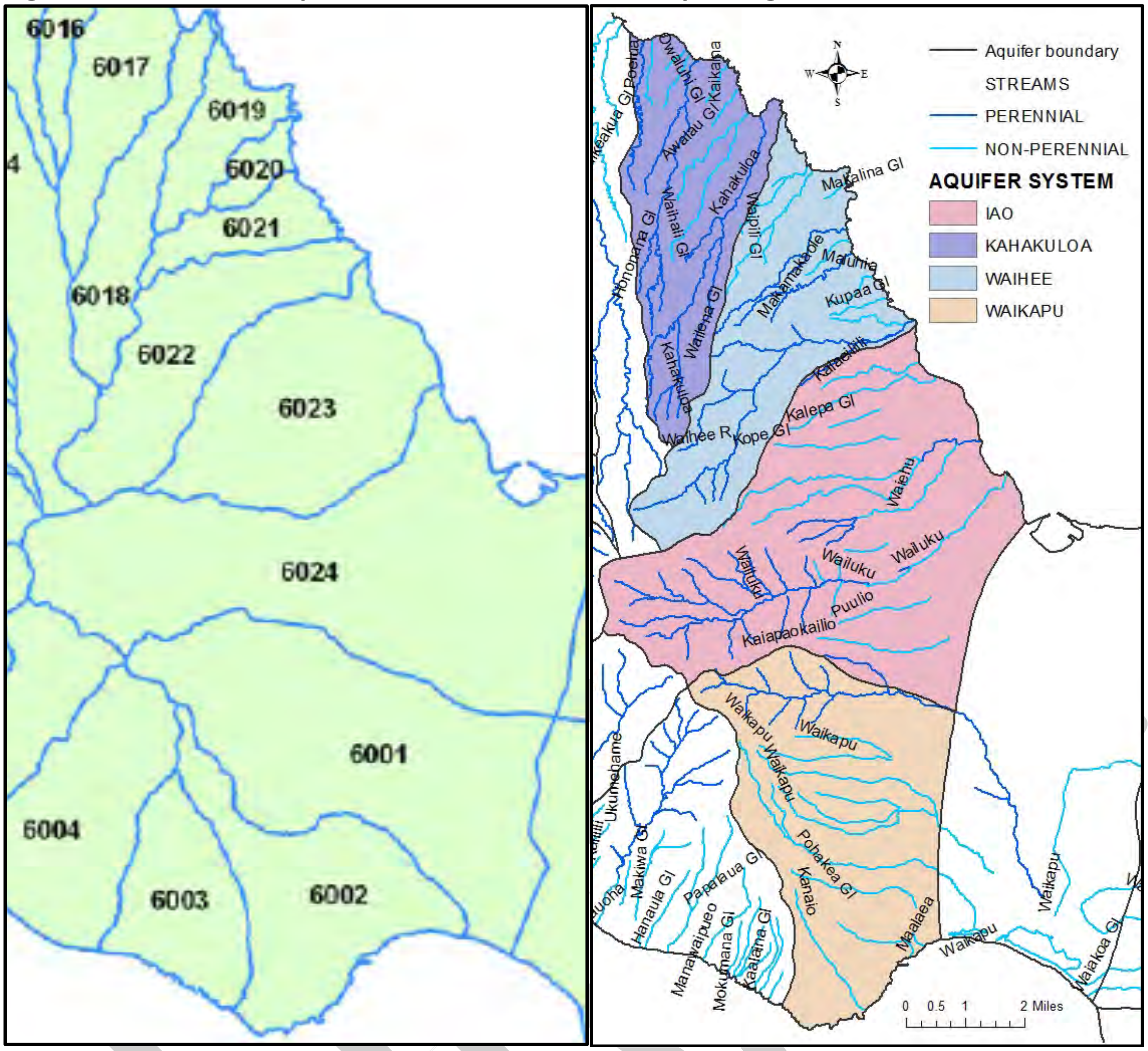
Figure 14-5 Wailuku Aquifer Sector Moku and Watershed Boundaries



Surface Water Availability

The surface water hydrologic units (generally referred to as watersheds, or ahupua`a) and streams are shown below. There are 11 surface water units within the area encompassed by the Wailuku ASEA.

Figure 14-6 Wailuku Aquifer Sector Surface Water Hydrologic Units and Streams



Source: CWRM Water Resources Protection Plan, 2008

Table 14-3 Wailuku ASEA Surface Water Hydrologic Units

6001	Waikapū
6002	Pohakea
6016	Poelua
6017	Honanana
6018	Kahakuloa
6019	Waipili
6020	Waiolai
6021	Makamaka`ole
6022	Waihe`e
6023	Waiehu
6024	`Īao

Table 14-4 Wailuku ASEA Perennial Streams

6201	Poelua
6202	Honanana
6203	Kahakuloa
6205	Waiolai
6206	Makamaka`ole
6207	Waihe`e River
6208	Waiehu
6209	Wailuku River (`Īao Stream)
6210	Waikapū

Hawai`i Stream Assessment, Report R84, December 1990

There are 57 declared stream diversions in the CWRM database and 27 gages within the Wailuku ASEA. Diversion systems that transported water to the former plantations continue to support agricultural, municipal and domestic needs. Diverted streams can affect streamflow, which can adversely affect kuleana and appurtenant rights, Hawaiian traditional and customary practices, stream ecology, water quality, recreational activities, and aesthetics.

The following table shows the interim instream flow standards (IIFS), number of diversions and gages for Wailuku Aquifer Sector streams. The IIFS generally reflects the diverted amounts existing when the status quo IIFS were adopted, or as subsequently amended by CWRM. The ongoing contested case and proposed IIFS for the streams of Nā Wai `Ehā are further discussed below.

Table 14-5 Wailuku ASEA Surface Water Diversions, Natural Streamflow, Gages and Proposed IIFS by Watershed Unit

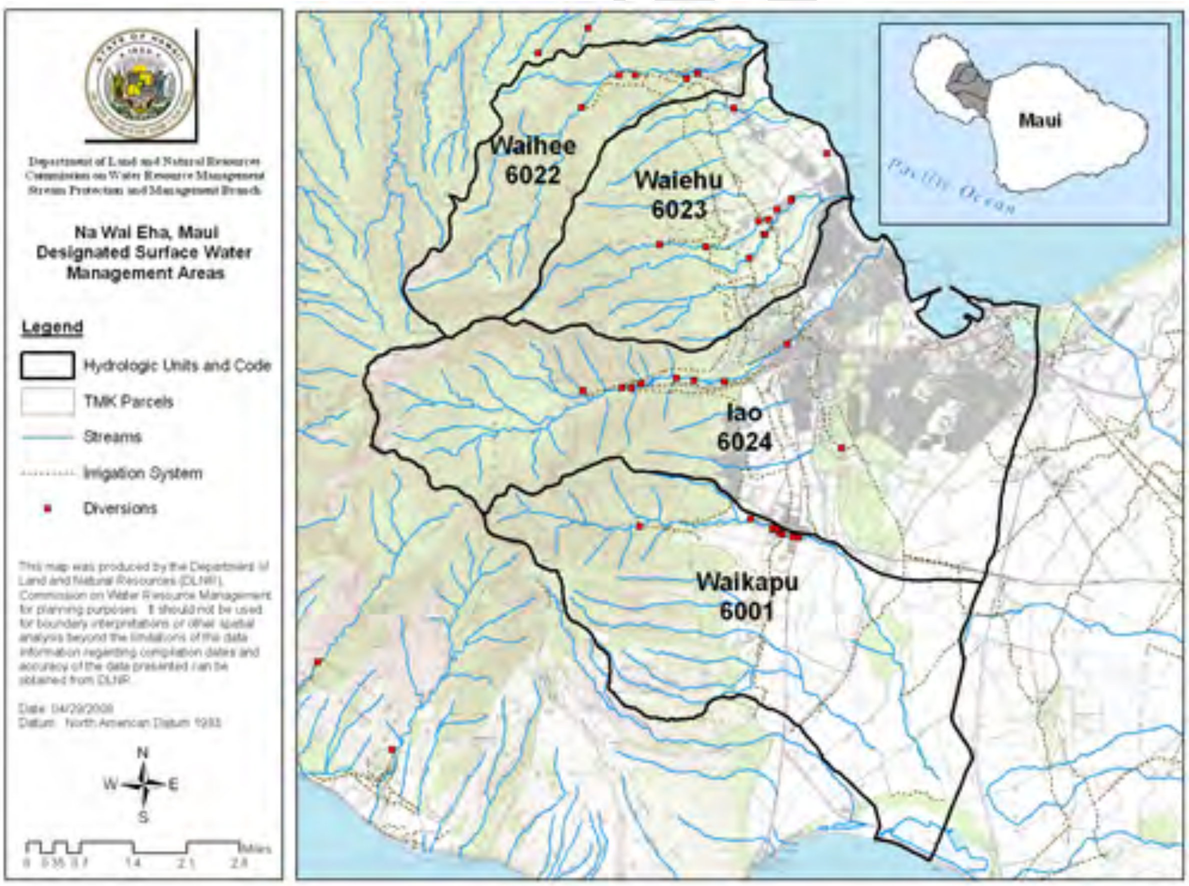
Aquifer System	Unit No.	Hydrologic Unit	Area (mi²)	Median Flow (Q50)* (MGD)	Low Flow (Q90)*² (MGD)	No. of Diversions	No. of Gages	Interim IFS
Waikapū	`	Waikapū	16.4	4.8	3.3	12	4	2.9 mgd below S. Waikapū Ditch return
Waikapū	6002	Pohakea	8.31	N/A	N/A	0	1	HAR §13-169-48
Kahakuloa	6016	Poelua	2.02	N/A	N/A	0	2	HAR §13-169-48
Kahakuloa	6017	Honanana	4.66	N/A	N/A	2	0	HAR §13-169-48
Kahakuloa	6018	Kahakuloa	4.24	5.17	2.84	10	3	HAR §13-169-48. Amended to include SCAP MA-133 on Kahakuloa Stream for reconstruction of an existing stream diversion (6/2/1994)
Waihe'e	6019	Waipili	2.65	N/A	N/A	2	0	HAR §13-169-48
Waihe'e	6020	Waiolai	0.97	N/A	N/A	1	0	HAR §13-169-48
Waihe'e	6021	Makamaka`ole	2.28	N/A	N/A	4	2	HAR §13-169-48
Waihe'e	6022	Waihe'e	7.11	34	24	5	4	10mgd below Waihe'e Ditch intake and 10mgd below Spreckels Ditch intake
`Īao	6023	Waiehu	10.1	5.5	2.7	12	5	1.6 mgd below N. Waiehu Ditch intake on N. Waiehu and 0.9 mgd below Spreckels Ditch intake on S. Waiehu
`Īao	6024	`Īao (Wailuku River)	22.55	25	13	9	6	10 mgd below `Īao-Waikapū Ditch at Kepaniwai Park and 5 mgd at the stream mouth
TOTAL:				74.47	45.84	57	27	

Source: 2008 WRPP, CCHMA0601-2 CWRM Order Adopting 1) Hearing Officer's Recommendation on the Mediated Agreement Between the Parties; and 2) Stipulation Re Mediator's Report of Joint Proposed Findings of Fact, Conclusions of Law, Decision and Order, April 17, 2014
*Streamflow 50 percent of the time
*²Streamflow 90 percent of the time

Nā Wai `Ehā Surface Water Management Area and Instream Flow Standards

Nā Wai `Ehā, or "the four great waters of Maui," is the collective name for the Waihe`e River and Wailuku River (formerly `Īao Stream) and the Waiehu and Waikapū Streams. On June 25, 2004 Petitioners/Appellants Hui o Nā Wai `Ehā and Maui Tomorrow Foundation, Inc., through Earthjustice, filed a *Petition to Amend the Interim Instream Flow Standards for Waihe`e, North and South Waiehu, `Īao , and Waikapū Streams and Their Tributaries*, which had been in place since 1988.

Figure 14-7 – Nā Wai `Ehā -Designated Surface Water Management Areas



In accordance with the Water Code, the CWRM establishes and administers instream flow standards (IFS) on a stream-by-stream basis as necessary to protect the public interest. The IFS 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." The IIFS for Waihe`e and Waiehu streams were not amended, while retaining the existing values for Wailuku River and Waikapū Stream. The decision to not amend IIFS values for Wailuku River and Waikapū Stream was appealed to the Hawai`i Supreme Court, which ruled that CWRM must consider ecosystem services (explanation of "services" in these parentheses, habitat for native biota, and traditional and customary practices in establishing IIFS values. A mediated settlement of additional IIFS values for the two streams was reached between the parties involved, which were approved by CWRM in 2014. This agreement, left the Waihe`e River restoration at the 2010 amended flow, modified the Waiehu Stream 2010 restoration and restored water to Wailuku River and Waikapū Stream.

The third stage of the contested case process is to determine surface water use permits and the integration of the instream flow standards, appurtenant rights and surface water use permits. However, in response to the 2016 announcement by Alexander & Baldwin, Inc. that it would close HC&S by the end of 2016 and eventually transition to diversified agriculture, the Parties filed and the CWRM accepted a *Petition to Amend Upward the IIFS for Waihe`e, Waiehu, `Īao, and Waikapū Streams and Their Tributaries; and Motion to Consolidate or Consider in Parallel with Case CCH-MA 15-01.*[9] The CCH is currently ongoing. In December 2017, the CCH hearing officer issued his proposed FOF, COL and D&O. The parties have filed their objections/exceptions in January of 2018 and at the time of this Draft, CWRM has yet to adopt the proposed FOF, COL and D&O. The proposed amended IFS for the Nā Wai `Ehā rivers and streams are summarized below.

The table shows how much daily mean streamflow is required to equal or exceed 50 percent of the time (Q_{50}) the stream flows. This flow reflects typical streamflow conditions. Flow that is exceeded 90 percent of the time reflects low flow conditions (Q_{90}). Streamflow can consist of groundwater discharge (base flow), direct runoff, water returned from stream bank storage, direct rainfall, and recharge from leaks of manmade ditches and reservoirs.

[9] Staff Submittal to the CWRM, June 17, 2016.
http://files.Hawai`i.gov/dlnr/cwrm/submittal/2016/sb20160617C3.pdf

Table 14-6 Nā Wai `Ehā Proposed Instream Flow Standards as of December 2017

Stream	Instream Streamflow Standard	Lowest Median Flow, Q_{50} (mgd)	Lowest Median Flow, Q_{90} (mgd)	Water Use Permits	Appurtenant Rights (reasonable & beneficial)
North Waiehu	• Above all diversions Q_{90}: 1.4 – 2.7 mgd; Q_{70} 2.3 – 2.7 mgd, Q_{50} 3.1 – 3.6 mgd • Waihe`e Ditch: 1 mgd (or if less above diversion, corresponding amount)	3.1	1.4	0.83 MGD (832,930 gpd)	0.49 MGD (493,730 gpd)
South Waiehu	• Above all diversions Q_{90}: 1.3 – 2.0 mgd; Q_{70} 1.9 – 2.8 mgd, Q_{50} 2.4 – 4.2 mgd • Waihe`e Ditch: 0.9 mgd (or if less above diversion, corresponding amount) • No special treatment under low flow conditions for kuleana ditch users off HC&S diversion into Spreckels Ditch • Rivermouth: est. 0.6 mgd accounting for infiltration losses	2.4	1.3		
Wailuku River	• Above all diversions Q_{90}: 13 mgd; Q_{70} 18 mgd, Q_{50} 25 mgd • Downstream of diversion: 10 mgd (or if less above diversion, corresponding amount) • No special treatment for MDWS and kuleana ditch users off `Īao-Waikapū Ditch • Rivermouth: 5 mgd. No water may be diverted at Spreckels Ditch except when stream flow is adequate to allow 5 mgd at mouth	25	13	6.43 MGD (6,428,297 gpd)	1.34 MGD (1,344,723 gpd)
Waihe`e River	• Above all diversions Q_{90}: 24 mgd; Q_{70} 29 mgd, Q_{50} 34 mgd • Downstream of diversion: 14 mgd (or if less above diversion, corresponding amount) • Rivermouth: est. 10 mgd (corresponding to 14 mgd less losses averaging 4 mgd into streambed)	34	24	8.32 MGD (8,327,070 gpd)	4.74 MGD (4,737,530 gpd)
Waikapū Stream	• Above all diversions Q_{90}: 3.3 – 4.6 mgd; Q_{70} 3.9 - 5.2 mgd, Q_{50} 4.8 – 6.3 mgd • 2.9 mgd below S. Waikapū Ditch • No alterations to Waihe`e Ditch diversion that would increase diversion of high stream flows	4.8	3.3	2.96 MGD (2,957,252 gpd)	1.2 MGD (1,196,078 gpd)
Multiple sources				17.99 MGD (17,991,392 gpd)	0.65 MGD (649,000 gpd)
System losses				2.73 MGD (2,730,000 gpd)	
Total:				**39.27 MGD (39,266,941 gpd)**	**8.42 MGD (8,421,861 gpd)**

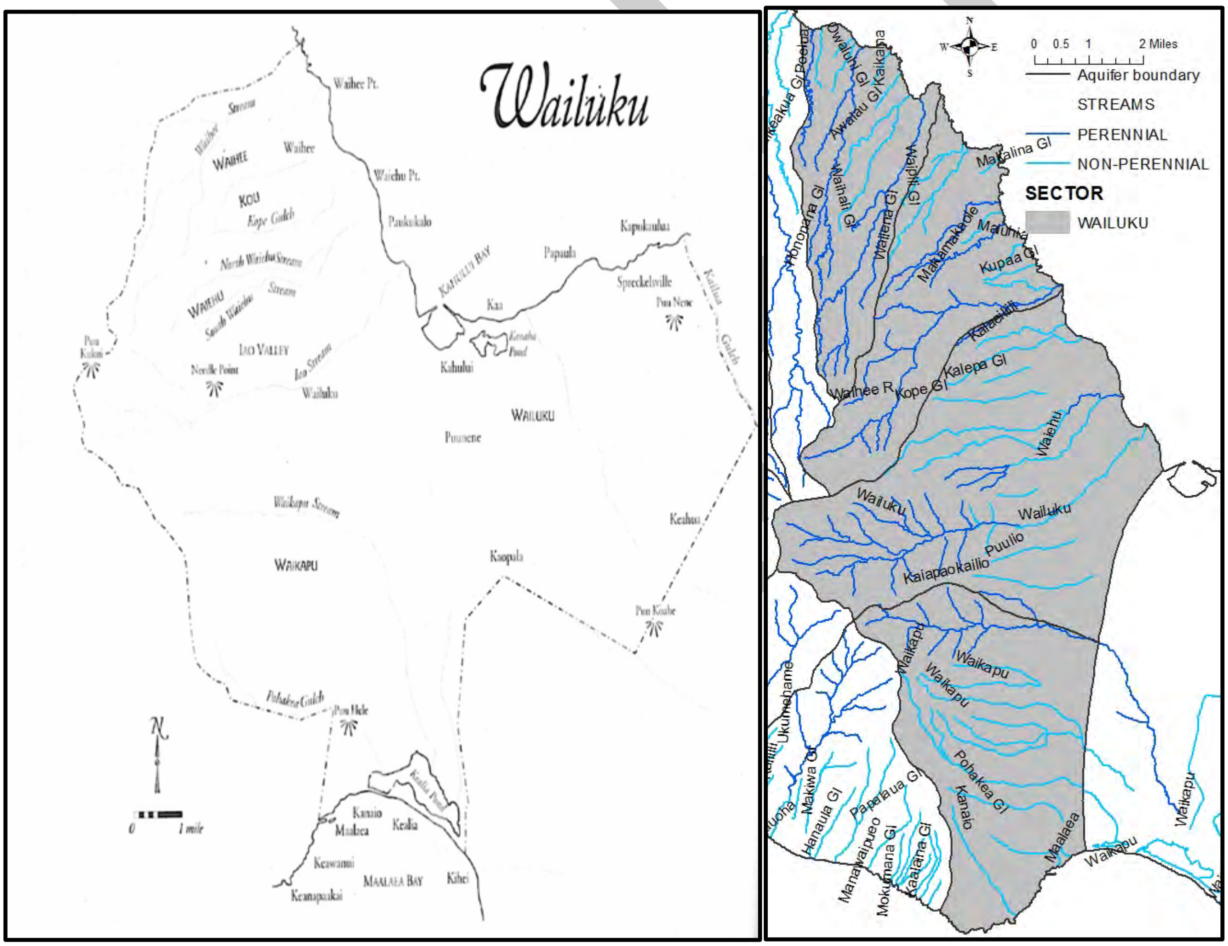
The 2017 proposal concluded that the flows established below the diversions shall be augmented/increased by the amounts necessary to meet the requirements of downstream water-use permittees and domestic users. Except for Waikapū Stream, which did not flow continuously to the ocean under normal conditions, the IIFS for the other streams are intended to result in continual mauka to makai stream flows to enable instream resource values, such as fish and wildlife habitats.[10] When stream flows are insufficient to meet the proposed permitted amounts, a balance between upstream and downstream users while meeting the IIFS would have to be maintained.

[10] CCHMA 1501 Hearing Officer's Proposed Findings of Fact, Conclusion of Law, and Decision & Order, November 1, 2017

14.3 Settlement Patterns and Cultural Resources

This section strives to acknowledge and highlight how Hawaiian history and cultural practices of the past relate to the present, as well as how they can inform options for meeting the future water needs and uses of Maui Island, while preserving and celebrating Hawai`i's past. The lands encompassed by the Wailuku-Kahului Community Plan and Wailuku ASEA have historically been a significant population center and agricultural area. The major stream and river valleys--Waikapū, `Īao, Waiehu, Waihe`e and Kahakuloa--and the lands along the coastline, all show evidence of continuous habitation for many centuries. Traditional irrigation and cultivation structures--`auwai and lo`i--still remain in use in some isolated areas within the Wailuku ASEA.[11] Archaeology and traditional Native Hawaiian historic and cultural information provides a foundation for establishing continuity between past, present and future water use in the Wailuku area.

Figure 14-8 Wailuku Region and Wailuku Aquifer Sector



[11] County of Maui, Wailuku-Kahului Community Plan, 2002, page 4.

The place name of Wailuku means "waters of destruction," stemming from the aftermath of King Kamehameha's invasion of Maui and may have arisen because of the many men who were killed and dammed the water, it was given the name Wailuku-Water of Destruction."[12]

`Īao Stream was recently renamed The Wailuku River in honor of its former title and its previously abundant flow prior to its diversion for sugarcane. Today, the stream waters and the aquifers it feeds supply much of Central Maui's water supply.

14.3.1 Historical Context

Maui County's original inhabitants developed a unique system of land and ocean tenure and use that divided land into large sections called moku. Typically, each moku is comprised of many ahupua`a. An ahupua`a is a land division unit that extends from the upland mountain top to the sea, and usually includes the bounding ridges of a valley and the stream within.

The ancient moku of Wailuku extended from Waihe`e to Wailuku ahupua`a, including the central Maui areas of Sprecklesville and Pā`ia, the shoreline of Mā`alaea and North Kīhei, which also includes portions of Kahului and Pā`ia Aquifers, and includes the shoreline north to Waihe`e. Some documentation may refer to Waikapū, Waiehu and Waihe`e as ahupua`a within the larger moku of Wailuku (Pu`ali Komohana Moku). This is considered a more contemporary interpretation as Wailuku was quickly populated and westernized at the turn of the century. Early Land Commission awards refer to each of the four areas as individual ahupua`a within the region of Nā Wai `Ehā with an abundance of 'ili 'aina (smaller land divisions) within them. For the purpose of this document, each of the four areas, Waikapū, Wailuku, Waiehu and Waihe`e will be referred to and defined as ahupua`a.

The primary source of water for all four ahupua`a comes from Mauna Kahālāwai, the West Maui Mountain Range. Kahālāwai translates as "the meeting place" for two reasons. First, it is the meeting place and central water resource for all of Nā Wai `Ehā and West Maui. Second, Kahālāwai is where the heavens meet the land. Kapuna (ancestors) had a saying, "Ue ka lani, ola ka honua," or "when the heavens cry the land lives." Rain provides fresh water, a fundamental element in sustaining life. The rains from the heavens fall and meet the waters of Kane, the life giving waters. Rising 5,788 ft. above sea level and stretching 18 miles long and 15 miles wide, the mountain is a composition of dark basalts formed from pahoehoe lava eruptions and dates back some 1.3 million years.[13] Mauna Kahālāwai is the older of Maui's two volcanoes and the backdrop of Nā Wai `Ehā because it connects all four ahupua`a and is the binding feature that unites Nā Wai `Ehā as one region.

The fresh water from Mauna Kahālāwai is culturally significant in that it is one of the areas identified as the Waters of Kane. Kane was the God of fresh water. Hawaiian mythology tells us

---

[12] Cockett, Pia, Audio Collection HAW- "I believe and so does M.K. Pukui that the name is much older than the time of Kamehameha" (Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 86).
[13] Hazlett, Richard W. and Hyndman, Donald W., *Roadside Geology of Hawai'i*, page 129

that Kane and Kanaloa, two of the major Hawaiian Gods, would travel from island to island and bring forth fresh water from cliffs, rocks and hills.[14]

14.3.2 Historic Sharing and Transport of Water

Post-1778 history has seen water demand exceed supply in the moku of largely populated Wailuku, and taro growers have had to compete with other uses such as sugarcane, commercial centers and residential housing.

The idea of transporting water between geographical areas and maximizing its use on distant kula lands and among diverse users is not new.

> "These two `auwai have existed immemorially and were evidently constructed for the purpose of irrigating kalo on the plains which stretch away to the northward and southward of the river. Several minor `auwai's have, since ancient times, tapped the river at different points lower down and spread the water through the lands in the gulch on either side of the river bed."[15]

There were times that there was not sufficient water to meet all users' needs, so the water managers were challenged to optimize water use efficiency and "juggle" the scarce resource in an effort to satisfy everyone.

> "The testimony shows that before cane culture was begun, the natives had frequent quarrels in regard to the distribution of water during times of drought. There was no definite and regular method of distribution of water. The konohiki or head man of the land divided the water, in times of scarcity, taking care that the kalo patches of the chief who held possession of the ahupua`a, were filled first, and he endeavored to provide that all should have sufficient water to keep his crop in condition. We understand that agreements were made as to the care of the ditch called Kama`auwai and the distribution of water there from…Greater diligence is shown to be used by the plantation in keeping its ditches clean of weeds and moss than is used by the cultivators of kalo, who, in addition to negligence in the care of their smaller ditches, do not now tamp their ditches to make them hold water. A considerable amount of loss of crop from scarcity of the water actually reaching the crop may be fairly attributed to this neglect."[16]

Historically, part of the streamflow was used for agriculture, and the other part was used to maintain constant streamflow, and different users shared water by allocations at different times of the day. The case of Peck vs. Bailey decided that Kalani`auwai and Kama`auwai were entitled to the same quantity of water: two `auwai's were entitled to one-third each of the water of the river in ordinary times, the remaining third to flow down the stream or the lands in the gulch. In times of freshet, the bulk of the water would naturally flow down the stream because of its larger capacity and greater fall. In times of drought where water is diminished in the Wailuku River, these `auwai's (Kalani and Kama) would lose pro rata.[17] Efforts made to

---

[14] Beckwith, *Hawaiian Mythology*, page 64

[15] Lonoaea vs. Wailuku Sugar Co. Hawaiian Reports. 9:654-657, 660-665, May 20, 1895 [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 86].

[16] Ibid.

[17] Lonoaea vs. Wailuku Sugar Co. Hawaiian Reports. 9:654-657, 660-665, May 20, 1895 [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 86].

accommodate all interested parties, even those downstream and instream uses of the natural streamflow.

> "Mr. W.H. Bailey, in his deposition, testified that the water ran continuously in the `auwai's night and day in ordinary times, but when there was a shortage he took the water into the `auwai's in the day time and turned the water at night down the river. He also said: 'On the Kama`auawai we simply left the division as it was day and night all the time'." [18]

14.3.3 Conflicts of Kalo vs. Post-1778 Sugarcane

Nā Wai `Ehā, which includes Waihe`e to Waikapū, is famous as being the largest wet taro growing area in Hawai`i.[19] Most Nā Wai `Ehā place names are related to water, speaking to its abundance in the area.

Waihe`e, like Kahakuloa, takes its name from historic lo`i. This patch, named Waihe`e, formerly belonged to the ali`i and is a large patch near the sea. In ancient times the kalo terraces were more or less continuous in a belt between the sand dunes and the present irrigation ditch. [20]

Waiehu's place name comes from the water in the upland: when the water came down the cliff, the sprays fly just as it does over the sea. It was called Waiehu.[21]

Wailuku contained a much larger population, where archaeological remnants include terraced agricultural infrastructure to support it. Much of the upper section of what is now the city of Wailuku is built on old terrace sites.[22]

Waikapū's place name likely expresses the relative scarcity and sacredness of stream water in the makai areas.

> "The sea was dark with victorious canoes; Kamehameha landed at Kalepolepo, and a kapu was put upon the nearest stream. It became sacred to royalty, as was the custom and is known as Waikapū to this hour-that is, forbidden water…Waikapū Stream is not the nearest stream to Kalepolepo, but, it drains into Keālia Pond which is fairly near and may have been the nearest running stream."[23]

---

[18] Ibid.
[19] E.S.C. Handy, Hawaiian Planter, 107 [Sterling, Elspeth P. Sites of Maui. Bishop Museum Press, 1997, page 65].
[20] Ibid.
[21] Pia Cockett, Audio Collection HAW 84.3.2
[22] Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997

[23] (Opinion of the Court by McCully, J., In the Matter of the Boundaries of Pulehunui, *Hawaiian Reports*, 1879. 4:239-255.) Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 250

Taro (kalo) growers in Wailuku have had to compete with other uses such as sugarcane for over a century.

> "The district of Wailuku was once thickly settled, kuleanas to the number of over 400 were granted to natives and others. A large proportion of these cultivated kalo with the aid of water from the river... The cultivation of sugar cane on a small scale was begun by Kamehameha III in the early fifties [1850s]. Then followed a few years later the plantation of Peck and others..." [24]

Before sugarcane, there was a cultural precedent to prioritize the water supply for kalo. "The ancient water rights of the kalo lands in this district were not clearly defined either as to quantity or time, the only limit being a sufficient quantity for the kalo."[25]

Water began being diverted from lo`i kalo to sugarcane in the middle 1800s, and during that era the courts supported the idea that kalo cultivation and sugarcane cultivation deserved equal use of water, which began the transition from predominantly kalo water use to predominantly sugarcane water use.

14.3.4 Stream Flow and Cultural Resources—Mauka to Makai Connections

Fresh water was as essential in ancient times as it is today. The connection between the mauka and makai zones was critical in order to maintain healthy, vibrant ecosystems within all water zones. Ancient Hawaiians maintained a continuous cycle of water flow from the mauka zone to the makai zone. Freshwater from the mauka zone fed into nearby stream beds, or kahawai, and was carried into a sophisticated system of `auwai, man-made irrigation ditches that nourished the lo`i kalo (taro patches) and other forms of cultivation. The water was then transported makai to both natural and man-made fishponds. The brackish water within these fishponds provided healthy aquatic ecosystems that sustained native plant and marine life. The amphidromous life cycle of many of the native Hawaiian fresh water stream life depend on this constant flow. Without viable connections between the streams and the ocean, this stream life cannot complete its life cycle. Examples include the 'O'opu, a native Gobioid, `Opae, native shrimp and the hihiwai, a native snail. Populations of these native species have significantly declined due to stream degradation and modification, including channelization, channel modification and water diversion.

Cultural experts and community witnesses have testified to limitations on Native Hawaiians' ability to exercise traditional and customary rights and practices in the greater Nā Wai `Ehā area, due to the lack of freshwater flowing in streams and into the nearshore marine waters.[26]

---

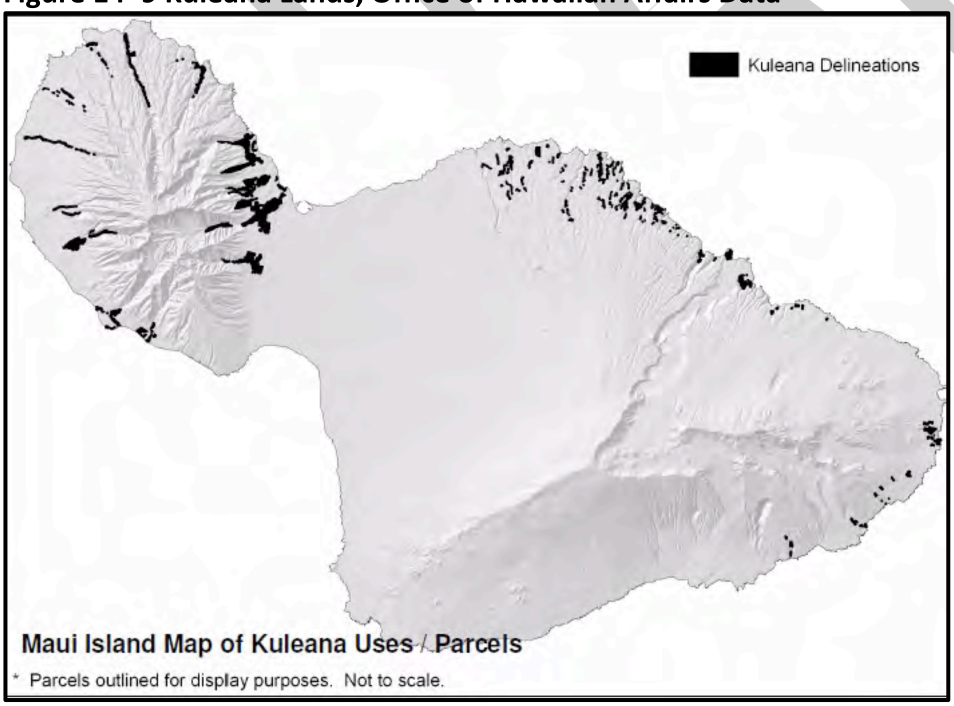
[24]Ibid.
[25]Ibid.
[26] CCH-MA15-01 Hui O Nā Wai `Ehā 's, Maui Tomorrow Foundation, Inc's, and Office of Hawaiian Affairs' Joint Proposed Findings of Fact, Conclusion of Law, Decision and Order, 2/17/17

14.3.5 Kuleana Parcels

Water rights include “appurtenant or kuleana water rights” to use that amount of water from a water source (usually a stream) which was used at the time of the Māhele of 1848 on kuleana and taro lands for the cultivation of taro and other traditional crops and for domestic uses on that land;[27] and “riparian rights” which protect the interests of people who live on land along the banks of rivers or streams to the reasonable use of water from that stream or river on the riparian land subject to other rights of greater value. These rights run with the land.[28]

Water for kuleana parcels in Nā Wai `Ehā are derived directly from the rivers and streams and also from the plantation ditches and reservoirs after the establishment of plantation ditch systems to which the kuleana systems were connected. Before the 1980s, delivery to most kuleana systems only occurred during periods when water was delivered for agricultural operations. When plantations shifted from furrow to drip irrigation, pipes replaced many of the ditches, which made deliveries more reliable and consistent.[29] The `auwai irrigating kuleana parcels are to a large extent dependent on the plantation irrigation systems. Maintenance of the kuleana ditches and pipes by present users has been inconsistent, with some users maintaining portions of some of the systems and other systems receiving no maintenance from the users.[30]

Figure 14–9 Kuleana Lands, Office of Hawaiian Affairs Data



[27] Haia, Moses. *Protecting and Preserving Native Hawaiian Water Rights.* http://www.Hawai`i.edu/ohelo/resources/AluLikeWorkbook/Chap7.pdf
[28] Ola I Ka Wai: A Legal Primer For Water Use And Management In Hawai'i
[29] CCH-MA06-01, June 2010, FOF 215
[30] CCH-MA06-01, June 2010, FOF 217

14.3.6 Contemporary Native Hawaiian Cultural Resources

Native Hawaiian culture is preserved and kept current through multiple regional institutions:

- The Hawaiian Islands Land Trust Waihe`e Coastal Dunes & Wetlands Refuge actively restores critical native wildlife habitat, while preserving the area's rich archaeological and cultural resources.
- The Maui Nui Botanical Garden is dedicated to the protection of Maui Nui's rich native plants and cultural heritage and provides people with a place to see and understand the important relationship these plants have to economic, social, and cultural livelihoods.
- The Maui Historical Society Bailey House Museum collects and displays folklore, history and heritage of Maui and operates an archival resource center.

14.3.7 Lessons Learned from the Past

The Wailuku region encompasses an area that is fed by the once abundant Nā Wai `Ehā waters. The ancient past paints a picture of a land that supported a number of Hawaiian villages and a much larger Native Hawaiian population. Some of their traditional cultural resources and activities have survived and still thrive today; but compared to ancient times, disease, commercial development, gentrification, and a drastic shift in the cultural landscape has greatly reduced the contemporary Native Hawaiian population, as well as their cultural resources and practices.

Historically, great efforts were made to allocate water for all needs. Despite significant challenges, some Native Hawaiian practitioners in Nā Wai `Ehā continue to exercise traditional and customary rights and practices, including gathering stream life for subsistence and cultivating taro. Practitioners would like expand the scope of their traditional and customary practices and families seek to re-establish kalo lo`i if water is returned to the streams. Nā Wai `Ehā continues to hold the potential to support a subsistence lifestyle and to benefit Native Hawaiians and other communities who seek to reconnect with nature and culture.[31]

While CWRM's Interim Instream Flow Standards (IIFS) attempts to balance the needs of the environment, agriculture, and Native Hawaiian cultural practitioners; disagreement remains as to how water resources should be equitably divided among competing interests. However, the current Water Code ensures protection for kuleana rights and instream uses (including kalo cultivation) and certain public trust uses, and the Water Code favors such uses above non-instream and non-public trust uses, such as large scale agriculture. There are also alternative supply options, such as the use of groundwater available to non-instream uses that aid in balancing allocation of all needs. In the case of Nā Wai `Ehā, the burden has shifted from the practitioners and taro growers to the State Water Commission to ensure fair allocation for all

[31] CCH-MA15-01 Hui O Nā Wai `Ehā 's, Maui Tomorrow Foundation, Inc's, and Office of Hawaiian Affairs' Joint Proposed FOF, COL, D&O, 2/17/17

needs and during various stream flows. Alternative solutions have been brought forward in the Nā Wai `Ehā contested case, including the following:

1. Seasonal IIFS, based on seasonal streamflow amounts;
2. Adjustable IIFS, considering temporary decreased IIFS when streamflows drop below a certain low flow amount;
3. Categorizing water users by priority, where allocations by water use permit are defined based on public trust status.

Past struggles to define regular methods of water distribution in times of drought have helped teach the importance of diligently maintaining ditch and `auwai systems. Another important element of successful comprehensive management of Nā Wai `Ehā resources is to clearly define responsibilities and a practical implementation plan. The responsibilities on all parties involve watershed management, ditch and reservoir maintenance, gauging streamflow, accurate reporting and monitoring of diversions, and practicing water conservation for all end uses and needs.

Some Native Hawaiian cultural practices are challenged by the negative consequences of resource "ownership," with "owners" often uninspired to share with other potential users. Perhaps past strategies of communal sharing and timing of flows can be adopted in order to ensure all water users are supplied with this important resource.

Wailuku-Kahului Community Plan

Goals and objectives in the Wailuku-Kahului Community Plan reflect and respect the past Native Hawaiian cultural prosperity. One of the Plan’s stated desirable opportunities is to revitalize the infrastructure of lo`i kalo and ultimately, the agricultural productivity of the ancients; and to preserve and protect Native Hawaiian rights and practices customarily and traditionally exercised for subsistence, cultural and religious purposes.[32] Community Plan policies seek to preserve historic, cultural and archaeological sites and resources; preserve and restore historic roads, paths, and water systems as cultural resources, and support public access. According to the Community Plan, the prioritization and allocation of water resources is a major interregional issue that needs to be addressed in a comprehensive manner, which includes sharing of water resources and prioritization of traditional Native Hawaiian water uses.[33]

[32] County of Maui, Wailuku-Kahului Community Plan, 2002, page 14.
[33] Wailuku-Kahului Community Plan, 2002, page 10

14.4 Land Use

Gently sloping areas around west Maui and on the isthmus between west and east Maui have been used for agriculture for over a century. The urban areas spread over the northern part of the isthmus at Wailuku and Kahului. The interior of west Maui is mostly forested conservation land. The principal agricultural crops have been sugarcane, pineapple, macadamia nuts, and diversified agriculture. As large-scale plantation agriculture declined after 1979, land-use changes were significant. During the period 1979–2004, agricultural land use declined about 21 percent throughout the isthmus, mainly from decreases in sugarcane acreage.

On the east slope of West Maui Mountain (Nā Wai `Ehā), the Wailuku Sugar Company (currently the Wailuku Water Company) first began growing sugarcane in 1856. By the mid-1980s, sugarcane was replaced by macadamia trees on the northern extent of the plantation. Additional sugarcane lands were replaced by pineapple by the end of the 1980s. In the 1990s, the company continued diversifying away from sugarcane and agriculture altogether. By 2005, the company had leased the southern extent of the plantation to HC&S, halted macadamia operations, and sold much of its land for residential development.

Wailuku maintains its role as a civic-financial-cultural center with older residential areas intermixed with business uses. New residential development occurring in the lands around Wailuku has connected Wailuku and Waikapū on former agricultural lands. Wailuku Town and Kahului together provide the greatest employment center of all community plan regions. In Wailuku, commercial areas are composed of smaller, older buildings intermixed with residential neighborhoods. In the last decade, Wailuku has been undergoing revitalization to revive commercial activities, increase mixed-use development and build out the Civic Center District with additional government office space. Waihe’e to the north is a small rural primarily residential town with small-scale agriculture. Waikapū to the south is rural residential with a small commercial component. Mā`alaea along the south shore is a residential community with visitor-oriented businesses around the harbor.

14.4.1 Land Use Plans

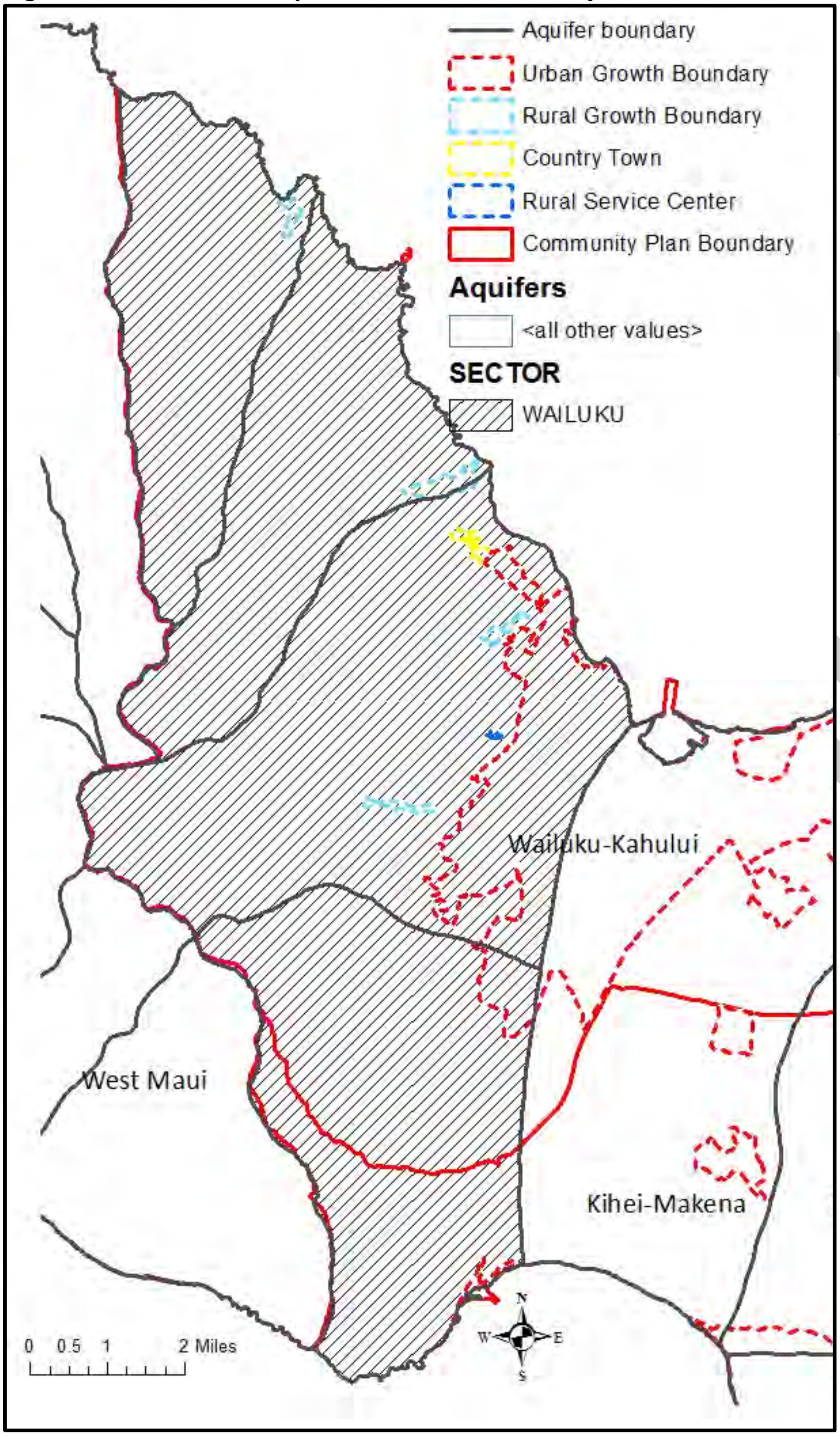
Urban infill and three new planned growth areas for the Wailuku ASEA are identified in the Maui Island Plan: Pu`unani, Kahili Rural Residential, and Waikapū Tropical Plantation Town.

The Wailuku ASEA includes two community plan districts:

- Wailuku-Kahului Community Plan, (adopted 2002; 89% of ASEA within the community plan)
- Kīhei-Mākena Community Plan (adopted 1998; 10±% of ASEA within community plan)

Based on the extent of the community plans and planned growth areas within the ASEA, growth rates for the Wailuku-Kahului community plan district as forecasted in the MIP are applied to project future demand in Chapter 14.6. The figure below portrays the relationship of the Wailuku ASEA, community plans and directed growth boundaries.

Figure 14-10 Wailuku Aquifer Sector, Community Plans and Directed Growth Boundaries

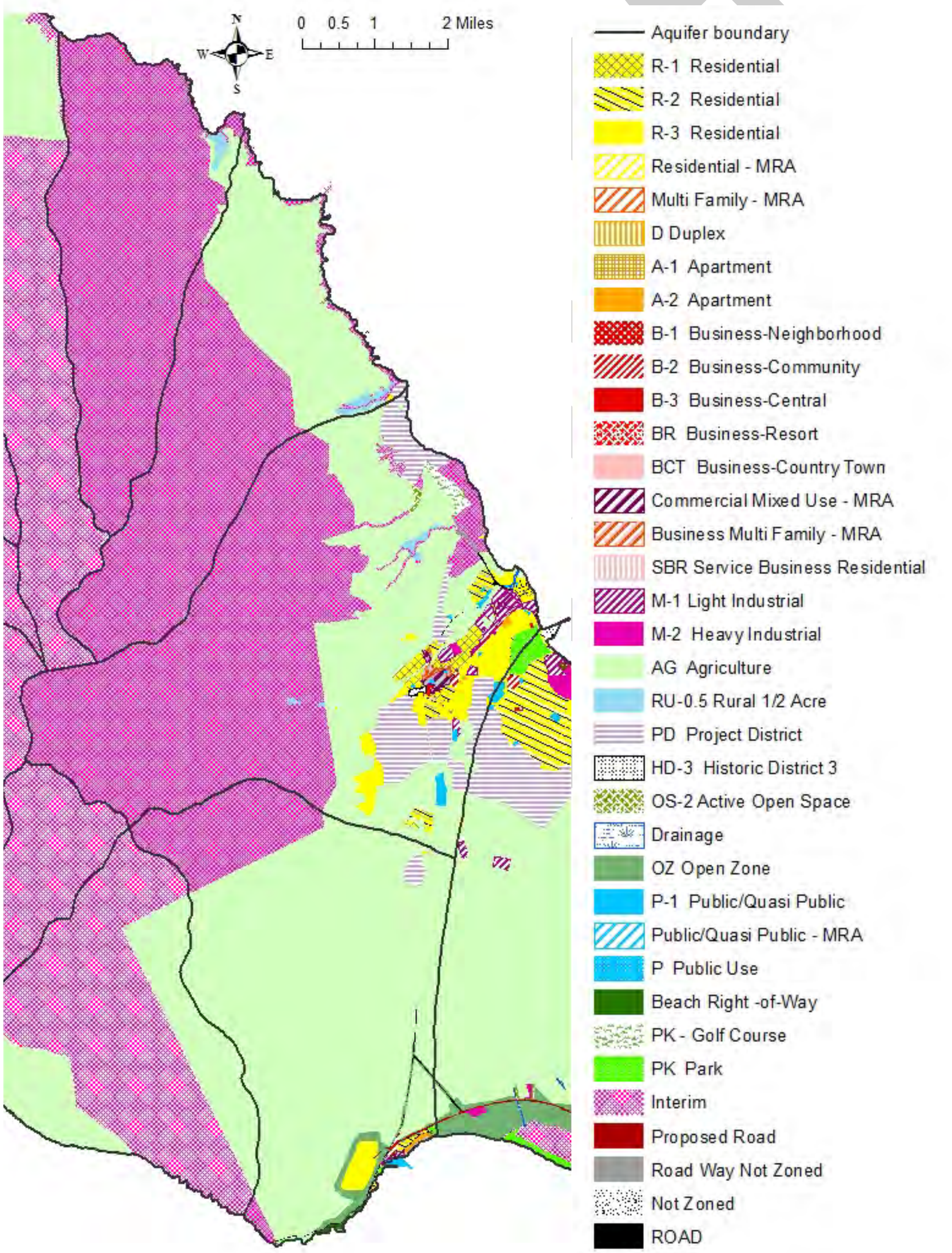


Key land use issues relating to the sub-regions within the Wailuku-Kahului community plan region include: maintain separation between the sub-regions through the use of parks, greenways and protected areas; urban infill of multi-family units for purchase and rental; and revitalization of the Wailuku downtown and Civic Center District.

Maui County Zoning

There are about 41,900 zoned acres in the Wailuku ASEA excluding DHHL lands (151 acres).

Figure 14-11 Wailuku ASEA County Zoning Districts



Zoning districts are aggregated by land uses types with similar water use rates for the purpose of projecting potential full build-out water demand. Directed Growth Plan guidance and Community Plan designations were generally used for purposes of calculating water demand associated with Interim zoned lands. The Interim Zoning District encompasses 22,030 acres, and the Wailuku Community Plan assigns the following land use designations to those Interim zoned acres: Park (112 acres [Golf Course 92 acres]); Project District (2.78 acres); Road (10 acres); Single Family (196.58 acres); Agriculture (21 acres); Business/Commercial (0.92 acres); Rural (19.52 acres); Open Space (155 acres); Conservation (21,489 acres); Public (19.85 acres).

Table 14-7 Summary of Zoning Use Types, Wailuku ASEA (Excluding DHHL Lands)

Zoning Summary (Corresponding County Zoning Categories found within the Wailuku ASEA in Parentheses)	Acres	% of Total
SF Single Family Residential, Duplex, Residential (R-1, R-2, R-3, MRA), RU-0.5 Rural - 1/2 Acre, SBR Service Business Residential)*	1,862.22*	4.45%
Apartment (A-1 Apartment, A-2 Apartment), MRA Multi-Family Residential, MRA Business Multi-Family*[2]	249*[2]	0.60%
Business (B-1 Business, B-2 Business, B-3 Business, BCT Business Country Town) *[3]	110.32*[3]	0.26%
Industrial (M-1 Light Industrial, M-2 Heavy Industrial)*[4]	201.95*[4]	0.48%
Hotel (BR Business – Resort)	1.09	0.00%
Agriculture (AG Agriculture)	16,160.70	38.62%
Golf Course (PK-4 Park - Golf Course)*[5]	510.56	1.22%
P-1 Public/Quasi-Public MRA, Public, HD-3 Historic District 3*[6]	249.13*[6]	0.60%
PK Park	84.81	0.20%
Open Space (Conservation, Drainage, Open Space, OS-2 Open Space Active, OZ Open Zone, Proposed Road, Road, Unzoned Road, Beach Right of Way)*[7]	22,409.15*[7]	53.55%
Undesignated Interim and Project District	5.61	0.01 %
TOTAL excluding DHHL Lands	**41,844.54**	**100%**

Source: Table prepared by MDWS, Water Resources & Planning Division. Excludes DHHL lands.
Zoning supplied by Maui County Planning Department, Long Range Division, May 2015.
Interim zoning was assigned to CWRM categories based on Community Plan land use designations. Table excludes 211 acres of DHHL lands zoned Agriculture that are excluded from Agricultural zoning category.

*Single Family Residential (1862.22 acres): RU-0.5 Rural - 1/2 Acre (190.22 acres), MRA – Residential (8.52 acres), R-1 Residential (282.09 acres), R-2 Residential (158 acres), R-3 Residential (791.14 acres), SF Single Family Residential (2.57 acres [CP designation, Project District zoned]) (196.58 acres [Interim-CP Single Family Residential], [19.52 Interim-CP Rural], (Project District Single Family Residential estimate using 52:48 ratio of Single Family Residential to Multi-Family Residential existing development projects within applied to all acreage [213.58 acres]).

*[2] Apartment (249 acres): A-1 Apartment (1.33 acres), A-2 Apartment (27.09 acres), D Duplex (0.35 acres), SBR – Service Business Residential (0.178 acres); MRA Multi-Family Residential (8.73 acres), MRA Business Multi-Family (14.16 acres); Project District CP designation and using 52:48 ratio of Single Family Residential to Multi-Family Residential existing development projects within applied to all acreage (197.17 acres) apartment/multi-family

*[3] Business (110.32 acres): B-1 Business - Neighborhood (2.85 acres); B-2 (46.47 acres), B-3 Business – Central District (8.29 acres), BCT Business Country Town (2.18 acres), Commercial Mixed Use – MRA (49.60 acres), Business/Commercial (0.91 acres)

*[4] Industrial (201.95 acres): (1) M-1 Light Industrial (190.47 acres); (2) M-2 Heavy Industrial (11.48 acres)

*[5]Golf Course (510.56 acres): (1) Waiehu Golf Course (88.15 acres zoned and CP designated Park - Golf Course), (91.76 acres zoned Interim, but CP designated Park [Golf Course]); (2) Kahili and Kamehameha courses that are zoned Agriculture, but CP designated Park --Golf Course (330.65 acres)

*[6]Public (249.13 acres): Public Use (15.62 acres), P-1 Public/Quasi-Public (62.10 acres), Interim/Public (19.84 acres), Project District/Public (0.85 acres), Historic District (12.09 acres), Public/Quasi-Public – MRA (3.20 acres), Project District without CP designation based on ratio of Project District with CP designation (135.42 acres)

*[7] Open Space (22,409.15 acres): (1) Conservation (21,489 acres); (2) Drainage (4.30 acres); (3) Open Space (157.58 acres): (4) OS-2 Open Space Active (17.75 acres); (5) OZ Open Zone (208.14 acres); (6) Proposed Road (10.9 acres); (7) Road (64.93 acres); (8) Unzoned Road (10.54 acres); (9) HD-3 Historic District 3 (12.09 acres); (10) Beach Right of Way (24.54 acres).

*[7] Acreage represents the difference between County zoning and Community Plan designations for "Interim": 5.61 acres were designated "Interim" in County zoning, but not designated a Community Plan use type, and therefore, remained undesignated "Interim" County zoning.

14.4.2 The DHHL Maui Island Plan

The Hawaiian Homes Commission adopted its Maui Island Plan as the overarching planning document in 2004. The Department of Hawaiian Homelands (DHHL) Central Maui planning region encompasses three tracts totaling 155.19 acres: Waiehu (91 acres), Paukūkalo (64 acres), and Wailuku (0.19 acres). All three tracts are within the Wailuku-Kahului Community Plan and Wailuku Aquifer Sector (ASEA) areas, and within the `Īao Aquifer System Area (ASYA).

Figure 14-12 DHHL Lands, Wailuku ASEA

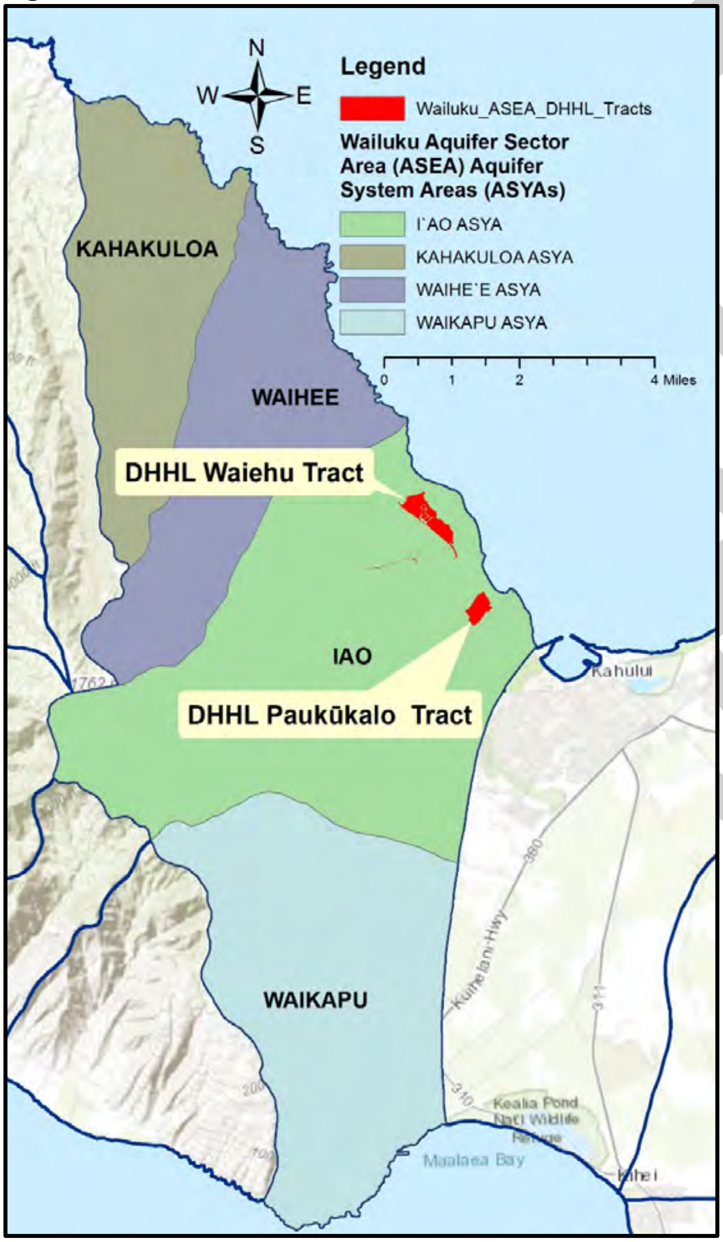


Table 14-8 DHHL Planned Land Use, Wailuku ASEA

Category	Acres or Residential Units	% of Total
Residential (Acres/Units)	179 acres/351 units	84.76%
Commercial (Acres)	0.19	0.0008%
Industrial (Acres)	0	0%
Agriculture (Acres)	16	7.57%
Community (Acres)	16	7.57%
Open Space (Acres)	0	0
Total (Acres)	**211.19 acres/ 351 Units**	100%

Source: DWS, Water Resources & Planning Division, May 2015, based on DHHL Maui Island Plan and Regional Plans. Open Space includes conservation, cultural protection and similar use types

14.5 Existing Water Use

Water systems can extend over multiple aquifer units and utilize water resources transported from multiple hydrologic units – aquifers or watersheds. Water use, by type and by resource, are inventoried for the Wailuku ASEA as a hydrologic unit. However, for practical purposes existing water use and future water demand are also analyzed and projected for county and private water systems that share water resources from multiple hydrologic units. For example, the municipal Maui County Department of Water Supply (MDWS) Central Maui system services the region from Waihe`e to Pā`ia-Kū`au and south to Mā`alaea, Kīhei and Mākena. The Central Maui system overlies Wailuku ASEA and the Central ASEA. The sources for this MDWS system are groundwater from the `Īao and Waihe`e aquifers and the Wailuku River in the Wailuku ASEA, and groundwater from Kahului aquifer in the Central ASEA.

14.5.1 Water Use by Type

Existing water uses are summarized in this sector according to the Commission on Water Resource Management categories for the purposes of water use permitting and reporting. These categories and sub-categories are:

- 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 Department of Health)

There are 82 wells installed in the Wailuku Aquifer Sector, of which 18 are observation wells, 12 are unused, and 1 is unspecified. Active wells and reported pumpage reflect the base year 2014.

Surface water diversions were analyzed for various years. Water use reporting was inadequate for the year 2014 and more complete data was derived applying the median of reported water use over the years 2011 - 2015 streams based on CWRM investigations and testimony.[34] Surface water end use was difficult to establish according to the CWRM categories. Diversions from Wailuku River to MDWS make up the only treated surface water use for municipal purposes. End uses for all other diversions are assumed to fall in either of the categories Domestic, Industrial, Agriculture or Irrigation.

Because `Īao Aquifer is designated a Groundwater Management Area, and Nā Wai `Ehā is designated a Surface Water Management Area, water use is allocated by water use permits.

---

[34] Aaron Strauch, CWRM, Supplemental Testimony 10/11/16, CCH-MA15-01

Allocated groundwater use permits (GWUPs) are shown in the table below. Requested new GWUPs for additional water are addressed under Future Water Use in chapter 14.6.

Surface water use permits (SWUPs) are considered by CWRM in the ongoing contested case and have not been allocated to date. In the November 2017 proposed Findings of Fact, Conclusion of Law and Decision and Order (FOF, COL and D&O), water is allocated in such a manner as to accommodate all approved surface water use permit applications (SWUPAs) when possible after sufficient water is returned to the Nā Wai `Ehā rivers and streams to meet IIFS. The proposed allocation categorizes uses by order of priority:

- Category 1: existing and new uses exercised under traditional and customary Native Hawaiian rights, and domestic uses of the general public, particularly drinking water – i.e. MDWS
- Category 2: existing and new uses exercised under appurtenant rights; and existing uses
- Category 3: new uses not based on appurtenant rights

Only a few applicants attempted to measure their existing use. Most applicants estimated their actual use based on irrigation requirements for kalo lo`i previously established by the courts (300,000 gpd per acre). When existing uses cannot be verified, CWRM assumed the amount required for economic and efficient use for the specific end use and acreage.[35] Interim existing SWUPs and the proposed existing uses as defined in the hearing officer's November 2017 proposed FOF, COL and D&O are shown in the table below as "Nā Wai `Ehā Proposed Category 1 and 2". Domestic uses are exempt from CWRM permit requirement and shown separately under the proposed categories as "Domestic". New uses that fall under Category 3 are addressed under Future Water Use in chapter 14.6.

Table 14-9 Reported Groundwater Pumpage and Diverted Surface Water by Type, Water User Permit Allocations, Wailuku ASEA, 2014 (mgd)

Aquifer/Pumpage	Domestic	Industrial	Agriculture	Irrigation	Municipal	Military	Total
Waikapū	--	--	--	--	--	--	--
`Īao	--	--	0.001	0.341	16.938	--	17.280
Waihe`e	0.005	0	0	0.058	3.415	--	3.479
Kahakuloa	--	--	--	--	--	--	--
Total Pumpage (mgd)	**0.005**	**0**	**0.0001**	**0.400**	**20.354**	**0**	**20.760**
% of Pumpage	0%	0%	0%	1.9%	98%	0%	100%
`Īao Aquifer Water Use Permits (mgd)	0.003		0.020	0.709*	19.063		19.795
Total No. of Production Wells	7	--	10	17	9	--	82

[35] CCHMA 1501 Hearing Officer's Proposed Findings of Fact, Conclusion of Law, and Decision & Order, November 1, 2017

<table>
<tr><th>Surface Water/ Diverted</th><th>Domestic</th><th>Industrial</th><th>Agriculture</th><th>Irrigation</th><th>Municipal</th><th>Military</th><th>Total</th></tr>
<tr><td>Waikapū Stream</td><td colspan="4">1.406</td><td>--</td><td>--</td><td>1.41</td></tr>
<tr><td>Wailuku River</td><td colspan="4">10.49</td><td>0.99</td><td>--</td><td>11.48</td></tr>
<tr><td>Waiehu Stream</td><td colspan="4">3.99</td><td>--</td><td>--</td><td>3.99</td></tr>
<tr><td>Waihe`e River</td><td colspan="4">17.62</td><td>--</td><td>--</td><td>17.62</td></tr>
<tr><td>Total Diverted Surface Water (mgd)</td><td colspan="4">33.51**</td><td>0.99</td><td>--</td><td>34.50</td></tr>
<tr><td>Percent of Diverted Surface Water</td><td colspan="4">97.2%</td><td>2.8%</td><td>--</td><td>100%</td></tr>
<tr><td>Nā Wai `Ehā Proposed Category 1 and 2</td><td>0.06</td><td>0</td><td colspan="3">32.49</td><td></td><td>32.56</td></tr>
<tr><td>Reclaimed WW</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>0</td></tr>
<tr><td>TOTAL PUMPAGE AND DIVERSIONS (mgd)</td><td colspan="4">33.89</td><td>21.34</td><td></td><td>55.23</td></tr>
</table>

*Caprock wells

**Wailuku Water Company end uses include domestic, agriculture and irrigation. Excludes deliveries to MDWS `Īao Treatment Plant (11.48 mgd – 0.99 mgd = 10.49 mgd)

There is no reclaimed wastewater treated or distributed within the Wailuku ASEA. Wastewater generated is treated at the Kahului Wastewater Treatment Facility, east of Kahului Harbor in the Central ASEA. All reclaimed water treated to R-2 is utilized within the Central ASEA.

Figure 14-13 Reported Pumpage by Well Type, Wailuku ASEA, 2014

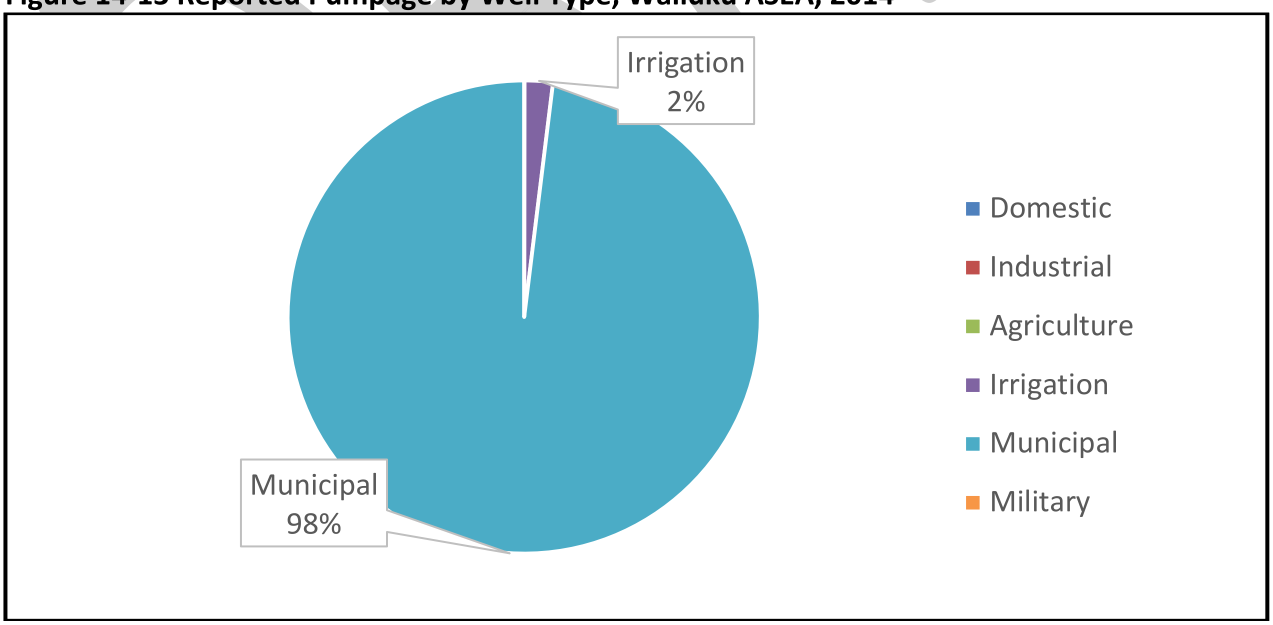


Figure 14-14 Reported Pumpage by Well Type and Aquifer System, Wailuku ASEA, 2014 (mgd)

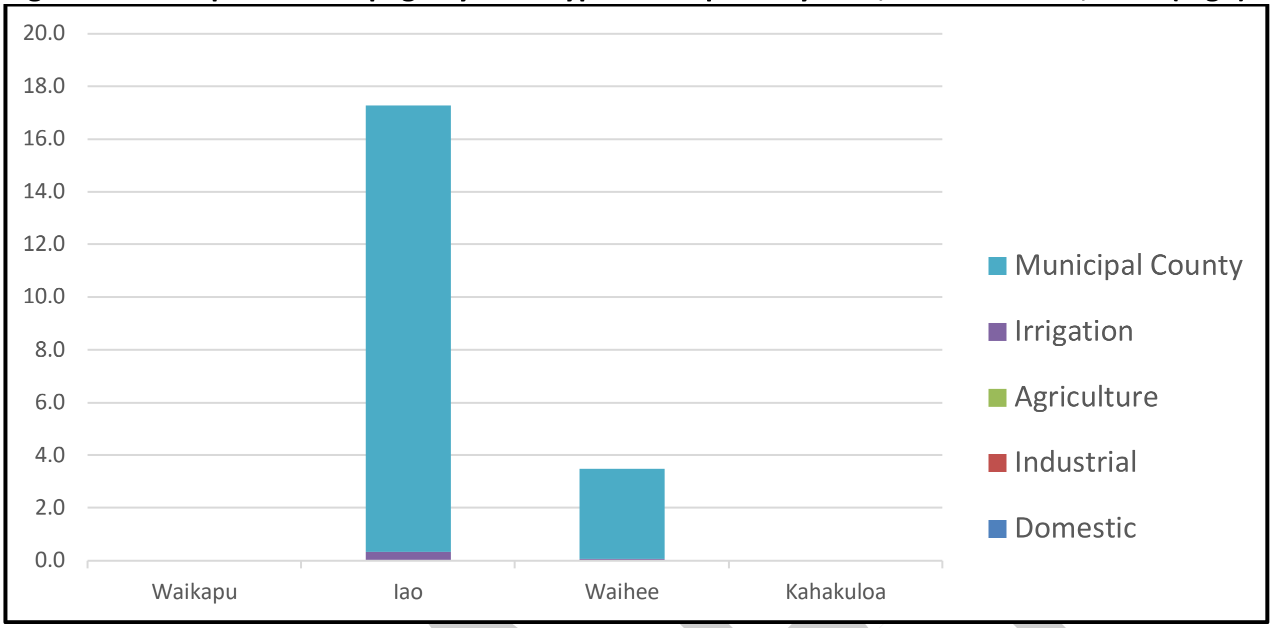
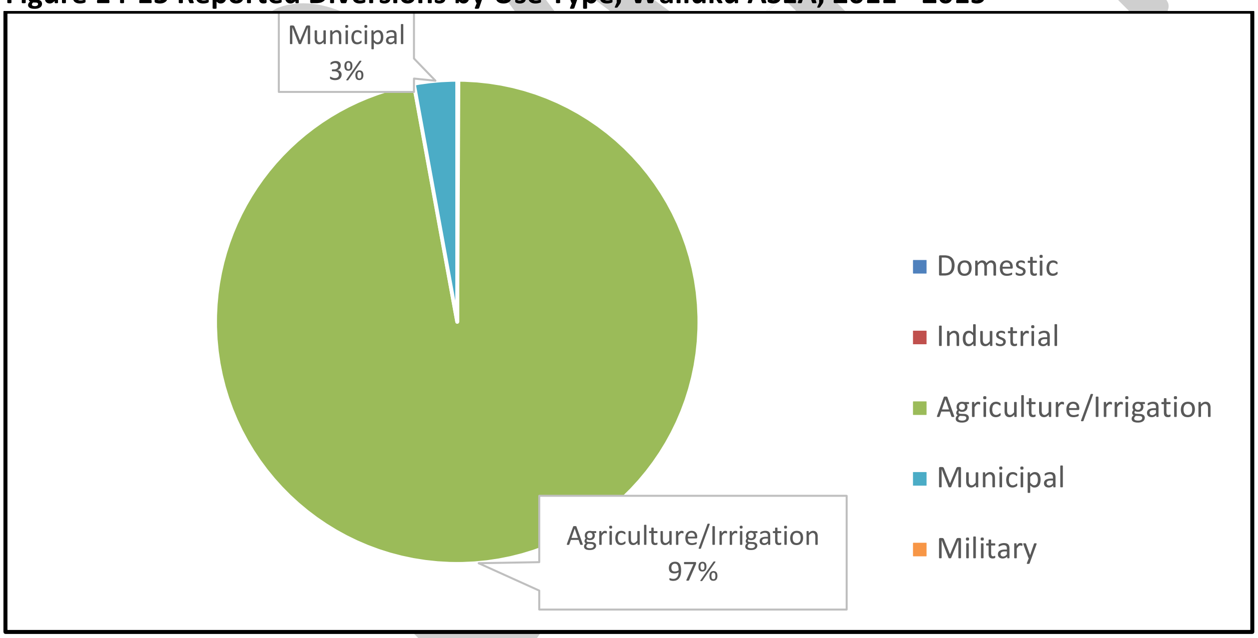


Figure 14-15 Reported Diversions by Use Type, Wailuku ASEA, 2011 - 2015



Domestic Use

There are seven wells classified as domestic according to the CWRM well database. Reported pumpage for domestic wells is less than 6,000 gpd, or 0.006 mgd. It is likely that domestic use is underreported. The largest portion of customers served by the municipal MDWS system are for domestic type uses – serving individual households. These users are included under Municipal Use below and compared to other customer classes served by MDWS.

Domestic use is defined in the State Water Code as "any use of water for individual personal needs and for household purposes such as drinking, bathing, heating, cooking, non-commercial gardening, and sanitation".[36] The code does not quantify the amount of water that would qualify for domestic use. There is one domestic well in the `Īao GWMA with 3,000 gpd water use permit allocated. There are surface water use permit applications for domestic needs in the Nā Wai `Ehā SWMA. Based on the 2017 proposed FOF, COL and D&O, domestic uses were quantified to 65,664 gpd (0.066 mgd).

In the hearing officer's proposed 2017 decision, the maximum amount of water qualifying for domestic use is capped at 3,000 gpd for domestic cultivation. The amount is based on the 2002 State of Hawai`i Water System Standard for Maui County of 3,000 gpd per acre (gpa), assuming domestic cultivation not exceed 1 acre. Domestic uses are exempt from surface water user permit requirements, which otherwise apply to all existing and new uses in the designated surface water management area of Nā Wai `Ehā. [37]

Industrial and Military Use

There is no reported pumpage from industrial wells. There are no wells classified as Industrial or Military. There is no reported surface water diversions for industrial use. However, SWUPAs for industrial uses were submitted in the Nā Wai `Ehā contested case but all were denied in the hearing officer's November 2017 proposed FOF, COL and D&O.

Irrigation Use

There are 17 wells classified as Irrigation. Reported pumpage is primarily for golf course irrigation (85%) drawing from brackish or near brackish water in the caprock portion of the `Īao Aquifer. It should be noted that caprock water withdrawals do not count against sustainable yield.

The water use category for reported surface water diversions is difficult to qualify as the end uses are generally not identified. For example, Wailuku Water Company is the registered diverter that delivers surface water to a range of end users, the latter not identified in the reporting. Therefore solely based on water use reports, the amount of water diverted for agricultural irrigation versus non-agricultural irrigation cannot be distinguished. However, applicants for Surface Water Use Permits (SWUPs) from Nā Wai `Ehā must identify the water use category for which the desired permit is sought. As mentioned above, not all applications represent a measured amount of water but instead, they are sometimes estimated. Therefore, SWUP applications and appurtenant right claims are not used as basis for "existing water uses" but for projected use from 2017 on. SWUPs have not been issued and adopted by CWRM to date. The 2017 proposed FOF, COL and D&O did not summarize requested and approved water uses by CWRM category. Permit applications in the contested case and proposed allocations

[36] H.R.S. §174C-3
[37] CCHMA1501-20171101, p 306-307

were reviewed here to distinguish water use categories. Approved SWUPs for non-agricultural irrigation purposes total 1.164 mgd, with about 90 percent for golf course irrigation.

Agricultural Use

Historically, the principal large scale agricultural crops have been sugarcane, pineapple, macadamia nuts and diversified agriculture. The Wailuku Sugar Company (currently the Wailuku Water Company) first began growing sugarcane in Nā Wai `Ehā in 1856. From 1862 through 1988, Wailuku Sugar irrigated about 5,250 acres with approximately 45 MGD from the ditch system. By the mid-1980s, sugarcane was replaced by macadamia trees on the northern extent of the plantation. In the 1980s, Wailuku Agricultural Company (WACI) used about 8 MGD to irrigate 1,580 acres of macadamia nut using micro-sprinklers. Additional sugarcane lands were replaced by pineapple by the end of the 1980s. In the 1990s WACI irrigated about 1,900 acres of pineapple using drip irrigation. In the 1990s, the company continued diversifying away from sugarcane and agriculture altogether. By 2005, the company had leased the southern extent of the plantation to HC&S, halted macadamia operations, and sold much of its land for residential development. Water from the Wailuku ASEA and Nā Wai `Ehā was transported to irrigate sugarcane on the central Maui isthmus, which has been grown continuously from the late 1800s until the cessation of HC&S at the end of 2016. The figure below shows the changes in agricultural land use in Wailuku ASEA from the established macadamia crops of the 1980s to 2015, before cessation of sugarcane crops. A 2007 U.S. Geological Survey study by Engott and Vana identified agricultural land use changes and estimated the historical application of irrigation water.

HC&S was continuously cultivating sugarcane on the 1,120 acres `Īao-Waikapū Fields using Nā Wai `Ehā surface water. Their 2009 Surface Water Use Permit Application (SWUPA) for these fields were for 10.58 mgd plus 36.29 mgd for the 3,650 acres Waihe`e-Hopoi Fields using Nā Wai `Ehā surface water via the Wai`ale Reservoir. Most of the diverted surface water in the Wailuku ASEA is transported to the Central ASEA. Neither the HC&S SWUPA, nor the contested case documents identify water use within the Wailuku ASEA. Using the 2015 Agricultural Baseline data and irrigation duty for sugarcane cultivation, irrigation of the 1,265 acres of HC&S plantation located within the Wailuku ASEA would represent about 7 mgd. The table below illustrates current agricultural crops and associated water use. Crop acreage is based on the 2015 Agricultural Baseline. Water duty is assigned in accordance with State Department of Agriculture Irrigation Water Use Guidelines. The 1,265 acres of HC&S plantation located within the Wailuku ASEA represents the majority of associated irrigation water use in the table below The A&B Inc.'s diversified agriculture plan and proposed irrigation needs are analyzed under future water use, chapter 14.6.

Figure 14-16 Wailuku ASEA Historic and Current Agricultural Land Use

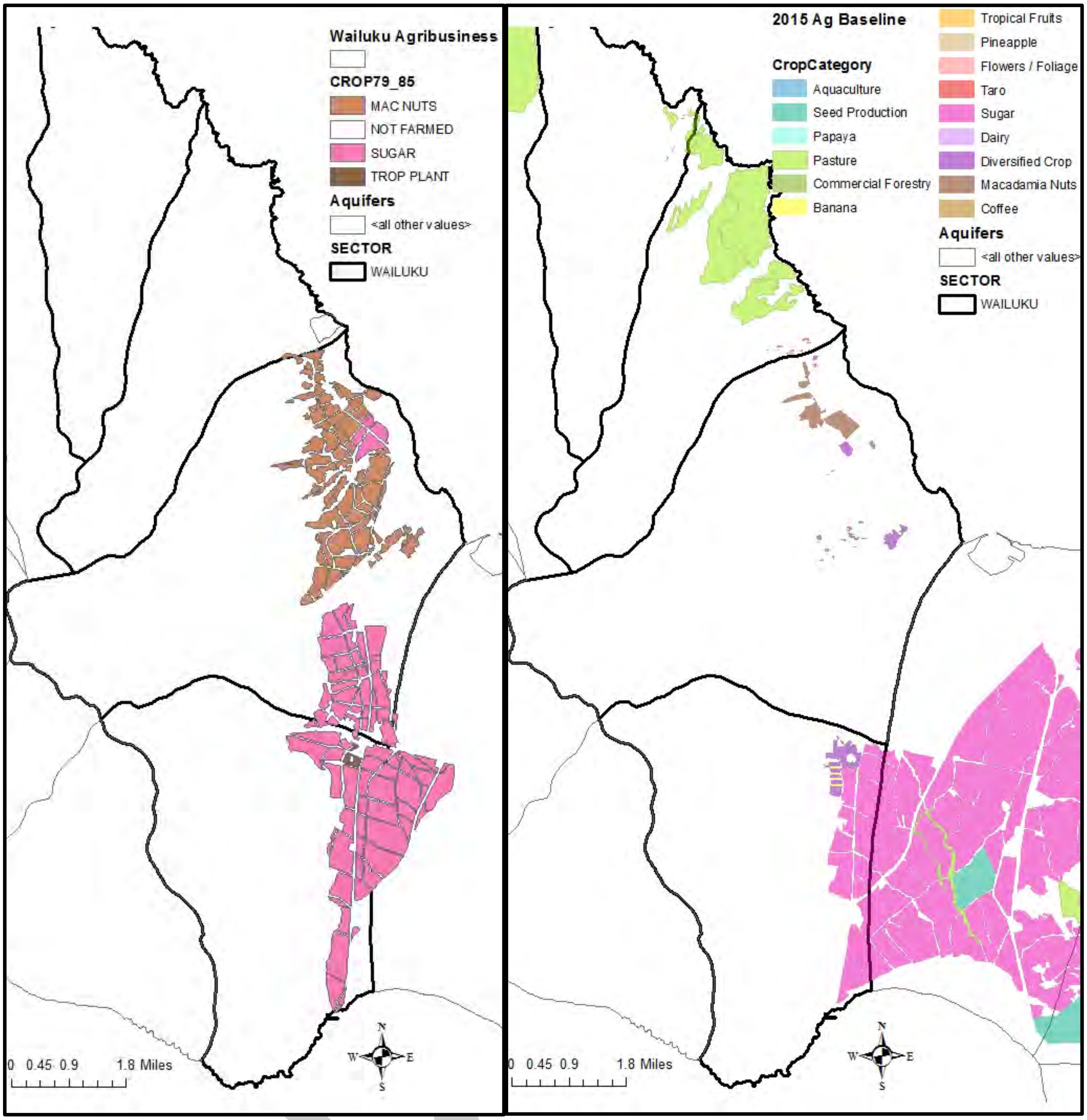


Table 14-10 Wailuku ASEA, Agricultural Water Use Based on Crop, 2015

Crop	Acreage	Water Duty (gpd/acre)	Estimated Water Use (mgd)
Banana	18.39	3400	0.062
Diversified Crop	226.40	3400	0.769
Flowers / Foliage / Landscape	0.60	5000	0.003
Macadamia Nuts	186.32	4400	0.819
Pasture	1439.15	0	0
Sugar	1265.17	5555	7.029
Taro	**15.23**	**27,500***	**0.418**
Wailuku Total	**3151.29**		**9.103**

Source: State of Hawai`i Department of Agriculture, Statewide Agricultural Land Use Baseline, 2015
***Consumptive use, 15,000 – 40,000 gallons per acre (gpa)

<u>Kalo Lo`i and Appurtenant Rights</u>

The 2015 Statewide Agricultural Land Use Baseline indicates that about 15 acres are currently cultivated in taro. The consumptive use is not the streamflow required through the lo`i for healthy plants, but it is the plant use that is not returned to the stream, i.e. the lo`i kalo water lost through percolation, evaporation and evapotranspiration. The characterization and adequacy of streamflow for lo`i kalo and other instream uses are addressed in the contested case. Irrigation requirements for lo`i kalo are thoroughly analyzed. Paul Reppun, an expert on wetland taro cultivation, shared his opinion that current irrigation requirements are between 100,000 to 300,000 gallons per acre per day (gad) of “new” water, which is enough water to maintain low enough temperatures to prevent crop failure. The 2017 Proposed Decision deems 150,000 gad adequate with consideration to reasonable weed management, fallowing and reasonable use of irrigation water among other factors.

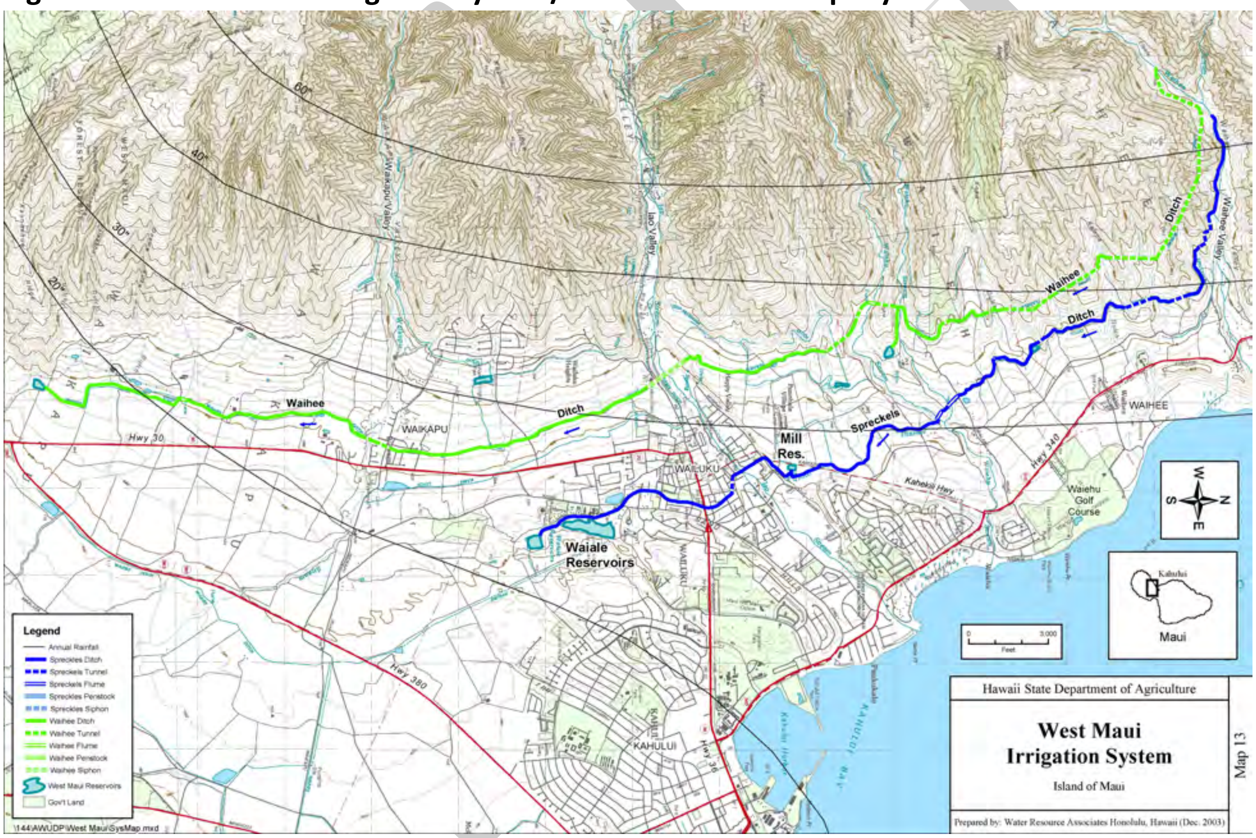
At the 2010 CWRM hearing for CCH-MA06-01, testifiers stated an estimated 135 acres of kuleana lands, of which about 45 acres were or were intended to be cultivated, primarily in lo`i kalo, but also for other subsistence and cultural purposes. The hearing officer recognized a total of 248.69 acres as having appurtenant rights attached. Amounts determined to be reasonable and beneficial total 8,421,861 gpd (8.421 mgd) which include other uses than lo`i kalo. The hearing officer noted that most of the appurtenant rights have not been exercised in the CCH.

As reported under chapter 14.3.5, kuleana systems which receive water through the Wailuku Water Company distribution system are expected to maintain their own systems. Wailuku Water Company maintains its ditches to the point of delivery of water into the kuleana ditch or pipe system.

West Maui Irrigation System/Wailuku Water Company

The ditch system owned and managed by Wailuku Water Company (WWC) is at the heart of agricultural operations within Wailuku ASEA and for water exports to adjacent Central ASEA. The figure below shows the main ditches Waihe`e Ditch and Spreckels Ditch. The former Wailuku Sugar Co. took over Waihe`e Plantation in 1895, at which time Spreckels' 1882 Waihe`e Ditch became a source of conflict and legal action between Wailuku Sugar Co. and Mr. Spreckels of HC&S. Before legal resolution, HC&S was acquired by new owners and a second ditch was constructed to divert Waihe`e Stream flows at higher elevation, known as Waihe`e Canal, now Waihe`e Ditch. (The older ditch is now called the Spreckels Ditch, formerly known as Waihe`e Ditch). Besides the major ditches, Wailuku Sugar Co. had nine smaller ditches, some of which have been abandoned or consolidated. [38]

Figure 14-17 West Maui Irrigation System/Wailuku Water Company



Source: DOA, Agricultural Water Use & Development Plan, 2004

Currently, the WWC ditch system consists of eight primary ditches: Waihe`e Ditch, Spreckles Ditch, `Īao-Maniania Ditch, `Īao -Waikapū Ditch, South Waikapū Ditch, North Waiehu Ditch, Kama Ditch and Everett Ditch. Non-potable water is diverted through a series of concrete intakes located on the Waihe`e, North Waiehu, South Waikapū Streams and Wailuku River.

[38] DOA, Agricultural Water Use & Development Plan, 2004

There are 20.3 miles of open ditches, largely earthen berms, except for portions of the `Īao - Waikapū Ditch which are lined with cement. Each of the major intakes has a designed engineering capacity to divert stream waters. WWC limits the actual amount of diversions by adjusting radial gates. The design capacity for the Waihe`e Ditch intake is rated at 60 MGD capacity. The Spreckles ditch intake design capacity is 30 MGD. The `Īao intake is rated at 60 MGD. South Waikapū intake design is 5 MGD, and the North Waiehu intake is rated at 5 MGD. Maximum potential delivery, as regulated by settings, is approximately 76.5 MGD. WWC maintains a "storm setting" for the ditches when heavy rains are forecasted. Most ditches are then generally set higher. A minimum flow is maintained to carry debris and silt with the flow of water.[39]

Prior to the designation of Nā Wai `Ehā as a surface water management area, WWC estimated the portion of streamflow taken through intakes as follows:
North Waiehu Stream: 40 - 60 %
Waikapū Stream: 60 - 80 %
Wailuku River (`Īao Stream): 30 - 50 %
Waihe`e Stream: 70 - 90 %

System losses through leaks, seepage and evaporation were estimated to approximately 7.34 %. WWC records indicate lowest ditch flows at 15.622 billion gallons per year (BG) in 1974 and as high as 30.016 BG in 1982. Streamflow in 1987 was 41.5 BG while ditch flow was 28.582 BG. In 2005 streamflow was 34 billion gallons (BG) and ditch flow 21.383.[40] In comparison the current estimated Q90 for the four streams combined is 43 mgd (million gallons per day), or 15.695 BG (billion gallons a year).

Table 14-11 Capabilities of West Maui/Wailuku Water Company Ditch System (mgd)

Stream	Ditches Served	Intake	Design Capacity
Waihe`e	Waihe`e	Waihe`e Stream at Waihe`e Ditch	60 MGD
Waihe`e	Spreckles	Spreckles	30 MGD
Wailuku River	`Īao -Waikapū	`Īao	60 MGD
Wailuku River	`Īao -Maniania	`Īao	
Waikapū	South Waikapū	South Waikapū	5 MGD
Waikapū	Waihe`e	Waihe`e	10 MGD
North Waiehu	Waihe`e	North Waiehu	5 MGD
North Waiehu	Spreckles		

WWC maintains and uses 17 reservoirs with a design capacity of 79 MG. Due to siltation, current capacity is approximately 55 - 60 MG. Reservoir 6, 9, 97, 90, 92, 10, 25 and 45 are

[39] CCH-MA0601 Opening Statement of Wailuku Water Company LLC; Certificate of Service
[40] Ibid.

primary reservoirs. No. 9 is used as a back-up reservoir and provides irrigation to adjacent quarry area, formerly for irrigation of 260 acres. No. 6, 90 and 92 provide irrigation water for HC&S fields. No. 97 is used for sugarcane and golf course irrigation. Reservoir No. 10 is for other end-users in Waikapū area. No. 25 is for diversified farmers and Malaihi Subdivision. No. 45 is for Wailuku Country Estates and kuleana users in that area. [41]

HC&S was until recently the largest user with a share of 79% of total end use for approximately 5,400 acres sugarcane production. Kuleana users account for 10%, or 2.5 MGD from Spreckles Ditch, and County of Maui for 4%. The water delivery agreements to 35 customers account for 7%, including Kīhei Gardens and Landscaping, the Maui Tropical Plantation, Waikapū Estates Coffee, Wailuku County Estates, Ko`olau Cattle Company, and the King Kamehameha and Kahili golf courses. Construction companies use ditch water for dust control and other irrigation needs. MDWS is the only user of `Īao Tunnel, averaging 2.2 MGD use. The `Īao Tunnel also discharges about 250,000 GPD into the `Īao Ditch. The remaining water moving through Spreckles Ditch ends up in the Wai`ale Reservoir.

WWC owns 13,170 acres in four large watershed parcels and maintains exclusive rights for the entire Wailuku Ditch system and the reservoirs located on lands it no longer owns. WWC has title to eight inversion high level dike tunnels.

Municipal Use

Municipal use comprised about 98 percent of reported groundwater pumpage in the Wailuku ASEA, but less than 3 percent of diverted surface water. Residential and commercial uses comprise the majority of the Municipal use category. In addition to the County Department of Water Supply (MDWS) there are two small privately owned "public water systems" as defined by the Department of Health (systems serving more than 25 people or 15 service connections). A few domestic wells serve individual households. These systems in total comprise about 1% of the water supplied, with municipal DWS systems comprising about 99%.

Table 14-12 Public Water Systems, Wailuku ASEA

PWS No.	Name	Owner	Population Served	No. of Connections	Average Daily Flow (gpd)	Source
212	Wailuku	MDWS	68,976	20,465	19,611,000	Ground/ Surface
240	Hawai`i Nature Center	Hawai'i Nature Center	75	3	300	Ground
249	Kahakuloa	Kahakuloa Acres Water Co.	150	48	20,000	Ground

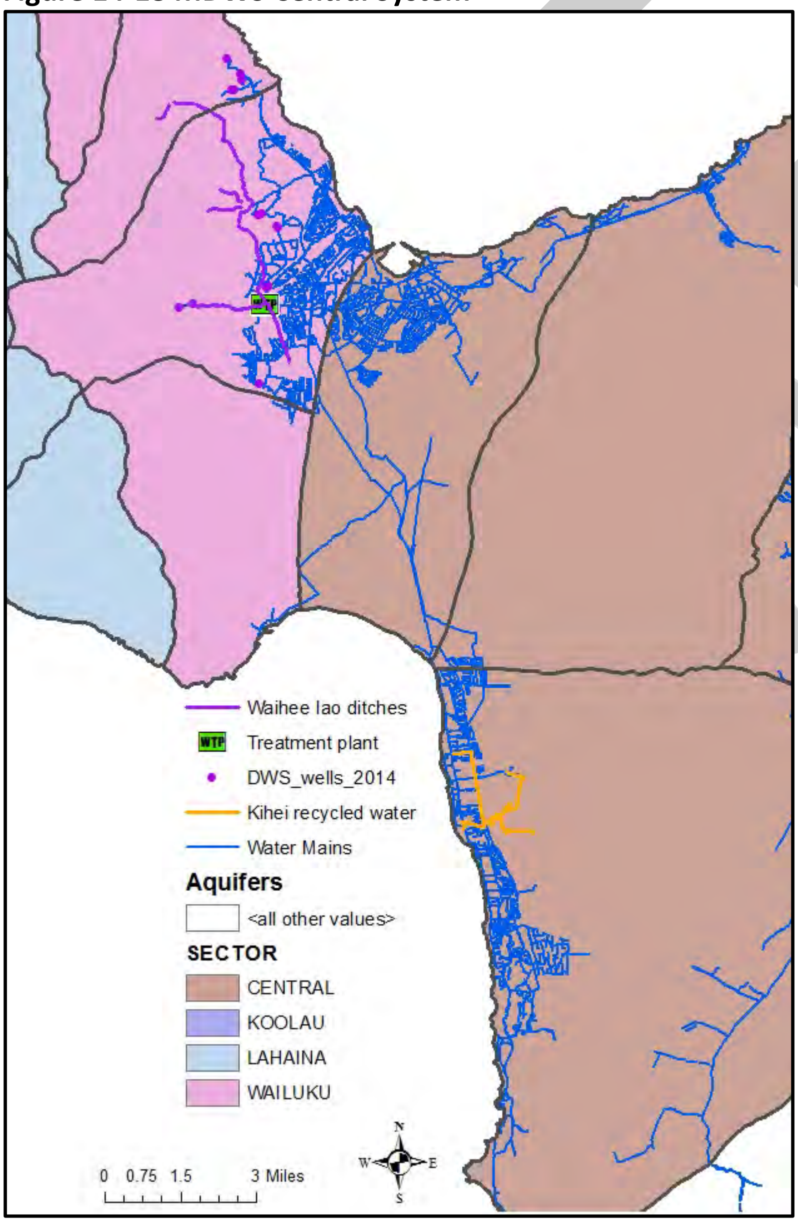
Source: State Dept. of Health, 2015 based on 2013 survey of water production submitted by providers every three years. DWS 2014 Annual Report

[41] Ibid.

MDWS Wailuku District/Central Water System (PWS 212)

The MDWS Central system, also referred to as Wailuku District by the Department of Health (DOH), generally serves the area extending from Waihe`e to Pā`ia/Kū`au on the north shore; Kahului, Wailuku and Waikapū on the Central isthmus; and from Mā`alaea to Mākena on the south shore. The system has 20,465 meters and serves about 69,000 people (Table 14-12 is based on DOH 2013 data). The sources of water are primarily from groundwater pumped from the `Īao and Waihe`e aquifers supplemented with groundwater from Kahului aquifer, surface water from Wailuku River, and a production tunnel in the `Īao Valley. Surface water from Wailuku River via `Īao Ditch is treated at the `Īao Water Treatment Facility.

Figure 14-18 MDWS Central System



The system consists of the following facilities: 19 wells; 1 high level tunnel; 1 microfiltration surface water treatment plant; 35 steel and concrete storage tanks ranging from 10,000 gallons to 3 million gallons. Disinfection is achieved by chlorination (gas and sodium hypochlorite). An ultraviolet treatment system was in place 2014 but was damaged and demolished in the September 2016 `Īao Valley storm. The largest source of this system, Wailuku Shaft 33, was permanently shut down in 2016. Replacement wells to distribute pumpage throughout the `Īao Aquifer were developed over the last decade, including the Waikapū Tank Site Well, the `Īao Tank Site Well, and the Wailuku Well 1 and 2. The `Īao Water Treatment Facility withdraws surface water from Wailuku River through the `Īao-Waikapū Ditch. The plant is exposed to open air and was not built for permanent use. A new treatment facility capable of treating an additional 1.5 mgd went online November 2018 mauka of the existing plant.

Two major transmission lines convey about 12 mgd from wells in the Wailuku ASEA via gravity to the south side. An 18-inch line supplies water to 7 tanks along Pi`ilani Highway. The 36-inch line is interconnected to 3 tanks in Kīhei and also supplies water to the last tank on the system in Mākena. Except for the Maui Lani wells pumping from Kahului aquifer in the Central ASEA, all water sources are located within the Wailuku ASEA. Source pumps are controlled remotely via the control center and operate automatically via the level in the reservoirs. The level in the reservoirs sets the pressure in the distribution system. Booster pumps are used to pump groundwater from reservoirs at lower elevations to reservoirs at higher elevations.

DOH classifies the system as “mixed system” having both ground and surface water sources. The system is therefore subject to sanitary survey requirements under the Ground Water Rule (GWR). The system is in compliance with all drinking water standards and regulations under the Safe Drinking Water Act, including the Coliform Monitoring Program and the Lead and Copper Monitoring Program. Single family use accounts for the greatest demand. Although the CWRM water use category “Municipal” includes all MDWS billing classes, the table below provides a breakdown of water consumption that closest corresponds to CWRM sub-categories and actual water use.

Table 14-13 MDWS Central System Water Consumption by CWRM Category, 2014

CWRM Category	2014 (gallons)	% of Total
Domestic Residential	12,700,856	60.04%
Domestic Non-Residential	6,284,171	29.71%
Industrial	611,938	2.89%
Municipal	1,228,621	5.81%
Agriculture	24,130	0.11%
Irrigated	256,824	1.21%
Military	17,232	0.08%
Unknown	30,216	0.14%
TOTAL GPD	21,153,987	100.00%
TOTAL MGD (million gallons/day)	**21.154**	**100.00%**

While the base year for this WUDP is 2014, alternative periods were reviewed to determine whether 2014—which exhibited a strong El Nino—is representative of consumption over time. The 10-year average was fairly consistent with the 2014 average daily demand.

Table 14-14 MDWS Central System Water Consumption 3-Year and 10-Year Average

MDWS District	2014 Daily Ave	3-Yr Ave 2012-14	10-Yr Ave 2005-14	Variation 10-Yr Ave / 2014 Ave
Central Wailuku	21.154	21.299	21.288	1%

Water consumption also varies seasonally, with the low demand months most significantly reflecting lower outdoor irrigation demands. For the MDWS systems, large seasonal fluctuations indicate the potential for outdoor water conservation.

Table 14-15 Comparison of High and Low Month Consumption, MDWS Central System/Wailuku District, 2011 to 2015 Average (mgd)

High Month	Low Month	Variation	% Variation
28,061.59	19,482.29	8,579	44%

State Water Systems

`Īao Valley State Park Water System

The `Īao Valley State Park water system is located at the end of `Īao Valley Road, outside of Wailuku. The water system is owned and operated by the State of Hawai`i and managed by the DLNR-State Parks. The water system provides irrigation to a taro patch (1,500 SF) within the state park. The non-potable source for the water system is a stream diversion from the Wailuku River. Stream water is diverted through a 2-inch pipe and flows by gravity to the irrigation system. The estimated non-potable water demand was not reported. A surface water use permit for 5,000 gallons per day was sought from Wailuku River for approximately 500 square feet of kalo lo`i. The November 2017 Proposed Decision for Nā Wai `Ehā awarded 5,600 gpd. The potable park consumption is supplied by the County of Maui, DWS water system. State water demand projections are encompassed within the population based projections for Wailuku ASEA. The proposed surface water use allocation of non-potable demand is included in total irrigation demand.

Federal Water Systems

There are no federal water systems.

Private Public Water Systems

Kahakuloa Acres Private Water Company (PWS 249)

Located approximately eight miles west of Wailuku, the Kahakuloa Acres Private Water Company is situated between elevations 1,000' - 1,500' on the eastern slopes of the West Maui Mountains. The company depends entirely on groundwater as a source with an Average Daily Flow of 20,000 gallons per day (gpd) to serve both the Maluhia Country Ranches and the neighboring Kahakuloa agricultural subdivisions with lots vary in size from 2 – 20 acres. One well is installed in the northern portion of Waihe`e aquifer, north of Makamaka`ole Stream, and has a pump capacity of 288,000 gpd. No backup supply is identified. The system has 48 service connections providing groundwater to approximately 150 people. Water is chlorinated and there have been no EPA violations reported for the Kahakuloa System Public Water System since 2004.[42]

Hawai`i Nature Center: `Īao System (PWS 240)

The Hawai`i Nature Center, located in the `Īao Valley of Wailuku, is a non-profit environmental education center established in 1981. The Hawai`i Nature Center highlights Hawaiian flora and fauna with hands-on outdoor programs focusing on educating Maui's keiki. The source for the system is the `Īao Tunnel, a high level tunnel owned by Wailuku Water Company. The Maui Department of Water Supply provides non-potable water to Center for treatment on site. Water delivered ranges widely from 2,700 – 11,000 gpd. The system has 3 service connections, serving approximately 75 transient non-community people. No future expansion is anticipated for the water system.

[42] HI DOH SDWB; CWRM; http://www.maluhiacountryranches.com/intro.htm; http://www.ewg.org/tap-water/whatsinyourwater/HI/Kahakuloa-Water-Co/0000249/

14.5.2 Water Use by Resource

Water use in 2014 comprised about 55 mgd in the Wailuku ASEA, with surface water accounting for about 62 percent of the total. Since the cessation of sugarcane cultivation, reported surface water use is significantly less and further analyzed under Future Water Use.

Water Transport

Interactions between ground and surface waters occur naturally in the water cycle, and also by mechanical means where water is transported between regions through conveyance pipes and ditches. Irrigation of large scale agriculture on the Central isthmus, primarily sugarcane until 2016, is supplied by surface water derived from outside a hydrologic unit, and recharges the underlying groundwater. This manmade recharge is not accounted for in establishing Sustainable Yield.

Groundwater from Wailuku ASEA is transported throughout the municipal Central Maui System/Wailuku District, serving population centers in the Central ASEA. Between 4.6 – 5 mgd of the groundwater withdrawn from Wailuku ASEA is consumed within the Wailuku ASEA. The rest is transported to the Central ASEA. Groundwater from `Īao and Waihe`e aquifers is mixed with groundwater from the Maui Lani wells in the Kahului aquifer and surface water from the Wailuku River. Therefore the exact amounts used within each aquifer sector cannot be determined. About 34.5 mgd of surface water was diverted from Nā Wai `Ehā in 2014, with 15 – 17 mgd used within the Wailuku ASEA and the rest transported to Central ASEA for sugarcane irrigation prior to December 2016, before HC&S sugar plantation shut down, and 1 mgd was used for municipal uses. Estimated water transfers are shown below.

Table 14-16 Estimated Water Transfers, Wailuku ASEA

Water Resource	Wailuku ASEA Discharge	Central ASEA Discharge
Surface Water	15 - 17	16 - 18
Groundwater	5	15.7
Total	**25 - 27**	**31.7 – 33.7**

Source: CWRM 2014 Well Pumpage and Diversion Data, MDWS 2014 Billing and Production; CCHMA 06-01-2 D&O. Smaller purveyors and end uses not shown.

Ground Water Resources

Most of the public water supply on Maui is derived from basal sources in the Wailuku Sector. Groundwater withdrawals from the Wailuku Sector began in 1948 when Shaft 33 was built above Wailuku. Withdrawals from the Waihe`e Aquifer began in 1997. No significant withdrawals are reported from the Waikapū and Kahakuloa aquifers. Groundwater withdrawals in this area increased from less than 10 MGD during 1970 to about 23 MGD during 2006. In response to increased withdrawals from the freshwater-lens system, water levels declined, the transition zone between freshwater and saltwater became shallower, and the chloride concentrations of pumped water increased. With a goal to reduce the overall impact on the freshwater lens while optimizing withdrawals, DWS has co-funded multiple studies by the U.S. Geological Survey (USGS) in the ASEA, including the 2008 study of groundwater availability with the Wailuku sector as primary focus. The rate of natural recharge for `Īao Aquifer, which serves 59 percent of municipal groundwater withdrawals on Maui, has varied from an estimate of 15 mgd by CWRM in 1990, to 42 mgd by USGS in 2007. The highest estimate was based on a method that accounted for fog drip, daily time steps and irrigation return scenarios among other factors. A USGS study initiated in 2015 "Reassessment of Groundwater Recharge for Central and West Maui" includes improved methods of estimating fog interception, including forest canopy interception and the differentiation of native and alien forests. The results of this study can impact on revisions of sustainable yield as new developments in rainfall data and a refined water-budget model could substantially improve the estimates of groundwater recharge for Central and West Maui. The table below shows pumpage and pump capacity of installed wells, compared to sustainable yield. Pump capacity does not reflect permitted or actual pumpage, but the total capacity of installed pumps in gallons per minutes multiplied by 24 hours.

Table 14-17 Pumpage and Pump Capacity of Wells Compared to Sustainable Yield, Wailuku ASEA

Aquifer System	Pumpage	Installed Pump Capacity	SY	Pumpage as % of SY
Waikapū	0.000	3.362	3	0.0
`Īao	17.281	57.177	20	86.4
Waihe`e	3.480	10.273	8	43.5
Kahakuloa	0.000	0	5	0.0
Total	**20.761**	**70.812**	**36**	**57.7**

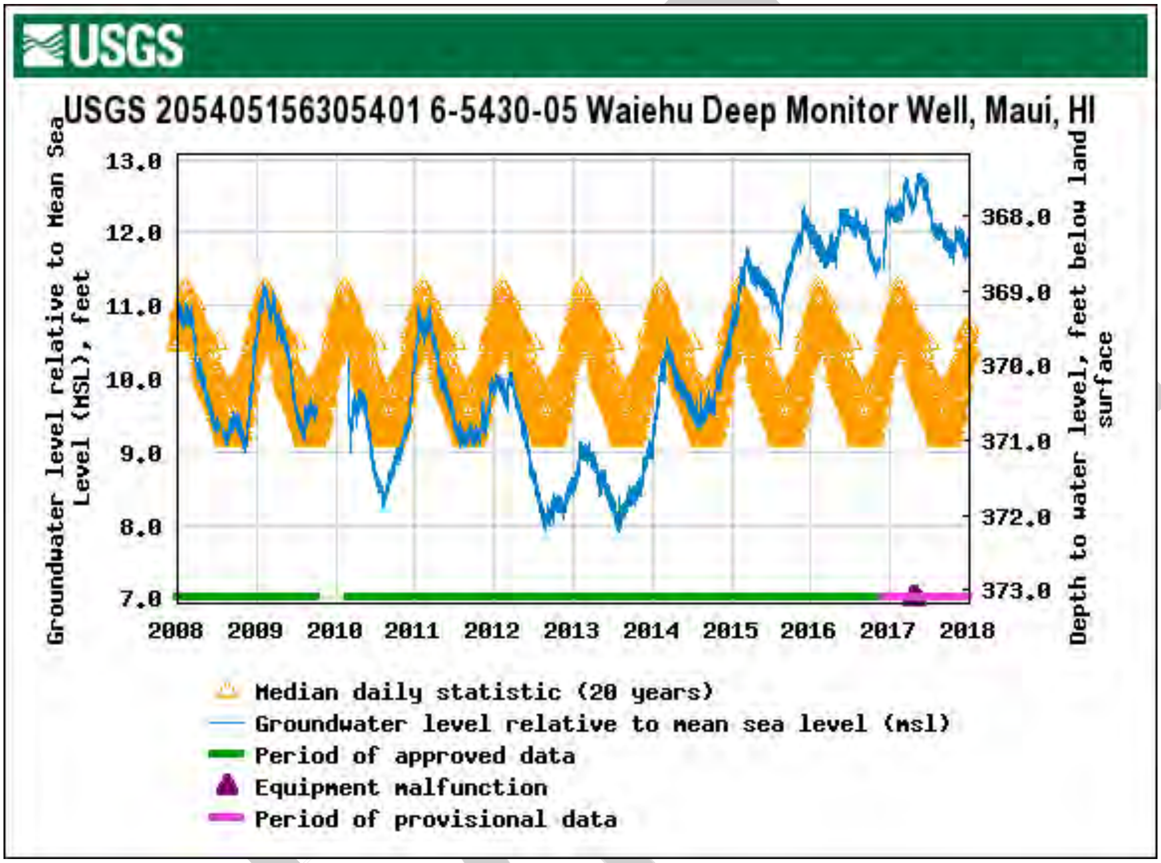
Source: CWRM Well Index 5/29/15 for production wells and 2014 pumpage reports, 12-month moving average

Chloride Concentrations

Salinity of water withdrawn from wells in the aquifer sector generally increases with depth, proximity to the coast, and withdrawal rates. The MDWS wells in this aquifer sector mostly produce water with low chlorides, 1 % or less of seawater. However, a number of wells have seen chloride levels as high as 2.5% of salinity. Rising chlorides can be due to concentrated pumpage from a single large well or production wells that are located very close together and operated simultaneously rather than in rotation. Upconing was deemed to occur at the Mokuhau and Waiehu Heights well fields at the time of groundwater management area designation.

Monitoring wells measure the salinity profiles in deep open boreholes, which provide an indication of changes in freshwater volume over time. Two deep monitoring wells in the `Īao Aquifer are sampled by the USGS and CWRM. The Waiehu Deep Monitor well has indicated a shallowing of the brackish water transition zone and a reduction of freshwater thickness over time. The middle of the transition zone rose by 154 ft. during 1985 – 2006. The second well, `Īao Deep Monitor Well, had limited temporal data to indicate trends. [43] Since the 2008 USGS study, monitoring data has indicated a recovery of groundwater levels relative to mean sea level (MSL), ranging from a low 8 ft. above MSL to 12 ft. above MSL in 2017. Distribution of pumpage, adequate spacing and proper pump rates are required to maintain sustainable withdrawals.

Figure 14-19 Groundwater Level Relative to Mean Sea Level, `Īao Aquifer Monitoring Well 2008 - 2017



Source: USGS, https://nwis.waterdata.usgs.gov/nwis/uv?site_no=205405156305401

<u>**Inversion Tunnels**</u>

There were twelve tunnels known to be excavated in Nā Wai `Ehā between 1900 and 1926. Eight inversion tunnels (high-level dike tunnels) tap dike-impounded groundwater. The other four were excavated beneath Wailuku River and Waiehu Stream and collect water from beneath the streams. About 9 mgd of dike impounded groundwater was developed by tunnels. Black Gorge Tunnel and `Īao Needle Tunnels Number 1 and 2 and Waikapū Tunnels Number 1 and 2 discharge directly into streams.[44] The Waihe`e tunnels may have contributed to Waihe`e River flow after their construction but it is not likely that they presently contribute appreciably

[43] USGS Report 2008-5236, Groundwater Availability in the Wailuku Area, Maui, Hawai`i 2008
[44] CCH-MA06-01, June 2010, FOF 141-143

to total flow.[45] MDWS has an agreement with Wailuku Water Company (WWC) to use the `Īao Tunnel at Kepaniwai (Well No. 5332-02). Tunnels that tap high level dike-impounded groundwater do not count towards sustainable yield. WWC applied for water use permits for six of the tunnels at the time of groundwater management area designation. However, the Waikapū tunnels are not considered as part of `Īao Aquifer and flow into Waikapū Stream. Water use permits for the three tunnels discharging into Wailuku River upstream of all diversions were denied and the amounts discharged incorporated into the IIFS for Wailuku River. Water use permits for existing uses of inversion tunnels within the `Īao groundwater management area were awarded in 2010. Water use permit applications for new uses would be addressed in the combined contested case for the designated surface water management area Nā Wai `Ehā and establishment of IIFS. The table below summarizes available data on tunnels within the Wailuku Aquifer Sector Area.

Table 14-18 Inversion Tunnels, Wailuku ASEA

Name	Owner	Estimated Yield (mgd)	Water Use Permit (mgd)	Discharge	Use	Year Drilled	Ground Elevation
Waikapū Tunnel 1	HC&S	Less than 0.01	N/A	Waikapū Stream	AG	1900	1360
Waikapū Tunnel 2	HC&S	1.0	N/A	Waikapū Stream	AG	1905	1500
`Īao Tunnel/Tunnel 9/Waiehu Tunnel	WWC/ County of Maui	N/A	Incomplete	?	IRR	1900	440
`Īao Tunnel (Puako)	HC&S	0.1	0.1 pending (interim)	Spreckles Ditch	IRR	1900	240
Black Gorge Tunnel	WWC	dry	denied	Wailuku River	IRR	1926	1305
`Īao Tunnel (Kepaniwai)	MDWS	2.2	1.359 (0.841 pending)	`Īao Ditch	MUN	1939	785
Field Gorge Tunnel	Wailuku Sugar	N/A	N/A	?	ABNSLD	1942	700
`Īao Needle Tunnel	WWC	N/A	denied	Wailuku River	IRR	1942	1425
`Īao Needle Tunnel 2	Wailuku Sugar	N/A	denied	Wailuku River	ABNSLD	1942	1475
Waihe`e Tunnel 1	HC&S	N/A	N/A	Waihe`e River	AG	N/A	1625
Waihe`e Tunnel 2	HC&S	N/A	N/A	Waihe`e River	AG	N/A	1650
Waiehu Tunnel	Wailuku Sugar	N/A	N/A	Waihe`e River	OBS	1942	300

Source: CCH-MA06-01, June 2010, FOF 141-143, CWRM well data index 2015, WUP database and personal comm.

[45] ibid

Surface Water Resources

There are 9 streams in the Wailuku ASEA shown in Figure 14-6. U.S Geological Survey (USGS) data show statistically significant downward trends in the annual base flow of streams from 1913-2002.[46] Surface water diversions constituted the majority of water diverted from Nā Wai `Ehā for agricultural purposes through 2016. MDWS relies to 95% on groundwater for municipal needs of the Central System.

Table 14-19 Surface Water Diversions, Wailuku ASEA

Surface Water	Domestic	Industrial	Agriculture/Irrigation	Municipal	Military	Total
Waikapū Stream	0.0261		1.38	--	--	**1.4061**
Wailuku River			10.49	0.99	--	**11.48**
Waiehu Stream			3.99	--	--	**3.99**
Waihe`e River			17.62	--	--	**17.62**
Total Diverted Surface Water	**0.0261**		**33.48**	**0.99**	**0**	**34.4961**

Surface and Groundwater Connection

Before the addition of irrigation water from outside the Central isthmus, the Kahului aquifer was believed to be naturally brackish. Many of the holder high-capacity irrigation wells and shafts operated by sugarcane plantations in central Maui reported salinity exceeding 4 % of seawater. [47] The influx of surface water from Nā Wai `Ehā and from East Maui for sugarcane irrigation contributed irrigation return recharge to augment the quality and quantity of the groundwater lens below. The 2008 USGS study of groundwater availability in the region modeled pumpage scenarios under various conditions, including restored streamflow in Nā Wai `Ehā. The modeled scenario assumed an additional 12.3 mgd recharge distributed between the Waikapū Stream, Wailuku River, Waiehu Streams and Waihe`e River. The model showed significant increased groundwater levels, thickening freshwater body and decreased salinity from additional recharge resulting from restored streamflow over a 150 year period. Another scenario representing no agricultural irrigation on the isthmus in combination with proportionate reduction in stream diversions for agricultural irrigation was modeled. The effect of additional recharge beneath the streams was greater than the effects from the loss of

[46] Engott, J. 2007, Effects of Agricultural Land- Use Changes and Rainfall on Ground-Water Recharge in Central and West Maui, Hawai`i, 1926-2004, USGS SIR 2007-5103 and Oki, D.S. 2004, Trends in Streamflow Characteristics in Hawai`i, 1913-2002. Fact Sheet 2004-3104. United States Geological Survey, prepared in cooperation with the State of Hawai`i, Commission on Water Resource Management

[47] USGS Report 2008-5236, Groundwater Availability in the Wailuku Area, Maui, Hawai`i 2008

recharge beneath the central isthmus. An update to the groundwater study for Waikapū, `Īao and Waihe`e aquifers addresses potential impact on groundwater recharge as large scale irrigation was cut back in 2016.

14.5.3 Alternative Water Resources

Rainwater Catchment

Annual rainfall ranges from about 20 inches in the south and southeastern portions of the aquifer sector, up to 350 inches in the upper forested watersheds. It is assumed some small-scale rain catchment exists north of the MDWS service area from Waihe`e to Kahakuloa, but records are not maintained.

Rainwater catchment is not as reliable as conventional water resources because it is extremely sensitive to the climate. Rain barrels, cisterns or infiltration wells could supplement irrigation on a limited basis in the region.

Recycled Wastewater

There is no wastewater reclamation facility located within the Wailuku ASEA. The Kahului Wastewater Reclamation Facility (WWRF) located in the Central ASEA has limited distribution of recycled water, none of which extends into the Wailuku sector. Recycled water from the Kahului WWRF, the Kīhei WWRF and the private Mākena WWRF are all integral components and strategies to meet future irrigation needs in the Central aquifer sector. Recycled water in the Central ASEA has the potential to offset demand in Central ASEA that would otherwise be supplied by conventional water resources originating in the Wailuku ASEA. Therefore the Kahului and Kīhei WWRFs are briefly assessed here, and further analyzed in the Central ASEA Sector Report, Chapter 15.

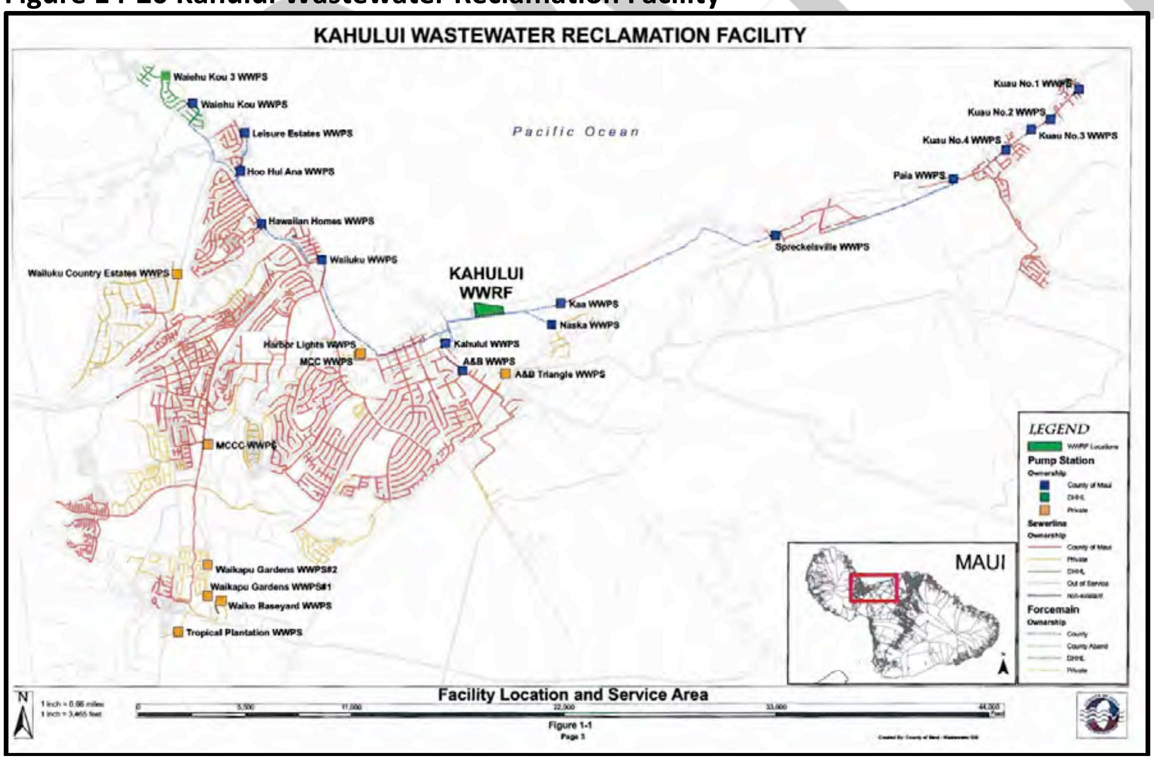
The State of Hawai`i defines R-1 water as the highest-quality recycled water; it has undergone filtration and disinfection to make it safe for use on lawns, golf courses, parks, and other areas used by people. R-2 recycled water can only be used under restricted circumstances where human contact is minimized. The Kīhei WWRF produces R-1 water and the Kahului WWRF produces R-2 water quality. The Maui County Code was amended in 1996 requiring commercial properties (agricultural, commercial, public uses) within 100 feet of a Maui County R-1 water distribution system to connect within one year of recycled water availability and to utilize recycled water for irrigation purposes. The CWRM can also require dual water supply systems for new commercial and industrial developments in designated water management areas if a non-potable source of water is available.

The Department of Environmental Management's Wastewater Reclamation Division (WWRD) must fulfill R-1 water obligations for projects that are either a) already utilizing R-1 water and will see increased use as projects build out, or for b) projects that are in close proximity to the existing distribution system and will be connecting in the near future.

Kahului WWRF

The Kahului WWRF serves the Central Maui area from Waiehu to Kū`au. The current dry weather flow capacity is 7.9 mgd and average dry weather flow is 4.4 mgd. Currently, all of the wastewater processed by the facility is treated to R-2 recycled water standards meaning that there are restrictions on its uses and applications. Key restrictions on the use of R-2 water via spray irrigation are that R-2 water can only be used at night and there must be 500 foot buffer zones between the area being spray-irrigated and adjacent properties. In order for the recycled water from the facility to be utilized in the urban environment such as for spray irrigation at commercial properties, the facility would need to undergo an upgrade to enable it to produce R-1 water. The volume of R-2 water reused from the facility ranges from 3 to 7% of the incoming wastewater flow. The daily average of R-2 water used is 0.2 mgd with most of the recycled water utilized within the facility for landscape irrigation and industrial uses. Some of the R-2 water is sold to construction companies that use it for dust control.[48]

Figure 14-20 Kahului Wastewater Reclamation Facility



Source: Department of Environmental Management, Wastewater Reclamation Division, Central Maui Recycled Water Verification Study, December 2010

---

48 Department of Environmental Management, Wastewater Reclamation Division, Central Maui Recycled Water Verification Study, December 2010

Table 14-20 Wastewater Reclamation Facility Capacity, Production and Use, 2014 (mgd)

WWRF	Treatment Level	WWRF Design Capacity	Recycled Water Produced	Recycled Water Used	% of Total Produced Used	% of Design Capacity Used	Application
Wailuku-Kahului	R-2	7.9	4.7	0.25	5.3%	3.2%	None
Kīhei	R-1	8	3.6	1.5	41.5%	18.7%	Golf Course, Agriculture, Dust Control, Landscape, Fire Protection
Mākena (Private)	R-1	0.75	0.08	0.08	10.6%	10.6%	Golf Course

Source: County systems: County of Maui Environmental Management Dept., Wastewater Reclamation Division, 2014 Average. Other systems, 2013 Update of the Hawai'i Water Reuse Survey and Report, State of Hawai'i, 2012 data.

Kīhei WWRF

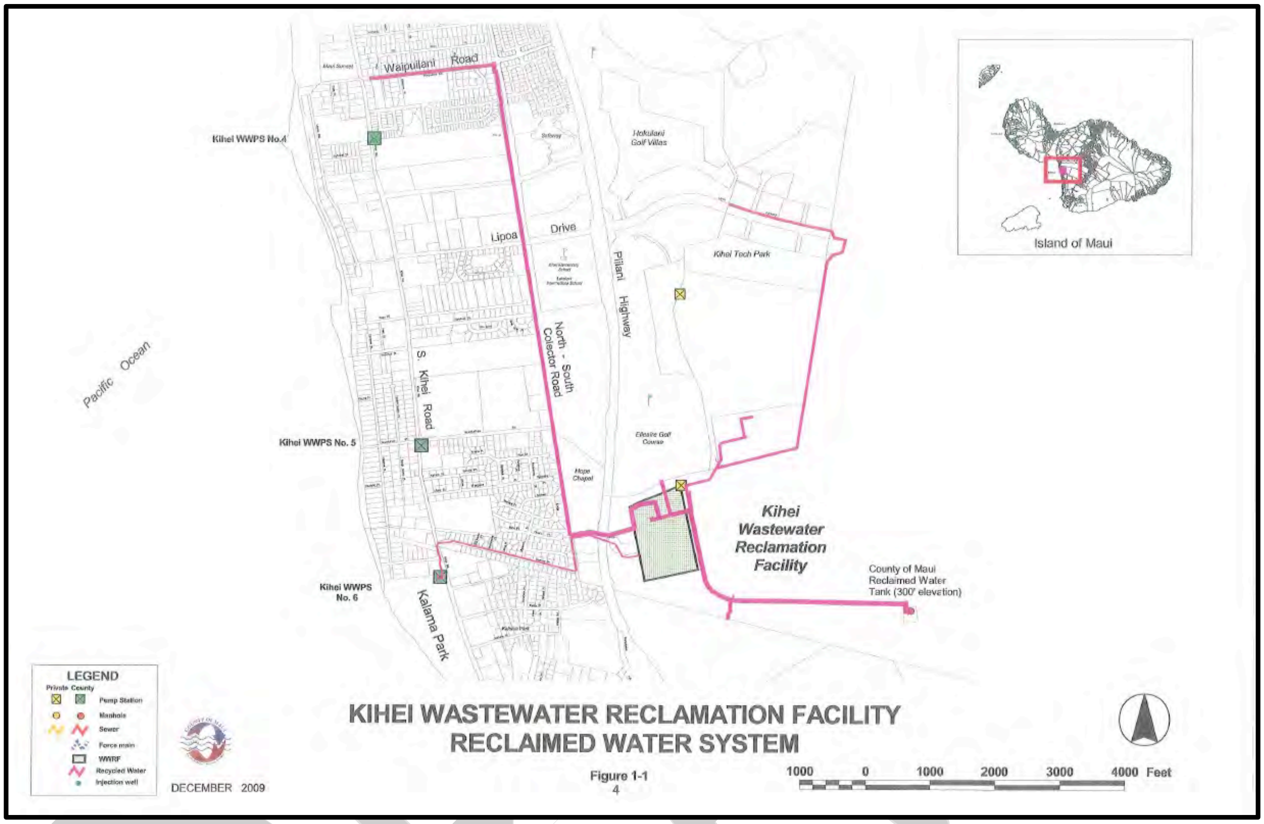
The Kīhei WWRF serves the South Maui area from Wailea to Sugar Beach. The current dry weather flow capacity and R-1 production capacity is 8.0 mgd, and the average dry weather flow to the WWRF is 3.58 mgd. The volume reused R-1 water ranges from 20-52% of the incoming wastewater flow depending upon the time of the year. The South Maui distribution system provides R-1 water to 24 commercial properties in South Maui for landscape and agricultural irrigation, cooling, fire control, erosion and dust control, drinking water for cattle, and other uses. [49]

The volume of R-1 water reused is subject seasonal fluctuations. Generally, more water is used for irrigation in the dry summer and fall months. The highest average daily volume for peak season use was 1.75 mgd in August, 2008. The excess R-1 water that is currently available during peak demand months is about 1.39 mgd (3.14 mgd wastewater flow minus 1.75 mgd peak month use). The available volume will be less due to additional planned R-1 use at developing commercial properties located near the existing R-1 distribution system. As of 2016, the WWRF estimates 0.7 mgd excess R-1 supply is available. During winter months, wastewater flow rates to the WWRF typically increase due to greater visitor levels in South Maui while irrigation demands lessen and as a result excess R-1 water is available. Large irrigated areas are needed to utilize the seasonal excess water in winter months. However, in summer months

[49] Department of Environmental Management, Wastewater Reclamation Division, Department of Water Supply Water Resource Planning Division, South Maui R-1 Recycled Water Verification Study, December 2009

there would unlikely be sufficient R-1 produced to meet irrigation demands for such large acreage, therefore requiring alternative sources as contingency.

Figure 14-21 Kīhei Wastewater Reclamation Facility



Source: Department of Environmental Management, Wastewater Reclamation Division, Department of Water Supply Water Resource Planning Division, South Maui R-1 Recycled Water Verification Study, December 2009

Mākena Resort Wastewater Reclamation System

The Mākena area is predominantly served by cesspools. There is no publicly owned treatment works operating in the area. Mākena Resort is served by a privately owned individual wastewater system with effluent treated to R-1 quality. The Mākena Wastewater Reclamation Facility encompasses an area of approximately 13 acres, mauka of the Mākena North Golf Course. The reclaimed water is pumped up to a larger reservoir within the golf course irrigation system, mixed with non-potable groundwater from nearby wells, and used to irrigate portions of the North and South courses. Its average daily capacity is approximately 0.72 mgd and is designed to be expanded to 1.5 mgd in the future. The current average daily flow is approximately 80,000 gallons. The primary reuse is golf course irrigation. Additional reuse is for wastewater facility uses such as landscape irrigation, washdown and dilution water.

Stormwater Reuse

Capture and reuse of stormwater runoff is an under-utilized water resource that provides an opportunity to reduce reliance on groundwater and surface water for landscape irrigation, especially when incorporated into the design of development projects in order to minimize infrastructure costs. There is no reported stormwater reuse in the Wailuku sector, although some development projects may have stormwater controls incorporated into project design to reduce runoff and its effects. The *Hawai'i Stormwater Reclamation Appraisal Report, 2005, and Study Element 3: An Appraisal of Stormwater Reclamation and Reuse Opportunities in Hawai'i*, September 2008, screened and identified four projects on Maui within the final ranking, which might provide opportunities to augment agricultural irrigation water that is diverted currently from Maui streams, in addition to providing other benefits:[50] The Wai`ale Road Stormwater Drainage option uses an existing stormwater drainage channel and detention pond located along Wai`ale Road to capture and convey stormwater into the Waihe`e and Spreckels Irrigation Ditch Systems for agricultural irrigation to the south and east. This is a strategy evaluated for the Central sector as an alternative to stream diversions associated with Spreckels and Waihe`e Ditches for agricultural water demands in Central Maui.

Stormwater reuse at the parcel scale may also provide an opportunity to offset landscape and other irrigation demand of projects or households.

Desalination

There are no desalination projects in the Wailuku ASEA. Desalination of ocean or brackish water was explored by Brown & Caldwell as a supplemental option to the MDWS Central Maui System/Wailuku District with a long term goal to reduce draw on the `Īao Aquifer. An analysis targeting desalination treatment capacity of 5 mgd using reverse osmosis (RO) technology was completed for brackish and seawater alternatives. Both are technically feasible alternatives that meet current health standards and drinking water regulations. [51] Brackish water desalination appears economically feasible. All evaluated facility sites are in the Central ASEA and is further discussed as a strategy option in chapter 14.8 below.

---

[50] Hawai'i Stormwater Reclamation Appraisal Report, 2005, and Study Element 3: An Appraisal of Stormwater Reclamation and Reuse Opportunities in Hawai'i, September 2008. http://files.Hawai'i.gov/dlnr/cwrm/planning/hsrar_element3.pdf

[51] Brown & Caldwell, 2006. County of Maui Department of Water Supply Central/South Maui Desalination Feasibility Study Final Report

14.6 Future Water Needs

14.6.1 General

Two alternative methods were used to project water demand to the year 2035: 1. Population growth rates based on 20-year population growth projections in the Socio-Economic Forecast Report (2014) applied to current consumption; and 2. Build-out of permitted land use based on County zoning and Department of Hawaiian Homelands' land use plans. Population based demand takes into account social and economic factors that are anticipated to drive growth over the planning period.

14.6.2 Water Use Unit Rates

The State of Hawai`i 2002 Water Use Standards are used for land use based demand projections. Most of the water use in the Wailuku ASEA is for residential or single family use, followed by Agriculture. The 2002 Water Use Standards for residential use are 600 gallons per day (gpd) per unit, 3,000 gpd per acre for single family/duplex, and 5,000 gpd per acre for multi-family use. System standards factor in outdoor use and are generally higher than empirical use in the region, because irrigation needs are relatively low.

The Maui Island Plan projects a 20-year 13 percent population increase for the Wailuku ASEA from 2015 to 2035. The population of the Wailuku ASEA includes shares of resident population from the Kīhei-Mākena and Wailuku-Kahului community plan areas. Almost 90% of the Wailuku ASEA is within the western portion of the Wailuku-Kahului Community Plan district. About 10% of the ASEA is within the western portion of the Kīhei-Mākena Community Plan district. The population of the Wailuku-Kahului community plan area was estimated to be 60,336 in 2015 and is projected to increase by approximately 13 percent to 67,986 by 2035. The area remains the economic and population center of the island.

14.6.3 Land Use Based Full Build-Out Water Demand Projections

Full build-out projections for the Wailuku area based on County zoning and DHHL land use categories yield a projected water demand of 65.39 million gallons per day (mgd). Full build out by county zoning designation is neither realistic over the planning period, nor supported by the County General Plan. System standard water rates for agricultural zoning is theoretically assigned, but does not represent regional irrigation needs.

<u>Maui County Zoning</u>

Maui County Zoning for the Wailuku ASEA includes predominantly Agriculture and to a lesser extent Interim Use Zone Districts. Interim zoned land (mostly Conservation) was assigned a zone based on Directed Growth Plan guidance and Community Plan land use designations in order to calculate water demand. No water demand is associated with their Open Space zoning.

A summary of the County land use-based demand follows a discussion of DHHL land use-based demand. Percentage zoned acres of total is rounded.

Table 14-21: Summary of Zoning Use Types, Wailuku ASEA (Excluding DHHL Lands)

Zoning Summary (Corresponding County Zoning Categories found within the Wailuku ASEA in Parentheses)	Acres	% of Total	Water Use Rates (gpd per acre)
SF Single Family Residential, Duplex, Residential (R-1, R-2, R-3, MRA), RU-0.5 Rural - 1/2 Acre, SBR Service Business Residential)*	1,862.22*	4.45%	3,000
Apartment (A-1 Apartment, A-2 Apartment), MRA Multi-Family Residential, MRA Business Multi-Family*[2]	249*[2]	0.60%	6,000
Business (B-1 Business, B-2 Business, B-3 Business, BCT Business Country Town) *[3]	110.32*[3]	0.26%	6,000
Industrial (M-1 Light Industrial, M-2 Heavy Industrial)*[4]	201.95*[4]	0.48%	3,400
Hotel (BR Business – Resort)	1.09	0.003%	1,700
Agriculture (AG Agriculture)	16,160.70	38.62%	1,700
Golf Course (PK-4 Park - Golf Course)*[5]	510.56	1.22%	1,700
P-1 Public/Quasi-Public MRA, Public, HD-3 Historic District 3*[6]	249.13*[6]	0.60%	1,700
PK Park	84.81	0.203%	1,700
Open Space (Conservation, Drainage, Open Space, OS-2 Open Space Active, OZ Open Zone, Proposed Road, Road, Unzoned Road, Beach Right of Way)*[7]	22,409.15*[7]	53.55%	
Undesignated Interim and Project District	5.61	0.013 %	
TOTAL excluding DHHL Lands	**41,844.54**	**100%**	

Source: Table prepared by MDWS, Water Resources & Planning Division. Excludes DHHL lands. Zoning supplied by Maui County Planning Department, Long Range Division, May 2015.

State Department of Hawaiian Home Lands (DHHL) Water Demand Projections

DHHL maintains land use jurisdiction over Hawaiian Homes and are not subject to county zoning designations. The Hawaiian Homes Commission adopted its Maui Island Plan as the overarching planning document in 2004. The State Water Projects Plan (SWPP) was updated in 2017 for DHHL water needs. DHHL zoned lands are not accounted for in Table 14-21 above. DHHL lands excluded from county zoning and associated water rates used by the SWPP Update, DHHL, May 2017, are summarized in the table below.

Table 14-22 DHHL Lands Excluded from Zoning and Projected Demand, Wailuku ASEA

DHHL Land Use Category Based			
DHHL Land Use	**Acres / Residential Units**	**Water Use Rate (gpd)**	**Projected Demand (gpd)**
Residential	179 acres/ 351 units	600 gal/unit	210,600
Commercial	0.19	3,000 gal/acre	570
Agriculture	16	3,400 gal/acre	54,400
Community	16	1,700 gal/acre	27,200
Total	**179 acres/ 351 units**	**N/A**	**292,770**

DHHL Domestic Residential (107,400 gpd) use is residential unit-based (600 gpd/unit), other County-zoned Domestic Residential is based on acreage (5,225,004 gpd).

DHHL requested a reservation from the `Īao Aquifer in 2004 for a total of 2.118 mgd. Water service to most existing DHHL development and facilities on Maui is currently provided by the MDWS systems. There are no DHHL owned and operated water systems on Maui. The 2017 SWPP update projects a demand of 20,400 gpd of potable water for already existing projects in Waiehu and Paukūkalo within the `Īao Aquifer and Wailuku ASEA, and this demand is not expected to increase through the DHHL planning horizon through 2031. The Waiehu and Paukūkalo tracts are small residential communities mauka of Waiehu Beach Road (Paukūkalo) and Kahekili Highway (Waiehu). These tracts that will require water are within the service area of the MDWS System. The projections in the tables do not take into account alternate sources of water that may be available or developed.

Table 14-23 DHHL Projects and Planned Use, Wailuku ASEA, 2031 (mgd)

Aquifer System	DHHL Project	Total Acres	Community Acres	Agricultural Acres	Residential Acres	Commercial Acres
`Īao	Waiehu	147	10	16	121	0
`Īao	Paukūkalo	64	6	0	58	0
`Īao	Wailuku	0.19	0	0	0	0.19

Source: State of Hawai`i Water Projects Plan (SWPP), May 2017 Final Report, Tables 3.7 and 4.7, Cumulative Average Day Demand (gpd).

According to the SWPP, the existing MDWS Central System has the capacity to serve the total potable demand for the Waiehu and Paukūkalo DHHL lands. Currently, the MDWS Central System is able to meet the existing potable water demand of 20,400 gpd, and DHHL does not anticipate any increase in demand through 2031.[52]

Table 14-24 DHHL Projects and Planned Land Use, Wailuku ASEA

Aquifer System	Project	Acres	Potable (gpd)	Potable Strategy
`Īao	Waiehu	147	17,000	sufficient MDWS system capacity
`Īao	Paukūkalo	64	3,400	sufficient MDWS system capacity

Source: State of Hawai`i Water Projects Plan (SWPP), May 2017 Final Report, Tables 3.7 and 4.7, Cumulative Average Day Demand (gpd).
0.19 acres of DHHL land in Wailuku mentioned in the Maui Island Plan in 2003 was not included because it was not mentioned in the more recent State of Hawai`i Water Projects Plan (SWPP), 2017 Final Report

Waiehu Tract

The Community Plan and zoning designation is Agricultural use. The recommended land uses for the Waiehu tract are Residential (84 acres) and Community (7 acres). The MDWS Central System serves the existing Waiehu 1 and 2 subdivisions and Waiehu Kou 3. DHHL's Waiehu lands do not allow for more residential development; however, there may be opportunities to purchase adjacent properties to develop additional residential properties.[53]

Paukūkalo Tract

Paukūkalo's proposed uses are Residential (58 acres) and Community (6 acres). Paukūkalo is an aging residential homestead and contains no vacant lands for future homestead uses. The Community Plan designation is Single Family Residential use, and County zoning is R-2. The MDWS Central System serves the Paukūkalo tract.[54] There are no proposed future surrounding uses, as the area is already built out.[55]

Wailuku Land (0.19 acres)

DHHL has title to a small parcel adjacent to the Wailuku fire station. The community plan designation is Single Family (SF), and zoning is Community Business District (B-2).[56] Water

[52] State of Hawai`i Water Projects Plan (SWPP), May 2017 Final Report, Tables 3.7 and 4.7, page 4-29.
[53] State of Hawai`i, Department of Hawaiian Homelands, Maui Island Plan, 2004, page 4-23.
[54] Ibid, page 4-27.
[55] Ibid, page 4-25.
[56] Ibid, page 4-29.

demand for the 8,145-square foot parcel is approximately 1,124 gallons per day. There are no proposed future surrounding uses as the area is already built out.[57]

The following table summarizes County and DHHL land use/zoning based demand.

Table 14-25 Full Build-Out Water Demand Projections by CWRM Use Type, Wailuku ASEA

CWRM USE CATEGORY	CWRM Land Use Category Based			DHHL Land Use Category Based				Total Proj. Demand (MGD)
	Acres	Water Use Rate (gpd)	Proj. Demand (gpd)	DHHL Land Use	Acres / Residential Units	Water Use Rate (gpd)	Proj. Demand (gpd)	
DOM-RES	2,115.44	3,000*-5,000**	6,851,654	Residential	179 acres/ 351 units	600 gal/unit	210,600	**7.062**
DOM-NON-RES	108.54	6,000 gal/ac (Business) or 17,000 gal/ac (Resort)	663,230	Commercial	0.19	3,000 gal/acre	570	**0.664**
IND	201.95	6,000 gal/ac	1,211,700	Industrial	0	6,000 gal/acre	0	**1.212**
AG	16,160.70	3,400 gal/ac	54,946,380	Agriculture	16	3,400 gal/acre	54,400	**55.000**
OS	22,409.15	0	0	Open Space	0	0	0	**0**
IRR	510.56	1,700	867,952	N/A	N/A	N/A	N/A	**0.868**
MUN	330.74	1,700 gal/ac	562,258	Community	16	1,700 gal/acre	27,200	**0.589**
MIL	0	N/A	0	N/A	N/A	N/A	N/A	**0**
TOTAL	41,837.08	**N/A**	**65,103,174**	**N/A**	**179 ac/ 351 units**	**N/A**	**292,770**	65.396

Source: MDWS Water Resources & Planning Division. Figures may not add due to rounding. Open space, conservation/cultural protection and similar land use types not included due to lack of water demand.
County Zoning: Based on zoning supplied by Maui County Planning Department, Long Range Planning Division, May 2015. DHHL lands are excluded.
DHHL Lands: Based on DHHL Maui Island Plan and Regional Plans. Future land uses are unknown for some lands.
*3,000 gpd is the State of Hawai`i 2002 Water Use Standards water use rate for Single Family Residential use.
**5,000 is the State of Hawai`i 2002 Water Use Standards water use rate for Apartment use.

[57] Ibid, page 4-28.

State Water Projects Plan (SWPP) Water Demand Projections

Many of the planned projects in the 2003 State Water Projects Plan (SWPP) indicated in the data tables below have already been implemented. The 2003 plan does not project demand longer than to 2018. It is assumed that state projects are accounted for in projected demand based on population growth.

Table 14-26 State Water Projects Plan Water Demand Projections (2003), Wailuku ASEA (GPD)

Aquifer	SWPP 2018 Non-potable Demand (GPD)	SWPP 2018 Potable Demand (GPD)	SWPP 2018 Total Potable/Non-Potable Demand (GPD)
Waikapū	0	8,600	8,600
\`Īao	16,980	493,490	510,470
Waihe\`e	5,100	15,030	20,130
Kahakuloa	0	0	0
TOTAL	**22,080**	**517,120**	**539,200**

Source: State of Hawai\`i, State Water Projects Plan (SWPP) Update, Volume 4, Islands of Lanai/Maui/Molokai 2003, page 3-9.

Agricultural Water Use and Development Plan (AWUDP)

The 2004 AWUDP inventoried the West Maui Water System, now the Wailuku Water Company and projected water demand for diversified agriculture served by this system only. Other data referenced in the report indicates existing and potential agricultural water use may be closer to the low or midpoint of the range. Agricultural land use on former Wailuku Agribusiness changed drastically since the adoption of the AWUDP. By 2005, the company had leased the southern extent of the plantation to HC&S, halted macadamia operations, and sold much of its land for residential development. The data used in the 2003 AWUDP for the lands served by Wailuku Water Company is obsolete and not used here to adjust agricultural demand projections.

Table 14-27 Water Demand Forecast for Diversified Agriculture, Wailuku ASEA, 2001-2021

Total Acres	Acreage Forecast for Diversified Agriculture		Forecasted Water Demand (mgd)	
	Worst Case	Best Case	Worst Case	Best Case
5400	214	892	0.73	3.03

Source: Complied based on Tables 6b and 7d, AWUDP, 2003, revised 2004.

14.6.4 Population Growth Based Water Demand Projections (20-Year)

Population growth rate projections were applied in 5-year increments over the 20-year planning period from 2015 to 2035 for high, medium (base case) and low-growth scenarios. Water consumption, including both public and private water systems, are compared to the incremental water needs for the next 20 years based on the *Socio-Economic Forecast Report, 2014* prepared by the Planning Department consistent with the Maui Island Plan. High, medium and low ranges are based on low, medium and high population growth rates established in the 2014 Socio-Economic forecast for the Wailuku ASEA Community Plan areas. Water consumption and demand based on population growth rates do not account for large-scale agricultural irrigation needs. It was assumed that population growth, and thus water use, from projects described in the State Water Projects Plan including DHHL are already accounted for by the population projections.

Wailuku Town is one of Maui's primary urban communities with a 2010 population of 15,313. Wailuku saw a 31% growth in population from 2000 to 2010. Mā'alaea is located in the Wailuku-Kahului Community Plan District and has grown considerably less than the rest of the district. Most of the growth in the Wailuku ASEA is projected within the urban growth boundaries to the north and south of Wailuku as set forth in the MIP's Directed Growth Plan. Future growth rates in both CP districts are shown below. Approximately 41% of the MDWS Central System, also known as Wailuku District, water use is in the Wailuku-Kahului Community Plan District, and 59% of water use is in the Kīhei-Mākena Community Plan District. Applying the appropriate community plan growth rate for each MDWS sub-district generates an average growth rate applicable to the water system as a whole shown in the table below.

Table 14-28 Historical and Projected Population to 2035, Wailuku-Kahului and Kīhei-Mākena Community Plan Region (Wailuku ASEA)

COMMUNITY PLAN AREA	2000	2010	2015	2020	2025	2030	2035
Wailuku-Kahului	41,503	54,433	60,336	62,102	64,188	65,734	67,986
Percent Increase		31.15%	10.84%	2.37%	3.36%	2.41%	3.31%
Kīhei-Mākena	22,870	27,244	29,599	34,757	39,975	46,370	52,044
Percent Increase		19.13%	8.64%	17.42%	15.01%	15.99%	10.90%
MDWS Central System/Wailuku District Applied Growth Rate				11.45%	10.58%	11.17%	9.35%

Source: Population Forecast: 2014 Socio-Economic Forecast, Maui County Planning Department, Long Range Planning Division, Water Demand: MDWS, Water Resources & Planning.

Projecting water demand for the Wailuku ASEA hydrologic unit only (not including the entire MDWS Central System) is shown in the table below. Low to high population growth rates are consistent with low to high growth rates established for the community plan districts in the 2014 Socio-Economic Forecast.

Table 14-29 Projected Low, Base and High Population Based Water Demand to 2035, Wailuku ASEA (mgd)

CASE	2015	2016	2017	2018	2019	2020	2025	2030	2035
Base Case	4.709	4.737	4.765	4.792	4.820	4.847	5.010	5.131	5.307
High Case	5.080	5.110	5.140	5.170	5.199	5.229	5.405	5.535	5.725
Low Case	4.307	4.332	4.357	4.382	4.408	4.433	4.582	4.692	4.853

Source: MDWS, 2017.

Population Growth Based Demand in Planned Growth Areas

The Directed Growth Plan was adopted as the primary purpose of the MIP to accommodate population and employment growth in a manner that is fiscally prudent, safeguards, the island's natural and cultural resources, enhances the built environment, and preserves land use opportunities for future generations. The Directed Growth Plan establishes the location of future development and provides a framework for future community plan and zoning changes and guides the development of the county's short-term and long-term capital improvement plan budgets. [58] According to the updated 2014 socio-economic forecast, over a third of projected population and housing demand is concentrated to the Wailuku-Kahului region.

Hydrologic units are not isolated as water is naturally and mechanically conveyed from high yield watersheds and aquifers to population centers and planned growth areas. Water sources in Wailuku ASEA will continue to meet population growth based demand throughout Central and South Maui. Projected water transports of Wailuku ASEA resources through the MDWS Central Maui System as a whole is therefore addressed in this Sector report under *MDWS Water Demand Projections*. Groundwater sources in the Kahului aquifer, within the Central ASEA hydrologic unit, supplement the MDWS Central System and must also be factored into the analysis of resource adequacy. Planned growth areas within and outside the Wailuku ASEA that is completely or partially serviced by water resources from Wailuku ASEA are discussed below.

Urban infill will be a major source of additional housing units in the Wailuku-Kahului community plan region. There are four new planned growth areas: Wai`ale, Pu`unani, Kāhili Rural Residential and Waikapū Tropical Plantation Town.

Wailuku-Kahului Planned Growth Areas

The MIP recommends new multi-family development to have at least 15 to 25 units per acre net density in areas such as Lower Main Street, Happy Valley, Pi`ihana and Waiehu areas. The

[58] Maui County General Plan 2030, Maui Island Plan page 8-2

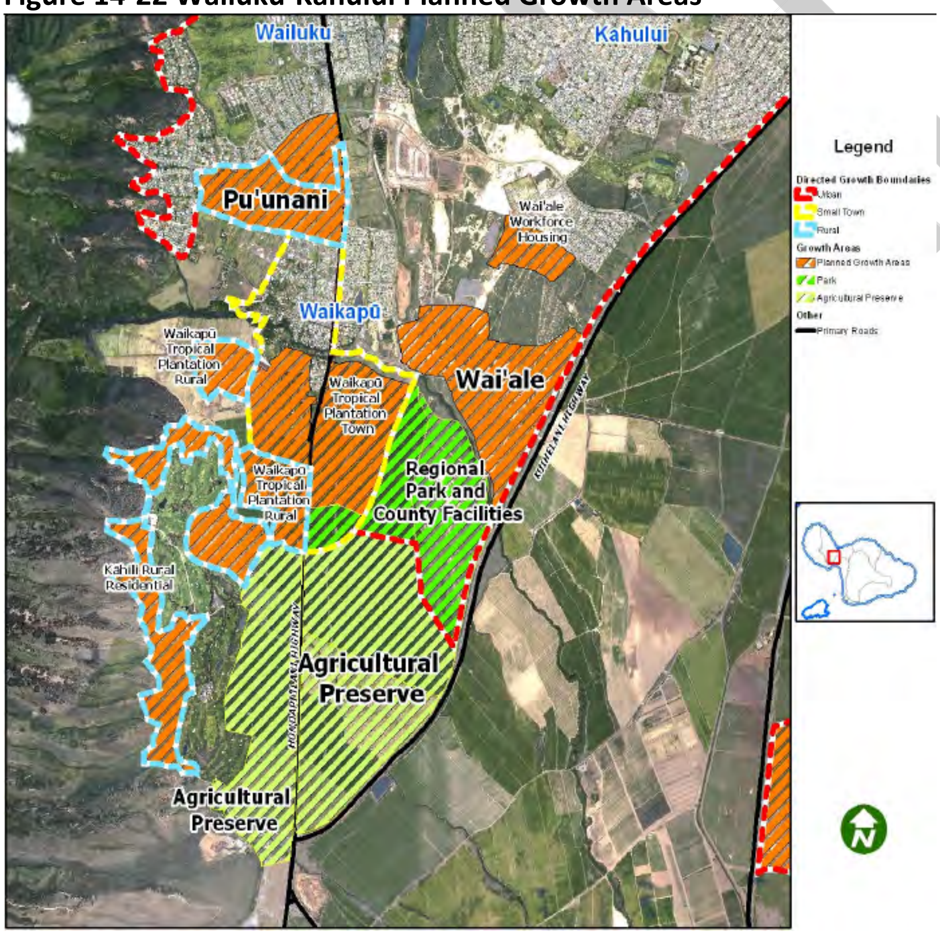
Pu`unani planned growth area is intended to be a mixed-use project with 450 multi-family units and 143 acres rural low density residential development. Pu`uani project area overlies the `Īao Aquifer.

Wai`ale mixed-use town is the largest proposed town on the island and the largest planned growth area for this community plan region with approximately 2,254 dwelling units and 300 workforce housing units planned. Wai`ale overlies and would be supplied by groundwater from the Kahului aquifer.

Kāhili Rural Residential located mauka of the Kāhili Golf course within the Waikapū aquifer would allow 218 acres rural expansion. No residential unit count is determined. The development could be supplied by ground or surface water in the Wailuku ASEA.

Waikapū Tropical Plantation Town mostly overlies the Waikapū aquifer and extends into Kahului aquifer on the makai side of Honoapi`ilani Highway. Approximately 1,433 single family and multi-family dwelling units would be developed on 360 small town acres and 142 rural acres. Private source development in Waikapū aquifer has been developed to support the project.

Figure 14-22 Wailuku-Kahului Planned Growth Areas



(Figure 14-22 - 26: Source Maui Island Plan)

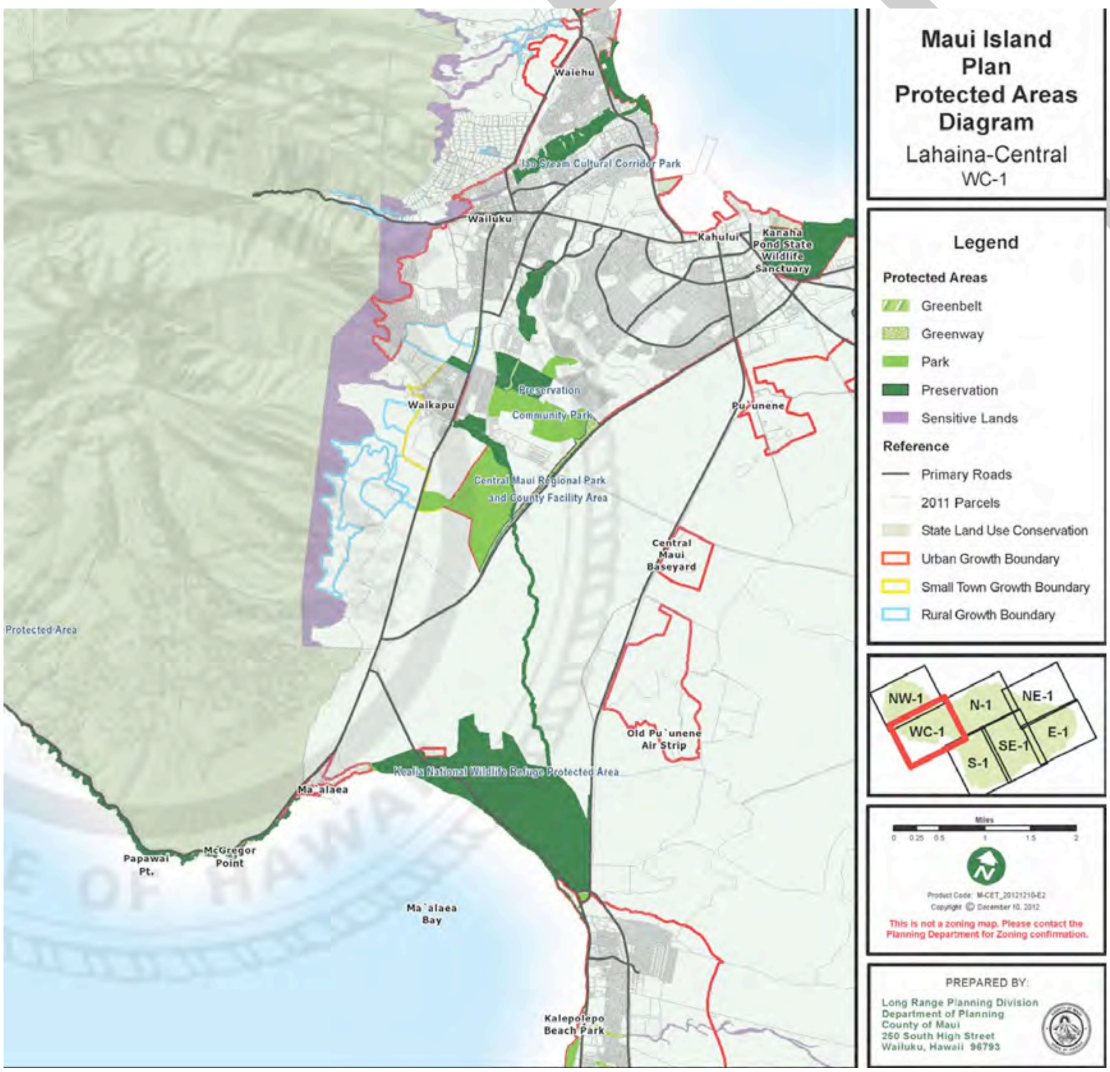
Wailuku-Kahului Planned Protected Areas and Sensitive Lands

A planned open-space area within and adjacent to the Wai`ale project will be further defined during the community plan update and Wai`ale project approval. Irrigation needs and source will need to be addressed.

`Īao Stream Cultural Corridor Park is a linear open-space corridor along the Wailuku River.

Sensitive Lands, indicated purple in the figure below, are lands that contain development constraints including steep slopes, floodplains, significant drainage features, and adjacent intact forested areas.

Figure 14-23 Wailuku-Kahului Planned Protected Areas and Sensitive Lands



Kīhei- Mākena Planned Growth Areas

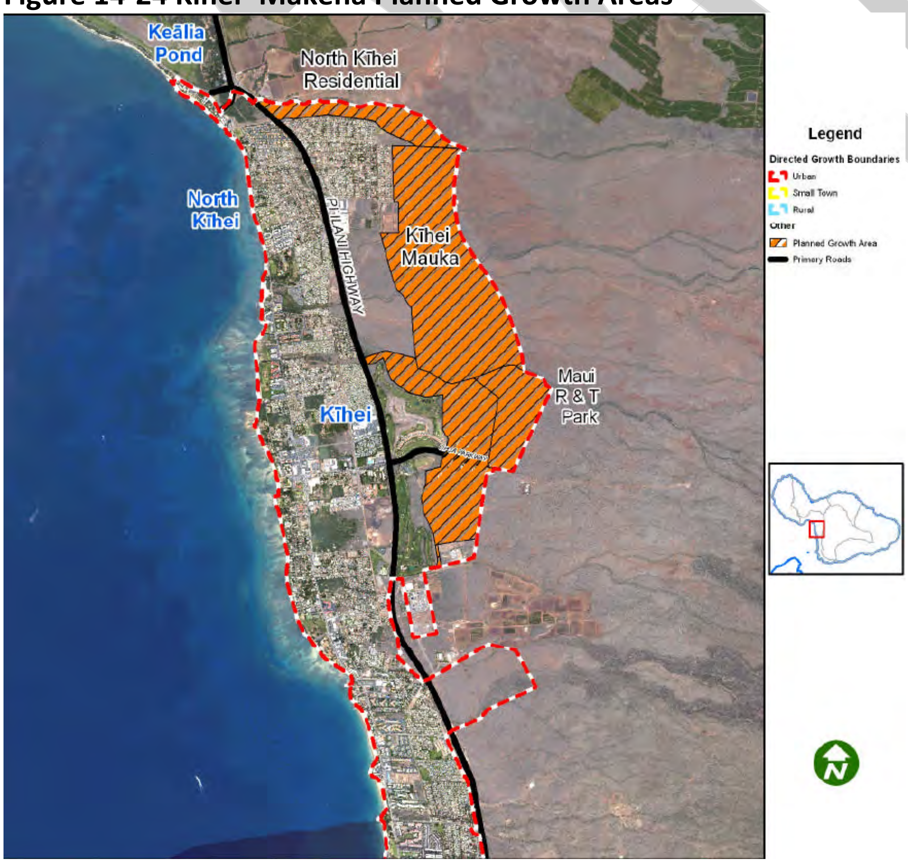
The southern-most portion of the Wailuku Aquifer Sector is located within the Kīhei- Mākena Community Plan district. Urban infill and planned growth in the district will mostly be provided by water resources originating in the Wailuku ASEA. Four new planned urban growth areas: North Kīhei Residential, Kīhei Mauka, Maui Research and Technology Park, and Pulehunui, are all located in the Central Aquifer Sector and most overlying the Kama`ole aquifer. Non-potable water needs for planned growth are anticipated to be increasingly met by alternative resources within the Central ASEA, including recycled water and brackish water. These are further explored in the Central Aquifer Sector Report, chapter 15.

The North Kīhei Residential planned growth area would provide approximately 600 single and multi-family homes along with commercial uses, a park and open space.

Kīhei Mauka will encompass 583 acres and be comprised of a mix of land uses, housing types and facilities. The project would include approximately 1,500 residential units.

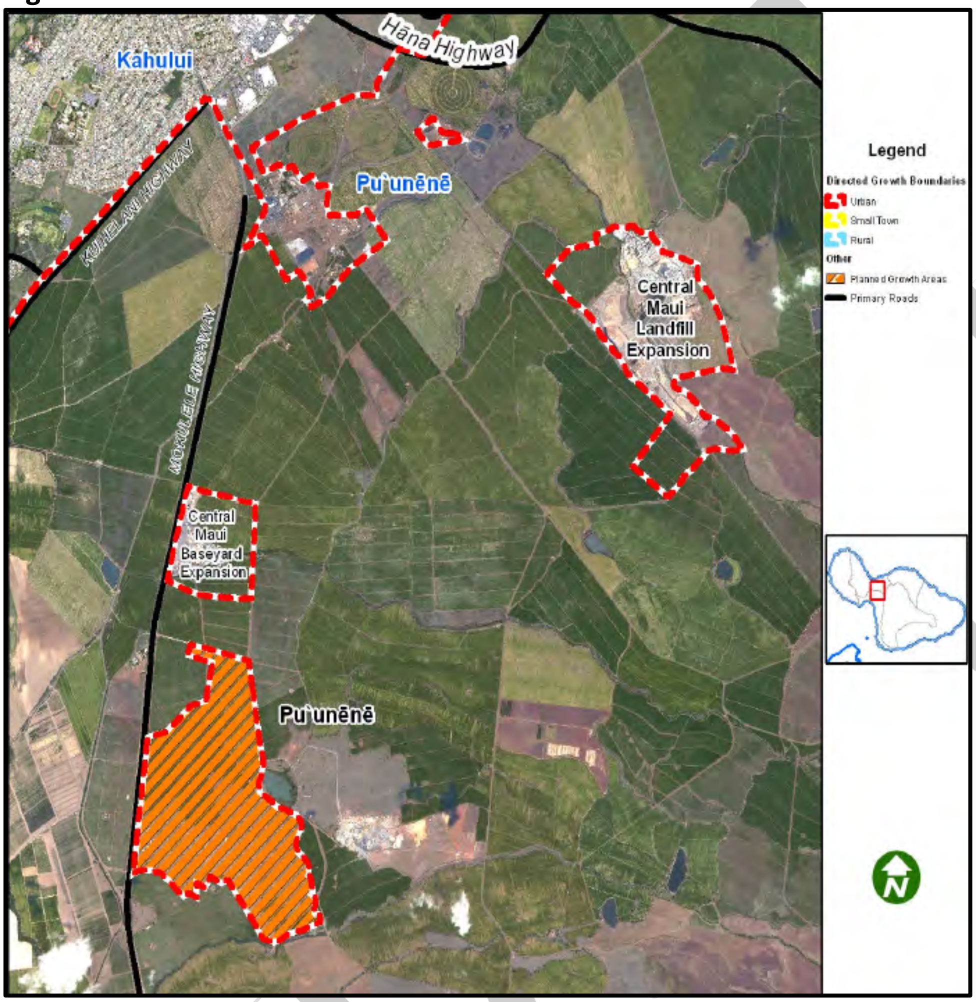
The Maui Research and Technology Park employs about 400 persons in high-technology and related industries. Planned growth should provide about 1,250 units of diverse housing options in close proximity to jobs along with up to 2 million square feet of retail and commercial space.

Figure 14-24 Kīhei- Mākena Planned Growth Areas



The Pulehunui planned growth area encompasses 639 acres and will be used primarily for heavy industrial, public/quasi-public, and recreational purposes. There is limited MDWS infrastructure serving existing uses in the area. Private wells in the Kahului aquifer are developed for industrial and non-potable purposes.

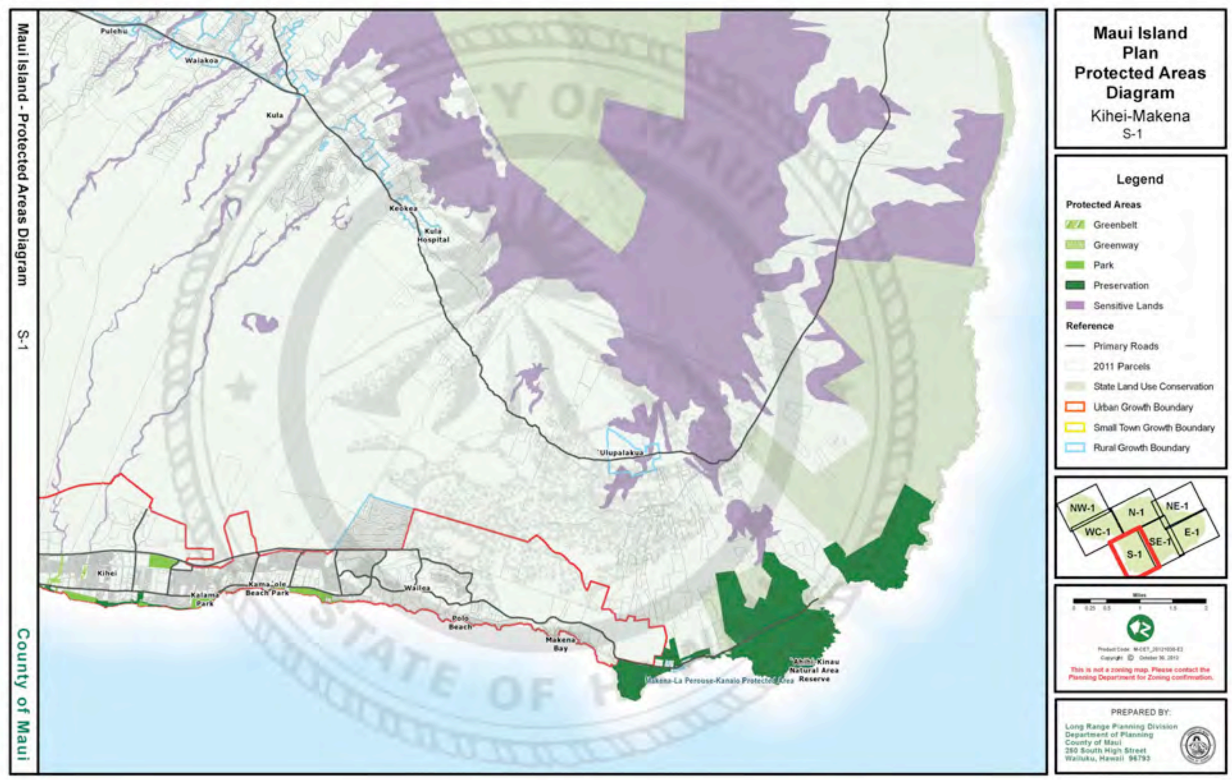
Figure 14-25 Pulehunui Planned Growth Areas



Kīhei – Mākena – Planned Protected Areas

Two planned protected areas are identified: the Mākena – La Perouse – Kanaio Protected Area and the Keālia National Wildlife Refuge. The former is shown in Figure 14-26 below. The Keālia National Wildlife Refuge should accommodate seasonal flooding for healthy wetland habitat. The refuge is naturally recharged from the Waikapū Stream in the Wailuku ASEA. With the interim restoration to Waikapū Stream, noticeably more water is being observed in Keālia Pond, a natural hydrologic connection between the Wailuku and Central aquifer sector areas.

Figure 14-26 Kīhei – Mākena – Planned Protected Areas



Projected demand for planned growth to meet population and housing needs in the designated growth areas is summarized in the table below. As stated above, planned growth areas within and outside the Wailuku ASEA that are completely or partially serviced by water resources from Wailuku ASEA are included.

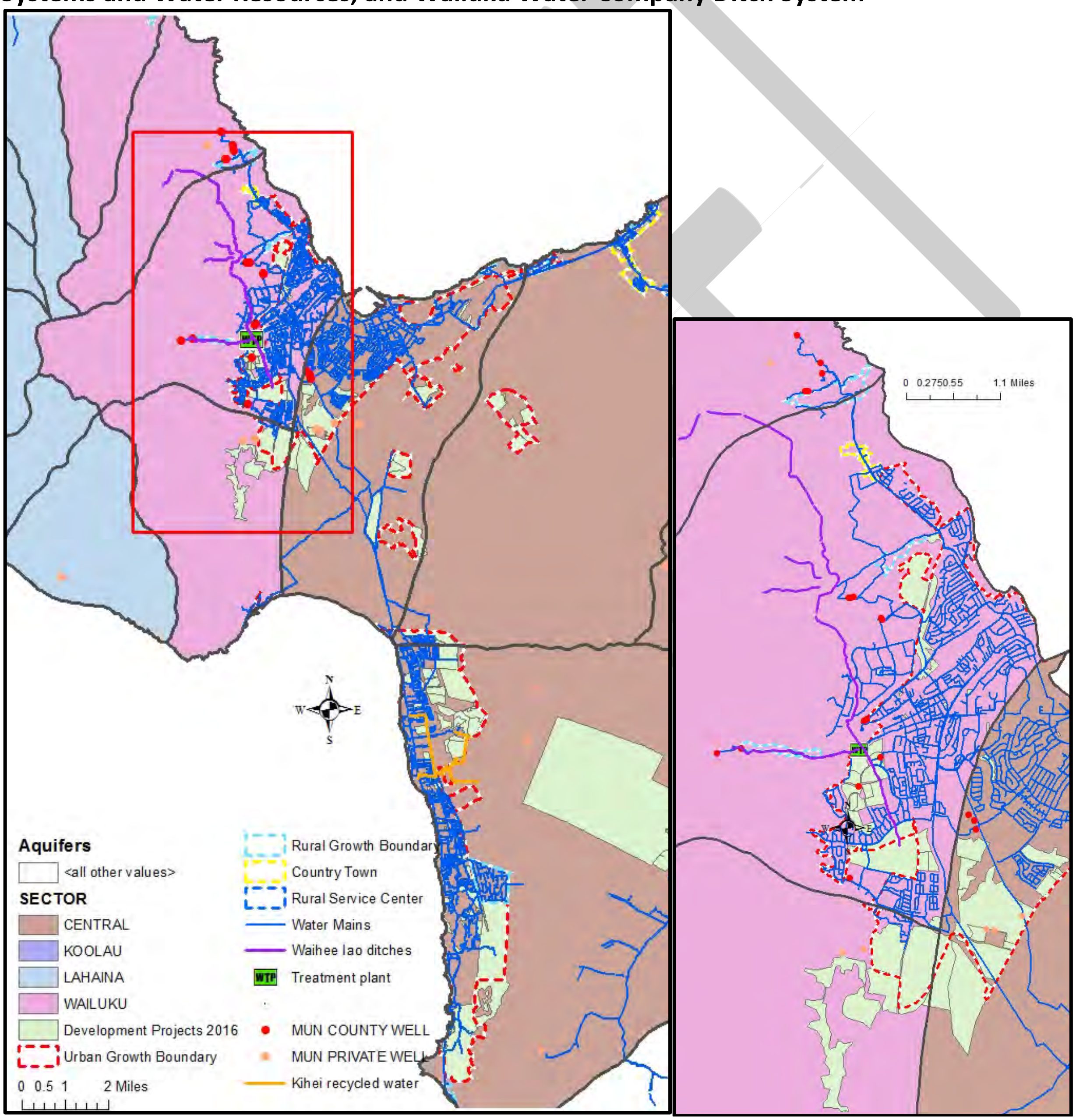
Table 14-30 Planned Growth Wailuku ASEA and MDWS Central Maui System Service Area

Planned Growth Area	# Units	# Acres	Projected Demand (mgd)
Wai`ale	300+2,254	50+495	1.40 – 1.52
Pu`unani	450/TBD	209	0.75
Kāhili Rural Residential	TBD	218	0.65
Waikapū Tropical Plantation Town	1433	502	0.86 – 1.51
North Kīhei Residential	600	95	0.29 - 0.36
Kīhei Mauka, , and Pulehunui	1,500	583	0.90 – 1.75
Maui Research and Technology Park	1,250	437	0.98 – 1.03
Pulehunui	N/A	639	3.83
TOTAL		**3,228**	**9.6 – 11.04**

Development Projects and Projected Demand in Planned Growth Areas

The Planning Department maintains a list of large development projects that have come to their attention, some of which have been entitled, committed or are supported by the Maui Island Plan but not necessarily the Community Plan. The map below shows the Growth Boundaries, the location of projects on the 2016 Development Projects list, the MDWS Central System, potable wells and ditches. Within designated growth areas, location of proposed development projects and existing infrastructure can indicate which resource and purveyor is appropriate to serve the development.

Figure 14-27 Comparison of Growth Boundaries, 2016 Development Project List, Water Systems and Water Resources, and Wailuku Water Company Ditch System



Development projects on the 2016 Development Projects list that are located within the Wailuku ASEA correspond to about 3.3 mgd of projected demand.

While unlikely all projects will be approved as proposed, or constructed once approved, the List is instructive as to location and planning for water sources. The population growth based demand of a projected 5.3 mgd by 2035 is compared to the residential demand of Development Projects for Wailuku ASEA in the table below.

Table 14-31 Population Based Demand 2035 Compared to 2016 Development Projects List (mgd), Wailuku ASEA

Aquifer	2035 Demand	2016 Development Projects List		
		Entitled	Not Entitled	Total
`ĪAO	4.845	1.213	0.984	2.197
KAHAKULOA	0.001	0	0	0
WAIHE`E	0.121	0	0	0
WAIKAPŪ	0.341	0.109	1.012	1.121
TOTAL:	5.306	1.323	1.996	3.319

Source: MDWS, Maui County Planning Department, Long Range Planning Division. Numbers may not add due to rounding

As shown in Figure 14-27 above, development projects throughout the Central ASEA hydrologic unit may be served by resources originating in Wailuku ASEA, through the MDWS Central System or a private purveyor. Wailuku and Central hydrologic units are entwined as groundwater from both units are mixed and distributed throughout Wailuku and Central ASEAs. For example, the Maui Lani wells withdraw groundwater from Kahului aquifer and service customers from Wailuku Heights in the Wailuku ASEA to Kīhei in the Central ASEA. Some development projects are known or expected to be served by private purveyors' groundwater sources in the Kahului aquifer system, for example the Wai`ale Development. Some development projects plan to use brackish water in the lower Kama`ole aquifer system. For example, the Honua`ula project plans to treat brackish water with reverse osmosis to serve the approximate 0.6 mgd development. The table below illustrates development projects within Wailuku ASEA assumed to be serviced by resources in Wailuku ASEA as wells as Kahului Aquifer, and development projects throughout the Central ASEA that are primarily served by water resources from the Wailuku ASEA and supplemented with water resources from the Kahului and Kama`ole aquifers in the Central ASEA. Assumptions are based on proximity to the MDWS Central System, general elevation and source specific information for proposed projects. The table excludes development projects located at elevations ranging from 700 to 4,000 feet elevation that would be primarily served by the MDWS Upcountry System.

Projects summarized in the table below do not constitute a plan or commitment by MDWS to serve such projects. The size and type of a project may require private source development; the developer may opt to develop a private source, or connect to the Kīhei reclaimed water distribution system for irrigation of common areas.

Table 14-32 2016 Development Projects Aquifer Sector Location and Potential Aquifer Source (mgd)

Development Project Location	Potential Source	2016 Development Projects List		
		Entitled	Not Entitled	Total
Wailuku ASEA	Wailuku ASEA + Kahului aquifer	1.323	1.996	3.319
Central ASEA (Kama`ole, Kahului, Pā`ia Aquifers)		3.072	3.875	6.947
Kama`ole aquifer	Kama`ole aquifer	0.666	0	0.666

Source: MDWS, Maui County Planning Department, Long Range Planning Division.

Domestic Use

Reported pumpage for domestic wells and domestic uses allocated from surface water in the 2017 Proposed Decision for Nā Wai `Ehā are the basis for future projections. Domestic uses are assumed to increase at the same rate as population growth. Reported water use was available for 2014 and 2015 while the domestic use claims for Nā Wai `Ehā were assessed in 2017. The difference appears as a jump in demand projections between 2015 and 2016.

MDWS Water Demand Projections

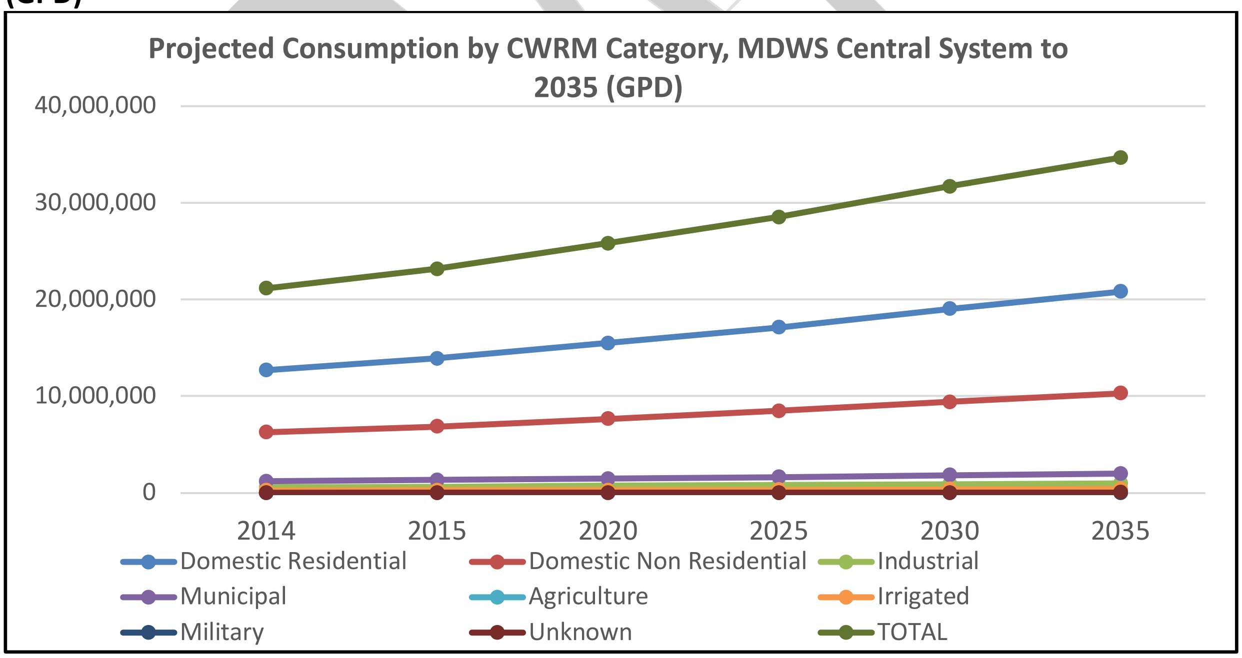
Water demand projections to 2035 for the MDWS Central System, also known as Wailuku District, are provided below. Source development to meet projected demand must consider the water system as a whole, servicing multiple hydrologic units and utilizing a mix of resources. MDWS needs are projected to be about 34 mgd by 2035. As shown below residential use accounts for the greatest demand. Although the CWRM water use category "Municipal" includes all MDWS billing classes, the table and figure below provide a breakdown of water consumption that closest corresponds to CWRM sub-categories and actual water use. MDWS meters with no assigned billing class are shown as "unknown". Demand is projected using population growth rates with 2014 billed water consumption as basis. Growth rates were applied for the community plan district of individual MDWS sub-system to reflect the higher growth rates on the south shore per the 2014 socio-economic forecast. Sub-systems Kīhei, Mākena and Mā`alaea are located within the Kīhei – Mākena Community Plan District and all other sub-districts, except Pā`ia-Kū`au are located in the Wailuku-Kahului Community Plan District.

Total additional projected consumptive water use on the MDWS system as a whole is about 13.48 mgd.

Table 14-33 Projected Consumption by CWRM Category, MDWS Central System to 2035

CWRM CATEGORY	2014	2015	2020	2025	2030	2035
Domestic Residential	12,700,856	13,917,175	15,503,723	17,137,436	19,042,779	20,817,699
Domestic Non-Residential	6,284,171	6,885,985	7,670,983	8,479,317	9,422,048	10,300,249
Industrial	611,938	670,541	746,982	825,696	917,497	1,003,014
Municipal	1,228,621	1,346,282	1,499,757	1,657,794	1,842,108	2,013,806
Agriculture	24,130	26,440	29,454	32,558	36,178	39,550
Irrigated	256,824	281,420	313,501	346,537	385,065	420,955
Military	17,232	18,882	21,034	23,251	25,836	28,244
Unknown	30,216	33,110	36,885	40,771	45,304	49,527
TOTAL GPD	21,153,987	23,179,835	25,822,320	28,543,360	31,716,815	34,673,044
TOTAL MGD	**21.154**	**23.180**	**25.822**	**28.543**	**31.717**	**34.673**

Figure 14-28 Projected Consumption by CWRM Category, MDWS Central System to 2035 (GPD)



In summarizing all non-MDWS water uses and categories below and for analyzing resource adequacy, water *production* rather than billed consumption is applied. Therefore groundwater pumpage and surface water treatment plant production is used for the MDWS Central System in Table 14-34. Requested new groundwater use permits (GWUPs) for additional use of `Īao Aquifer are also summarized with demand projections for all water use categories.

Private/Small System Water Consumption Data Projections

System administrators were queried for projected growth and demand. In the absence of responses, Maui Island Plan population projections (Socio-Economic Report, 2014 Draft) were applied.

Other Population Based Demand Projections

There are likely individual households that are not served by any public water system and no groundwater pumpage or diverted surface water is reported. Domestic use from wells, kuleana stream diversions, rainwater catchment and similar means are estimated 'order of magnitude' to 0.276 mgd island wide and projected to increase at a negligible rate.[59] There are no known rainwater catchment systems as there is no official inventory but it's assumed that scattered systems occur north of Waihe`e to Kahakuloa.

14.6.5. Agricultural Demand Projections

Non-potable agricultural irrigation demand is not coordinated to population growth and represent additional demand. Because agricultural growth is directly linked to water resource allocations from Nā Wai `Ehā and available alternative water resources, no hypothetical increase in acreage for the crops inventoried in the Crop Summary, Table 14-9, is analyzed. Instead, high and low growth agricultural scenarios are derived from requested and proposed allocations in the contested case hearing officer's November 2017 proposed Findings of Fact, Conclusion of Law, and Decision & Order (Proposed Decision). Demand include those water uses projected to be served by water resources from Wailuku ASEA, including lo`i kalo of Nā Wai `Ehā, agricultural uses on former Wailuku Agribusiness land, and the Waihe`e-Hopoi fields of the HC&S plantation. The Proposed Decision does not summarize requests or surface water use permit (SWUP) allocations by CWRM categories Agriculture, Irrigation, Industrial, Commercial and Municipal. Categorized permits are by priority as explained under Section 14.5.1. When sufficient water is not available to accommodate all approved permits due to the variable nature of stream flow, category 1 has priority to category 2, followed by category 3. SWUP applications determined to meet permitting requirements totaled about 39 mgd. Proposed category 1 and 2 permit allocations that can be sufficiently determined as Agriculture totals about 28.11 mgd and category 3 totals about 3.97 mgd. Available water for category 3 uses - new uses not based on appurtenant rights, will be determined at the end of one year. There is no time restriction to apply for new use SWUP.

[59] 2010 Census Block Group populations that appear to be outside public purveyor service areas – approx. 1,190; apply average MDWS per capita rate of 248 gpd based on 2010-2014 consumption and interpolated population = 296,144 gpd. Excluding domestic well pumpage of 20,495 gpd results an estimated demand of 275,649 gpd.

Kalo Lo`i and Appurtenant Rights

The 2017 Proposed Decision characterizes acreage and required streamflow for lo`i kalo. The proposed IIFS are assumed to satisfy instream flow required for healthy taro cultivation demand. The general irrigation requirement for individual lo`i would be 200,000 gpd/acre, and 150,000 gpd/acre for lo`i complexes. The hearing officer recognized a total of 248.69 acres as having appurtenant rights attached. Amounts determined to be reasonable and beneficial total 8.421 mgd, which include other uses than kalo lo`i. The hearing officer noted that most of the appurtenant rights have not been exercised in the contested case. Appurtenant rights include Native Hawaiian traditional and customary rights, if these rights were exercised by a Native Hawaiian on the land prior to 1892, for subsistence, cultural or religious purposes.[60]

Diversified Agriculture

At the time of this WUDP draft, there are no longer irrigated sugarcane crops and only a small portion of HC&S diversified agriculture plan has materialized. Until final IIFS and appurtenant rights have been adopted, and existing water use permits have been allocated, it's reasonable to use the CWRM hearing officer's proposed water duty and allocation in assessing future irrigation needs for the former HC&S, (now A&B Inc.) operations and other applications for Nā Wai `Ehā surface water. Proposed allocations represent a mid-growth demand scenario. In the 2017 proposed FOF, COL and D&O, the hearing officer reduced HC&S's irrigation requirements from 17.43 to 16.6 mgd on the premises that 10 percent of the irrigated acreage is expected to be in cover crops at any one time. There is an allocated permit to irrigate the Waihe`e-Hopoi fields for 13.6 mgd of surface water, with 0.1 mgd from HC&S `Īao Tunnel and 3 mgd from Well No. 7. The SWUPA for the `Īao -Waikapū fields are pursued by Waikapū Properties in lieu of HC&S.

HC&S requested water use permit for existing uses represents a high growth scenario. Since the cessation of sugarcane cultivation and the re-opening of the contested case in Nā Wai `Ehā, HC&S requested a water use permit for existing uses of 17.43 mgd for agricultural irrigation, and 2.15 mgd for system losses.

Failure to establish viable crops on former plantation lands, leaving plantation lands fallow could represent a low growth scenario. However, there is no substantiated basis for decreasing the acreage forecasted to be in production. None of the plantation lands in the Wailuku Aquifer Sector are designated Important Agricultural Lands. Development pressures make conversion of agricultural lands to urban use possible, but since this scenario is not supported by the General Plan it is not further analyzed. Parties to the contested case have disputed the water duty and actual water needs for diversified agriculture cultivation on the Waihe`e-Hopoi fields

[60] CCHMA 1501 Hearing Officer's Proposed Findings of Fact, Conclusion of Law, and Decision & Order, November 1, 2017

that are serviced by Nā Wai `Ehā.[61] Applying the water duty of 2,500 gpd per acre, consistent with previous CWRM determinations for diversified agriculture, would present a low growth scenario of 9.13 mgd for the 3,650 acres.

14.6.6. Irrigation Demand Projections

In the Wailuku ASEA, basal and caprock wells and diverted stream water provide for golf courses, parks and common area non-potable irrigation needs. Irrigation needs for new parks and recreation areas are assumed to increase at the rate of population growth. Irrigation within the Wailuku ASEA is not related to resort use and the visitor industry to the extent of the south shore. Surface water diversions for non-potable irrigation purposes from Nā Wai `Ehā is limited by water use permit allocations. No adjustments are made to the proposed allocations by categories in the Proposed Decision. Category 1 and 2 SWUP allocations that can be determined as non-agricultural irrigation totals about 1.16 mgd. Permits include commercial and common area landscaping, such as Wailuku County Estates and the Maui Tropical Plantation, and golf course irrigation. About 90%, or 1.04 mgd, of allocated SWUP for irrigation purposes is for golf course use. Because there are no planned growth that includes golf course development, it is assumed that irrigation needs as allocated by SWUPs will remain flat, rather than increase at population growth rate.

Irrigation demands *outside* the Wailuku ASEA will generally be served by regional water resources in the respective hydrologic unit. Non-potable irrigation at parks, resorts and golf courses throughout the *Central* ASEA are primarily served by regional brackish groundwater from Kama`ole aquifer, groundwater from Kahului aquifer, recycled water from the Kīhei Wastewater Reclamation Facility and the Mākena private recycled water facility. The MDWS Central Maui System/Wailuku District does not provide non-potable water but potable water is used for yard landscaping and other irrigation uses. Resource allocation for these "incidental" irrigation uses are discussed under source development for the MDWS Central Maui System/Wailuku District.

14.6.7 Population Growth Based Water Demand Projections Analysis

To determine source needs and accommodate planned growth consistent with the MIP, projected demand is summarized in Table 14-34. For municipal needs, water production rather than billed consumption is used as 2014 basis for projections. Water needs for the MDWS Central Maui/Wailuku District as a whole are projected as water resources from the Wailuku ASEA, mixed with groundwater from Central ASEA, and service area spans both hydrologic units. The Maui Lani wells in the Kahului aquifer provides about 1.09 mgd. Surface water permit allocations for MDWS of 3.2 mgd is accounted for in the 20-year projections.

[61] January5, 2018 CCH-MA15-01 Hui On Nā Wai `Ehā's and Maui Tomorrow Foundation, Inc's Exception to the Proposed Findings of Fact, Conclusion of Law, and Decision and Order, Dated November 1, 2017.

Department of Hawaiian Homelands (DHHL) in the Wailuku ASEA are served by the MDWS Central Maui System and therefore accounted for in existing and projected municipal use.

Agricultural use of surface water from Nā Wai `Ehā also extends to both Wailuku and Central aquifer sectors. SWUP allocations for new use that was categorized as "3" with no priority are included in Agricultural projections from year 2017. It is not known to date whether the recommended Instream Flow Standards of Nā Wai `Ehā will accommodate category 3 uses. The selected mid-growth scenario projects total water use to increase from 57 mgd in 2014 to 69 mgd in 2035. Total potable demand accounting for use of Maui Lani wells in Central ASEA would increase from 22 mgd to 34 mgd. Total potable and non-potable demand, accounting for Wailuku Water Company water losses, would increase from about 60 mgd to 72 mgd, as shown in Table 14-40.

For the purposes of illustrating water use strictly within the Wailuku ASEA, billed water consumption can be adjusted up 15% to estimate production for sub-systems located within the hydrologic unit. The lion's share of water resources for agricultural irrigation is outside the hydrologic unit so for illustrative purposes the 2015 Agricultural baseline data is applied. Decreasing the water duty for HC&S acreage from sugarcane (5,555 gpd/acre) to diversified agriculture (3400 gpd/acre) results in a decrease in agricultural demand from 9.1 mgd in 2016 to 6.4 from 2017 on. Total demand within Wailuku ASEA is estimated to increase from 14.4 to 15.4 by 2035.

Figure 14-29 Projected Water Use by CWRM Category to 2035, Population Growth Based (Low, Medium, High) Wailuku ASEA + MDWS Central System; Wailuku ASEA only (medium) Land Use Full Build-Out Wailuku ASEA only (mgd)

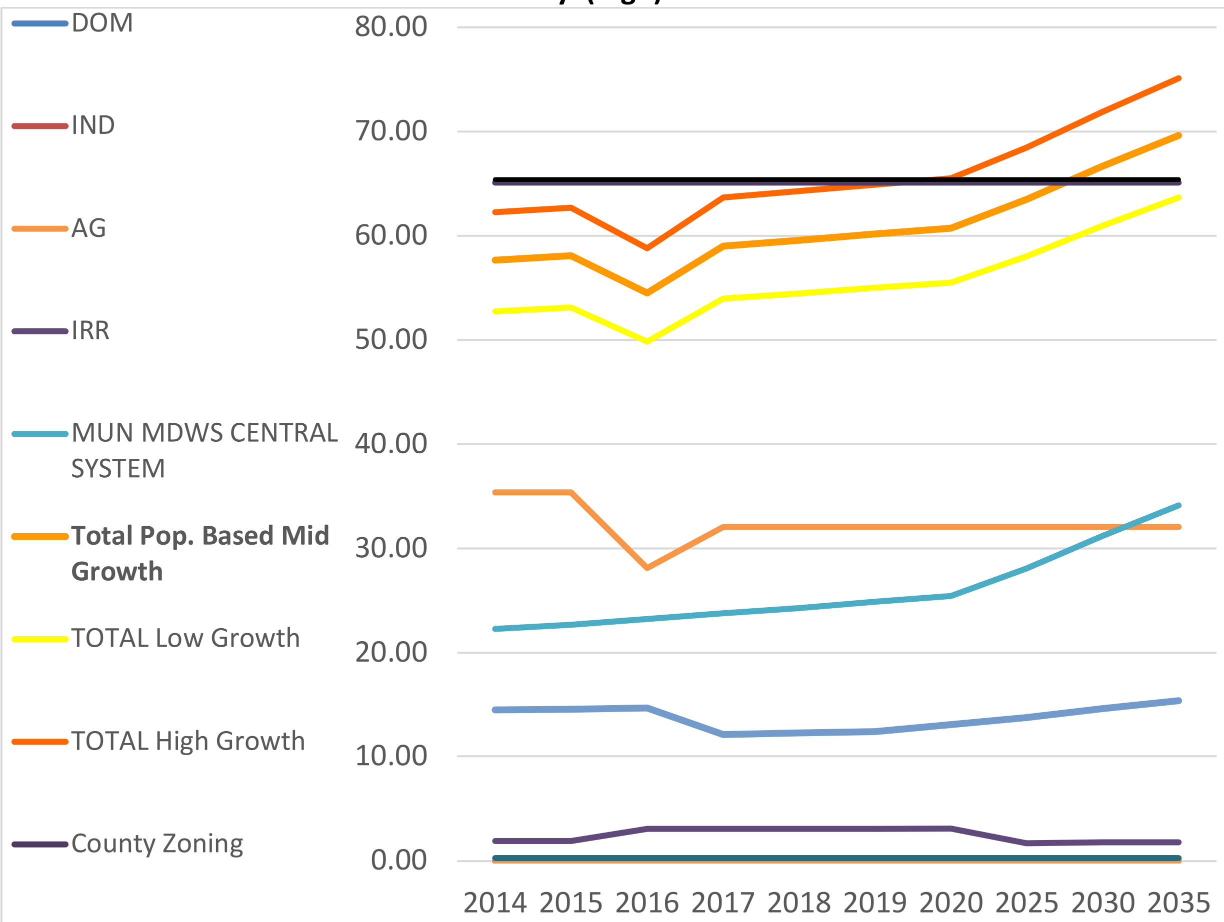


Table 14-34 Projected Water Use by CWRM Category to 2035, Wailuku ASEA and MDWS Central System (mgd)

CWRM CATEGORY	2014	2015	2016	2017	2018	2019	2020	2025	2030	2035
POPULATION BASED WAILUKU ASEA AND MDWS CENTRAL SYSTEM										
Domestic	0.0311	0.0311	0.086	0.088	0.090	0.092	0.094	0.104	0.116	0.126
Industrial	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Agriculture	35.380	35.380	28.114	32.092	32.092	32.092	32.092	32.092	32.092	32.092
Irrigation			3.081	3.091	3.101	3.111	3.161	3.214	3.275	3.332
Municipal*	22.274	22.699	23.219	23.751	24.295	24.852	25.421	28.100	31.224	34.134
Military	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL Pop. Based Mid Growth	**57.685**	**58.111**	**54.501**	**59.022**	**59.578**	**60.146**	**60.728**	**63.464**	**66.656**	**69.630**
TOTAL Low Growth	52.753	53.142	49.841	53.975	54.484	55.004	55.535	58.038	60.957	63.676
TOTAL High Growth	62.231	62.690	58.796	63.673	64.272	64.886	65.513	68.465	71.909	75.116
Total Pop. Based Mid Growth *WAILUKU ASEA only*	*14.484*	*14.587*	*14.713*	*12.141*	*12.273*	*12.407*	*13.092*	*13.797*	*14.626*	*15.392*
LAND USE BUILD OUT BASED WAILUKU ASEA										
County Zoning	65.103	65.103	65.103	65.103	65.103	65.103	65.103	65.103	65.103	65.103
DHHL	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293
TOTAL Land Use Based	**65.396**	**65.396**	**65.396**	**65.396**	**65.396**	**65.396**	**65.396**	**65.396**	**65.396**	**65.396**

*MDWS includes Central Maui/Wailuku District services throughout Wailuku AND Central ASEAs. Existing and Projected use includes DHHL.

14.7 Water Source Adequacy

The analysis of available resources and projected 20-year demand result in the following findings:

1. Groundwater sustainable yield (SY) can serve population growth based municipal demands throughout Wailuku sector including the MDWS Central Maui System.

2. Transport of Wailuku ASEA groundwater is needed to meet 20-year planned growth in directed growth areas throughout the Wailuku-Kahului Community Plan and the Kīhei-Mākena Community Plan districts.

3. A hypothetical reduction in SY under long term drought conditions and climate change could not alone provide for 2035 population growth throughout the MDWS Central Maui System. Supplemental and alternative resources outside the Wailuku ASEA is needed to meet planned growth.

4. Surface water under low flow, or drought conditions (Q^{90}) can generally meet recommended Interim Instream Flow Standards (IIFS), domestic uses, Category 1 surface water use permits and necessary water losses as allocated in the November 2017 Proposed Decision. Category 2 permit allocations could generally be satisfied under normal, or median flow (Q^{50}) conditions.

5. Category 2 and Category 3 uses, if exercised, may require contingency and alternative resources during low flow conditions. The 2017 proposal concluded that a balance between upstream and downstream users is necessary to meet IIFS and that the flows established below the diversions shall be augmented by the amounts necessary to meet the requirements of downstream water-use permittees and domestic users. [62]

14.7.1 Source Adequacy vs. Land Use Based Full Build-Out Demand Projections

Full build-out of land use classifications throughout Wailuku ASEA, representing 65.3 mgd, is not realistic to occur on a 20-year planning horizon or supported by the Socio-Economic Forecast. Full build-out of zoning throughout the Central ASEA is not clearly correlated to the use of Wailuku ASEA resources and analyzed in the Central ASEA sector report, Chapter 15.

Figure 14-30 and Table 14-35 below illustrate available water resources within Wailuku ASEA, alternative and selected 20-year demand projections, existing and proposed groundwater and surface water use permit allocations.

[62] CCHMA 1501 Hearing Officer's Proposed Findings of Fact, Conclusion of Law, and Decision & Order, November 1, 2017

14.7.2 Source Adequacy vs. Population Growth Based Demand Projections

Wailuku ASEA water resources currently supply the population centers in Central and South Maui through existing transmission and storage infrastructure. It is assumed that groundwater, and to a lesser extent, surface water, will continue to supply planned growth around existing infrastructure within sustainable limits. Based on the population projections, future water demand for the Wailuku ASEA including the MDWS Central System will increase from about 57 mgd to about 69 mgd by 2035, within a range of 63 – 75 mgd. Long term projections are trends with expected short-term variations. Factors that especially impact growth in the Wailuku and Central Maui region are large master-planned communities. Development project entitlements should be monitored and considered as needed to adjust projected source development needs over the planning period.

Figure 14-30 Population Mid-Growth Based 20-Year Water Demand Projections and Available Resources, Wailuku ASEA and Kahului Aquifer (mgd)

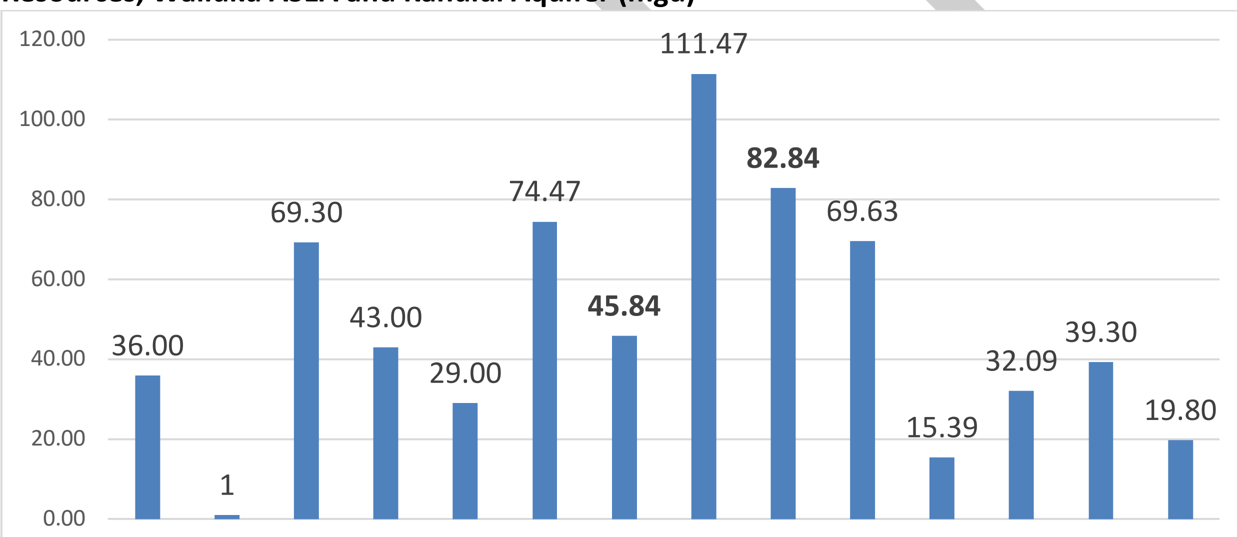


Table 14-35 Population Mid-Growth Based 20-Year Water Demand Projections and Available Resources, Wailuku ASEA and Kahului Aquifer (mgd) (use as legend for Figure 14-30)

Groundwater Sustainable Yield (SY)	36.00
Nā Wai `Ehā Surface Water Median Flow (Q^{50})	69.30
Nā Wai `Ehā Surface Water Low Flow (Q^{90})	43.00
Nā Wai `Ehā Surface Water Proposed IIFS 2017	29.00
Surface Water incl. Kahakuloa Median Flow (Q^{50})	74.47
Surface Water incl. Kahakuloa Low Flow (Q^{90})	45.84
TOTAL AVG YIELD (Q^{50}, SY WAILUKU ASEA+ Kahului Aquifer 1 mgd)	**111.47**
TOTAL DROUGHT YIELD (Q^{90}, SY WAILUKU ASEA)	**82.84**
DEMAND Pop-based mid-growth incl. MDWS Central System	**69.63**
Demand Pop-based mid-growth Wailuku ASEA only	15.39
Agricultural Demand only	32.09
Nā Wai `Ehā Surface Water Use Permits (SWUPs)	39.30
`Īao Aquifer Groundwater Use Permits (GWUPs)	19.80

14.7.3 Alternative Sources within the Central Aquifer Sector Area

Groundwater and surface water use for non-potable purposes can in some cases be substituted or supplemented by non-potable sources, such as brackish groundwater or recycled water. With the objective to manage water equitably, strategies #38 and #39 in Chapter 12.3 recommend to promote the highest quality water for the highest end use; and to protect and prioritize public trust uses in allocating groundwater in regions of limited resources and conflicting needs. All available conventional and alternative water resources within the Central ASEA are assessed in the Central ASEA Sector Report, Chapter 15. However, the resources potentially available to offset demand on the MDWS Central Maui System/Wailuku District and the transport of water from the Wailuku ASEA are analyzed here.

Recycled Water

Upgrade of the Wailuku-Kahului Wastewater Reclamation Facility (WWRF) from R-2 to R-1 production could offset about 3 mgd of diverted stream water or pumped groundwater for non-potable irrigation. The Department of Environmental Management's fiscal year 2018 capital improvement program budgeted $0.5M for design of a new water distribution line connecting the Kahului WWRF to an existing line at the old Maui Pineapple processing facility. The project budgeted $6.2M for construction in fiscal year 2020 that would make R-1 water available to the HC&S fields east of Kuihelani Highway, currently served by East Maui stream diversions through the East Maui Irrigation Company distribution system. This project is temporarily on hold.

The Kīhei WWRF has a treatment capacity of 8 mgd, with about 42% of R-1 the water produced utilized. 2014 average use of 1.5 mgd represents agricultural irrigation by Monsanto and commercial properties that otherwise would have been served by the municipal MDWS Central System. According to the WWRD, about 0.7 mgd R-1 remains available at peak demand periods. The remaining 0.7 mgd R-1 capacity is assumed to incrementally offset municipal demand and groundwater sources from Wailuku ASEA from 2020 on.

Basal and Brackish Groundwater in Central ASEA

Most of the water supply for the MDWS Central Maui System comes from the Wailuku ASEA and serve uses overlying the aquifers of Kahului, Kama`ole and Pā`ia. The suitability of these aquifers to meet projected demand on the MDWS Central Maui System is discussed below.

Kahului Aquifer

Where chloride levels are above 250 mg/l, the water quality is generally considered brackish and not suitable for potable purposes. Water quality in Kahului, Kama`ole and Pā`ia Aquifers in the Central ASEA varies widely. Established sustainable yield accounts only for basal groundwater and ignores significant importation of surface water into Kahului and Pā`ia from outside the aquifer system areas. This explains the ability to withdraw fresh water from the Kahului aquifer at significantly higher rates than the sustainable yield without apparent negative impacts (i.e. rising chloride concentrations or decreasing water levels). Most of the pumpage from Kahului and Pā`ia Aquifers through 2016 was from HC&S wells and shafts for agricultural irrigation. Although 2014 is the base year used to project future demand, 2017 pumpage data was reviewed and included in the table to reflect decreased sugarcane irrigation needs. Current pumpage still far exceeds established natural sustainable yield for Kahului aquifer. Pumpage totaling 45.4 mgd for Maui Electric Company industrial wells was not reported in 2014, and explains the jump in pumpage reported for 2017. In comparison, HC&S reported 1.2 mgd withdrawals in 2017 versus 28.2 mgd in 2014. Municipal wells, including the Maui Lani wells and the Wai`ale wells, may see rising chloride levels due to the decrease in irrigation return flow from East Maui stream diversions to HC&S plantation lands overlying these aquifers. Because the impact on the Kahului aquifer yield and quality is highly uncertain, it is not assumed that additional brackish or fresh groundwater is available beyond natural SY of 1 mgd to develop or offset demand on the MDWS Central Maui System.

Pā`ia Aquifer

Water quality in the Pā`ia Aquifer ranges from brackish close to the coast to potable quality above 700 feet ground elevation. Municipal wells in the Pā`ia Aquifer serve individual public water systems and supplements the MDWS Upcountry system. Irrigation wells pump about 0.16 mgd mostly brackish water and are densely installed throughout Spreckelsville. Following cessation of sugarcane cultivation the withdrawals from Pā`ia Aquifer has decreased from 29 mgd to 0.4 mgd. The aquifer sustainable yield of 7 mgd could potentially support potable supply for the MDWS Central Maui System, or brackish irrigation supply to offset demands on the potable system. The Hamakuapoko wells at 700 ft. elevation and above can convey up to about 0.9 mgd combined to the MDWS Upcountry system during droughts. The contaminant Dibromochloropropane detected at the wells is treated using Granular Activated Carbon (GAC) filtration. Because chemical contaminants in the Pā`ia Aquifer are an issue, potable well development would need to consider the investment and cost of GAC treatment and possibly additional treatment for nitrates.

Kama`ole Aquifer

Brackish groundwater occurs regionally at lower elevations of Kama`ole aquifer. Known chloride levels for irrigation wells throughout the aquifer range from 100 to over 1,400 mg/l. Installed pump capacity in the Kama`ole aquifer is 18.8 mgd. The sustainable yield established by CWRM is 11 mgd. Reported pumpage for irrigation purposes is 2.82 mgd for 2014/2015.

Pumpage is reported from 26 of 75 installed irrigation wells. Additional pumpage is assumed to occur from Kama`ole aquifer beyond the 35% of installed irrigation wells that report to CWRM. CWRM well data indicate lower chloride levels in wells above 500 ft. elevation but still above 200 mg/l. Densely spaced irrigation wells along the shoreline are subject to rising sea-levels and associated saltwater intrusion. It is anticipated that water quality along the south shore will have increased chloride levels and that additional yield may be developed above 500 ft. elevation to serve regional growth and offset non-potable demand on the MDWS Central Maui System. Available yield cannot be determined until improved reporting and water use data is available.

The table below summarizes sustainable yield, installed pump capacity and reported 2014 – 2015 pumpage for the Kama`ole, Kahului and Pā`ia Aquifer systems within the Central ASEA. The "Potential Yield Available" refers to aquifer yield not dedicated to serve the MDWS Upcountry system. These aquifer systems are further addressed in the Central ASEA Report, Chapter 15.

Table 14-36 Kahului, Kama`ole and Pā`ia Aquifer Sustainable Yield, Pump Capacity, Pumpage 2014 and 2017 and Remaining Yield

Aquifer	Sustainable Yield (mgd)	# Wells	Installed Pump Capacity (mgd)	Agriculture Pumpage 2014 (mgd)	Total Pumpage 2014 (mgd)*	Total Pumpage 2017 (mgd)	Potential Yield Available
Kahului	1	172	102.12	28.22	29.99	53.18	1
Pā`ia	7	45	153.72	29.09	29.50	0.41	6**
Kama`ole	11	139	18.82	0	2.85	2.81	TBD

Source: CWRM well data, 2015, 2017
* 2014 data did not account for unreported MECO pumpage
**Hamakuapoko wells service to MDWS Upcountry System deducted

Figure 14-31 Population Mid-Growth Based 20-Year Water Demand Projections, and Available Conventional and Alternative Resources, Wailuku ASEA and Kahului Aquifer in Central ASEA (mgd)

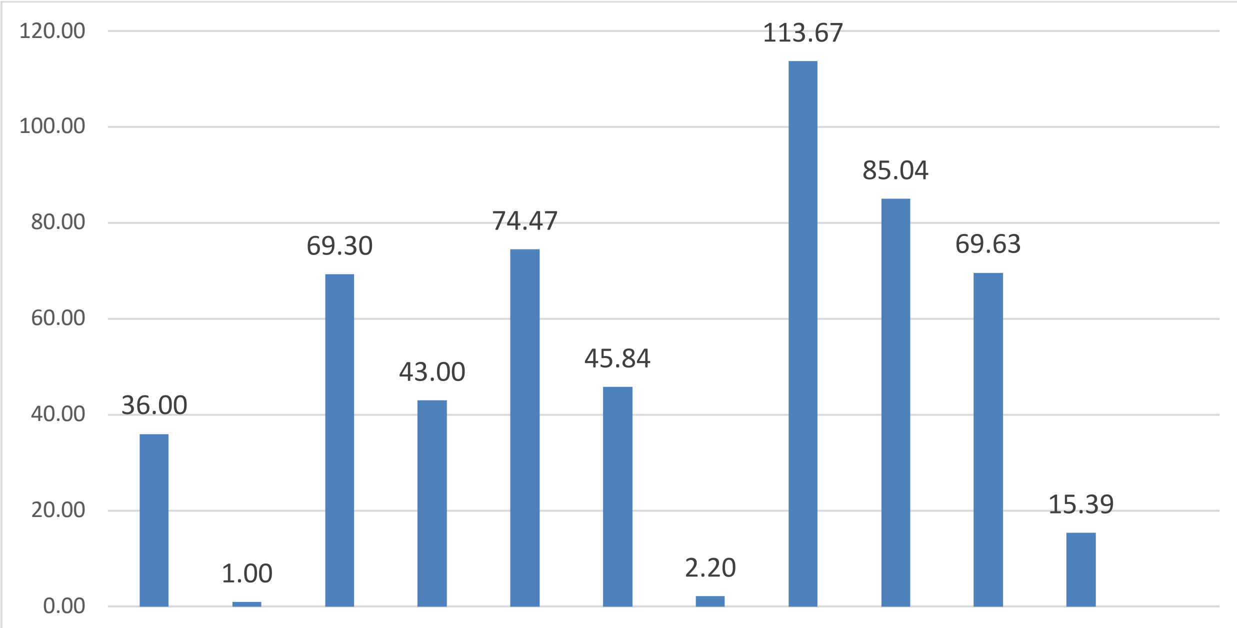


Table 14-37 Population Mid-Growth Based 20-Year Water Demand Projections and Available Conventional and Alternative Resources, Wailuku ASEA and Kahului Aquifer in Central ASEA (mgd) (use as legend for Figure 14-31)

WAILUKU ASEA Sustainable Yield	36.00
CENTRAL ASEA Kahului Aquifer Sustainable Yield	1.00
Nā Wai `Ehā Surface Water Median Flow (Q^{50})	69.30
Nā Wai `Ehā Surface Water Drought Flow (Q^{90})	43.00
Surface Water incl. Kahakuloa Median Flow (Q^{50})	74.47
Surface Water incl. Kahakuloa Drought Flow (Q^{90})	45.84
CENTRAL ASEA Recycled Water	2.2
WAILUKU ASEA and Kahului Aquifer Average Total Yield	**113.67**
WAILUKU ASEA and Kahului Aquifer Drought Total Yield	**85.04**
Pop-based mid-growth incl. MDWS Central System	**72.73**
Pop-based mid-growth Wailuku ASEA Only	**15.39**

14.8 Strategies to Meet Planning Objectives

The WUDP update public process generated a set of planning objectives through an iterative process. Multiple resource options to meet planning objectives and projected demand were reviewed and evaluated in regional public meetings and workshops to assess constraints, relative costs, implementation risk and viability[63]. Planning objectives, preliminary strategies and related material reviewed in the final public workshop, November 29, 2016 is attached as Appendix 13. The selected strategies are presented below along with available cost estimates, hydrological, practical and legal constraints, opportunities and risks that were considered in assessing the viability of a specific resource or strategy. Life cycle costs are estimated for conventional and alternative resource strategies where engineering studies and reports were available, including capital, operation and maintenance costs per 1,000 gallons supply.

Key issues identified in the WUDP public process for the region focused on restoration and protection of streamflow, concerns about the lack of aquifer information and water use reporting in regions that are not designated groundwater management areas, and saltwater intrusion. Maximizing use of alternative sources while minimizing well and surface water use is desired and living within the limits of local water resources rather than transporting water. Water availability regulations are considered critical to ensure long term sustainable use of water resources.

Recommended alternatives include resource management as well as development of conventional and alternative resources. All strategies are assumed to include conservation consistent with recommended supply and demand side conservation strategies outlined in Section 12.2. Implementation schedule, estimated costs and potential lead agencies, including funding sources, are summarized in Table 14-41. It should be emphasized that the WUDP provides guidance for resource use and infrastructure development. Actions to effectuate the intent of the policies and strategies should be developed over the twenty-year planning period. Estimated timeframes for implementation are indicated, allowing for flexibility to re-scope, prioritize and adjust to available funding.

14.8.1 Resource Management

Planning objectives related to resource management identified and confirmed in the WUDP update public process, the Maui Island Plan (MIP) and the Wailuku-Kahului Community Plan include:

- Restore mauka to makai streamflow.
- Protect water resources in the region from contamination, including protecting groundwater recharge areas and wellhead protection areas.
- Protect cultural and archaeological sites: Wailuku River (`Īao Stream), taro lo'i terraces in `Īao Valley, Na Wai 'Eha.
- Promote and implement programs for groundwater and wellhead protection.

[63] Preliminary Strategies for Central and Wailuku Sectors (Central-South) November 29. 2016

- Native Hawaiian water rights: Water rights include current and future water use for Hawaiian Homelands, domestic water use for kuleana lands, and traditional and customary rights. The ahupua`a systems that exist should be maintained and enhanced.

Watershed Protection

Issue and Background: Watershed management plans are in place from Kahakuloa to Waikapū. The West Maui Mountains Watershed Partnership (WMMWP) and the Pu`u Kukui Watershed Preserve focus their efforts on protection of the upper critical watersheds of Mauna Kahālāwai. The Department of Land and Natural Resources has identified "Priority Watershed Areas" which are areas of highest rainfall and resupply, based on climatic conditions that provide high recharge and fog capture. Currently protective measures are focused in these priority areas above the 3,000 foot elevation with direct benefit to makai lands and the nearshore environment. Over 47,321 acres of the West Maui Mountains are being protected and preserved. The major threats to this watershed are feral ungulates, invasive weeds, human disturbances and wildfires. Ongoing efforts include ungulate control through fence construction, retrofitting and regular trap checks weed management, planting and enclosures, monitoring, and human activities management through outreach and education.

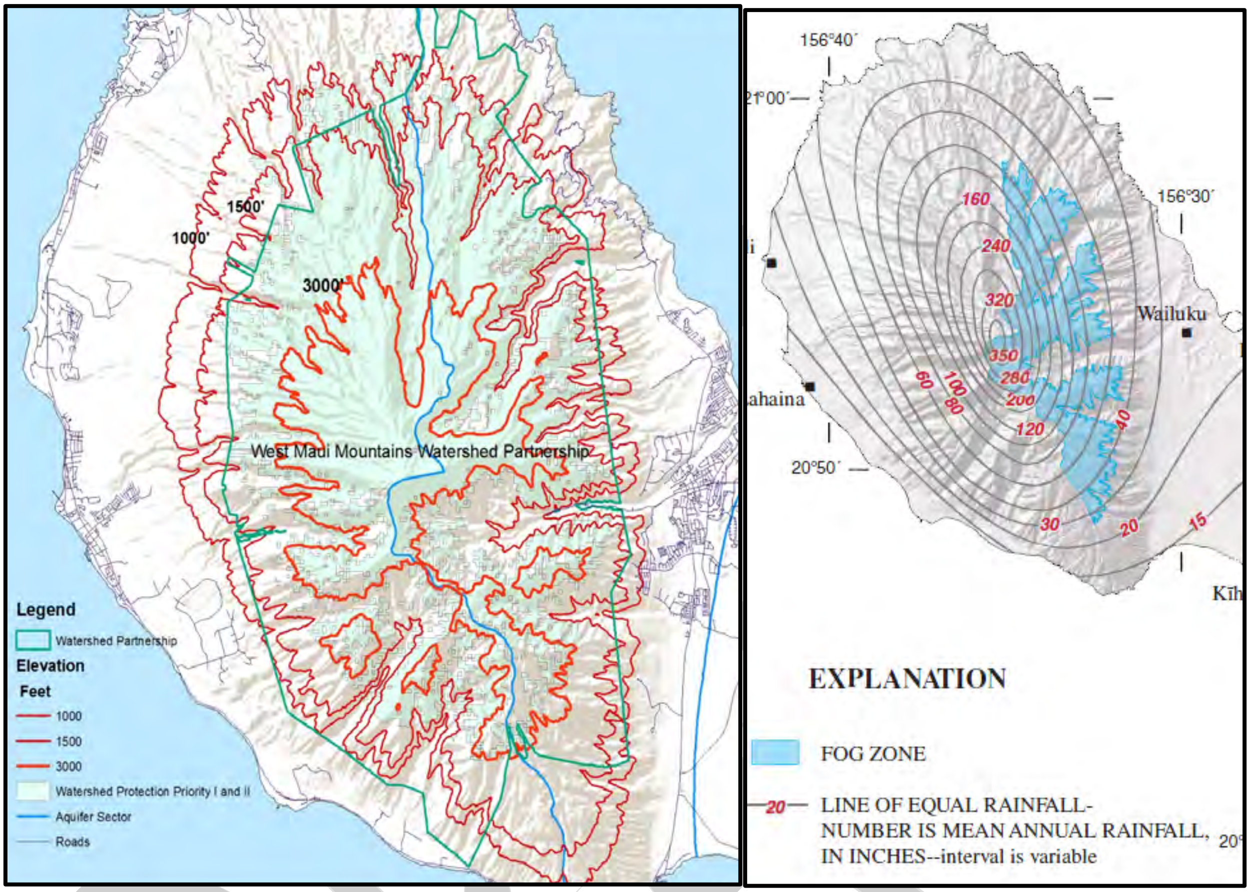
Below the 3,000 ft. elevation, there begins a transition from native-dominated into more alien-dominated vegetation types, with Strawberry Guava, Ironwood, Koster's Curse and other invasive trees and shrubs.

The WMMWP manages a watershed that recharges the primary drinking water sources for MDWS and the Nā Wai `Ehā streams, and includes `Īao Aquifer beneath the lands of Wailuku Water Company. While the freshwater supply is the primary concern for water purveyors, watershed management provides for biological and cultural values, erosion prevention, aesthetic and economic values that benefit the community as a whole. The cooperative, integrated management approach includes best practices, strategic fencing, and collaborative sharing of expertise within and outside the partnership. The Maui Invasive Species Committee (MISC) targets pest animals and plant species to prevent their influx and establishment in the mauka critical watersheds. [64]

Climate change in the form of reduced rainfall, prolonged droughts and more intense floods as well as wild fires are anticipated to increase the challenges of watershed management. Maintaining healthy forests is essential to maintaining the healthy streams and groundwater aquifers. When the forest is damaged, it loses its capacity to capture rainwater and increase condensation and rainfall. The single greatest threat to the native forest is the destruction caused by non-native, invasive animals and plants. State and county agencies as well as private purveyors can provide financial support and participation in watershed protection partnerships and reforestation programs. An across-the-board fee for water use can impart a conservation price indicator, and fund the cost of water management and conservation.

[64] West Maui Mountains Watershed Management Plan, 2013

Figure 14-32 West Maui Mountains Watershed Protection Priority Areas, Elevation, Fog Zone and Rainfall



Source: Gingerich, S.B., 2008, Ground-water availability in the Wailuku area, Maui, Hawaiʻi: U.S. Geological Survey Scientific Investigations Report 2008–5236. DLNR

Strategy #1: Continue Maui County financial support for watershed management partnerships' fencing and weed eradication efforts. Funding and supporting watershed protection provides a strategy for effectively protecting and restoring the resilience of natural aquatic ecosystems and thereby protecting ground and surface water resources and a range of ecosystem services. The watershed management approach fosters partnerships that involve the people most affected by allowing them to participate in key management decisions. This ensures that environmental objectives are well integrated with cultural, social and economic goals.

Annual costs for priority tasks to control invasive weeds and ungulates in the actively managed watershed areas of Mauna Kahālāwai ranged from $1.1M to $1.7M over fiscal years 2014 to 2016 based on county, state and leveraged funding for West Maui Mountains Watershed Partnership and the Pu`u Kukui Watershed Preserve. Management efforts are directly linked to available subsidies where a gap in consistent funding levels jeopardizes decades of progress in keeping major threats at bay.

Restoration of Mauka to Makai Streamflow

Issue and Background: Stream restoration is a key objective reiterated in the General Plan and the WUDP public process. The connection between the mauka and makai zones is critical in order to maintain healthy, vibrant ecosystems and was the basis for Hawaiian subsistence and management of each ahupua`a. Freshwater from the mauka zone feeds streams and the 'auwai to irrigate lo'i kalo (taro patches) and other forms of cultivation. Water returned from the lo`i and within the streams then provide for healthy aquatic ecosystems as well as man-made brackish fishponds. These ecosystems and native species dependent on them decline under water diversions and from stream degradation. There has been a significant revival of instream values in all of Nā Wai `Ehā following the Interim Instream Flow Standards (IIFS) amendments of 2010 and 2014**:** Waihe`e River has increased from 1% to 11.1% of natural habitat units, and near 20% at its mouth; the springs and wetlands have been returning. Waiehu Stream has increased from 6.1% to 55.5% of natural habitat units. Wailuku River has resulted in the river being deep enough in places for swimming and the revival of springs in its lower reaches. [65] The 2010 decision and order did not restore water to the Waikapū Stream. However, following the 2014 Mediated Agreement, 2.9 mgd flow just below the South Waikapū Ditch has resulted in the stream recharging Keālia Pond, despite the natural intermittent nature of flows in its lower reaches. According to the National Wildlife Refuge staff at Keālia Pond, since the flow restoration, pumpage from wells at the refuge has not been necessary.

The hearing officer findings state that any further increases in habitat from increasing the restoration flows will not result in proportionate increases. Wailuku River's restoration of 10 mgd is 2.9 mgd greater than its lowest flow of 7.1 mgd and has resulted in deep stretches of the river and the return of springs at the mouth. Numerical instream flow standards based on scientific information ensure that stream specific in and off stream needs are weighed against each other during different flow conditions. Because Nā Wai `Ehā is designated a surface water management area and the IIFS are subject to the ongoing contested case, the WUDP does not attempt to further allocate instream and offstream uses but needs to adjust depending on the contested case outcome. Alternative solutions that have been brought forward include:

1. Seasonal IIFS, based on seasonal streamflow amounts;
2. Adjustable IIFS, considering temporary decreased IIFS when streamflows drop below a certain low flow amount;
3. Categorizing water users by priority, where allocations by water use permit are defined based on public trust status.

The lessons learnt from Hawaiian history discussed under 14.3.6, including challenges to agree on regular methods of water distribution in times of drought and diligence in maintenance of ditches and 'auwai, echo the trials of today. Key to fair and successful comprehensive management of Nā Wai `Ehā resources, is clearly defined responsibilities and a practical implementation plan. Operational stream gauges, accurate reporting and monitoring of

[65] Contested Case No. CCH-MA 15-01 HO-D&O

diversions, and adequate CWRM staffing are necessary for ahupua`a residents and the community to have confidence in fair implementation of the IIFS.

<u>**Exercise of Traditional and Customary Rights in Nā Wai `Ehā**</u>

Issue and Background: The outreach to community groups and organizations with knowledge about traditional and customary (T&C) uses did not yield site specific information to consider in the Ka Pa`akai analysis. However, the contested case process for Nā Wai `Ehā produced a comprehensive permitting process for T&C rights. Cultural experts and community witnesses have provided uncontroverted testimony regarding limitations on Native Hawaiian's ability to exercise T&C rights and practices in the greater Nā Wai `Ehā area due to the lack of fresh water flowing in the streams and into the nearshore marine waters. Despite significant challenges, some Native Hawaiian practitioners continue to exercise these practices, including gathering native fish, mollusks, and crustaceans as well as limu (seaweed) in streams for subsistence and medicinal purposes, cultivating taro for religious and ceremonial uses, gathering materials for hula, lua (ancient Hawaiian martial arts), and art forms.[66] Testimonies in the contested case identify Waihe`e and Waiehu as sources for hau, palapalai, la`i, and laua`e for hula ceremonies, and the custom to soak the leaves in a flowing stream as part of the protocol. Other practitioners would like to expand the scope of T&C practices if water is returned to the streams.

Certain parties to the contested case state that the proposed decision would diminish protection for T&C rights by redefining and limiting such rights to individuals who can trace their practices back to 1892, rather than just show that kalo cultivation was established in the ahupua`a. [67] The exception to the proposed decision filed by the Office of Hawaiian Affairs (OHA) calls for awarding "Category 1" water use permits to the Native Hawaiian applicants who are ahupua`a tenants and that seek to grow kalo on their land. OHA also has concerns that the proposed decision does not restore sufficient stream flow to adequately protect T&C rights and that the protection of kalo growers needs downstream of diversions are left to the diverters, Wailuku Water Company (WWC) and HC&S. Also WWC has concerns over the implementation order in the proposed decision, and whether the Commission can delegate such obligations to a private party.[68]

The hearing officer's proposed decision would permit about 13 mgd for kalo cultivation and the mauka to makai flow will certainly improve the conditions for exercising T&C practices but does not address overall management, access to the lands and water courses. Many T&C practitioners rely to large extent on the ditch system and WWC's management of the ahupua`a. For the WWC to continue to deliver allocated water through its ditch systems, it will have to be economically viable. Should WWC cease its operations, all users of ditch delivered water would

[66] Contested Case No. CCH-MA 15-01 HO-D&O, 11/1/17
[67] Contested Case No. CCH-MA 15-01 Office of Hawaiian Affairs' Exceptions to the Hearing Officer's Proposed Findings of Fact, Conclusions of Law and Decision and Order field November 1, 2017 and Joinder in Hui O Nā Wai `Ehā and Maui Tomorrow Foundation, Inc. Exceptions. 1/5/18
[68] Contested Case No. CCH-MA 15-01 HO Wailuku Water Company LLC's Exceptions to the Hearing Officer's Proposed Findings of Fact, Conclusions of Law and Decision and Order field November 1, 2017. 1/5/18

have no access to the water. The current county administration has preliminary plans to acquire and operate the WWC system. WWC, Wahi Ho`omalu, and Maui County are among the large landowners responsible for management of their watershed lands. Beyond implementation of the IIFS, once adopted, a long term strategy to sustain ditch operations, land management and adequate access for ahupua`a residents and all stream users is needed. It is recommended that all parties take an adaptive management approach.

Strategy #2: Establish a diverse working group to address alternative structures for future management of the watershed lands and sustained operations of the WWC ditch system. Adequate funding, watershed land ownership, liability, costs and insurance options for maintaining unlined ditches and reservoirs, as well as county bargaining unit contract restrictions are issues. Potential parties are Hui O Nā Wai `Ehā, OHA, Maui County, Aha Moku and major landowners.

<u>**Water Quality**</u>

Issue and Background: `Īao and Waihe`e aquifers are the primary sources for Maui Department of Water Supply (MDWS) largest customer base. Wells drilled over the last decades in these aquifers are in agricultural and urban areas where land uses pose a potential risk of contaminating the underlying groundwater. Proactive measures are needed to protect existing potable wells from potential sources of contamination. Development of new groundwater sources must consider surrounding land uses to not unnecessarily put public health at risk. Wellhead protection and future well siting are addressed under island-wide strategies #6 "Implementing well siting criteria to avoid contaminated groundwater supplies and unnecessary risks to public health" and #7 "Adopt wellhead protection measures for potable wells."

14.8.2 Conservation

The Wailuku-Kahului Community Plan and the input from the WUDP public process identified an overall planning objective to "maximize efficiency of water use" and the following supply augmentation and demand controls:

- Promote conservation of potable water through use of treated waste water effluent for irrigation.
- Reuse treated effluent from the County's waste water treatment system for irrigation and other suitable purposes in a manner that is environmentally sound.
- Provide incentives for water and energy conservation practices.
- Promote energy conservation and renewables.
- Incorporate drought tolerant plant species and xeriscaping in future landscape planting.

Qualitative criteria to evaluate and measure resource strategies against this planning objective include:

- Per capita water use decreased
- Potable and irrigation systems water loss decreased

- Community water education increased
- Incentives for water conservation increased
- Renewable energy use increased

Issue and Background: The recommended supply and demand side conservation strategies outlined in Section 12.2 apply island wide. MDWS is the single largest municipal water purveyor in the region with residential use making up 60% of total customer water use. The MDWS Central Maui System (also known as the Wailuku District) shows the same downward trend in water use per service as other MDWS systems. Approximately 15 mgd of potable groundwater and less than 1 mgd of surface water originating in the Wailuku aquifer sector is used throughout Kahului, Mā`alaea, Kīhei and Mākena in the Central aquifer sector. These areas are dry microclimates with less than 15 inches of rainfall per year. There is great potential for further conservation targeting residential and commercial irrigation using potable water supply. Based on empirical data, average consumption per residential water service is about 23% higher on the dry south shore compared to Waikapū and Wailuku with higher rainfall. It can be assumed that the higher use to large extent represents incidental yard irrigation.

<u>Demand Side Conservation Measures</u>

Demand side conservation strategies recommended in Section 12.2 that would target outdoor uses of potable water include comprehensive water conservation ordinance to include xeriscaping regulations, landscaping and water efficient irrigation system incentives.

The cost-effectiveness of conservation strategies is an important consideration in developing and sustaining a conservation program. As discussed under Section 12.2, cost-effectiveness compares the costs of a portfolio of programs to promote water savings with the costs the utility and its customers would otherwise incur. In evaluating cost-effectiveness, MDWS compared the costs to develop and deliver new sources of water to meet future demand with the savings attributed to conservation. Cost savings vary with the portfolio of conservation programs selected, market penetration, timeframe and other assumptions. A preliminary analysis of the proposed conservation measure portfolio outlined in Section 12.2 shows that doubling current investments (MDWS annual FY14 – FY17 conservation budget, excluding leak detection is $170,000) would result in net capital and operational savings. The potential for a net savings is also expected for the MDWS Central Maui System due to the need for new source development.

Recommended demand side conservation measures at all levels and type of use for public water systems outlined in Table 13-1 (strategies # 10 – 25) apply to the Wailuku ASEA and the MDWS Central Maui System as a whole. Because the areas served by the MDWS Central Maui System are planned growth areas to support the lion share of new housing, conservation measures that are implemented in the design and build phase rather than retrofits and incentives are important strategies. Strategies #17, 22 and 25 outlined in Table 13-1 are especially appropriate in planned growth areas:

- Revise county code to require high efficiency fixtures in all new construction. Develop a comprehensive water conservation ordinance to include xeriscaping regulations.

- Revise County Code: Water conserving design and landscaping in new development (xeriscaping targets dry areas).
- Revise County Code and/or incentivize water- efficient building design that integrates alternative sources (greywater, catchment).

Supply Side Conservation Measures

The sustainable and efficient use of water resources, as well as the capacity and integrity of water systems, can be improved by accounting for water as it moves through the system and taking actions to ensure that water loss is prevented and reduced to the extent feasible.

A water audit provides a data driven analysis of water flowing through a water system from source to customer point-of-service and is the critical first step in determining water supply efficiency and responsible actions to manage and reduce water loss consistent with available source, operational and financial resources.[69]. Comprehensive audits for all MDWS systems are performed annually. Public water systems serving a population of 1,000 or more and those within water management areas regardless of population served are required to submit annual water audits beginning July 1, 2020. There are no other large public water systems in the aquifer sector but the Hawaii Nature Center (PWS 240) in `Īao Valley is in a designated surface water and groundwater management area. The average water loss for public water systems in the United States is 16 percent, with up to 75 percent of that loss able to be recovered.[70] The preliminary results of a fiscal year 2017 water audit for MDWS Central Maui System indicate water losses of 15.7%, due to inaccurate meters on both consumer and production side, main leaks and flushing. The results will guide MDWS maintenance and repair programs. Part II Strategy # 28 addresses water system maintenance and operations to minimize sources of water loss.

Agricultural Water Systems Water Loss Mitigation

Issue and Background: The Wailuku Water Company plantation ditch system is the focal point for the objectives that seek to provide sufficient water to all permittees and allocations within Nā Wai `Ehā. System losses were determined by a 1988 study to about 11.6% of total diversions. WWC has repaired structures and ditches since, resulting in a reduction of system losses to about 7.34% of total diversions. With five reservoirs closed after 2010, WWC has reduced system losses to 4.97%, which is well below American Water Works Association standards and US Department of Agriculture guidance. To further reduce losses by converting

[69] USEPA. Using Water Audits to Understand Water Loss. A Joint Presentation of the USEPA Office of Groundwater and Drinking Water and the American Water Works Association, 1/26/2012. https://www3.epa.gov/.../waterinfrastructure/docs/water-audits_presentation_01-2012.pdf *Accessed March 29, 2017.*

[70] US EPA, Water Audits and Water Loss Control for Public Water Systems https://www.epa.gov/sites/production/files/2015-04/documents/epa816f13002.pdf Accessed March 24, 2017.

open ditch segments to cement lined ditch would require $5M investment.[71] WWC system operations and costs would be addressed by a working group as proposed in Strategy #2 above.

14.8.3 Conventional Water Source Strategies

Conventional water sources include groundwater (wells and tunnels) and surface water (stream diversions).

Planning objectives related to groundwater and surface water source use and development identified in the WUDP update public process include:

- Manage water equitably
- Provide for Department of Hawaiian Homelands needs
- Provide for agricultural needs
- Protect cultural resources
- Provide adequate volume of water supply
- Maximize reliability of water service
- Minimize cost of water supply

The Maui Island Plan objective 6.3.2 to "increase the efficiency and capacity of the water systems" applies island wide. The adopted policy is to "acquire and develop additional sources of potable water", with the action item to "pursue development of additional potable water sources to keep pace with the County's needs".

The MIP also calls for a continual assessment of the current and future adequacy of water supplies in a holistic way, including the establishment of appropriate principles and standards; determining the capital improvements that would be required to treat and deliver the needed water, and the best ways to pay for these improvements.

Planning objectives and policies related to water availability and use identified in the Wailuku-Kahului Community Plan are:

- Coordinate water system improvement plans with growth areas to ensure adequate supply and a program to replace deteriorating portions of the distribution system. Future growth should be phased to be in concert with the service capacity of the water system.
- Coordinate the construction of all water and public roadway and utility improvements to minimize construction impacts and inconveniences to the public.
- Coordinate expansion of and improvements to the water system to coincide with the development of residential expansion areas.

Implementing actions include:

- Adopt a water allocation plan for the region and require use of water from Central Maui Water System for future development to be subject to water allocation plan.

[71] 2014 Mediated Agreement, FOF, WWC Opening Brief

- Plan and construct water system improvements, including additional source, transmission, and storage capabilities.

Groundwater Availability Issues

Residents want the WUDP to ensure that water resources will be utilized in a way that ensures long-term sustainability. Central Maui residents are concerned with the health of our aquifers; the lack of reporting of private wells and the lack of data impact on establishing sustainable yields. The amount of groundwater that can be developed is limited by the amount of natural recharge and aquifer outflow that contribute to streamflow and to prevent seawater intrusion, established as sustainable yield. Because delineation of aquifer sectors and systems in some cases are based on limited hydrologic information, areas for potential groundwater development must be assessed on its own merits to determine any additional needs for hydrologic studies and interaction with surface water and other sources.
Understanding potential impact of climate change adds to uncertainty in long-term groundwater availability. The primary responsibility to determine potential impacts on water resource availability lies with the State CWRM who in turn relies on studies and predictions by the scientific community and other agencies. Water purveyors need guidance how to mitigate and adjust to potential changes in groundwater availability.

Other constraints on groundwater availability include access and cost. Conveyance from high yield aquifers in remotely located watersheds to growth areas can be difficult and expensive due to topography and distance. Adding wells in already developed aquifers must also consider distribution of pumpage. Development adjacent to existing infrastructure is preferred from a cost perspective, but adding transmission to distribute wells further throughout an aquifer system may be warranted to optimize pumpage and mitigate aquifer impact.

Hydrogeological studies to inform impact from climate change and future well development on groundwater health. A 2008 US Geological Survey (USGS) study*, Ground-Water Availability in the Wailuku Area*, assessed recharge during average and drought conditions and used a numerical groundwater flow and transport model to estimate the effects of various withdrawal and recharge scenarios on water levels and on the transition zone between fresh water and ocean water. Since then, recharge estimates have been updated, or are being updated and new wells were drilled, which can be measured to provide new water level information. Therefore MDWS entered into a new cooperative agreement with USGS in 2015 to update the groundwater-flow model to evaluate effects of planned wells on the salinity and transition zone of the `Īao, Waihe`e and Waikapū aquifers. The results of the ongoing study and modeling results should guide individual well development to mitigate saltwater intrusion, impact to adjacent sources and surface water.

Infrastructure Availability Issues

Residents believe a water availability rule ("Show Me the Water") is critical to maintain water availability in a sustainable fashion. The County Availability Rule, codified in Maui County Code

Section 14.12 applies to the MDWS systems and only addresses residential developments. The current rule does not clearly distinguish between long term water supply available by *infrastructure*, including developed source capacity, or long term water supply in terms of *resource limits*, defined as sustainable yield and instream flow standards. Community concerns raised with regards to the current policy range from excessive burden on private developers to supply water source; a convoluted process that impedes development of much needed housing; lack of expertise by MDWS to complete the rigorous assessment mandated in the rule; loop holes that exempt commercial development and non-county water systems from the rule; proliferation of small private water systems around the island versus a cohesive government-managed water system; and inadequate protection of the resource. The rule has been largely blamed for blocking small to medium-scaling housing from being built. [72]

On January 28, 2018 the MDWS adopted administrative rule 16-201 with the purpose to provide uniform handling of applications for water service. The rule applies to all MDWS systems, except the Upcountry system and all requests for water service, with certain exceptions. Where a request for a large quantity of water, as defined in the rule, the MDWS may impose special conditions in accordance with County Code Chapter 14.04.010. Such special conditions mean the development and dedication of water source, transmission and/or distribution pipelines, and/or storage infrastructure to serve the proposed project. Water service requests are assessed in relation to maximum reliable capacity of the MDWS infrastructure and forecasted water use. The administrative rule resolves some of the loop holes and concerns associated with Maui County Code Chapter 14.12.

Groundwater Development to Meet Population Growth

Issue and Background: Groundwater is the corner stone of a reliable water supply to meet population growth based demand. Non-potable agricultural and large scale irrigation demands (golf courses, parks etc.) are primarily met by surface water and account for 33.92 mgd of the total 2035 projected water demand. Remaining demand for domestic and municipal needs within Wailuku ASEA and throughout the MDWS Central Maui System totals 35.76 mgd, within a low to high range of 32.56 – 38.42 mgd. Groundwater originating in Wailuku ASEA supplies 95% of these needs, and is supplemented by the Maui Lani Wells in the Kahului aquifer and the `Īao Water Treatment Facility diverting about 1 mgd from the Wailuku River.

The table below shows current resources used for municipal and domestic needs. Basal groundwater is withdrawn from `Īao and Waihe`e aquifers. MDWS does not fully utilize allocated water use permits for the `Īao Aquifer. High level water is from dike confined aquifers that is not accounted for toward sustainable yield. There are additional withdrawals from the caprock section of `Īao Aquifer for irrigation purposes. These do not count towards sustainable yield and are not directly correlated to population growth.

[72] Public Testimony, Maui County Council Water Resources Committee meeting January 6, 2016

Table 14 –38 Wailuku ASEA and MDWS Central Maui System, Municipal and Domestic Use by Water Resource 2014

Water Use/ Water Resource	Demand 2014 (mgd)
MUNICIPAL	
Wailuku Basal Groundwater	18.12
Wailuku High Level Groundwater	2.23
Wailuku Surface Water	0.99
(Wailuku ASEA only Subtotal)	***21.33***
Kahului Aquifer	0.93
MUNICIPAL USE TOTAL	**22.26**
DOMESTIC	
Wailuku Basal Groundwater	0.01
Wailuku Surface Water	0.03
DOMESTIC USE TOTAL	0.03
MUNICIPAL AND DOMESTIC TOTAL	**22.29**

Numbers may not add up due to rounding

Groundwater will continue to be the primary source to meet potable municipal needs. Basal groundwater within the Wailuku aquifer sector includes the Kahakuloa aquifer with a sustainable yield of 5 mgd. It is not anticipated that this aquifer be further explored for demand over the 20 year planning period. Table 14-39 below compares the following:

1. Current and projected municipal and domestic water use within Wailuku ASEA and on the MDWS Central Maui System.
2. Installed pump capacity, which includes backup wells and unused capacity, and rated surface water treatment plant capacity.
3. MDWS Source Capacity, limited by water system standards (meet max demand at 16 hours pumping with the largest system pump out of service), water use permits, and source agreements.
4. Non-MDWS Source Capacity, limited by water system standards and water use permits.
5. Total Source Capacity. Only groundwater pumpage was available for 2014 data of Domestic uses. From 2017, Domestic uses of Nā Wai `Ehā surface water, mostly for household irrigation, is added as available Source Capacity. `Īao Water Treatment Facility expanded capacity and the anticipated allocation of 3.2 mgd is included in the total.

As shown in the table, conventional water resources can feasibly meet most of the population growth based municipal and domestic needs.

Table 14 -39 Groundwater Source Development to Meet Population Growth Based Municipal Demand - Wailuku ASEA and the MDWS Central Maui System 2035 (mgd)

Aquifer System (Sustainable Yield)	2014 Use	Installed Pump Capacity	MDWS Source Capacity*	Non-MDWS Source Capacity*	Total Source Capacity	2035 Municipal & Domestic Supply
Waikapū (3)	0.000	3.36	0.00	2.24	2.24	26.05****
`Īao (20)	14.71	57.17	18.84	0.73	18 (19.58)****	
Waihe`e (8)	3.41	10.27	4.43	1.38	5.81	
Kahakuloa (5)	0.00	0.00	0.00	0.00	0.00	0.00
Maui Lani Wells/ Kahului (1)	0.93	2.25	1.20		1.20	1.20
High Level Sources	2.23	2.40	1.89		1.89	1.89
Wailuku River/`Īao WTF	0.99	2.31	1.78		3.20**	3.20
Nā Wai `Ehā	0.03			0.08***	0.08	0.08
Unmet demand						**-1.84**
Total	**22.30**	**77.77**	**28.15**	**4.43**	**32.42**	**34.26**

Source: MDWS Water Resources & Planning Division, 2017. Numbers may not add up due to rounding
*Water System Standards, Water Use Permits
**`Īao WTF expansion projected on line 2018-2019
*** 2018 CCH Proposed Decision Domestic Uses WUP and exempt allocations
****Total source capacity is 27.63 mgd. Water use permit allocations for `Īao aquifer equals 19.58 mgd but are assumed to not be utilized up to more than 18 mgd.

Peak demand for projected needs must be accounted for to ensure reliable supply. Typically, during drought conditions, average daily demand per user increases. In MDWS source development studies, a "peaking factor" of about 20% is added in calculating source development needs.[73] Actual peak demand is calculated in the engineering analysis for an individual well site, pump size and service area. The historic 10-year peak month production for the MDWS Central Maui System is 18% higher than the average month. Adding 20% to projected 2035 demand of 34.26 mgd is 41.11 mgd. Available source capacity is 32.42 mgd, which would require the balance 8.69 mgd to be developed.

34.26 mgd 2035 Municipal and Domestic Demand + Peak Factor 20% = 41.11 mgd
- 32.42 mgd Available Source Capacity
= 8.69 mgd Source Needed

Regional resource use is generally more economic as it avoids water transport and associated water losses. However, existing population centers and directed growth areas in dry Central and South Maui are supported by infrastructure but lack sufficient regional water resources. It should be noted that unmet needs to be served by the MDWS Central Maui System do not have "priority" to available conventional resources in the Central ASEA. The analysis of all Central ASEA water resources, projected demands and source development needs are

[73] MDWS, 2013Water Source Development Options Report for the South-Central Maui and the Upcountry Maui Areas

addressed in the Central ASEA Report Chapter 15. Potential resources to meet unmet potable demand are portions of remaining yields in Waihe`e Aquifer, Waikapū Aquifer, Pā`ia Aquifer, Ha`ikū Aquifer and surface water from East Maui. Surface water from Nā Wai `Ehā is assumed to be limited to new water use permit and exempt allocations for domestic and municipal uses per the hearing officer's proposed decision. Potential alternative sources to offset new irrigation demand on the MDWS Central Maui System include R-1 water from the Kīhei Water Reclamation Facility and desalination.

`Īao Aquifer

Approximately 75 % of the water supplied by the MDWS Central Maui system is withdrawn from the `Īao Aquifer. Issued water use permits for the designated groundwater management area total 19.8 mgd, which represents 99% of the aquifer's sustainable yield. It may not be prudent to utilize the full allocation unless distribution of pumpage would indicate stable chlorides and aquifer health. MDWS Source Capacity of 18.84 mgd in Table 14-39 above represents water system standards, which is lower than CWRM issued allocation to MDWS of 19.63 mgd. The 2009 "Maui WUDP Central District Final Candidate Strategies Report" developed by Ha`ikū Design & Analysis recommended four committed short term strategies to distribute pumpage within `Īao Aquifer and add source outside of the aquifer: development of `Īao Tank Site Well and Waikapū Tank Site Well in `Īao Aquifer; development of Kupa`a Well in Waihe`e aquifer and the Maui Lani wells in Kahului Aquifer. All four strategies have been implemented. Two additional wells, Wailuku Well 1 & 2, have been developed in `Īao Aquifer to replace Wailuku Shaft 33 since 2016. The `Īao Water Shortage Rule and response plan is currently being updated to reflect the new well configuration and to formalize actions to address water shortage and aquifer changes. Deep observation wells monitored by USGS and CWRM in combination with frequent monitoring by MDWS at production wells are in place and consistent with recommended island wide strategies e, f, and g in Chapter 12.3.

Waikapū Aquifer

Waikapū aquifer's sustainable yield is 3 mgd and has remained relatively undeveloped until recently. It is anticipated that installed source capacity in Waikapū aquifer will serve planned growth within designated growth areas in consistency with the Wailuku-Kahului Community Plan and Maui Island Plan objectives. Projects may be served by MDWS if constructed wells are dedicated to the department, or by the developers of the Waikapū Country Town, who own approximately 1,290 acres of land and the 4 constructed wells in the northern portion of the aquifer. Pump test data from existing exploratory wells is incorporated in the ongoing USGS 2015 groundwater-flow model to evaluate long term effects of planned wells on the salinity and transition zone of the aquifer. Total aquifer pumpage should not exceed 90 % of sustainable yield to satisfy community concerns over lack of data impact on establishing sustainable yields and section 174C-41 of the State Water Code, which could trigger groundwater management area designation. Negotiations between the County and the developers is ongoing. County code requires that source agreements between the County and private developers are approved by County Council. This measure mitigates the concern raised in the Maui Island Plan over private water systems potentially undermining county land use policies when new developments are built beyond water service areas. Private water source development should implement County directed growth strategies that seek to direct future growth to the most appropriate locations and communities. Projected 20-year costs, including capital costs, operation and maintenance, repair and replacements, not accounting for inflation and other economic factors were estimated to approximately $4.25 per 1000 gallons. Costs were not assessed for the entire yield but based on development of 1 mgd source capacity.[74]

Strategy #3: Adapt pumpage of constructed wells in Waikapū aquifer with guidance from the 2015 USGS groundwater flow model results, when available to ensure sustainable chloride levels and aquifer health. Anticipated yield would be up to 2.7 mgd with 20-year projected costs approximately $4.25 per 1000 gallons. Proposed lead agencies are MDWS, USGS and Waikapū Properties, LLC.

<u>Waihe`e Aquifer</u>

Installed capacity in the southern portion of Waihe`e aquifer of 6.51 mgd is not fully utilized. CWRM has recommended to limit withdrawals from south of Makamaka`ole Stream to 4 mgd in response to a rising transition zone. Hydrologic study and groundwater modeling by the USGS to assess the impact on the Waihe`e aquifer from additional and redistributed pumpage is pending. Results from this study should guide any further development of the aquifer. MDWS investigated drilling in the northern portion of the Waihe`e aquifer, which would also help spread pumpage throughout the entire aquifer. The terrain is rugged and well development would be expensive due to required substantial transmission improvements. Development of 4 wells to supply 1 mgd each, water lines, tanks, booster pump station, power extension and Environmental Impact Statement costs were estimated to $64.7M in 2013. Approximate design and development cost per exploratory well would be $5M. The remaining yield of 3 – 4 mgd is not enough to provide the 8.9 mgd source needed. Due to the extensive transmission cost it is not cost effective to develop isolated well fields in multiple remote aquifers. [75] Modeled pumpage scenarios in a 2008 USGS study[76] indicated that the freshwater lens in the northern portion across Makamaka`ole Stream is likely to be thinner than the southern portion and well yield would be less than previously thought. A configuration of many smaller wells was characterized and would be comparatively more expensive due to lower expected production capability. Simulated pumping scenarios run in the 2008 USGS groundwater model for the southern portion of the aquifer with some restored streamflow of Waiheu Stream and Waihe`e River showed increased chlorides with pumpage above 3.5 mgd but stable chlorides with pumpage at 3.5 mgd. The pending USGS update of this study incorporates increased streamflow restoration and scenarios for an additional well in the southern portion of the aquifer. Model results should guide decision for an exploratory well to supplement the MDWS

[74] MDWS, Water Source Development Options Report for the Central-South Maui and the Upcountry Maui Areas, 2013

[75] MDWS, Water Source Development Options Report for the Central-South Maui and the Upcountry Maui Areas, 2013

[76] Gingrich, S. Groundwater Availability in the Wailuku Area, Maui, Hawai`i, USGS Report 2008-5236

Central Maui System and further distribute pumpage between existing wells. Life cycle costs have not been assessed for this option to date.

Development of two private wells for a total of 3 mgd are underway at approximately 600 ft. elevation and 2000 ft. distance from the MDWS system. Based on preliminary study results, it's questionable whether an additional 3 mgd pumpage can be accommodated without negative impact on the aquifer. Well yield, impact on aquifer and existing production wells should be monitored.

Strategy #4: Explore new basal well development in the southern portion of Waihe`e aquifer based on results of USGS groundwater model and best pumping scenarios. Potential yield for 1 – 2 wells is estimated to 1.6 mgd. Monitor impact on existing production wells and aquifer transition zone from development of Mendez wells. Lead agency should be the MDWS.

<u>Kahakuloa Aquifer</u>

Development of basal groundwater from Kahakuloa aquifer was assessed as a preliminary candidate strategy in the 2009 WUDP update for the MDWS Central District. Well development would require substantial water and electric power transmission improvements to connect with the existing distribution system. A configuration of eight wells were characterized by Ha`ikū Design & Analysis. The cost, potential impact on a very remote community, in combination with highly uncertain hydrology deemed this option not cost effective or a desirable strategy.

<u>Pā`ia Aquifer</u>

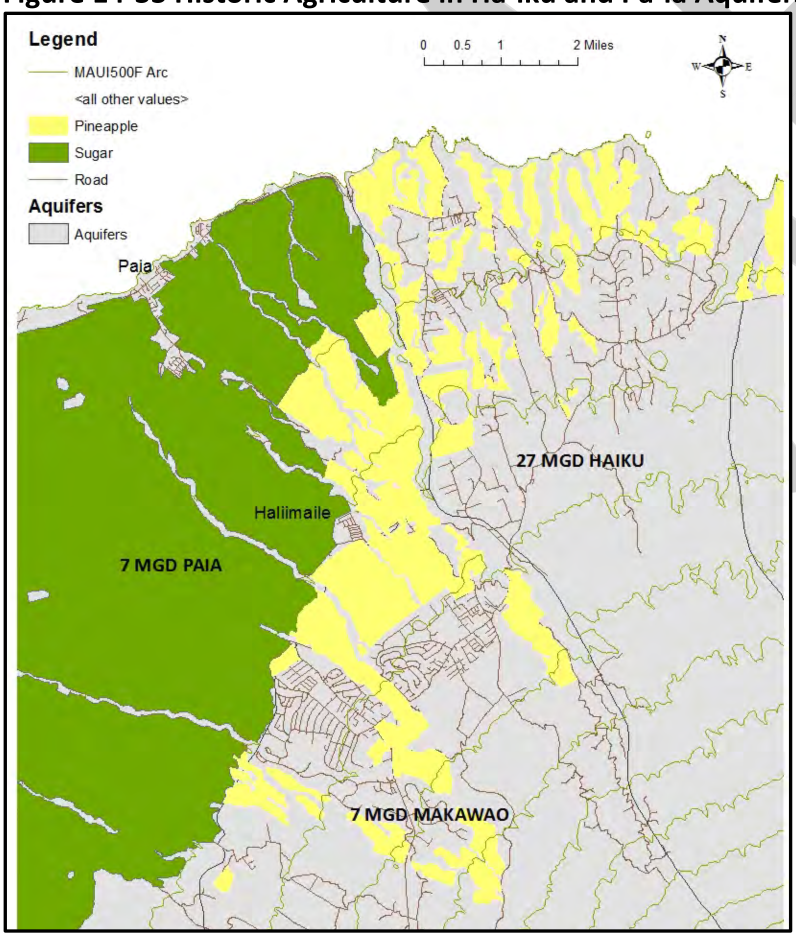
The Pā`ia Aquifer was not considered a candidate for potable source for the MDWS Central Maui System by the Central Maui Water Advisory Committee or in the 2016 public process for the WUDP update. Most of the aquifer underlies the HC&S plantation and is a potential brackish to semi brackish source for non-potable uses. Current and projected agricultural and irrigation uses of the Pā`ia Aquifer is analyzed for the Central Aquifer Sector in Chapter 15.

<u>Ha`ikū Aquifer</u>

Subsequent to the 1990 WUDP, long range water development plans included well exploration in the Pā`ia and Ha`ikū aquifers to serve a growing population in Central Maui. The plans were stopped by lawsuits raising claims about impact on stream flows. The 2003 Consent Decree essentially put a halt to groundwater development in the subject area. Unfortunately, well development further east or "mauka" of the consent decree area will require higher costs to pump and transport water. The plaintiffs in the case allowed only phase 1 of the East Maui Water Development Plan to be implemented, which included the Hamakuapoko wells and limited transmission connection to the Central Maui. Since 2003 there have been multiple assessments and cost benefit analyses conducted to explore groundwater development outside the Consent Decree area in the Ha`ikū Aquifer, and alternative options including additional surface water from Nā Wai `Ehā .

Various configurations of eastward basal groundwater development was assessed in the 2004 – 2009 WUDP Central DWS District Plan update. Well development and transmission from Honopou and Waikamoi aquifers and use of the HC&S Lowrie Ditch were rejected in favor of the Ha`ikū aquifer strategy. Neither candidate strategy was favored in the 2015 – 2016 public process. In examining the economics of well and transmission installation at various elevations, the capital costs of extensive transmission dominate in all cases. Since completion of the major water transmission components is necessary before any production wells can benefit the Central Maui System, it is not possible to effectively "phase" the installation of water transmission. Wells at higher elevation require additional cost to pump water but avoid potential treatment costs for pesticide contaminants associated with previous pineapple cultivation. DBCP (1,2-Dibromo-3-chloropropane) and TCP (1,2,3-Trichloropropane) are currently detected in Ha`ikū aquifer wells below approximately 1,500 ft elevation. The higher cost associated with developing wells at higher elevation is a trade-off to avoiding the costs and risks of contaminated aquifers at lower elevations.

Figure 14-33 Historic Agriculture in Ha`ikū and Pā`ia Aquifers



Development of a series of wells at about 1000 feet elevation with new transmission to the Central System was considered a final candidate strategy by the Central Water Advisory

Committee, recognizing that compliance with the terms of the East Maui Water Development Plan Consent Decree would be necessary. Concerns over impact of basal groundwater pumping upon existing wells, springs and surface water sources remain a concern raised by residents. Capital and operational costs for well development at 1000 feet and 1500 feet elevations over a 50-year study period were analyzed by Ha`ikū Design & Analysis. Adjusting for inflation rates, capital cost would be approximately $93M in 2017 dollars to install 16 mgd (8 wells) for a reliable capacity of 7 - 10 mgd. [77]

The "Maui County WUDP Central DWS District Plan Update", adopted by Maui County Council in 2010, recommended to "monitor construction costs for water transmission and storage reservoir projects to determine the ongoing economic feasibility of the Northward and Eastward Basal Groundwater strategies". [78]

Source options and strategies for the DWS Central System, including the Wailuku ASEA were analyzed by MDWS engineering in the 2013 "Water Source Development Options Report for the South-Central Maui and the Upcountry Maui Areas". Well development in Ha`ikū aquifer was compared to scenarios for well development in Waihe`e, Kahului, `Īao and Waikapū aquifers. Because the quantity available from these four aquifers is far below the quantity needed to supply 20-year source needs and the Ha`ikū aquifer is abundant in source capacity, the study recommended Ha`ikū aquifer the prime candidate. [79] A scenario to develop 12.5 mgd between ten (10) wells, transmission, tanks, land purchase, easement, booster pumps, power extension, Environmental Impact Statement and contingencies was assessed to $133M. Development of 8.5 mgd between six (6) wells and associated infrastructure was assessed to $92M. Twenty year projected life cycle cost was $3.71 per 1000 gallons.

A third assessment of potential sources to serve projected growth on the MDWS Central Maui System was completed by Brown & Caldwell in December 2013. The engineering analysis reviewed an extensive list of available sources and documents to evaluate available capacity, projected demand, source needs and alternatives for the MDWS Central Maui System. Life cycle cost evaluation for 13.7 mgd average production rate was assessed to $9.67 per 1000 gallons over a 25-year planning period. The analysis concluded that development of eastward basal groundwater is a viable strategy with low implementation risk from a technical perspective if legal issues can be resolved.

The Ha`ikū aquifer has been marginally developed and no extensive hydrologic study undertaken. Whether perched water, a higher level groundwater storage above the basal lens, is what feeds the streams must be evaluated by a hydrologic study and monitoring wells. In the 2016 public review of preliminary strategies, the need for hydrologic studies of the Ha`ikū aquifer was emphasized.

---

[77] MDWS 2018. Reliable capacity 45% - 67% of installed capacity

[78] Ha`ikū Design & Analysis, Maui County Water Use and Development Plan Central DWS District Plan Update, November 16, 2010 Exhibit A

[79] MDWS, Water Source Development Options Report for the Central-South Maui and the Upcountry Maui Areas, 2013

Strategy #5: Continue exploration of East Maui well development in consideration of reliable capacity for planned growth areas, including the MDWS Central Maui System. Initiate a hydrologic study to determine any negative impact on existing ground and surface water sources, streamflow and influences from dikes. Potential yield is more than the needed 8.69 mgd. Lead agencies would be CWRM and MDWS and hydrologic study to be completed by USGS.

Groundwater Development to Meet Irrigation Needs

Issue and Background: Current groundwater use for irrigation within Wailuku ASEA is primarily for golf course irrigation (85%) drawing from brackish or near brackish water in caprock portion of the `Īao Aquifer. Current irrigation demand of 0.4 mgd for parks and recreation areas are assumed to increase at the rate of population growth to about 0.7 mgd. However, because planned growth in the aquifer sector does not include golf course development, irrigation needs from groundwater may remain relatively flat. The hypothetical additional 0.3 mgd needed could be met with available groundwater from Wailuku ASEA. Water use permits are required for new caprock wells within the `Īao Groundwater Management Area, although caprock pumpage does not count towards sustainable yield.

Total projected 2035 irrigation demand of 1.83 mgd includes 1.16 mgd of proposed surface water permit allocations per the November 2017 Proposed Decision for Nā Wai `Ehā . These allocations are not projected to increase significantly.

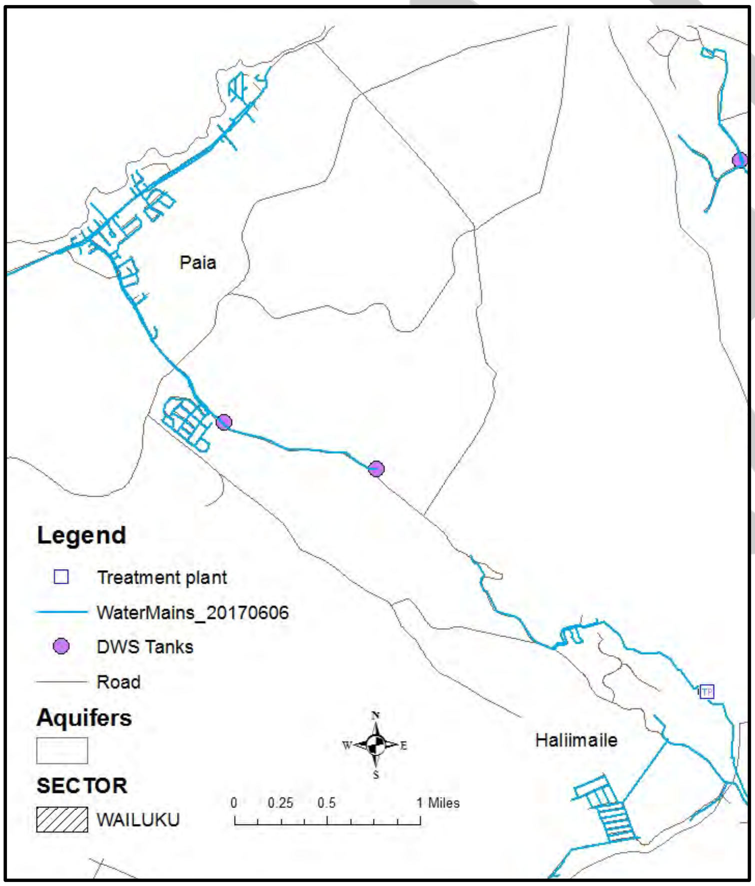
Basal groundwater in Wailuku ASEA is generally of excellent quality, especially high level groundwater, is of pure quality and if available through inversion tunnels does not necessitate pumping from sea level to area of service. Prioritizing high level and good quality groundwater for potable needs and using brackish, semi-brackish and otherwise compromised quality water for non-potable uses can be achieved through dual distribution systems and increased use of alternative resources for non-potable demand. This is consistent with the island wide strategy to promote the highest quality water for the highest end use, set forth in Chapter 12.3. Irrigation demands *outside* the Wailuku ASEA are recommended to be served by regional water resources in the respective hydrologic unit to the extent possible. This strategy is also addressed under the Central ASEA Chapter 15. Non-potable irrigation needs for parks, resorts and golf courses throughout the Central ASEA can be served by regional brackish groundwater from Kama`ole aquifer, groundwater from Kahului aquifer, and recycled water from the Kīhei Wastewater Reclamation Facility. The MDWS Central Maui System does not provide non-potable water. The strategy can be implemented through land use permit approvals, expansion of the recycled water distribution system and requirements, and improved water use data for Kama`ole and Kahului aquifers.

Strategy #6: Reduce non-potable use of Wailuku aquifer sector basal and high level water to the extent feasible. Prioritize available recycled water and brackish water for non-potable uses where available in the Central aquifer sector. Lead agencies are CWRM, MDWS, Maui County Planning Department and Maui County Department of Environmental Management.

Groundwater Reliability and Efficiency: Interconnection of the MDWS Central Maui System and Upcountry System

Issue and Background: The MDWS Central Maui System and the Upcountry System are not connected and are served by separate sources. The Central Maui System ends above Skill Village in Pā`ia and the Upcountry System terminates approximately 2,000 feet further mauka on Baldwin Avenue. Interconnecting the two MDWS systems could provide improved reliability and operational economics. Costs and benefits were analyzed by Ha`ikū Design and Analysis.[80]

Figure 14-34 MDWS Central System Pā`ia Terminus and Upcountry System Hāli`imaile Terminus



Water from the Wailoa Ditch is treated at the Kamole water treatment facility and subject to streamflow reliability, instream flow standards yet to be adopted, and an agreement with East Maui Irrigation Company. Connecting the system to provide additional reserve capacity to the

[80] Ha`ikū Design & Analysis, Maui County Water Use and Development Plan Candidate Strategies Central District Preliminary Draft, September 12, 2006

Central System in drought conditions would be of little value as ditch flows would be limited. The option could provide economical water production during conditions of ample ditch flow but would not provide reliable capacity or displace other source development investments for the Central System.

Consistent with the planning objectives to maximize reliability of water service and Strategy # 48 in Table 13-1, system connection can increase system flexibility so that regional sources can be moved to support areas of need. A constraint to using water from Wailoa Ditch for the purpose of servicing growth on the MDWS Central System is the offstream uses addressed in the contested case for East Maui Streams. MDWS needs and evidence supporting such needs were limited to the MDWS Upcountry System and the Upcountry Priority List. Another constraint to connect the MDWS Upcountry and Central System is mixing of supply sources with potential impact on water quality. Surface water with high organic content and corrosive chemistry can introduce new lead and copper compliance problems in homes with older plumbing that are currently served by groundwater. Even though the Central System serves a large number of older homes with potential lead plumbing, lead has not been a concern among Central System customers due to the less acidic water chemistry. Introduction of new source and blending of supply requires Department of Health approval. Economic benefits could result from interconnection when abundant less expensive surface water is available in wet season to supplement areas regularly served by groundwater supply. Reducing withdrawals of aquifers allows displaced groundwater resources to recharge.

Strategy #7: It is recommended that the following is monitored in order to determine the benefits and viability of interconnecting the MDWS Upcountry and Central Systems: outcome of the pending East Maui Streams contested case and final Instream Flow Standards, available ditch flow and water quality implications of blending the water source. Lead agency is MDWS.

Department of Hawaiian Homelands Public Trust Needs

As shown in section 14.6.3 above, Department of Hawaiian Homelands (DHHL) projects in the Wailuku ASEA are mostly built-out and will not require significant additional source over the planning period. MDWS Central System serves existing potable demand of about 20,400 gpd and incidental population based growth of the existing Waiehu and Paukūkalo communities. DHHL domestic needs are a protected public trust use that will benefit from source development and increased source reliability of the MDWS Central System as a whole.

Surface Water Use and Development

Concerns raised in public process and documented in the Maui Island Plan relate to the lack of numerical Instream Flow Standards (IFS), which are needed to restore sufficient stream flow and which impacts MDWS long-range planning for surface water resources.

Objectives related to surface water use in the adopted Wailuku-Kahului Community Plan are:

- Protect cultural and archaeological sites: `Īao Stream, taro lo`i terraces in `Īao Valley, Nā Wai `Ehā.
- Preserve and protect Native Hawaiian rights and practices customarily and traditionally exercised for subsistence, cultural and religious purposes.
- Encourage traditional Hawaiian agriculture, such as taro cultivation, within the agricultural district, in areas which have been historically associated with this cultural practice.

Issue and Background: Because the pending IFS and surface water use permits determine allocation of surface water from Nā Wai `Ehā, no further strategies for surface water use and development are proposed here. Allocations recommended in the 2017 Proposed Decision are reflected as supply resources. However, certain stream use allocations may fall short under low flow conditions and require supplemental sources. The 2017 Proposed Decision may also be significantly revised in CWRM deliberations but is used as a primary guidance until any adjustments are necessary.

<u>Mauka to Makai Connection</u>

The 2017 Proposed Decision concluded that the established flows below the diversions must be increased if necessary to meet the needs of downstream water-use permittees and domestic users. The established flows are intended to result in continual mauka to makai streamflows, with the exception of Waikapū Stream, which did not flow continuously to the ocean under normal conditions.[81] When streamflows are insufficient to meet the proposed permitted amounts, a balance between upstream and downstream users while meeting the IIFS would have to be maintained. The IIFS, once adopted should therefore ensure fish and wildlife habitats, which in turn protects and provides for traditional and customary uses.

<u>Public Trust Uses</u>

The Hawai'i Supreme Court has identified four trust purposes which are equally protected under the law, three in the Waiahole Water Case, and a fourth in its 2004 decision, *In the Matter of the Contested Case Hearing on Water Use, Well Construction, and Pump Installation*

[81] CCHMA 1501 Hearing Officer's Proposed Findings of Fact, Conclusion of Law, and Decision & Order, November 1, 2017

Permit Applications, filed by Waiola o Moloka'i, Inc. and Moloka'i Ranch, Limited. These four trust purposes are:

- Maintenance of waters in their natural state;
- Domestic water use of the general public, particularly drinking water;
- The exercise of Native Hawaiian and traditional and customary rights, including appurtenant rights; and
- Reservations of water for Hawaiian Home Land allotments.

The Court has also identified several principles for the water resources trust, which have been applied in the Proposed Decision, including the two following:

- Competing public and private water uses must be weighed on a case-by-case basis, and any balancing between public and private purposes begins with a presumption in favor of public use, access, and enjoyment;
- Reason and necessity dictate that the public trust may have to accommodate uses inconsistent with the mandate of protection, to the unavoidable impairment of public instream uses and values. Offstream use is not precluded but requires that all uses, offstream or instream, public or private, promote the best economic and social interests of the people of the State.

Surface water under low flow, or drought conditions (Q90) can generally meet recommended Interim IFS, domestic uses, Category 1 surface water use permits and necessary water losses as allocated in the November 2017 Proposed Decision. This would at least theoretically satisfy the protected public trust uses. Category 2 permit allocations could generally be satisfied under normal, or median flow (Q50) conditions. Category 2 and Category 3 uses, if exercised, may require contingency and alternative resources during low flow conditions.

<u>Surface Water for Municipal Use</u>

Water provided by MDWS is for municipal purposes, which includes domestic uses for the general public and also limited industrial and commercial uses, government and fire protection. Surface water from Nā Wai `Ehā is a very cost effective strategy to serve projected population growth within Wailuku ASEA and throughout the service area of the MDWS Central Maui System. MDWS currently has an agreement with Wailuku Water Company for delivery of up to 3.2 mgd of surface water from the `Īao-Waikapū Ditch. The existing `Īao Water Treatment Facility (WTF) has a peak production capacity of 2.3 mgd and MDWS is currently able to produce approximately up to 1.7 mgd. A new WTF adjacent to the existing plant went online in November of 2018 that can deliver the full 3.2 mgd flow in the future. The Proposed Decision allocates 3.2 mgd for MDWS municipal needs.

Additional surface water for municipal needs was considered as preliminary candidate strategy in the 2009 WUDP update for the MDWS Central System. Alexander & Baldwin Properties designed the Wai`ale Water Treatment Facility with 9 mgd capacity in anticipation of future housing needs. Alternative treatment and storage strategies were considered in the WUDP update for MDWS Central Maui by Ha`ikū Design & Analysis, including a WTF in Waihe`e, various operational configurations and storage volumes. All of the above strategies were one of the least expensive alternatives to meet projected demand but not viable unless a long term source of water would be confirmed. Following designation of Nā Wai `Ehā as a surface water management area, such new uses are weighed against other potentially competing instream and offstream uses. Given recommended IFS and surface water use permit allocations as of the November 2017 Proposed Decision, a larger allocation of Nā Wai `Ehā stream water for municipal purposes is not plausible.

<u>East Maui Stream Uses in Central ASEA</u>
Conveyance of East Maui surface water for the MDWS Central Maui System municipal uses could be a cost effective alternative in wet season with ample stream flows. Alternative options are augmentation of the Hamakua Ditch to supplement South Maui growth areas and associated advantage of gravity for hydroelectric generation; alternative locations for water treatment facilities and reservoirs. However, the use of East Maui stream resources for planned growth in Central Maui was not introduced in the East Maui Contested Case or further explored in the WUDP update.

14.8.4 Climate Adaptation

Issue and Background: Data and research suggest that Hawai'i should be prepared for a future with a warmer climate, diminishing rainfall, declining stream base flows, decreasing groundwater recharge and storage, and increased coastal groundwater salinity, among other impacts associated with drought.

Reliance on surface water will become more uncertain in a future of longer droughts and varying rainfall. No streamflow projections are available for the coming century but projections include a decline in base flow and low flows, with streamflows becoming more variable and unstable (flashy), especially in wet years. [82] Groundwater recharge decreases in drought but local impact from climate change has not been projected to date.

In consistency with the *Climate Change Adaptation Priority Guidelines*, water purveyors should increase resilience and reduce vulnerability to risks related to climate change. Wailuku ASEA and Mauna Kahālāwai that recharges the basal aquifers and streams of Nā Wai `Ehā are the freshwater supply backbone for all of Central Maui. There are several recommended island wide and sector specific strategies in this plan that can mitigate impacts from climate change:

1. Continue Maui County financial support for watershed management partnerships' fencing and weed eradication efforts (Chapter 12.3, Strategy #1). West Maui Mountains Watershed Partnership and the Pu`u Kukui Watershed Preserve actively manage the critical

[82] Summarized from EcoAdapt. 2016. Climate Changes and Trends for Maui, Lāna'i, and Kaho'olawe. Prepared for the Hawaiian Islands Climate Synthesis Project

watersheds and key recharge areas for Wailuku aquifer sector ground and surface water sources.

2. Demand side conservation measures, such as water conserving design and landscaping in new development, incentives for efficient irrigation systems, landscape ordinance and promoting xeriscaping in dry areas will increase tolerance for prolonged droughts. (Chapter 12.3 Strategies # 13, 14, 15, 17)
3. Promote alternative resource incentives, such as greywater systems and rainwater catchment to supplement conventional resources. Incentives for green infrastructure and use of alternative water sources are needed to ensure such upfront investments in new development. (Chapter 12.3 Strategies# 20 and 21)
4. Formalize demand response plans for water purveyors that address water shortage and aquifer changes (Chapter 12.3 Strategy #46). Except for the designated `Īao groundwater management area, shortage plans are not required to have in place. MDWS and private purveyors should formalize action plans and alternative pump rate scenarios for all wells in response to declining water levels, increases in chlorides or escalated pumpage to protect aquifer health.
5. Diversify supply for agricultural use to increase reliability. Under extended droughts and low streamflows, diversified agriculture on HC&S lands will compete with priority public trust uses for surface water. Planned extension of R-2 recycled water from the Kahului WWTF to HC&S fields can supplement groundwater from the Central aquifer sector. (Chapter 12.3 Strategy #51).
6. Expand requirements for new development to connect to recycled water infrastructure, promote closer collaboration between MDWS and MDEM to utilize Drinking Water State Revolving Funds to maximize recycled water use. (Chapter 12.3 Strategies # 61 and 62)
7. Explore and promote opportunities for large volume stormwater runoff for agricultural irrigation. The Wai`ale Road Stormwater Drainage option assessed in "*T*he *Hawai'i Stormwater Reclamation Appraisal Report, 2005, and Study Element 3: An Appraisal of Stormwater Reclamation and Reuse Opportunities in Hawai'i*, *September* 2008" uses an existing stormwater drainage channel and detention pond located along Wai`ale Road to capture and convey stormwater into the Waihe`e and Spreckels Irrigation Ditch Systems for agricultural irrigation to the south and east. (Chapter 12.3 Strategy # 66)

14.8.5 Alternative Water Source Strategies

Residents want to maximize use of alternative sources of water (R-1 wastewater, rainwater, greywater, etc.) which would mitigate well and surface water use and the transport of water. Planning objectives related to alternative water sources identified in the WUDP update public process include:

- Maximize efficiency of water use

Planning objectives and policies related to alternative water sources adopted in the 2002 Wailuku-Kahului Maui Community Plan are:

- Promote conservation of potable water through use of treated wastewater effluent for irrigation
- Reuse treated effluent from the County's wastewater treatment system for irrigation and other suitable purposes in a manner that is environmentally sound

Qualitative criteria to evaluate and measure resource strategies against this planning objective include:

- Use of recycled water increased
- Greywater and catchment systems installed
- Infrastructure projects increase recycled water use and stormwater capture

Recycled Water

Issue and Background: Wastewater reclamation in Central Maui is managed by the Maui Department of Environmental Management (MDEM). There is no wastewater reclamation facility located within the Wailuku ASEA. Recycled water from the Kahului Wastewater Reclamation Facility (WWRF), the Kīhei WWRF and the private Mākena WWRF are all located in the Central ASEA. The Kīhei WWRF supplements the MDWS Central System, but does not extend service into the Wailuku ASEA. Recycled water generated in the Central ASEA therefore has the potential to offset demand in the Central ASEA that would otherwise be supplied by conventional water resources originating in the Wailuku ASEA. Recycled water availability and uncertainties are analyzed in Chapter 11.2.

<u>Kahului Wastewater Reclamation Facility</u>

R-2 water from the Kahului WTF can offset limited demand on the MDWS Central System as the approved uses of R-2 water are restricted. Treatment upgrade to R-1 quality and expansion of distribution from the Kahului WWRF to the Maui Lani area, the Kahului airport and Kanahā Beach Park were estimated to about $35M and has great potential to offset potable water while reducing effluent discharge to injection wells. There are no current plans or budget allocated for these projects.

The fiscal year 2018 MDEM budget included a $6.7M project to design a new distribution line connecting the Kahului WWTF to an existing line at the old Maui Pineapple processing facility in Kahului. Recycled water would then be available for landscape or agricultural irrigation on HC&S lands east of Kuihelani Highway. The project could preserve brackish water resources and offset irrigation demand on portions of the 1,951 acres of HC&S lands currently slated for "Large Diversified Farm Leases".[83] The Central Maui recycled water distribution system has not been developed to date because the majority of candidate commercial properties currently utilize inexpensive brackish or ditch water.[84] Irrigation of an energy crop on HC&S land that is not subject to the stricter requirements for edible crops, would benefit MDEM by reducing its reliance on injection wells for effluent disposal, and would benefit the HC&S lessee by displacing irrigation water otherwise diverted from Nā Wai `Ehā or East Maui streams. The project could serve to offset conventional resources from Ko`olau, Central and Wailuku aquifer sectors. This strategy applies to the Central ASEA Chapter 15 as well.

Strategy #8: Expand distribution from the Kahului WWTF and the application for planned energy crops. Potential available recycled water is 4.2 mgd. Lead agency is MDEM.

Kīhei Wastewater Reclamation Facility

The Kīhei WWRF serves the South Maui area from Wailea to Sugar Beach. As with potable water, recycled water production must meet their customers' needs at all times. As demand peaks during the summer months, MDEM estimates they have as little as 0.7 - 1 mgd of excess recycled water available during the peak demand months of summer. Therefore, peak use limits additional potable water displacement unless a seasonal storage reservoir or brackish groundwater can supplement peak demand use. MDEM projects currently budgeted (as of April 2018) include two projects:

1. Liloa Drive distribution line design, to create a looped system and reliable service to the planned Kīhei High School. The $0.5M project will coincide with roadway construction.
2. Second storage tank and booster station to provide more reliable service for existing R-1 customers and allow for more customers to connect to the South Maui recycled system. The project is budget to $6.2M to be implemented in 2018.

These projects will increase reliability and offset potable water from the MDWS Central System and benefit the Wailuku ASEA and Central ASEA. Funding is a key constraint to implement planned expansions of the R-1 system.

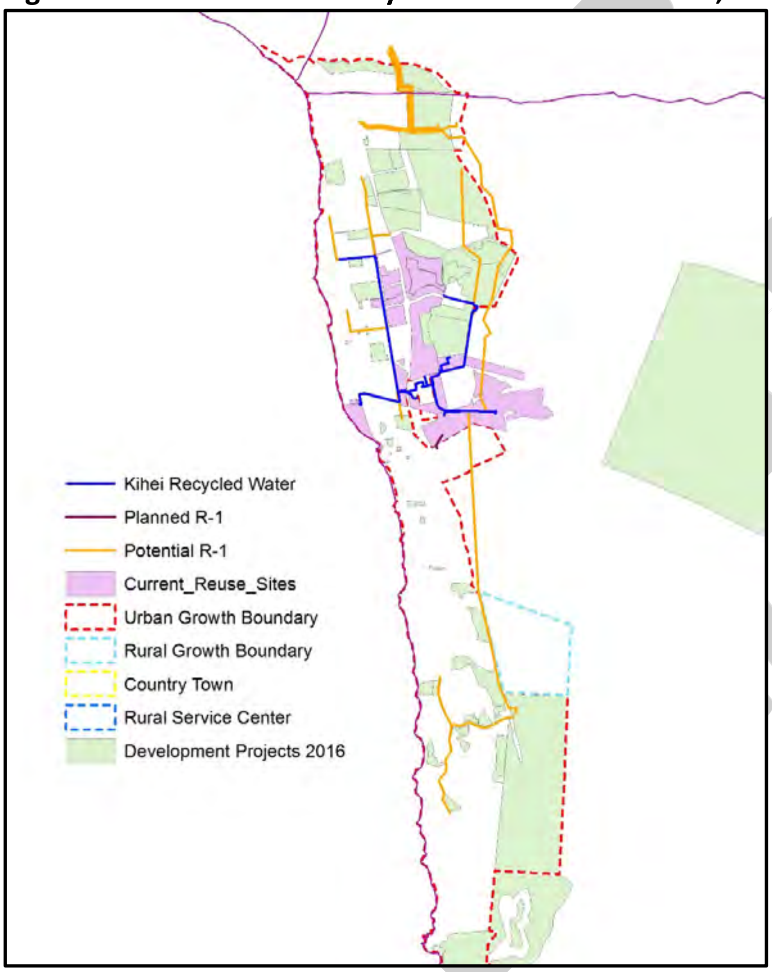
The 2009 Maui WUDP Central DWS District Plan update and the 2009 South Maui R-1 Recycled Water Verification Study explored a new transmission line to the Wailea area to displace potable water used for irrigation purposes. About 1.1 mgd of potable water could potentially be

[83] Mayor's Proposed Budget FY2018 Capital Improvement Program CBS-1171
[84] 2010 Central Maui Recycled Water Verification Study

offset during the winter months when R-1 water use at existing and planned future properties decreases. Capital costs for 26,235 feet of transmission, 19 service laterals, two R-1 storage tanks, and ultra violet disinfection, pressure reduction and pump station upgrades were estimated to $21M. The viability and potential funding of this strategy is still not determined. Strategy #8 applies to Wailuku ASEA and Central ASEA.

Strategy #9: MDWS and MDEM collaborate to identify private-public partnerships, state and federal funding sources to maximize utilization of recycled water produced at the Kīhei WWTF and supplemental non-potable sources for seasonal use of R-1 water. Lead agencies are MDEM and MDWS.

Figure 14-35 South Maui Recycled Water Service Area, Planned and Potential Expansion



It's preferable to provide the non-potable infrastructure in design and construction rather than retrofitting existing uses with separate non-potable distribution lines and backflow preventer to avoid cross-contamination.

Rainwater Catchment Systems

Issue and Background: Rainwater catchment is not as reliable as conventional water resources because it is extremely sensitive to the micro climate. Rain barrels and cisterns can still supplement irrigation on a limited basis in the Wailuku region, with less potential in the South Maui region served by the MDWS Central System. Rain barrel incentive programs are included in recommended demand side conservation strategies and the MDWS conservation program.

Stormwater Reuse

Issue and Background: Streamflows becoming more variable and unstable (flashy) is predicted, especially in wet years. Increased stormwater flows pose opportunities for stormwater recycling and further resource diversification in the region. Stormwater capture and use can provide multiple mitigating effects on climate change, including off-setting potable supply for irrigation needs; recharging low level and more brackish portions of the region’s aquifers; and mitigating sediment runoff reaching the nearshore marine environment and reefs. Stormwater management is under the Maui County Department of Public Works responsibilities.

The *Hawai'i Stormwater Reclamation Appraisal Report, 2005, and Study Element 3: An Appraisal of Stormwater Reclamation and Reuse Opportunities in Hawai'i*, *September 2008*, screened and identified four projects on Maui within the final ranking, which might provide opportunities to augment agricultural irrigation water that is diverted currently from Maui streams, in addition to providing other benefits:[85] The Wai`ale Road Stormwater Drainage option uses an existing stormwater drainage channel and detention pond located along Wai`ale Road to capture and convey stormwater into the Waihe`e and Spreckels Irrigation Ditch Systems for agricultural irrigation to the south and east. The collection area is about 560 acres and adjacent to large tracts of agricultural land. Current source for the Waihe`e and Spreckels ditches are Nā Wai `Ehā streams. The 2017 Proposed Decision for Nā Wai `Ehā contested case limits uses of the Spreckels Ditch and does not address the stormwater reuse as an alternative water source. No institutional constraints were identified for this opportunity with cost assessed to about $10M. Potential beneficiaries include A&B Inc., HC&S and land lessees, and Spencer Homes. The viability of this option and seasonal benefit needs be further explored.

Strategy #10: Explore the Wai`ale Road Stormwater Drainage as potential to offset stream diversions associated with Spreckels and Waihe`e Ditches and supplement irrigation sources for agricultural water demands in Central Maui. Lead agencies would be State DOA, Maui County Department of Public Works, HC&S and agricultural end users.

[85] Hawai'i Stormwater Reclamation Appraisal Report, 2005, and Study Element 3: An Appraisal of Stormwater Reclamation and Reuse Opportunities in Hawai'i, September 2008. http://files.Hawai'i.gov/dlnr/cwrm/planning/hsrar_element3.pdf

Stormwater reclamation and reuse can also offset landscape irrigation demand at the project or household level. Strategy #22 in the WUDP Part II addresses incentives and code revisions to promote incorporating green infrastructure in new development.

Desalination

Issues and Background: Desalination is viewed by some as energy intensive and potentially impacting natural nearshore ecosystems. Desalination of brackish groundwater is an alternative for potable water. A feasibility study that considered desalination of brackish groundwater or seawater determined that brackish groundwater was the more cost-effective option of the two.[86] A preliminary strategy for desalination of brackish groundwater includes the development of a 5.0 mgd reverse osmosis desalination facility in Central Maui to meet a portion of future needs on the MDWS Central System. Brackish groundwater would be pumped from the Kahului aquifer to supply the treatment plant. The reverse osmosis process would remove salt and other minerals to create potable water. Brine residual liquid stream created in the process would require disposal. Deep injection wells into salt water below the groundwater lens is considered to be the most practical and economical solution. [87] Desalination is feasible but was not a favored strategy in the WUDP update public process. Uncertainty on imported energy sources, the high cost and environmental issues associated with brine disposal are concerns that do not make the strategy viable at this time.

[86] Brown & Caldwell, Central/South Maui Desalination Feasibility Study, Final Report, December 2006
[87] Ibid.

14.9 Recommendations

In summary, groundwater in the Wailuku region can supply most of the projected population growth served by the Maui Department of Water Supply Central System through year 2025. Municipal use comprised about 98 percent of groundwater withdrawals from the Wailuku ASEA, but less than 3 percent of diverted surface water. Source development needs assumes that the Kahakuloa aquifer, with a sustainable yield of 5 mgd, is not developed over the planning period. Hydrologic studies and groundwater models underway should guide the county and private purveyors' future development and source distribution in the Waihe`e and Waikapū aquifers to ensure long term sustained withdrawals. Recycled water can contribute at minimum an additional 0.7 mgd to offset supply on the Central Maui System.

Depending on multiple socio-economic factors, additional groundwater source imports from outside the Wailuku and Central aquifer sectors will be needed within the next ten years to provide for planned growth in Central and South Maui. Exploration of East Maui basal water requires a comprehensive hydrologic study to determine any negative impact on existing ground and surface water sources, streamflow and influences from dikes.

A combination of resource augmentation, developing and expanding the use of alternative resources and conservation measures will delay the need for source development and further diversify our water supply to prepare us for long term impact from climate change.

Agricultural needs on the Central isthmus that historically have relied on abundant streamflow from Nā Wai `Ehā will need to adapt to a lesser share, especially in dry season. Collaboration between county agencies and private parties to implement and fund alternative water resource strategies should not be delayed.

Restoration of streamflow is the center piece to Native Hawaiian subsistence and cultural needs in the region. Ecosystems and native species dependent on mauka to makai connection have seen a significant revival in Nā Wai `Ehā following stream restoration over the last few years. Pending the final outcome of the contested case for Nā Wai `Ehā , it's not too early to establish clear responsibilities and a practical implementation plan for successful management of Nā Wai `Ehā resources.

Potable and non-potable supply to meet the selected demand scenarios are summarized in Table 14-40. As the Water Use and Development Plan must be based on hydrologic units, in this case aquifer sectors, demand and supply within the Wailuku aquifer sector are included in the table. As discussed throughout this chapter, the Wailuku, Central and Ko`olau hydrologic units are historically and currently closely entwined through water imports and exports. Land use planning based on community districts further links the Wailuku, Kahului and South Maui communities. Resource use and projected demand for the MDWS Central System as a whole is therefore used for practical planning purposes, in addition to agricultural and other non-potable needs.

Table 14-40 Selected Demand Scenario: Projected Water Demand and Supply Options Wailuku ASEA and MDWS Central System

DEMAND (MGD)	2014	2015	2020	2025	2030	2035
MDWS Potable Wailuku and Central ASEA*	22.274	22.699	25.421	28.100	31.224	34.134
MDWS Potable export to Central ASEA	17.664	17.990	20.574	23.090	26.093	28.828
MDWS Potable Wailuku ASEA only	*4.610*	*4.709*	*4.847*	*5.010*	*5.131*	*5.307*
Total Potable:	22.274	22.699	25.421	28.100	31.224	34.134
Non-Potable (AG, IRR, DOM)**	35.411	35.411	35.307	35.365	35.432	35.495
Other, Non-Potable (water losses)	2.730	2.730	2.730	2.730	2.730	2.730
Total Non-Potable	38.141	38.141	38.037	38.095	38.162	38.225
TOTAL DEMAND	**60.415**	**60.841**	**63.458**	**66.194**	**69.386**	**72.360**
SUPPLY (MGD)						
Potable Groundwater Wailuku ASEA	20.353	19.909	19.939	21.355	19.071	16.493
`Īao Aquifer GWMA	17.28	16.430	15.939	14.255	12.171	9.593
Waihe`e Aquifer	3.479	3.479	4.000	4.900	4.900	4.900
Waikapu Aquifer	0.000	0.000	0.000	2.200	2.000	2.000
Potable Groundwater Central ASEA/Kahului Aquifer/Maui Lani Wells	0.930	1.090	1.090	1.090	1.090	1.090
Non-Potable Groundwater	0.400	0.408	0.457	0.505	0.561	0.613
`Īao Aquifer GWMA	0.341	0.348	0.377	0.405	0.441	0.493
Waihe`e Aquifer	0.058	0.06	0.08	0.1	0.12	0.12
Potable surface water	0.990	1.700	3.200	3.200	3.200	3.200
Non-Potable surface water	36.161	36.154	36.000	36.010	36.022	36.032
Waikapu Stream	2.957	2.957	2.957	2.957	2.957	2.957
Wailuku River	5.438	4.728	3.228	3.228	3.228	3.228
Waiehu Stream	0.833	0.833	0.833	0.833	0.833	0.833
Waihe`e River	8.327	8.327	8.327	8.327	8.327	8.327
Na Wai Eha multiple sources	18.606	19.308	20.655	20.665	20.676	20.687
Recycled Water (South Maui MDWS Service Area)	1.580	1.580	2.080	2.280	2.280	2.280
Water Conservation (8% per capita)	0.000	0.000	0.692	1.755	3.163	4.651
Potable Groundwater Import Ko`olau ASEA/Ha`ikū Aquifer	0.000	0.000	0.000		**4.000**	**8.000**
TOTAL SUPPLY	**60.414**	**60.841**	**63.458**	**66.194**	**69.386**	**72.360**

*Includes Maui Lani Wells

**Includes AG served by Nā Wai `Ehā

Table 14-41 below summarizes recommended strategies and indicates the planning objectives that each strategy supports. Estimated costs are, unless indicated otherwise, life cycle costs for the twenty-year planning period per 1,000 gallons. Life cycle costs include capital, operational and maintenance costs and include inflationary effects. Costs to develop and implement sustainability projects are not quantified per volume water supply. Lead agencies, or organization to implement a strategy is proposed as a starting point. The timeframe for implementation is indicated as short term – less than 5 years, and long term- 5 – 20 years. Many strategies are multi-year actions with implementation beginning within 5 years and continuing through the long term (indicated as 1, 2).

Table 14-41 Summary of Recommended Strategies Wailuku ASEA

	STRATEGY	PLANNING OBJECTIVES	ESTIMATED COST	IMPLEMENTATION 1: Short-term 1 – 5 years 2: Long-term 5 – 20 years	
				AGENCY	TIME-FRAME
	RESOURCE MANAGEMENT				
1	Continue Maui County financial support for watershed management partnerships' fencing and weed eradication efforts.	Maintain sustainable resources Protect water resources Protect and restore streams	$1.1M to $1.7M - per year (from all funding sources)	MDWS Maui County	1
2	Establish a diverse working group to address alternative structures for future management of the watershed lands and sustained operations of the WWC ditch system	Maintain sustainable resources Protect water resources Protect and restore streams	N/A	Aha Moku Hui O Nā Wai `Ehā OHA Maui County Wailuku Water Company	1
	CONVENTIONAL WATER SOURCE STRATEGIES				
3	Adapt pumpage of constructed wells in Waikapū Aquifer with guidance from the 2015 USGS groundwater flow model results, when available.	Provide adequate volume of water supply Maximize reliability of water service Minimize adverse environmental impacts Minimize cost of water supply	$4.25* /1,000 gallons	MDWS Waikapū Properties LLC USGS	1, 2
4	Explore new basal well development in the southern portion of Waihe`e aquifer based on results of USGS groundwater model and best pumping scenarios. Monitor impact on existing production wells and aquifer transition zone from development of Mendez wells.	Provide adequate volume of water supply Maximize reliability of water service Minimize adverse environmental impacts Minimize cost of water supply	N/A (costs only assessed for northern portion of aquifer)	MDWS	1

STRATEGY		PLANNING OBJECTIVES	ESTIMATED COST	AGENCY	TIME-FRAME
5	Continue exploration of East Maui well development in consideration of reliable capacity for planned growth areas, including the MDWS Central Maui System. Initiate a hydrologic study to determine any negative impact on existing ground and surface water sources, streamflow and influences from dikes.	Maintain sustainable resources Provide adequate volume of water supply Maximize reliability of water service Minimize adverse environmental impacts Minimize cost of water supply	$3.71*/1000 gallons	CWRM USGS MDWS	1
6	Reduce non-potable use of Wailuku Aquifer Sector basal and high level water to the extent feasible. Prioritize available recycled water and brackish water for non-potable uses where available in the Central Aquifer Sector.	Maximize water quality Manage water equitably Maintain consistency with General and Community Plans		CWRM MDWS MDEM MDP	
7	Monitor outcome of the East Maui Streams contested case and final Instream Flow Standards, available ditch flow and water quality implications of blending the water source to determine benefits and viability of interconnecting the MDWS Central Maui and Upcountry Systems.	Maximize reliability of water service Maximize efficiency of water use Minimize cost of water supply	N/A	MDWS	2
ALTERNATIVE WATER SOURCE STRATEGIES					
8	Expand distribution from the Kahului WWTF and the application for planned energy crops.	Maximize efficiency of water use Maintain consistency with General and Community Plans	$6.7M	MDEM HC&S	1 2
9	Identify private-public partnerships, state and federal funding sources to maximize utilization of recycled water produced at the Kīhei WWTF and supplemental non-potable sources for seasonal use of R-1 water.	Maximize efficiency of water use Maintain consistency with General and Community Plans	(Transmission South Kīhei to Wailea $21M)	MDEM MDWS	1 2
10	Explore the Wai`ale Road Stormwater Drainage as potential to offset stream diversions associated with Spreckels and Waihe`e Ditches and supplement irrigation sources for agricultural water demands in Central Maui.	Minimize adverse environmental impacts Maximize efficiency of water use Maintain sustainable resources	$10.0M	DPW DOA HC&S	2

*20-year total cost includes upfront capital costs, operation and maintenance, repair and replacement and does not include inflation and other economic factors

14.9.1 Implementation Program

In consistency with the Maui Island Plan, strategies recommended and adopted in the WUDP do not legally bind the agencies and organizations to execute. The recommendations provide guidance for land use and infrastructure, including the county capital improvement programs (CIP), over the planning period.

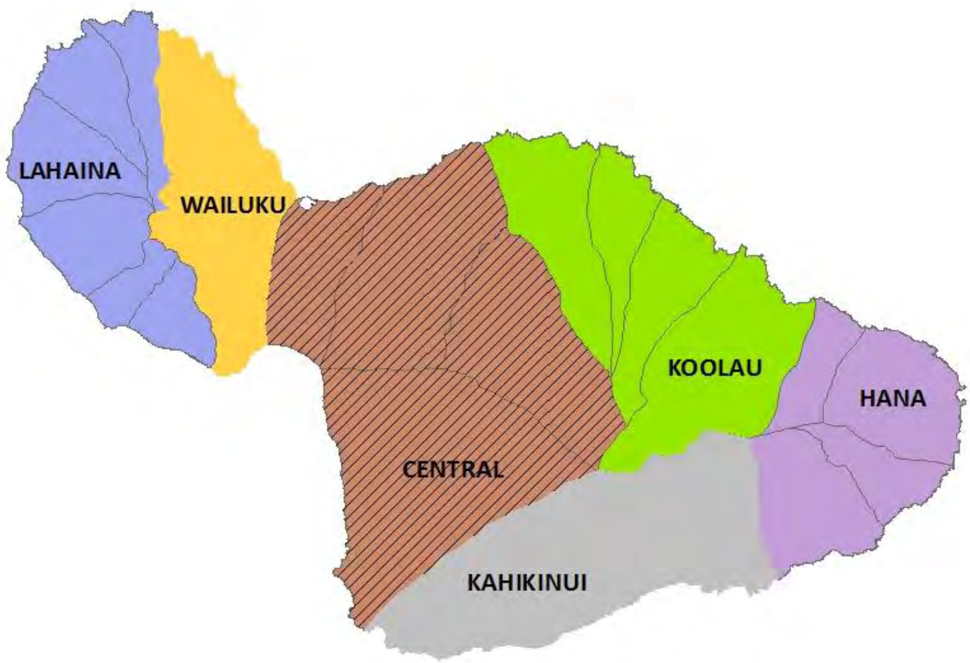
Timing and prioritizing of conventional and alternative resource strategies are tied to actual population growth and economic factors that drive individual development projects. Prioritizing and timing of resource management and augmentation strategies will also depend on available manpower and expertise by agencies and organizations tasked to scope out and execute a strategy. Funding is of course the driving factor of implementation. For the Wailuku region, the lion's share of conventional and alternative resource strategies rely on funding by the county agencies, but will also require creative public-private partnerships. Resource protection, conservation and alternative resource strategies have state-wide support including the following:

- The Hawai`i Fresh Water Initiative, launched in 2013 by the Hawai`i Community Foundation to increase water security for the Hawaiian Islands. A state-wide goal of 100 mgd in additional fresh water focuses on three aggressive water strategy areas and individual targets for the public and private to achieve by 2030: 1) **Conservation**: Improve the efficiency of the total underground aquifer water use rate by 8% with a target of 40 mgd in increased water availability; 2) **Recharge**: Increase Hawai`i's ability to capture rainwater in key aquifer sector areas by improving stormwater capture and nearly doubling the size of our actively protected watershed areas with a target of 30 mgd in increased water availability; and 3) **Reuse**: More than double the amount of wastewater currently being reused on the Islands with a target of 30 mgd in increased water availability by 2030.

- The watershed initiative program by the State Department of Land and Natural Resources "The Rain Follows the Forest" seeks to double the acreage of protected watershed forests by 2021.

Major capital improvements for conventional resource strategies under the jurisdiction of MDWS were roughly assessed in the Maui Island Plan to meet projected demand to year 2030. Depending on the combination of new sources pursued, cost was estimated at $100 million, which roughly corresponds to recommended conventional resource strategies in this update. The MDWS capital improvement program budget for the Wailuku and Central region currently does not include additional groundwater source development to serve projected growth. Implementation timeframe of the recommended strategies will ultimately depend upon available capital funding.

Over the planning period, implementation and performance of the recommended strategies can be assessed using qualitative criteria and quantitative targets formulated in the WUDP Part I, Table 3-3. Goals and performance measures on an island wide basis is provided in Appendix 15.



MAUI ISLAND WATER USE AND DEVELOPMENT PLAN DRAFT

PART III REGIONAL PLANS

CENTRAL AQUIFER SECTOR AREA

Table of Contents

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS:

CWRM	Commission on Water Resource Management
DHHL	State of Hawai'i Department of Hawaiian Home Lands
DLNR	State of Hawai'i Department of Land and Natural Resources
DOA	State of Hawai'i Department of Agriculture
DOH	State of Hawai'i Department of Health
HRWA	Hawai'i Rural Water Association
Maui County	Maui County Administration and Maui County Council
MDEM	Maui County Department of Environmental Management
MDP	Maui County Department of Planning
MDPW	Maui County Department of Public Works
MDWS	Maui County Department of Water Supply
SWCD	Soil and Water Conservation District
UH CTAHR	University of Hawai`i College of Tropical Agriculture and Human Resources
USDA	U.S. Department of Agriculture
USGS	U.S. Department of the Interior, U.S. Geological Survey
WWC	Wailuku Water Company

15.0 CENTRAL AQUIFER SECTOR AREA

The Central Aquifer Sector Area (ASEA) encompasses about 229.33 square miles, including 4 groundwater aquifer system areas (ASEAs) underlying the western flank of Haleakalā Mountain: Kahului, Pā`ia, Makawao, and Kama`ole. The population of the Central Aquifer Sector Area includes parts of the resident populations from the following community plan areas: Kīhei-Mākena, Wailuku-Kahului, Makawao-Pukalani-Kula, Pā`ia-Ha`ikū, and to a very minor extent Hāna. The estimated population of the Central ASEA was 103,970 in 2015 and is projected to increase by approximately 33 percent to 138,164 by 2035.

The Central Aquifer Sector Area (ASEA) remains the economic and population center of the island. In the 1990s, this area saw significant increases in trade, transportation, communications and utilities, and government jobs. Kahului is the island's major commercial-industrial and shipping center and has the largest employment center. The Central ASEA comprises about 50% of the Wailuku-Kahului Community Plan District. The district has the largest resident population of all community regions. Kahului's residential neighborhoods are separated from commercial uses. The 2030 Socio-Economic Forecast suggests the Wailuku-Kahului Community Plan Area will grow faster than other parts of Maui, as former sugar lands are developed into residential subdivisions. Wailuku-Kahului is expected to maintain its status as home to more than a third of Maui's households.

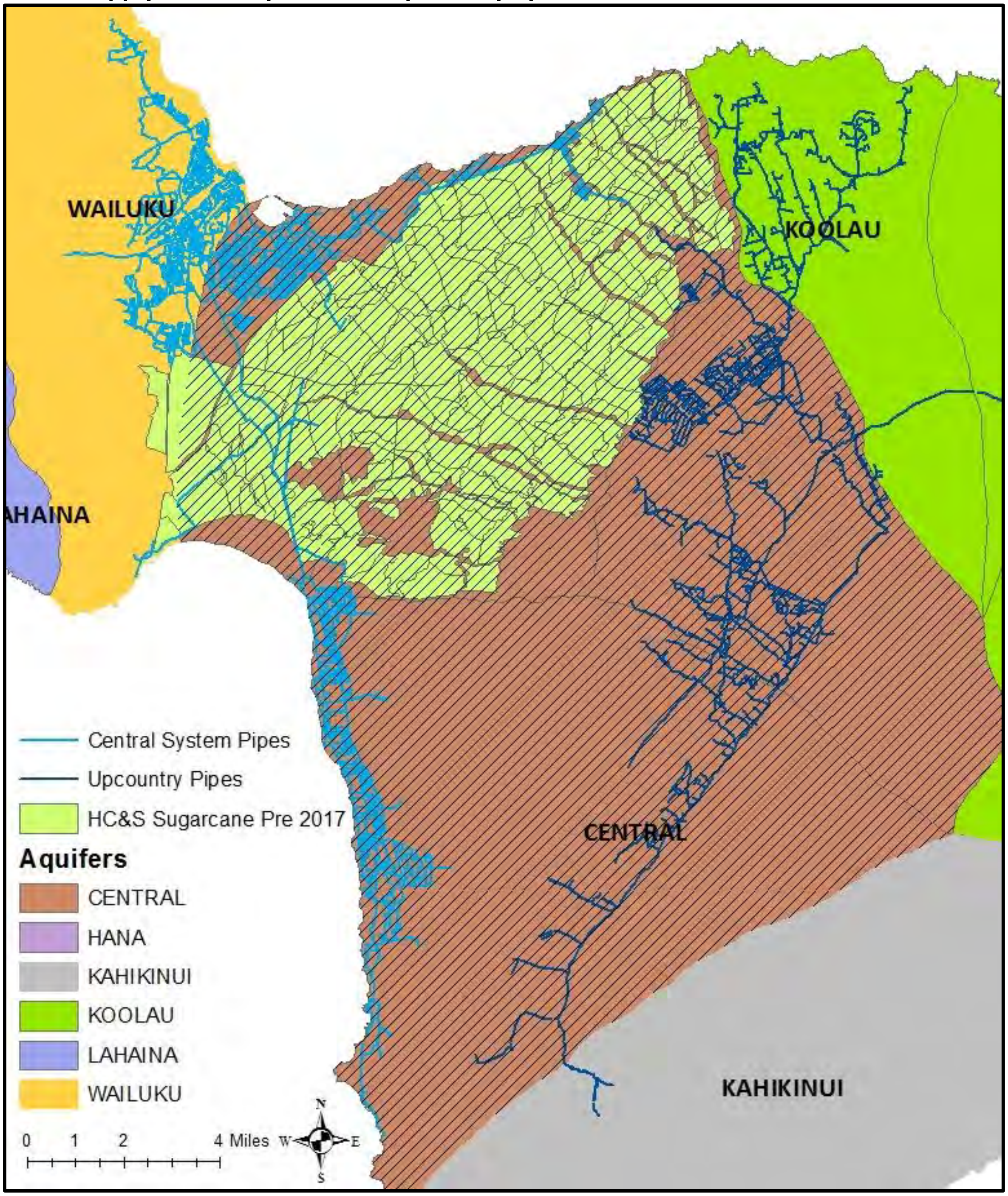
The WUDP uses aquifer sector hydrologic units for presentation and analysis consistent with state requirements for updating the plan. The Central ASEA spans multiple moku that are generally more aligned with watershed boundaries than aquifer sectors. The majority of the Central ASEA lies within the moku of Kula, with portions of the Central isthmus also encompassing the moku of Pu`ali Komohana and Hāmākuapoko (Hāmākua Poko), and to a minor extent the moku of Hāmākualoa (Hāmākua Loa). The southernmost portion of the ASEA is encompassed by the moku of Honua`ula.

The roughly 37,000 acre Hawai`i Commercial and Sugar (HC&S) plantation overlies the Central ASEA. Lands cultivated in sugarcane through 2016 are undergoing a transition to diversified agriculture. Agricultural irrigation supply on the Central isthmus comes from a combination of surface water from East Maui Streams in the Ko`olau ASEA, surface water from Nā Wai `Ehā in the Wailuku ASEA, and groundwater within the Central ASEA.

Public water supply used in the Central ASEA is also primarily generated from outside the aquifer sector. Two of the Maui Department of Water Supply (MDWS) systems are partially located in the Central ASEA: The Central Maui System (Central System) services the north shore from Waihe`e to Pā`ia/Kū`au, Kahului, Wailuku, Waikapū and the south shore from Mā`alaea to Mākena. The Upcountry System services the Ha`ikū, Makawao, Pukalani and Kula communities.

The figure below shows the MDWS systems and HC&S lands overlying the three aquifer sectors.

Figure 15-1 Wailuku, Central and Ko`olau Aquifer Sectors, HC&S Lands, Maui Department of Water Supply Central System and Upcountry System



15.1 PLANNING FRAMEWORK

15.1.1 Key Issues

Issues Raised in the Water Use and Development Plan Public Process

Initial efforts to update the 1990 WUDP included a public process and stakeholder meetings in 2007 – 2009 that addressed the MDWS Upcountry system but not all water uses and users in the Central ASEA. The Upcountry Water Advisory Committee identified a broad range of planning objectives and suggested candidate strategies for this MDWS system.

The WUDP update was reignited at the end of 2015 and MDWS staff subsequently held several rounds of open public meetings, workshops and focus meetings for various stakeholder and special interest groups during 2016 that identified key issues and concerns for each region. In addition to input at meetings, the Department conducted manual and on-line surveys to poll residents on water issues and solutions for their regions. Because the overlap between the MDWS water systems and hydrologic boundaries can be confusing, meetings held in Upcountry focused both on the resources within the Central and Ko`olau Aquifer sectors and the MDWS Upcountry system, while meetings held in Central Maui focused on the Wailuku aquifer sector and the MDWS Central System. Many of the issues raised pertain to stream diversions from the Ko`olau ASEA that are ultimately transported to Central and Upcountry Maui. While overlapping, key issues identified for the Central ASEA, which includes Central, South and Upcountry Maui communities and water resources within the Ko`olau ASEA relate to managing the development and transportation of water from areas with abundant rainfall to areas with scarce rainfall and subsidizing infrastructure in water scarce areas, maintenance of traditional resource management using the ahupua`a system and ensuring that traditional and customary practices are safe guarded. Much of the public water use in the Central ASEA relies on Ko`olau surface water resources conveyed via privately owned transmission systems. A key issue for the region is providing affordable water for future needs, providing for Upcountry and central Maui isthmus farming and other public trust uses during droughts, and managing resources in a sustainable way.

Key issues and concerns can be categorized within the following interests:

- Water Management and Transport
- Streamflow Protection and Native Hawaiian Rights and Uses
- Department of Hawaiian Homelands Needs
- Impact of HC&S transition
- Environmental Protection
- Alternative Water Sources and Conservation
- Water Availability and the Upcountry Priority List

Water Management and Transport

- Transport of water primarily from the Ko`olau ASEA to Upcountry, Central, and South Maui is an issue for all of the affected communities.
- Understanding of the concepts of "precautionary planning" to reduce and adapt to the effects of drought and climate change upon water resource availability and quality is important.
- The cost of managing the East Maui Irrigation System is necessary information to evaluate future management responsibilities.

Streamflow Protection and Native Hawaiian Rights and Uses

- Access to lands for gathering, hunting and other native Hawaiian traditional and customary practices.
- Consultation and coordination with Native Hawaiian community/moku and local experts on resource management and invasive species removal should be prioritized.
- Increase streamflows in order to facilitate an increase in cultivation of kalo.

Water Availability and the Upcountry Priority List

- Adequate water supply to support Upcountry agriculture is a community value.
- The Community Plan says if water is available the priority is agriculture and DHHL.

Alternative Water Sources and Conservation

- Adapting future populations to local water resource conditions, integrating conservation and the use of alternative resources

Environmental Protection

- Watershed protection and its prioritization is important, including invasive alien plant control, ungulate control, and reforestation via watershed partnership programs.
- Build up what is taken from aquifers.

Department of Hawaiian Homelands Needs

- Water needs of DHHL should be considered in general and in accordance with the 2017 State Water Projects Plan.

Impact of HC&S transition

- Long term plans to manage the EMI system, including use and maintenance of reservoirs are a concern
- EMI system efficiency

Maui Island Plan Issues

The Maui Island Plan (MIP), adopted in 2012 identified challenges and opportunities for the MDWS systems. Issues generally apply island wide, but some are specific to the Central ASEA, the MDWS Upcountry system and users:

- Reliance on surface water Upcountry makes the system vulnerable to drought conditions
- Voluntary and mandatory water use restrictions imposed on residential and agricultural users during droughts often negatively impact the productivity of farmers
- The expense of treating (filtering and chlorinating) municipal water is not necessarily needed for agricultural users that rely on the MDWS Upcountry system
- Uncertainty over long term source to support large scale agriculture in Central Maui
- Competition for unused diverted water and uncertainty has the potential for negatively affecting future agriculture due to lending institutions' requirements to demonstrate long-term access to water to secure loans
- Potential to increase use of reclaimed water for agricultural operations and more cost effective desalination and improved technologies

Community Plan Issues

This section describes key issues identified in the Pā`ia-Ha`ikū Community Plan, the Makawao-Pukalani-Kula Community Plan and the Wailuku-Kahului Community Plan as it relates to regional and inter-regional water resources and use.

- The development of new ground water sources in Ha`ikū to service the Central Maui area of Wailuku-Kahului and Kīhei-Mākena raises a concern over the allocation of water resources to these other regions if and when the present and future needs of the Pā`ia-Ha`ikū area are not met.[1]
- A primary concern for Makawao-Pukalani-Kula residents is the limited development of water resources and a distribution system to meet the needs of the region. The proper allocation of water resources is considered essential to, in order of priority: (1) preserve agriculture as the region's principal economic activity, promote diversified agricultural activities, and effectively encourage the development of Department of Hawaiian Home Lands (DHHL) parcels; and (2) ensure the long-term viability of the region's residential and economic base.[2]

Water use in the Upcountry region is recognized as having impacts on the streams of East Maui and the agricultural activities of the central valley. A comprehensive water management strategy must be developed to strike a balance between the various interests and accommodate environmental, agricultural and residential needs of all neighboring regions.[3]

[1] County of Maui, Pā`ia-Ha`ikū Community Plan, 1994, page 11
[2] County of Maui, Makawao-Pukalani-Kula Community Plan, 1996, page 12
[3] Ibid, page 15.

15.1.2 Plans, Goals, Objectives and Policies

The planning objectives identified by the Upcountry Water Advisory Committee through 2009 consider water service availability, reliability, quality, cost, protection of streams, water resources, cultural resources, sustainability, equity, viability, and conformance with general and community plans. [4] These are consistent with the broad planning objectives synthesized in the WUDP update public process.

The MIP island-goals, objectives and policies that apply island wide are summarized in Chapter 14.1.2. All goals and objectives adopted in Chapter 6.3 of the MIP are consistent with the broad planning objectives of the WUDP as shown in the matrix of WUDP Part I, Appendix 2 *"County Plan Policy and Programs Relevant to the WUDP, and Consistency with the Planning Objectives".*

The Central ASEA contains areas that fall under three different Community Plans: (1) the 2002 Kahului-Wailuku Community Plan; (2) the 1996 Makawao-Pukalani-Kula Community Plan; and 3) the 1995 Pā`ia-Ha`ikū Community Plan. Region and inter-regional goals, objectives and policies for the three community plans are summarized below.

The 2002 Kahului-Wailuku Community Plan

The Wailuku-Kahului Community Plan adopted in 2002 remains in effect. Relevant goals, objectives and policies related to water resources and water infrastructure are summarized below.

Water Resources

- Protect water resources in the region from contamination, including protecting ground water recharge areas, and wellhead protection areas within a 1.25-mile radius from the wells.
- Protect cultural and archaeological sites: `Īao Stream, taro lo`i terraces in `Īao Valley, Nā Wai `Ehā.
- Promote and implement programs for ground water and wellhead protection.

Water Availability and Use

- Coordinate water system improvement plans with growth areas to ensure adequate supply and a program to replace deteriorating portions of the distribution system. Future growth should be phased to be in concert with the service capacity of the water system.
- Improve the quality of potable water.
- Coordinate the construction of all water and public roadway and utility improvements to minimize construction impacts and inconveniences to the public.

[4] Haiku Design & Analysis, Maui County Water Use and Development Plan Upcountry District, Final Candidate Strategies Report, Upcountry Water Advisory Committee Review Draft, July 27, 2009 page 12.

- Coordinate expansion of and improvements to the water system to coincide with the development of residential expansion areas.
- Preserve agricultural lands as a major element of the open space setting bordering various communities.
- Preserve and protect native Hawaiian rights and practices customarily and traditionally exercised for subsistence, cultural and religious purposes.
- Encourage traditional Hawaiian agriculture, such as taro cultivation, within the agricultural district, in areas which have been historically associated with this cultural practices.

Supply Augmentation/Demand Controls

- Promote conservation of potable water through use of treated wastewater effluent for irrigation.
- Reuse treated effluent from the County's wastewater treatment system for irrigation and other suitable purposes in a manner that is environmentally sound.
- Provide incentives for water and energy conservation practices.
- Promote energy conservation and renewable energy.
- Incorporate drought-tolerant plant species and xeriscaping in future landscape planting.

The 1996 Makawao-Pukalani-Kula Community Plan

Water Availability and Use

- Prioritize the allocation of water as new resources and system improvements become available as follows: (a) for maintenance and expansion of diversified agricultural pursuits and for the Department of Hawaiian Home Lands projects; and then (b) for other uses including development of new housing, commercial and public/quasi-public uses.
- Encourage a flexible and comprehensive water management approach that recognizes the various collection and delivery improvements as one cohesive system.
- The Department of Water Supply shall expand water supply and distribution systems, including catchment systems, in accordance with the directions set forth in the Makawao-Pukalani-Kula Community Plan.
- Restrict the use of any water developed within or imported to the Upcountry region to consumption within the Upcountry region, with exception provided for agricultural use.
- Recognize and support the immediate allocation of water resources for Department of Hawaiian Home Lands projects and agriculture.
- Seek expanded municipal withdrawal from the lowest cost source to serve the Upcountry region.
- Support the development of separate domestic and irrigation water systems. Encourage the construction of additional storage capacity by the Department of Water Supply, commercial developers, and individual farmers to help alleviate the inadequate water supply.
- Encourage cooperative efforts among Federal, State, and County agencies, and developers to ensure that water storage and delivery needs of the region are met in a timely and orderly manner.

Supply Augmentation/Demand Controls

- Explore the development of alternative water sources (e.g., grey water, catchment systems, etc.) to meet the needs of diversified agriculture, businesses and residents.
- Recognize the importance of the forested watershed areas and that their health and well-being are vital to all the residents of the Upcountry area.
- Explore a comprehensive reforestation program to increase and catch more rainwater for the Upcountry area.

The section that addresses DHHL needs notes that water use in the Upcountry region is recognized as having impacts on the streams of East Maui and the agricultural activities of the central valley. A comprehensive water management strategy must be developed to strike a balance between the various interests and accommodate environmental, agricultural and residential needs of all neighboring regions. [5]

<u>The 1995 Pā`ia-Ha`ikū Community Plan</u>

Water Resources

- Ensure that the development of new water sources does not adversely affect in-stream flows.

Water Availability and Use

- Increase water storage capacity with a reserve for drought periods.
- Ensure that adequate water capacity is available for domestic and agricultural needs of the region. Continue the conversion to drip irrigation in sugar cane fields, provided that the practice complies with soil conservation standards.
- Improve the existing potable water distribution system and develop new potable water sources prior to further expansion of the State Urban District boundary or major subdivision of land in the State Agricultural or Rural Districts.
- Ensure adequate supply of groundwater to residents of the region before water is transported to other regions of the island.

<u>The 1998 Kīhei-Mākena Community Plan</u>

An important overall goal of the Kīhei-Mākena Community Plan is to not allow development for which infrastructure may not be available concurrent with the development's impacts.

Water Availability and Use

- Provide for appropriate water source and transmission improvements concurrent with planned growth of the Kīhei-Mākena region.
- Support and expand the projected development of the Central Maui and East Maui water systems in order to meet the needs of all Maui residents.

[5] County of Maui Makawao-Pukalani-Kula Community Plan, 1996, page 15

Supply Augmentation/Demand Controls

- Develop water conservation, reuse and educational programs.
- Encourage the use of non-potable water for irrigation purposes and water features.
- Prohibit the use of potable water in large water features or require substantial mitigation fees.
- Encourage the use of plants which have a relatively low need for water.

15.2 Physical Setting

15.2.1 Climate and Geology

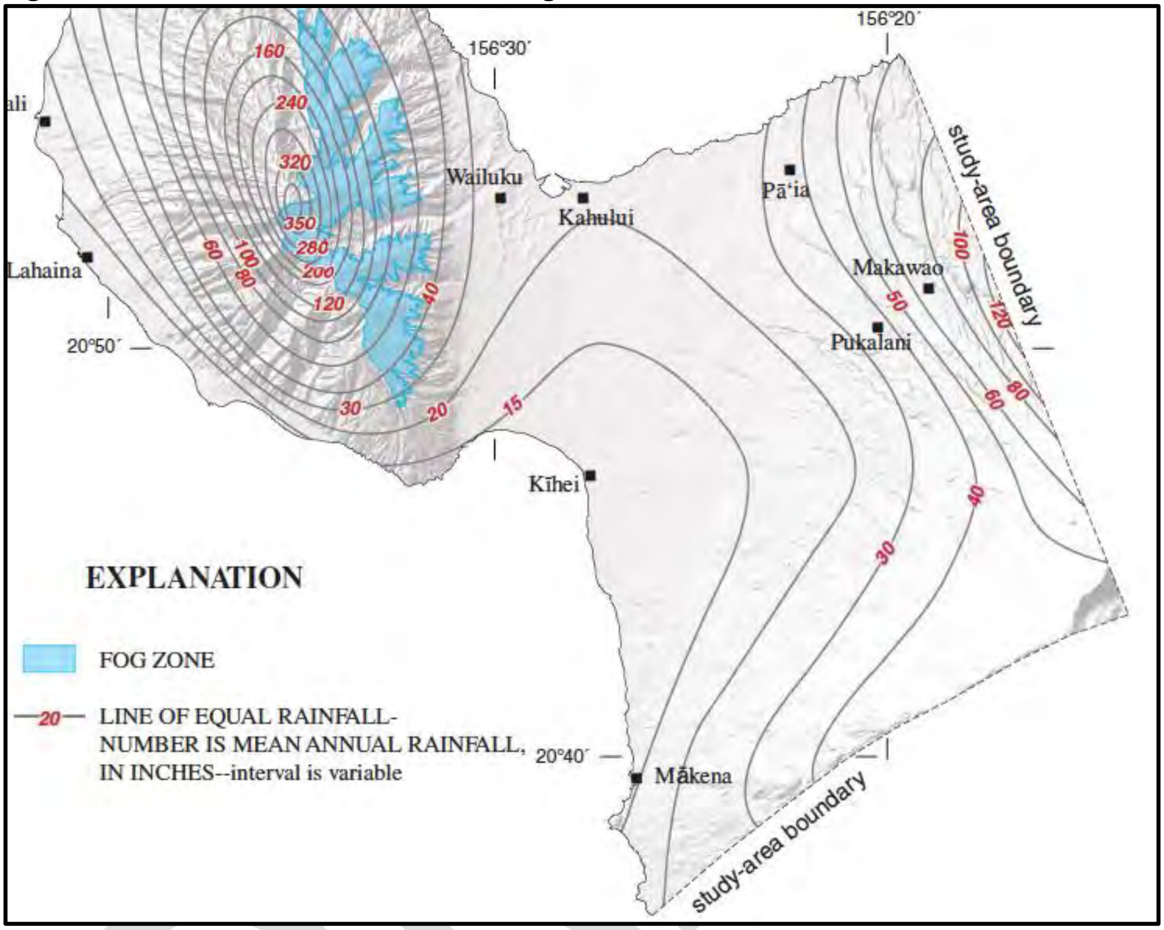
Climate

The Central Aquifer Sector includes a vast range of micro-climates. The eastern boundary is the Maliko Gulch from sea level to the summit of the Haleakalā volcano. The western boundary is the foot hills of Mauna Kahalawai, or West Maui Mountains and the south shore from Mā`alaea to Mākena. Rainfall distribution on the northern flank of Haleakalā is primarily controlled by the orographic effect. Precipitation is heaviest where the prevailing northeasterly trade winds encounter the flank of the volcano, forcing moist air to higher altitudes. The topography of Maui and the location of the north Pacific anticyclone relative to the island affect its climate, which is characterized by mild and uniform temperatures, seasonal variation in rainfall, and great geographic variation in rainfall.[6] At higher altitudes, precipitation is a combination of rainfall and fog drip where the montane forest canopy intercepts cloud water. Giambelluca and Nullet (1991) defined the fog zone on the leeward slopes of Haleakalā as extending from altitudes of about 3,900 to 5,900 ft and estimated a thicker fog zone, at altitudes of 2,000 to 6,560 ft, along windward slopes. Precipitation is supplemented by an unknown amount of fog drip, which is fog and precipitation (not measured by rain gages) that is intercepted by vegetation and that subsequently drips to the ground surface.[7]

According to the Western Region Climate Center (2007), the average temperature in Wailuku, near the coast, is 75º F, whereas the average at Haleakalā summit is 47º F. During the warmer dry season (May–September), the stability of the north Pacific anticyclone produces persistent northeasterly winds, known locally as trade winds, which blow 80–95 percent of the time. During the cooler rainy season (October–April), migratory weather systems often travel past the Hawaiian Islands, resulting in less persistent trade winds that blow 50–80 percent of the time. Low-pressure systems and associated southerly winds can bring heavy rains to the island, and the dry coastal areas can receive most of their rainfall from these systems. Mean annual rainfall ranges from 16 – 20 inches at the western boundary of Upcountry to more than 240 inches on the eastern boundary.

[6] Blumenstock, D.I. and Price, S. (1967) Climate of Hawai`i. In: Climates of the States, No. 60-51, Climatography of the United States, US Department of Commerce, Washington D.C.
[7] Ibid.

Figure 15-2 Mean Annual Rainfall and Fog Zone in Central and West Maui



Source: USGS Groundwater Availability in the Wailuku Area, Maui, Hawai`i Report 2008-5236 (modified from Giambeluca and Nullet, 1991)

Geology

The geology of Maui was described in detail by Stearns and Macdonald[8] and some of the geologic units were subsequently reclassified by Langenheim and Clague.[9] Haleakalā has three rift zones that trend in northerly, southwesterly, and easterly directions. The rocks of Haleakalā Volcano consist of the shield-stage Honomanū Basalt, which is overlain by the postshield-stage Kula Volcanics and younger Hāna Volcanics.

The Kula Volcanics, which overlies the Honomanū Basalt, comprises post-shield-stage lava flows of hawaiite with some ankaramite and alkalic basalt and associated intrusive rocks and

[8] Stearns, H.T., and Macdonald, G.A., 1942, Geology and groundwater resources of the island of Maui, Hawai`i: Hawai`i Division of Hydrography Bulletin 7

[9] Langenheim, V.A.M., and Clague, D.A., 1987, The Hawaiian- Emperor volcanic chain, part II, stratigraphic framework of volcanic rocks of the Hawaiian Islands, chap. 1 of Decker, R.W., Wright, T.L., and Stauffer, P.H., eds., Volcanism in Hawai`i: U.S. Geological Survey Professional Paper 1350, v. 1

pyroclastic and sedimentary deposits. The Kula Volcanics almost completely covers the underlying Honomanū Basalt and exposures range between 2,500 ft. in thickness near the summit to 50–200 feet in thickness near the coast. Stearns and Macdonald have found the thickness of individual lava flows averages about 20 feet near the summit and 50 feet near the periphery, but flows as much as 200 ft. thick are not rare. The usual dip of the flows is about 10 degrees. The Kula Volcanics and the Hāna Volcanics are the most widespread geologic units exposed at the land surface on Maui.

The Central Isthmus is formed by nearly flat-lying lava flows of the Honomanū Basalt, which are interbedded with consolidated and unconsolidated sedimentary deposits. Beneath the isthmus, Honomanū Basalt of Haleakalā overlies older Wailuku Basalt of West Maui Volcano with a wedge of sedimentary deposits between the two units. Stearns and Macdonald (1942) determined that sedimentary deposits throughout Maui have been divided into consolidated earthy deposits, calcareous sand dunes, and unconsolidated deposits. A sedimentary wedge beneath the Kahului area contains a westward-thickening wedge of alluvial clay, sand, and gravel that may reach 30–50 ft. in thickness within the area. Overlying the alluvium and extending farther southeastward over residual clay on the lava is a buried coral reef complex, which appears to be the landward continuation of the present offshore reef. This reef material is dominantly coral mixed with coral debris and medium to fine sand. The reef complex is overlain by sand, which grades landward from coarse to fine and reaches thicknesses of 20-30 feet. The sedimentary materials are capped beneath the land areas by the windblown sand and soils of the present land surface.[10] A similar sedimentary sequence would be expected across the isthmus and report marine sediments 40 feet above sea level near the center of the isthmus in the Waikapū Shaft Test Hole (5128-01).

15.2.2 Water Resources

The Central Aquifer Sector Area (ASEA) northern boundary stretches from Kahului to Pā`ia; the southern boundary extends to Kama`ole Aquifer in Mākena. A basal lens in the Kula Volcanics and the Honomanū Basalt comprise the groundwater resource in Kama`ole Aquifer. Within about one mile of the coast and below an elevation of 500 – 1,000 feet the groundwater is brackish. Further inland it freshens. The freshwater lens is thin. Because recharge originates in low rainfall areas and discharge of the lens at the coast is unimpeded by caprock, the head of the lens is less than 3 feet below a ground elevation of about 500 feet.[11]

Groundwater moves mainly from inland recharge areas to coastal discharge areas. Eastward flowing water from the West Maui Volcano converges with westward flowing water from Haleakalā. Groundwater recharge by direct infiltration of rainfall occurs throughout the area as

[10] Burnham, W.L., Larson, S.P., and Cooper, H.H., Jr., 1977, Distribution of injected wastewater in the saline lava aquifer, Wailuku-Kahului wastewater treatment facility, Kahului, Maui, Hawai`i: U.S. Geological Survey Open-File Report no. 77-469

[11] Brown & Caldwell, Central/South Maui Desalination Feasibility Study Final Report, 2006

high level, potentially perched, water with downward migration impeded by low-permeability geologic layers and as a freshwater lens floating on underlying saltwater. High-level water discharges to springs or directly into streambeds. There are no perennial streams in the aquifer sector that would exist where a stream intersects the groundwater table or where rainfall is persistent. [12]

Climate hydrology, geology and human activities affect the hydrologic cycle and the interconnected surface and ground water systems. Perennial and intermittent streams on windward Haleakalā are generally fed by abundant rainfall and groundwater discharge.[13] Streamflow has been extensively assessed in the Ko`olau ASEA, and it is relevant because it is a significant source of water imported to the Central ASEA via the East Maui Irrigation Company (EMI) aqueduct system. Most of the public water supply in the Central ASEA is from a freshwater lens in the Wailuku ASEA. The `Īao aquifer provides most of the groundwater supply and has been extensively studied. The main groundwater system in this area consists of a freshwater lens system in dike-free volcanic rocks. Sedimentary caprock with lower permeability between West Maui Volcano and Haleakalā impedes groundwater flow between Wailuku and the isthmus as well as groundwater discharge to the coast. The water table in the dike-free volcanic rocks is less than a few tens of feet above sea level. In general, the water-table altitude is lowest near the coast and increases landward at a rate of about 1 foot per mile.[14]

Groundwater and Surface Water Recharge

A water budget includes water input and output and is modeled based on best available hydrologic, geologic and land use data. Groundwater recharge replenishes aquifers and is fed mainly by precipitation and irrigation that infiltrates the ground surface and percolates beyond the root zone in the soil. Recharge is greatest in the inland mountainous regions. Dike impounded groundwater discharges to streams, representing the continuous base flow. Where the groundwater table is below the streambed, seepage from streambeds generally recharges groundwater. Fresh groundwater that does not discharge to streams or tunnels, or is not withdrawn from wells in the dike-impounded system, flows to downgradient areas in the freshwater lens system.[15]

Caprock water refers to water confined in sedimentary caprock, commonly along the shoreline, that is recharged from surface flows, local rainfall, return irrigation water, and leakage from

[12] Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially distributed groundwater recharge estimated using a water-budget model for the Island of Maui, Hawaiʻi, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168, 53 p., http://dx.doi.org/10.3133/sir20145168.

[13] Gingerich, S.B., 1999a, Ground water and surface water in the Haiku area, East Maui, Hawai`i: U.S. Geological Survey Water-Resources Investigations Report 98–4142, 38 p.13 ; Gingerich, S.B., 1999b, Ground-water occurrence and contribution to streamflow, northeast Maui, Hawai`i: U.S. Geological Survey Water-Resources Investigations Report 99–4090

[14] Gingrich, S. 2008 U.S. GEOLOGICAL SURVEY. Ground-Water Availability in the Wailuku Area, Maui, Hawai`i Scientific Investigations Report 2008-5236

[15] Ibid.

confined basal water. It's generally limited to non-potable uses due to its saline quality.[16]

Before the cessation of sugar cultivation in December of 2016, most water diverted from the streams in Nā Wai `Ehā, in the Wailuku ASEA, was transported to the isthmus—the center of the island found between Haleakalā and Mauna Kahalawai within the Central ASEA--and used for irrigation outside the area contributing recharge to the Wailuku ASEA. The amount and location of recharge has been profoundly affected by plantation-scale sugarcane cultivation (and, to lesser degrees, pineapple and macadamia nuts) in agricultural areas. Since the early 20th century, about 100 billion gallons of surface water has been diverted each year from island streams for crop irrigation. More than half of this diverted water, about 59 billion gallons per year, originated in East Maui. Under natural conditions, most stream water would flow to the ocean. Instead, stream water diverted for irrigation is applied to the plant-soil system, creating an artificial increase in groundwater recharge of the underlying aquifer systems (Kahului and Pā`ia Aquifers). The export probably caused a net decrease in recharge to the aquifers underlying diverted streams and a net increase in recharge to the Central ASEA. Since sugarcane irrigation ceased in 2016, the impact on natural and artificial recharge has not been quantified; however, in the past, the transition from ditch/furrow irrigation to drip irrigation systems has shown to significantly decrease the amount of artificial recharge.

The interaction between the Wailuku ASEA and Ko`olau ASEA "export" hydrologic units and the Central ASEA "import" hydrologic unit is important to assess the viability of sources that are impacted by natural and artificial changes in recharge. The Maui Lani wells drilled within the Kahului Aquifer just eastward of the `Īao aquifer boundary are believed to be impacted by recharge from `Īao aquifer, leaching from unlined reservoirs fed by Nā Wai `Ehā surface water, as well as irrigation return recharge within the Kahului Aquifer.

Irrigation rates in the Wailuku and Central Maui regions have been steadily decreasing since the 1970s. This decrease coincided with periods of below-average rainfall, leading to substantially reduced recharge rates. Estimated recharge for Central and West Maui declined 44 percent during the period 1926 – 2004. Groundwater recharge during average climate conditions and drought conditions was estimated by the U.S Geological Survey (USGS). A drought scenario based on rainfall during the 1998–2002 period yielded a 29 percent reduction in recharge compared to average climate conditions.

Table 15-1 Central ASEA Groundwater Recharge Estimates Drought and Average Conditions

Aquifer Sector Area	2008 WRPP Average Recharge	USGS Average Recharge	USGS Drought Recharge	% Drought Recharge Reduction (USGS)
Central	59	179	134	25%

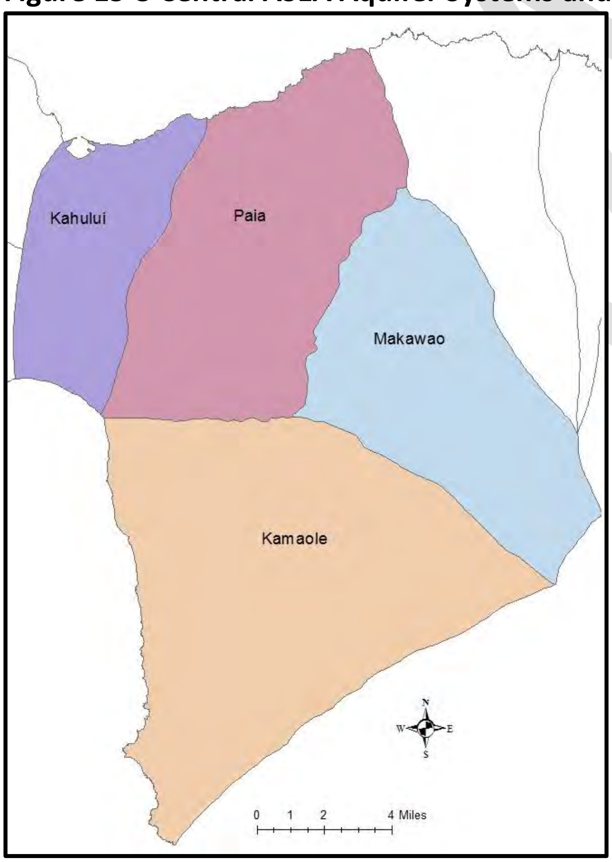
USGS, Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawai'i, 2014, Table 8. Average climate conditions are 1978–2007 rainfall and 2010 land cover. Drought conditions are 1998–2002 rainfall and 2010 land cover. WRPP- 1990, updated 2008 from CWRM where applicable, natural conditions are 1916–1983 mean rainfall and a uniform, unirrigated land cover. Scenario study areas may differ from the WRPP areas.

[16] CWRM Water Resources Protection Plan, 2008 p 3-11

Groundwater Availability

The Central ASEA includes four aquifer systems: Pā`ia, Kahului, Kama`ole and Makawao Aquifers. The `Īao and Waihe`e aquifer systems on the eastern side of West Maui Mountain are the principal sources of domestic water supply for the island of Maui, including the Central ASEA. The groundwater sustainable yield (SY) is the maximum rate that groundwater can be withdrawn without impairing the water source as determined by the Commission on Water Resources Management (CWRM). Generally, SY is conservatively set at the low end of the estimated range of predicted sustainable yields for an aquifer. Statewide SY updates are under review in the pending 2017 State Water Resource Protection Plan. The total sustainable yield of the Central ASEA is 26 mgd, as established by CWRM in 2008. SY is believed to be the best estimate based on available hydrologic data. The CWRM ranks confidence in SY data dependent on available hydrologic studies, deep monitoring wells and established pumping records, ranging from (1) most confident to (3) least confident. Kahului and Pā`ia aquifer SY are ranked as (2) moderately confident and Makawao and Kama`ole aquifers are ranked (3) least confident, recognizing that there is significant uncertainty associated with the SY due to the lack of hydrogeologic and pumpage information.[17]

Figure 15-3 Central ASEA Aquifer Systems and Sustainable Yield

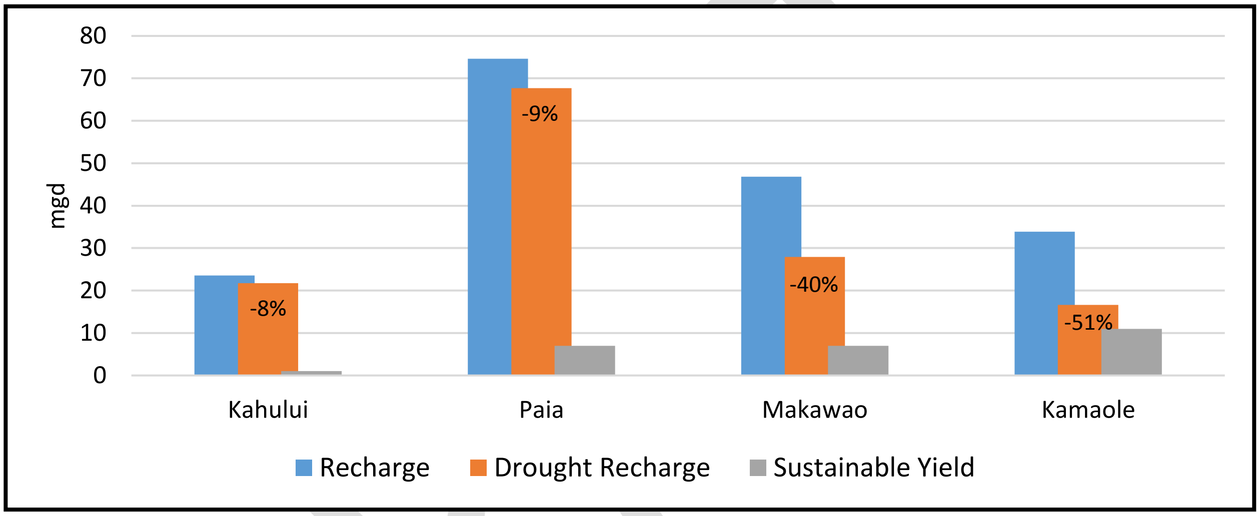


Aquifer System	Aquifer Code	Sustainable Yield Range (mgd)	Sustainable Yield (mgd)
Kahului	60301	1	1
Pā`ia	60302	7-8	7
Makawao	60303	7-20	7
Kama`ole	60304	11-16	11
Total			**26**

[17] CWRM, Water Resources Protection Plan, 2008 pp 3-82.

Sustainable yield accounts only for basal ground water and equals a fraction of estimated recharge. In a basal lens, the fraction is usually more than half of the total groundwater recharge. According to the State Water Resources Protection Plan, 2008, about three-fourths of the recharge of high-level aquifers can be taken as sustainable yield. For planning purposes, recharge during long-term drought conditions, hydrologic drought, should be considered as it impacts sustainable yield estimates over time. However, the WUDP updates will monitor continuous SY updates by CWRM and adjust accordingly. Recharge compared to sustainable yield for this aquifer sector is illustrated in the figure below.

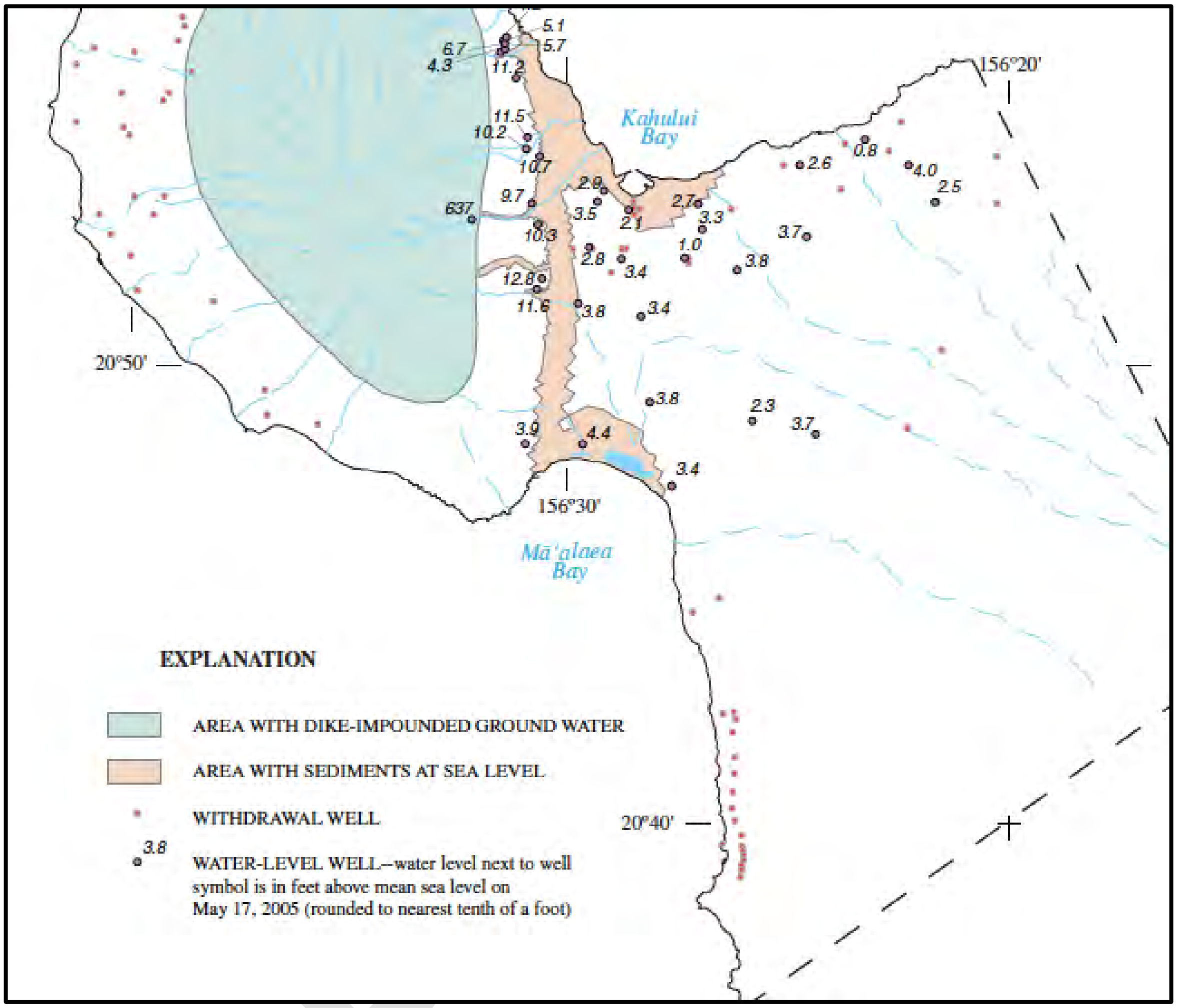
Figure 15-4 Average Mean Recharge under Average Climate and Drought Conditions by Aquifer System, Percent Recharge Reduction during Drought, and Sustainable Yield (mgd)



Source: CWRM 2008 Sustainable Yields, USGS, Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai'i, 2014

Sustainable yield does not account for water transfers, such as irrigation return flow that percolates back into the aquifer to be potentially re-pumped. SY accounts for basal, perched, and high-level water. Generally, only caprock and salt water are excluded, although in a few cases (such as `Īao Tunnel), high-level sources are not excluded from available SY. Surface water is conveyed from the Ko`olau ASEA to the Central ASEA via the EMI aqueduct system, and from the Wailuku ASEA via the Wailuku Water Company system. The impact on "available" groundwater that can be extracted from the Kahului and Pā`ia Aquifers from irrigation return flow is highly uncertain since the cessation of sugarcane cultivation in 2016. Groundwater levels are also an indicator of changes in recharge or withdrawals and can be an indicator of freshwater lens thickness. In the 2008 USGS groundwater study of the area, measured water levels were lowest near the coast and increase inland toward the recharge areas of West Maui and Haleakalā Volcano. A synoptic water level survey in 2005 measured water levels with no pumpage over a period of time. Water levels ranged from 0.84 feet above sea level near the coast to about 637 feet AMSL in dike impounded aquifers of the Wailuku ASEA. The figure below shows water levels measured in 2005. There are no monitoring wells in the Central ASEA aquifers to gage water level changes over time. A simulated scenario in the 2008 USGS study modeled additional recharge from restored streamflow and complete removal of irrigation return recharge. The latter decreased water levels and increased salinity in the central isthmus while recharge through streams significantly increased water levels, thickens the freshwater body and decreased salinity at withdrawals sites in the Wailuku ASEA. [18]

Figure 15-5 Central ASEA Groundwater Levels Measures in 2005 (Feet Above Mean Sea Level)



Climate Change Impact on Groundwater Availability

The Pacific Regional Integrated Sciences and Assessments' (Pacific RISA) *Maui Groundwater Project* is an interdisciplinary research effort to inform decisions about the sustainability of groundwater resources on the Island of Maui under future climate conditions. A new hydrologic model is being used to assess the impact of changing climate and land cover on groundwater recharge over the Island. Preliminarily future climate projections for Maui Island suggest that wet areas get wetter with mean annual rainfall increases. Scientists' confidence in trends and

[18] USGS, 2008 Groundwater Availability in the Wailuku Area, Maui, Hawai`i Sir 2008-5236

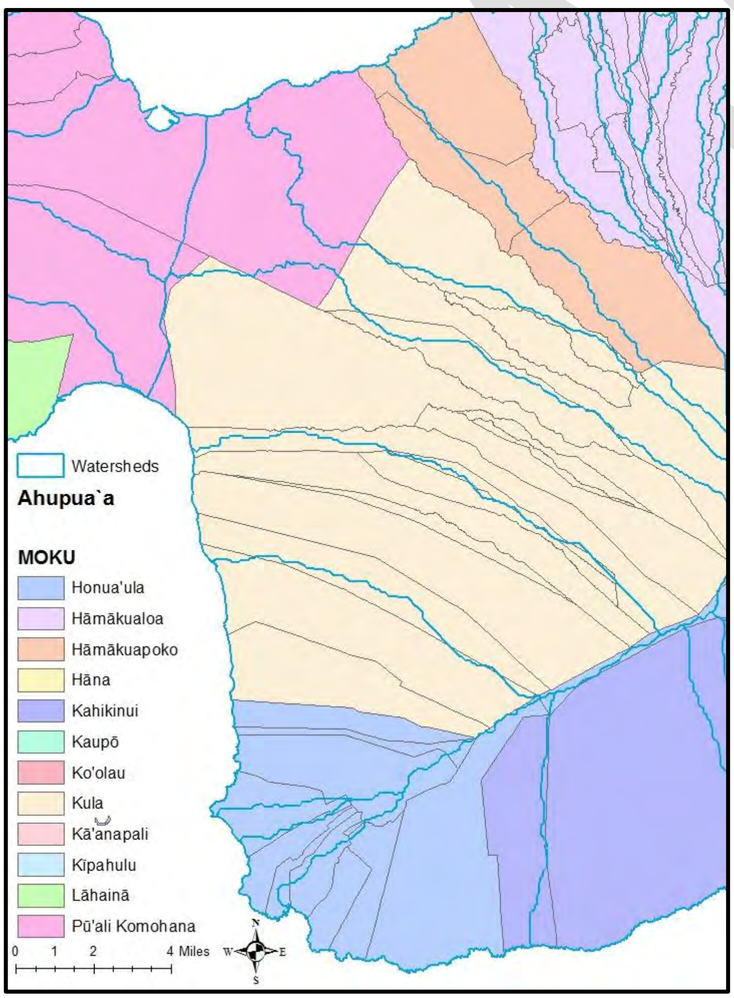
changes to rainfall and associated recharge is relatively low. No streamflow projections are available for the coming century. The impact on recharge and streamflow from climatic changes at the time of this plan is highly uncertain.

Two ongoing USGS studies initiated in 2015 assess the impact of land-cover changes on past and future groundwater recharge on Maui, and they also assess the hydrologic impact from native versus alien forested watersheds. Study results and improved methods of estimating fog interception, including forest canopy interception and the differentiation of native and alien forests could potentially affect future estimates of sustainable yield.

Moku and Watersheds

The Central ASEA spans multiple moku that are generally more aligned with watershed boundaries than aquifer sectors. The majority of the Central ASEA lies within the moku of Kula, with portions of the Central isthmus also encompassing the moku of Pu`ali Komohana and Hāmākuapoko, and to a minor extent the moku of Hāmākualoa. The southernmost portion of the ASEA is encompassed by the moku of Honua`ula.

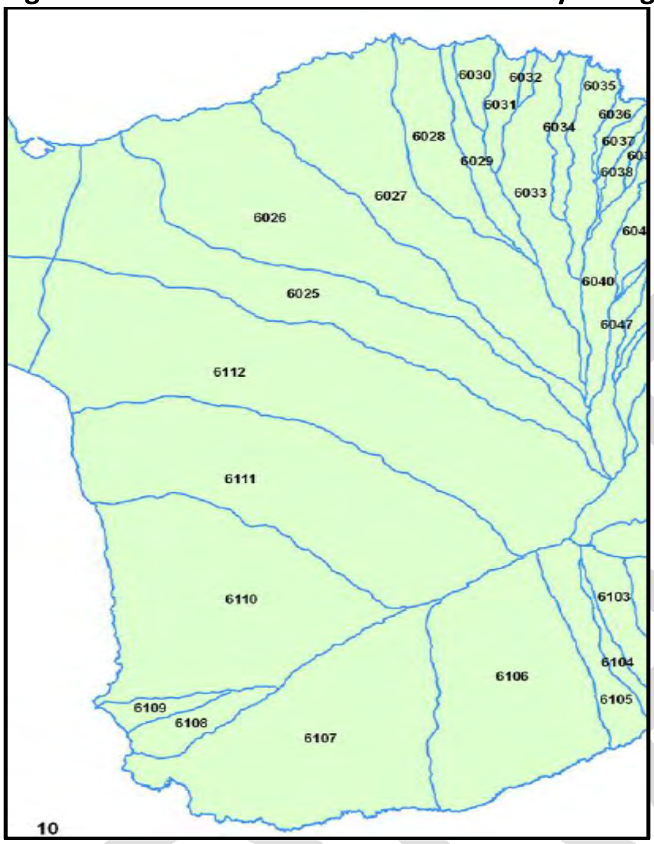
Figure 15-6 Central Aquifer Sector Moku and Watershed Boundaries



Surface Water Availability

Surface water hydrologic units, or Watershed units, are shown below but not further utilized for resource assessment and analysis.

Figure 15-7 Central ASEA Surface Water Hydrologic Units



Hydrologic Units

6001	Waikapu*
6025	Kalialinui Gulch**
6026	Kailua Gulch*
6027	Maliko Gulch*
6108	Ahihi Kinau**
6109	Mo`oloa**
6110	Wailea**
6111	Hapapa**
6112	Waiakoa Gulch**

*1) Hawaii Stream Assessment, Report R84, December 1990 and 2) Office of Planning, State of Hawai`i, Watershed Unit Boundaries for the 8 major Hawaiian Islands, generated in Arc/Info and GRID using USGS DEM data, 1995.

**Office of Planning, State of Hawaii, Watershed Unit Boundaries for the 8 major Hawaiian Islands, generated in Arc/Info and GRID using USGS DEM data, 1995.

Perennial Streams

6301	Maliko
6210	Waikapu

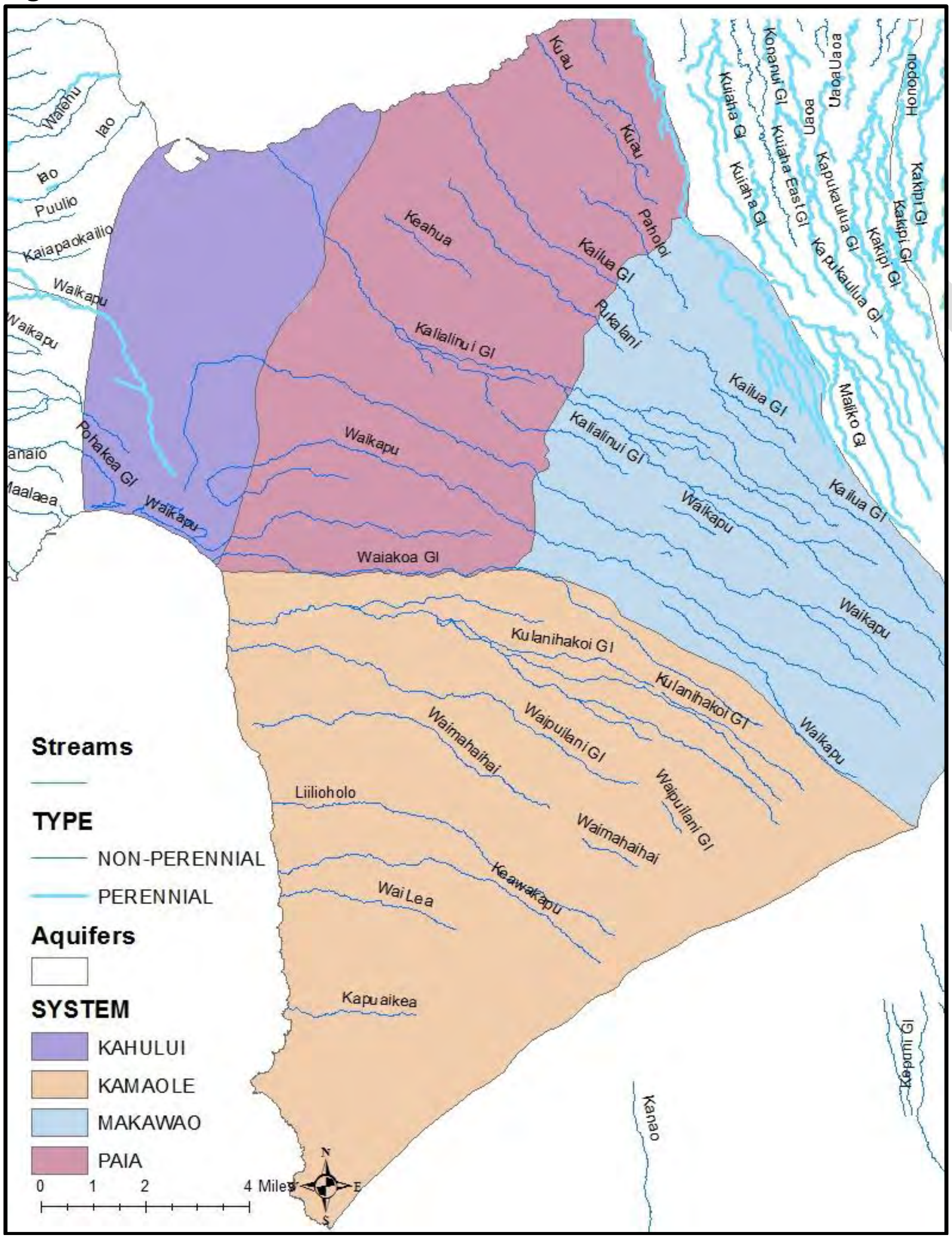
Source: Hawaii Stream Assessment, Report R84.

There are only two perennial streams in the Central ASEA: 1) Maliko Gulch, which makes up the boundary to Ko`olau Aquifer Sector; and 2) Waikapū Stream, originating in Wailuku ASEA. Recently restored flows of 2.9 mgd just below the South Waikapū Ditch from Waikapū Stream has resulted in the stream recharging Keālia Pond overlying the Kahului Aquifer. According to the National Wildlife Refuge staff at Keālia Pond, since the flow restoration, pumpage from wells at the refuge has not been necessary.

The interaction of surface water resources and use between the Wailuku, Central and Ko`olau Aquifer sectors is extremely complex from a hydrological and legal standpoint. The availability of surface water from Wailuku ASEA is subject to the contested case and instream flow standards explained in Chapter 14.2.2. Surface water use from Nā Wai `Ehā in the Central ASEA is assessed below in Chapter 15.5.

The Maliko surface water unit has five stream diversions and is part of the East Maui Irrigation System. Availability of surface water from Ko`olau ASEA is addressed in the Ko`olau Aquifer Sector report, Chapter 16.2.2 Surface water use in Central ASEA from streams diverted through the EMI system is assessed below in Chapter 15.5. Streams on windward Haleakalā in the Ko`olau ASEA are fed by abundant rainfall and groundwater discharge.[19] In the area between Makawao and Ke`anae Valley, groundwater discharges to streams from a perched, high-level saturated groundwater system.

Figure 15-8 Central ASEA Streams



19Gingerich, S.B., 1999b, Groundwater occurrence and contribution to streamflow, northeast Maui, Hawai`i: U.S. Geological Survey Water-Resources Investigations Report 99–4090, 69 p.

Registered diversions are limited to four spring diversions along the south east boundary of Makawao Aquifer, none of them reported in use. It's possible that a more extensive forested watershed provided fresh water at the Ulupalakua springs in the past.

Table 15-2 Central ASEA Surface Water Diversions, Gages by Watershed Unit

Aquifer System	Hydrologic Unit Code	Hydrologic Unit	Area (mi^2)	Total Diversions per Watershed Unit	No. of Gages per Watershed Unit
Makawao	6025	Kalialinui	30.28	0	3
Makawao	6026	Kailua Gulch	29.76	0	0
Kama`ole	6108	Ahihi Kinau	3.68	0	0
Kama`ole	6109	Mo`oloa	1.9	0	0
Kama`ole	6110	Wailea	35.76	4	2
Kama`ole	6111	Hapapa	40.89	0	1
Pā`ia	6112	Waiakoa	55.76	0	2
TOTAL			**198.03**	**4**	**8**

Source: CWRM, *State Water Resources Protection Plan*, 2008.

Transport of Stream Water from Nā Wai `Ehā

The four streams Waihe`e River, Wailuku River (formerly `Īao Stream), Waiehu and Waikapū Streams of Nā Wai `Ehā provide surface water through the Wailuku Water Company ditch system for use in the Central ASEA. The CWRM designated Nā Wai `Ehā a surface water management area in 2008. Streamflow and status of Interim Instream Flow Standards are assessed in Chapter 14.2.2.

Transport of Stream Water from East Maui

Streams in the Ko`olau ASEA, bordering Kūhiwa Aquifer System (ASYA) to the west, are subject to the East Maui Contested Case due to significant diversions by East Maui Irrigation Company (EMI) to Central Maui. Water from Ko`olau ASEA is transported to the Central ASEA for agricultural and municipal uses. Streamflow and the status of the contested case is assessed in Chapter 16.2.2.

15.3 Settlement Patterns and Cultural Resources

This section strives to acknowledge and highlight how Hawaiian history and cultural practices of the past relate to the present, and how those traditions can inform options for meeting the future water needs of the people of Maui Island, while preserving and celebrating Hawai`i's past. Archaeological remains and traditional Native Hawaiian culture-history provide a foundation for establishing continuity between past, present and future water use in the Central ASEA. Population fluctuations within the last 200 years have largely occurred due to changes of land ownership, droughts and the establishment of homesteads.[20]

Early Hawaiian settlement is evident from the large numbers of archeological sites within the region. There are numerous recorded and unrecorded heiau, stone walls, building platforms and petroglyphs which provide evidence of intensive habitation and land use well before European contact in 1778, when Captain Cook arrived in the Hawaiian Islands.[21]

15.3.1 Historical Context

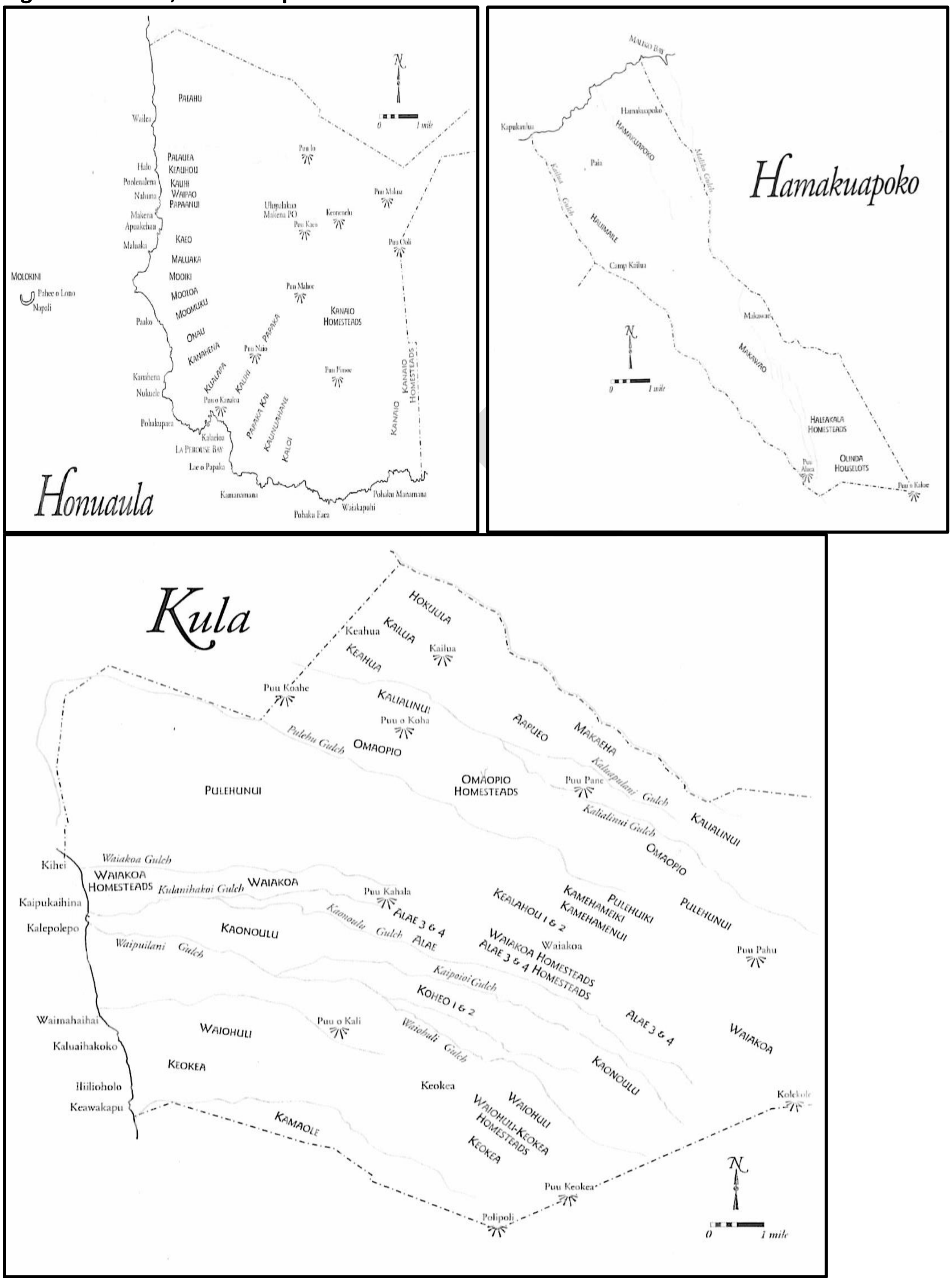
Maui County's original inhabitants developed a unique system of land and ocean tenure and use that divided land into large sections called moku. Typically, each moku is comprised of many ahupua`a. An ahupua`a is a land division unit that extends from the upland mountain top to the sea, and usually includes the bounding ridges of a valley and the stream within.

Boundary Delineations

The Central ASEA spans multiple moku that are generally more aligned with watershed boundaries and ahupua`a's than aquifer sectors. The majority of the Central ASEA lies within the Moku of Kula, with portions of the Central isthmus also encompassing the Moku of Pu`ali Komohana and Hāmākuapoko, and to a minor extent the Moku of Hāmākualoa. Present day Mākena is located in the southernmost portion of the Central ASEA and is encompassed by the Moku of Honua`ula. Historical and contemporary boundary delineations of Kula differ from the boundaries identified by the aquifer sector areas used by the WUDP. The historical delineation is bounded on the west by Pulehunui in the Central Maui isthmus, Kaluapulani Gulch to the north and east, on the south, moving from the west, Kama`ole, Kēōkea, Ka`ono`ulu, and Waiakoa. The DLNR Kula Aquifer Sector Area includes the Central Maui aquifers of Makawao, Kama`ole and a portion of Pā`ia. Historically, the district extended to the shoreline of Kīhei, but the shorelines of Mā`alaea, Wailea and Mākena were excluded. In recent times, Kula is considered to run approximately from approximately the 1,000-4,000 foot level on the inland-facing flank of Haleakalā that abuts the Central Maui isthmus, located between Maui's two mountain ranges. Today, most people think of Kīhei and Kula as disconnected areas because there is no public road directly connecting them.

[20] County of Maui, Makawao-Pukalani-Kula Community Plan, page 11.
[21] Ibid, page 28.

Figure 15-9 Kula, Hāmākuapoko and Honua`ula Moku



Source: Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997.

<u>Hāmākualoa Place Name</u>

On the wetter side of the Central ASEA, Hāmākualoa, the place name reflects the influence of rain, "Ka ua pe`e puhala o Hāmākua," means the rain of Hāmākua that makes one run to the hala tree to hide."[22]

15.3.2 Historic Agriculture

Previously, during the 1900s, Kula was an agricultural breadbasket for both Maui and O`ahu, but not all crops thrived there. In recent decades, the region has become famous for the quality of vegetables and flowers exported to Hawaiian and international markets.

<u>Kula and Hāmākuapoko Staples</u>

Smaller scale farming in Kula was actually begun by the pre-1778 Hawaiians and the area was especially known for its `uala or sweet potatoes. The cool and relatively dry climate, as well as exceptional soil, makes the Kula area excellent for a number of crops and for many years it has been the center of the island's diversified agriculture industry.[23]

Handy writes about the cultivation of crops within the ancient Moku of Hāmākuapoko.

> "The deep gulch of Maliko Stream widens at its seaward end into a flat-bottomed valley which, in pre-sugar days when the stream had constant flow, harbored a number of terraces. The gradually rising land of Hāmākuapoko in earlier times would have been suitable for dry taro but not for wet. It was probably well-populated and cultivated, for the kula land east of Maliko was a small patchwork of ahupua`a."[24]

15.3.3 Historic Water Scarcity

Handy writes, "Kula was always an arid region, throughout its long, low seashore, vast stony *kula* lands and broad uplands. Both on the coast, where fishing was good, and on the lower westward slopes of Haleakalā, a considerable population existed.[25]

<u>East Maui's Historical Contribution to Upcountry Agriculture</u>

In order for historic Upcountry farming to have flourished since the 1800s, surface water from East Maui was transported via a 17-mile aqueduct system.

[22] Baker, Edward to M.k. Pukui, Mar. 25-April 1, 1960, MS SC Sterling 3.12.3 [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 97].
[23] County of Maui, Makawao-Pukalani-Kula Community Plan, page 10.
[24] Ibid, page 109.
[25] Ibid, page 242.

"Kula today is naturally dry area, dependent for farm irrigation on a man-made pipeline system extending from Waikamoi, at the edge of the remaining windward rain forest belt on the east flank of Haleakalā…"[26]

In 1876, the construction of Hāmākua Ditch brought water to the dry central valley and northwestern slopes of Haleakalā, making sugar production possible where once only scrublands existed. Captain James Makee's "Rose Ranch" at Ulupalakua produced sugarcane until the destruction of the forest above the ranch by cattle and other causes reduced the total rainfall and made sugar an unprofitable venture.[27]

Pre-1778 Water

Ancient Hawaiian lore tells of the clouds always encircling the mountain, creating enough fog drip precipitation to generate underground water and ocean springs.

"Makali`i told me about the Cloud Warriors, Naulu and Ukiukiu-trade-wind driven clouds split by the height and mass of Haleakalā into two long arms. Naulu traveled along the southern flank of the mountain, Ukiukiu along the northern and they battled forever to possess the summit. Usually Ukiukiu was victorious, but occasionally Naulu pushed him back."[28]

Despite the comparative lack of water resources, a fairly sizable population existed along the south Maui shorelines and on the inland slope of Haleakalā.

"On the coast, where fishing was good, and the lower westward slopes of Haleakalā, a considerable population existed, fishing and raising occasional crops of potatoes along the coast, and cultivating large crops of potatoes inland, especially in the central and northeastern section including Kēōkea, Waiohuli, Koheo, Ka`ono`ulu, and Waiakoa, where rainfall drawn round the northwest slopes of Haleakalā increases toward Makawao."[29]

According to E.S.C. Handy, there was probably little human settlement in ancient times before European contact between Kīhei and Mākena.[30] The moku of Honua`ula straddles the Maui Department of Water Supply's (MDWS) Central Aquifer Sector's Kama`ole System and Kahikinui ASEA's Luala`ilua System. At the time of the census in 1831, Honua`ula was the 4th largest population center on Maui; however, today, it is one of the least populated areas on Maui.[31] Prior to the introduction of cattle, the forest zone of this region was much lower and rainfall

[26] Kula Farm Area's Drought, Sunday Star-Bulletin and Advertiser, July 1, 1962, A15 [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 245].
[27] County of Maui, Makawao-Pukalani-Kula Community Plan, page 9.
[28] A. von Tempski, Born in Paradise, page 14. [Sterling, Elspeth P. Sites of Maui. Bishop Museum Press, 1997, page 243].
[29] Ibid, page 243.
[30] E. S. C. Handy. Hawaiian Planter, The Museum, 1892, page 159.
[31] Kawa`a, Luana, Cultural Survey & Moku Inventory: Moku of Kipahulu and Hana, Island of Maui (Draft), Ka Piko O Ka Na'auao (The Hawaiian Learning Center), 2009, page 3.

more abundant. Forest zone plants grew profusely in this area, and dryland taro and sweet potatoes were cultivated.[32]

Post-1778 Human-influenced Environmental Change

Today, with one exception there are no perennial streams flowing to Maui's Central isthmus from either mountain; but in the past, there was a time when water was more abundant, and the streams of Haleakalā and Mauna Kahalawai's (West Maui) waters met.

> "Kaopala is where the water from the mountains (the acclivities of east and west Maui) meet. The former name of the place now called Kaopala, was Kailinawai because there the waters of the two mountains joined…"[33]

Watershed Destruction

The native forest once produced significantly more fog-drip precipitation that percolated underground to the coastline, where there were extensive freshwater ponds in Kīhei and Ma'alaea Bay, located along the shoreline below present day Kula. Looking up the central Haleakalā mountain flank, one can see that 70% of the forest has been destroyed. Some of the causes of destruction are: (1) sandalwood trade with China in the early 1800s; (2) deforestation for cattle grazing; and (3) deforestation for growing vegetables for whaling ships and the California Gold Rush in the 1800s.

> "'The destruction of the forest in Kula was completed by the ranchers clearing for pasture'. Korte said…Before the forests were cut down, he said, it was possible to fill a sizable tank with water from cloud drip in Kula during one night…A secondary result of the clearing of the Kula forests, he said, was the destruction of extensive fresh water ponds in Kīhei, on the Ma'alaea Bay coast below Kula…When the forest was cleared, water was free to rush down the mountain, carrying soil from Kula to the coast and filling with mud the ponds for which Kīhei was once famous."[34]

Drought and Famine

The success of agriculture in Kula in both past and modern times has varied depending on the amount of rain produced. In times of famine, people have had to resort to eating "famine foods" as a drastic measure to deal with the lack of water and agricultural productivity in times of drought.

> "Many people came there to play games and to go swimming in a pool, Waimalino. Kula and a part of Makawao were waterless lands, and so this pool became a place where all enjoyed

---

[32] Ibid, page 7.

[33] Opinion of the Court by McCully, J., in the Matter of the Boundaries of Pulehunui. Hawaiian Reports, 1879. 4:239 – 255 [Sterling, Elspeth P. Sites of Maui. Bishop Museum Press, 1997, page 254].

[34] Kula Farm Area's Drought, Sunday Star-Bulletin and Advertiser, July 1, 1962, A15 [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 245].

> themselves and danced hulas…There was a famine in Kula and Makawao, and the people subsisted on laulele, paulele, popolo, and other weeds."[35]

Droughts are a natural phenomenon historically experienced throughout the Hawaiian Islands, but historic activities since 1778 have drastically contributed to environmental destruction that has resulted in more intense droughts than previously resulted from natural weather cycles.

> "…the Kula farming area, now suffering from drought, lost its natural supply of water as a direct result of the California gold rush that started in 1849…This is according to research into old records as reported by Karl H. Korte, Maui District Forester for the State Department of Land and Natural Resources…The current drought is due to weather conditions that have interrupted the normal flow of moist trade winds against windward East Maui…But, Korte said, before 1850 Kula was supplied with moisture naturally through the existence of a large forest…'That forest was cut down when land was cleared in Kula to open farm plots in 1850. This was in answer to the demand for food in California during the gold rush'. Korte explained…He said the explanation can be found in old records, which he has seen."[36]

15.3.4 Hawaiian Culture Today

Historic sites and cultural resources provide evidence of Central Maui's history and serve as tools for conveying the heritage of the region to its youth as a legacy for the future. Today, the areas that make up the Central ASEA: south Maui, Upcountry, and Central Maui; contain numerous ancient archaeological sites and host events that support traditional Native Hawaiian cultural/community groups such as hula halau and outrigger canoe clubs, helping perpetuate the traditional Native Hawaiian culture. The Maui Arts and Cultural Center opened in 1994 as the culmination of a long-standing dream of Maui's residents to build a world-class gathering place for the arts, and is committed to the past, present and future of Maui, through entertainment, education, Hawaiian cultural programming. There are no kuleana parcels identified within the Central Aquifer Sector.

15.3.5 Lessons Learned from the Past

Historic regional water transportation/sharing strategies from East Maui to Upcountry have affected the practice of Native Hawaiian culture in the East Maui region. Historic practices and infrastructure designed to maximize diversions of streamflow for transport to arid regions are not sustainable today. In establishment of Instream Flow Standards, CWRM takes into account instream and offstream needs. There is community sentiment that favors developing areas with regional existing water resources, rather than transporting water from wet regions. Upcountry farmers are in favor of transporting agricultural water and residents seeking home development are at odds with East Maui residents who favor leaving the water in the streams.

---

[35] Lucy K. Henriques. Paper read before the Hawaiian Historical Society, Fall Meeting, 1916. *Hawaiian Ethnological Notes,* 2:214 [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 244].

[36] Kula Farm Area's Drought, Sunday Star-Bulletin and Advertiser, July 1, 1962, A15 [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 245].

Watershed Management

The Kula region encompasses a rural area whose water needs are mostly fed by a combination of transported east Maui water formed from orographic precipitation and Upcountry fog drip formed by clouds moving through the forests. In the past, the area's fog drip precipitation supported a number of springs, anchialine pools, Hawaiian villages and a much larger Native Hawaiian population; but environmental change, disease, gentrification, and a drastic shift in the cultural landscape has reduced the Native Hawaiian population, traditional resources, and those that live by those cultural traditions. Additionally, the natural fog-drip precipitation has been drastically reduced due to historic deforestation of sandalwood and other native trees, cattle grazing and vegetable farming for whaling ships and the California gold rush during the 1800s; therefore, Native Hawaiian upslope agriculture and nearshore aquaculture have been severely diminished by changing weather patterns (global warming) and human-induced environmental degradation (deforestation). Ahupua'a management measures that include watershed management and reforestation could facilitate more fog-drip precipitation and the resulting increased capacity for Native Hawaiian agriculture and cultural practices on Kula lands over a longer timeframe than the WUDP's 20-year planning period. Reforestation and watershed management efforts could also benefit Native Hawaiian cultural practitioners by increasing water in downslope nearshore wetlands and fishponds in Kīhei and Mākena. Those downslope areas are hydrologically connected to upslope kula lands by way of underground mauka-to-makai water flow that surfaces at the ocean saltwater/freshwater interface, due to the denser saltwater forcing the less-dense freshwater upward to form springs along the shoreline.

DHHL Water Resources

Due to the extensive Department of Hawaiian Homelands (DHHL) land holdings and their plans to further develop the area for Native Hawaiian habitation and farming activities; adequate water supply is becoming increasingly important for Native Hawaiians to resettle and facilitate their cultural practices in the area. DHHL lands are occupied by Native Hawaiians who are assumed to live the full-range of traditional Native Hawaiian cultural practices based on their ability to implement the knowledge of their heritage. Upcountry Maui (Kēōkea/Waiohuli, Ulupalakua, Kualapa) has over 6,000 acres of DHHL lands. The Makawao-Pukalani-Kula Community Plan section, "Identification of Major Problems and Opportunities of the Region Problems," cites "limited development of water resources and distribution system to meet the needs of the region as a primary concern," and notes that "The proper allocation of water resources is considered essential to encourage the development of Department of Hawaiian Home Lands (DHHL) parcel."[37]

Water use in the Upcountry region, including DHHL needs, is recognized as having impacts on the streams of East Maui and the agricultural activities of the central valley. A comprehensive

[37] County of Maui, Makawao-Pukalani-Kula Community Plan, page 12.

water management strategy is needed to strike a balance between the various interests and accommodate environmental, agricultural and residential needs of all neighboring regions.[38]

[38] Ibid, page 15.

15.4 Land Use

The isthmus between west and east Maui have been used for agriculture for over a century. Urban areas spread over the northern part of the isthmus at Wailuku and Kahului and along the south shore from Mā`alaea to Mākena. The area known as Upcountry, roughly located between 1000 – 4000 feet elevation is bounded in the west by the HC&S plantation and extends out to Kēōkea in the south. Upcountry is distinctly isolated from the urban regions on the isthmus with no road connection south of Haleakalā Highway. The aquifer sector encompasses urban, rural and agricultural land uses, each with unique challenges and opportunities.

15.4.1 Land Use Plans

Urban infill and planned growth areas for the Central ASEA are identified in the Maui Island Plan (MIP). The MIP provides policy direction to enhance agricultural lands, protect the rural character and scenic beauty of the countryside and direct growth to appropriate areas. When urban development is needed to accommodate growth, it is almost inevitable that agriculturally zoned land will be converted. It is the “default” zoning or district and most often borders our urbanized areas. Key issues associated with the land use types in the region as identified in the MIP are summarized below.

Agricultural Lands

- Diminished production capacity associated with fragmentation of agricultural parcels
- Higher land costs to farmers as non-agricultural land uses are viewed by many to be a more profitable investment.
- Social changes as commercial farming may be considered a difficult occupation.
- Affordable housing needs fragment properties through subdivisions
- Reliable and affordable water for viable crops competes with other uses.

Rural Lands

Low density residential sprawl in the regions from Ha`ikū to Ulupalakua due to population growth, development pressures and decreasing agricultural activities

Urban Lands

Less than five percent of Maui’s lands are within the State Urban District. The challenge in prudent planning and managed development is to mitigate the impact on agricultural lands, rural communities and natural resources.

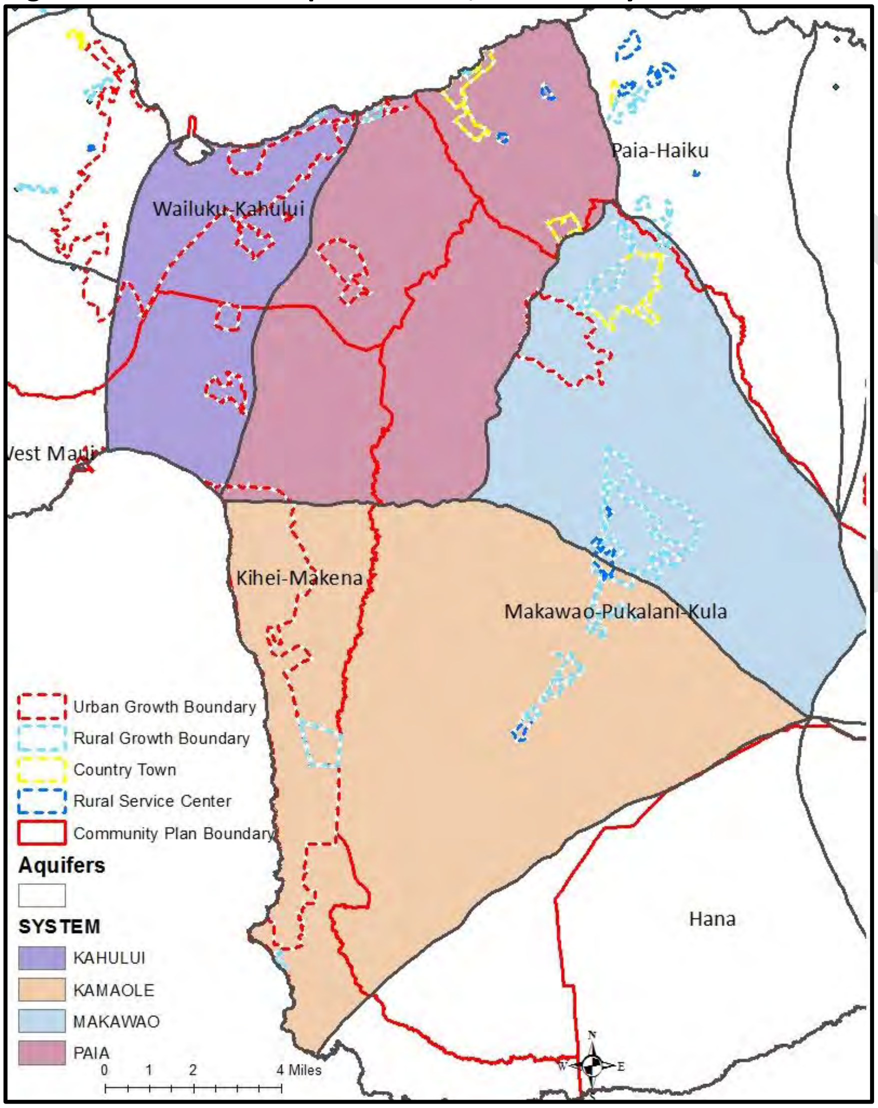
The Central Aquifer Sector encompasses four community plan districts:

- Wailuku-Kahului Community Plan, adopted 2002
- Kīhei-Mākena Community Plan, adopted 1998

- Makawao-Pukalani-Kula Community Plan, adopted 1996
- Pā`ia-Ha`ikū Community Plan, adopted 1995

The figure below portrays the relationship of the Wailuku ASEA, community plans and directed growth boundaries.

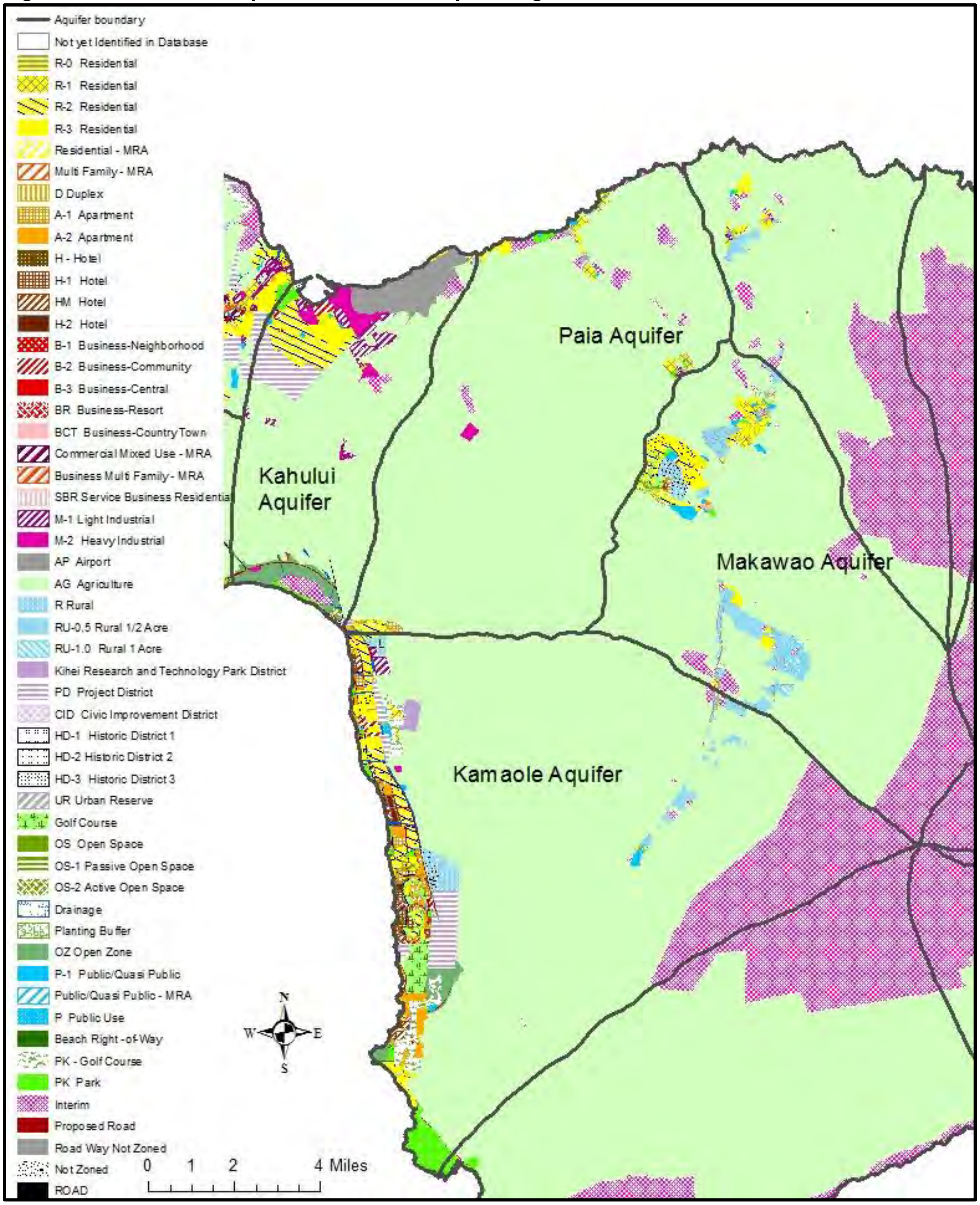
Figure 15-10 Central Aquifer Sector, Community Plans and Directed Growth Areas



Maui County Zoning

Maui County Zoning for this ASEA includes a range of resource, rural and urban zoning districts.

Figure 15-11 Central Aquifer Sector County Zoning Districts



Zoning districts are aggregated by land uses types with similar water use rates for the purpose of projecting potential full build-out water demand in the table below.

Table 15-3 Summary of Zoning Use Types, Central ASEA (Excluding DHHL Lands)

Zoning Summary (Corresponding County Zoning Categories found within the Wailuku ASEA in Parentheses)	Acres	% of Total
SF Single Family Residential, Duplex, Residential (R-0, R-1, R-2, R-3), Rural RU-0.5	8,434.03	6.20%
Airport	1,390.96	1.02%
Apartment (A-1 Apartment, A-2 Apartment)	993.41	0.73%
Business (B-1 Business, B-2 Business, BCT Business Country Town)	338.32	0.25%
Industrial	1353	1.00%
Hotel (BR Business – Resort)	437.96	0.32%
Agriculture (AG Agriculture)	118,839.14	87.42%
Golf Course (PK-4 Park - Golf Course)*[5]	900	0.66%
P-1 Public/Quasi-Public, Public Use Park	1,631	1.20%
Open Space	1,623	1.19%
TOTAL excluding DHHL Lands	135,940.27	**100%**

Source: Table prepared by MDWS, Water Resources & Planning Division. Excludes DHHL lands.
Zoning supplied by Maui County Planning Department, Long Range Division, May 2015.
Interim zoning was assigned to CWRM categories based on Community Plan land use designations. Table excludes 211 acres of DHHL lands zoned Agriculture that are excluded from Agricultural zoning category.

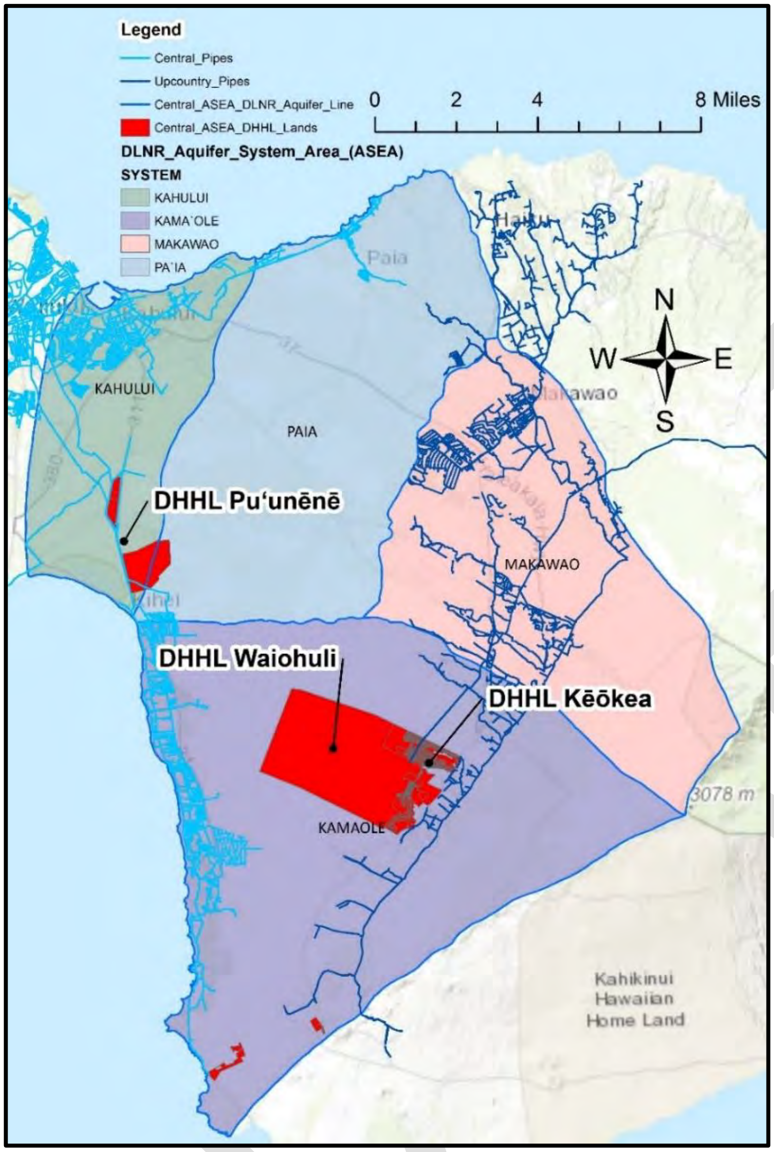
15.4.2 The DHHL Maui Island Plan

The Hawaiian Homes Commission adopted its Maui Island Plan as the overarching planning document in 2004. The DHHL Central Maui planning region encompasses three large land tracts totaling 2,141 acres, and there are three major DHHL project areas in the Central ASEA (Pu`unēnē, Kēōkea, and Waiohuli). The tracts are within the Kīhei-Mākena Community Plan area (DHHL Pu`unēnē) and Makawao-Pukalani-Kula Community Plan area (DHHL Kēōkea and Waiohuli), and as indicated in the figure below, the DHHL Pu`unēnē lands are found both within the Kahului and the Pā`ia Aquifers, while the DHHL Kēōkea and Waiohuli lands are located in the Makawao Aquifer. A smaller DHHL property, Kualapa, in shown in the southern portion of Kama`ole Aquifer.

<u>Kuleana Parcels</u>

There are existing kuleana parcels located within the Waiohuli homestead; however, the term "kuleana" is used differently within the context of DHHL land grant recipients compared to the term's common use, which is synonymous with appurtenant water rights holders. In general, kuleana parcels were historically awarded in fee by the Hawaiian monarchy in mid-1800s. History notes that kuleana parcels have also been awarded by Konohiki (ali'i) to tenants. According to the GIS layer supplied by OHA, the only "kuleana" water rights parcel is located in Maliko Gulch/Stream (1.98 acres).

Figure 15-12 Central Aquifer Sector – Department of Hawaiian Homelands Tracts



Source: State Water Projects Plan, May 2017

Kēōkea/Waiohuli – Priority Tract

Upcountry Maui (Kēōkea/Waiohuli, Ulupalakua, Kualapa) has over 6,000 acres of DHHL lands. The Makawao-Pukalani-Kula Community Plan section, "Identification of Major Problems and Opportunities of the Region Problems" cites "limited development of water resources and distribution system to meet the needs of the region as a primary concern," and notes that "The proper allocation of water resources is considered essential to encourage the development of Department of Hawaiian Home Lands (DHHL) parcel."[39]

[39]County of Maui, Makawao-Pukalani-Kula Community Plan, 1996, page 12.

Kula Residence Lots

The Kula Residence Lots subdivision is located in the northern portion of the Kēōkea-Waiohuli homestead area (yellow on the accompanying map). The subdivision will include a total of 420 lots developed to Rural Residential half-acre standards.

Pu`unēnē

The Pu`unēnē tract consists of Industrial and General Ag land use areas. It overlies the Kahului aquifer. Funds have been appropriated for the development of a comprehensive water and wastewater master plan for the Pulehunui area in Central Maui, which includes the Pu`unēnē tract and lands owned by the Department of Land and Natural Resources.

Kualapa

Located along Kula Highway south of Ulupalakua near Kanaio, this tract does not have immediate development potential due to infrastructure constraints. The water system is old and undersized and is not able to accommodate any further growth; and extensive off-site improvements would be needed to support residential development.

Future DHHL Development

DHHL has long range conceptual plans for about 1,100 more residential lots in the area below the latest developments. The future subdivisions are envisioned to include community facilities, a school site, parks, archaeological preserves, and open space. These future plans are dependent on the development of water, wastewater, road improvements, and funding. The timeframe for these developments is beyond 2020.

15.5 EXISTING WATER USE

Water systems can extend over multiple aquifer units and utilize water resources transported from multiple hydrologic units – aquifers or watersheds. Water use, by type and by resource, are inventoried for the Central ASEA as a hydrologic unit. However, for practical purposes existing water use and future water demand are also analyzed and projected for county and private water systems that share water resources from multiple hydrologic units. For example, the municipal Maui County Department of Water Supply (MDWS) Central Maui System services the region from Waihe`e to Pā`ia-Kū`au and south to Mā`alaea, Kīhei and Mākena. The Central Maui System overlies Wailuku ASEA and the Central ASEA. Because practically all freshwater supply for this system generates in the Wailuku ASEA, the Wailuku ASEA Report addressed the MDWS Central Maui System as a whole. This Central ASEA Report focuses on all other water use in the Central ASEA, including the MDWS Upcountry System.

15.5.1 Water Use by Type

The CWRM has established the following water use categories based for the purposes of water use permitting and reporting:

- Domestic (Residential Domestic—includes: (1) potable and non-potable water needs and Single and Multi-Family households, including non-commercial gardening; (2) Non-residential Domestic--includes potable [and non-potable] water needs; Commercial Businesses, Office Buildings, Hotels, Schools, Religious Facilities)
- Industrial (Fire Protection, Mining, Dust Control, Thermoelectric Cooling, Geothermal, Power Development, Hydroelectric Power, Other Industrial Applications)
- Irrigation (Golf Course, Hotels, Landscape and Water Features, Parks, School, Habitat maintenance)
- Agriculture (Aquatic Plants & Animals, Crops Irrigation and Processing, Livestock Water, Pasture Irrigation, and Processing, Ornamental and Nursery Plants, Taro, Other Agricultural Applications)
- Military (all military use)
- Municipal (County, State, Private Public Water Systems--as defined by Department of Health)

There are 362 wells installed in the Central Aquifer Sector, of which 18 are observation wells, 54 are unused, and seven are unspecified. Active wells and reported pumpage reflect the base year 2014.

There are no streams providing water supply within the Central ASEA. Surface water diversions from the Wailuku ASEA and from the Ko`olau ASEA are imported for potable and non-potable uses.

Table 15-4 Reported Groundwater Pumpage and Diverted Surface Water by Type, Central ASEA, 2014 (mgd)

Aquifer	Domestic	Industrial	Agriculture	Irrigation	Municipal	Military	Total
Kahului	0	0.208*2	28.222	0.476	1.093	0	29.999*2
Pā`ia	0	0	29.097	0.161	0.248	0	29.506
Makawao	0	0	0	0.220	0.139	0	0.366
Kama`ole	0	0	0	2.826	0.027	0	2.853
Central Total Pumpage	**0**	**0.208**	**57.319**	**3.683**	**1.507**	**0**	**62.724**
% of Pumpage	0%	0.33%	91.39%	5.87%	2.40%	0%	100%
Total Number of Production Wells	6	21	22	172	17	0	238
Total Diverted Surface Water*4	0	0	0.003*3	0.003*3	0	0	0.007
Reclaimed Wastewater5	0	0	0	1.830*5	0	0	1.830*5
WAILUKU GW IMPORT	0	0	0	0	15.654	0	15.654
WAILUKU SW IMPORT	0	0	18	0	0	0	18
WAILUKU TOTAL IMPORT	0	0	18	0	15.654	0	33.654
KO`OLAU SW IMPORT	0	0	116.133	0	5.632	0	121.765
KO`OLAU TOTAL IMPORT	0	0	116.133	0	5.632	0	121.765
CENTRAL TOTAL USE	**0**	**0.208**	**191.455**	**5.516**	**22.793**	**0**	**219.973**

*2Does not include 53 mgd of groundwater use from wells located near coastal areas recently declared by MECO. This should be accounted for in future WUDP updates.

*30.0069 mgd use unknown, assumed to be either Irrigation or Agriculture, so 0.003452 mgd distributed between both categories.

*4Sourced from within Central ASEA (does not include imported surface water from Wailuku and Ko`olau ASEAs)

*5Wastewater generated within the Central ASEA is treated at the Kahului Wastewater Treatment Facility, east of Kahului Harbor, and the Kīhei Wastewater Treatment Facility. All reclaimed water is utilized within the Central ASEA.

Figure 15-13 Reported Pumpage by Well Type, Central ASEA, 2014 (mgd, percent)

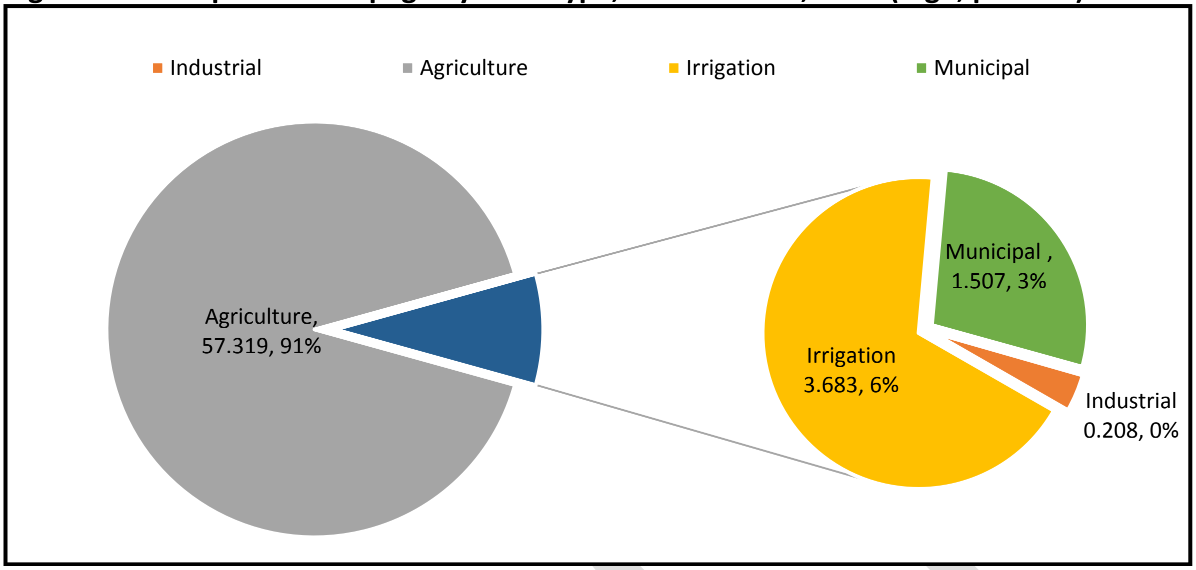
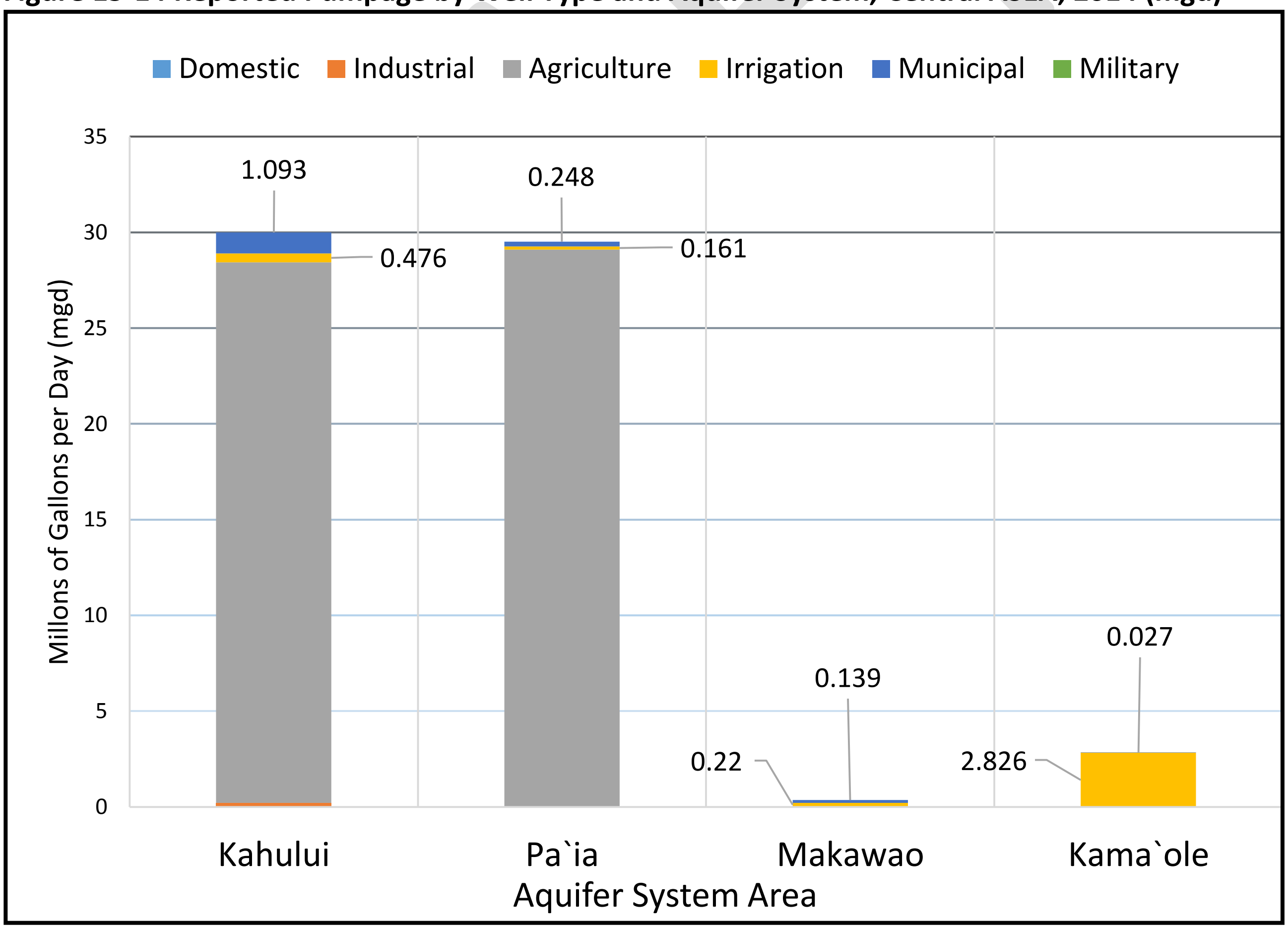


Figure 15-14 Reported Pumpage by Well Type and Aquifer System, Central ASEA, 2014 (mgd)



Domestic Use

Domestic use is defined in the State Water Code as "any use of water for individual personal needs and for household purposes such as drinking, bathing, heating, cooking, non-commercial gardening, and sanitation".[40] The code does not quantify the amount of water that would qualify for domestic use.

According to the CWRM well database, there are six wells classified as Domestic within the Central ASEA. It is likely that domestic use is underreported. The largest portion of customers served by the municipal MDWS system are for domestic type uses – serving individual households. These users are included under Municipal Use and compared to other customer classes served by MDWS.

Military Use

There are no wells classified as Military use within the Central ASEA.

Industrial Use

There are 21 wells that produce 0.208 mgd classified as Industrial use within the Central ASEA, all withdrawing from the Kahului Aquifer. Although MECO uses 53.00 mgd of industrial water, it is omitted from data tables because they only began reporting its use in 2018; therefore, there was no 2014 reported use to include with the other 2014 baseline data.

Irrigation Use

There are 172 wells classified as Irrigation use, producing 3.683 mgd within the Central ASEA, most from Kama`ole Aquifer: 2.826 mgd. All surface water use diversions originate from outside the Central ASEA. End uses of surface water diversions are not generally qualified by use type. It's possible that some surface diverted through the Wailuku Water Company for irrigation purposes extend into the Central ASEA. Surface water diverted via the East Maui Irrigation System is used for agricultural and municipal uses. A small surface water diversion of 0.006 mgd within the Central ASEA is not qualified but assumed to be for agricultural or irrigation end uses.

Agricultural Use

Water from the Nā Wai `Ehā in the Wailuku ASEA and from East Maui Streams in the Ko`olau ASEA was transported to irrigate sugarcane on the central Maui isthmus, which has been grown continuously from the late 1800s until the closing of HC&S sugarcane operations at the end of 2016. The figure below illustrates agricultural crops and associated water use based on the 2015 Agricultural Baseline. Water duty is assigned in accordance with State Department of Agriculture Irrigation Water Use Guidelines.

[40] H.R.S. §174C-3

The 36,000 acre HC&S plantation is no longer cultivated in sugarcane as indicated in the figure below. A&B diversified agricultural operations recently began transition to new diversified agriculture activities: (1) livestock pastures – a 4,000-acre expansion of the previous 29 acres of pasture space for grass-fed beef ranching, which is a collaborative effort with Maui Cattle Company that will allow Maui ranchers to keep more beef in Hawai`i to serve local markets; (2) Feedstock -- A 500-acre project including corn, sorghum, and soybeans to grow feedstock to be used at the Maui County Wailuku-Kahului Wastewater Treatment Plant; and (3) a 250-acre trial to study the viability of cultivating Pongamia as an energy crop. The biofuel project may expand up to 2,000 acres. The HC&S/A&B Inc.'s diversified agriculture plan and proposed irrigation needs are analyzed under future water use, chapter 15.6.

Figure 15-15 Central ASEA 2015 Agricultural Baseline Land Use

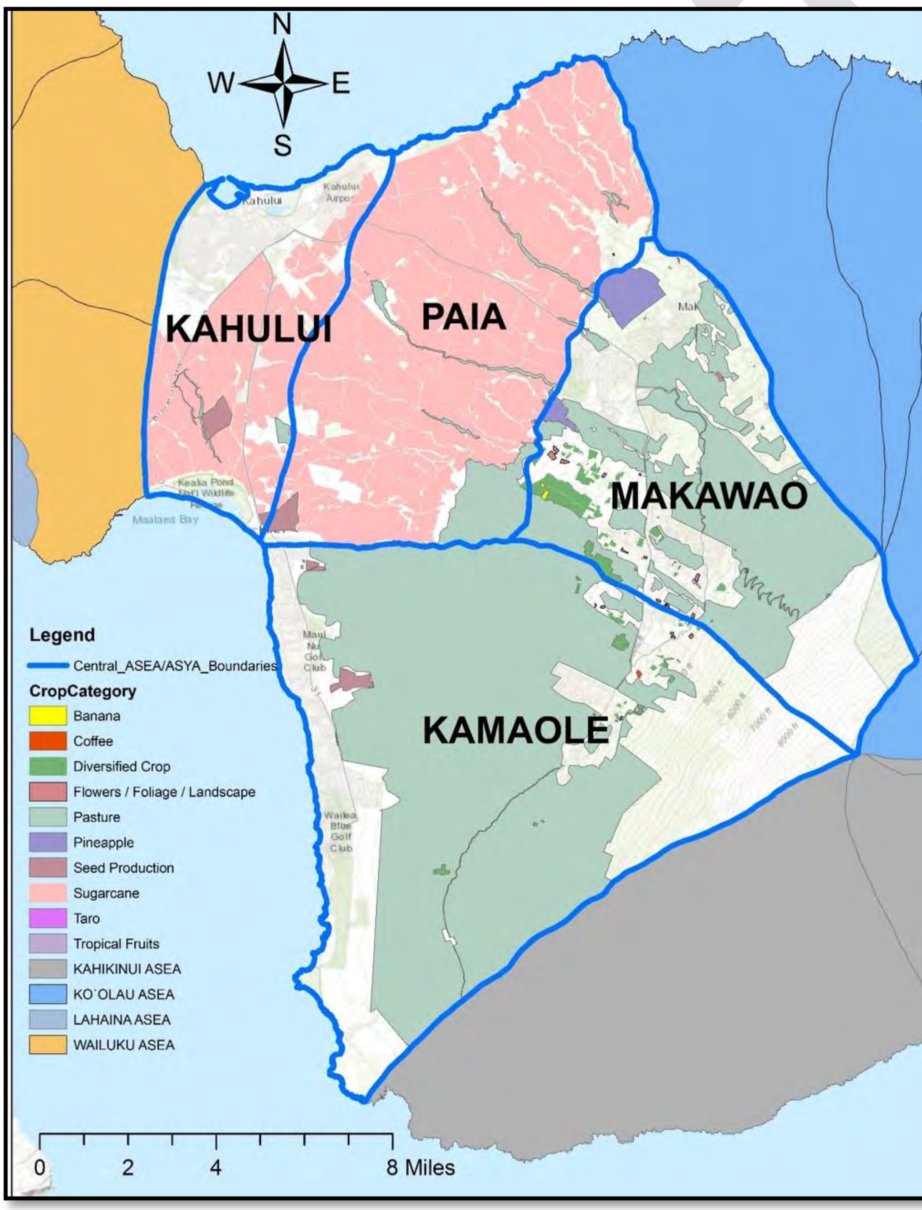


Table 15-5 Central ASEA Agricultural Water Demand (mgd), 2015 Agricultural Baseline

Crop	Acreage	Water Use Rate (gpd per acre)	Estimated Water Demand 2015 (mgd)
Banana	16.70	3,400	0.057
Coffee	10.58	2,900.00	0.031
Diversified Crop	1,197.22	3,400.00	4.071
Flowers / Foliage/ Landscape	97.97	4,000-6,000	0.490
Pasture	53,720.04	0-6,700	0.000
Pineapple	1,093.52	1,350.00	1.476
Seed Production	754.41	3,400.00	2.565
Taro	0.23	100,000-300,000*	0.035*
Tropical Fruits	21.69	4,400-10,000	0.156
Kula Agricultural Park	302.00 (usable)	*2	1.027*2
Kula Agricultural Park Expansion	742.00 (usable)	*3	2.523*3
CENTRAL Total	**57,929.08**		**12.431**

Sources: State of Hawai`i Department of Agriculture, Statewide Agricultural Land Use Baseline, 2015
Water Use Rates - HDOA Guidelines Coffee: 2004 AWUDP - 2500 gpd; however, 2900 gpd reported by plantation on Oahu per Brian Kau, HDOA, and personal communication 10/12/2016.; Wetland taro: Per CWRM CC D&O, Nā Wai `Ehā and East Maui Streams

*Taro water use per acre is the middle point (150,000 gpd) of the range (100,000 gpd – 300,000 gpd) of water flow needed for taro—not consumption

*2 Kula Agricultural Park numbers based on actual use

*3 Estimated water demand for 860-acre planned future expansion of the current Kula Agricultural Park (360 acres) was calculated based on the present demand and ratio of usable area to unusable area of the presently operating Kula Agricultural Park, with an additional 10% more anticipated to be required, based on a lower elevation (1,075 feet--675 feet lower) and less precipitation.

Kalo Lo`i and Appurtenant Rights

The 2015 Statewide Agricultural Land Use Baseline indicates that about 0.23 acres are currently cultivated in taro within the Central ASEA. The consumptive use is not the streamflow required through the lo`i for healthy plants, but it is the plant use that is not returned to the stream, i.e. the lo`i kalo water lost through percolation, evaporation and evapotranspiration.

Municipal Use

Municipal use comprised 2.4 percent of reported groundwater pumpage within the Central ASEA. Residential and commercial uses comprise the majority of the Municipal use category. In addition to the County Department of Water Supply (MDWS) there are five small privately owned "public water systems" as defined by the Department of Health (systems serving more than 25 people or 15 service connections). It is noted that Department of Health (DOH) identifies public water systems by source serving the system.

Table 15-6 Public Water Systems, Central ASEA

PWS No.	Name	Owner	Population Served	No. of Connections	Average Daily Flow (gpd)	Source
212	Wailuku/ Central System	MDWS	68,976	20,465	21,153,987	Ground/ Surface
215	Upper Kula/ Upcountry System	MDWS	7,038	2,346	19,611,000	Ground/ Surface
247	Lower Kula/ Upcountry System	MDWS	3,192	1,064	3,431,000	Surface
213	Makawao/ Upcountry System	MDWS	28,702	6,675	3,580,000	80% Surface/20% Ground
254	Maunaolu Plantation	Maunaolu Plantation Homeowners Association	100	39	200,000	Ground
255	Kula Nani	Kula Nani Estates Community Association	80	38	85,000	Surface (MDWS)
256	Maui Highlands	Highland Services, LLC	--	53	530,000	Ground
258	Consolidated Baseyards	Consolidated Baseyards Association	69	35	83,000	Ground
261	Maui Business Park	Maui Business Park Phase II Association, a subsidiary of Alexander & Baldwin, LLC	--	127	383,124	Pural Potable and Non-potable Ground

Source: State Dept. of Health, 2015 based on 2013 survey of water production providers submit every three years.

<u>MDWS Wailuku District/Central System (PWS 212)</u>

The MDWS Central System, also referred to as Wailuku District by the DOH, generally serves the area extending from Waihe`e to Pā`ia/Kū`au on the north shore; Kahului, Wailuku and Waikapū on the Central isthmus; and from Mā`alaea to Mākena on the south shore. The sources of water are primarily from groundwater pumped from the `Īao and Waihe`e aquifers supplemented with groundwater from Kahului Aquifer, surface water from the Wailuku River, and a production tunnel in `Īao Valley. The MDWS Central System is addressed in the Wailuku ASEA Report, with existing water use shown in Table 14-13 and the system distribution in Figure 14-18.

MDWS Upcountry System

The MDWS relies on three surface water sources, one of which is delivered by EMI through the Wailoa Ditch, and the other two through two MDWS higher elevation aqueducts maintained by EMI that transport water to Olinda and Kula, under a contractual agreement originated under the 1973 East Maui Water Agreement and subsequent agreements. MDWS and EMI diverts water from Ko`olau ASEA, conveyed to treatment plant facilities located in Ko'olau ASEA (Pi`iholo Water Treatment Facility) and the Central ASEA (Olinda and Kamole Weir Water Treatment Facilities). The Olinda facility diverts water at the upper Waikamoi Flume from the Waikamoi, Puohokamoa, and Haipuena Streams. Water is stored in two 15 million gallon reservoirs and one 100-million gallon reservoir. The Pi`iholo facility diverts water from the Waikamoi, Puohokamoa, Haipuena Streams and Honomanū streams into a 50-million gallon reservoir. The Kamole Weir facility relies on EMI diversions from eastern most Makapipi stream to the western most Honopou stream.

The Upcountry System spans Ko`olau and Central Aquifer Sectors, as illustrated in the figure below, and serves about 35,200 people. MDWS also serves non-potable water to 31 farm lots at the Kula Agricultural Park (KAP). Current water use at the KAP is about 0.4 mgd. About 80 – 90 percent of the delivered water comes from surface water sources and the remaining portion from basal aquifer wells. Ha`ikū Well and Kaupakalua Well are located in the Ko`olau ASEA, Hāmākuapoko Well 1 & 2 and Po`okela Well are located in the Central ASEA. The combined surface and groundwater source production capacity is 17.9 mgd, 13 mgd from surface water and 4.9 mgd from groundwater. Accounting for system and operational limitations, and use restrictions from Hāmākuapoko wells, the reliable capacity is 9.1 mgd. Current water use averages 7.9 mgd within a range of 6 – 10 mgd. The DOH divides the MDWS Upcountry System into three separate systems: Upper Kula; Lower Kula and the Makawao Systems, although all three are interconnected.

MDWS Makawao/Upcountry Water System (PWS 213)

The MDWS Makawao/Upcountry System, also referred to as Makawao District by the DOH, generally serves the area extending from Ha`ikū, Makawao, and Pukalani to Hali`imaile/Pā`ia. The system has 6,680 meters and serves about 28,702 people. The sources of water are primarily from surface water imported from East Maui (80%) and well water (20%) from the Ha`ikū and Makawao Aquifers. Surface water from the Wailoa Ditch, generated in the Ko`olau ASEA, is treated at the Kamole Weir Water Treatment Facility (WTF). The facility uses micro-filtration technology and is the largest surface water treatment facility on Maui. It has four booster pumps to move water up to the 2,800 foot elevation, where it can be pumped to the highest service areas at 4,500 feet. Historically, the Kamole Weir WTF is the primary source of water for nearly all of Upcountry during times of drought. There is no raw water storage at the WTF.

Two wells in the Ha`ikū Aquifer supplies most of the Ha`ikū service area. The Ha`ikū Well has detections of the contaminants 1,2-Dibromo-3-chloropropane (DBCP) and 1,2,3-

Trichloropropane (TCP) at below allowable limits. Po`okela Well, with a backup well under development, withdraws water from the Makawao Aquifer. Two wells located in the Pā`ia Aquifer can supplement the Makawao System during drought. The Hāmākuapoko wells are outfitted with granular activated carbon treatment technology to remove the chemical DBCP detected in the wells. All sources meet Safe Drinking Water standards.

MDWS Lower Kula/Upcountry Water System [PWS 247]
The MDWS Lower Kula/Upcountry System, also referred to as Lower Kula District by the DOH, generally serves the area extending from Kula Kai to Omaopio to mid and lower Kimo Drive areas. The system has 1,064 meters and serves about 3,192 people. The sources of water are primarily from surface water imported from East Maui treated at the Pi`iholo WTF. The facility uses direct filtration technology. Granular activated carbon and air stripping treatments were added in 2015 to reduce disinfection-byproducts in the water supply. The system can be supplemented with groundwater from Makawao Aquifer.

MDWS Upper Kula/Upcountry Water System [PWS 215]
The MDWS Upper Kula/Upcountry System, also referred to as Upper Kula District by the DOH, generally serves the area extending from Upper Kula to Kula Highlands to Kama`ole to Upper Olinda-Pi`iholo to Kula Glen to Ulupalakua-Kanaio. The system has 2,346 meters and serves about 7,038 people. The source of water is primarily from surface water from Waikamoi treated at the Olinda WTF. The facility uses micro-filtration technology. Disinfection is provided by anhydrous ammonia, blended with chlorine to form chloramines. Water is stored in 30 MG Waikamoi Reservoirs and the 100 MG Kahakapao Reservoirs.

The Upcountry water treatment facilities, annual and average production is shown in the table below. 2014 is the base year for forecasting demand in this WUDP update. Demand varies annually due to multiple factors. 2014 was a relatively wet year but demand is comparable to water use over a 10-year period. Demand varies seasonally as shown by high and low month average daily production. Typically, during drought conditions, average daily demand increases. The Upcountry system monthly variation was as high as 89 percent in 2014.

Table 15-7 MDWS Upcountry Water Treatment Facilities, Annual and Average Daily Production, Central ASEA

WTF	2014 YTD (1000 gal)	ADP (mgd)	High YTD Production 2012-2014 (1000 gal)	High Month ADP 2012-2014 (mgd)	% Variation High Yr ADP 2012-2014/ 2014 ADP (mgd)
Olinda	336.690	0.922	546.770	1.494	62.4%
Pi'iholo	1,044.967	2.863	1,265.306	3.457	21.1%
Kamole Weir	674.200	1.847	881.770	2.409	30.8%

Source: MDWS
YTP= Year Total Production; ADP= Average Daily Production. Olinda was offline in the last quarter of 2014.
High ADP 2012-14 for the individual WTPs did not all occur in the same year.

Table 15-8 MDWS Upcountry System Production, 10-Year Daily Average, 2005-2014, Central ASEA (mgd)

Total Production			Groundwater			Surface Water		
Total Daily Ave	High Month Total	% High / Ave Month	Daily Ave	High Month	% High / Ave Month	Daily Ave	High Month	% High / Ave Month
7.61	10.36	36%	1.23	2.06	68%	6.38	8.79	38%

MDWS production, 2005-2014

The MDWS Central System and the MDWS Upcountry System are not interconnected. The figure below illustrates both distribution systems, general location of wells, ditches and water treatment facilities.

Figure 15-16 MDWS Central and Upcountry Systems and Infrastructure

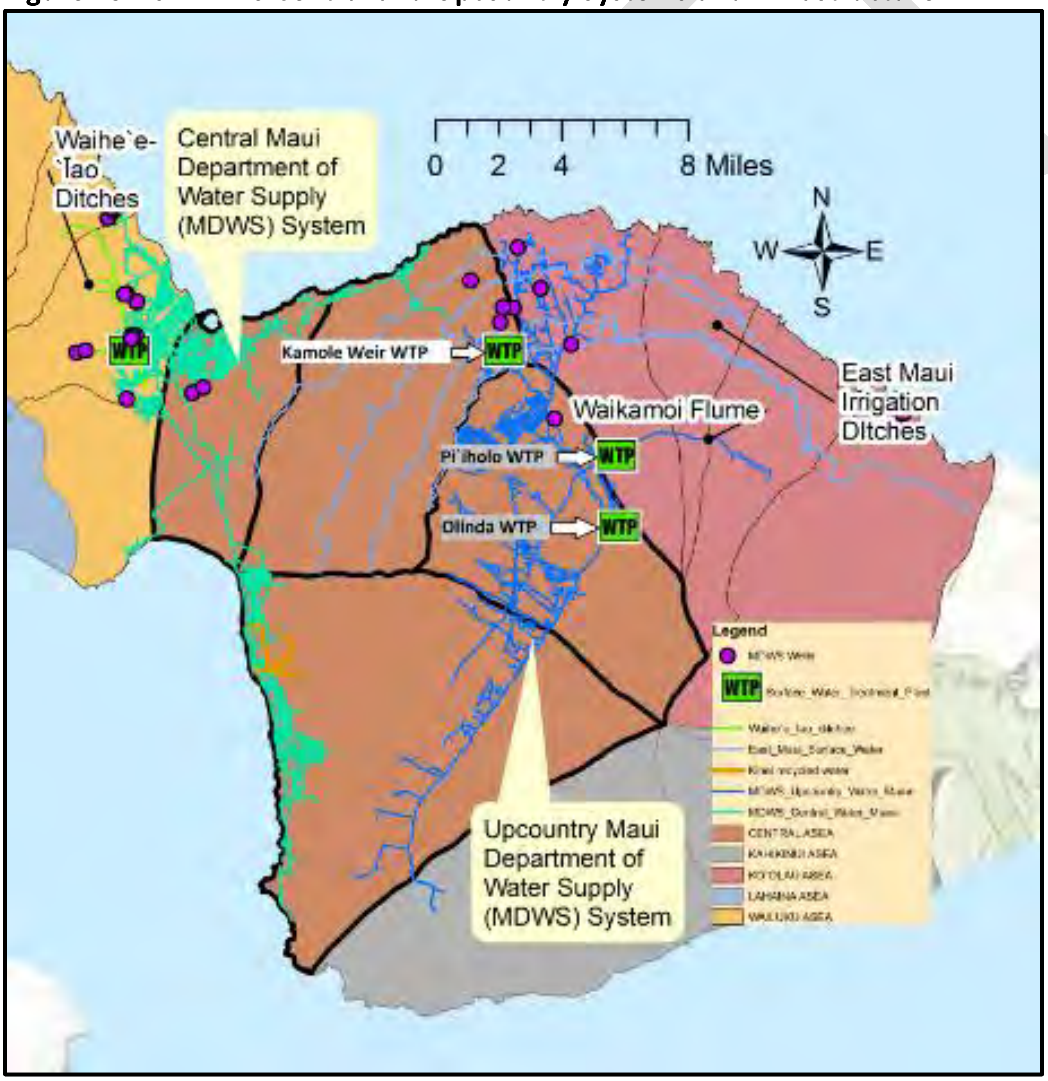


Table 15-9 MDWS Upcountry System (Excluding Kula Agricultural Park) Water Consumption by CWRM Category, 2014

DWS Upcountry System Total (excluding Kula Agricultural Park)	2014 (MGD)	2014 (GPD)	% of Total
Domestic Residential	4.8583	4,858,253	77.59%
Domestic Non-Residential	0.2412	241,212	3.85%
Industrial	0.0001	82	0.00%
Municipal	0.6051	605,061	9.66%
Agriculture	0.5367	536,687	8.57%
Irrigated	0.0010	991	0.02%
Military	0.0002	197	0.00%
Unknown	0.0190	18,958	0.30%
TOTAL	**6.2614**	**6,261,441**	**100.00%**

Table 15-10 MDWS Upcountry System (Including Kula Agricultural Park) Water Consumption by CWRM Category, 2014

DWS Upcountry System Total (with Kula Ag Park)	2014 (MGD)	2014 (GPD)	% of Total
Domestic Residential	5.1134	5,113,400	77.00%
Domestic Non-Residential	0.2449	244,940	3.69%
Industrial	0.0001	82	0.00%
Municipal	0.6051	605,061	9.11%
Agriculture	0.6569	656,896	9.89%
Irrigated	0.0010	991	0.01%
Military	0.0002	197	0.00%
Unknown	0.0190	18,958	0.29%
TOTAL	**6.6405**	**6,640,525**	**100.00%**

State Water Systems

A non-potable State water system exists within the Polipoli State Recreation area. The Polipoli Springs State Recreation Area water system is located in the Kahikinui Forest Reserve, overlying the Kama`ole Aquifer. The water system is owned and operated by the State of Hawai`i and managed by the DLNR-State Parks. The water system serves a park cabin and campground area. The non-potable source for the water system is an unnamed spring. The spring water flows through a 1-1/2-inch pipe to the campground area. The estimated water demand is 0.002 mgd. Information to determine the stream diversion capacity is not available and flow measurements are not recorded. System source capacity adequacy could not be determined. Future water demands for the park are unknown.[41]

Federal Water Systems

There are no federal water systems within the Central ASEA.

Private Public Water Systems

Maunaolu Plantation: Pā`ia System of the Central Sector (PWS 254)

The Maunaolu Plantation Public Water System is owned by the Maunaolu Plantation Homeowners Association and operated by the Pural Water Company, serving approximately 100 people. The Average Daily Flow is 0.2 million gallons per day (mgd), serving 39 meters/service connections. Potable water for Maunaolu Plantation is supplied by basal groundwater obtained from deep wells drawing from the Pā`ia Aquifer. Water from the well is chlorinated to ensure that drinking water meets the Safe Drinking Water Regulations of the EPA and the Safe Drinking Water Branch of the Hawai`i Department of Health.

Water is stored in an 80,000 gallon steel tank. The average daily consumption per class of customer (Single Family) is 5,000 gpd. No future expansion is anticipated for the water system.

During a period from 2004 to 2009, one contaminant, Ethylene Dibromide (EDB), was found to exceed the legal limit. There have been no EPA violations reported for Public Water System 254 Maunaolu Plantation since 2004.[42]

Kula Nani: Kama`ole System of the Central Sector (PWS 255)

The Kula Nani Public Water System purchases surface water from the MDWS. It is owned by the Kula Nani Estates Community Association and maintained and operated by Pural Water Specialty Company. The system provides drinking and irrigation water to its approximately 80 customers on 38 service connections. Infrastructure includes two water storage tanks with a capacity to store a total of 0.085 mgd. The average daily consumption per class of customer (Single Family) in PWS 255 Kula Nani is 2,236 gpd. No future expansion is anticipated for the water system.[43]

Maui Highlands: Kama`ole System of the Central Sector (PWS 256)

The Maui Highlands Public Water System is owned by Highland Services, LLC, and operated by the Pural Water Company, serving approximately 53 service connections, stored in a 600,000

[41] State of Hawai`i, State Water Projects Plan, Volume 3, 2003.
[42] HI DOH SDWB; CWRM; Mr. Efren Ugalino; http://www.nps.gov/hale/planyourvisit/index.htm; http://www.ewg.org/tap-water/whatsinyourwater/HI/Maunaolu-Plantation/0000254/
[43] State of Hawai`i DOH SDWB; CWRM; Mr. Efren Ugalino; http://puralwater.com/

gallon steel tank. According to DOH, the Average Daily Flow (Single Family) is 10,000 gpd. Water is supplied by basal groundwater obtained from deep wells drawing from the Kama`ole Aquifer. Water from the two wells is chlorinated. No future expansion is anticipated for the water system.[44]

Consolidated Baseyards: Kahului System of the Central Sector (PWS 258)

The Consolidated Baseyards Public Water System is owned and operated by the Consolidated Baseyards Association, and serves 35 meters and approximately 69 people. According to DOH, the Average Daily Flow is 83,000 gpd. Potable water for Consolidated Baseyards is supplied by basal groundwater obtained from deep wells drawing from the Kahului Aquifer, and it is stored in a 350,000 gallon steel tank. Water from the wells is chlorinated. No future expansion is anticipated for the water system.[45]

Maui Business Park: Kahului System of the Central Sector (PWS 261)

The system is owned by the Maui Business Park Phase II Association, a subsidiary of Alexander & Baldwin, LLC. The 154-acre industrial-zoned land in central Kahului is in close proximity to Kahului Harbor and Airport.

Currently, service is provided to approximately 127 commercial customers, using an estimated 383,124 gpd, consisting of 258,795 gpd of non-potable water,[46] and 124,329 gpd of potable water.[47] Both potable and non-potable water are pumped from the Kahului Aquifer. This is a dual water system supply where each lot has two water meters, one for potable and one for non-potable. The non-potable well is located in the vicinity of the Business Park, within the Kahului Aquifer. Water is chlorinated and stored in a 600,000 gallon glass-fused steel tank.[48] Future expansion is anticipated for the water system to accommodate the lots that are not metered at this time. There are no residential or heavy industrial water users.

Department of Hawaiian Homelands (DHHL)

DHHL does not operate any water systems in the Central ASEA. DHHL developments Upcountry have relied on the MDWS municipal system, which extends to the Kēōkea/Waiohuli development. Consumption is therefore included in the MDWS Upcountry System water use. An additional 768 residential lots are proposed for future residential homesteads at Waiohuli pursuant to the development of an on-site production well. Other DHHL tracts in Central ASEA are not developed.

---

[44] Ibid.
[45] State of Hawai`i DOH SDWB; CWRM; Mr. Efren Ugalino.
[46] State of Hawai`i Commission on Water Resource Management, Waiale 1 Well (Well Number 6-5129-004) and Waialae 2 Well (Well Number 6-5129-005), average pumpage October 1, 2011 to April 1, 2018.
[47] Ibid, MBPII Non-Potable (Well Number 6-5226-00) average pumpage, January 1, 2014 to April 1, 2018
[48] Ibid; www.mauibusinesspark.com

15.5.2 Water Use by Resource

Water use in 2014 totaled 219.97 mgd in the Central ASEA, with surface water accounting for 71.5 percent of the total. Since the cessation of sugarcane cultivation, reported surface water use is significantly less and further analyzed under Future Water Use.

Water Transport

Irrigation of large scale agriculture on the Central isthmus, primarily sugarcane until 2016, was supplied by surface water derived from outside the Central ASEA hydrologic units and recharges the underlying groundwater within the Central ASEA. This manmade recharge is not accounted for in establishing Sustainable Yield.

Groundwater from Wailuku ASEA is transported throughout the municipal Central Maui System/Wailuku District, serving population centers in the Central ASEA. Groundwater from `Īao and Waihe`e aquifers is mixed with groundwater from the Maui Lani wells in the Kahului Aquifer and surface water from the Wailuku River. Therefore, the exact amounts used within each aquifer sector cannot be determined. Surface water diverted from Nā Wai `Ehā was previously transported to the Central ASEA for sugarcane cultivation. One mgd is used for municipal uses.

Surface water from Ko`olau ASEA is conveyed through the East Maui Irrigation (EMI) System for irrigation of previous sugarcane cultivation. The MDWS purchases water from the Wailoa Ditch for municipal use Upcountry and non-potable water from Wailoa Ditch services the Kula Agricultural Park. The MDWS diverts surface water from Ko`olau ASEA at intakes above the EMI system for the Lower Kula and the Upper Kula systems. Estimated water transfers are shown below.

Table 15-11 Estimated Water Imports, Central ASEA

Water Resource	Central ASEA Imports from Wailuku ASEA	Central ASEA Import from Ko`olau ASEA	Total
Surface Water	16 - 18	121.76	**137.76 - 139.76**
Groundwater	15.7	0	**15.7**
Total:	**31.7 – 33.7**	**121.76**	**153.46 - 155.46**

Source: CWRM 2014 Well Pumpage and Diversion Data, MDWS 2014 Billing and Production; CCHMA 06-01-2 D&O. Smaller purveyors and end uses not shown.

Ground Water Resources

Most of the public water supply on Maui Island, including the Central ASEA, is derived from basal sources in the Wailuku ASEA. Groundwater from the Kahului, Kama`ole and Pā`ia Aquifers are primarily used for non-potable purposes. Well development in the Makawao Aquifer is limited. The table below shows pumpage and pump capacity of installed wells, compared to sustainable yield. Pump capacity does not reflect permitted or actual pumpage, but the total capacity of installed pumps in gallons per minute, multiplied by 60 minutes, multiplied 24 hours, in order to determine how much water could be pumped if the well were in operation for a full day.

Table 15-12 Pumpage and Pump Capacity of Wells Compared to Sustainable Yield of Aquifers, Central ASEA

Aquifer System	Pumpage	Installed Pump Capacity	SY	Pumpage as % of SY
Kahului	30	102.12	1*	3000%
Pā`ia	29.51	153.73	7*	422%
Makawao	0.37	4.96	7*	5%
Kama`ole	2.85	18.83	11	26%
Total	62.72	279.64	**26**	**241%**

Source: CWRM Well Index 5/29/15 for production wells and 2014 pumpage reports, 12-month moving average
*Only basal water

Chloride Concentrations

Salinity of water withdrawn from wells in the aquifer sector generally increases with depth, proximity to the coast, and withdrawal rates. Before the addition of irrigation water from outside the Central isthmus, the Kahului Aquifer was believed to be naturally brackish. Many of the older high-capacity irrigation wells and shafts operated by sugarcane plantations in central Maui reported salinity exceeding 4 percent of seawater.[51] The influx of surface water from Nā Wai `Ehā and from East Maui for sugarcane irrigation contributed irrigation return recharge to augment the quality and quantity of the groundwater lens below. Generally, wells along the coast lines and areas of Kahului Aquifer are semi-brackish to brackish. The MDWS Maui Lani wells have experienced rising chloride levels, which can be due to concentrated pumpage from production wells that are located very close together and operated simultaneously rather than in rotation, or decreased recharge. When a well is pumping freshwater from an aquifer that consists of two sublayers (freshwater and saltwater), the interface between freshwater and saltwater will rise due to the drawdown at the free surface of freshwater.

Hawaiian Commercial and Sugar Company (HC&S) pumped brackish to semi-brackish water from the Kahului and Pā`ia Aquifers for irrigation of sugarcane but also for industrial uses. Brackish groundwater pump capacity is 115 – 120 mgd. Pumpage for agricultural uses decreased from about 57 mgd in 2014 to 0.3 mgd in 2017. Decreased irrigation water return recharge over these aquifers have to date unknown impact on chloride levels. Increased chlorides in the Kahului and Pā`ia Aquifers will likely also impact irrigation, municipal and other potable and non-potable wells.

In the long term, irrigation wells along the south shore in Kama`ole Aquifer and along the north coast in Kahului and Pā`ia Aquifers are potentially subject to rising sea-levels with associated seawater intrusion.

[51] USGS Report 2008-5236, Groundwater Availability in the Wailuku Area, Maui, Hawai`i 2008

Impacts from Climate Change

The Central Aquifer Sector may be especially vulnerable to climate change impacts due to multiple factors:

1. The region hosts the bulk of population centers with growth regions and major infrastructure along the north and south shore coast lines, subject to sea-level rise.
2. Wells throughout Kahului, Pā`ia and Kama`ole aquifers are relatively shallow with potential impact from sea-level rise.
3. The dry micro-climates in Kahului and Kama`ole aquifer systems have already seen a decrease in total rainfall.
4. Recharge under drought conditions are projected to be most severe for the aquifer system of Kama`ole with a 51 percent decrease compared to normal rainfall conditions.

Surface Water Resources

There are 10 streams/springs in the Central ASEA shown in the table below. Waikapū Stream is the only Nā Wai `Ehā perennial stream that extends to the Central ASEA, but its lower reaches within the Central ASEA are usually dry. Surface water diversions constituted the majority of water diverted from Nā Wai `Ehā for agricultural purposes through 2016. An estimated 16 – 18 mgd of surface water used in the Central ASEA is imported from the Wailuku ASEA. An estimated 121.76 mgd used is imported from the Ko`olau ASEA. MDWS uses about 1 mgd of surface water from Wailuku River for municipal uses and between 5.6 – 7.4 mgd from the Ko`olau ASEA.

Table 15-13 Surface Water Diversions, Central ASEA (gpd)

Surface Water	Domestic	Industrial	Agriculture/Irrigation	Municipal	Military	Total
Waihou Spring	--	--	--	--	--	**--**
Waika`alu Spring	--	--	--	--	--	**--**
Waika`ahi Spring	--	--	--	--	--	**--**
Polipoli Spring	--	--	--	--	--	**--**
Maliko Stream*	--	--	6,904*	--	--	**6,904***
“Unnamed stream 1.”*[2]	--	--	--	--	--	**--**
“Unnamed stream 2.”*[3]	--	--	--	--	--	**--**
Total Diverted Surface Water	**--**	**--**	6,904*	**--**	**--**	**6,904***

*Stream diversion, pump from Maliko Stream. Declared Q was estimated from pump capacity and the total Q (diverted quantity) of 1.260 MGY (6,904 gpd) includes both diversions #6-5218-002D and 6-5218-003D.
*[2]Stream diversion, from unnamed stream. Diversion from Wai`ale Reservoir (74) to Waihe`e Ditch.
*[3]Spring diversion, pipe from unnamed stream and rights claim.

Alternative Water Resources

Rainwater Catchment

Rainfall averages 15 inches along the southern coastline on Haleakalā, and it increases to 70 inches as one moves eastward and into higher elevations.[52] Rainfall catchment systems occur in the eastern part of the hydrologic unit, from Makawao and Olinda and also scattered throughout Kula. There is no official inventory of catchment systems but it is an important supplemental resource for non-potable purposes. Catchments systems using potable treatment technologies have been installed Upcountry due to water meter limitations imposed by the Upcountry Meter Priority List.

Recycled Wastewater

There is reclaimed wastewater treated and distributed within the Central ASEA. The State of Hawai`i defines R-1 water as the highest-quality recycled water; it has undergone filtration and disinfection to make it safe for use on lawns, golf courses, parks, and other areas used by people. R-2 recycled water can only be used under restricted circumstances where human contact is minimized. Wastewater generated within the Central ASEA is treated at the Kahului Wastewater Reclamation Facility (WWRF), east of Kahului Harbor, and the Kīhei WWRF. Both facilities are described in the Wailuku ASEA Report, Chapter 14.5.1. Private wastewater treatment plants in Mākena and Pukalani generate R-1 water used for golf course irrigatation.

The Maui County Code was amended in 1996 requiring commercial properties (agricultural, commercial, public uses) within 100 feet of a Maui County R-1 water distribution system to connect within one year of recycled water availability and to utilize recycled water for irrigation purposes. The CWRM can also require dual water supply systems for new commercial and industrial developments in designated water management areas if a non-potable source of water is available.

The Department of Environmental Management's Wastewater Reclamation Division (WWRD) must fulfill R-1 water obligations for projects that are either: a(1 already utilizing R-1 water and will see increased use as projects build out; or (2)) projects that are in close proximity to the existing distribution system and will be connecting in the near future.

Kahului WWRF

The Kahului WWRF serves the Central Maui area from Waiehu to Kū`au. The current dry weather flow capacity is 7.9 mgd and average dry weather flow is 4.4 mgd. Currently, all of the wastewater processed by the facility is treated to R-2 recycled water standards meaning that there are restrictions on its uses and applications. The volume of R-2 water reused from the facility ranges from 3 to 7% of the incoming wastewater flow. The daily average of R-2 water

[52] Johnson Engott, USGS, Spatially Distributed Groundwater Recharge Model, Maui 2014-5168, page 6.

used is 0.2 mgd with most of the recycled water utilized within the facility for landscape irrigation and industrial uses. Some of the R-2 water is sold to construction companies that use it for dust control.[53]

Kīhei WWRF

The Kīhei WWRF serves the South Maui area from Wailea to Sugar Beach. The current dry weather flow capacity and R-1 production capacity is 8.0 mgd, and the average dry weather flow to the WWRF is 3.58 mgd. The volume reused R-1 water ranges from 20-52% of the incoming wastewater flow depending upon the time of the year. The South Maui distribution system provides R-1 water to 24 commercial properties in South Maui for landscape and agricultural irrigation, cooling, fire control, erosion and dust control, drinking water for cattle, and other uses. [54]

The volume of R-1 water reused is subject seasonal fluctuations. Generally, more water is used for irrigation in the dry summer and fall months. The highest average daily volume for peak season use was 1.75 mgd in August, 2008. The excess R-1 water that is currently available during peak demand months is about 1.39 mgd (3.14 mgd wastewater flow minus 1.75 mgd peak month use). The available volume will be less due to additional planned R-1 use at developing commercial properties located near the existing R-1 distribution system. As of 2016, the WWRF estimates 0.7 mgd excess R-1 supply is available. During winter months, wastewater flow rates to the WWRF typically increase due to greater visitor levels in South Maui while irrigation demands lessen and as a result excess R-1 water is available.

Large irrigated areas are needed to utilize the seasonal excess water in winter months. However, in summer months there would unlikely be sufficient R-1 produced to meet irrigation demands for such large acreage, therefore requiring alternative sources as contingency.

[53] Department of Environmental Management, Wastewater Reclamation Division, Central Maui Recycled Water Verification Study, December 2010.

[54] Department of Environmental Management, Wastewater Reclamation Division, Department of Water Supply Water Resource Planning Division, South Maui R-1 Recycled Water Verification Study, December 2009.

Table 15-14 Wastewater Reclamation Facility Capacity, Production and Use, 2014 (mgd)

WWRF	Treatment Level	WWRF Design Capacity	Recycled Water Produced	Recycled Water Used	% of Total Produced Used	% of Design Capacity Used	Application
Wailuku -Kahului	R-2	7.9	4.7	0.25	5.3%	3.2%	None
Kīhei	R-1	8	3.6	1.5	41.5%	18.7%	Golf Course, Agriculture, Dust Control, Landscape, Fire Protection
Mākena (Private)	R-1	0.75	0.08	0.08	10.6%	10.6%	Golf Course
Pukalani (Private)	R-1	0.29	0.19	0.19	100%	65.5%	Landscape

Source: Department of Environmental Management, Wastewater Reclamation Division, Central Maui Recycled Water Verification Study, December 2010

Mākena Resort Wastewater Reclamation System

The Mākena area is predominantly served by cesspools. There is no publicly owned treatment works operating in the area. Mākena Resort is served by a privately owned individual wastewater system with effluent treated to R-1 quality. The Mākena Wastewater Reclamation Facility encompasses an area of approximately 13 acres, mauka of the Mākena North Golf Course. The reclaimed water is pumped up to a larger reservoir within the golf course irrigation system, mixed with non-potable ground water from nearby wells, and used to irrigate portions of the North and South courses. Its average daily capacity is approximately 0.72 mgd and is designed to be expanded to 1.5 mgd in the future. The current average daily flow is approximately 80,000 gallons. The primary reuse is golf course irrigation. Additional reuse is for wastewater facility uses such as landscape irrigation, washdown and dilution water.

Pukalani Wastewater Reclamation System

Hawai`i Water Service Company treats 200,000 gpd of wastewater using membrane bio-reactor technology used to irrigate the adjacent Pukalani golf course. About 190,000 gpd are used and no recycled water expansion plans are identified.

Stormwater Reuse

Capture and reuse of stormwater runoff is an under-utilized water resource that provides an opportunity to reduce reliance on groundwater and surface water for landscape irrigation, especially when incorporated into the design of development projects in order to minimize infrastructure costs. There is no reported stormwater reuse in the Central ASEA, although some development projects may have stormwater controls incorporated into project design to reduce runoff and its effects. The *Hawai'i Stormwater Reclamation Appraisal Report, 2005, and*

Study Element 3: An Appraisal of Stormwater Reclamation and Reuse Opportunities in Hawai'i, September 2008, screened and identified four projects on Maui within the final ranking, which might provide opportunities to augment agricultural irrigation water that is diverted currently from Maui streams, in addition to providing other benefits:[55] The Wai`ale Road Stormwater Drainage option uses an existing stormwater drainage channel and detention pond located along Wai`ale Road to capture and convey stormwater into the Waihe`e and Spreckels Irrigation Ditch Systems for agricultural irrigation to the south and east.

Desalination

There are no desalination projects in the Central ASEA. Desalination of ocean or brackish water was explored by Brown & Caldwell in 2006 as a supplemental option to the MDWS Central Maui system/Wailuku District with a long term goal to reduce draw on the `Īao aquifer. An analysis targeting desalination treatment capacity of 5 mgd using reverse osmosis (RO) technology was completed for brackish and seawater alternatives. Both are technically feasible alternatives that meet current health standards and drinking water regulations. [56] Brackish water desalination appears economically feasible.

[55] Hawai'i Stormwater Reclamation Appraisal Report, 2005, and Study Element 3: An Appraisal of Stormwater Reclamation and Reuse Opportunities in Hawai'i, September 2008. http://files.Hawai'i.gov/dlnr/cwrm/planning/hsrar_element3.pdf

[56] Brown & Caldwell, 2006. County of Maui Department of Water Supply Central/South Maui Desalination Feasibility Study Final Report

15.6 Future Water Needs

15.6.1 General

Two alternative methods were used to project water demand to the year 2035: Population growth rates based on 20-year population growth projections in the Socio-Economic Forecast Report (2014) applied to current consumption and build-out of permitted land use based on County zoning and Department of Hawaiian Homelands land use plans. Population-based demand takes into account social and economic factors that are anticipated to drive growth over the planning period.

15.6.2 Water Use Unit Rates

Historically, most of the water use in the Central ASEA is for agricultural use, with residential or single family use following. The 2002 Water Use Standards are used for land use-based demand projections. The Water System Standard for residential use on Maui is 600 gallons per day (gpd) per unit and 3,000 gallons per acre. Future water demand is projected based on the standard of 3,000 gpd per acre for single family/duplex and 5,000 gpd per acre for multi-family use.

The Central Aquifer Sector Area (ASEA) encompasses about 229 square miles, including 4 groundwater aquifer system areas underlying the western flank of Haleakalā Mountain: Kahului, Pā`ia, Makawao, and Kama`ole. The population of the Central ASEA includes parts of the resident populations from the following community plan areas: Kīhei-Mākena, Wailuku-Kahului, Makawao-Pukalani-Kula, Pā`ia-Ha`ikū. The estimated population of the Central ASEA was 103,970 in 2015 and is projected to increase by approximately 33 percent to 138,164 by 2035.

15.6.3 Land Use-Based Full Build-Out Water Demand Projections

Build-out of land use-based on zoning designations represents a snapshot of ultimate demand. Since DHHL lands are not subject to County Zoning regulations, DHHL acreages are addressed separately based on the DHHL's Maui Island Plan and its regional plans. Full build-out projections for the Central ASEA area based on County zoning and DHHL land use categories yield a projected water demand of 427,000,241 gpd, or 427 million gallons per day (mgd). Full build-out by county zoning designation is not realistic over the 20-year planning period or supported by the County of Maui General Plan. The directed growth strategy in the General Plan provides the framework for future zoning changes.

About 78 percent of land in the Central ASEA is zoned Agriculture. System standard water rates for agricultural zoning are assigned but do not represent regional irrigation needs. Agricultural land include former irrigated sugarcane fields as well as unirrigated pasture along the leeward western flank of Haleakalā. It should be noted that large scale agriculture has historically relied on surface water for their irrigation needs and is not projected to be served by the municipal system or available groundwater in the Central ASEA.

Maui County Zoning

Maui County Zoning Districts are aggregated by land uses types with similar water use rates for the purpose of projecting potential full build-out water demand in the table below. Directed Growth Plan guidance and Community Plan designations were generally used for purposes of calculating water demand associated with Interim zoned lands. Interim and Project District-zoned land was assigned a zoning classification based on Directed Growth Plan guidance and Community Plan land use designations, in order to calculate water demand for these areas. There are over 142,173 zoned acres in the Central ASEA, excluding DHHL lands.

Table 15-15 Summary of Zoning and Community Plan Designation Types, Central ASEA (Excluding DHHL Lands)

Zoning Summary (Corresponding County Zoning Categories in Parentheses)	Acres	% of Total	Water Use Rates (gpd per acre)
SF Single Family Residential, Duplex, Residential (R-1, R-2, R-3, MRA), RU-0.5 Rural - 1/2 Acre, SBR Service Business Residential)	9,060.40	6.37%	3,000
Apartment (A-1 Apartment, A-2 Apartment), MRA Multi-Family Residential, MRA Business Multi-Family	1,687.89	1.19%	5,000
Business (B-1 Business, B-2 Business, B-3 Business, BCT Business Country Town)	553.91	0.39%	6,000
Industrial (M-1 Light Industrial, M-2 Heavy Industrial)	1,316.38	0.93%	6,000
Hotel (BR Business – Resort)	537.11	0.38%	17,000
Agriculture (AG Agriculture)	110,780.01	77.92%	3,400
Golf Course (Park - Golf Course)	1,309.95	0.92%	1,700
P-1 Public/Quasi-Public MRA, Public, HD-3 Historic District 3	2,037.79	1.43%	1,700
PK Park	1,175.00	0.83%	1,700
Open Space (Conservation, Drainage, Open Space, OS-2 Open Space Active, OZ Open Zone, Proposed Road, Road, Unzoned Road, Beach Right of Way), Planting Buffer	13,714.77	9.65%	0
TOTAL excluding DHHL Lands	**142,173.21**	**100%**	

Zoning supplied by Maui County Planning Department, Long Range Division, May 2015.
Lands both zoned and CP-designated "Project District" were assigned to either single family or multi-family residential uses based on ratio of similar existing development projects' assignments per ASYA.

State Department of Hawaiian Home Lands (DHHL) Water Demand Projections

The DHHL maintains land use jurisdiction over Hawaiian Homes and is not subject to county zoning designations. Water rates used by the State Water Projects Plan Update, DHHL, May 2017, and projected demand based on the DHHL Maui Island and regional land use plans are described in the table below.

Table 15-16 DHHL Land Use, Central ASEA Acreage, and Water Standards for Maui

Land Use	Acres or Residential Units Central ASEA	Potable Water Standard	Non-potable (gal/acre)
Residential	1,286 acres: Kēōkea (386 units [66 Subsistence Agriculture 3-ac lots, 320 Residential 1-acre lots]), Waiohuli (768 units = 768 acres)	600 gal/unit	None
Subsistence Ag	100 acres: Kēōkea-Waiohuli (ranching/grazing)*	600 gal/unit	3400 gal/acre
Supplemental Agriculture	0	None	3400 gal/acre
Pastoral	0	600 gal/unit	20 gal/acre
General Ag	546 acres: Pu`unēnē	None	3400 gal/acre
Special District		Varies	Varies
Community Use acres	109 acres: Kēōkea (69 ac) + Waiohuli (40 ac)	1,700 gal/acre or 60 gal/student	None
Conservation	0	None	None
Commercial	0	3,000 gal/acre	None
Industrial	100 acres: Pu`unēnē	6,000 gal/acre	None

Table prepared by MDWS, Water Resources & Planning Division. Figures are estimates based on DHHL Maui Island Plan and Regional Plans.
*State of Hawai`i, Department of Hawaiian Homelands, Kēōkea-Waiohuli DHHL Regional Plan, 2011, page 18

The 2017 State Water Projects Plan (SWPP) has been updated to address DHHL's project needs from 2016 to 2031.[57] There are three major DHHL project areas in the Central ASEA (Pu`unēnē, Kēōkea, and Waiohuli). Planned projects by aquifer system area are summarized below. Projected water demand and strategies for build-out of the Central ASEA DHHL projects over the WUDP planning period are discussed below. Build out of the two projects are not included in directed growth areas, or appear accounted for in the MIP. Therefore, projected demand

[57] State of Hawai`i Department of Hawaiian Homelands, State Water Projects Plan Update, 2017

based on land use designations are added to the population growth-based forecast of water use for this aquifer sector.

Table 15-17 DHHL Projects and Planned Land Use by Aquifer System, Central ASEA

Aquifer System	DHHL Project	Total Acres	Community Acres	Industrial Acres	Agricultural Acres	Residential Acres
Kama`ole	Kēōkea/Waiohuli	1,495	109	0	100*	1,286
Central	Pu`unēnē	646	0	100	546	0

*State of Hawai`i, Department of Hawaiian Homelands, Kēōkea-Waiohuli DHHL Regional Plan, 2011, page 18.

Kēōkea/Waiohuli

Kēōkea/Waiohuli is a large mixed use tract. The future Residential, Subsistence Agricultural and Community Use land use areas which will require water are limited to the mauka half of the tract in the SWPP timeframe. The remaining 768 proposed Residential units and approximately 40 acres of Community Use which will be located below the 2,400-foot elevation will require a new water system. According to the SWPP, an exploratory well at the 1,900-foot elevation of the Waiohuli tract located water at approximately six feet above sea level. The water will need to be pumped from the wells to a reservoir which will service the higher elevations, and then will flow by gravity to the remainder of the service area. A second reservoir and a series of Pressure Reducing Valves (PRVs) will also be required.

The SWPP states that non-potable water will be required for irrigation of the Subsistence Agriculture lands, which could be supplied by the Upcountry Maui Irrigation System. The U.S. Department of Agriculture (USDA), National Resource Conservation Service (NRCS), is in the process of constructing this agricultural water system to supply untreated irrigation water from the Kahakapao Reservoir to farmers in the Upper Kula area, which will be operated by MDWS. The 1997 Final Watershed Plan Environmental Impact Statement indicated that there would be nine lateral systems supplied by the main pipeline, including the DHHL Kēōkea area. Due to budgetary considerations, DOA has indicated that they do not have any plans to construct the lateral to service the Kēōkea area, but that DHHL could construct this lateral at its own cost. Nevertheless, it is expected that the DHHL demands will be reflected in the upcoming Agricultural WUDP update. The USDA indicated that the current supply of water from MDWS may not be adequate to even service the proposed project area identified in the 1997 watershed plan. The DHHL recommends a coordinated effort be undertaken between DHHL, DOA and MDWS to determine the feasibility of utilizing the Upcountry Maui Irrigation System to supply the non-potable demands and, if so, to ensure that costs of the Kēōkea lateral are reflected in the AWUDP.

DHHL has a 1997 Water Credits Agreement with MDWS for 0.5 MGD of potable water for homesteading use in exchange for DHHL improvements to the water system. The agreement stipulates that MDWS shall not impose any time limitations on DHHL to draw or use the reservation. Two existing developments, the 321-unit Kula Unit 1, and the 44-unit Hikina infill developments already used 0.219 MGD of the water credits, leaving a remaining balance of 0.281 mgd for future use. The Kēōkea Phase 1-4 project proposes a total potable demand of 0.809 mgd and non-potable demand is 0.578 mgd exceeding remaining credits.

The Waiahuli Project will be located below the 2,400-foot elevation and will require a new water system. The exploratory well at the 1,900-foot elevation of the Waiohuli tract is a feasible option should the Upcountry Irrigation System not be funded to serve non-potable demand.

Pu`unēnē

Pu`unēnē tract consists of Industrial and General Agriculture land use areas located within the Kahului Aquifer System Area, which has a sustainable yield of 1 MGD. Water demand for the 100 acres of industrial use is approximately 0.6 mgd. There is a 36-inch MDWS Central Maui transmission main that runs alongside the tract which supplies potable water to Kīhei; however, the sources that supply this transmission main are limited. The DHHL MIP indicates that there are two abandoned brackish wells in the vicinity that would be acceptable for irrigation use. Funds have been appropriated for the development of a comprehensive water and wastewater master plan for the Pulehunui area in central Maui, which includes the DHHL Pu`unēnē tract. The master plan will be a collaborative effort between DHHL, DLNR, the Department of Public Safety and the Department of Accounting and General Services. At the time of the SWPP update, DHHL had developed a matrix of potential water servicing alternatives, which included options such as collaboration with multiple agencies, water conservation, and water reuse.

The remaining 546 acres would be set aside for general agricultural use with the opportunity to continue the existing sugar cane lease with HC&S.[58] However, the HC&S 2017 Diversified Ag Plan does not indicate any proposed use for the 546 acres. The uncertainty of HC&S lease prospects and the viability of groundwater from the Kahului Aquifer needs to be further assessed. According to the SWPP water resource strategies need to be determined.

Other Central Aquifer Sector Tracts

There is a small DHHL land holding in Ulupalakua with a projected potable demand of 0.0034 mgd. Source strategy has not been identified. Kualapa and Kalihi/Kanahena lands overlying the Kama`ole Aquifer have no projected water demand.

[58] DHHL Maui Island Plan, page 4-19

Table 15-18 Projected Water Demands and Strategies for DHHL Projects, Central ASEA, 2031 (mgd)

Sector/ System	Project	Potable (mgd)	Potable Strategy	Non-potable (mgd)	Non-potable Strategy
Central/ Kahului	Puʻunene	1.734	To be determined. Potential transport from Kama`ole to Kahului Aquifer	1.8564	To be determined
Central/ Kama`ole	Kēōkea/ Waiohuli	0.8097	Water Credit Agreement MDWS (0.2810) (Upcountry), New State System (0.5287)	0.578	Upcountry Maui Irrigation System
Central/ Kama`ole	Ulapalakua	0.0034	Coordinate with MDWS (Upcountry) – source not identified	0	
Total		**2.5471**		**2.4344**	

State Water Projects Plan, DHHL, May 2017 Final Report

The Makawao-Pukalani-Kula Community Plan calls for an increase in the deliverable capacity of the Lower Kula line to 7.5 mgd and to extend the line to Kēōkea to serve Department of Hawaiian Home Lands projects.[60]

[60] Ibid, page 37.

The following table (Table 15-19) summarizes County and DHHL land use/zoning based demand.

Table 15-19 Full Build-Out Water Demand Projections by CWRM Use Type, Central ASEA

CWRM USE CATEGORY		CWRM Land Use Category Based		DHHL Land Use Category Based				Total Proj. Demand (MGD)
	Acres	Water Use Rate (gpd)	Proj. Demand (gpd)	DHHL Land Use	Acres/ Residential Units	Water Use Rate (gpd)	Proj. Demand (gpd)	
Domestic Residential	10,748.29	3,000-5,000*	28,562,900	Residential	1,286 acres, Kēōkea (386 units), Waiohuli (768 units)	600 gal/unit	692,400	**29,255,300**
Domestic Non-residential	1,091.03	6,000 gal/ac (Business) or 17,000 gal/ac (Resort)	12,454,330	Commercial	0	3,000 gal/acre	0	**12,454,330**
Industrial	1,316.38	6,000 gal/ac	7,898,280	Industrial	100	6,000 gal/acre	600,000	**8,498,280**
Agriculture	110,781.01	3,400 gal/ac	376,655,437	Agriculture	546*	3,400 gal/acre	2,533,000	**379,188,437**
Open Space	13,714.77	0	0	Open Space	100	0	0	**13,714.77**
Irrigation	1,309.95	1,700	2,226,915	N/A	N/A	N/A	0	**2,226,915**
Municipal	3,212.79	1,700 gal/ac	5,461,743	Community	109	1,700 gal/acre	185,300	**5,647,043**
Military	0	N/A	0	N/A	N/A	N/A		**0**
TOTAL		**N/A**	**433,259,605**	**N/A**	**1,286 ac/1,154 units**	**N/A**	**4,010,700**	**437,270,305**

Water demand calculation is minus 100 acres for non-irrigated pasture; 151.14 acres in south Maui parcels was not included because it not mentioned in the 2017 SWPP DHHL update

State Water Projects Plan (SWPP) Water Demand Projections

The land use based projections are compared to those in the State Water Projects Plan, which projects future water demand to 2020. The SWPP states that, in general, new housing developments, agriculture irrigation projects, major facilities or major expansions were considered as having a significant impact on water resources. The SWPP was updated in 2017 for DHHL projects only, and therefore DHHL projects are not addressed in the summary below.

Table 15-20 SWPP Projected Water Demands, Central ASEA (mgd)

2020 Potable Demand	2020 Non-potable Demand	2020 Total Demand	Unmet Needs to be Met by MDWS	Projects with New State Water System	Non-potable Demand to be Met by Potable Sources
0.812	9.947	10.759	4.759	6.000	0.034

State Water Projects Plan, Hawai'i Water Plan, Volume 4, SWPP for Islands of Lanai/Maui/Moloka'i, 2003. DHHL Water Demands totaling 6.4484 mgd are excluded. Projects with New State Water System- Lower Kula Watershed Project. (DHHL Maui Island Plan Development 07082015.xlsx)

State projects include the Upcountry Irrigation Project which is tabled for the time being, and the Lower Kula Watershed Project. These are source transmission and development rather than end use demand. Many projects identified for the Central ASEA in the 2003 SWPP have been developed over the last 15 years. State projects that are assumed to add demand over the WUDP planning period are summarized in the table below. These projects include school and community center development which are assumed to be accounted for in the socio-economic forecast. No adjustments are therefore made to population growth based demand through 2035.

Table 15-21 SWPP Projected Water Demands Unmet Needs 2018 - 2035, Central ASEA (mgd)

2020 Potable Demand	2020 Non-potable Demand	2020 Total Demand
0.174	0.005	0.179

Agricultural Water Use and Development Plan (AWUDP)

The State Department of Agriculture oversees and promotes diversified agriculture and state-owned irrigation systems. The 2004 Agricultural Water Use and Development Plan (AWUDP) projects demand to 2020 on lands served by major irrigation systems which include the East Maui and Upcountry Maui Irrigation Systems. The AWUDP projected an increased water demand of 3 to 12 mgd on 891 to 3,544 acres of agricultural expansion based on a water use rate of 3,400 gpd per acre (which does not include irrigation system water losses). The projection was based upon population growth, partial replacement of imported produce with locally grown produce, and maintaining farm value growth in diversified agriculture.

Table 15-22 AWUDP Water Demand Forecast for Diversified Agriculture, Central ASEA 2001-2021

Irrigation System	Total Acres	Acreage in Use		Unused Acreage Remaining Available	Acreage Forecast for Diversified Agriculture		Forecasted Water Demand (mgd)	
		Estimated Percent	Acres		Worst Case	Best Case	Worst Case	Best Case
Upcountry	1,751	no data	no data	0	55	142	0.19	0.48

Compiled by MDWS based on AWUDP, 2003, revised 2004, Table 6b and 7d

More current data is available to project agricultural irrigation needs. The scope for the pending AWUDP update proposes to update the status of the 2004 AWUDP CIP, but it is not clear how extensively demand will be reanalyzed or reiterated for these previously studied systems. No adjustments are done using the 2004 AWUDP.

The 2004 AWUDP also assessed the Upcountry Maui Irrigation System proposed for development by Hawai`i Department of Agriculture, MDWS, the U.S. Department of Agriculture Natural Resources Conservation Services, and the Olinda-Kula Soil and Water Conservation District. The project, also known as the Upcountry Maui Watershed Plan, proposed to install a separate agricultural water distribution system to supply untreated water for irrigation purposes to farmers in the Upper Kula area. The water source, Kahakapao Reservoir is by definition not a source, but the same storage of Ko`olau diverted stream water that currently supplies the MDWS Upper Kula potable system. In October 2017, the project sponsors determined to discontinue construction, based on economics, project timeline and federal requirements.[61]

15.6.4 Population Growth-Based Water Demand Projections (20-Year)

Population growth rate projections were applied in 5-year increments over the 20-year planning period from 2015 to 2035 for high, medium (base case) and low growth scenarios. Water consumption, including both public and private water systems, are compared to the incremental water needs for the next 20 years based on the *Socio-Economic Forecast Report, 2014* prepared by the Planning Department consistent with the Maui Island Plan. Water consumption and demand based on population growth rates do not account for large-scale agricultural irrigation needs. It was assumed that population growth, and thus water use, from the projects projected since 2017 in the State Water Projects Plan, excluding DHHL, are already accounted for by the population projections. DHHL projects are added to population growth based demand.

[61] 10/4/2017 USDA Soil & Water Conservation District letter

Most of the growth in the Central ASEA is projected within the designated urban and rural growth areas in Kahului, Pā`ia, Kīhei and Wailea, Makawao, Pukalani and Kula. Growth rates vary significantly between the Community Plan (CP) districts that make up the Central ASEA. Future growth rates in the districts are shown below. Applying the appropriate community plan growth rate for each MDWS subdistrict generates an average growth rate applicable to the MDWS water systems as a whole shown in the table below.

An average growth rate for the Central ASEA overall was calculated based on the portions of the hydrologic unit located in each community plan district. This average growth rate is applied to Domestic, Industrial and Irrigation uses that are not served by a MDWS system in the Central ASEA.

Table 15.23 Historical and Projected Population to 2035, Wailuku-Kahului, Kīhei-Mākena and Makawao-Pukalani-Kula Community Plan Regions and Projected Growth Rates (Central ASEA)

COMMUNITY PLAN AREA	2000	2010	2015	2020	2025	2030	2035
Wailuku-Kahului	41,503	54,433	60,336	62,102	64,188	65,734	67,986
Percent Increase		31.15%	10.84%	2.37%	3.36%	2.41%	3.31%
Kīhei-Mākena	22,870	27,244	29,599	34,757	39,975	46,370	52,044
Percent Increase		19.13%	8.64%	17.42%	15.01%	15.99%	10.90%
Makawao-Pukalani-Kula	21,571	25,198	26,551	28,438	28,949	29,482	29,852
Percent Increase		16.81%	5.37%	7.11%	1.80%	1.84%	1.26%
Pā`ia-Ha`ikū	11,866	13,122	13,820	13,949	14,045	14,139	14,153
Percent Increase		10.58%	5.32%	0.93%	0.69%	0.67%	0.10%
MDWS Central System Growth Rate			1.91%	11.45%	10.58%	11.17%	9.35%
MDWS Upcountry System Growth Rate			1.09%	6.01%	1.68%	1.69%	1.2%
Central ASEA Average Growth Rate			1.682%	2.222%	10.146%	10.938%	8.923%

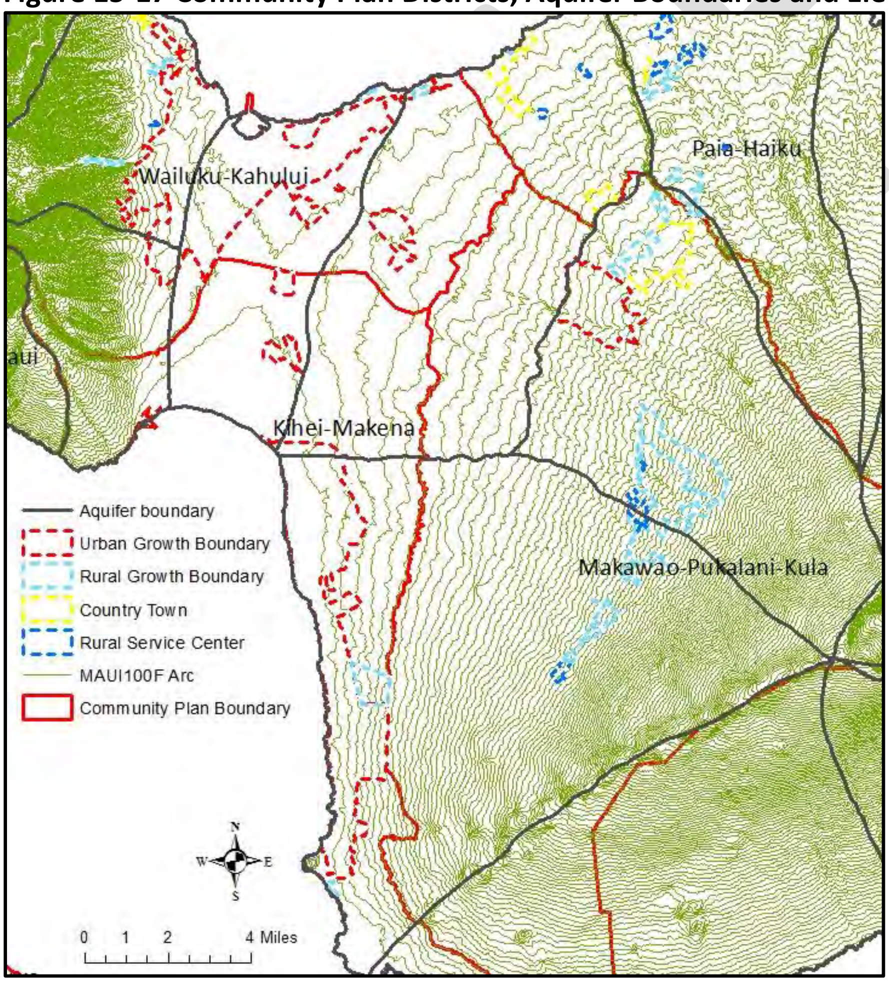
Source: Population Forecast: 2014 Socio-Economic Forecast, Maui County Planning Department, Long Range Planning Division, Water Demand: MDWS, Water Resources & Planning.

The table above represents base, or mid-growth rates. Low and high growth rates of -8.55 % and +7.88 % respectively are based on the 2014 Socio-Economic Forecast and calculated for Domestic, Irrigation, Industrial and Municipal uses in the analysis of population growth based water demand in Chapter 15.6.7.

Population Growth Based Demand in Planned Growth Areas

The Directed Growth Plan was adopted as the primary purpose of the MIP to accommodate population and employment growth in a manner that is fiscally prudent, safeguards the island's natural and cultural resources, enhances the built environment, and preserves land use opportunities for future generations. The Directed Growth Plan establishes the location of future development and provides a framework for future community plan and zoning changes and guides the development of the county's short-term and long-term capital improvement plan budgets.[62] Projected population growth and housing demand is concentrated to the Kahului and Kīhei regions. Hydrologic units are interconnected when water is conveyed from high yield watersheds and aquifers to population centers and planned growth areas. Natural groundwater flow connects land use boundaries as water generally flows mauka to makai with the hydraulic gradient matching ground elevations. Groundwater flows from the Makawao-Pukalani-Kula Community Plan district towards the ocean in the Community Plan districts below. Water sources in high yield aquifers and watersheds are needed to supply population growth throughout Central and South Maui.

Figure 15-17 Community Plan Districts, Aquifer Boundaries and Elevation, Central ASEA



---

62 Maui County General Plan 2030, Maui Island Plan page 8-2.

Projected water imports from the Wailuku ASEA resources through the MDWS Central System as a whole was addressed in the Wailuku ASEA Chapter 14.6. Water imports from the Ko`olau ASEA to the MDWS Upcountry system is addressed in this Sector under *MDWS Water Demand Projections*.

Planned growth areas span the aquifer sectors of Wailuku, Central and Ko'olau. Growth areas most likely served by the resources within the Wailuku ASEA and the MDWS Central System was addressed in the Wailuku ASEA Report. These include planned growth areas in Wailuku-Kahului: Wai`ale, Pu`unani, Kāhili Rural Residential and Waikapū Tropical Plantation Town; Kīhei-Mākena region: Kīhei Infill, North Kīhei Residential, Kīhei Mauka, Maui Research and Technology Park, and Pulehunui. Two projects would potentially be served by groundwater within the Central ASEA:

1) Wai`ale mixed-use town development is the largest proposed town on the island, with an estimated demand of 1.4 – 1.52 mgd. The on-site Wai`ale wells are developed in the Kahului Aquifer. Alternative sources may be groundwater from the Waikapū aquifer.
2) Pulehunui planned growth area encompasses 639 acres primarily slated for industrial, public/quasi-public, and recreational purposes. There is limited MDWS infrastructure serving the area while private wells in Kahului Aquifer serve industrial and non-potable uses. Source to supply up to 3.8 mgd would need to be identified.

Planned protected areas within the same regions were addressed in the Wailuku ASEA report as well. Two planned protected areas are located within the Central ASEA: the Mākena-La Perouse-Kanaio Protected Area and the Keālia National Wildlife Refuge, shown in Figure 14-26. As noted in Chapter 14.6.4, the wildlife refuge benefits from recharge by Waikapū Stream in the Wailuku ASEA. Stream restorations in Waikapū have resulted in noticeably more water recharge to Keālia Pond.

Makawao-Pukalani-Kula

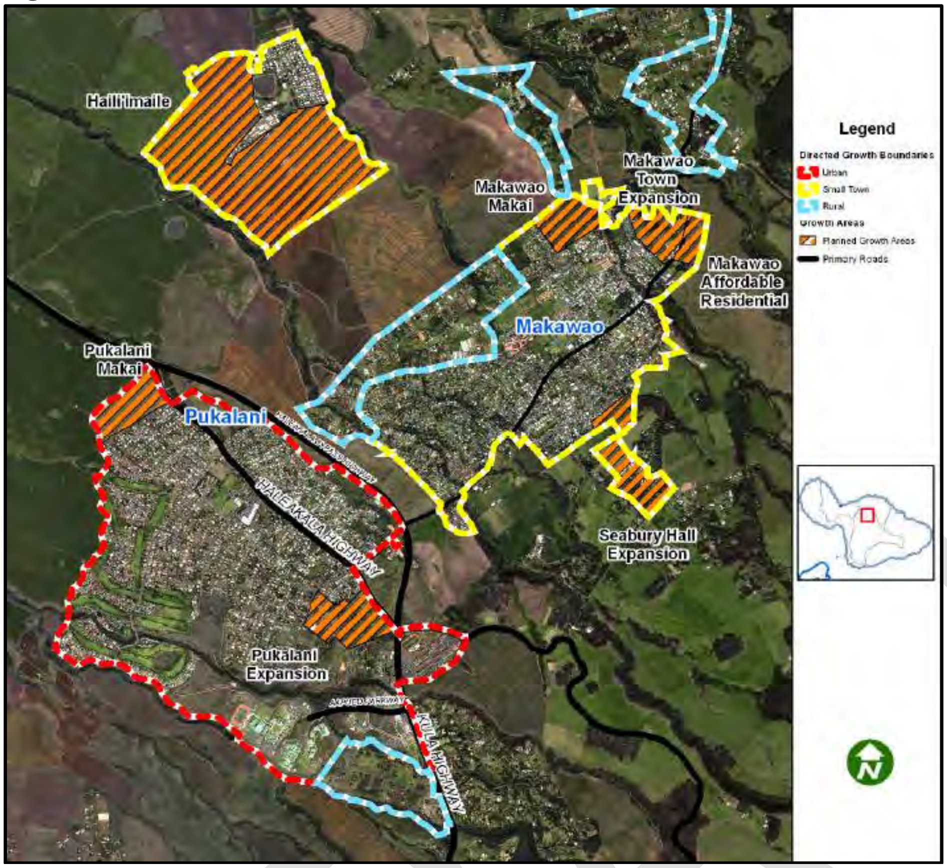
Makawao-Pukalani-Kula Community Plan region, also commonly referred to as Upcountry, is characterized by abundant open space, agricultural lands and rural towns. Nine planned growth areas are identified:

- Makawao Makai is a 39-acre expansion south of Makawao Veterans Cemetery on former pineapple fields.
- Makawao Town Expansion provides about 38 additional acres of town development.
- Makawao Affordable Residential, mauka of Makawao Avenue would provide affordable housing with no defined acreage or units to be developed.
- Seabury Hall planned growth area would add 68 acres for gradual expansion on land owned by Seabury Hall.
- Pukalani Expansion would be primarily residential development with neighborhood parks and a small commercial component.

- Pukalani Makai encompasses 45 acres of vacant agricultural land and would allow about 250 single family dwellings.
- Hali`imaile planned growth area comprises 330 acres mauka and makai of Hali`imaile Road. About 825 single family units would be developed as a range of affordable housing types.
- Anuhea Place is a planned rural growth area makai of Kula Highway and would provide 15 lots at 5 acres each.
- Ulupalakua Ranch planned rural growth area is intended to identify the boundaries of the ranch employee housing and provide opportunities for limited expansion.

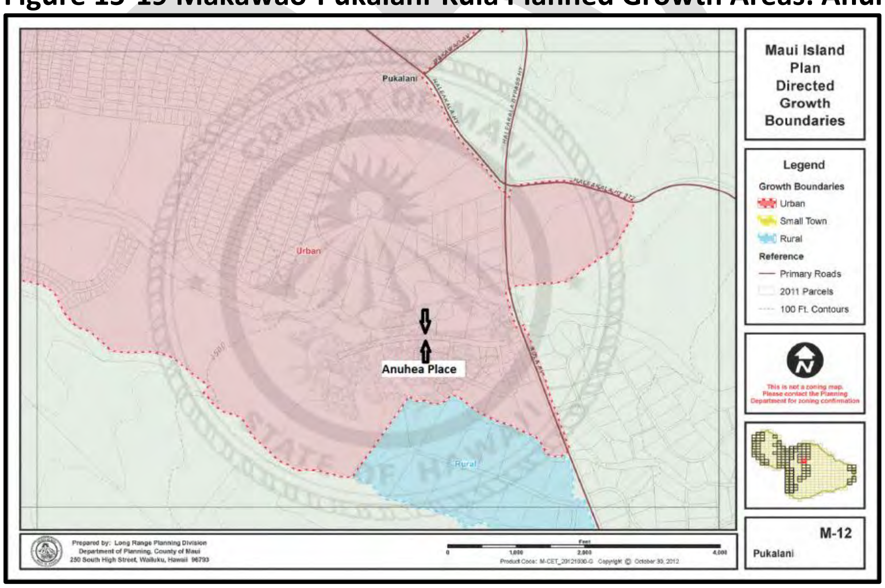
All planned growth areas could potentially be serviced by the MDWS Upcountry System. New water source development and storage are recommended regional facilities. Projected demand for planned growth to meet population and housing needs in the designated growth areas is summarized in Table 15-24 below.

Figure 15-18 Makawao-Pukalani-Kula Planned Growth Areas



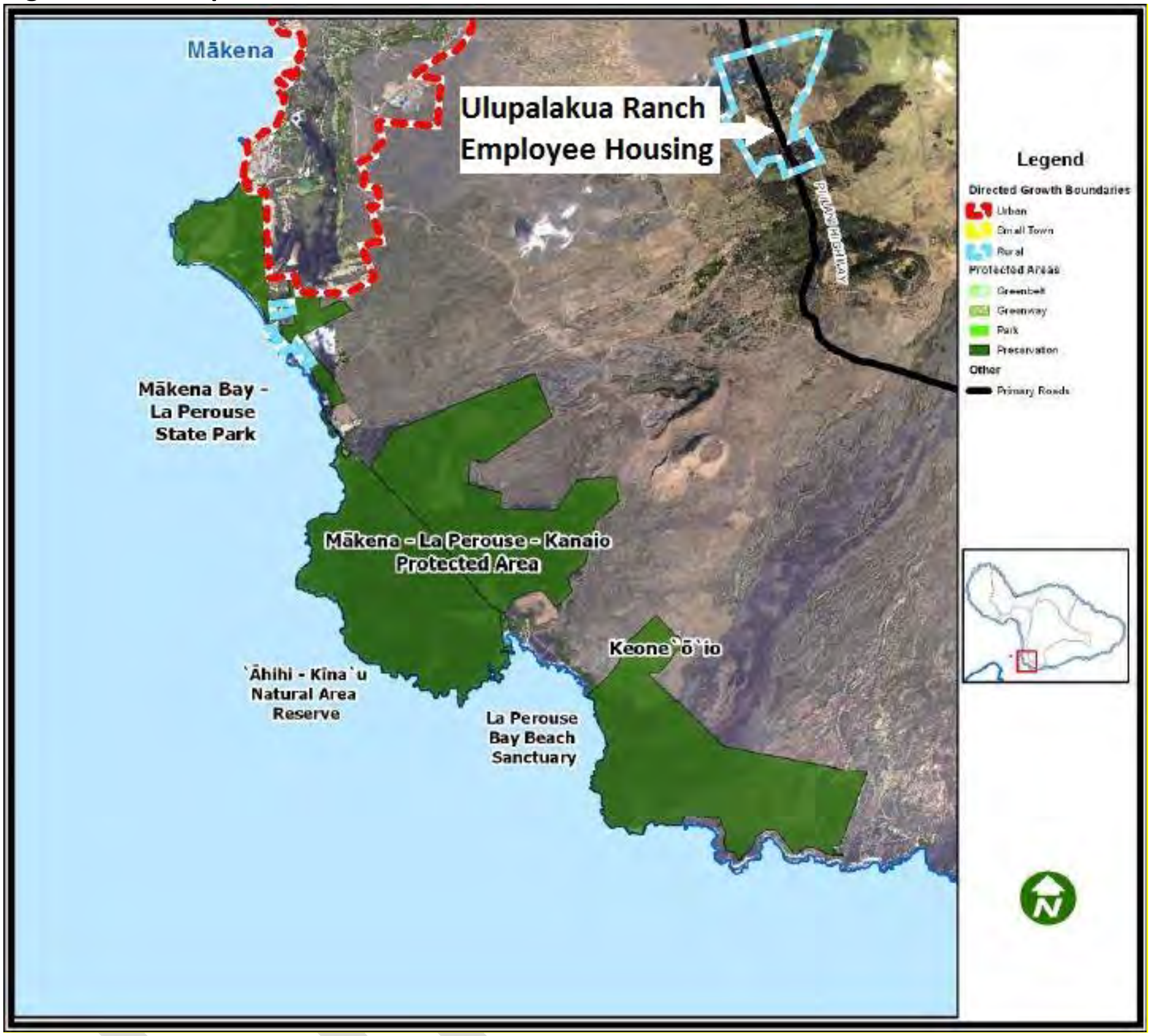
Source: Maui Island Plan

Figure 15-19 Makawao-Pukalani-Kula Planned Growth Areas: Anuhea Place



Source: Maui Island Plan

Figure 15-20 Ulupalakua Planned Growth Areas



Source: Mākena-La Perouse-Kanaio Protected Area and Planned Growth Areas (MIP page 8-34)

Table 15-24 Planned Growth Central ASEA and MDWS Upcountry System Service Area

Planned Growth Area	# Units	# Acres	Projected Demand (mgd)
Makawao Makai	90	39	0.054 – 0.117
Makawao Town Expansion		38	0.228
Makawao Affordable Residential	N/A	N/A	
Seabury Hall		68	0.115
Pukalani Expansion	311	56	0.168 – 0.186
Pukalani Makai	250	45	0.135 – 0.150
Hali`imaile	825	330	0.495 - 0.990
Anuhea Place	15	111	0.009 - 0.333
Ulupalakua Ranch	N/A	223	0.669
Total:	**1491**	**910**	**0.894 – 2.755 MGD**

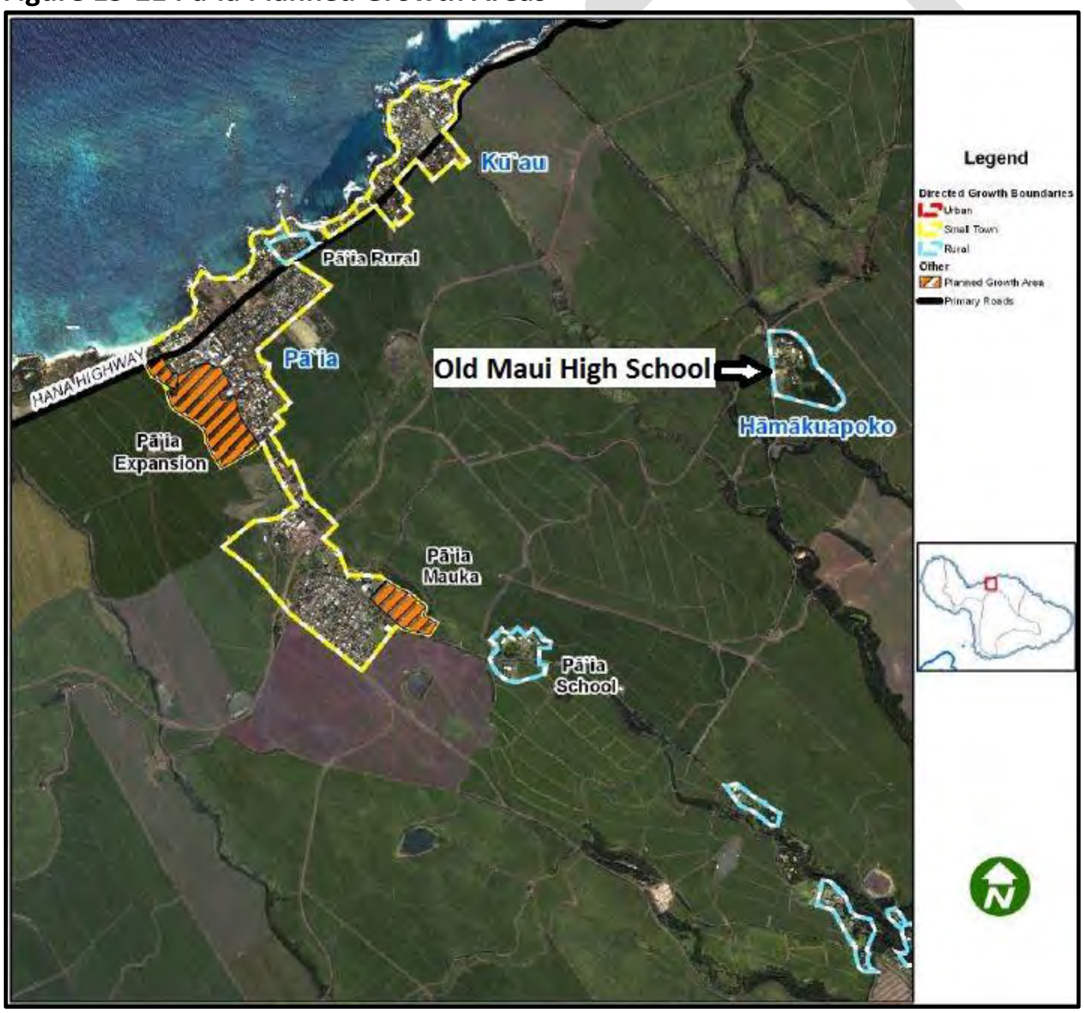
Planned protected areas include Corn Mill Camp and Upcountry Greenway. No water demand is associated with the protected areas.

Pā`ia-Ha`ikū Community Plan Region

Pā`ia and Kū`au are located in the Central ASEA and served by the MDWS Central System. Three planned growth areas are within the Central ASEA:

- Pā`ia Expansion is a 41 acre expansion of mixed-use west of Baldwin Avenue. About 207 single family and multi-family units would be developed
- Pā`ia Mauka is a 15 acre expansion of Skill Village that would allow about 68 units
- Old Maui High School Campus Revitalization is the remains of the Hāmākuapoko plantation camp. About 24 acres could potentially be developed as youth-educational camp, conference center, farmers market and other facilities

Figure 15-21 Pā`ia Planned Growth Areas



Source: Maui Island Plan

Table 15-25 Planned Growth Central ASEA Pā`ia (MDWS Central System)

Planned Growth Area	# Units	# Acres	Projected Demand (mgd)
Pā`ia Expansion	207	41	0.124 – 0.123
Pā`ia Mauka	68	15	0.048 – 0.45
Old Maui High School Campus Revitalization	N/A	24	0.75
Total:	**275**	**80**	**0.165 – 0.240 MGD**

Development Projects and Projected Demand in Planned Growth Areas

The Planning Department maintains a list of large development projects that have come to their attention, some of which have been entitled, committed or are supported by the Maui Island Plan but not necessarily the Community Plan.

Development projects in the Central ASEA and potentially served by the MDWS Central System and Wailuku ASEA resources is addressed in the Wailuku ASEA Chapter 14.6. As stated in Chapter 14.6, the Wailuku ASEA report includes development projects within *Kahului, Kama`ole and Pā`ia Aquifers*, and development projects throughout the Central ASEA that are primarily served by water resources from the *Wailuku ASEA*. Assumptions are based on proximity to the MDWS Central System, general elevation and source specific information for proposed projects. A few proposed residential development projects are known or expected to be served by private purveyors' groundwater sources in the Kahului Aquifer, for example the Wai`ale Development. Some development projects plan to use brackish water in the lower Kama`ole Aquifer, for example the Honua`ula project plans which would treat brackish water with reverse osmosis to serve potable demand. Table 14.32 in the Wailuku ASEA report excludes development projects located at elevations ranging from 700 to 4,000 feet elevation that would be primarily served by the MDWS Upcountry System.

The map below shows the Growth Boundaries, the location of projects on the 2016 list, municipal wells (public and privately owned) and the MDWS service areas. The MDWS Upcountry and Central Systems are not connected. Projects within the MDWS service areas could be serviced by private wells and water systems, opt to develop alternative sources, or be subject to other system restrictions such as the Upcountry Meter Priority List.

Projects summarized in the table below do not constitute a plan or commitment by MDWS to serve such projects. While unlikely all projects will be approved as proposed, or constructed once approved, the List is instructive as to location and planning for water sources. Development in the Central ASEA would primarily be served by the MDWS Central System or the MDWS Upcountry System.

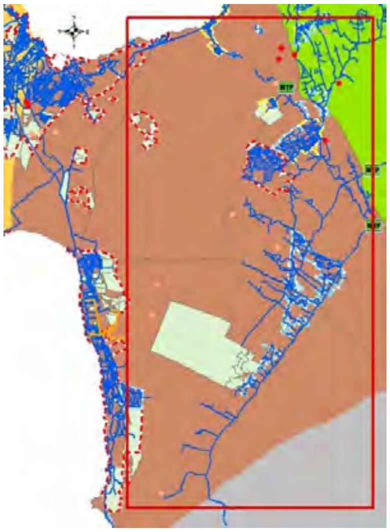
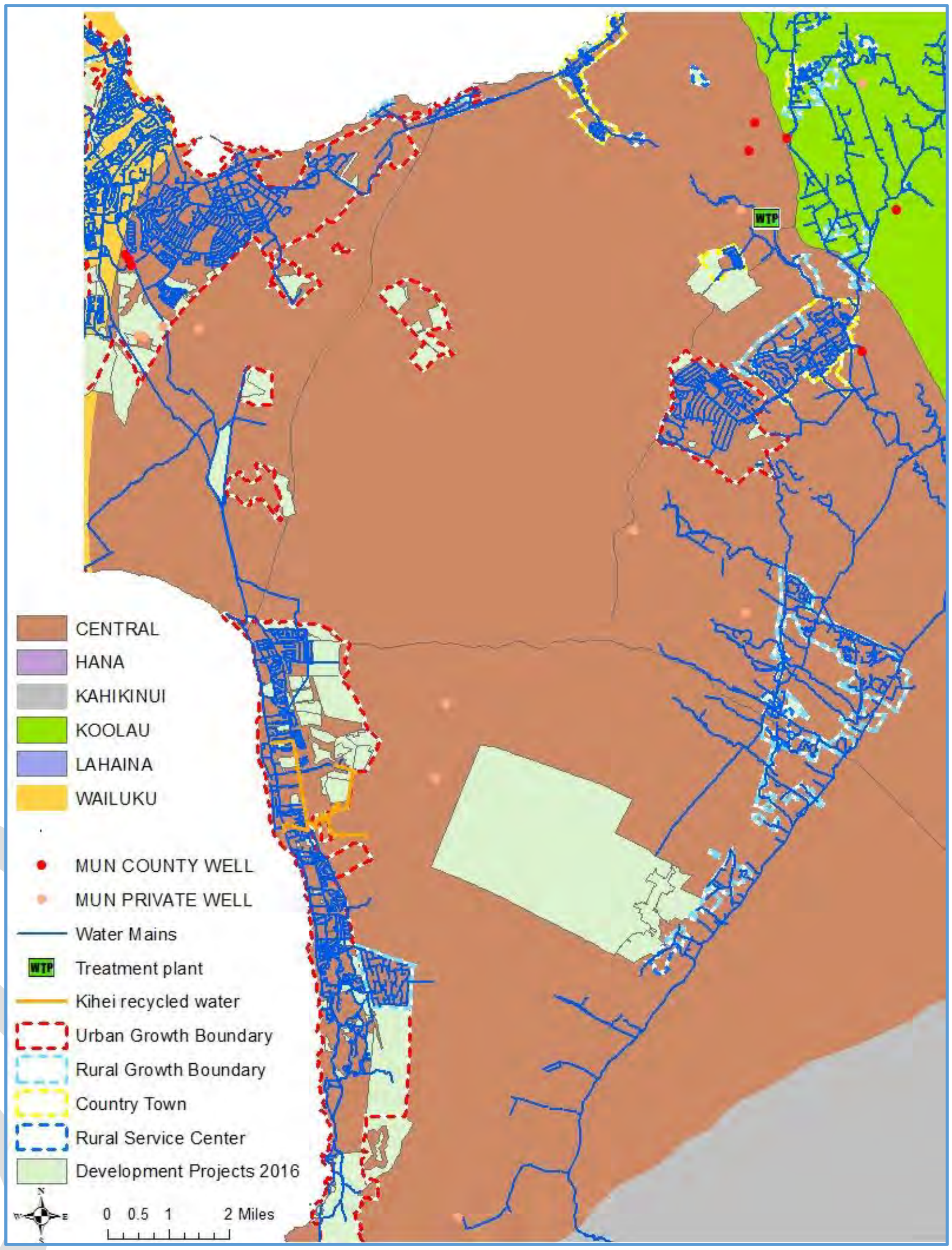


Figure 15-22 Comparison of Growth Boundaries, 2016 Development Project List, Water Systems and Water Resources



The Planning Department distinguishes projects that are committed or that are supported by the Maui Island Plan but not necessarily the Community Plan as "Entitled". Proposed projects that are not supported by the MIP or any land use designations as "Not Entitled".
Comparing proposed development projects potentially served by the MDWS Central System to projects potentially served by the MDWS Upcountry System, projected residential demand for projects in Wailuku and Central aquifer sectors total 11.725 mgd.

Table 15-26 2016 Development Projects Aquifer Sector Location and Potential Aquifer Source (mgd)

Development Project Location	Potential Source	2016 Development Projects List		
		Entitled	Not Entitled	Total
Wailuku ASEA	MDWS Central System (Wailuku ASEA)	1.323	1.996	3.319
Central ASEA (Kama`ole, Kahului, Pā`ia Aquifers)		3.072	3.875	6.947
Central ASEA (Kama`ole Aquifer)	Kama`ole Aquifer	0.666	0	0.666
Central ASEA (Makawao Aquifer)	MDWS Upcountry System (Makawao Aquifer, Ko`olau surface water)	0.296	0.497	0.793
Total:				**11.725**

Source: MDWS, Maui County Planning Department, Long Range Planning Division.

Domestic Use

There are six installed domestic wells in the Central ASEA but there was no pumpage reported in 2014 for domestic uses. As reporting is expected to improve through CWRM efforts, it is assumed that there are some active domestic wells utilized throughout the Central ASEA.

Industrial Use

About 0.208 mgd of groundwater is extracted from the Kahului for industrial purposes. Committed development projects within designated urban growth boundaries include some industrial development. Projected growth is assumed to increase based on population growth rate. Additional industrial demand for about 100 acres is associated with the DHHL Pu`unēnē Tract.

MDWS Water Demand Projections

Water demand projections for the MDWS Central System were analyzed in the Wailuku ASEA report. Table 14-33 shows 2035 projected consumption from the Central System would be 34.6 mgd, an increase from 21.1 in 2014. Projected water consumption for the MDWS Upcountry System would be about 7.02 mgd in 2035 based on population growth. Projected water use based on low to high growth scenarios are shown in the table below for the two MDWS systems.

Table 15-27 Projected Consumption by MDWS District, Base, High and Low Scenarios (mgd)

District	2014	2035 Base	2035 High	2035 Low
Central System	21.154	32.294	35.778	29.533
Upcountry System	6.263	7.020	7.573	6.420

Excludes Kula Ag Park

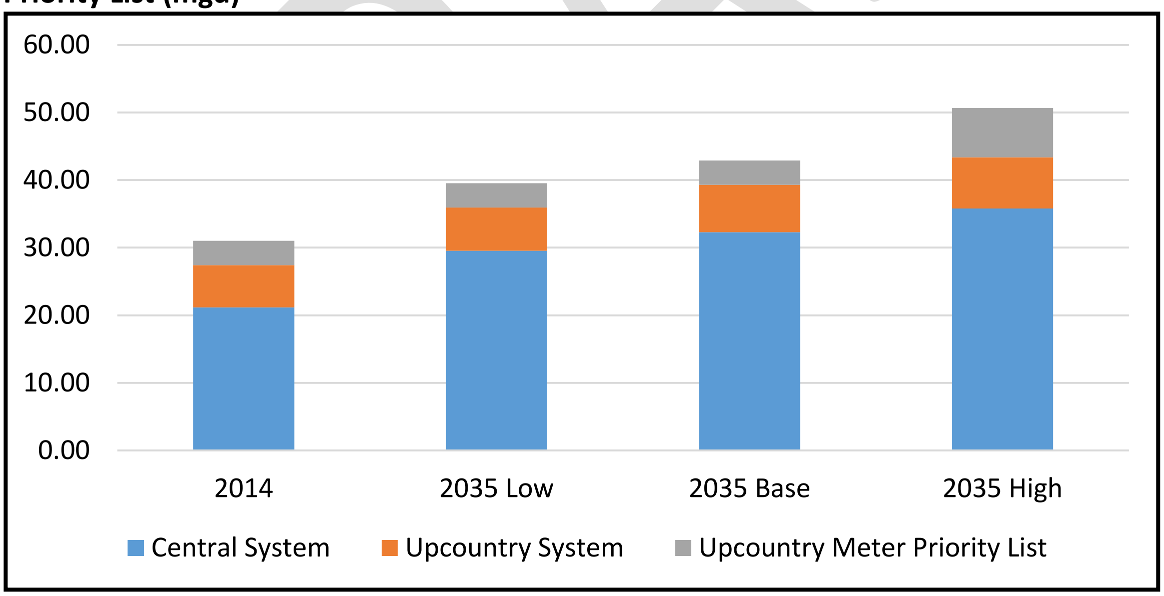
Water consumption in the table above is the volume water billed. Water produced at the source is higher due to water losses. The projected increase of 0.76 mgd for the Upcountry system does not represent demand on the Upcountry Meter Priority List. The List represents about 1,800 requests for an estimated total of 7.3 mgd. Historically, about 50 percent of the requests do not result in an installed meter. Projected demand to satisfy the priority list is therefore estimated within the range of 3.6 to 7.3 mgd.

Table 15-28 Comparison of Upcountry District With and Without Meter List (mgd)

Criteria	2014	2035	Increase (mgd)
Upcountry/Makawao	6.2	7.0	0.7
Upcountry/Makawao + Meter List	6.2	9.9 – 13.5*	3.6 – 7.3

*Assumes 50% - 100% of meter list requests are developed.

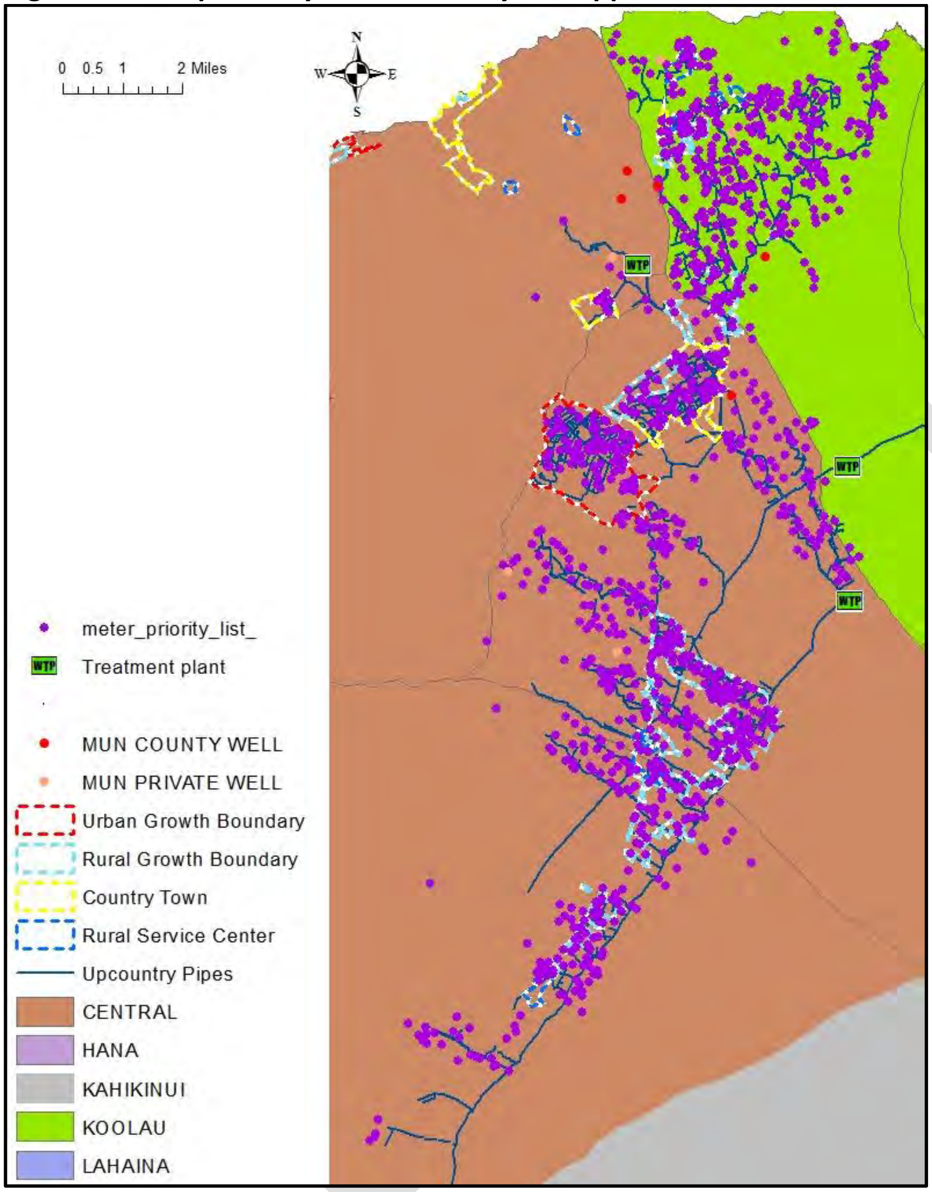
Figure 15-23 Projected 2035 Demand Central System and Upcountry System with Meter Priority List (mgd)



About two-thirds of the requests are for development that would be located outside designated growth areas. Sources for requests in Ha`ikū are primarily served by basal wells with sufficient backup capacity to reliably add new services. Sources for requests on the Upper Kula system are East Maui streams in the Waikamoi area that are subject to Instream Flow

Standards and vulnerable to drought. There remains uncertainty over the number and timing of new meters as well as occupancy.

Figure 15-24 Upcountry Meter Priority List Applications



<u>Private/Small System Water Consumption Data Projections</u>

Information on projected growth and demand for privately owned public water systems was queried but not available. Maui Island Plan population projections (Socio-Economic Report, 2014 Draft) were applied to 2014 reported water use.

Kula 1800 Subdivision is noted to have entitlement water from the Hāmākua Ditch dated February 8, 2008. In an agreement between the County and Maui Land & Pineapple Company (ML&P), the county agreed that it will sell to ML&P water sufficient to irrigate 326 acres of the 712 acre property 2-3-002:004 of pineapple, or sufficient water for any other crop not exceeding water requirements for pineapple. The agreement does not specify a range of water use. Average demand for pineapple per acre is 1,077 gpd or 351,192 gpd for 326 acres. (Letter dated April 18, 2008 from the University of Hawai`i College of Tropical Agriculture and Human Resources Cooperative Extension Service)

Wai`ale planned growth area geographically located within the Central ASEA is planned to be serviced from Waikapū aquifer in the Wailuku ASEA. The maximum estimated demand for the Wai`ale planned growth area is about 0.8 mgd.

<u>Other Population Based Demand Projections</u>

There are likely individual households that are not served by any public water system and no groundwater pumpage or diverted surface water is reported. Some domestic use from wells is assumed to occur that is not reported. There are known rainfall catchment systems scattered in the eastern portion of Makawao Aquifer but there is no official inventory.

15.6.5 Agricultural Demand Projections

Non-potable agricultural irrigation demand is not coordinated to population growth and represent additional demand. Agriculture is by far the most extensive land use and water use throughout the Central ASEA between the HC&S plantation overlying the Pā`ia and Kahului Aquifers, and the Upcountry diversified farming overlying the Makawao and Kama`ole Aquifers.

<u>Kalo Lo`i and Appurtenant Rights</u>

There are no identified kalo lo`i and appurtenant right uses in the Central ASEA. Proposed Interim Instream Flow Standards (IIFS) in Nā Wai `Ehā streams of Wailuku ASEA and East Maui Streams of Ko`olau ASEA address and protect instream uses. The Hearing Officer's 2017 Proposed decision for the Nā Wai `Ehā contested case and the CWRM June 20, 2018 decision for the East Maui Streams contested case are assumed to satisfy in-stream flow required for healthy taro cultivation demand. The WUDP Ko`olau Sector Report was drafted and submitted for review prior to the June 20, 2018 CWRM decision for East Maui Streams. However, a summary of IIFS by stream according to the 2018 decision is provided in this sector report as Appendix 15A.

Diversified Agriculture on HC&S Plantation

HC&S has approximately 30,000 acres of agricultural land in the Central ASEA that historically was irrigated with water from Ko`olau ASEA surface water, Wailuku ASEA surface water and groundwater from the Pā`ia and Kahului Aquifers. The land and water use on the HC&S plantation has changed quickly over the same period the WUDP update is drafted. At the time A&B/HC&S submitted their proposed findings for their Diversified Agriculture Plan (HC&S Findings of Facts, Conclusion of Law and Decision & Order, June 2017) in June 2017, the water use for the plantation was less than 20 mgd. A&B stated that the Diversified Agriculture Plan is constantly evolving as agreements of cattle grazing on 4,000 acres, renewable energy crops, a sale of 850 acres to the County for an agricultural park, and a commercial feedstock operation was being developed over 2017.[63] 2014 is used as base year for the Water Use and Development Plan existing water uses. Where surface water diversions 2014 data was missing, 2011 – 2015 average reported data was used. However, because the significant changes in water use since December 2016, agricultural demand projections consider inventoried 2017 water use in the Central ASEA. Existing 2014 and 2017 agricultural water use, imported water from Ko`olau and Wailuku aquifer sectors are shown in the table below. Agricultural use includes commercial agriculture such as the Kula Ag Park and Maui Pineapple Company, using surface water imported from Ko`olau ASEA.

Table 15-29 Central ASEA 2014 – 2017 Agricultural Water Use (mgd)

	2014	**2017**
Kahului Aquifer	28.222	0.313
Pā`ia Aquifer	29.097	0.000
Kama`ole Aquifer	0.000	0.001
Makawao Aquifer	0.000	0.000
Total Groundwater Pumpage	**57.319**	**0.314**
WAILUKU ASEA Surface Water Export*	18.000	5.000 - 7.000
KO`OLAU ASEA Surface Water Export**	116.133	20.000 – 23.000
CENTRAL ASEA Total Use	191.452	25.314 - 30.314

*Resource use accounted for in the Wailuku ASEA Report Chapter 14.6.4 and Table 14.34
**Estimated portion used for Ag irrigation based on surface water reported. Does not account for water losses between source and use.

Preliminary agricultural demand projections in the WUDP update applied percent acres cultivated of the HC&S plan and Important Agricultural Lands (IAL) as alternative low to high demand scenarios. Projections included all of the HC&S plantation, including lands historically irrigated with surface water from Nā Wai `Ehā. Scenario 1 represented 100% of HC&S Diversified Agriculture Plan, based on the acreage and water duty proposed in HC&S's plan and accounting for the entire plantation regardless of water source. Surface water from the designated Nā Wai `Ehā has not been allocated today. As discussed in the Wailuku Aquifer

[63] CCH-MA-13-01 Hawaiian Commercial and Sugar Company's Submission of Amended Proposed Findings of Fact and Conclusions of Law, June 2017

Sector Report, Chapter 14.6.4, it is reasonable to use the CWRM Hearing Officer's proposed 2017 Decision as basis for water duty and allocations from Nā Wai `Ehā. Projected agricultural demand for fields served by Nā Wai `Ehā was assessed and accounted for in the Wailuku Aquifer Sector Report Chapter. These demand projections are shown here separately in order to not double count demand and resource use. HC&S projected demand for the portion of the Diversified Agriculture Plan that would be served by the EMI system and supplemented by groundwater to 89.23 mgd. Irrigation needs were recognized in CWRM's June 2018 Decision of the East Maui Streams Contested Case.[64] The table below does not account for water losses.

Table 15-30 HC&S Diversified Agriculture Plan Projected Demand

	Scenario 1: 100% of Diversified Agriculture Plan, Fields Served by EMI, Nā Wai `Ehā and Groundwater	Scenario 2: 100% of Diversified Agriculture Plan, Fields Served by EMI and Groundwater
Irrigated (acres)	30,250	26,996
Irrigation Demand (mgd)	107.79	89.23

The Diversified Agriculture Plan envisions irrigating 26,996 acres of fields previously irrigated with surface water from Ko`olau ASEA delivered by the EMI system, and brackish water pumped from Pā`ia and Kahului Aquifers. An additional 3,954 acres are planned for unirrigated pasture where sufficient rainfall supports livestock. An additional 227 acres of unirrigated forestry is proposed. This scenario represents a high growth scenario, equivalent to Scenario 2 in the table above. Failure to establish viable crops on former plantation lands, leaving most plantation lands fallow represents a low growth scenario. The type of crops and timing of repurposing the plantation is highly uncertain. As a conservative approach **the selected scenario** is a phased build-out from 25 and 50 percent of Important Agricultural Lands (IAL) to 100 percent of the Diversified Agriculture Plan in active use over the 20-year planning period. In the June 2018 CWRM decision of the East Maui Streams contested case, the average water duty of about 3,305 gpd per acre was recognized. (While 2,500 gpd was applied for surface water use permits in Nā Wai `Ehā). It is noted again that the Central ASEA Sector Report addresses the plantation that is served by the EMI system and/or brackish water from the Central ASEA, which contain almost all lands designated IAL. There is some overlap with fields served by Nā Wai `Ehā. Areas served by the EMI system is shown in the figure below. Demand for the HC&S plantation within the EMI service area is summarized in Table 15-31 below.

[64] June 20, 2018 CCH-MA13-01 Findings of Fact, Conclusions of Law, & Decision and Order.

Figure 15-25 Important Agricultural Lands, EMI Ditches and Service Areas, and Rainfall for HC&S Lands

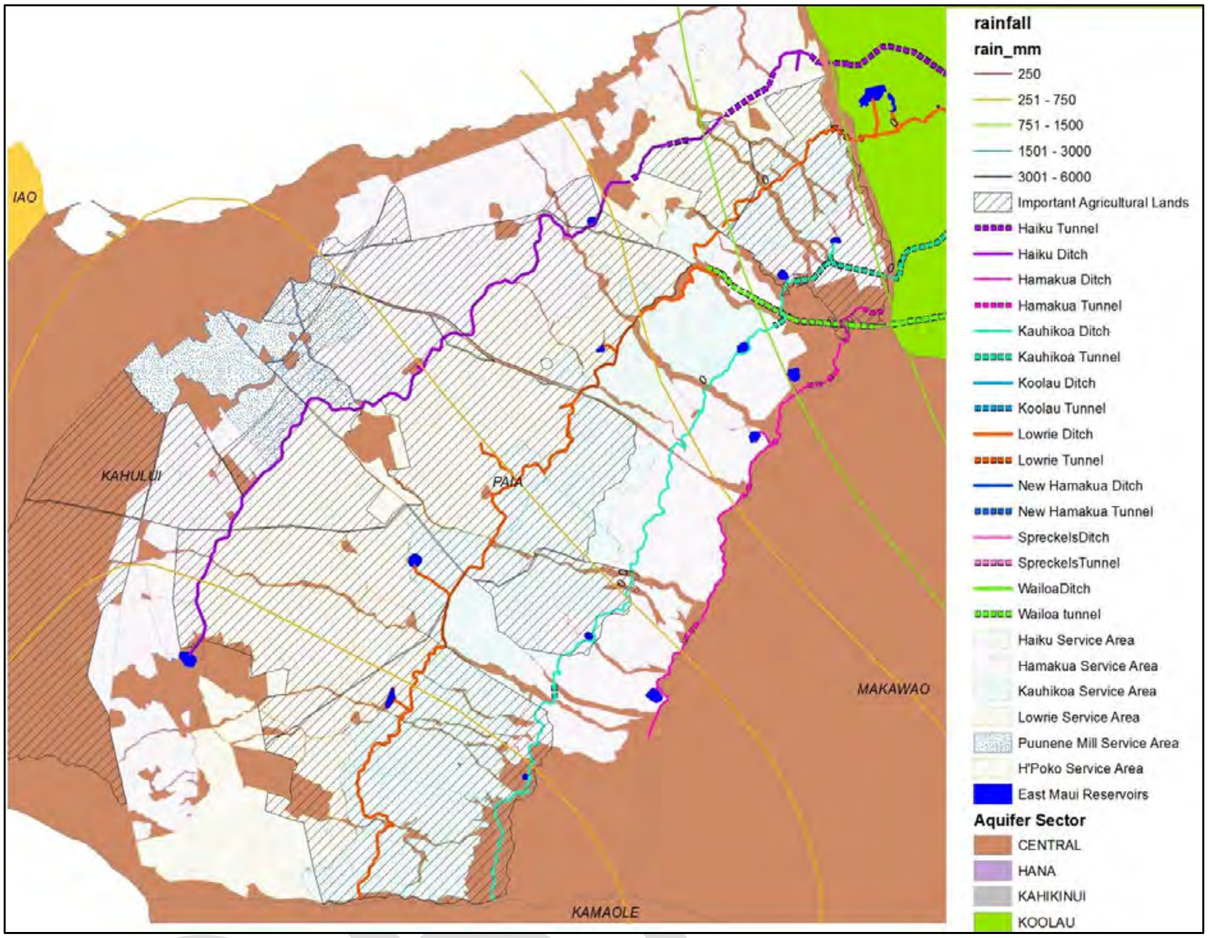


Table 15-31 Projected Low to High Agricultural Demand for A&B/HC&S Lands within EMI Service Area 2017 - 2035

	Low-Growth Scenario 25% of IAL Farmed	Mid-Growth Scenario 50% of IAL Farmed	High-Growth Scenario: 100% of Plantation Served by EMI and/or Brackish Water per HC&S Diversified Agriculture Plan
Time Frame	2020	2030	2035
Irrigated Acres	6,823	13,647	26,996
Irrigation Demand (mgd)	23.20	46.40	89.23

The extent to which brackish water from Pā`ia and Kahului Aquifers can and will be used is highly uncertain and probably directly related to the amount of irrigation return recharge over the same aquifers. It is anticipated that decreased irrigation return recharge will increase salinity and the sustainable level of groundwater use, compared to historic levels. The tolerance of various crops to brackish water quality further adds to uncertainty in use.

Diversified Agriculture Outside the HC&S Plantation

Upcountry Maui has a range of actively cultivated crops while the dry slopes between Kula and the coastal area of Kama`ole Aquifer is primarily unirrigated pasture. Based on the 2015 Agricultural Baseline and applying irrigation water duty in accordance with Hawai`i Department of Agriculture guidelines, water demand outside the HC&S plantation of the Central ASEA would be 9.9 mgd. Use includes the Kula Ag Park, the Maui Pineapple Company and Monsanto seed production on the Central isthmus. Projecting a potential 20 percent increase in agricultural use, and accounting for the planned expansion of the Kula Ag Park represents a high growth scenario. Adjustments to projected demand are anticipated once the the Agricultural Water Use & Development Plan is updated. Until then, the high growth scenario 11.8 mgd is conservatively selected as the 2035 demand projection. Table 15-32 below shows breakdown by crop, acreage and water duty over the planning period.

Table 15-32 Central ASEA Agricultural Water Demand (mgd), 2015 Agricultural Baseline (acreage), Agricultural Water Use Based on Crop, Water Use Rates - HDOA Guidelines

Crop	Acreage	Water Use Rate (gpd per acre)	Estimated Water Demand 2015 (mgd)	Estimated Demand 2035 (2015 + 20%)
Banana	16.70	3,400	0.057	0.068
Coffee	10.58	2,900.00	0.031	0.037
Diversified Crop	1,197.22	3,400.00	4.071	4.885
Flowers / Foliage / Landscape	97.97	4,000-6,000	0.490	0.588
Pasture	53,720.04	0-6,700	0.000	0.000
Pineapple	1,093.52	1,350.00	1.476	1.772
Seed Production	754.41	3,400.00	2.565	3.078
Taro	0.23	100,000-300,000*	0.035*	0.041*
Tropical Fruits	21.69	4,400-10,000	0.156	0.187
Kula Ag Park Expansion	302.00		1.027	1.232
CENTRAL Total	**57,214.35**		**9.908**	**11.888**

Coffee: per Brian Kau, HDOA, personal communication 10/12/2016.
Wetland taro: Per CWRM CC D&O, Nā Wai `Ehā and East Maui Streams

15.6.6 Irrigation Demand Projections

Reported irrigation use of 3.68 mgd within the aquifer sector includes brackish water used for golf course, resort and landscaping irrigation purposes. Over 75 percent of irrigation withdrawals are from the Kama`ole Aquifer but the data is likely under-reported. This is in addition to irrigation uses served by the MDWS Central and Upcountry Systems. Although irrigation needs may not correspond directly to population growth, it's prudent to project an increase in demand based on population growth, which is at a higher rate than the de facto population growth ("de facto" includes visitors). Demand would increase from 3.68 mgd to 5.59 mgd over the planning period.

In addition to groundwater withdrawals for irrigation, recycled water from the Kīhei Wastewater Reclamation Facility provides up to 1.75 mgd during peak summer months. Reclaimed water is distributed to 24 commercial properties in South Maui for landscape and agricultural irrigation, cooling, fire control, erosion and dust control, drinking water for cattle and other uses.[65] The volume of R-1 water reused varies seasonally. It is estimated that about 1 mgd is reused on average for irrigation purposes. An additional 0.08 mgd of reclaimed water is generated and used at the Mākena Resort, primarily for golf course irrigation. The reclamation facility is undergoing an upgrade to further integrate on site reclaimed water generation and use.

15.6.7 Population Growth-Based Water Demand Projections Analysis

To determine source needs and accommodate planned growth consistent with the MIP, projected demand is summarized in the table below. For municipal needs, water production rather than billed consumption is used as 2014 basis for projections. Water needs for the Upcountry System is projected separately and in combination with all other water needs within the Central ASEA dependent on resources within and outside the hydrologic unit. The MDWS Central System relies primarily on water resources from the Wailuku Aquifer Sector and is analyzed in the Wailuku Aquifer Sector Report.

Department of Hawaiian Homelands (DHHL) land use plans are not specifically addressed in the MIP or identified as planned growth areas. It is therefore assumed that DHHL water needs are not accounted for in municipal population growth based projections. Potable and non-potable demands for the Kēōkea/Waiohuli tract are currently served by the MDWS Upcountry System with a remaining allocation insufficient to meet projected needs. A MDWS allocation from the Upcountry System of 0.5 mgd has been partially credited against total projected potable demand of .809 mgd. There is no restriction to use the allocation for potable uses only. Less than half of the allocation has been used for development over the 20-year period since the 1997 agreement.

---

[65] Department of Environmental Management, Wastewater Reclamation Division, South Maui R-1 Recycled Water Verification Study, December 2009.

The selected 20-year projected demand scenario for the Central ASEA is population mid-growth based, that account for the MDWS Upcountry system as a whole, with the addition of DHHL needs and the Upcountry Meter Priority List. Total 2035 demand is projected to **128.105 mgd**. The MDWS Central System is **not** included in the selected scenario. Most of the source for the MDWS Central System is derived from the Wailuku ASEA and its distribution system spans both Wailuku and Central aquifer sectors. Supply to meet projected demand for the MDWS Central System is addressed in the Wailuku ASEA Report, Chapter 14. If accounting for demand on the MDWS Central System as well, total demand would be 165.27 mgd, shown in Table 15-33 below in italics only for comparative purposes. Land use-based demand is included in the table as the alternative scenario. Population growth-based sub-scenarios are illustrated as follows:

1. Agricultural demand projections for the HC&S plantation lands inherently has significant uncertainties over the planning period. The actual use of 191.45 mgd in 2014 is drastically reduced to 32.43 mgd in 2017. The 2017 projection is based on actual reported pumpage and diversions for 2017 less estimated uses for non-agricultural needs (such as reservoir storage for fire protection). Projected 2020 - 2025 demand roughly represents about 25 percent of IAL farmed; projected 2030 demand equals roughly 50 percent of IAL farmed, and 2035 demand 100 percent of the HC&S Diversified Agriculture Plan served by the EMI system and sources within the Central ASEA.
2. Municipal use "Municipal Private and Municipal Central ASEA Only", includes use within the Central aquifer sector only. The portions of the MDWS systems that are located in Ko`olau and Wailuku ASEAs are excluded.
3. Projected demand for the MDWS Upcountry system as a whole, not accounting for the Meter Priority List.
4. Total projected use within the Central ASEA only are shown including and excluding Agriculture. In consistency with the CWRM Framework in presenting water demand by hydrologic unit, 2035 demand within the Central ASEA is projected to 145.969 mgd, within a low to high range of 142.126 – 149.510 mgd. However, to plan for supply and source development it's only practical to consider demand and supply needs by water system and infrastructure.
5. The selected scenario includes the MDWS Upcountry system as a whole: "Total Population Based Mid Growth MDWS Upcountry System".
6. The Upcountry Meter Priority List is added to the selected scenario. The List does not represent population growth but considered committed water over the planning period. Historically about 50 percent of applications on the List have resulted in new water meter services. Amendments to county code over time have mitigated the cost and burden on applicants on the List. Therefor it is prudent to account for the entire List in planning for new source needs.

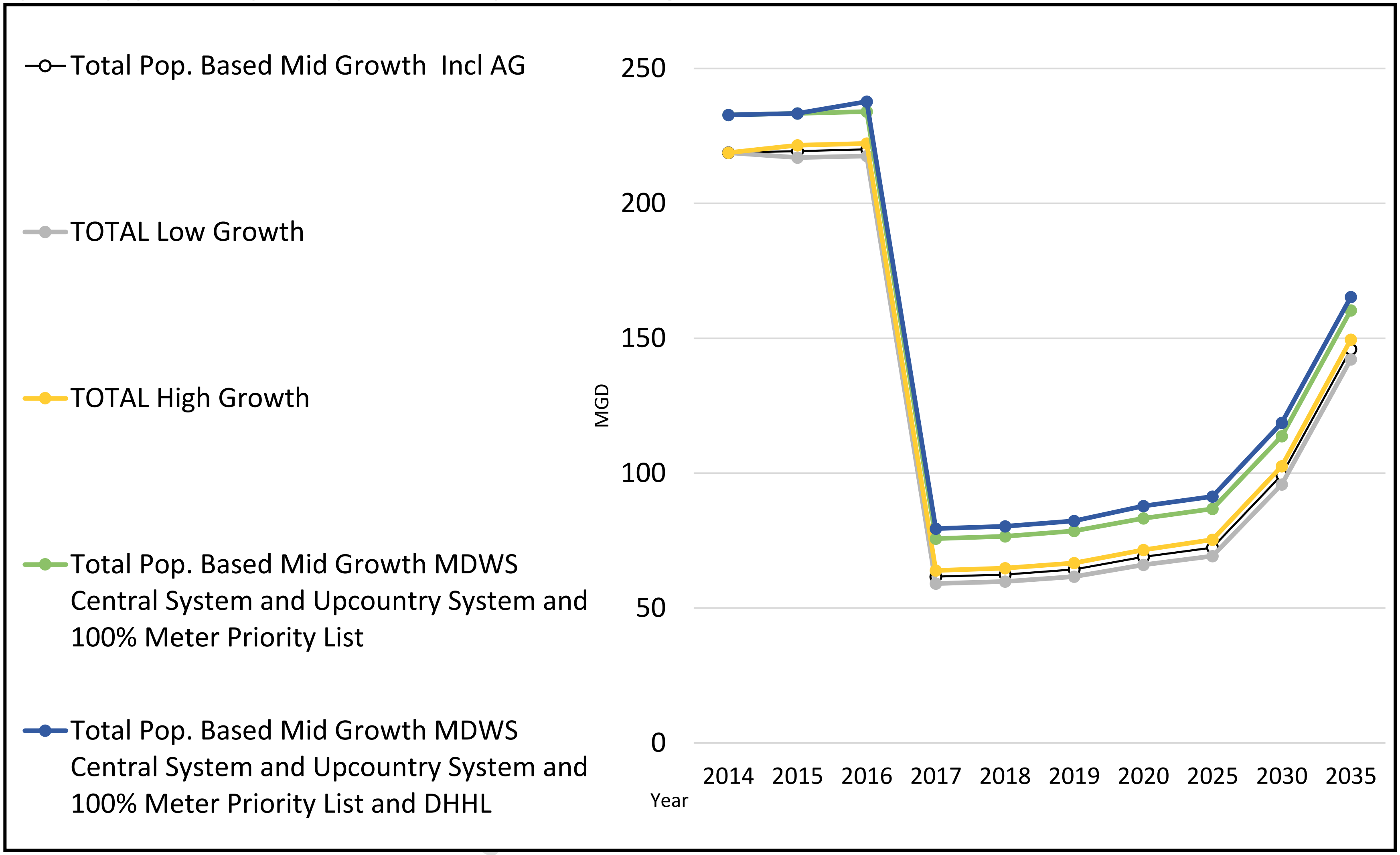
   Department of Hawaiian Homeland needs are added to the selected scenario for a total of **128.105 mgd.** It is not evident that planned DHHL developments is factored into population growth in the Maui Island Plan or community plans.

TABLE 15-33 Projected Water Use by CWRM Category to 2035 (mgd), CENTRAL ASEA

	2014	2015	2016	2017	2018	2019	2020	2025	2030	2035
POPULATION BASED										
Domestic	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial	0.208	0.211	0.217	0.222	0.227	0.232	0.237	0.261	0.290	0.316
Agriculture	191.452	191.452	191.452	32.434	32.534	33.749	35.415	35.415	58.200	101.030
Irrigation	3.683	3.744	3.836	3.927	4.018	4.110	4.201	4.627	5.133	5.591
R-1 Irrigation	1.008	1.025	1.050	1.075	1.100	1.125	1.150	1.267	1.405	1.531
Municipal MDWS (CENTRAL ASEA Only)	*22.235*	*22.609*	*23.160*	*23.712*	*24.263*	*24.814*	*25.366*	*27.939*	*30.995*	*33.761*
Municipal Private	*0.235*	*0.239*	*0.245*	*0.250*	*0.256*	*0.262*	*0.268*	*0.295*	*0.327*	*0.356*
Municipal CENTRAL ASEA Only	**22.470**	**22.899**	**23.423**	**23.960**	**24.509**	**25.070**	**27.928**	**30.871**	**34.303**	**37.501**
MDWS Upcountry System	**7.610**	**7.693**	**7.785**	**7.879**	**7.973**	**8.069**	**8.155**	**8.292**	**8.432**	**8.530**
Military	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL CENTRAL ASEA Only Mid Growth excl. AG	**27.368**	**27.880**	**28.526**	**29.184**	**29.854**	**30.537**	**33.517**	**37.026**	**41.132**	**44.939**
Total CENTRAL ASEA Only Mid Growth incl. AG	**218.820**	**219.332**	**219.978**	**61.618**	**62.388**	**64.286**	**68.932**	**72.441**	**99.332**	**145.969**
TOTAL Low Growth	218.820	216.948	217.539	59.122	59.835	61.675	66.066	69.276	95.815	142.126
TOTAL High Growth	218.820	221.529	222.226	63.917	64.740	66.692	71.573	75.359	102.573	149.510
Total Mid Growth MDWS Upcountry System	203.187	203.340	203.534	44.712	45.009	46.421	48.276	48.891	72.403	115.824
Total Mid Growth MDWS Upcountry System and 100% Meter Priority List	**232.761**	**233.339**	**234.054**	**75.763**	**76.604**	**78.573**	**83.261**	**86.793**	**113.688**	**160.298**
DHHL Additional Potable Kahului Aquifer	0.000	0.000	1.734	1.734	1.734	1.734	1.734	1.734	1.734	1.734
DHHL Additional Potable Kama`ole Aquifer	0.000	0.000	0.096	0.096	0.096	0.096	0.349	0.345	0.809	0.813

	2014	2015	2016	2017	2018	2019	2020	2025	2030	2035
DHHL Additional Non-potable Kama`ole Aquifer	0.000	0.000	0.000	0.000	0.000	0.000	0.578	0.578	0.578	0.578
DHHL Additional Non--potable (no source identified)	0.000	0.000	1.8564	1.8564	1.8564	1.8564	1.8564	1.8564	1.8564	1.8564
Total Pop. Based Mid-growth MDWS Central System and Upcountry System, 100% Meter Priority List and DHHL	***232.761***	***233.339***	***237.740***	***79.449***	***80.290***	***82.260***	***87.779***	***91.311***	***118.666***	***165.279***
SELECTED SCENARIO: Total Pop. Based Mid-growth Upcountry System, 100% Meter Priority List and DHHL	**210.487**	**210.640**	**214.521**	**55.698**	**55.995**	**57.408**	**60.094**	**60.708**	**84.681**	**128.105**
LAND USE BASED										
County Zoning	433.259	433.259	433.259	433.259	433.259	433.259	433.259	433.259	433.259	433.259
DHHL	4.011	4.011	4.011	4.011	4.011	4.011	4.011	4.011	4.011	4.011
TOTAL Land Use Based	**437.27**	**437.27**	**437.27**	**437.27**	**437.27**	**437.27**	**437.27**	**437.27**	**437.27**	**437.27**

Figure 15-26 Projected Water Use to 2035, Population Growth Based (Low, Medium, High) Central ASEA + MDWS Central and Upcountry Systems + Upcountry Meter Priority List + DHHL (mgd)



15.7 Water Resource Adequacy

The analysis of available resources and projected 20-year demand result in the following findings:

1. Groundwater sustainable yield (SY) and surface water within the hydrologic unit is **not** sufficient to supply population growth and planned growth areas.
2. Decreased transport of Ko`olau surface water for irrigation of lands overlying the Kahului and Pā`ia Aquifers will probably result in higher chlorides and less fresh water available to withdraw beyond these aquifers' natural sustainable yield.
3. Surface water from the Ko`olau ASEA under median (Q50) conditions (subject to IIFS established 6/20/18), accounting for baseflow only will probably meet the initial phase of transition to diversified agriculture on the Central isthmus. Median base flow will not be sufficient to realize the full Diversified Agricultural Plan. Estimated total flow (TF = additional water available beyond what is contributed by groundwater to streams) based on historic ditch flows, also appears to fall short of projected agricultural needs.
4. Surface water under low flow, or drought (Q90) conditions accounting for baseflow will not be sufficient to meet initial transition to diversified agriculture and projected municipal demand of the MDWS Upcountry System.
5. Non-potable irrigation and industrial demand can probably be met with water resources within the Central ASEA. Municipal and agricultural demand requires supplemental groundwater imports and alternative water resources.

15.7.1 Source Adequacy vs. Land Use-Based Full Build-Out Water Demand Projections

Full build-out of land use classifications throughout the Central ASEA represents 437 mgd in total water use. County zoning in the Central ASEA is designated Agriculture for about 78% of zoned lands. Large sections of Agricultural land are non-irrigated pastures on the dry southwest slope of Haleakalā with little or no projected water use. Another 36,000 acres make up the former HC&S sugarcane plantation now in transition. Low to high "growth" or active use of these lands are assessed based on percentage lands in active cultivation over the 20-year planning period. Therefore, land use build-out projections are used for the HC&S plantation lands, supplementing population growth-based projections. A full build-out scenario of other county zoned lands is not realistic nor supported by the Socio-Economic Forecast.

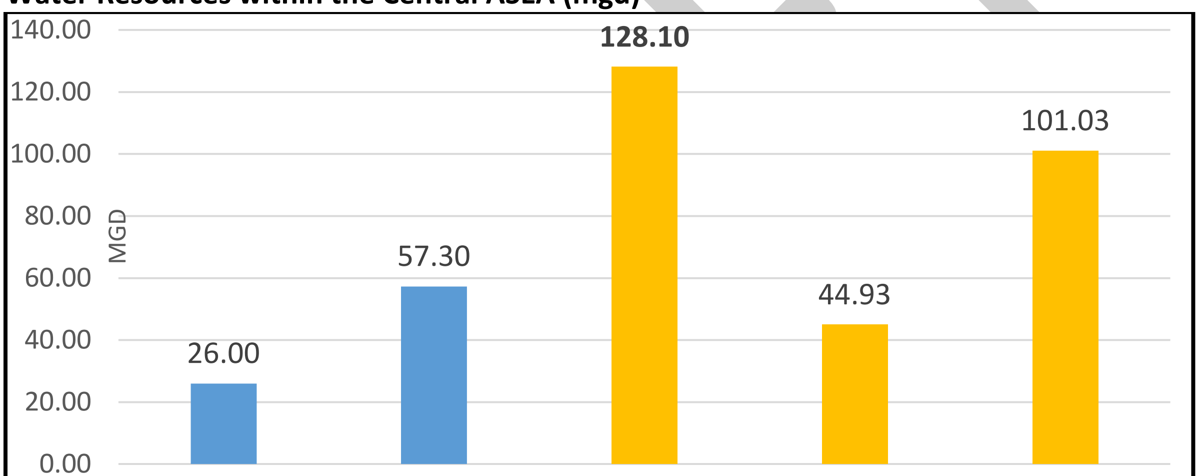
The Maui Island Plan, the Socio-Economic Forecast and the community plans do not specifically address Department of Hawaiian Homelands water needs for their planned developments in the Central ASEA. It is therefore assumed that DHHL needs are **not** factored into population growth. DHHL water use projections for the 20 year planning period are added to population growth based projections.

15.7.2 Source Adequacy vs. Population-Growth Based Water Demand Projections (20-Year)

The primary planned growth areas according to the Maui Island Plan are located in the Central ASEA from Kahului throughout the Central isthmus to the South Shore. Most of the population centers and planned growth areas are, or are anticipated to, be served by the MDWS Central System. Total population growth-based demand in the Central ASEA as a separate hydrologic unit is about 44.9 mgd. As stated previously, the MDWS Central System is addressed in the Wailuku ASEA Report. Total Central ASEA water use demand not accounted for elsewhere in this WUDP update is therefore **128.10 mgd**.

The chart below shows resources within the Central ASEA, brackish groundwater available in 2014, based on reported pumpage. Available brackish groundwater above natural sustainable yield is not known but assessed below under *Surface Water Imports from Ko`olau Aquifer Sector Area.*

Figure 15-27 Population Mid-Growth Based 20-Year Water Demand Projections and Available Water Resources within the Central ASEA (mgd)



Groundwater Sustainable Yield	26.00
Pā`ia and Kahului Brackish GW Available in 2014	57.30
DEMAND Pop. Mid-Growth, incl. MDWS Upcountry System, Priority List, Land use based AG and DHHL (excl. MDWS Central System)	128.10
Demand Pop. Mid-Growth CENTRAL ASEA only (portions of water systems located only within hydrologic unit)	44.93
Demand AG only	101.03

Population growth Based Water Demand Projections MDWS Central System

As stated in the Wailuku ASEA Report, MDWS Central System demand is projected to increase from about 22.2 mgd to 37.2 mgd. Most of future supply for the MDWS Central System would come from the Wailuku ASEA: about 19.1 mgd of groundwater and about 3.2 mgd of surface water. Potable groundwater from the existing Maui Lani wells in Kahului Aquifer would supply 1.1 mgd. Expanded conservation programs are projected to decrease per capita water use by 8 percent over the planning period and substitute about 5 mgd of needed water resources. The remaining 8 mgd for the MDWS Central System would come from potable groundwater imports from the Ha`ikū aquifer in the Ko`olau ASEA.

Population Growth Based Water Demand Projections Upcountry

Projected 2035 demand based on the selected mid-growth scenario is 8.5 mgd without the Upcountry Meter Priority List and 15.8 mgd accounting for the entire List. The combined surface and groundwater sources have a production capacity of 17.9 mgd: 13 mgd from surface water and 4.9 mgd from groundwater. Reliable capacity must consider system standards and limitations on the use of wells according to the following factors:

1. The largest surface water treatment facility being out of service: the Kamole Weir at 6.0 mgd capacity
2. The Po`okela Well at 1.3 mgd production capacity
3. The Hāmākuapoko Wells at 1.5 mgd, which is only available at times of emergency

Adjusting for the factors above reduces production capacity by 8.8 mgd, to reliable capacity of 9.1 mgd. Additional source capacity needs are 6.7 mgd to meet the 2035 projected demand of 15.8 mgd.

The Hāmākuapoko wells at 700 foot elevation and above can convey up to about 0.9 mgd combined to the MDWS Upcountry system during droughts.

Planned Growth Areas in Kahului Aquifer

As stated in Chapter 15.6.4, two planned growth areas would potentially be served by groundwater from Kahului Aquifer: Wai`ale mixed-use town development and Pulehunui industrial development. It is assumed that the planned housing development is accounted for in the socio-economic forecast and therefore included in population growth-based demand.

The Pulehunui industrial development of up to 3.8 mgd demand does not appear to be accounted for in population growth-based industrial water use projections, which total 0.316 mgd by 2035. The demand for Pulehunui could be considered additional to population growth-based demand, similar to the proposed DHHL Pu`unēnē developments of 3.5 mgd. It is not assumed that the Pulehunui industrial development would be served by the MDWS Central System and Wailuku ASEA resources.

Wells in the Kahului Aquifer, including the Wai`ale wells, may see rising chloride levels due to the decrease in irrigation return flow from East Maui stream diversions to HC&S plantation lands overlying the aquifer. Because the impact on the Kahului Aquifer yield and quality is highly uncertain, it is not assumed that significant yield of freshwater supply is available beyond natural SY of 1 mgd to meet potable demand. Non-potable irrigation needs for the Wai`ale development can probably be supplied from the existing Wai`ale wells in Kahului Aquifer. Potable demand will most likely be met by water resources in the Wailuku ASEA, such as Waikapū Aquifer. On site groundwater development for planned growth at Pulehunui, as well as the DHHL Pu`unēnē project, may be feasible for non-potable purposes. Source adequacy is highly uncertain due to the anticipated decrease in irrigation return recharge with the cessation of sugarcane cultivation.

Planned Growth Areas in Pā`ia Aquifer

The three projects listed in Table 15-26 all overlie the Pā`ia Aquifer. It is assumed that Pā`ia Expansion and Pā`ia Mauka housing projects are accounted for in population growth based demand. The projects are within the MDWS Central System service area. Source to supply projected demand in Pā`ia include ground and surface water from Wailuku ASEA and groundwater import from Ko`olau ASEA (see Table 14-38).

The Old Maui High School Campus Revitalization Project is not within the MDWS Central System service area and is probably not accounted for by population growth based private municipal water use projections, which total 0.356 mgd. Source alternatives for the projected 0.75 mgd project demand are not determined but could include groundwater development from the Pā`ia Aquifer.

The 825 unit planned Hali`imaile Development mostly overlies the Pā`ia Aquifer and could potentially be served by existing wells in the Pā`ia Aquifer. High nitrate levels are in nearby well development for the Baldwin Estates subdivision and is likely an issue.

Water quality in the Pā`ia Aquifer ranges from brackish close to the coast to potable quality above 700 feet ground elevation. Municipal wells in the Pā`ia Aquifer serve individual public water systems and supplements the MDWS Upcountry System. Irrigation wells pump about 0.16 mgd mostly brackish water and are densely installed throughout Spreckelsville. Following cessation of sugarcane cultivation, the withdrawals from Pā`ia Aquifer has decreased from 29 mgd to 0.4 mgd. The Hāmākuapoko wells at 700 foot elevation serves the MDWS Upcountry system during droughts. The contaminant 1,2-Dibromo-3-chloropropane, or DBCP, detected at the wells is treated using Granular Activated Carbon (GAC) filtration. By deducting the production capacity of Hāmākuapoko wells, the remaining sustainable yield can potentially be developed for non-potable supply in the region from Pā`ia-Kū`au to Pu`unēnē. Because chemical contaminants in the Pā`ia Aquifer are an issue, potable well development would need to consider the investment and cost of GAC treatment and possibly additional treatment for nitrates.

Planned Growth Areas Upcountry

Table 15-24 shows nine projects Upcountry, totaling 0.89 - 2.75 mgd. Although all planned growth areas Upcountry could theoretically be served by the MDWS Upcountry System, all development is subject to the Upcountry Meter Priority List. It is assumed that the planned additional 1491 housing units is accounted for by population growth and the 2014 Socio-Economic Forecast. The WUDP does not analyze individual projects status on the Meter Priority List but private source development will likely be required for some of the large projects, such as Hali`imaile, Pukalani Expansion and Pukalani Makai. Whether projects are served by private or the MDWS Upcountry system, source development is needed to meet municipal demand.

Most of planned growth Upcountry is located in the Makawao Aquifer with a sustainable yield of 7 mgd. The aquifer is relatively undeveloped, primarily due to the high cost of construction and pumping wells at over 1,000 foot depth. There are limited hydrological studies of the aquifer but existing wells generally have good water quality and productive yield. Basal water can provide potable supply to meet demand and contingency needs Upcountry.

<u>Planned Growth in Kama`ole Aquifer</u>

Planned growth from Mā`alaea to Mākena is with few exceptions within the MDWS Central System and addressed in the Wailuku ASEA Report, Chapter 14. Planned growth above 1,000 foot elevation is generally within the MDWS Upcountry System area. Brackish groundwater occurs regionally at lower elevations. Known chloride levels for irrigation wells throughout the aquifer range from 100 to over 1,400 mg/l. Installed pump capacity in the Kama`ole Aquifer is 18.8 mgd. The sustainable yield established by CWRM is 11 mgd. Reported pumpage for irrigation purposes is 2.82 mgd for 2014/2015. Pumpage is reported from 26 of 75 installed irrigation wells. Additional pumpage is assumed to occur from Kama`ole Aquifer beyond the 35% of installed irrigation wells that report to CWRM. CWRM well data indicate lower chloride levels in wells above 500 foot elevation but still above 200 mg/l. Densely spaced irrigation wells along the shoreline are subject to rising sea-levels and associated saltwater intrusion. It is anticipated that chlorides will increase in existing wells along the south shore coastline.

Few wells have been developed at higher than 400 – 500 foot elevation and chloride levels are unknown. Additional yield may be developed at 1000 foot elevation and higher in the Kēōkea region where chloride levels are assumed to be within potable range. Withdrawals below 500 feet to serve planned growth in the coastal area would require additional treatment to remove chlorides, such as reverse osmosis. Remaining yield cannot be determined until improved reporting and water use data is available, but it is assumed that existing wells can continue to provide current levels of non-potable irrigation supply of about 3 mgd in the Mā`alaea, Kīhei, Wailea and Mākena areas.

15.7.3 Alternative Sources within the Central Aquifer Sector Area

Planning objectives identified in the public process and in the Community Plans support increased use of recycled water, promoting the highest quality water for the highest end use, and to protect and prioritize public trust uses in allocating groundwater in regions of limited resources and conflicting needs. Recycled water is available in Kahului, Kīhei, Mākena and to a limited amount in Pukalani. There is no municipal wastewater treatment facility Upcountry where development generally is served by individual septic systems and cesspools. There is no existing stormwater collection facility in the Central ASEA.

Recycled Water

Upgrade of the Wailuku-Kahului wastewater reclamation facility (WWRF) from R-2 to R-1 production could offset about 3 mgd of diverted stream water or pumped groundwater for non-potable irrigation. The Department of Environmental Management's fiscal year 2018 capital improvement program budgeted $0.5M for design of a new water distribution line connecting the Kahului WWRF to an existing line at the old Maui Pineapple processing facility. The project budgeted $6.2M for construction in fiscal year 2020 that would make R-1 water available to the HC&S fields east of Kuihelani Highway, currently served by East Maui stream diversions through the East Maui Irrigation Company distribution system. This project is temporarily on hold. An analysis of irrigation system service areas and the HC&S Diversified Agricultural Plan, the R-1 project could benefit fields served by Nā Wai 'Ehā surface water, brackish water but not EMI ditch water. The project is not accounted for as available supply to meet demand in Table 14-38 until R-1 water is produced at the WWRF. Strategy #8 in the Wailuku ASEA Report recommends expanding distribution for additional supply of up to 4.2 mgd.

The Kīhei WWRF serves the South Maui area from Wailea to Sugar Beach. R-1 supply of 1.5 mgd is currently used with an additional 0.7 mgd available to off-set potable water on the MDWS Central System. The R-1 supply is included in Table 14-38 and Strategy #9 of the Wailuku ASEA Report.

The private Mākena WWRF was using about 0.08 mgd of R-1 for golf course irrigation of a 0.75 mgd production capacity. The facility is under redevelopment and is assumed to provide at least 0.08 of non-potable supply but will be reassessed in future WUDP update for additional supply.

The Pukalani WWRF uses about 0.19 mgd of R-1 water produced for non-potable irrigation. Use represents 65 percent of design capacity and is not assumed to increase.

15.7.4 Surface Water Imports from Ko`olau Aquifer Sector Area

Since the WUDP chapter for the Ko`olau ASEA was published for review, CWRM issued their decision in the Contested Case over East Maui Streams and established Interim Instream Flow Standards (IIFS). For the purpose of assessing available surface water for off-stream uses in the

Central ASEA, we have attempted to calculate stream flow under various conditions that would be available to divert after meeting established IIFS, based on the June 20, 2018 Findings of Fact, Conclusions of Law and Decision and Order (FoF, CoL and D&O) for the East Maui streams contested case. The following are key findings as it relates to water import from Ko`olau ASEA for agricultural use in Central ASEA:

1. Planned future uses of A&B/HC&S lands as set forth in the Diversified Agriculture Plan is consistent with the use of lands designated Important Agricultural Lands (IAL).
2. Water requirement forecasts for the plantation continue to evolve and will vary with crop rotations, agricultural methods, planted acreage and urban growth.
3. Not all of projected irrigation water needs under the Diversified Agriculture Plan will be met based on median base flow from the streams that can continue to be diverted.
4. Brackish groundwater is expected to provide some portion of the Diversified Agricultural Plan water needs.
5. It is expected that a sufficient amount of water would be available (after meeting IIFS) to provide the initial phase of IAL designated lands to be developed for diversified agriculture.
6. A&B/HC&S shall report on crops and acreage planted and changes in the Diversified Agriculture Plan.
7. It is A&B/HC&S' responsibility to allocate the water it may get under a lease from the Board of Land & Natural Resources (BLNR) between irrigation water and system losses.
8. CWRM continues to allow some streams to be diverted, which includes freshets and stormwater. The BLNR may continue to license diversions of water that is not needed to meet the adopted IIFS.

While the Hearing Officer's January 2016 and July 2017 Proposed FoF, CoL and D&Os stated the amount of water to be returned to the streams, the June 2018 decision does not. A&B/HC&S would be able to divert water through the EMI system from some of the streams subject to the contested case.

The table in Appendix 15A attempts to summarize IIFS and assess available water to divert for offstream uses. In comparing established IIFS and base flow at various conditions, 20.35 mgd would be available from the streams subject to the contested case as base flow during median flow conditions (Q50) to potentially divert through the EMI system. About 8 mgd would be available from the streams west of Honopou streams through Maliko Gulch. Therefore about **28 mgd** would potentially be available from Wailoa Ditch for use at Kamole Weir for MDWS, to Kula Ag Park and for A&B/HC&S diversified agriculture. However, because freshets (high stream flows during flooding events) and stormwater are allowed to be diverted, much more would potentially be available to divert during "normal", or wet season conditions. This total flow (TF) can be estimated based on historic ditch flows. About 122 mgd was imported from Ko`olau streams in 2014. For the period 2011 – 2015 the average diversions were 123.58 mgd. Subtracting median total flow (TFQ^{50}) for restored streams of 45.44 mgd, remaining surface water would be **78.14 mgd**. Appendix 15A also shows subtracted 2014 average use for the

MDWS Kamole Weir Water Treatment Facility and Kula Agricultural Park, leaving 72.92 mgd TF ^{Q50} ditch flow potentially available.

During low flow conditions, or Q90, only 2.21 mgd appears to be available for A&B/HC&S to divert after satisfying IIFS. Because IIFS are monitored on a 12-month moving average basis, any “overdraft” during short periods of droughts may not violate adopted IIFS. It is recognized that requiring a specific amount of streamflow at all times at a specific location is incompatible with the objectives.[66] However, it’s clear that the June 2018 Decision does not provide for sufficient diversions during extended droughts to meet proposed demand under the Diversified Agricultural Plan.

The chart below shows resources within the Central ASEA, resources in Ko`olau ASEA that were used in the base year 2014 to serve water use in the Central ASEA and estimated surface water resources available according to the June 2018 CWRM decision. The chart also shows brackish groundwater that was available to pump in 2014, based on reported pumpage. Available brackish groundwater above natural sustainable yield is not known. A hypothetical available yield is provided based on the CWRM June 2018 Decision’s reasoning where historically 20 - 30 percent of total use was groundwater. About 17.84 mgd of brackish groundwater could reasonably be used to supplement surface water, as interpreted in the June 2018 decision.

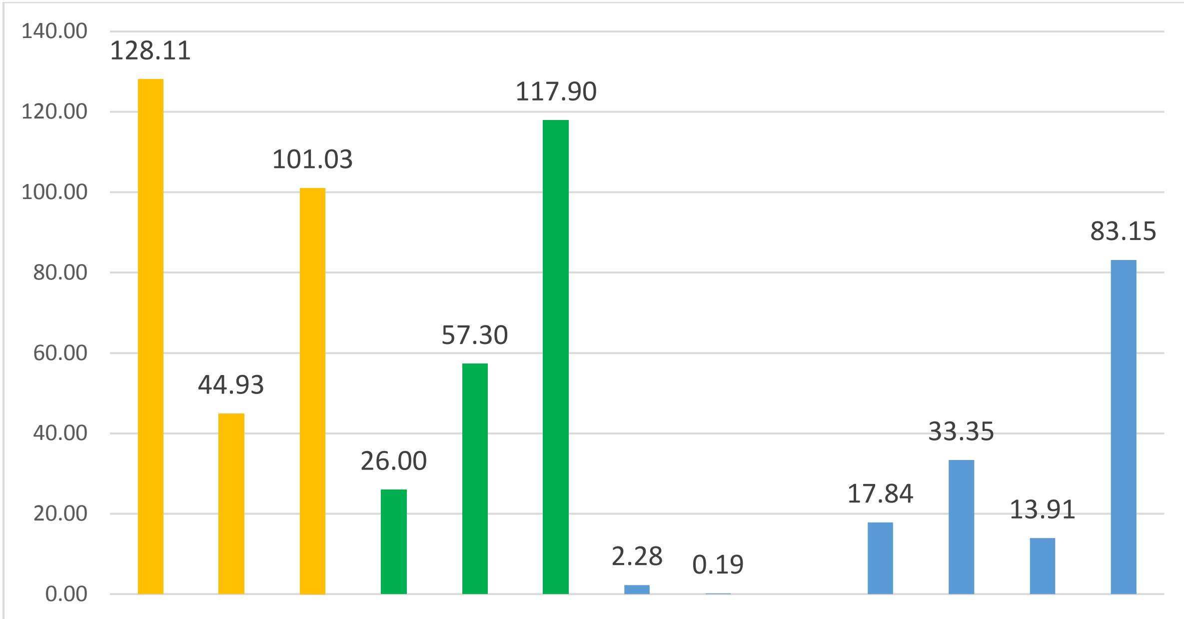
Recycled water available in South Maui includes 1.5 mgd currently used and an additional 0.7 mgd available from the Kīhei Wastewater Reclamation Facility (WWRF) and 0.08 mgd from the Mākena WWRF. Recycled water available in the Upcountry region is 0.19 mgd at the Pukalani WWRF.

Estimated surface water “available to divert”, is hypothetical with the understanding that off-stream uses have not been quantified or qualified. A&B/HC&S uses are subject to the Board of Land & Natural Resources allocations of land leases. MDWS use from the Wailoa Ditch requires an allocation agreement with A&B Properties.

The figure below compares demand projections to water resources assessed in 2014 and water resources estimated based on the June 2018 IIFS and corresponding effect on available groundwater.

[66] CWRM, June 20, 2018 Findings of Facts, Conclusion of Law and Decision and Order, CCH MA13-01

Figure 15-28 Population Mid-Growth Based 20-Year Water Demand Projections and Available Water Resources (2014 and 2018), Central ASEA and Ko`olau Surface Water Imports (mgd)



DEMAND Pop. Mid-Growth, incl. MDWS Upcountry System, Priority List, Land-Use Based AG and DHHL (excl. MDWS Central System)	**128.10**
Demand Pop. Mid-Growth CENTRAL ASEA hydrologic unit only	44.93
Demand AG only	101.03
Groundwater Sustainable Yield	26.00
Pā`ia and Kahului Brackish Groundwater Available in 2014	57.30
Ko`olau Surface Water Imports, 2014	117.90
R-1 Water Kīhei and Mākena Region (MDWS Central System Service Area)	2.28
R-1 Water Pukalani (MDWS Upcountry Service Area)	0.19
Pā`ia and Kahului Brackish Groundwater Potentially Available 2018	17.84
Ko`olau Surface Water Available to Divert at Median Base Flow (BF Q^{50}), less IIFS, 2018*	33.35
Ko`olau Surface Water Available to Divert at Drought Base Flow (BF Q^{90}), less IIFS, 2018**	13.91
Ko`olau Surface Water Available to Divert at Median Total Flow (TF Q^{50}), less IIFS, 2018*	83.15

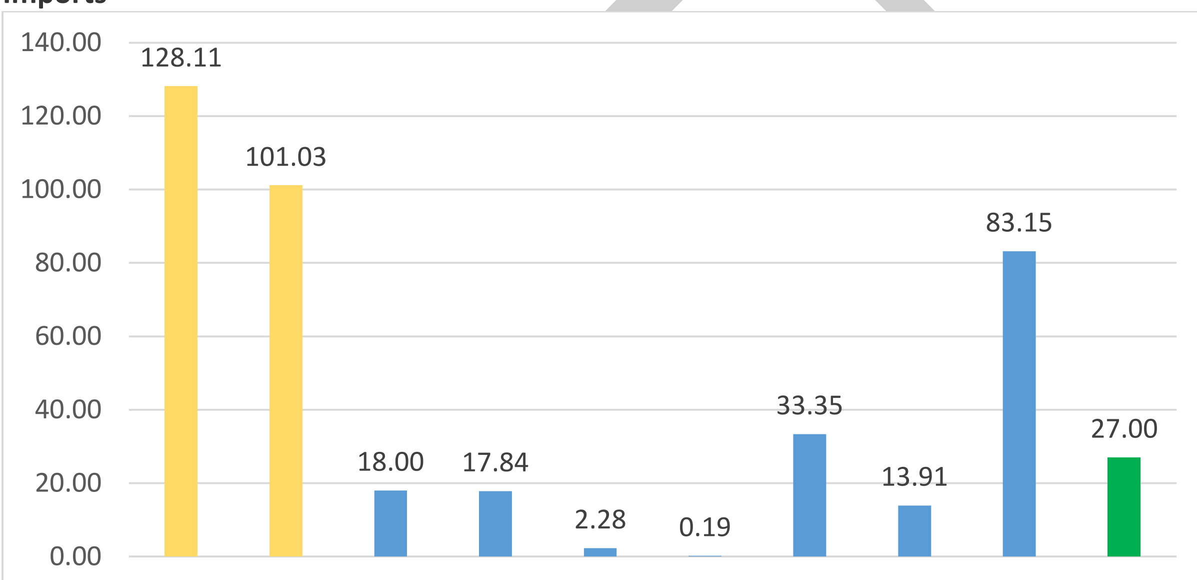
*Includes 5 mgd available to divert at Piiholo and Olinda water treatment facilities

**Includes 3.7 mgd available to divert at Piiholo and Olinda water treatment facilities at low flow

15.7.5 Groundwater Imports from Ko`olau Aquifer Sector Area

Sources for the MDWS Upcountry System includes two wells in the Ha`ikū aquifer of the Ko`olau ASEA: Ha`ikū Well, which produces about 0.5 mgd, and Kaupakalua Well producing about 0.9 mgd. The Ha`ikū aquifer is relatively undeveloped, with 0.82 mgd (less than 3 percent) total pumpage of established sustainable yield. The chart below shows the Central ASEA and Ko`olau Surface Water Resources assumed available in 2018 (excluding 2014 imports from the figure above), with the addition of Ha`ikū aquifer sustainable yield. It is noted that a portion of Ha`ikū aquifer is proposed to be explored to meet potable demand on the MDWS Central System per Chapter 14.8.

Figure 15 -29 Population Mid-Growth Based 20-Year Water Demand Projections and 2018 Estimated Available Water Resources, Central ASEA, Ko`olau Surface Water and Groundwater Imports



DEMAND Pop. Mid-Growth, incl. MDWS Upcountry System, Priority List, Land Use-Based AG and DHHL (excl. MDWS Central System)	**128.10**
Demand AG only	101.03
Makawao and Kama`ole GW Sustainable Yield	18.00
Pā`ia and Kahului Brackish GW Potentially Available	17.84
R-1 Water Kīhei and Mākena Region (MDWS Central System Service Area)	2.28
R-1 Water Pukalani (MDWS Upcountry Service Area)	0.19
Ko`olau Surface Water Available to Divert at Median Base Flow (BF Q^{50}), less IIFS	33.35
Ko`olau Surface Water Available to Divert at Drought Base Flow (BF Q^{90}), less IIFS	13.91
Ko`olau Surface Water Available to Divert at Median Total Flow (TF Q^{50}), less IIFS	83.15
Ko`olau Haiku Aquifer Sustainable Yield	27.00

15.8 Strategies to Meet Planning Objectives

The WUDP update public process generated a set of planning objectives through an iterative process. Multiple resource options to meet planning objectives and projected demand were reviewed and evaluated in regional public meetings and workshops to assess constraints, relative costs, implementation risk and viability.[67] Planning objectives, preliminary strategies and related material reviewed in the final public workshop, November 29, 2016 is attached as Appendix 13. The selected strategies are presented below along with available cost estimates, hydrological, practical and legal constraints, opportunities and risks that were considered in assessing the viability of a specific resource or strategy. Life cycle costs are estimated for conventional and alternative resource strategies where engineering studies and reports were available, including capital, operation and maintenance costs per 1,000 gallons supply.

Key issues identified for the Central ASEA, which includes Central, South and Upcountry Maui communities and water resources within the Ko`olau ASEA, relate to managing the development and transportation of water from areas with abundant rainfall to areas with scarce rainfall and subsidizing infrastructure in water scarce areas, maintenance of traditional resource management using the ahupua`a system and ensuring that traditional and customary practices are safe guarded. Much of the public water use in the Central ASEA relies on Ko`olau surface water resources conveyed via privately owned transmission systems. A key issue for the region is providing affordable water for future needs, providing for public trust uses, farming Upcountry and on the Central Maui isthmus during droughts, and managing resources in a sustainable way.

Recommended alternatives include resource management as well as development of conventional and alternative resources. All strategies are assumed to include conservation consistent with recommended supply and demand side conservation strategies outlined in Section 12.2. Recommendations should guide resource use and infrastructure development over the 20-year planning period. Estimated timeframes for implementation are indicated, allowing for flexibility to re-scope, prioritize and adjust to available funding.

15.8.1 Resource Management

Planning objectives related to resource management identified and confirmed in the WUDP update public process, the Maui Island Plan (MIP), the Pā`ia-Ha`ikū Community Plan, the Makawao-Pukalani-Kula Community Plan and the Wailuku-Kahului Community Plan include:

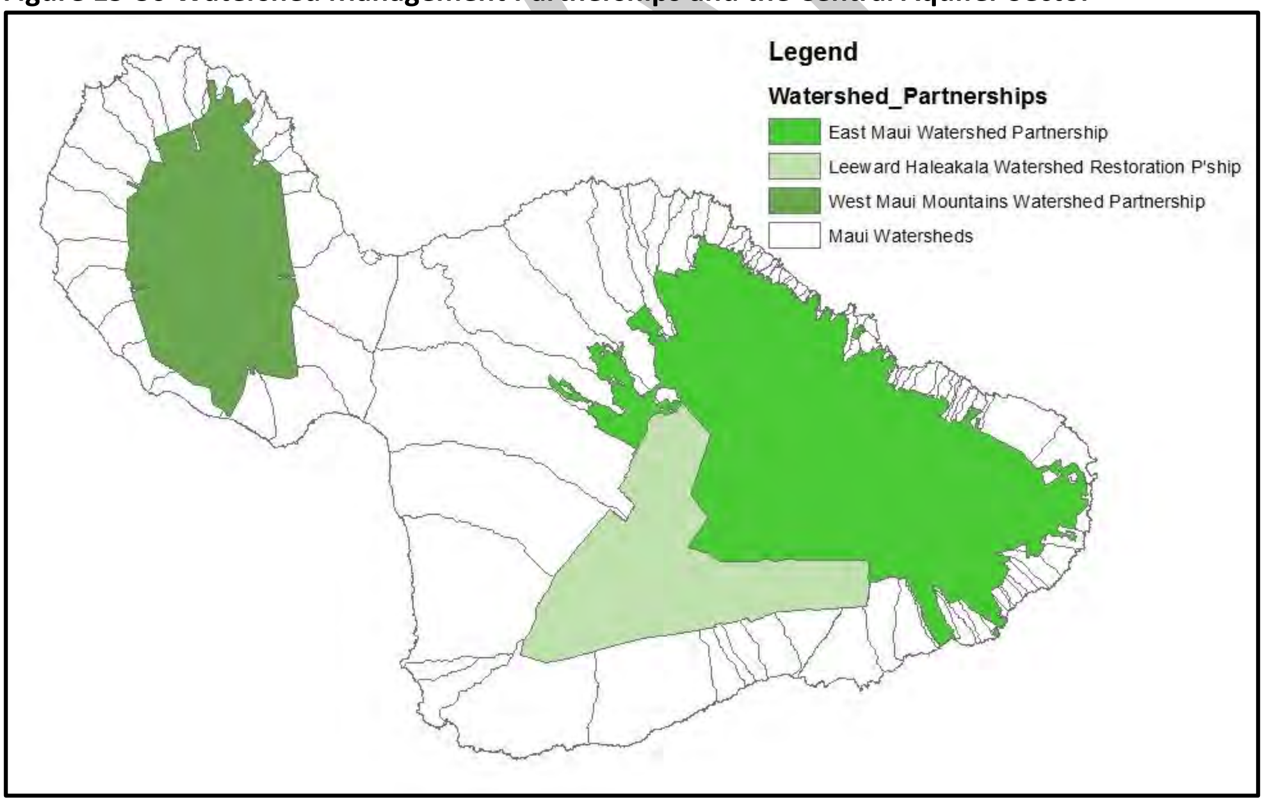
- Watershed protection and its prioritization is important, including invasive alien plant control, ungulate control, and reforestation via watershed partnership programs
- Build up what is taken from aquifers

[67] Preliminary Strategies for Central Sector (Upcountry) November 30. 2016

Watershed Protection

Issue and Background: Most land within this hydrologic unit are water resource "import" areas, rather than "export" areas in the sense that population and agricultural operations rely on water resources from adjacent watersheds. Watershed management in both types of watersheds are important. The Department of Land and Natural Resources has identified "Priority Watershed Areas" which are areas of highest rainfall and resupply, based on climatic conditions that provide high recharge and fog capture. Currently protective measures are focused in these priority areas above the 3,000 foot elevation with direct benefit to makai lands and the nearshore environment. The East Maui Watershed Partnership (EMWP) manages most of the forested upper critical watersheds of Ko`olau Aquifer sector. Ongoing efforts include ungulate control through fence construction, retrofitting and regular trap checks weed management, monitoring, and human activities management through outreach and education. On the dry side of Haleakalā, the Leeward Haleakalā Watershed Restoration Partnership (LHWRP) works towards restoring the disturbed landscape where once dryland forests captured rain and fog that recharged the freshwater supply. The Maui Invasive Species Committee (MISC) targets pest animals and plant species to prevent their influx and establishment in the mauka critical watersheds. Their efforts occur throughout the Central ASEA in rural and agricultural regions as needed.

Figure 15-30 Watershed Management Partnerships and the Central Aquifer Sector



The Makawao-Pukalani-Kula Community Plan states as objectives:

- Recognize the importance of the forested watershed areas and that their health and well-being are vital to all the residents of the Upcountry area.
- Explore a comprehensive reforestation program to increase and catch more rainwater for the Upcountry area.

The objectives support the ongoing efforts by EMWP, LHWRP and MISC. State and county agencies as well as private purveyors can provide financial support and participation in watershed protection partnerships and reforestation programs. Strategies for watershed management in Ko`olau is addressed in the Ko`olau ASEA Report, Chapter 16.8.1. Management efforts on leeward Haleakalā is addressed in the Kahikinui ASEA Report, Chapter 18.8.1.

Exercise of Traditional and Customary Rights in the Central ASEA

Issue and Background: The outreach to community groups and organizations with knowledge about traditional and customary (T&C) uses did not yield site specific information to consider in the Ka Pa`akai analysis. In order to identify traditional and cultural resources, anticipate impacts, and protect Native Hawaiian rights, MDWS consulted the Maui Aha Moku Advisory Committee, which possesses knowledge of persons who may be consulted on these issues. The Maui Island Aha Moku (Moku O Pi`ilani) was also consulted and has been actively engaged in the WUDP process. During meetings with the Water Committee of Moku O Pi`ilani and members of Wailuku, Kula, Honua`ula and other Moku, strong support was voiced for initiating and implementing a Native Hawaiian consultation process for the WUDP. The consultation implies two-way communication and influence between agencies and stakeholders. Representatives of the Kula moku (in the Central ASEA) were active participants in development of the WUDP and invited MDWS representatives to participate in their regional moku meetings. The intent is for the consultation process to continue as new site specific source development and resource use projects are developed.

Water Quality

Issue and Background: Contaminants primarily from many urban and agricultural land uses pose a risk to freshwater supplies. Atrazine is an herbicide associated with sugarcane cultivation that is detected in irrigation wells in the Pā`ia and Kahului Aquifers. Herbicides that were used decades ago in pineapple cultivation is still detected in Pā`ia Aquifer wells. As new sources are developed to meet projected demand, it is important to consider current and historic land uses of the underlying aquifer to avoid contamination of wells and associated treatment costs. Well siting and wellhead protection are addressed under island-wide strategies #6 "Implementing well siting criteria to avoid contaminated groundwater supplies and unnecessary risks to public health" and #7 "Adopt wellhead protection measures for potable wells."

15.8.2 Conservation

Input from the WUDP public process and issues identified in the community plans relate to water shortages and conservation:

- Reliance on surface water Upcountry makes the system vulnerable to drought conditions.
- Voluntary and mandatory water use restrictions imposed on residential and agricultural users during droughts often negatively impact the productivity of farmers
- Promote conservation of potable water through use of treated wastewater effluent for irrigation.
- Reuse treated effluent from the County's wastewater treatment system for irrigation and other suitable purposes in a manner that is environmentally sound.
- Provide incentives for water and energy conservation practices.
- Promote energy conservation and renewable energy.
- Incorporate drought-tolerant plant species and xeriscaping in future landscape planting.

Qualitative criteria to evaluate and measure resource strategies against this planning objective include:

- Per capita water use decreased
- Potable and irrigation systems water loss decreased
- Community water education increased
- Incentives for water conservation increased
- Renewable energy use increased

Issue and Background: The recommended supply and demand side conservation strategies outlined in Section 12.2 apply island wide. Development projects in the Central ASEA represent about 8.4 mgd, not accounting for projects located in the Wailuku ASEA. A large portion of the demand is for irrigation of single family home landscaping and common areas. Outdoor use is generally higher in Kahului, Mā`alaea, Kīhei and Mākena. These areas are dry microclimates with less than 15 inches of rainfall per year. There is great potential for further conservation targeting residential and commercial irrigation using potable water supply.

The Upcountry region has experienced voluntary and mandatory conservation measures for decades, primarily in dry season when the MDWS Upcountry System reservoir levels are low. Reliance on surface water and constraints in developing additional groundwater causes the system to be vulnerable to droughts.

Demand Side Conservation Measures

Demand side conservation strategies recommended in Section 12.2 that would target outdoor uses of potable water include comprehensive water conservation ordinance to include xeriscaping regulations, landscaping and water efficient irrigation system incentives.

In evaluating cost-effectiveness, MDWS compared the costs to develop and deliver new sources of water to meet future demand with the savings attributed to conservation. A preliminary analysis of the proposed conservation measure portfolio outlined in Section 12.2 shows that doubling current investments (MDWS annual FY14 – FY17 conservation budget, excluding leak detection is $170,000) would result in net capital and operational savings. The potential for a net savings is expected for both the MDWS Central System and the Upcountry System due to the need for new source development.

Recommended demand side conservation measures at all levels and type of use for public water systems are outlined in table 13-1 (strategies # 10 – 25). There is an opportunity to design and implement conservation measures in new housing development throughout planned growth areas. The recommended conservation Strategies #17, 22 and 25 outlined in Table 13-1 are implemented in the design and build phase and are especially appropriate in planned growth areas:

- Revise county code to require high efficiency fixtures in all new construction. Develop a comprehensive water conservation ordinance to include xeriscaping regulations.
- Revise County Code: Water conserving design and landscaping in new development (xeriscaping targets dry areas).
- Revise County Code and/or incentivize water- efficient building design that integrates alternative sources (grey water, catchment).

Supply Side Conservation Measures

The sustainable and efficient use of water resources, as well as the capacity and integrity of water systems, can be improved by accounting for water as it moves through the system and taking actions to ensure that water loss is prevented and reduced to the extent feasible.

A water audit provides a data driven analysis of water flowing through a water system from source to customer point-of-service and is the critical first step in determining water supply efficiency and responsible actions to manage and reduce water loss consistent with available source, operational and financial resources.[68]. Comprehensive audits for all MDWS systems are performed annually. Public water systems serving a population of 1,000 or more and those within water management areas regardless of population served are required to submit annual water audits beginning July 1, 2020. Except for the MDWS systems, there are no large public water systems in the aquifer sector subject to the requirement. The fiscal year 2017 audit for

[68] USEPA. Using Water Audits to Understand Water Loss. A Joint Presentation of the USEPA Office of Groundwater and Drinking Water and the American Water Works Association, 1/26/2012. https://www3.epa.gov/.../waterinfrastructure/docs/water-audits_presentation_01-2012.pdf *Accessed March 29, 2017.*

the Upcountry system revealed that apparent water losses are often due to data gaps between the amount of water withdrawn at the source, treated, stored and billed. The results will guide MDWS data collection, maintenance and repair programs. Part II Strategy # 28 addresses water system maintenance and operations to minimize sources of water loss.

Agricultural Water Systems Water Loss Mitigation

Issue and Background: The East Maui Irrigation (EMI) System is the only conveyance infrastructure of Ko`olau ASEA surface water to agricultural uses in Central Maui. Public concerns were voiced over the EMI system falling into disrepair, inefficiencies due to unlined storage reservoirs and system losses. In the East Maui Streams Contested Case, system losses were assessed to about 22 percent. As sugarcane cultivation is transitioned to other uses, EMI continues to maintain the system and keeping the main ditches functional even with reduced volume flow. CWRM in its June 2018 decision encourages HC&S to seek to make its storage and delivery of water to its fields more efficient to increase the productive yield of the irrigation water from East Maui. Raw water storage reservoirs are subject to state rules established by the State Department of Land and Natural Resources and stricter insurance requirements. The liability and associated costs impede refurbishment of privately owned reservoirs.
Any major infrastructure upgrades will require creative funding such as private-public partnerships with county or state contributions. The current county administration is considering pipe installation in unlined ditches and county ownership of the system. The island wide Strategy # 35 in Chapter 12 is further defined to apply to the EMI system:

Strategy #1: Explore funding and conduct a cost benefit analysis of improvements to the EMI non-potable conveyance system to mitigate losses and preserve existing reservoirs at risk of decommissioning. County of Maui and A&B Properties/EMI Company in partnership would lead initiatives. Priority components and associated costs TBD.

15.8.3 Conventional Water Source Strategies

Conventional water sources include groundwater (wells and tunnels) and surface water (stream diversions).

Planning objectives related to groundwater and surface water source use and development identified in the WUDP update public process include:

- Manage water equitably
- Provide for Department of Hawaiian Homelands needs
- Provide for agricultural needs
- Protect cultural resources
- Provide adequate volume of water supply
- Maximize reliability of water service
- Minimize cost of water supply

Planning objectives and policies related to water availability and use identified for the region include:

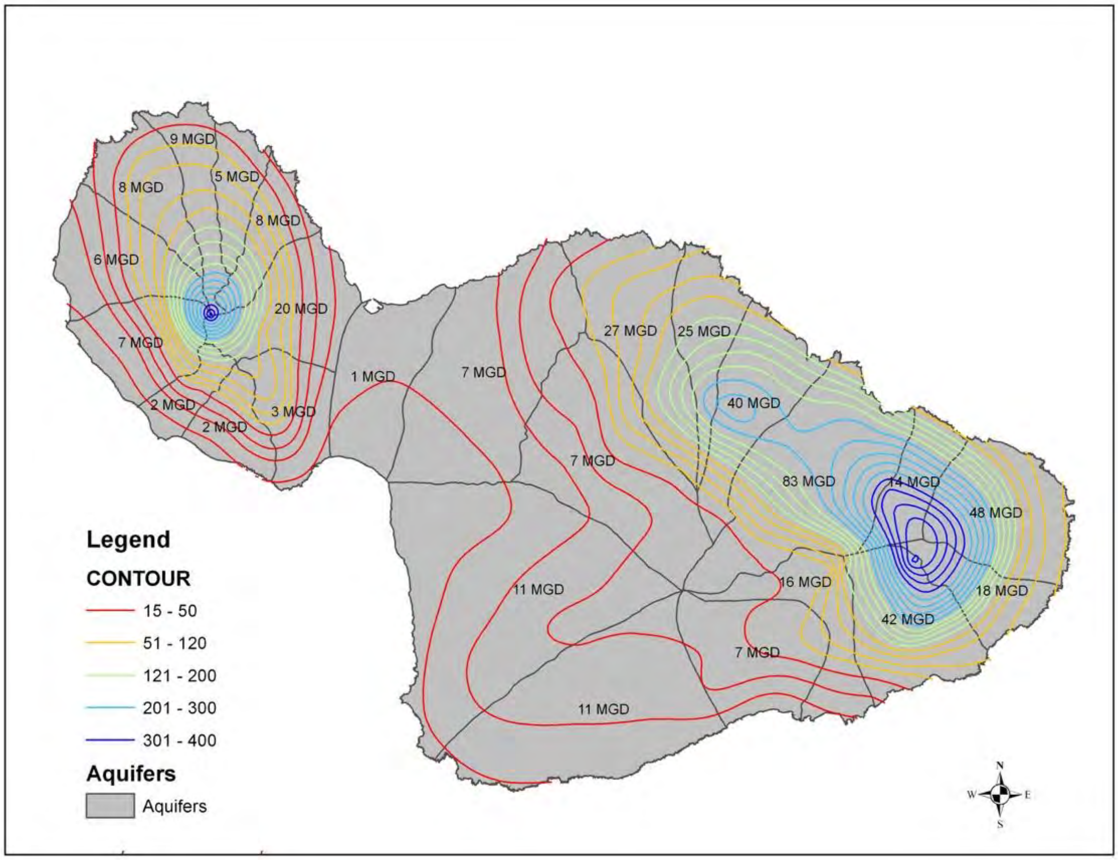
- Coordinate water system improvement plans with growth areas to ensure adequate supply and a program to replace deteriorating portions of the distribution system. Future growth should be phased to be in concert with the service capacity of the water system.
- Coordinate the construction of all water and public roadway and utility improvements to minimize construction impacts and inconveniences to the public.
- Coordinate expansion of and improvements to the water system to coincide with the development of residential expansion areas.
- Adequate water supply to support Upcountry agriculture.
- Priority for available water (Upcountry) is agriculture and DHHL.

Groundwater Availability Issues

The amount of groundwater that can be developed is limited by the amount of natural recharge and aquifer outflow that contribute to streamflow and to prevent seawater intrusion, established as sustainable yield. Because delineation of aquifer sectors and systems in some cases are based on limited hydrologic information, areas for potential groundwater development must be assessed to determine whether there is a need to conduct hydrologic studies or whether there is adequate information available to develop new water supplies. The primary responsibility to determine interaction with surface water and other sources lies with the State CWRM who in turn relies on studies and predictions by the scientific community and other agencies. Water purveyors need guidance how to mitigate and adjust to potential changes in groundwater availability.

Other constraints on groundwater availability include access and cost. Conveyance from high yield aquifers in remotely located watersheds to growth areas can be difficult and expensive due to topography and distance. The Central ASEA consist of the driest regions on Maui, with annual rainfall generally less than 50 inches. Population centers and growth rely on groundwater imports from the Wailuku ASEA and the Ko`olau ASEA where rainfall and groundwater recharge are substantially higher.

Figure 15-31 Rainfall Isohyets (inches per year) and Aquifer System Sustainable Yields



Infrastructure Availability Issues

Residents believe a water availability rule is critical to maintain water availability in a sustainable fashion. The County Availability Rule, Maui County Code Section 14.12 applies to the MDWS systems. The rule only addresses residential developments. On January 28, 2018 the MDWS adopted administrative rule 16-201 with the purpose to provide uniform handling of applications for water service. The rule applies to all MDWS systems, except the Upcountry system. The administrative rule resolves some of the loop holes and concerns associated with the County Availability Rule Chapter 14.12. The MDWS Upcountry System is subject to the Water Meter Issuance Provisions codified in Chapter 14.13 of the County Code.

The Upcountry Priority List

Issue and Background: In 1993, the MDWS determined that the existing Upcountry water system was found to have insufficient water supply developed for fire protection, domestic and irrigation purposes to add new or additional water services without detriment to those already served. MDWS created a list of Upcountry properties, by date of application, who requested new and additional water service. In 2002, an administrative rule "Water Meter Issuance Rule for the Upcountry Water System", Title 16, Chapter 106 was created. The rule outlined the procedure for processing applications for water service. New applicants were continually added to the list until provisions were codified in 2013 so that no new applications were accepted after the 2013 provisions became effective. A 2015 ordinance provided certain fire protection exemptions. Still, about half of meter offers are declined presumably due to the expense of required system improvements. The Priority List is estimated to represent an additional 3.7 – 7.3 mgd demand on the Upcountry system as a whole. There are about 1,800 requests for 4,300 meters (excluding those that did not accept a reservation offered, accepted a reservation, or where a meter was installed) for 1,900 dwelling units and a nominal number of commercial units. About two-thirds of the remaining requests are located outside designated growth areas. There remains uncertainty over the number and timing of new meters as well as occupancy.

Sources for requests in Ha`ikū are primarily served by basal wells with sufficient backup capacity to reliably add new services. Sources for requests on the Lower and Upper Kula subsystems are East Maui streams in the Waikamoi area that are subject to Instream Flow Standards and vulnerable to drought. Groundwater from Po`okela Well in Makawao Aquifer can supplement the Lower and Upper Kula subsystems. There remains uncertainty over the number and timing of new meters as well as occupancy.

Providing reliable capacity to satisfy the Priority List could be accomplished in alternative ways:

1. Develop basal wells to provide reliable capacity and assume significantly higher cost of service due to energy required to pump up to 4,000 foot elevation.
2. Separate the Priority List by service area and source, so that subsystems with adequate and reliable capacity are prioritized over subsystems reliant on surface water.
3. Public-private partnerships to develop source and infrastructure that benefit end users of the same subsystem.

Altering the priority list processing would require code changes and would without doubt cause opposition by applicants that would not benefit from such changes. The recommended strategy is assessing the various options of restructuring and processing the list while moving forward with needed source development.

Strategy #2: Assess alternative options to restructure and process the existing Upcountry Meter Priority List to improve processing rate and adequate source development. Lead agency is MDWS.

<u>Groundwater Development to Meet Population Growth</u>

Issue and Background: Groundwater resources will meet most of the potable demand that is served by the MDWS Central System. Source development needs for this system was addressed in the Wailuku ASEA Report. Remaining potable demand in the Central ASEA is either served by small privately owned systems or the MDWS Upcountry System.

Private municipal demand and Department of Hawaiian Homelands (DHHL) potable demand in the Kahului Aquifer, totally projected to about 2.09 mgd can probably be met with modest groundwater withdrawals from Kahului, Pā`ia and Kama`ole aquifers. DHHL potable demand in the upper Kama`ole aquifer (Kēōkea/Waiohuli) of 0.81 mgd may be met with Kama`ole aquifer groundwater or the MDWS Upcountry System.

The table below compares the following:

1. Installed pump capacity, which includes backup wells and unused capacity, and rated surface water treatment plant capacity
2. Source Capacity, limited by water system standards
3. Projected municipal water use in Central ASEA and the "lower" Kama`ole Aquifer; the "upper" Kama`ole aquifer which excludes the MDWS Upcountry System
4. Projected demand for the MDWS Upcountry System and the Upcountry Meter Priority List

Table 15-34 Groundwater Source Development to Meet Population Growth-Based Municipal Demand - Central ASEA and the MDWS Upcountry System 2035 (mgd)

Aquifer System (Sustainable Yield)	Installed Pump Capacity	Source Capacity*	2035 Municipal Demand
Kahului (1)**	1.58	0.84	2.09
Pā`ia (7)	0.216	0.216	
Kama`ole (11)	0.86	0.43	
	0.00	0.00	0.81
Subtotal Central Excl. Upcountry System	**2.66**	**1.50**	**2.90**
Pā`ia (7)	1.65	1.5	8.53
Makawao (7)	1.85	1.3	
Ha`ikū (27)	2.61	1.4	
Surface Water Treatment Plant Capacity	13.00	7.00	
Upcountry Meter Priority List			7.3
Unmet needs			**-4.63**
Upcountry System and Priority List	**19.11**	**11.2**	**15.83**

Source: MDWS Water Resources & Planning Division, 2018. Numbers may not add up due to rounding
*Water System Standards/Contingency wells
**excl. Maui Lani wells, serving MDWS Central System

As shown in the table, groundwater source development and/or surface water imports are needed to meet population growth-based municipal needs and the Upcountry Meter Priority List. Upcountry Maui (Kula, Makawao and Pukalani) that rely on surface water are particularly at risk to drought and its' impact on water supply. Although technically feasible, development of sufficient new basal wells to meet 100% of projected demand in the MDWS Upcountry system along with booster pumps, the high capital and pumping costs makes this option economically less desirable. A preferred option is to operate ground and surface water resources in the most economical manner during normal conditions with sufficient groundwater contingency source to supplement available surface water during droughts. This strategy is consistent with measures recommended for Upcountry by the Maui Drought Committee.[69] Ha`ikū and Makawao aquifers are preferred options based on available yield, elevation and connection to the existing distribution system.

Source Development for the MDWS Upcountry System

Recent amendments to the Interim Instream Flow Standards (IIFS) on East Maui streams results in decreased base flows in the Wailoa Ditch which is the source of water for the Kamole Water Treatment Facility (WTF). Even with decreased off-stream needs in the transition from sugarcane cultivation to diversified agriculture, water shortage in droughts will likely continue as long as the system relies on surface water as the primary source. Typically, during drought conditions, average daily demand per user increases. Peak demand for projected needs must therefore be accounted for to ensure reliable supply. The potential demand of fulfilling 100 percent of the Upcountry Meter Priority List is conservative as historically about 50 percent of meter applications on the List result in meter installations. Hence, peaking demand is only factored into projected demand based on population growth: 8.53 mgd. In a 2013 MDWS Study to Determine the Source Capacity of the Existing Water System peak daily demand for the system was identified as 11.6 mgd.[70] A "peaking factor" of about 20% is added in calculating source development needs.[71] Actual peak demand is calculated in the engineering analysis for an individual well site, pump size and service area.

In the 2013 study, the reliable capacity of the Upcountry System was determined to be 9.7 mgd. Adding the Hāmākuapoko wells in Pā`ia Aquifer of 1.5 mgd source capacity, the reliable capacity is 11.2 mgd, as shown in the table above.

Adding 20% to projected 2035 demand of 8.53 mgd for Upcountry is 10.23 mgd. With the addition of the Priority List demand of 7.3 mgd, total demand is 17.54 mgd. Available source capacity is 11.2 mgd, which would require the balance 6.34 mgd to be developed.

8.53 mgd 2035 Municipal Demand + Peak Factor 20% = 10.23 mgd
+ Upcountry Meter Priority List 7.3 mgd = 17.54 mgd
- 11.2 mgd Available Source Capacity
= 6.34 mgd Source Needed

Assumptions in the 2013 MDWS study were 50 percent of applicants on the List declining water meters due to the cost of required improvements or other reasons. Since the 2013 study,

[69] Wilson Okamoto Corporation, County of Maui Drought Mitigation Strategies, 2012 Update
[70] MDWS, 2013 Water Source Development Options Report for the South-Central Maui and the Upcountry Maui Areas
[71] MDWS, 2013 Water Source Development Options Report for the South-Central Maui and the Upcountry Maui Areas

amendments to the County Code have eased the financial burden on applicants which potentially could result in a higher percentage of meter acceptance.

A combination of increased source using the Hāmākuapoko wells, increased use of boosting surface water from to maintain raw water reservoirs levels at the Pi`iholo and Olinda water treatment facilities will support increased demand to a certain degree. New ground water source capacity will need to be developed to provide reliable service over the 20-year planning period. Preliminary groundwater source strategies for Upcountry included two candidate aquifer systems: Makawao and Ha`ikū.

Makawao Aquifer Well Development

Hydrological studies of Makawao Aquifer are limited. The State Department of Land and Natural Resources are currently developing a well in the Hanamu area at about 2,000 foot elevation. The existing MDWS Po`okela well at 1,820 foot elevation produces excellent water quality. With the addition of Po`okela Well B as a backup well, the primary well can be utilized permanently adding reliability to the system. Pumping deep wells (near sea level) to the high elevation and further boosting the water uphill to service areas involves higher electrical power consumption. In addition to high pumping cost, the depth of well pumps adds some complexity to development and maintenance. Historic pineapple cultivation has resulted in chemical contamination of certain areas of the aquifer. Well development upgradient of former pineapple fields increase pumping costs. Areas suited for well development and connection to existing infrastructure would not likely support the full source needs of 6.34 mgd. The 2013 MDWS study estimated well development at 2,050 foot elevation and related booster pump and transmission line to about $8.4M and a 20-year cost of $2.90 per 1,000 gallons for development of 1.2 mgd pump capacity, normally run at 0.8 mgd source capacity. The study only evaluated a scenario with one well in Makawao Aquifer and in combination with well development outside Makawao Aquifer.

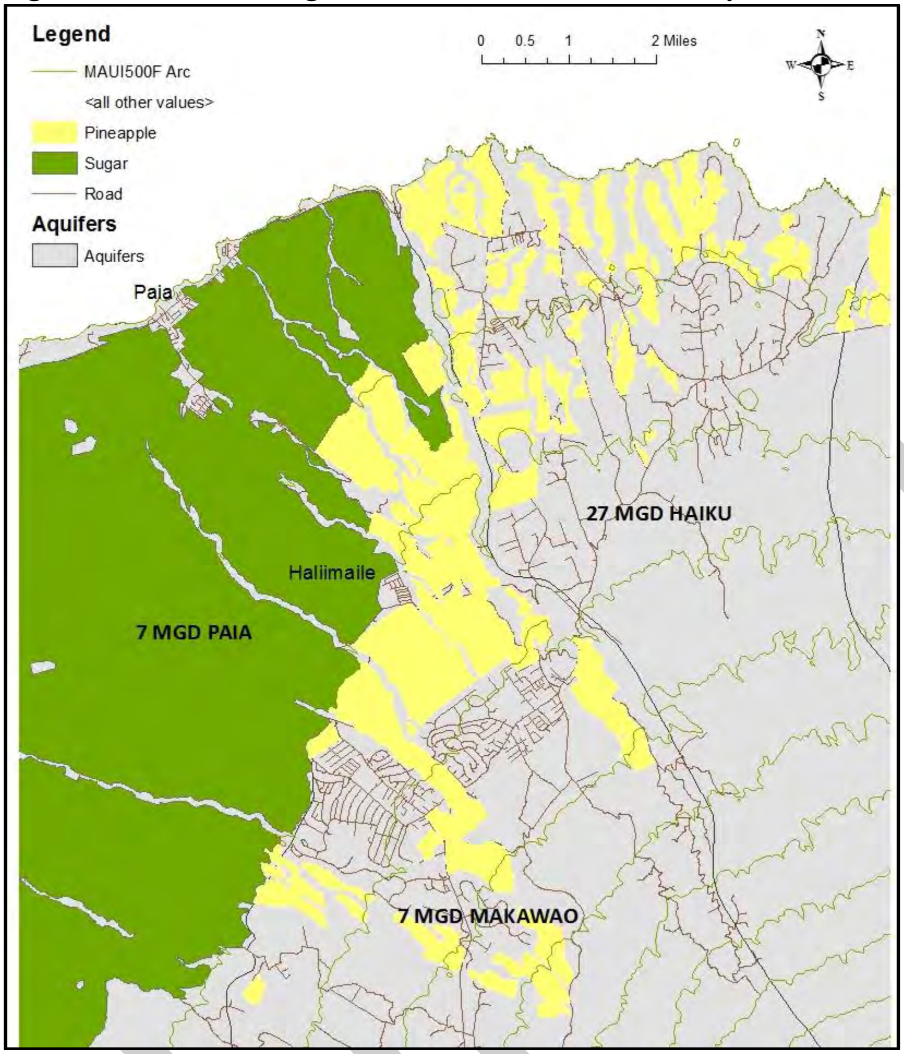
Strategy #3: Explore new basal well development in the Makawao Aquifer to accommodate growth Upcountry and add reliable new source. Potential yield is up to 3 mgd. Lead agency is MDWS, DLNR and/or public/private partnerships.

Ha`ikū Aquifer

The Ha`ikū Aquifer sustainable yield is sufficient to provide new basal groundwater well development. Subsequent to the 1990 WUDP, long range water development plans included well exploration in the Pā`ia and Ha`ikū aquifers. The plans were stopped by lawsuits raising claims about impact on stream flows. The 2003 Consent Decree essentially put a halt to groundwater development in the subject area. The plaintiffs in the case allowed only phase 1 of the East Maui Water Development Plan to be implemented, which included the Hāmākuapoko wells, located in the Pā`ia Aquifer. Since 2003 there have been multiple assessments and cost benefit analyses conducted to explore groundwater development outside the Consent Decree area in the Ha`ikū Aquifer and alternative options. Various configurations of eastward basal groundwater development were assessed in the 2004 – 2009 WUDP Upcountry DWS District Plan update. Well at 1,300 foot elevation and 1,800 foot elevation were explored. Booster pump upgrades were assumed to be installed as necessary to move water to higher elevations.

Well development and transmission from Honopou and Waikamoi aquifers were not considered as candidate strategies in the 2007 or the 2016 public process. In examining the economics of well and transmission installation at various elevations, the capital cost of extensive transmission dominates in all cases. Wells at higher elevation require additional cost to pump water but avoid potential treatment costs for pesticide contaminants associated with previous pineapple cultivation. DBCP (1,2-Dibromo-3-chloropropane) and TCP (1,2,3-Trichloropropane) are currently detected in Ha`ikū Aquifer wells below approximately 1,500 foot elevation. The higher cost associated with developing wells at higher elevation is a trade-off to avoiding the costs and risks of contaminated aquifers at lower elevations.

Figure 15-32 Historic Agriculture in Ha`ikū and Pā`ia Aquifers



Source options and strategies for the MDWS Upcountry System were analyzed by MDWS engineering in the 2013 "Water Source Development Options Report for the South-Central Maui and the Upcountry Maui Areas". The Ha`ikū Aquifer is abundant in source capacity, the study recommended Ha`ikū Aquifer the prime candidate. [72] A scenario to develop 5.3 mgd between five wells in Ha`ikū Aquifer and one well in Makawao Aquifer, and related transmission, tanks and booster pumps was assessed to $53.3M. The cost to upgrade existing booster pump stations and to replace the existing Kula transmission line and Omaopio Tank was assessed to $20.8M. Total cost of improvements of the Upcountry Water System would be $74.1M. 20-year projected life cycle cost was $4.50 per 1000 gallons.

[72] MDWS, Water Source Development Options Report for the Central-South Maui and the Upcountry Maui Areas, 2013

The Ha`ikū Aquifer has been marginally developed and no extensive hydrologic study undertaken. Whether perched water, a higher level groundwater storage above the basal lens, is what feeds the streams must be evaluated by a hydrologic study and monitoring wells. In the 2016 public review of preliminary strategies, the need for hydrologic studies of the Ha`ikū Aquifer was emphasized. Compliance with the terms of the East Maui Water Development Plan Consent Decree is necessary.

Strategy #5 in the Wailuku ASEA Report to continue exploration of East Maui well development for the MDWS Central System can theoretically serve a dual purpose to include source for the MDWS Upcountry System. Interconnection could provide a limited amount of redundancy of production equipment. However, this is of limited value since the Upcountry System is limited by source water capacity in drought rather than redundancy. New resources are necessary to meet demand. The 1995 Pā`ia-Ha`ikū Community Plan's objective "Ensure adequate supply of groundwater to residents of the region before water is transported to other regions of the island" is not assumed to preclude groundwater development that benefit the Upcountry System as a whole.

Strategy #4: Explore East Maui well development in combination with Makawao Aquifer basal groundwater to meet projected demand on the MDWS Upcountry System. Initiate a hydrologic study to determine any negative impact on existing ground and surface water sources, stream flow and influences from dikes. Potential yield is more than the needed 6.3 mgd (potentially in addition to development for the MDWS Central System). Lead agencies would be CWRM and MDWS and hydrologic study to be completed by USGS.

<u>Pā`ia Aquifer</u>

The Pā`ia Aquifer was not considered as a preliminary strategy for potable source in the public process for the WUDP update. Most of the aquifer underlies agricultural land previously in sugarcane or pineapple cultivation. The Maunaolu well, serving a public water system, and the Hāmākuapoko wells, serving the MDWS Upcountry System, require additional Granular Activated Carbon (GAC) treatment to remove chemical contaminants detected in the aquifer. Such additional treatment may be warranted where infrastructure is limited to serve individual projects. The Old Maui High School Campus Revitalization Project is not within the MDWS Central System or Upcountry System service areas. Well development with anticipated GAC treatment is a costly but a potential source option.

The 825 unit planned Hali`imaile Development could also be served by existing wells or new well development in the Pā`ia Aquifer. However, nitrate treatment may be necessary in addition to GAC considering high nitrate levels in nearby wells. It is not recommended that potable source with multiple treatment requirements is pursued if the project can be served by alternative sources outside the Pā`ia Aquifer. It is assumed that the Hali`imaile Development is included in population growth based projections for the region.

The Hāmākuapoko wells can only be used with certain caveats defined in Maui County Code 14.01.050. Water can be used as a backup to the MDWS Upcountry System, when a water shortage is declared, or for agricultural purposes. Although the source capacity of the wells is 1.5 mgd, it is assumed to be used 50% of the time in the future, providing 0.75 mgd supply to the MDWS Upcountry System.

Strategy #5: Explore Pā`ia Aquifer for non-potable demand, and potable use with additional treatment as necessary to serve projects included in the Maui Island Plan that cannot feasibly be serviced by MDWS source and infrastructure. Estimated demand for the Maui High School Campus is about 0.75 mgd. Lead agency is Maui County.

Kama`ole Aquifer Well Development

Kama`ole Aquifer is geographically divided with the communities of Kēōkea and Ulupalakua roughly above 2,000 foot elevation and the Kīhei to Mākena communities roughly below 500 foot elevation. Water is brackish to semi-brackish in the coastal area and can continue to provide non-potable supply to meet irrigation demand in Kīhei, Wailea and Mākena areas.

Water quality and yield are uncertain at higher elevations. As stated in Chapter 15.6.3, DHHL's Kēōkea/Waiohuli project has planned potable water needs of about 0.809 mgd within the State Water Projects Plan time frame. A 1997 agreement for 0.5 mgd potable water from the MDWS Upcountry System is not sufficient to meet projected demand. An exploratory well at the 1,900 foot elevation is developed in the Kama`ole Aquifer that is a feasible option. The WUDP does not adjust DHHL's planned strategy for potable source from the exploratory well and remaining credit from the MDWS Upcountry System. It is assumed that about 0.3 mgd will be needed from Kama`ole Aquifer.

Groundwater Development to Meet Irrigation Needs

Issue and Background: Most of groundwater withdrawn for irrigation purposes are from Kama`ole Aquifer. Future demand for golf course, resort and landscaping irrigation are projected to increase from 3.68 mgd to 5.59 mgd over the planning period. About 0.7 mgd of R-1 water can be used from the Kīhei Wastewater Reclamation Facility. Remaining demand is assumed to come primarily from Kama`ole Aquifer, and from Kahului and Pā`ia Aquifer existing wells.

The only reported irrigation use in Makawao Aquifer is the Pukalani golf course, which also uses reclaimed wastewater. No expanded use is proposed. Non-potable use of the Opana/Awalau tunnel and spring serve primarily agricultural uses Upcountry and possibly a limited number of irrigation needs. Any expanded use of this source is discussed under source development for agricultural demand below.

Strategy #6 in the Wailuku ASEA Report, Chapter 14.8.3 relates to irrigation demand in the Central ASEA: Basal groundwater imported from Wailuku ASEA to serve the MDWS Central System throughout Kahului and South Maui is generally of excellent quality, which should be prioritized for potable uses. Using brackish, semi-brackish and otherwise compromised quality water for non-potable uses can be achieved through dual distribution systems and increased use of alternative resources for non-potable demand. Strategy #6 calls for reducing non-potable uses of Wailuku basal water by prioritizing available R-1 water from the Kīhei Wastewater Reclamation Facility and brackish groundwater from Kama`ole and Kahului Aquifers. The strategy can be implemented through land use permit approvals, expansion of the recycled water distribution system and requirements, and improved water use data for Kama`ole and Kahului Aquifers.

Groundwater Development to Meet DHHL Non-Potable Needs

As stated in Chapter 15.6.3, DHHL's Kēōkea/Waiohuli project has planned non-potable water needs of about 0.578 mgd within the State Water Projects Plan timeframe. Non-potable water is proposed to be supplied by the Upcountry Maui Irrigation System, which would be untreated surface water from the existing Kahakapao Reservoir. The DHHL recommends a coordinated effort be undertaken between DHHL, DOA and MDWS to determine the feasibility of utilizing the Upcountry Maui Irrigation System to supply the non-potable demands and, if so, to ensure that costs of the Kēōkea lateral are reflected in the AWUDP. All surface water currently diverted to the Kahakapao reservoir is used by the potable MDWS Upper Kula system. Because the project sponsors determine to discontinue construction and funding of the project, on site Kama`ole groundwater may be necessary.

Groundwater Development to Meet Agricultural Needs

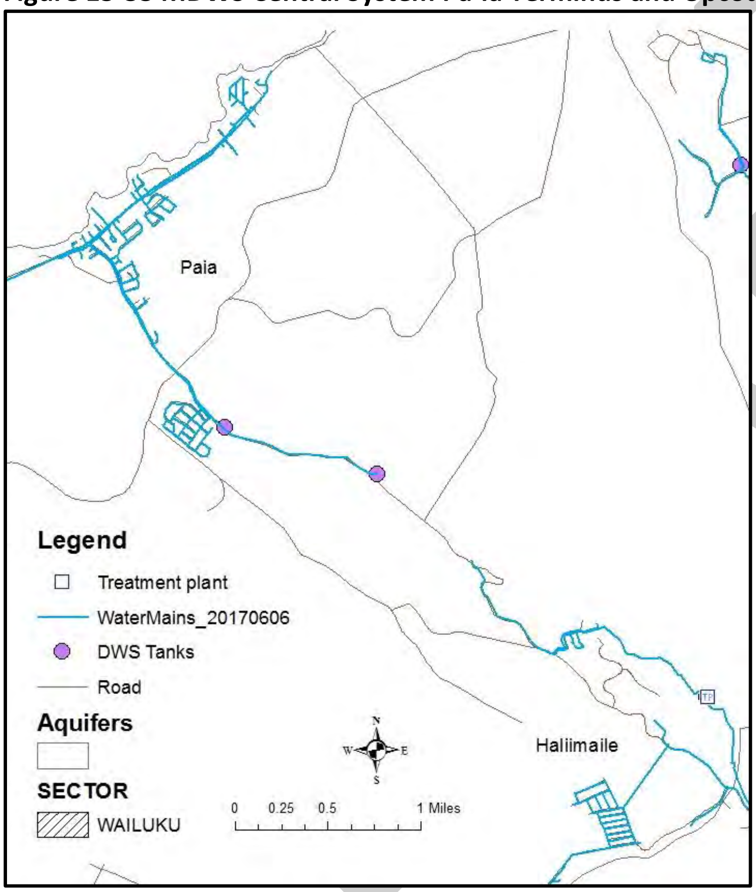
Issue and Background: Agricultural irrigation has historically relied on affordable untreated surface water and plantation distribution systems. Affordable and reliable water supply to support agriculture is consistent with general plan policies and community plan objectives. Based on public input, agricultural water use needs to be more efficient and should increasingly consider ambient rainfall and climate appropriate crops. A diversified supply is needed that combines sufficient reservoir storage to take advantage of high stream flows in wet season and to capture stormwater and regional rainfall, with non-potable groundwater as contingency in long-term drought periods. It is cost prohibitive to develop municipal potable groundwater and infrastructure capacity as contingency for agricultural zoned land. Expansion of cultivated agricultural land cannot be serviced by municipal potable supply but should identify alternative contingency sources.

The transition from sugarcane cultivation to diversified agriculture on the central isthmus has unknown impacts on groundwater availability in Kahului and Pā`ia Aquifers. In consistency with CWRM's June 2018 decision of the East Maui Streams Contested Case, it is assumed that brackish water from existing HC&S wells and shafts will be needed for up to 17.84 mgd. No new basal groundwater development is proposed. As recommended in the WUDP Chapter 12.3, the pending update of the Agricultural Water Use & Development Plan should address and coordinate with industry stakeholders alternative sources of irrigation water including wastewater reuse, recycled stormwater runoff, and brackish well water.

Groundwater Reliability and Efficiency: Interconnection of the MDWS Central System and Upcountry System

The MDWS Central System and the Upcountry System are not connected and are served by separate sources. The Central System ends above Skill Village in Pā`ia and the Upcountry System terminates approximately 2,000 feet further mauka on Baldwin Avenue.

Figure 15-33 MDWS Central System Pā`ia Terminus and Upcountry System Hali`imaile Terminus



Interconnecting the two MDWS systems could provide improved reliability and operational economics. Costs and benefits were analyzed by Ha`ikū Design and Analysis.[73]
The June 2018 Decision for East Maui Streams Contested Case does not preclude HC&S from diverting stormwater, available in periods of ample rainfall. Maximizing the use of surface water in wet season could provide economical water production for the Central System. This option would not displace the need to develop source for the MDWS Upcountry System. Using surface water generated in Ko`olau ASEA to support population growth in the Kahului-Wailuku

[73] Haiku Design & Analysis, Maui County Water Use and Development Plan Candidate Strategies Central District Preliminary Draft, September 12, 2006.

or Kīhei-Mākena Community Plan areas appears to conflict with the following objective in the 1996 Makawao-Pukalani-Kula Community Plan: "Restrict the use of any water developed within or imported to the Upcountry region to consumption within the Upcountry region, with exception provided for agricultural use."

The source for the Central System is groundwater and the Upcountry source at the terminus is surface water from the Wailoa Ditch, treated at the Kamole Weir Water Treatment Facility. Introducing surface water to the distribution system in Pā`ia have unknown impacts on water quality. Surface water can be more acidic and corrosive than groundwater which may cause leaching from lead plumbing in older homes. Strategy #7 in the Wailuku ASEA Report, Chapter 14.8.3 recommends monitoring of IIFS, available ditch flow and water quality implications of blending the water sources to determine the viability of interconnection.

Surface Water Use and Development

Surface water transport, use and allocation have been the focus for agriculture Upcountry and in Central Maui, and for growth in the Upcountry region. Objectives related to surface water use and development Upcountry include:

- Seek expanded municipal withdrawal from the lowest cost source to serve the Upcountry region.
- Support the development of separate domestic and irrigation water systems. Encourage the construction of additional storage capacity by the Department of Water Supply, commercial developers, and individual farmers to help alleviate the inadequate water supply.
- Encourage cooperative efforts among Federal, State, and County agencies, and developers to ensure that water storage and delivery needs of the region are met in a timely and orderly manner.
- Ensure that the development of new water sources does not adversely affect in-stream flows.
- Increase water storage capacity with a reserve for drought periods.

Surface Water Allocation for Agricultural Needs

Issue and Background: The diverted streams in East Maui are not in a designated surface water management area. That means that CWRM does not allocate off-stream uses by water use permits. Water for off-stream uses is licensed by the Board of Land & Natural Resources (BLNR). The State Water Code states that each county shall adopt a WUDP that sets forth the allocation of water to land use. The State Water Code and the Maui County Code do not explicitly provide any authority to implement or enforce water allocations. The WUDP serves to both guide land use decisions and to implement the County General Plan. Water resources and infrastructure to meet future agricultural irrigation needs are also under the purview of the Agricultural Water Use and Development Plan, currently under update.

The history and background of the East Maui Streams Contested Case was addressed in the WUDP Introduction Chapter 5.3 and Ko`olau ASEA Report Chapter 16.2. Since the WUDP chapter for the Ko`olau ASEA was published for review, CWRM issued their decision in the Contested Case over East Maui Streams and established Interim Instream Flow Standards (IIFS). CWRM continues to allow some streams to be diverted, which includes freshets and stormwater. Streamflow under various conditions that would be available to divert after meeting established IIFS based on the June 20, 2018 Findings of Fact, Conclusions of Law and Decision and Order (FoF, CoL and D&O) were assessed in Chapter 15.7.4. Not all of projected irrigation water needs under A&B Properties/HC&S's Diversified Agriculture Plan will be met based on median base flow from the streams that can continue to be diverted. It is expected that a sufficient amount of water would be available (after meeting IIFS) to provide the initial phase of diversified agriculture on designated Important Agricultural Lands.

Tentatively, about 28 mgd of base flow is estimated to be available from Wailoa Ditch under normal conditions. Uses include MDWS municipal needs, the Kula Agricultural Park and A&B/HC&S diversified agriculture. However, because freshets and stormwater are allowed to be diverted, much more would potentially be available to divert during "normal", or wet season conditions. An agreement between A&B and MDWS is needed to allocate Wailoa Ditch water under the established IIFS. If the current terms continue, MDWS would receive 12 mgd from Wailoa Ditch with an option for an additional 4 mgd, for a total of 16 mgd. During periods of low flow, MDWS receives a minimum allotment of 8.2 mgd and HC&S receive 8.2 mgd. If less is available both receive prorated shares of the water available.

Diversified Agriculture on HC&S Lands

CWRM established that the HC&S lands that are completely dependent on surface water require 28.28 mgd. With water losses the gross need is 36.59 mgd. The table below estimates the amount available for HC&S to divert from the streams subject to the June 2018 Decision, amount available from streams not subject to the contested case, and brackish groundwater according to the June 2018 Decision.

Table 15-35 Available East Maui Streams and Brackish Groundwater Resources for HC&S

Available Baseflow to Divert at Wailoa Ditch Q50 (Q90)	Streams West of Honopou to Maliko	Brackish (pro-rated based on total irrigation	Total Available Median Flow
20.35 (2.21)	8.00	17.84	46.19

In the June 2018 Decision, CWRM's best estimate is that IIFS provides for about 90 percent of the irrigation needs for lands designated Important Agricultural Lands.[74] Because ditch flow for offstream uses is not addressed in the decision, it is difficult to identify available flow from Wailoa Ditch as a whole. According to provided stream data and established IIFS, our calculations show that there would not be sufficient base flow under normal or drought conditions to meet HC&S's proposed needs. The total flow is estimated based on historic ditch flow and should be better informed through water use reporting under the new IIFS. HC&S has

[74] CCH-MA13-01 June 18, 2018 Findings of Fact, Conclusions of Law, & Decision and Order

not considered building additional or larger reservoirs. HC&S contracted a feasibility study for utilizing recycled wastewater from the Kahului Wastewater Reclamation Facility for use on fields served by Nā Wai `Ehā surface water. The study did not assess the cost of conveying recycled water to the fields served by East Maui surface water. Although alternative resources to potentially meet the proposed irrigation demand for the Diversified Agriculture Plan can be developed, HC&S deems alternatives cost prohibitive for viable agricultural pursuits. Alternative resources should be further explored as new crops are established and needs change over the WUDP planning period. Recycled water from the Kahului Wastewater Facility, and stormwater reclamation should be further scrutinized as viable options for agricultural irrigation in the update of the Agricultural Water Use & Development Plan and in land use permitting. This strategy (Strategy #4 in the Ko`olau ASEA Report, Chapter 16.8.3) applies both to Ko`olau and Central hydrologic units:

Strategy #6: Consider alternative sources of irrigation water including wastewater reuse, recycled stormwater runoff, and brackish well water in land use permitting to mitigate low flow stream conditions. Require alternative sources for irrigation when reasonably available in county discretionary land use permitting.

Kula Agricultural Park

Non-potable water for Kula Agricultural Park is pumped from HC&S reservoirs to the Park via the Upcountry Maui Irrigation System. Surface water from Wailoa Ditch bypasses the Kamole Weir Water Treatment Facility. An expansion of 373 acres is in progress, with 71 acres currently being farmed. There is 0.6 mgd from A&B Reservoir 40 available for the additional 302 unused acres under a 2002 agreement. Additional storage capacity and a long term source agreement are needed. Water delivery infrastructure funding will be sought from state and federal sources.[75]

Diversified Agriculture Upcountry

Farming Upcountry outside the Kula Agriculture Park generally uses municipal potable water supply for all irrigation needs. The Upcountry Maui Watershed Plan, initiated in 1997, proposed to install a separate agricultural water distribution system to supply untreated water for irrigation purposes to farmers in the Upper Kula area. The proposed water source, Kahakapao Reservoir, is the same storage system of Ko`olau diverted stream water that currently supplies the MDWS Upper Kula potable system. The surface water diverted at Waikamoi 4,000 feet elevation is available to service potable needs via gravity flow. The source is extremely valuable as the alternative, pumping ground or surface water uphill to serve existing needs is generally cost prohibitive but nevertheless subsidized both in terms of general and agricultural water

[75] Maui County Office of Economic Development presentation, Maui County Council Budget and Finance Committee, November 3, 2015.

rates. In October 2017, the project sponsors determined to discontinue the project, based on economics, project timeline and federal requirements. [76]

The Opana and Awalau surface water source located in the Ko`olau ASEA was described in the Ko`olau ASEA Report Chapter 16.5. An analysis by Ha`ikū Design & Analysis assessed the feasibility of expanding reservoir capacity and thereby the yield of the Opana/Awalau system for non-potable uses. A mass flow analysis determined the reliable yield of this source assuming several possible reservoir capacities. Because there were extended periods the analysis was based on providing "semi-reliable" yield in which the reservoir would be empty 10 percent of the time. Based on this analysis, it is not practical to provide drought period service reliability by expanding reservoir capacity. The yield of approximately 0.14 mgd is used by a partnership of agricultural users, including MDWS non-potable customers. It is recommended to continue and maintain this source as a non-potable water source.

Input from farmers in the region indicate that treated potable water is necessary to some extent due to Food and Drug Administration standards for produce. Potable water through the municipal system will still be needed.

In summary, agricultural irrigation needs Upcountry depend on reliable source that includes potable and non-potable water. A long term agreement that reflects the established IIFS and alternative ditch flows for the EMI system is required.

Strategy #7: Execute a long term source agreement for use and maintenance of the Wailoa Ditch that ensures adequate non-potable supply for the Kula Agricultural Park expansion and potable supply for projected MDWS Upcountry System needs over the planning period. Lead agencies are Maui County, MDWS and A&B Properties.

Surface Water Allocation for Municipal Needs

Issue and Background: Water provided by the MDWS Upcountry System is for municipal purposes. Current reliance on surface water for over 80 percent of freshwater supplies puts the Upcountry System at risk in extended droughts. Decreasing rainfall, whether as a result of long term droughts or climate change, has more immediate impacts on surface water flows making surface water vulnerable and generally less reliable over short-terms than groundwater. Groundwater is generally preferable to meet long-term reliable supply. Ha`ikū Aquifer has sufficient yield to supply projected growth Upcountry. However, well development in the Ha`ikū Aquifer must comply with the East Maui Consent Decree. The MDWS's efforts to initiate hydrologic studies and explore regional groundwater have been challenged. It is not certain that basal groundwater development in Ha`ikū Aquifer will be achievable. Makawao Aquifer yield cannot support the full projected need.

New source of about 6.3 mgd is needed to meet municipal needs and the Upcountry Meter Priority List. As stated earlier, the preferred option is to operate ground and surface water

[76] 10/4/17 USDA Soil & Water Conservation District letter

resources in the most economical manner during normal conditions with sufficient groundwater contingency source to supplement available surface water during droughts. This strategy is consistent with measures recommended for Upcountry by the Maui Drought Committee.[77]

MDWS relies on three surface water sources, one of which is delivered by EMI through the Wailoa Ditch, and the other two through two MDWS higher elevation aqueducts maintained by EMI that transport water to Olinda and Kula, under a contractual agreement originated under the 1973 East Maui Water Agreement and subsequent agreements.

Table 15-36 MDWS Upcountry System Surface Water Treatment Capacity

Water Treatment Facility	Elevation	Conveyance System	Production Capacity	Average Production
Olinda	4,200 feet	Upper Kula Flume	2.0 mgd	1.6 mgd
Pi`iholo	2,900 feet	Lower Kula Flume	5.0 mgd	2.5 mgd
Kamole Weir	1,120 feet	Wailoa Ditch	6.0 mgd	3.6 mgd

Recent amendments to the Interim Instream Flow Standards (IIFS) on East Maui streams result in decreased base flows in the Wailoa Ditch. Depending on future extent of droughts, the pace of increasing irrigation demand on the plantation and the utilization of brackish groundwater and other alternative sources, low flow conditions may not satisfy IIFS nor off-stream needs for periods of time that is difficult to predict. In drought conditions, both the Lower and Upper Kula systems require supplemental surface water from Kamole Weir and groundwater pumped up to 4,000 feet. Under current agreement with EMI, MDWS receives 12 mgd from the Wailoa Ditch with an option for an additional 4 mgd. During periods of low flow, MDWS will receive a minimum allotment of 8.2 mgd with HC&S also receiving 8.2 mgd, or prorated shares if less water is available. The August 2017 Proposed Decision restricted Wailoa ditch flow for off-stream uses so that less than 7 mgd would be available a few days a year. When more than 7 mgd is available under non-drought conditions, the proposed restored amount would come from EMI's share of the 16.4 mgd. Under normal flow, exceeding 16 mgd at Wailoa Ditch, and under an allocation of up to 12 mgd for MDWS, ditch flow could theoretically meet additional needed source of 6.3 mgd.

Water Treatment Facility Expansion

The June 2018 IIFS Decision allows continued diversions for the Upper Kula and Lower Kula subsystems. It is assumed that current production can continue at the Olinda WTF and the Pi`iholo WTF.

The Kamole Weir WTF, located at 1,120 feet elevation, utilizes the treatment processes of coagulation, flocculation, filtration, disinfection and pH adjustment for corrosion control. The

[77] Wilson Okamoto Corporation, County of Maui Drought Mitigation Strategies, 2012 Update.

majority of the treated water is boosted by the high service pump station to higher service elevations. The highest monthly average production over a ten year period is about 5.5 mgd. An assessment of Wailoa Ditch flow is needed to evaluate whether MDWS municipal needs, the Kula Agricultural Park and A&B/HC&S diversified agriculture plans can be met subject to recently adopted IIFS.

An agreement between A&B and MDWS is needed to allocate Wailoa Ditch water under the established IIFS. EMI provides water to MDWS under a Memorandum of Understanding (MOU). If the current terms continue, MDWS would receive 12 mgd from Wailoa Ditch with an option for an additional 4 mgd, for a total of 16 mgd. During periods of low flow, MDWS receives a minimum allotment of 8.2 mgd and HC&S receive 8.2 mgd. If less is available both receive prorated shares of the water available. Treatment of up to 12 mgd at 1,100 foot elevation would be a more cost effective resource to operate long-term compared to pumping groundwater from near sea level to 1,100 feet. Life cycle costs over 20 years for surface water treatment at Kamole Weir was estimated to $3.50 per 1,000 gallons in 2013. Groundwater pumpage increases life cycle costs by $1.64 to $5.93 per 1,000 gallons. Water from Kamole Weir can be booster pumped to supplement the Lower Kula and Upper Kula systems as needed.

Treatment of more than 6 mgd at the Kamole Weir will require expansion of the water treatment facility (WTF) and storage construction. Treatment plant expansion is conditioned upon an agreement with A&B Properties to secure long-term ditch flow allocation under alternative flow conditions. Treatment expansion is also contingent on reservoir storage.

Raw Water Storage Development

Raw water storage does not provide new source per se, but reduce the effects of low ditch flows by allowing surplus water to be stored during periods of high flows in the ditch to be used over periods where there is not sufficient flow for direct distribution. Raw water storage to supplement the reliable yields of the existing MDWS Upcountry surface water treatment systems was analyzed in the 2009 WUDP Upcountry District Final Candidate Strategies Draft Report by Ha`ikū Design & Analysis. Additional reservoir storage capacity increases the drought period reliable yield. Large new storage reservoirs require substantial up-front capital investments that yield long-term benefits in reduced system operation costs. The optimal capacity of raw water storage is a function of the amount of water and the streamflow characteristics of the stream, the capacities of the stream diversions and transmission. Ha`ikū Design & Analysis performed a detailed reservoir reliability and economic analysis for the Upper Kula, the Lower Kula and the Makawao subsystems. A mass flow analysis of historic streamflows, anticipated reductions in stream base flows and collection system and treatment plant characteristics determined contribution to system service reliability during drought and normal conditions for various assumed reservoir capacities for each Upcountry subsystem. Costs for estimated for various reservoir options and the analysis was conducted in several iterative rounds, considering integrated operation of the subsystems and other factors. Raw water storage compared to other resource strategies, such as basal well development, is more expensive if considered over a 25-year planning period. Considered over a 50 year study period, raw water storage is more cost effective. [79]

Raw Water Storage for Pi`iholo Water Treatment Facility

The Lower Kula subsystem served by the Pi`iholo WTF is the most economical location for additional storage expansion. A major constraint the location is the environmentally sensitive area, which also limits the size of a reservoir. Although cost effective in terms of reduced electrical power consumption and operating costs, construction of a 100 – 300 MG reservoir near or east of Pi`iholo WTF is not deemed practical.[80]

Raw Water Storage for Kamole Weir Water Treatment Facility

New raw water storage at the Kamole Weir WTF was evaluated in a 2015 Preliminary Engineering Report (PER) to reduce the effects of low flows in the Wailoa Ditch. The PER is based on the assumption that up to 8 mgd per 24-hour period will be made available to MDWS, continent upon available flow in the Wailoa Ditch. The analysis determined required storage for a sustainable flow rate of 5 mgd and 8 mgd.[81] The majority of water treated at the Kamole Weir WTF is boosted to service areas at higher elevations. There is currently no storage of raw water at the WTF. The 2015 PER recommended initial construction of a 48 MG reservoir at a cost of $8.7 million, with an additional four reservoirs totaling 441 MG at a cost of about $50M.

Table 15-37 Required Reservoir Storage for Year-Round Sustainable Supplies of 5 and 8 MGD

Scenario of Take from Wailoa Ditch	5 MGD Supply (MG)	8 MGD Supply (MG)
Unrestricted	47	92
Only Flows Above 10 MGD	138	279
Only Flows Above 20 MGD	279	470
Only Flows Above 30 MGD	336	569

Source: Storage Yield Analysis by Tom Nance Water Resource Engineering, July 15, 2014

The analysis by Ha`ikū Design & Analysis showed that this option would cost less than addition of basal wells in Ha`ikū aquifer. Service life can be assumed to be much longer and operational costs comparatively low. The optimal size for new capacity at the Kamole Weir WTF was determined at 100 – 200 million gallons (MG). A 20 mgd reduction in Wailoa Ditch base flow

[79] Haiku Design & Analysis, Maui County Water Use and Development Plan Upcountry District Final Candidate Strategies Report, July 27, 2009

[80] Ibid.

[81] Austin, Tsutsumi & Associates, Inc. Preliminary Engineering Report for Kamole Weir Water Treatment Plant Raw Water Reservoir Draft. May 11, 2015

would require 100 MG. A 30 MGD reduction in base flow would require a 200 MG reservoir.[82] Ditch flows based on the June 2018 Decision have yet to be assessed. Financing of raw water storage reservoirs may not be available as State Revolving Fund loans and needs to be identified.

In summary, reservoir and treatment plant expansion would have multiple benefits:

1. Improve reliable capacity
2. Economical water supply that minimized expensive groundwater pumping costs
3. Defer source development in Ha`ikū Aquifer in light of uncertainties related to the East Maui Consent Decree
4. Recharge regional groundwater in wet season when maximizing use of stormflow from rainfall

If financing can be secured, raw water storage construction presents an economic strategy compared to basal well development. If a string of basal wells and extensive transmission would be added to the MDWS Upcountry System during the same time frame as a reservoir, the economic benefit would be significantly diminished. Both resource strategies have long implementation timeframes and can be adjusted over time. Should development of basal source in the Makawao Aquifer produce adequate yield and quality, additional wells in Ha`ikū Aquifer ***OR*** expanded surface water storage and treatment will meet projected demand. Uncertainties in future stream flow must be weighed against increased reliability and cost of basal well development. Maximizing affordable surface water use in wet season must be weighed against "over building" expensive wells and infrastructure that is not used to capacity.

Strategy #8: Pursue hydrologic studies needed to explore the Ha`ikū Aquifer **and** an updated ditch flow analysis to optimize raw water storage and treatment plant capacity at Kamole Weir in order to expedite the most feasible new source. Raw water storage and Kamole Weir Water Treatment Facility expansion are contingent on a long-term agreement with A&B Properties allocating adequate surface water for the MDWS Upcountry System. The lead agency is MDWS.

This strategy supports multiple planning objectives, including to seek expanded municipal withdrawal from the lowest cost source to serve the Upcountry region and to increase water storage capacity with a reserve for drought periods.

It should be noted that improved storage and transmission efficiencies and limited source development have resulted in meters currently being offered to applicants on the Upcountry Meter Priority List. Although the creation of the List was due to source shortage, the pace of meter offerings is slow due to the backlog of applications, staff resources, and the complexity of processing meter offers.

[82] Haiku Design & Analysis, Maui County Water Use and Development Plan Upcountry District Final Candidate Strategies Report, July 27, 2009.

15.8.4 Climate Adaptation

Issue and Background: Data and research suggest that Hawai'i should be prepared for a future with a warmer climate, diminishing rainfall, declining stream base flows, decreasing groundwater recharge and storage, and increased coastal groundwater salinity, among other impacts associated with drought. Reliance on surface water will become more uncertain in a future of longer droughts and varying rainfall. No streamflow projections are available for the coming century but projections include a decline in base flow and low flows, with stream flows becoming more variable and unstable (flashy), especially in wet years. [83] Groundwater recharge decreases in drought but local impact from climate change has not been projected to date.

The Central ASEA is especially vulnerable due to water resources used:

- Upcountry region and agriculture dependent on surface water as primary resource
- Irrigation and other non-potable wells in Pā`ia and Kama`ole aquifer coastal areas are subject to sea-level rise

In consistency with the *Climate Change Adaptation Priority Guidelines*, water purveyors should increase resilience and reduce vulnerability to risks related to climate change. Chapter 12 Island Wide Strategies in this plan include the following strategies that can mitigate impacts from climate change:

1. Continue Maui County financial support for watershed management partnerships' fencing and weed eradication efforts (Chapter 12.3, Strategy#1). The Central ASEA is heavily dependent on forested watersheds in the Wailuku and Ko`olau hydrologic units to provide fresh water supplies.
2. Demand side conservation measures, such as water conserving design and landscaping in new development, incentives for efficient irrigation systems, landscape ordinance and promoting xeriscaping in dry areas will increase tolerance for prolonged droughts. (Chapter 12.3 Strategies # 13, 14, 15, 17)
3. Promote alternative resource incentives, such as greywater systems and rainwater catchment to supplement conventional resources. Incentives for green infrastructure and use of alternative water sources are needed to ensure such upfront investments in new development. (Chapter 12.3 Strategies# 20 and 21)
4. Diversify supply for agricultural use to increase reliability. Under extended droughts and low stream flows, diversified agriculture on HC&S lands will compete with priority public trust uses for surface water. Planned extension of R-2 recycled water from the Kahului WWTF to HC&S fields can supplement groundwater from the Central Aquifer Sector. (Chapter 12.3 Strategy #51).
5. Expand requirements for new development to connect to recycled water infrastructure, promote closer collaboration between MDWS and MDEM to utilize Drinking Water State Revolving Funds to maximize recycled water use. (Chapter 12.3 Strategies # 61 and 62)
6. Explore and promote opportunities for large volume stormwater runoff for agricultural irrigation. (Chapter 12.3 Strategy # 66

[83] Summarized from EcoAdapt. 2016. Climate Changes and Trends for Maui, Lāna'i, and Kaho'olawe. Prepared for the Hawaiian Islands Climate Synthesis Project

15.8.5 Alternative Water Source Strategies

Residents want to maximize use of alternative sources of water (R-1 wastewater, rainwater, greywater, etc.) which would mitigate well and surface water use and the transport of water. Planning objectives related to alternative water sources identified in the WUDP update public process and pertinent community plans include:

- Maximize efficiency of water use.
- Promote conservation of potable water through use of treated wastewater effluent for irrigation.
- Reuse treated effluent from the County's wastewater treatment system for irrigation and other suitable purposes in a manner that is environmentally sound.
- Explore the development of alternative water sources (e.g., grey water, catchment systems, etc.) to meet the needs of diversified agriculture, businesses and residents.

Qualitative criteria to evaluate and measure resource strategies against this planning objective include:

- Use of recycled water increased
- Graywater and catchment systems installed
- Infrastructure projects increase recycled water use and stormwater capture

Recycled Water

Issue and Background: Wastewater reclamation in Central Maui is managed by the Maui Department of Environmental Management (MDEM). Recycled water from the Kahului Wastewater Reclamation Facility (WWRF), the Kīhei WWRF and the private Mākena WWRF are all located in the Central ASEA. The Kīhei WWRF supplements the MDWS Central System. Recycled water has the potential to offset demand in the Central ASEA that would otherwise be supplied by conventional water resources. Recycled water availability and uncertainties are analyzed in Chapter 11.2.

<u>Kahului Wastewater Reclamation Facility</u>

R-2 water from the Kahului WTF can offset limited demand on the MDWS Central System as the approved uses of R-2 water are restricted. Treatment upgrade to R-1 quality and expansion of distribution from the Kahului WWRF to the Maui Lani area, the Kahului airport and Kanahā Beach Park were estimated to about $35M and has great potential to offset potable water while reducing effluent discharge to injection wells. There are no current plans or budget allocated for these projects.

The fiscal year 2018 MDEM budget included a $6.7M project to design a new distribution line connecting the Kahului WWTF to an existing line at the old Maui Pineapple processing facility in Kahului. Recycled water would then be available for landscape or agricultural irrigation on HC&S lands east of Kuihelani Highway. The project could preserve brackish water resources and offset irrigation demand on portions of the 1,951 acres of HC&S lands currently slated for "Large Diversified Farm Leases".[84] The Central Maui recycled water distribution system has not been developed to date because the majority of candidate commercial properties currently utilize inexpensive brackish or ditch water.[85] Irrigation of an energy crop on HC&S land that is not subject to the stricter requirements for edible crops, would benefit MDEM by reducing its reliance on injection wells for effluent disposal, and would benefit the HC&S lessee by displacing irrigation water otherwise diverted from Nā Wai `Ehā or East Maui streams. The project could serve to offset conventional resources from Ko`olau, Central and Wailuku aquifer sectors. This strategy applies to the Wailuku ASEA Chapter 14 as well.

Strategy #9: Expand distribution from the Kahului WWTF and the application for planned energy crops. Potential available recycled water is 4.2 mgd. Lead agency is MDEM.

Kīhei Wastewater Reclamation Facility

The Kīhei WWRF serves the South Maui area from Wailea to Sugar Beach. As with potable water, recycled water production must meet their customers' needs at all times. As demand peaks during the summer months, MDEM estimates they have as little as 0.7 - 1 mgd of excess recycled water available during the peak demand months of summer. Therefore, peak use limits additional potable water displacement unless a seasonal storage reservoir or brackish groundwater can supplement peak demand use. MDEM projects currently budgeted (as of April 2018) include two projects:

1. Liloa Drive distribution line design, to create a looped system and reliable service to the planned Kīhei High School. The $0.5M project will coincide with roadway construction.
2. Second storage tank and booster station to provide more reliable service for existing R-1 customers and allow for more customers to connect to the South Maui recycled system. The project is budget to $6.2M to be implemented in 2018.

These projects will increase reliability and offset potable water from the MDWS Central System and benefit the Wailuku ASEA and Central ASEA. Funding is a key constraint to implement planned expansions of the R-1 system.

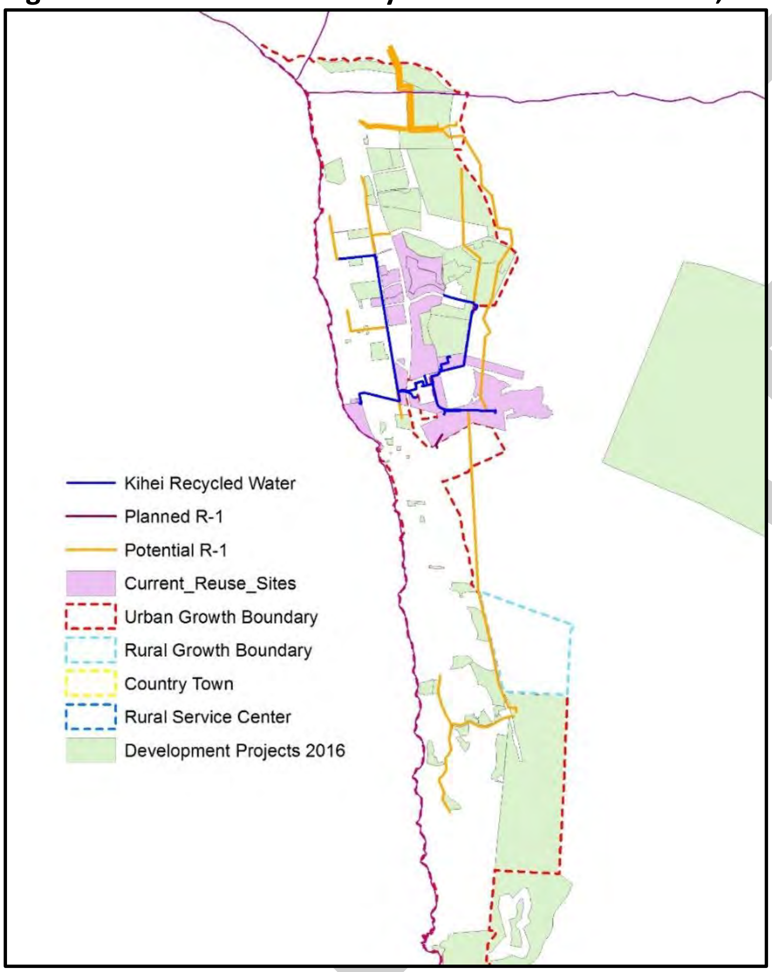
The 2009 Maui WUDP Central DWS District Plan update and the 2009 South Maui R-1 Recycled Water Verification Study explored a new transmission line to the Wailea area to displace potable water used for irrigation purposes. About 1.1 mgd of potable water could potentially be offset during the winter months when R-1 water use at existing and planned future properties decreases. Capital costs for 26,235 feet of transmission, 19 service laterals, two R-1 storage

[84] Mayor's Proposed Budget FY2018 Capital Improvement Program CBS-1171
[85] 2010 Central Maui Recycled Water Verification Study

tanks, and ultra violet disinfection, pressure reduction and pump station upgrades were estimated to $21M. The viability and potential funding of this strategy is still not determined. Strategy #8 applies to Central ASEA and Wailuku ASEA.

Strategy #10: MDWS and MDEM collaborate to identify private-public partnerships, state and federal funding sources to maximize utilization of recycled water produced at the Kīhei WWTF and supplemental non-potable sources for seasonal use of R-1 water. Lead agencies are MDEM and MDWS.

Figure 15-34 South Maui Recycled Water Service Area, Planned and Potential Expansion



It's preferable to provide the non-potable infrastructure in design and construction rather than retrofitting existing uses with separate non-potable distribution lines and backflow preventer to avoid cross-contamination.

Rainwater Catchment Systems

Issue and Background: Rainfall averages 15 inches along the southern coastline on Haleakalā, and it increases to 70 inches as one moves eastward and into higher elevations.[86] Rainfall catchment systems occur in the eastern part of the hydrologic unit, from Makawao and Olinda and also scattered throughout Kula. Catchments systems using potable treatment technologies have been installed Upcountry due to water meter limitations imposed by the Upcountry Meter Priority List. Determining appropriate system sizing requires an accurate analysis of water demand relative to precipitation patterns.[87] The feasibility of using catchment for domestic use depends on demand, catchment area such as roof area, rainfall patterns and storage capacity. Scenarios illustrating average demand, catchment area, rainfall and required storage is provided in Chapter 11.2. Rainfall (low to high) presented is similar to averages for the Kahului, Pukalani and Ha`ikū areas, respectively.

Rain barrels and cisterns for individual household use can supplement irrigation on a limited basis throughout the region, with less potential in dry South Maui. Catchment systems are not regulated by the county. However, rain barrel incentive programs are included in recommended demand side conservation strategies and the MDWS conservation program.

Catchment systems for agricultural uses have historically played an important role Upcountry. Support for increased adaptation to natural ambient rainfall and climate adapted crops is consistent with the objective to use appropriate water quality for appropriate uses. To reduce demand for off-non- potable stream uses of surface water, rainwater catchment for diversified agriculture could potentially increase. Where ambient rainfall can adequately satisfy agricultural demand during normal rainfall conditions, conventional resource use including surface and ground water can be used solely as contingency.

Stormwater Reuse

Issue and Background: Streamflows becoming more variable and unstable (flashy) is predicted, especially in wet years. Stormwater capture and use can provide multiple mitigating effects on climate change, including off-setting potable supply for irrigation needs; recharging low level and more brackish portions of the region's aquifers; and mitigating sediment runoff reaching the nearshore marine environment and reefs. Stormwater management is under the Maui County Department of Public Works responsibilities. The East Maui Irrigation System and the surface water diversions serving the Lower Kula and Upper Kula regions capture stormwater as total flow. Increased transmission efficiencies, raw water storage and treatment plant expansion indirectly increases the use of stormwater from these systems.

[86] Johnson Engott, USGS, Spatially Distributed Groundwater Recharge Model, Maui 2014-5168, page 6.
[87] US EPA. *Rainwater Harvesting- Conservation, Credit, Codes, and Cost Literature Review and Case Studies,* January 2013, pp. 3-4.

The Central Maui Soil and Water Conservation District (SWCD) Kula Stormwater Reclamation Study (2011) evaluated and prepared alternatives for capturing and storing stormwater for use by agricultural producers to alleviate drought impacts in the Kula region.

Stormwater reclamation and reuse can also offset landscape irrigation demand at the project or household level. Strategy #22 in the WUDP Part II addresses incentives and code revisions to promote incorporating green infrastructure in new development.

Desalination

Issue and Background: Desalination is more costly than conventional water resources due to treatment and monitoring requirements, although costs have been decreasing. The energy intensive technology currently available would add freshwater supplies but not provide other environmental co-benefits. Supplying 10% of Maui's current municipal demand with brackish desalinated water would require an estimated 14% of MDWS current energy demand. The energy demand for the same amount of seawater desalination would be about 45% of current MDWS energy demand. [88]

Desalination of brackish water is generally more cost-effective and environmentally-friendly than use of sea water. Effects on Kahului and Pā`ia Aquifer chlorides due to reduced irrigation are issues, along with impacts on source water quality, and wastewater disposal injection wells. However, since brackish groundwater contributes toward the sustainable yield of the aquifer, desalination of sea water can be advantageous because it is not a limited resource.[89] Overall, desalination may have potential within the 20-year planning horizon but does not warrant a recommended strategy aside from continued monitoring of progress in technology and energy use.

A feasibility study that considered desalination of brackish groundwater or seawater determined that brackish groundwater was the more cost-effective option of the two.[90] A preliminary strategy for desalination of brackish groundwater includes the development of a 5.0 mgd reverse osmosis desalination facility in Central Maui to meet a portion of future needs on the MDWS Central System. Brackish groundwater would be pumped from the Kahului Aquifer to supply the treatment plant. The reverse osmosis process would remove salt and other minerals to create potable water. Brine residual liquid stream created in the process would require disposal. Deep injection wells into salt water below the groundwater lens is considered to be the most practical and economical solution. [91]

[88] E.A. Grubert and M.E. Webber, Energy for water and water for energy on Maui Island, Hawai`i, April 2015
[89] WRPP, 2008
[90] Brown & Caldwell, Central/South Maui Desalination Feasibility Study, Final Report, December 2006
[91] Ibid.

Recommendations by the Board of Water Supply on the 2010 WUDP Central District stated that the Board sees desalination of brackish groundwater as one of the most expensive methods for supplying potable water and considered the byproducts of the process highly toxic.[92] Desalination is economically feasible but was not a favored strategy in the WUDP update public process. Uncertainty on imported energy sources, the high cost and environmental issues associated with brine disposal are concerns. While the technology and energy source options are improving, sustainable brine management and disposal remains a challenge.

[92] Board of Water Supply April 30, 2010 letter to Maui County Council

15.9 Recommendations

The Central Aquifer Sector is practically divided into the Upcountry Region and the communities in Central and South Maui even though some overlie the same hydrologic unit. Population growth and agriculture in the ASEA is highly dependent on imported water resources from the adjacent Ko`olau and Wailuku sectors. To mitigate water transport, a combination of aggressive conservation, investment in recycled water, increased reliance on ambient rainfall and climate adapted crops are needed.

Resource protection and augmentation strategies that benefit end uses in the Central ASEA are addressed in the Sector Reports where the generating watersheds and water resources are located. Protection and restoration of the East Maui watershed, the Mauna Kahalawai and the leeward Haleakalā region are addressed in the Ko`olau, Wailuku and Kahikinui Aquifer Sector Reports.

Policies that drive water resource use and capital investments have been discussed by policy bodies, including the County Council and the Board of Water Supply but have yet to be resolved. Many of these policies are framed and recommended in this plan and sector report and other remain to be addressed. Identifying and allocating water resources to satisfy the Upcountry Meter Priority List and agricultural needs in the region are possibly the greatest challenges of this WUDP Update. The just recent adoption of Interim Instream Flow Standards for some East Maui Streams does not allocate water for offstream uses in the Central ASEA. Adoption of this plan would implicitly or explicitly make several policy determinations, such as:

1. Substantial capital investments and associated increased water system development fees are needed to develop new source and reliable supply for the Upcountry region, including the Upcountry Meter Priority List.
2. Investments in alternative water sources are required to meet projected agricultural irrigation demand.
3. Conservation programs that combine mandatory upfront investment and incentives are needed to aggressively cutback outdoor water use.
4. Less cost effective alternative resources, such as recycled water, are needed to mitigate water transports and to diversify water supplies in light of climate change.

The recommended strategies attempt to address the planning objectives derived from the public process, the Maui Island Plan, the pertinent community plans and the Upcountry District Water Advisory Committee. In summary, groundwater imports from Wailuku ASEA and Ko`olau ASEA are needed to supply projected population growth served by the Maui Department of Water Supply Central System and Upcountry System over the planning period. Exploration of East Maui basal water requires a comprehensive hydrologic study to determine any negative impact on existing ground and surface water sources, stream flow and influences from dikes.

Potable and non-potable supply to meet the selected demand scenarios are summarized in the table below. Demand and supply within the Central aquifer sector are included in the table, excluding the MDWS Central System which is addressed in Table 14-38 of the Wailuku ASEA Report. As discussed throughout this chapter, the Wailuku, Central and Ko`olau hydrologic units are historically and currently closely entwined through water imports and exports. Resource use and projected demand for the MDWS Upcountry System as a whole is used for practical planning purposes, in addition to agricultural and other non-potable needs. Resources within the Central ASEA allocated to demand in the Wailuku ASEA are noted in the table.

The complexities in selecting the most appropriate source to meet demand and mitigate Upcountry drought conditions are significant. Development of groundwater in Ko`olau ASEA is subject to hydrologic studies and the East Maui Consent Decree. New wells carry relatively lower capital costs than new raw water storage but entail the uncertainty of the quantity and quality of water. Expansion of surface water treatment capacity and raw water reservoir construction are subject to ditch flow analysis based on the June 2018 established Interim Instream Flow Standards and a long-term agreement of ditch water for municipal use. Actual projected potable demand is contingent on the portion of Upcountry Meter Priority List applicants accepting meter offers. Therefore, potable demand and source development needs by 2030 will certainly be adjusted. The selected source would be surface water use expansion, Ha`ikū groundwater development OR a combination of the two. Surface water expansion of 4 mgd for a total of 11.7 mgd supply in 2030 is replaceable with 4 mgd groundwater development in Ha`ikū aquifer. If surface water expansion is the preferred source strategy, as indicated in the table, there would be a surplus demand of about 3 mgd. The surplus would accommodate seasonal use, taking full advantage of affordable gravity fed surface water in wet season, with contingent basal groundwater use in dry season.

Non-potable agricultural demand will likewise certainly be adjusted as the HC&S plantation transitions to diversified agriculture. Unmet non-potable demand is roughly estimated, based on proposed irrigation needs and unknown quantity of total flow. Increased efficiencies of the EMI system, climate adapted crops and irrigation best practices are anticipated to mitigate the non-potable supply shortage over the 20-year planning period.

Table 15-38 Selected Scenario Projected Water Demand and Supply Options Central ASEA and MDWS Upcountry System

DEMAND (MGD)	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**
MDWS Potable (Upcountry excl. Priority List)	7.610	7.693	8.155	8.292	8.432	8.530
Upcountry Meter Priority List	7.3	7.3	7.3	7.3	7.3	7.3
Municipal Private Potable	0.235	0.239	0.268	0.295	0.327	0.356
DHHL Potable Kahului Aquifer	0.000	0.000	1.734	1.734	1.734	1.734
DHHL Potable Kama`ole Aquifer	0.000	0.000	0.349	0.349	0.810	0.813
TOTAL POTABLE DEMAND	**15.145**	**15.232**	**17.806**	**17.970**	**18.603**	**18.734**
Irrigation Non-potable	3.683	3.744	4.201	4.627	5.133	5.591
Agriculture, Non-potable	191.452	191.452	35.415	35.415	58.220	101.030
Industrial, Non-potable	0.208	0.211	0.237	0.261	0.290	0.316
DHHL, Non-potable	0.000	0.000	2.434	2.434	2.434	2.434
TOTAL NON-POTABLE DEMAND	**195.343**	**195.408**	**42.288**	**42.738**	**66.078**	**109.372**
TOTAL DEMAND	**210.487**	**210.640**	**60.094**	**60.708**	**84.681**	**128.105**

SUPPLY (MGD)	2014	2015	2020	2025	2030	2035
Potable Groundwater Kahului Aquifer (serving MDWS Central System)*[1]	*1.093*	*1.093*	*1.093*	*1.093*	*1.093*	*1.093*
Potable Groundwater Kahului Aquifer (non MDWS)*[2]	0.161	0.161	1.895	1.895	1.895	1.895
Potable Groundwater Kama`ole Aquifer	0.027	0.027	0.027	1.036	1.497	1.500
Potable Groundwater Pā`ia Aquifer*[3]	0.248	0.998	0.998	0.998	1.500	1.500
Potable Groundwater Makawao Aquifer	0.139	0.500	0.500	1.300	2.000	3.000
Potable Groundwater Ko`olau ASEA Ha`ikū Aquifer	0.81	0.81	1.4	1.4	1.4	1.4
Potable Surface Water Ko`olau ASEA	6.460	7.700	7.700	7.700	11.700	11.700
Conservation (8% per capita)	0.000	0.000	0.519	1.195	1.989	2.676
TOTAL POTABLE SUPPLY	**7.845**	**10.196**	**13.039**	**13.629**	**20.086**	**21.776**
Unmet Potable Demand	-7.300	-5.036	-4.767	-4.341	1.483	3.043
Non-potable Groundwater Kahului Aquifer	28.906	28.906	2.169	2.169	10.776	10.776
Non-potable Groundwater Pā`ia Aquifer	29.258	29.258	9.081	9.081	9.081	9.081
Non-potable Groundwater Kama`ole Aquifer	2.826	2.888	3.345	3.991	4.277	4.735
Non-potable Groundwater Makawao Aquifer	0.220	0.220	0.220	0.220	0.220	0.220
Non-potable Surface Water Ko`olau ASEA *[4]	133.943	134.133	27.473	27.277	28.500	28.500
Recycled Water (South Maui WWTF) Offset MDWS Central System*	*2.280*	*2.280*	*2.280*	*2.280*	*2.280*	*2.280*
Recycled Water Kahului WWTF)*[5]	0.000	0.000	*3.000*	*3.000*	*3.000*	*3.000*
Recycled Water Upcountry	0.19	0.19	0.19	0.19	0.19	0.19
TOTAL NON-POTABLE SUPPLY	**195.343**	**195.594**	**42.478**	**42.928**	**53.044**	**53.502**
Unmet Non-potable Demand	0.000	0.000	0.000	0.000	**-13.034**	**-55.870**
TOTAL SUPPLY	**203.187**	**205.790**	**55.517**	**56.557**	**73.130**	**75.278**

*[1]accounted for in Wailuku ASEA Supply
*[2] May also supply Pulehunui Ind. Development +3.8 mgd, source adequacy TBD
*[3]Includes Old Maui High School Project 0.75 mgd, source TBD
*[4]28.5 mgd base flow. Available stream flow range from <28.5 mgd drought base flow to >78 mgd total flow
*[5]Potential alternative source for Ag. Not counted as available supply

Table 15-39 below summarizes recommended strategies and indicates the planning objectives that each strategy supports. Estimated costs are, unless indicated otherwise, life cycle costs for the twenty-year planning period per 1,000 gallons. Life cycle costs include capital, operational and maintenance costs and include inflationary effects. Costs to develop and implement sustainability projects are not quantified per volume water supply. Lead agencies, or organization to implement a strategy is proposed as a starting point. The timeframe for implementation is indicated as short-term – less than 5 years, and long-term 5 – 20 years. Many strategies are multi-year actions with implementation beginning within 5 years and continuing through the long-term (indicated as 1, 2).

Table 15-39 Summary of Recommended Strategies Central ASEA

	STRATEGY	PLANNING OBJECTIVES	ESTIMATED COST	IMPLEMENTATION 1: Short-term 1 – 5 years 2: Long-term 5 – 20 years	
				AGENCY	TIME-FRAME
	RESOURCE MANAGEMENT				
1	Explore funding and conduct a cost benefit analysis of improvements to the EMI non-potable conveyance system to mitigate losses and preserve existing reservoirs at risk of decommissioning. Priority components and associated costs TBD.	Maintain sustainable resources Protect water resources Protect and restore streams Maximize efficiency of water use	N/A	Maui County A&B Properties/ EMI	1,2
	CONVENTIONAL WATER SOURCE STRATEGIES				
2	Assess alternative options to restructure and process the existing Upcountry Meter Priority List to improve processing rate and adequate source development.	Provide adequate volume of water supply Maximize reliability of water service	N/A	MDWS	1,2
3	Explore new basal well development in the Makawao Aquifer to accommodate growth Upcountry and add reliable new source. Potential yield is up to 3 mgd.	Provide adequate volume of water supply Maximize reliability of water service Minimize adverse environmental impacts	$4.5 – 6.0 /1000 gallons	MDWS DLNR Public/ private partnerships	1,2
4	Explore East Maui well development in combination with Makawao Aquifer basal groundwater to meet projected demand on the MDWS Upcountry System. Initiate a hydrologic study to determine any negative impact on existing ground and surface water sources, stream flow and influences from dikes. Potential yield is > 6 mgd.	Provide adequate volume of water supply Maximize reliability of water service Minimize adverse environmental impacts	$3.71* /1000 gallons	CWRM USGS MDWS	1,2
5	Explore Pā`ia Aquifer for non-potable demand, and potable use with additional treatment as necessary to serve projects included in the Maui Island Plan that cannot feasibly be serviced by MDWS source and infrastructure. Estimated demand for the Maui High School Campus is about 0.75 mgd.	Provide adequate volume of water supply Maximize reliability of water service	N/A	Maui County	1,2

	STRATEGY	PLANNING OBJECTIVES	ESTIMATED COST	AGENCY	TIME FRAME
6	Execute a long-term source agreement for use and maintenance of the Wailoa Ditch that ensures adequate non-potable supply for the Kula Agricultural Park expansion and potable supply for projected MDWS Upcountry System needs over the planning period.	Provide adequate volume of water supply Maximize reliability of water service	N/A	Maui County MDWS A&B Properties	
7	Pursue hydrologic studies needed to explore the Ha`ikū Aquifer **and** an updated ditch flow analysis to optimize raw water storage and treatment plant capacity at Kamole Weir in order to expedite the most feasible new source. Surface water strategies are contingent on a long-term agreement with A&B Properties allocating adequate surface water for the MDWS Upcountry System.	Minimize cost of water supply Provide adequate volume of water supply Maximize reliability of water service Maintain consistency with General and Community Plans	Surface water $5.15 /1000 gal (20 yr) (construction cost $50M, Operational $1.47/1000 gal) Groundwater $3.71/1000 gal	MDWS	1,2
	ALTERNATIVE WATER SOURCE STRATEGIES				
8	Consider alternative sources of irrigation water including wastewater reuse, recycled stormwater runoff, and brackish well water in land use permitting to mitigate low flow stream conditions. Require alternative sources for irrigation when reasonably available in county discretionary land use permitting.	Maintain sustainable resources Protect and restore streams Minimize adverse environmental impacts Maximize efficiency of water use Maintain consistency with General and Community Plans	N/A	Maui County DEM HC&S	1,2
9	Expand distribution from the Kahului WWTF and the application for planned energy crops. Potential available recycled water is 4.2 mgd.	Maximize efficiency of water use Maintain consistency with General and Community Plans	$6.7M	MDEM HC&S	1,2
10	MDWS and MDEM collaborate to identify private-public partnerships, state and federal funding sources to maximize utilization of recycled water produced at the Kīhei WWTF and supplemental non-potable sources for seasonal use of R-1 water.	Maximize efficiency of water use Maintain consistency with General and Community Plans	(Transmission South Kīhei to Wailea $21M)	MDEM MDWS	1,2

*20 year total cost includes upfront capital costs, operation and maintenance, repair and replacement and does not include inflation and other economic factors

15.9.1 Implementation Program

In consistency with the Maui Island Plan, strategies recommended and adopted in the WUDP does not legally bind the agencies and organizations to execute. The recommendations provide guidance for land use and infrastructure, including the county capital improvement programs (CIP), over the planning period.

Timing and prioritizing of conventional and alternative resource strategies are tied to actual population growth and economic factors that drive individual development projects. Prioritizing and timing of strategies will also depend on available manpower and expertise by agencies and organizations tasked to scope out and execute a strategy. Funding is of course the driving factor of implementation. Conventional source exploration and development for the Upcountry region lies primarily with Maui County Water Department. The Upcountry Meter Priority List is a deviation from "planned growth" as it's not accounted for in population growth for the Upcountry region. The demand is far in excess of socio-economic forecast projections. The pace of processing the List is highly dependent on county staff resources and priorities rather than funding. Upcountry source development, including satisfying the List, was estimated to $100 million at the time the Maui Island Plan was adopted. Raw water storage versus basal well development will roughly require the same level of capital investment. Funding of system expansions to serve growth should primarily be borne by new development to ensure that costs are distributed equitably to uses befitting from the improvements. The Water System Development Fee is the current funding mechanism.

Major projected capital costs are not limited to source development but includes improvement, replacement and upgrade of waterlines; and construction and replacement of water tanks. The MDWS infrastructure and the agricultural infrastructure are to a large extent in fair to poor condition and require major repairs and replacements over the planning period.

Agricultural needs largely fall outside the Maui Island Plan focus and projections. The two major areas – HC&S plantation and expansion of the Kula Agricultural Park – are expected to be addressed in the Agricultural WUDP Update underway by the State Department of Agriculture.

The alternative resource strategies rely on funding by the county agencies, but will also require creative public-private partnerships. Resource protection, conservation and alternative resource strategies have state-wide support including the following:

- The Hawai`i Fresh Water Initiative, launched in 2013 by the Hawai`i Community Foundation to increase water security for the Hawaiian Islands. A state-wide goal of 100 mgd in additional fresh water focuses on three aggressive water strategy areas and individual targets for the public and private to achieve by 2030: 1) **Conservation**: Improve the efficiency of the total underground aquifer water use rate by 8% with a target of 40 mgd in increased water availability; 2) **Recharge**: Increase Hawai`i's ability to capture rainwater in key aquifer sector areas by improving stormwater capture and nearly doubling the size of our actively protected watershed areas with a target of 30 mgd in increased water availability; and 3) **Reuse**: More than double the amount of wastewater currently being reused in the Islands with a target of 30 mgd in increased water availability by 2030.

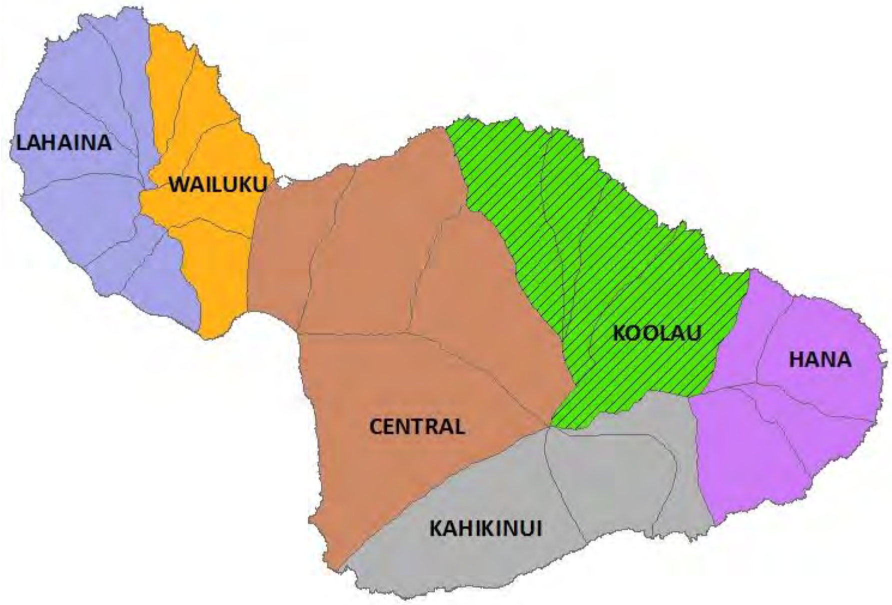
- The watershed initiative program by the State Department of Land and Natural Resources "The Rain Follows the Forest" seeks to double the acreage of protected watershed forests by 2021.

Over the planning period, implementation and performance of the recommended strategies can be assessed using qualitative criteria and quantitative targets formulated in the WUDP Part I, Table 3-3. Goals and performance measures on an island wide basis is provided in Appendix 15.

APPENDIX 15A East Maui Streams Assessment
Based on June 20, 2018 Findings of Facts, Conclusion of Law, and Decision & Order

Unit	Unit Name	BFQ50 at IIFS (cfs)	BFQ50 at IIFS (mgd)	IIFS (cfs)	IIFS (mgd)	BF Avail. to divert at Q50	BF Avail. to divert at Q90	TFQ50 (cfs)	TFQ50 (mgd)
6027	Maliko								
6028	Kuiaha								
6029	Kaupakulua								
6030	Manawaiiao								
6031	Uaoa								
6032	Keali`i								
6033	Kakipi								
6034	Honopou	6.50	4.20	0.00		0.00	0.00		
6035	Ho`olawa								
6036	Waipio								
6037	Hanehoi	2.54	1.64	0.00	0.00	0.00	0.00		
	Puolua (Huelo) Stream	1.47	0.95	0.00	0.00	0.00	0.00		
6038	Hoalua								
6039	Hanawana								
6040	Kailua								
6041	Naili'ilihaele								
6042	Puehu								
6043	O`opuola								
6044	Ka`aiea								
6045	Punalu`u								
6046	Kolea								
	Alo								
	Wahinepe`e	0.90	0.58	0.90	0.58				
6048	Puohokamoa	8.40	5.43	1.10	0.71	4.72	-0.59	13.00	8.40
6049	Haipuaena	4.90	3.17	1.36	0.88	2.29	-0.88	6.60	4.27
6050	Punalau	4.50	2.91	2.90	1.87	1.03		3.60	2.33
6051	Honomanū	4.20	2.71	4.20	2.71	3.17	0.71	6.20	4.01
6052	Nua'ailua	0.28	0.18	2.20	1.42	-1.24	-1.42	0.56	0.36
6053	Pi`ina`au	14.00	9.05	0.00	0.00	0.00	0.00	21.00	13.57
	Palauhulu Stream	11.00	7.11	0.00	0.00	0.00	0.00	6.10	3.94
6054	Ohia	4.70	3.04	0.00	0.00	3.04			0.00
6055	Waiokamilo	3.90	2.52	0.00	0.00	0.00	0.00	7.00	4.52
6056	Wailuanui	6.10	3.94	0.00	0.00	0.00	0.00		0.00
6057	West Wailuaiki	6.00	3.88	0.00	0.00	0.00		8.50	5.49
6047	Waikamoi	6.70	4.33	3.80	2.46	1.87	-2.44	6.60	4.27

	Waikamoi								0.00
6058	East Wailuaiki	5.80	3.75	3.70	2.39	1.36	-0.58	8.00	5.17
6059	Kopiliula	5.00	3.23	3.20	2.07	1.16	-0.52	8.00	5.17
	Puaka`a Stream	1.10	0.71	0.20	0.13	0.58	-0.13	1.90	1.23
6060	Waiohue	5.00	3.23	0.00	0.00	0.00	0.00	6.20	4.01
6061	Pa`akea	0.90	0.58	0.18	0.12	0.47	-0.12	1.50	0.97
6062	Waia`aka	0.77	0.50	0.77	0.50	0.00	-0.15		0.00
6063	Kapaula	2.80	1.81	0.56	0.36	1.45	1.12	4.90	3.17
6064	Hanawi	4.60	2.97	0.92	0.59	2.38	1.08	7.70	4.98
6065	Makapipi	1.30	0.84	0.00	0.00	0.00	0.00	7.40	4.78
Wailoa Ditch Available to Divert			73.26		16.80	20.35	2.21	62.36	40.30
Petitioned Streams								124.76	80.63
Fully Restored TFQ50								70.31	45.44
IIFS					13.50				
Wailoa Ditch Flow at Honopou 2011 -15 TFQ50								135.26	87.42
New Hamakua Ditch at Honopou 2011 -15 TFQ50								19.34	12.50
Lowrie Ditch at Honopou 2011 -15 TFQ50								16.85	10.89
Haiku Ditch at Honopou 2011 -15 TFQ50								6.46	4.18
Ditch gain between Honopou and Maliko								13.30	8.60
Total Flow diverted prior to IIFS								191.21	123.58
IIFS Restored Streams TFQ50								70.31	**45.44**
Remains to Divert:								120.90	**78.14**
DWS Kamole Weir Average 2014									3.60
Kula Ag Park								2.50	1.62
Remains for HC&S (Est.)									**72.92**
Restoration Status Full									
Restoration Status Connectivity									



KO`OLAU AQUIFER SECTOR AREA

MAUI ISLAND WATER USE AND DEVELOPMENT PLAN DRAFT

PART III REGIONAL PLANS

Table of Contents

List of Tables

List of Figures

KO`OLAU AQUIFER SECTOR AREA

16.0 KO`OLAU AQUIFER SECTOR AREA

The Ko`olau Aquifer Sector Area (ASEA) encompasses approximately 134 square miles underlying the eastern and northern flanks of Haleakalā. The Ko`olau ASEA is comprised of four groundwater Aquifer System Areas (ASYA): Ha`ikū, Honopou, Waikamoi, and Ke`anae. The northern boundary stretches from Ha`ikū to Ke`anae; the southern boundary stretches up into Haleakalā Crater. The 2015 population of the Ko`olau ASEA was 11,892 residents, which includes: a portion of the population (10,824) of the Pā`ia-Ha`ikū Community Plan [CP] area that amounts to 91 percent of the Ko`olau ASEA's total population; a small portion of the Makawao-Pukalani-Kula CP population (701) that accounts for 5.9 percent of the Ko`olau ASEA population; and a small portion of the Hāna CP area's population (368), which accounts for 3.1 percent of the Ko`olau ASEA's total population. The population of the Ko`olau ASEA is projected to increase by 3.6 percent to 12,321 by 2035. The WUDP uses hydrologic units for presentation and analysis consistent with state requirements for updating the plan. The corresponding geographic areas of the Ko`olau ASEA encompass all or portions of the various moku of Ko`olau, Hāmākualoa, Kula; and to lesser extents Kahikinui, Kīpahulu, Kaupō, Honua`ula; and their underlying ahupua`a. Agricultural activities are limited within most of the Ko`olau ASEA, and are generally confined to grazing cattle in pasture land and a small number of nurseries and diversified agriculture (including traditional taro cultivation) on small tracts of land.

16.1 PLANNING FRAMEWORK

16.1.1 Key Issues

Open public meetings and workshops during 2016 identified key issues and concerns for the Hāna region, including the Ko`olau ASEA. Many of the issues raised pertain to stream diversions from the Ko`olau ASEA that are ultimately transported to Central and Upcountry Maui. While overlapping, key issues identified for the Ko`olau community and water resources within the Ko`olau ASEA relate to watershed management and participation by the local community; maintenance of traditional resource management using the ahupua`a system and ensuring that traditional and customary practices are safe guarded. Projected increases in public water use are relatively modest, with an anticipated 3.6 percent increase in population growth for the Ko`olau ASEA.[1] However, public water use in the Central ASEA relies on Ko`olau surface water resources conveyed via various aqueduct systems. A key issue for the region is providing affordable water for future needs, providing for taro lo`i and other public trust uses during droughts, and managing resources in a sustainable way. Region specific input received at community meetings, via surveys and at policy board meetings generally focused on the following issues:

<u>Public/Community Meeting Issues</u>

The following issues were fielded at community meetings and workshops.

- Transport of water from the Ko`olau ASEA to upcountry and central Maui is an issue for all of the affected communities.
- Watershed protection and its prioritization is a key issue, including invasive alien plant control, ungulate control, and reforestation via watershed partnership programs.
- Maintaining access to lands for gathering, hunting and other native Hawaiian traditional and customary practices should be implemented.
- Improving the understanding of the concepts of "precautionary planning" to reduce and adapt to the effects of drought and climate change upon water resource availability and quality is important.
- Adapting future populations to local water resource conditions, integrating conservation and the use of alternative resources should be pursued.
- Water needs of DHHL should be considered in general and in accordance with the 2017 State Water Projects Plan.

[1] County of Maui, Final Draft Socio-Economic Forecast, Maui County Planning Department, Long Range Planning Division, 2014, based on the weighted averages (per capita populations in each community plan area) of the following community plan areas: (1) the 1994 Hāna Community Plan; (2) the 1996 Makawao-Pukalani-Kula Community Plan; and 3) the 1995 Pā`ia-Ha`ikū Community Plan.

- Consultation and coordination with Native Hawaiian community/moku and local experts on resource management and invasive species removal should be prioritized.
- "Wai" (water) as a vital cultural and sustaining resource for humans and nature.
- Maui's natural beauty, native ecology and cultural heritage should be a source of pride: to reside in one of the most beautiful and distinctive places in the world, valuing protection of Maui's native ecology as essential to preserving the island's beauty and cultural history, including its agrarian roots.
- Because Maui is blessed with abundant groundwater, streams and ocean resources to serve its diverse needs, efforts should be made to maintain the sustainability of water resources.
- An abundant, high-quality water supply should be provided for all of Maui's needs.
- Make efforts to respect and implement the Public Trust doctrine and State Water Code as a foundation for water planning.
- The "water kuleana" of all Mauians creates responsibilities as well as rights.

Community Plan Issues

This section describes key problems and opportunities, formulated by the 1992 Citizens Advisory Committee, provides the underlying basis for the planning goals, objectives and policies which are described later.[2]

- The development of new ground water sources in Ha`ikū to service the Central Maui area of Wailuku-Kahului and Kīhei-Makena raises a concern over the allocation of water resources to these other regions if and when the present and future needs of the Pā`ia - Ha`ikū area are not met.[3]
- Protect and maintain a rural character distinct from the city-like form of other urban communities on Maui by incorporating a small town or village development, such as the neotraditional form of town planning with an emphasis on defined growth limits and mixed uses, organized and designed for pedestrian and bicycle mobility and comfort.[4]
- Expand opportunities for diversified agriculture, "rural light industry," "cottage-scale" businesses and other small-scale, owner-operated businesses.[5]
- A primary concern for Makawao-Pukalani-Kula residents is the limited development of water resources and a distribution system to meet the needs of the region. The proper allocation of water resources is considered essential to, in order of priority: (1) preserve agriculture as the region's principal economic activity, promote diversified agricultural activities, and effectively encourage the development of Department of Hawaiian Home

[2] County of Maui, Pā`ia-Ha`ikū Community Plan, 1994, page 10.
[3] County of Maui, Pā`ia-Ha`ikū Community Plan, 1994, page 11, cited as a "problem," also cited as an "interregional issue," page 12.
[4] Ibid, page 12, cited as an "opportunity."
[5] Ibid.

Lands (DHHL) parcels; and (2) ensure the long-term viability of the region's residential and economic base.[6]

- Water use in the Upcountry region is recognized as having impacts on the streams of East Maui and the agricultural activities of the central valley. A comprehensive water management strategy must be developed to strike a balance between the various interests and accommodate environmental, agricultural and residential needs of all neighboring regions.[7]

16.1.2 Plans, Goals, Objectives and Policies

The Ko`olau ASEA implements the Maui County General Plan and is subject to the plans, goals, policies and objectives discussed in Chapter 3 of the Water Use and Development Plan (WUDP). The Maui Island Plan (MIP) addresses island-wide issues and does not identify goals, objectives and policies that are specific to Ko`olau. All goals and objectives adopted in Chapter 6.3 of the MIP are consistent with the broad planning objectives of the WUDP as shown in the matrix of WUDP Part I, Appendix 2 *"County Plan Policy and Programs Relevant to the WUDP, and Consistency with the Planning Objectives."* The Ko`olau ASEA contains areas that fall under three different community Plans: (1) the 1994 Hāna Community Plan; (2) the 1996 Makawao-Pukalani-Kula Community Plan; and 3) the 1995 Pā`ia-Ha`ikū Community Plan.

<u>The 1994 Hāna Community Plan</u>

The 1994 Hāna Community Plan reflects regional issues expressed at the community meetings for the WUDP. Community plan goals and policies related to water resources and use are summarized below.

<u>Water Resources</u>

Goal:

Protection and management of land, water and ocean resources.

Objectives and Policies

- Protect, preserve and increase natural marine, coastal and inland resources, encouraging comprehensive resource management programs.
- Recognize residents' traditional uses of the region's natural resources, which balance environmental protection and self-sufficiency.
- Discourage water or land development and activities which degrade the region's existing surface and groundwater quality.
- Encourage resource management programs that maintain and re-establish indigenous and endemic flora and fauna.
- Protect, restore and preserve native aquatic habitats and resources within and along streams.

[6] County of Maui, Makawao-Pukalani-Kula Community Plan, 1996, page 12, cited as a "problem."
[7] Ibid, cited as an "interregional issue, page 15.

- Ensure that groundwater and surface water resources are preserved and maintained at capacities and levels to meet the current and future domestic, agricultural, commercial, ecological and traditional cultural demands of each area in the Hāna District.

Water Availability and Use

Goal:

Timely and environmentally sensitive development and maintenance of infrastructure systems, including the provision of domestic water.

Objectives and Policies

- Improve water source and delivery facilities to ensure that water supplied to the region's residents and visitors is of the highest quality.
- Identify water service area expansion needs in the Hāna region.
- Encourage water conservation measures by residents and businesses.

The 1996 Makawao-Pukalani-Kula Community Plan

Water

Goal
The timely and environmentally sensitive development and maintenance of infrastructure systems which protect and enhance the safety and health of Upcountry's residents and visitors, including the provision of domestic water, utility and waste disposal services, and effective transportation systems which meet the needs of residents and visitors while maintaining the region's rural character.

Objectives and Policies

- Prioritize the allocation of water as new resources and system improvements become available as follows: (a) for maintenance and expansion of diversified agricultural pursuits and for the Department of Hawaiian Home Lands projects; and then (b) for other uses including development of new housing, commercial and public/quasi-public uses.
- Encourage a flexible and comprehensive water management approach that recognizes the various collection and delivery improvements as one cohesive system.
- The Department of Water Supply shall expand water supply and distribution systems, including catchment systems, in accordance with the directions set forth in the Makawao-Pukalani-Kula Community Plan.
- Restrict the use of any water developed within or imported to the Upcountry region to consumption within the Upcountry region, with exception provided for agricultural use.

- Recognize and support the immediate allocation of water resources for Department of Hawaiian Home Lands projects and agriculture.
- Seek expanded municipal withdrawal from the lowest cost source to serve the Upcountry region.
- Support the development of separate domestic and irrigation water systems.
- Explore the development of alternative water sources (e.g., grey water, catchment systems, etc.) to meet the needs of diversified agriculture, businesses and residents.
- Encourage the construction of additional storage capacity by the Department of Water Supply, commercial developers, and individual farmers to help alleviate the inadequate water supply.
- Recognize the importance of the forested watershed areas and that their health and well-being are vital to all the residents of the Upcountry area.
- Explore a comprehensive reforestation program to increase and catch more rainwater for the Upcountry area.
- Encourage cooperative efforts among Federal, State, and County agencies, and developers to ensure that water storage and delivery needs of the region are met in a timely and orderly manner.

The 1995 Pā`ia-Ha`ikū Community Plan

Water

Goal
An adequate supply of potable and irrigation water to meet the needs of the region.

Objectives and Policies

- Increase water storage capacity with a reserve for drought periods.
- Ensure that adequate water capacity is available for domestic and agricultural needs of the region.
- Ensure that the development of new water sources does not adversely affect in-stream flows.
- Continue the conversion to drip irrigation in sugar cane fields, provided that the practice complies with soil conservation standards.
- Improve the existing potable water distribution system and develop new potable water sources prior to further expansion of the State Urban District boundary or major subdivision of land in the State Agricultural or Rural Districts.
- Ensure adequate supply of groundwater to residents of the region before water is transported to other regions of the island.

16.2 Physical Setting

16.2.1 Climate and Geology

Ko`olau is located on the younger of Maui Island's two mountain ranges on the East Maui Volcano known as Haleakalā. The volcanism of the area is considered dormant.[8] The rainy eastern slope of Ko`olau Aquifer Sector Area (ASEA) has valleys that are separated by broad areas and ridges.[9] At middle and lower altitudes of Haleakalā, forests cover much of the wet windward slopes.[10] The lush tropical growth and deep erosion along the Ko`olau coastline contrast vividly with Haleakalā's dry southwest shore. Most of Ko`olau's lower areas consist of seacoast cloaked in tropical forest. Mountains obstruct trade-wind air flow and create wetter climates on north- and northeast-facing (windward) mountain slopes where much of Ko`olau is positioned.[11] Persistent trade winds and orographic lifting of moist air result in recurrent clouds and frequent rainfall on windward slopes and near the peaks of all but the tallest mountains of the Hawaiian Islands.[12] When trade winds are present, the vertical development of clouds is restricted by the trade-wind inversion layer. The altitude of the inversion, however, varies over time and space and is affected by thermal circulation patterns, such as land and sea breezes.[13] Most of Maui is usually immersed in the moist air layer below the inversion. On Haleakalā, mean rainfall exceeds 200 inches per year on mid-altitude windward slopes. Rainfall is extremely variable in the sector. The Ke`anae Aquifer System Area (ASYA) includes a small portion of Haleakalā Crater, where rainfall in the cool dry upper elevations is about 50 inches per year. On average, USGS data indicates rainfall ranges from 101 inches per year in the cooler, dryer upper elevations to as much as 454 inches per year in the Ke`anae ASYA.[14]

The only road in and out of Ko`olau, Highway 360, winds past changing landscapes mostly consisting of tropical rainforests perched upon intensely steep cliffs. On at least four occasions, fluid lava flows followed Ke`anae Valley to the coast, with the youngest flow, 10,000 years ago, having built most of the modern Ke`anae Peninsula. The landscape changes near milepost 24, where the road passes Haleakalā's east rift zone. Dozens of cinder cones and lava flows of Hāna

[8] Macdonald, G.A., Abbott, A.T., and Peterson, F.L., 1983, Volcanoes in the sea (2d ed.): Honolulu, Hawai`i, University of Hawai`i Press, page 517.

[9] Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially distributed groundwater recharge estimated using a water-budget model for the Island of Maui, Hawai`i, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168, page 5, http://dx.doi.org/10.3133/sir20145168.

[10] Ibid, page 7.

[11] Sanderson, Marie, 1993, Introduction, chap. 1 *of* Sanderson, Marie, ed., Prevailing trade winds: Honolulu, Hawai`i, University of Hawai`i Press, page 1–11.

[12] Giambelluca, T.W., Nullet, M.A., and Schroeder, T.A., 1986, Rainfall atlas of Hawai`i: Hawai`i Department of Land and Natural Resources, Division of Water and Land Development Report R76, page 267

[13] Giambelluca, T.W., and Nullet, Dennis, 1991, Influence of the trade-wind inversion on the climate of a leeward mountain slope in Hawai`i: Climate Research, v. 1, p. 207–216.

[14] Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially Distributed Groundwater Recharge Estimated using a Water-budget Model for the Island of Maui, Hawai`i, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168, page 38, http://dx.doi.org/10.3133/sir20145168.

and Kula basalt create a terrain hundreds of thousands of years younger than the one on older volcanic rocks.[15]

16.2.2 Water Resources

Climate, hydrology, geology and human activities affect the hydrologic cycle and the interconnected surface and ground water systems. Perennial and intermittent streams on windward Haleakalā are generally fed by abundant rainfall and groundwater discharge.[16] Stream flow has been extensively assessed in the Ko`olau ASEA. Occurrence of groundwater in the Hānawi watershed in Nahikū was evaluated extensively, as was groundwater occurrence and contribution to stream flow from Maliko Gulch in the west to Makapipi stream in the east.

On northeast Haleakalā, in the area between Makawao and Ke`anae Valley, fresh saturated groundwater occurs as perched, high-level water held up by relatively low-permeability geologic layers above an unsaturated zone,[17] and a freshwater-lens system underlain by seawater.[18] The perched groundwater is several tens of feet below the ground surface within layers of thick lava flows, ash, weathered clinker beds, and soils. Collectively, this assemblage of layers has low permeability that impedes the downward movement of the perched, high-level groundwater. An unsaturated zone and a freshwater-lens system are beneath the high-level groundwater. The freshwater-lens system is located within high-permeability basalt lava flows and has a water table that is several feet above sea level. In the area between Ke`anae Valley and Nāhiku, the groundwater system appears to be saturated above sea level to altitudes greater than 2,000 ft.[19]

<u>Groundwater Recharge</u>

Groundwater recharge describes the amount of water that travels from the air, through the soil, and ultimately into the groundwater and aquifers. The 2014 USGS study, *Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Ko`olau, 1978–2007*, reassessed average climate conditions on recharge using 2010 land cover. For this study, direct recharge was defined as water that passes directly to the groundwater system, completely bypassing the plant-root zone. Hence, direct recharge was not

[15] Hazlett, Richard W. and Hyndman, Donald W., *Roadside Geology of Hawai`i*, page 129.

[16] Gingerich, S.B., 1999a, Ground water and surface water in the Ha`ikū area, East Maui, Hawai`i: U.S. Geological Survey Water-Resources Investigations Report 98–4142, 38 p.13 ; Gingerich, S.B., 1999b, Ground-water occurrence and contribution to streamflow, northeast Maui, Hawai`i: U.S. Geological Survey Water-Resources Investigations Report 99–4090, 69 p.

[17] Gingerich, S.B., 1999b, Ground-water occurrence and contribution to streamflow, northeast Maui, Hawai`i: U.S. Geological Survey Water-Resources Investigations Report 99–4090, 69 p.

[18] Gingerich, S.B., 1999a, Ground water and surface water in the Ha`ikū area, East Maui, Hawai`i: U.S. Geological Survey Water-Resources Investigations Report 98–4142, 38 p.

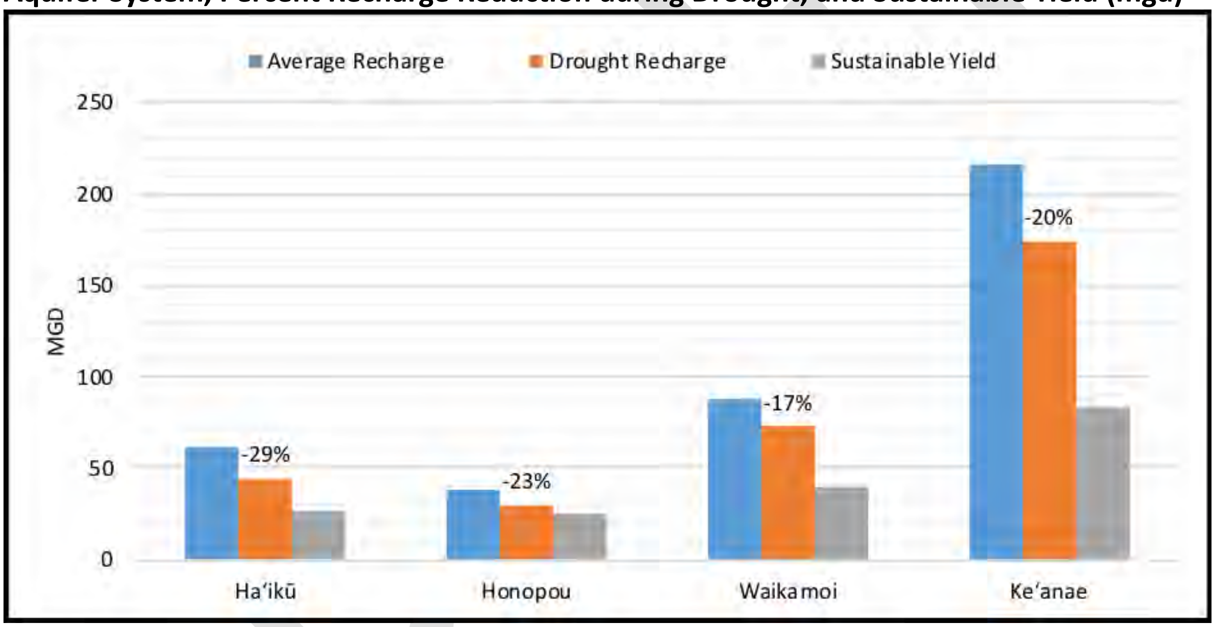
[19] Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget model for the Island of Maui, Hawai`i, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168, 53 p.

subject to direct runoff or evapotranspiration processes.[20] Of Maui's total mean recharge for average climate conditions, 60 percent occurs in the Ko`olau and Hāna ASEA's on windward Haleakalā.[21] A drought condition scenario modeled for the Ko`olau ASEA based on rainfall during the 1998–2002 period yielded a 21 percent reduction in recharge sector-wide, compared to average climate conditions.

Table 16-1 Ko`olau ASEA Groundwater Recharge Estimates Drought and Average Conditions

Recharge Average Climate Conditions (mgd)	Recharge Drought Climate Conditions (mgd)	% Decrease Drought Climate Conditions
404	319	21

Figure: 16-1 Average Mean Recharge under Average Climate and Drought Conditions by Aquifer System, Percent Recharge Reduction during Drought, and Sustainable Yield (mgd)



Source: CWRM 2008 Sustainable Yields. Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget model for the Island of Maui, Hawai`i, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168

The Pacific Regional Integrated Sciences and Assessments' (Pacific RISA) *Maui Groundwater Project* is an interdisciplinary research effort to inform decisions about the sustainability of groundwater resources on the island of Maui under future climate conditions. A new hydrologic model is being used to assess the impact of changing climate and land cover on groundwater

[20] Ibid, 30 p., http://dx.doi.org/10.3133/sir20145168.
[21] Ibid 49 p.

recharge over the island. Preliminarily future climate projections for Maui Island suggest that wet areas get wetter with mean annual rainfall increases. Scientists' confidence in trends and changes to rainfall and associated recharge is relatively low. No stream flow projections are available for the coming century. The impact on recharge and stream flow from climatic changes at the time of this plan is highly uncertain.

Groundwater Availability

The groundwater sustainable yield (SY) is the maximum rate that groundwater can be withdrawn without impairing the water source as determined by the Commission on Water Resources Management (CWRM). Generally, SY is conservatively set at the low end of the estimated range of predicted sustainable yields for an aquifer. Updated SY for the entire state is under review for the pending 2018 State Water Resource Protection Plan.

Table 16-2 Sustainable Yields for Ko`olau Aquifer System Areas

Ko`olau Aquifer System Area (ASYA)	Aquifer Code	Sustainable Yield Range	2008 WRPP Sustainable Yield (mgd)
Ha`ikū	60401	27*	27
Honopou	60402	25-26	25
Waikamoi	60403	40*	40
Ke`anae	60404	83*	83
TOTAL			**175**

Source: CWRM, *State Water Resource Protection Plan (SWRPP*, June 2008, page 3-66.
*No range given for this

Table 16-3 Pumpage by Well Type for Ko`olau Aquifer System Areas (ASYAs)

Aquifer	Domestic	Industrial	Agriculture	Irrigation	Municipal County	Municipal Private Public	Municipal Total	Total
Ha`ikū	0.007	0	0.0139	0.0017	0.811	0.005	0.816	0.839
Honopou	0.0007	0	0	0		0.0098	0.0097	0.0104
Waikamoi	0	0	0	0	0	0	0	0
Ke`anae	0	0	0	0	0.066	0	0.066	0.066
Ko`olau Total	**0.0078**	**0**	**0.0139**	**0.0017**	**0.877**	**0.0149**	**0.892**	**0.916**
% of Total	**0.85%**	**0%**	**1.52%**	**0.19%**	**95.81%**	**1.63%**	**97.44%**	**100%**

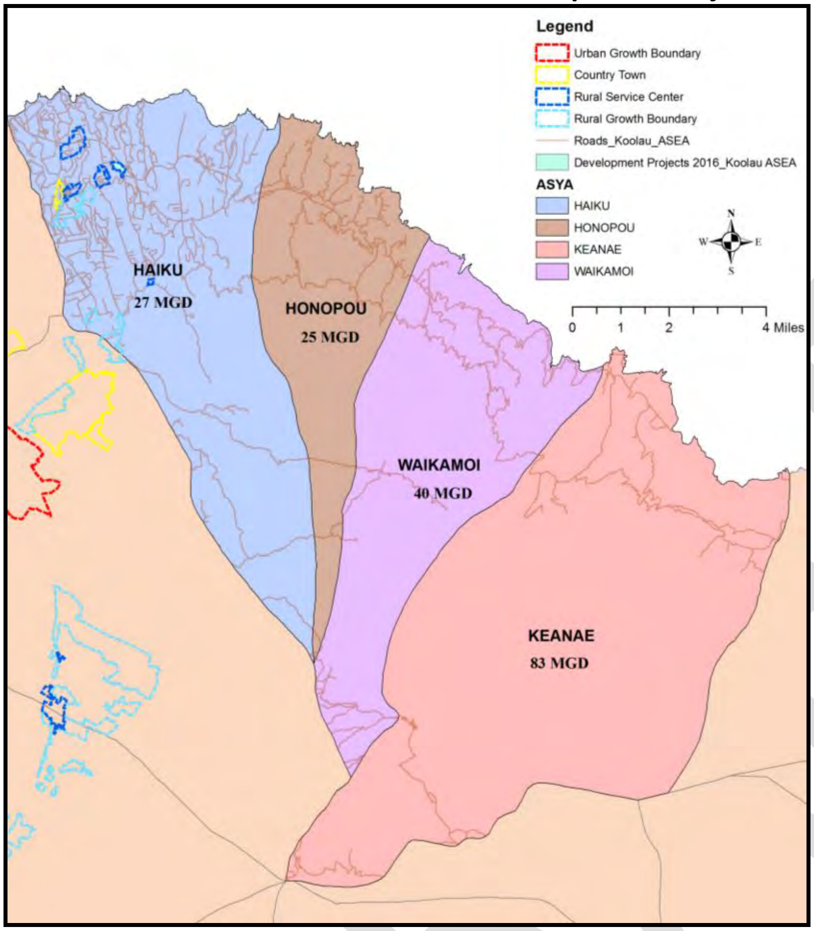
Source: CWRM Well Database 2014 and revised SY figures for 2016 WRPP

CWRM ranks the SY values according to the degree of confidence that CWRM places on the number, ranging from (1) most confident to (3) least confident. The degree of confidence is directly related to the type, quality and quantity of hydrologic data used in the SY determination. Other than the Ha`ikū Aquifer that was ranked as (2) moderately confident[22], CWRM ranked all other aquifer systems in this sector (3) least confident, recognizing that there is significant uncertainty associated with the SY due to the lack of hydrogeologic and pumpage information.[23]

Sustainable yield (SY) does not account for water transfers, such as irrigation return flow that percolates back into the aquifer to be potentially re-pumped, and SY accounts for basal, perched, and high-level water. Groundwater is developed and utilized within the Ha`ikū and Ke`anae ASYAs, and surface water is conveyed from the Waikamoi ASYA to the Central ASEA via an aqueduct system. Significant surface water is transported from Ko`olau ASEA to THE Central ASEA. Additionally, surface water is transported via the Nahikū Tunnel located by Makapipi Stream within the Hāna ASEA to Ke`anae within the Ko`olau ASEA. The figure below shows the relationship between aquifer systems, Maui Island Plan growth boundaries and development projects.

[22] Sufficient data or studies are available to indicate that the adopted Sustainable Yield is not likely to overestimate the true Sustainable Yield of the aquifer system area. However, more detailed studies are required to better refine the potential range of Sustainable Yields. Source: CWRM, Water Resources Protection Plan, 2008 pp 3-86.
[23] CWRM, Water Resources Protection Plan, 2008 pp 3-82.

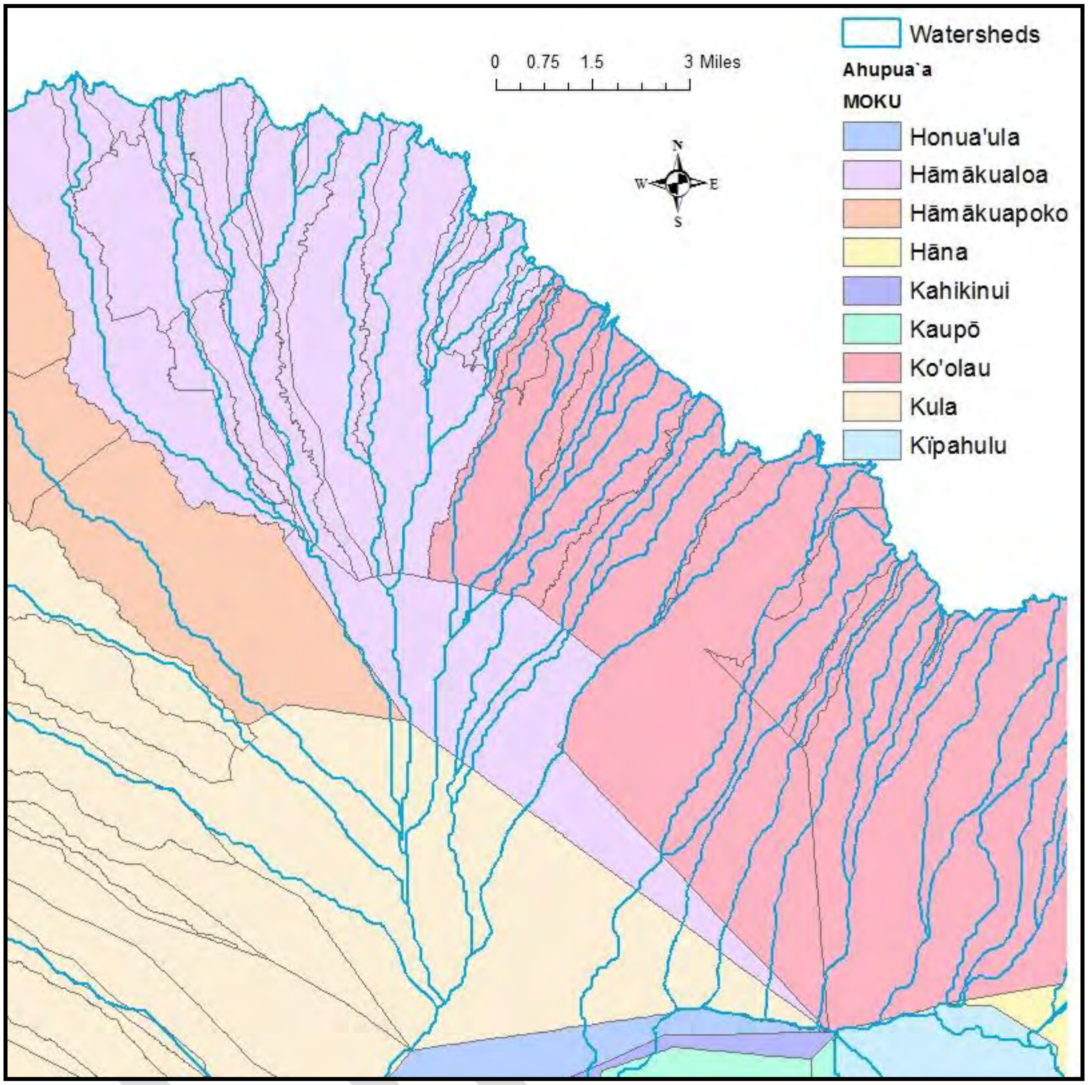
Figure 16-2 Ko`olau ASEA Relationship of Aquifer System Areas and Sustainable Yield to Maui Island Plan Growth Boundaries and Development Projects



Moku and Watersheds

Watershed boundaries established by the Commission on Water Resource Management are proximate but not identical to ahupua`a, which in turn are united into larger moku. Most of the aquifer sector encompasses the Hāmākualoa moku and the Ko`olau moku. The figure below shows moku and watershed boundaries in the Ko`olau ASEA.

Figure 16-3 Ko`olau ASEA Moku and Watershed Boundaries



Surface Water Availability

Streams in the Ko`olau ASEA generally originate in the wet uplands of Haleakalā and flow toward the coast. Streams on windward Haleakalā are fed by abundant rainfall and groundwater discharge.[24] In the area between Makawao and Ke`anae Valley, groundwater discharges to streams from a perched, high-level saturated groundwater system.[25] East of Ke`anae Valley, groundwater discharges to streams from a vertically extensive freshwater-lens

[24]Gingerich, S.B., 1999b, Ground-water occurrence and contribution to streamflow, northeast Maui, Hawai`i: U.S. Geological Survey Water-Resources Investigations Report 99–4090, 69 p.

[25] Gingerich, S.B., 1999a, Ground water and surface water in the Ha`ikū area, East Maui, Hawai`i: U.S. Geological Survey Water-Resources Investigations Report 98–4142, 38 p.

system.[26] Water is diverted from many streams on windward Haleakalā and prior to the closing of Hawaiian Commercial & Sugar, was mainly used to irrigate sugarcane in the isthmus. The diversions are now primarily used as a source of domestic water supply and diversified agricultural activities for the Central ASEA. Stream reaches on leeward Haleakalā tend to be ephemeral.[27]

The surface water hydrologic units (a surface drainage area or a ground water basin or a combination of the two),[28] generally referred to as watersheds, and historically referred to as ahupua`a,[29] are shown below. 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.[30] There are 37 surface water hydrologic units (i.e. watershed units) within the Ko`olau ASEA.[31] There are 36 streams in the Ko`olau ASEA that are classified as perennial.[32] Of these streams, 31 are considered continuous and 5 are considered intermittent.[33] There are 11 USGS gages on streams in this sector.

The 1990 Hawai`i Stream Assessment prepared for CWRM inventoried streams statewide. However, data on stream flow is only available through either active gages or stream assessment and studies.   With three known active gages, information on stream flow under various conditions is extremely limited. Where no stream flow data is available, declaration of water use and kuleana parcels can provide some guidance to water availability.

[26] Meyer, William, 2000, A reevaluation of the occurrence of ground water in the Nahikū area, East Maui, Hawaii, U.S. Geological Survey Professional Paper 1618, 81 p.

[27] Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially distributed groundwater recharge estimated using a water-budget model for the Island of Maui, Hawai`i, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168, 53 p., http://dx.doi.org/10.3133/sir20145168.

[28] State of Hawai`i, DLNR, Commission on Water Resource Management, Surface-Water Hydrologic Units: A Management Tool for Instream Flow Standards, PR-2005-01, June 2005, page 1.

[29] Ahupua`a and watershed boundaries are similar but do differ in boundary areas. Ahupua`a has been used traditionally in Native Hawaiian culture as a unit of land division with economic, social and natural resources considerations. Watershed units are used in this document interchangeably with hydrologic units and are primarily used to identify units of land using water resources/hydrologic boundaries.

[30] State of Hawai`i, DLNR, Commission on Water Resource Management, Surface-Water Hydrologic Units: A Management Tool for Instream Flow Standards, PR-2005-01, June 2005, page 2.

[31] Hawai`i Stream Assessment Report, R-84 December 1990.

[32] Ibid.

[33] Ibid.

Figure 16-4 Ko`olau ASEA Hydrologic Units/Watersheds (East Section of ASEA)

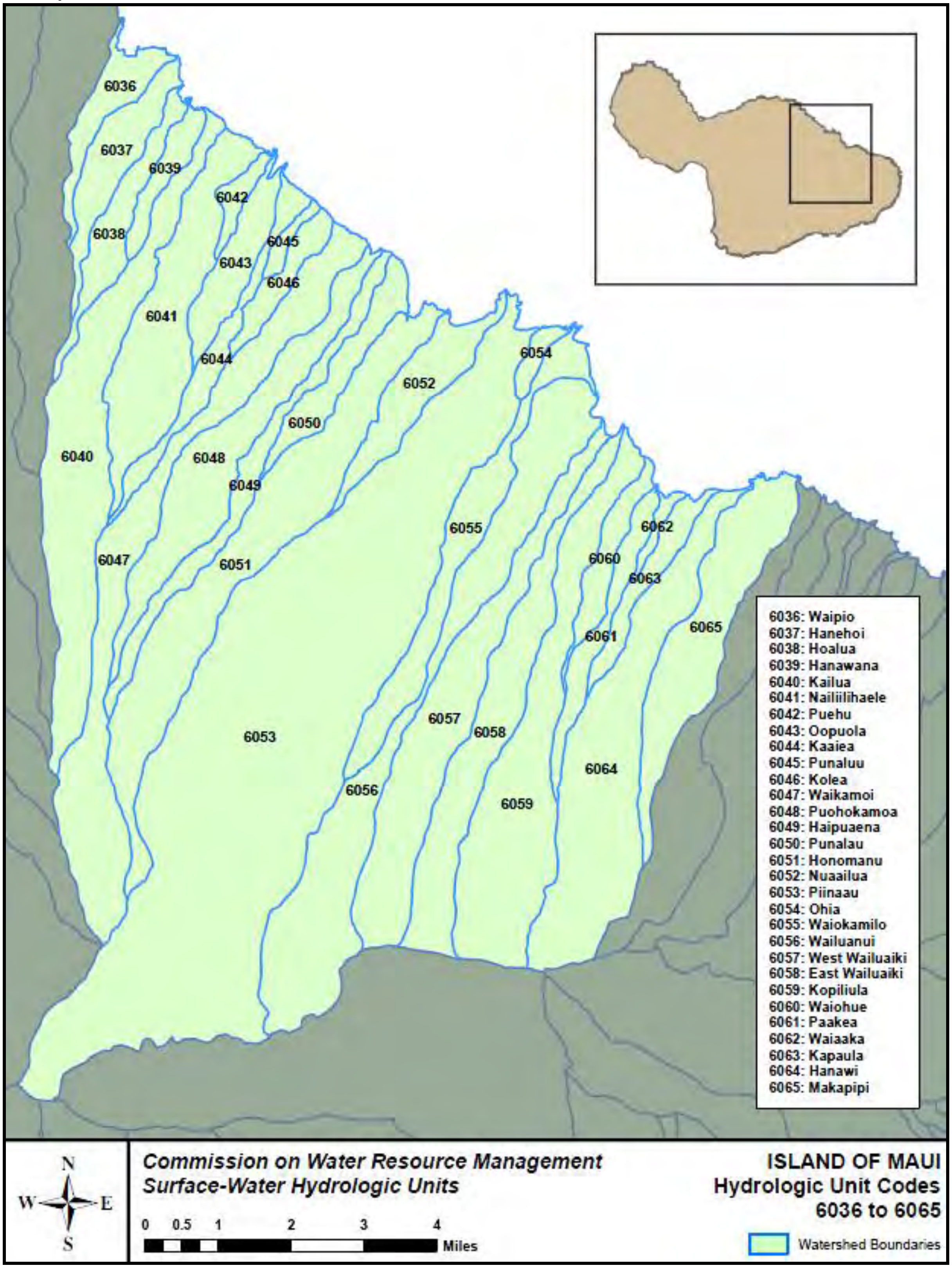
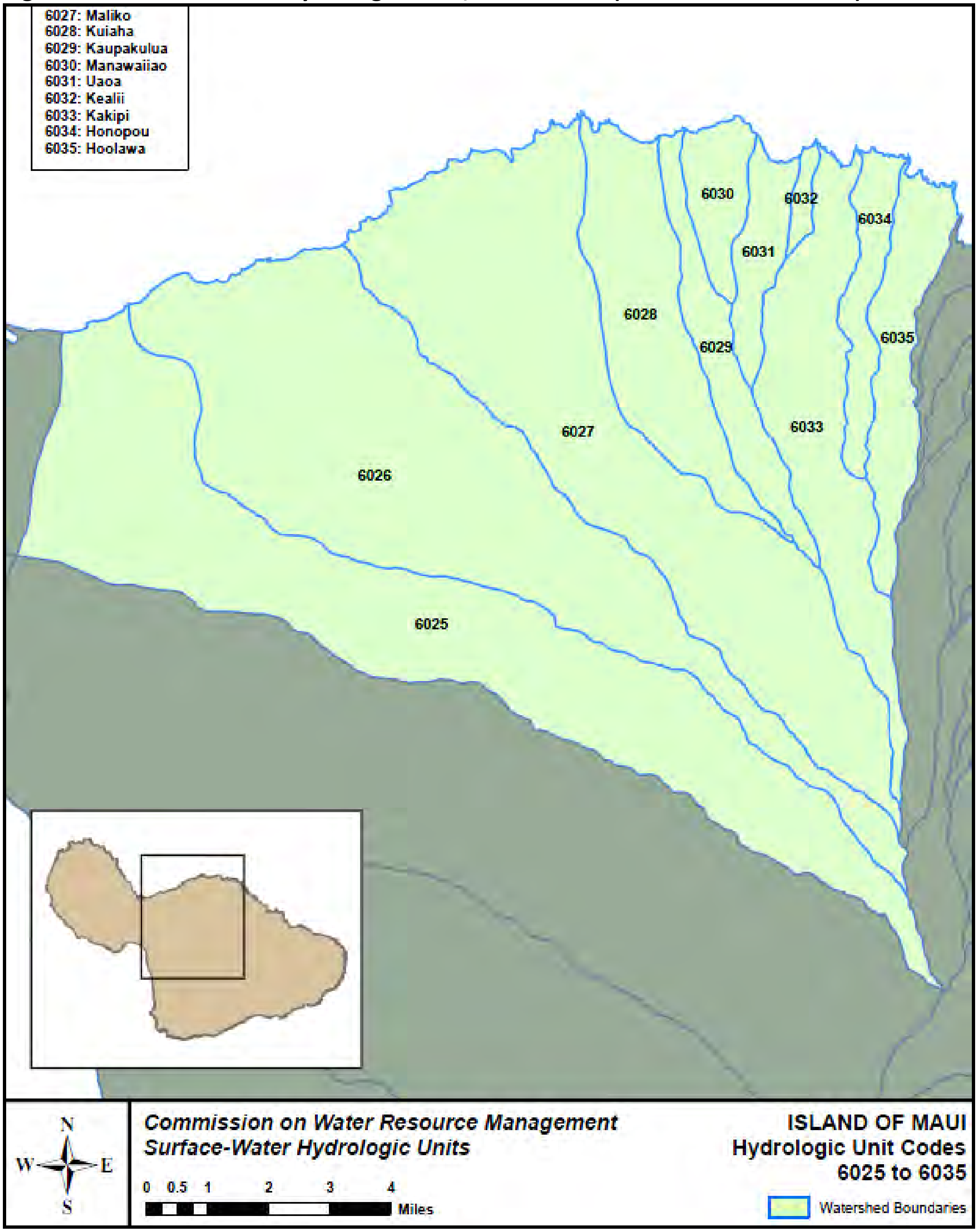


Figure 16-5 Ko`olau ASEA Hydrologic Units/Watersheds (West Section of ASEA)



NOTE: Hydrologic units 6025 and 6026 are outside the Ko`olau ASEA—all other adjacent hydrologic units (6027-6035) are within the Ko`olau ASEA

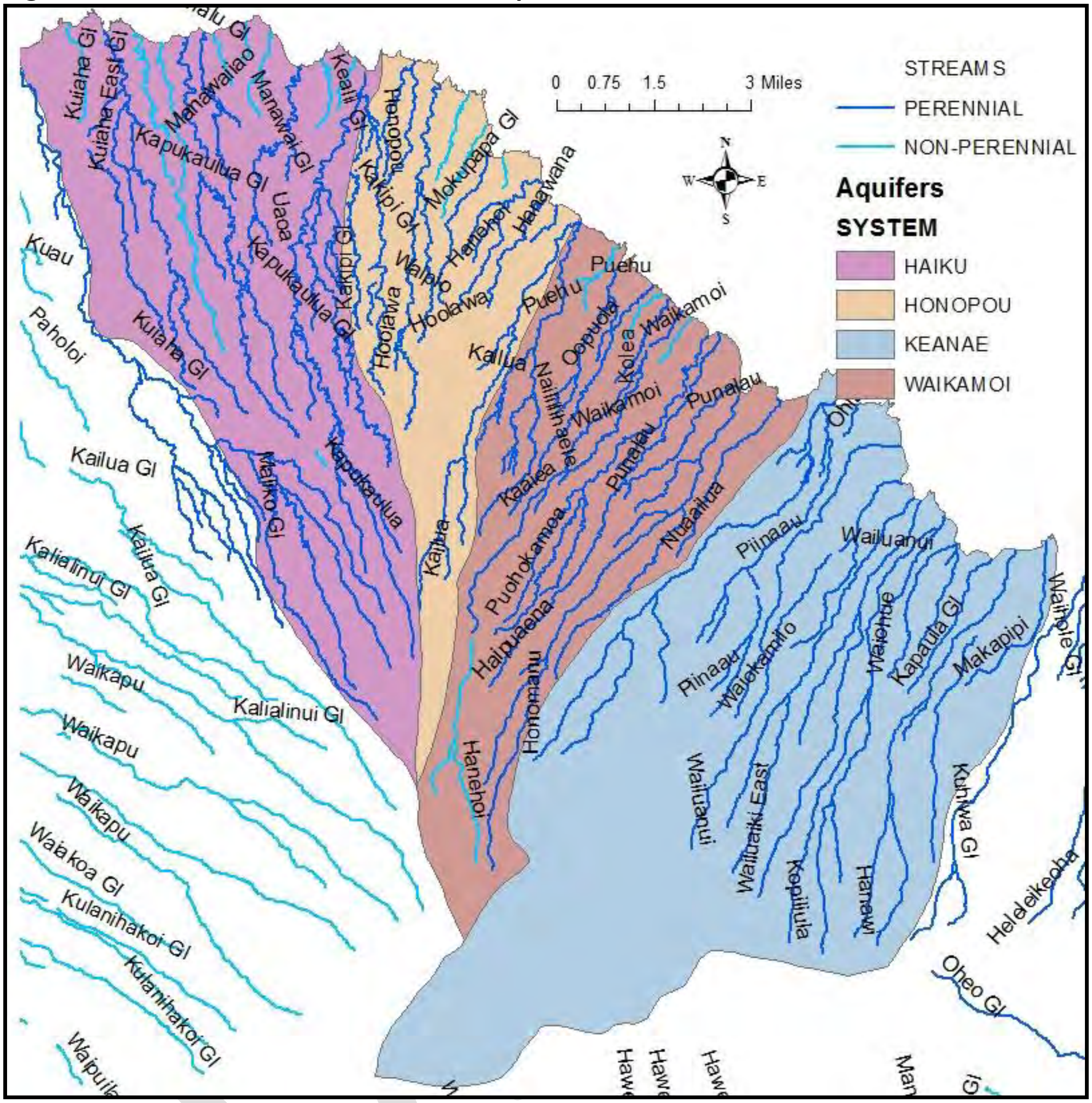
Table 16-4 Hydrologic Units and Perennial Streams in Ko`olau ASEA

Hydrologic Units	
6027	Maliko
6028	Kuiaha
6029	Kaupakulua
6030	Manawaiiao
6031	Uaoa
6032	Keali`i
6033	Kakipi
6034	Honopou
6035	Ho`olawa
6036	Waipio
6037	Hanehoi
6038	Hoalua
6039	Hanawana
6040	Kailua
6041	Naili`ilihaele
6042	Puehu
6043	O`opuola
6044	Ka`aiea
6045	Punalu`u
6046	Kolea
6047	Waikamoi
6048	Puohokamoa
6049	Haipua`ena
6050	Punalau
6051	Honomanu
6052	Nua`ailua
6053	Pi`ina`au
6054	Ohia
6055	Waiokamilo
6056	Wailuanui
6057	West
6058	East
6059	Kopiliula
6060	Waiohue
6061	Pa`akea
6062	Waia`aka
6063	Kapaula
6064	Hānawi
6065	Makapipi

Perennial Streams	
6301	Maliko
6302	Kuiaha
6303	Kaupakulua
6304	Manawai`iao
6305	Uaoa
6307	Kakipi
6308	Honopou
6309	Ho`olawa
6310	Waipio
6311	Hanehoi
6312	Hoalua
6313	Hanawana
6314	Kailua
6315	Naili`ilihaele
6401	O`opuola
6402	Ka`aiea
6403	Kolea
6404	Waikamoi
6406	Puohokanioa
6407	Haipua`ena
6408	Punalau
6409	Honomanu
6410	Nua`ailua
6411	Pi`ina`au
6412	Ohia
6413	Waiokamilo
6414	Wailuauui
6415	W. Wailuaiki
6416	E. Wailuaiki
6417	Koplilula
6418	Waiohue GL
6419	Pa`akea
6420	Waia`aka
6421	Kapaula
6422	Hānawi
6423	Makapipi

Source: *Hawai`i Stream Assessment Report, R-84 December 1990.*

Figure 16-6 Ko`olau ASEA Streams and Aquifer Boundaries



The CWRM database indicates that there are 323 declared stream diversions in the Ko`olau ASEA and 11 gages, of which, only three are "active." Most of these diversions belong to the East Maui Irrigation Company (EMI).

A summary of stream flow, diversions and gages by hydrologic unit and interim instream flow standards (IIFS) established June 20, 2018 for Ko`olau ASEA is provided in Appendix 16 A. The IIFS for this region reflects the diverted amounts estimated at 64% of median base flows (BFQ50), also known as (H90) flows, for stream restoration, and the numbers are only estimates eventually to be confirmed by actual flows from which the H90 can be established.[34]

[34] State of Hawai`i Commission on Water Resource Management, Petition to Amend Interim Instream Flow Standards for WAIKAMOI, PUOHOKAMOA, HAIPUA`ENA, PUNALAU/KOLEA, HONOMANU, WEST WAILUAIKI, EAST WAILUAIKI, KOPILIULA, PUAKA`A, ) WAIOHUE, PA`AKEA, KAPAULA & HANAWI STREAMS, June 20, 2018, page 267.

`Transport of Stream Water from East Maui

Streams in the Ko`olau ASEA are subject to the East Maui Contested Case due to significant diversions by East Maui Irrigation Company (EMI) to Central Maui, resulting in surface water being transported from the Ko`olau ASEA to the Central Maui ASEA.

Until 2016, the EMI diverted stream water for the Hawaiian Commercial & Sugar's (HC&S) Central Maui cane fields. A relatively small amount of water is used for residential and agricultural use by the MDWS for its Upcountry Maui Water Systems. The EMI ditch system, which began construction in 1876, is the nation's largest privately built and operated water system; it consists of approximately seventy-five (75) miles of ditches, tunnels, siphons, flumes, and reservoirs. The Hawai`i Department of Agriculture's Agricultural Water Use and Development Plan (2004) listed the average delivery at 165 mgd with a delivery capacity of 435 mgd.

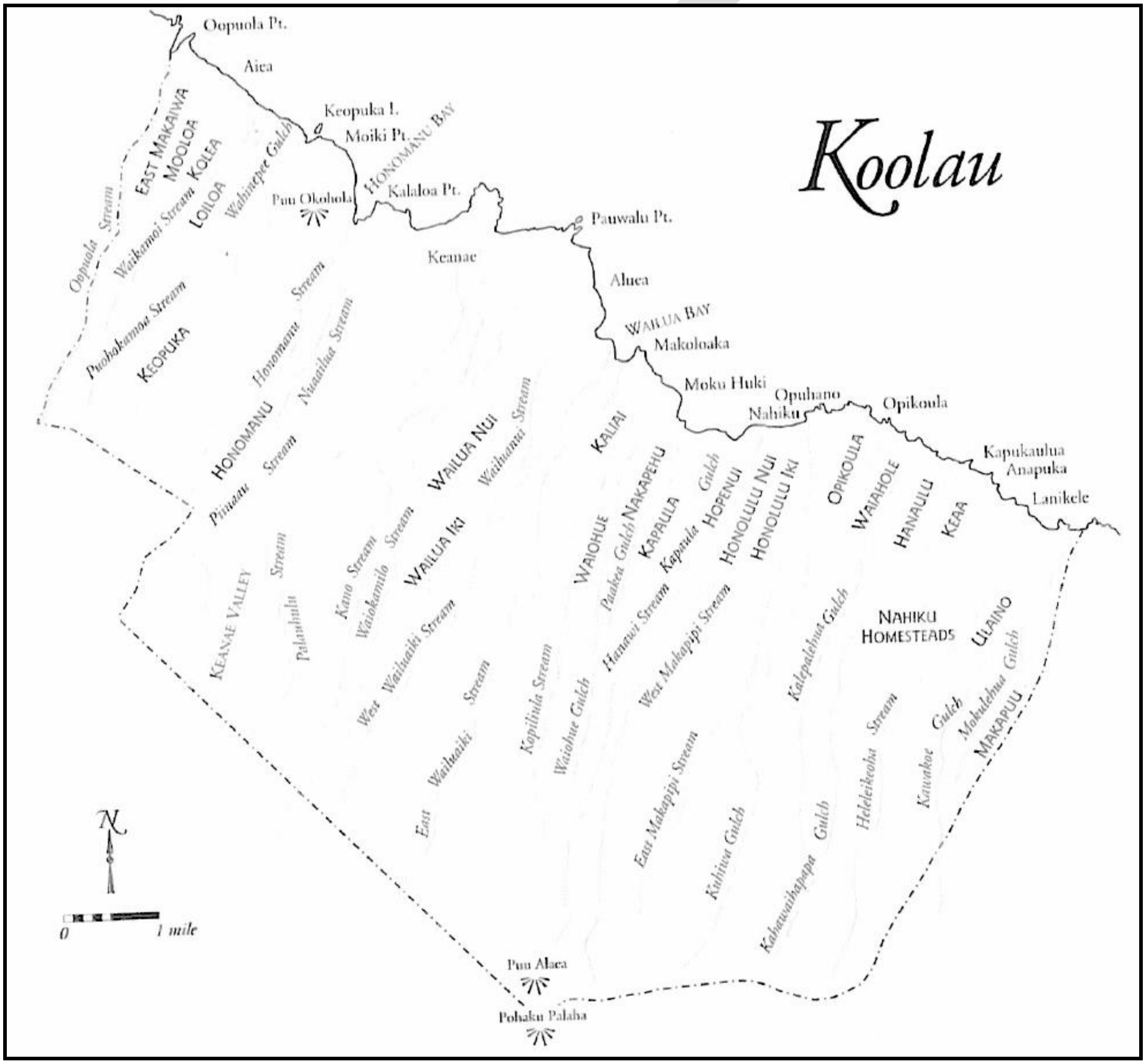
Wailoa Ditch	195 mgd
New Hāmākua Ditch	100 mgd
Lowrie Ditch	70 mgd
Ha`ikū Ditch	70 mgd
Total Capacity	**435 mgd**

Native Hawaiian cultural practitioners require sufficient water from some of these streams for taro cultivation and gathering rights.

16.3 SETTLEMENT PATTERNS AND CULTURAL RESOURCES

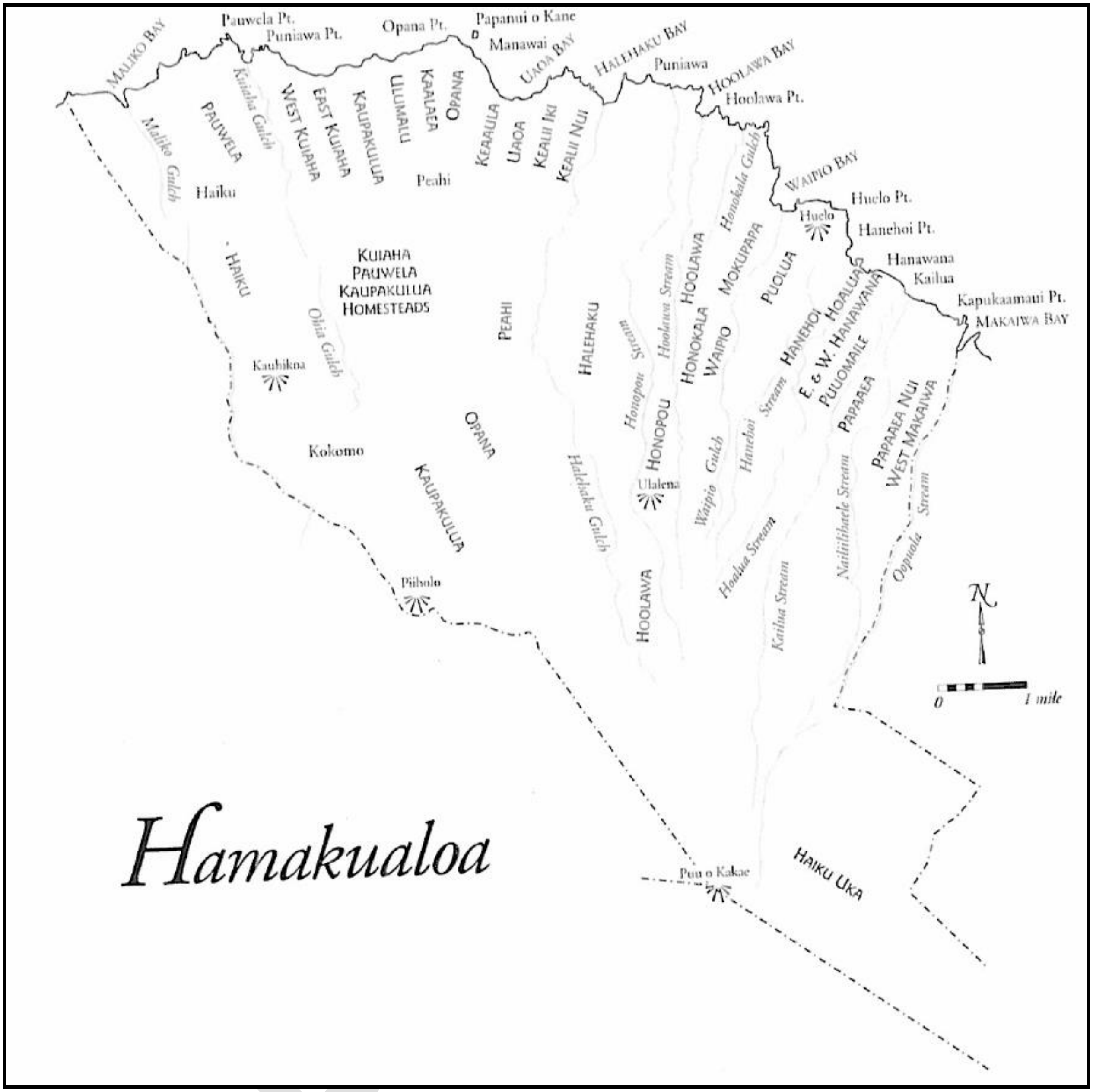
This section strives to acknowledge and highlight how Hawaiian history and cultural practices of the past relate to the present. That historical perspective can inform options for meeting the future water needs of the people of Maui Island, while preserving and celebrating Ko`olau's past. Awareness of past land and water use through archaeology and traditional Native Hawaiian culture history provides a foundation for establishing continuity between present and future water use in the Ko`olau area.

Figure 16-7 Traditional Moku of Ko`olau within the Ko`olau ASEA



Source: Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997.

Figure 16-8 Traditional Moku of Hāmākualoa within the Ko`olau ASEA



Source: Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997.

Historical Boundaries

The Ko`olau Aquifer Sector Area (ASEA) includes the traditional areas, or moku (districts) of Ko`olau, Hāmākualoa, Kula; and to lesser extents Kahikinui, Kīpahulu, Kaupō, Honua`ula, while the boundaries of the Ko`olau ASEA used by the WUDP extends to the Honopou and Ha`ikū ASYAs. Although an abundance of water is produced in Ko`olau, the rugged topography, with its extreme slopes and general lack of level land, renders many areas unsuitable for human habitation.

Water

Cultural historian Kepa Mali describes Ko`olau, the northeast coast of East Maui, as having "precipitous shores eroded by the waves which the trade winds sweep against its cliffs, and inlets. Here the flank of Haleakalā is steep, and as the trade winds blow up across their forested slopes they are cooled and release their moisture, making this the wettest coastal region in all the islands."[35] On average, USGS data indicates rainfall ranges from 101-454 inches per year, making the Ko`olau ASEA Maui Island's rainiest ASEA and one of the wettest places in Ko`olau.[36]

16.3.1 Historic Agriculture

<u>Historical Native Hawaiian Agriculture and Cultural Resources</u>

O'opuola Gulch marked the northwestern boundary of Ko`olau. Its stream along with Waikamoi, Puohokamoa, and Haipuena streams, watered small lo`i.[37]

<u>Kalo</u>

"It is on the broad flat peninsula of lava extending for about half a mile into the sea from the western line of the valley that Ke`anae's famed taro patches are spread out offering striking evidence of old Hawai`i's ingenuity. Polaukulu [Palauhulu] Stream, which breaks through the gap at the northwestern corner of the valley, gives an abundant supply of water to the many wet patches (about half those once cultivated) which are still used for raising wet taro. A flume (*ha wai*) carried the water across the narrow channel below the *pali*. When well-tended, the taro growing there was as healthy as any we have seen, indicating that there is ample water. But we are told that there has been taro disease in some of the patches and that some of the lower terraces were abandoned because the earth bottoms, which rest on rough lava, breakthrough in spots and allow the water to drain out."[38]

Beyond Wailuanui there is a succession of small deep gulches, each one having a few lo`i: East Wailuaiki and West Wailuaiki (Little Wailua), Kapili`ula [Kopili`ula], Waiohue, Pa`akea, Kapa`ula, and Hānawi. Then comes Nahikū, a settlement spread over gently rising ground above the shore, with a number of groups of lo`i watered from Makapipi Stream. Some wet taro was still grown there in 1934.[39] Eastward from Nahikū there are no large streams or gulches in Ko`olau.

[35] Kumu Pono Associates, Volume I, Wai O Ke Ola: He Wahi Mo'olelo No Maui Hikina, A collection of Native Traditions and Historical Accounts of the lands of Hāmākua Poko, Hāmākua Loa and Ko`olau, Maui Kikina (East Maui), Island of Maui, 2001, page 8.

[36] Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially distributed groundwater recharge estimated using a water-budget model for the Island of Maui, Hawai`i, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168, page 38, http://dx.doi.org/10.3133/sir20145168.

[37] E.S.C. Handy, Hawaiian Planter, page 109 [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 108].

[38] E.S.C. Handy, Hawaiian Planter, page 109 (Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, pages 109-110).

[39] Ibid.

The shore is low and the terrain gently sloping. At Ulaino and Honoma`ele there are a number of places where dry taro was still planted by Hawaiians in 1934, together with other small subsistence plantings. Formerly there was scattered planting all along the coast and forest plantations inland, between Ulaino and Nahikū, which are connected by the old Alaloa Trail crossing the low-lands near the coastline.[40]

Sweet Potatoes

For the most part, even the lower kula of Ko`olau is too wet to be favorable for sweet potato planting except in a dry season, but according to Handy, in 1934 there were some excellent patches of sweet potatoes above Ke`anae and at Wailua and Nahikū, and above the latter place there were wild sweet potatoes in the lower forest, indicating that they used to be planted there.[41]

Ahupua`a of Ko`olau

E.S.C. Handy describes the kalo of Ko`olau as follows,

"Throughout wet Ko`olau, the wild taro growing along the streams and in the pockets high on the canyon like walls of the gulches reveals former planting of stream taro along the water courses, on the side of the gulches, and in the forest above. The same is true of the wild taros seen here and there in the present forest above the road and in protected spots on what was formerly low forest land, now used as pasture."[42]

Honomanū Valley

A large population was supported in Honomanū Valley in ancient times. The bay was famous for fishing, and a large stream was in the deep, flat valley bottom…one family still raises taro in the old patches near the sea (early 1900s), but abandoned terraces extend up into the valley as far as the level land goes, a little less than a mile. Above Honomanū on elevated flatlands there used to be some terraces and houses.[43] Elspeth Sterling makes mention of the old lo`i system on that side of the Valley "which was abandoned probably as a result of the loss of the water supply, perhaps at the time of the 1938 earthquake, perhaps earlier…The walls in this area are quite extensive…."[44]

Many lo`i systems have been lost over time, "Still another, Kolea Stream is now shown running into the Honomanū Valley itself on the current TMK 1-1-01. This is in the vicinity of the old lo`i system"[45] The areas of Papiki, Nuili'i and Punalau lie on the north side of the little stream by the name of Punalau, which was formerly the source of water for the lo`i in that area, …taro was

[40] Ibid, Handy page 111; Sterling page 115.
[41] Ibid, Handy page 160; Sterling, page 109.
[42] Ibid, Handy page 111; Sterling page 115.
[43] Ibid, page 110.
[44] Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 110.
[45] Ibid.

apparently extensively grown on both sides of the main stream, as well as in the 3 ili cited above on the banks of the Punalau Stream.[46]

Nu`uailua

Culture historian Kepa Maly describes "This smaller, flat-bottomed valley between Honomanū and Ke`anae, now uninhabited, was formerly the site of a settled community which raised wet taro in terraces."[47] Archaeologist Elspith Sterling noted that "There are broad slopes above this valley which were presumably inhabited and cultivated. Upland taro should have flourished there."[48]

Ke`anae

Ke`anae lies just beyond Honomanū Valley and is described as follows,

> "…a unique wet-taro growing `ahupua`a that early inhabitants settled, planting upland rain-watered taro far up into the forested area, and on the lower part of the valley an area of irrigated taro was developed on the east side, but today (2001) it is mostly covered by grass. The energies of the people were diverted to create the lo`i complex which now covers the peninsula. It was here that the early inhabitants settled, planting upland rain-watered taro far up into the forested area."[49]

Although there are different versions of the creation of the Ke`anae Peninsula, one story of the founding of the Ke`anae lo`i area is very interesting because it describes how ancient Hawaiians were able to transform formerly unusable land into a fertile lo`i system, demonstrating how knowledgeable and ingenious Native Hawaiians were connected to nature. Handy writes,

> "Anciently, according to Henry Ikoa, the peninsula was barren lava. But a chief, whose name is not remembered, was constantly at war with the people of neighboring Wailua and was determined that he must have more good land under cultivation, more food, and more people. So he set all his people to work (they were then living within the valley and going down to the peninsula only for fishing), carrying soil in baskets from the valley down to the lava point. The soil and the banks enclosing the patches were thus, in the course of many years, all transported and packed into place. Thus did the watered flats of Ke`anae originate. A small lo`i near the western side of the land formerly belonged to the chief of Ke`anae and has the name Ke`anae (the Big Mullet): it is said that the entire locality took its name from this small sacred lo`i. Here, as at Kahakuloa, the taro that grew in the sacred patch of the ali`i was reported to be of great size."[50]

---

[46] Ibid.

[47] Kumu Pono Associates, Volume I, Wai O Ke Ola: He Wahi Mo'olelo No Maui Hikina, A collection of Native Traditions and Historical Accounts of the lands of Hāmākua Poko, Hāmākua Loa and Ko`olau, Maui Kikina (East Maui), Island of Maui 2001, page 9.

[48] E.S.C. Handy, Hawaiian Planter, page 109-110 (Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 111.

[49] Ibid

[50] E.S.C. Handy, Hawaiian Planter, page 109-110 (Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 111).

Wailua

There are several small streams between Ke`anae and Wailuanui. They flow in deep small gorges, and the terrain is very rough, but there were a few small lo`i developments. There are said to have been two springs of fresh water, which were opened by Kane and Kanaloa in their travels on Maui. From these springs, in a valley named Ohi`a, comes the water that irrigates the lo`i in Wailua, so says the legend.[51] The Wailuanui Stream gushes down in a beautiful cascade in its gorge just before flowing into the lo`i area. This cascade is called Wai-o-Kane (Water of Kane). This is significant, because Kane is the very important god of fresh water, and the fact the waterfall is referred to as "Water of Kane" may suggest that the area is characterized by its exceptional abundance of fresh water.

> “Wailua has been notable for its continued occupancy and cultivation by Hawaiian families. About half the gently sloping land seaward of the cliff was terraced with lo`i, which were watered by Wailuanui (Big Wailua) Stream, the largest of the three that flow into the bay. The land beyond the terraced area, on the Ke`anae side toward the sea is too high for irrigation; here sweet potatoes were planted. The mouth of Wailuanui Stream empties into Wailua Nui Bay, which is generally unsuitable for recreational swimming. The hydrologic unit of Wailuanui supports the largest complex of taro cultivation in the east Maui region (center).”[52]

Nahikū

Handy describes historic kalo cultivation in Nahikū as extensive,

"Nahikū has a number of terraces, some still under cultivation, below the village. The people of this genuinely Hawaiian community also cultivate dry taro patches above their houses. Throughout wet Ko`olau the wild taro growing along the streams and in the pockets high on the canyon-like walls of the gulches bespeaks former planting of stream taro along the watercourses, on the sides of the gulches, and in the forest above. The same is true of the wild taros seen here another in the present forest above the road and in protected spots on what was formerly low forest land, now used as pasture. Eastward from Nahikū there are no large streams or gulches in Ko`olau…At Ulaino and Honomaele there are a number of places where dry taro is still planted by Hawaiians together with other small subsistence plantings. Formerly there was scattered planting all along the coast and forest plantations inland, between Ulaino and Nahikū, which are connected by an old trail crossing the lowlands near the coastline."[53]

Hāmākualoa

Speaking to the possible frequency and intensity of the rain in the area, which has a different orientation to the wind compared to the eastern facing areas as it begins to wrap around the

---

[51] Ka Nupepa Ku`oko`o, October 4, 1923.

[52] State DNLR, CWRM. Instream Flow Standard Assessment Report, Island of Maui, Hydrologic Unit 6056, Wailuanui, September 2008, PR-2008-05 http://files.hawaii.gov/dlnr/cwrm/ifsar/PR200805.pdf

[53] E.S.C. Handy, Hawaiian Planter, page 111 (Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 115)

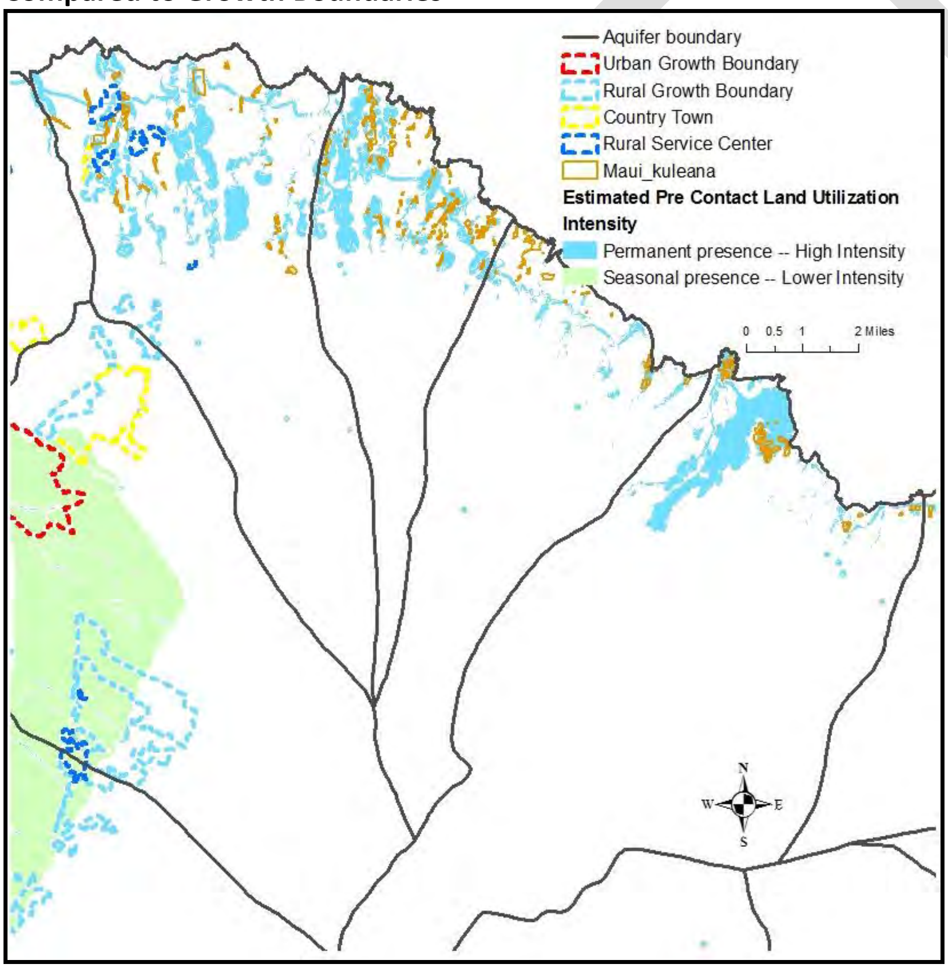
northern shoreline, Mary Pukui recalls how it was described by Edwin Baker, "Rain of Hāmākua, Ka ua pe`e puhala o Hāmākua, 'the rain of Hāmākua that makes one run to the hala tree to hide.'"[54]

Ancient legends describe the water resources of the area before and after the Gods Kaneloa and Kane traveled to Hāmākualoa, indicating that it now has abundant water:

> "Kaneloa said to Kane, 'We have circled Ko`olau let us go to Maui.' They sailed to and landed on Maui. They toured Maui until they reached Hāmākua. They drank awa but because there was no water they caused the fresh water to flow and drank all of the awa. They continued on and the water which they had caused to flow was called the water of Kaneloa. This water flows unto this day."[55]

The figure below illustrates extensive pre-contact permanent presence in the Ko`olau region.

Figure 16-9 Estimated Native Hawaiian Pre-Contact Land Utilization and Kuleana Lands Compared to Growth Boundaries



Source: The Nature Conservancy, Ladefoged, T.N. et al (2011), and Maui Island Plan (2012)

[54] Edward Baker to M.K. Pukui MS SC Sterling 3.12 (Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 101).

[55] Waiamau, Ka Ho`omana Kahiko, Ka Napepa Kuokoa, January 19, 1865.

16.3.2 Contemporary Hawaiian Culture in Ko`olau

Ke`anae Arboretum Taro Project

The Ke`anae Arboretum Taro Project supports a local volunteer group, Wailua Nui Hui, in their efforts to restore traditional taro fields and provide interpretive history of the local area to Arboretum visitors, per a Cooperative Agreement between Ko`olau Division of Forestry and Wildlife, Tri-Isle Resource Conservation and Development Council, Inc. and Wailuanui Hui. Fencing was completed to keep out wild pigs while replanting taro has continued.[56]

Wetland Taro

Today taro, or kalo, is extensively cultivated throughout the Ko`olau region. The CWRM identified the acreage of taro for each stream through the undocumented declarations of registered diverters, as a total of 1,006 acres plus water for domestic needs. Stream diversions for wetland kalo cultivation under traditional and customary Native Hawaiian rights are discussed below.

Kuleana Parcels and Traditional and Customary Native Hawaiian Access Rights

Traditional and cultural Hawaiian practices are deeply intertwined with the geographical environment of the islands. Prior to the arrival of Westerners and the idea of private land ownership, Hawaiians communally managed, accessed and gathered the resources from the land and seas to fulfill their community responsibilities. Traditional and customary Hawaiian rights are personal rights "customarily and traditionally" exercised for subsistence, cultural and religious purposes and possessed by ahupua`a tenants who are descendants of native Hawaiians who inhabited the Hawaiian Islands prior to 1778, subject to the right of the State to regulate such rights. These rights remain in force today. In order to qualify as traditional and customary Hawaiian rights, gathering of stream animals and the exercise of appurtenant rights must meet specified criteria. Not all appurtenant rights holders have traditional and customary Hawaiian rights, because appurtenant rights are property rights held by any owner of the appurtenant lands, while traditional and customary Hawaiian rights are personal rights.

Traditional and customary Native Hawaiian rights are exercised in the streams in the form of subsistence gathering of native fish, mollusks, and crustaceans, and stream flows are diverted for the cultivation of wetland taro, other agricultural uses, and domestic uses that can be traced back to the Māhele. The maintenance of fish and wildlife habitats to enable gathering of stream animals and increased flows to enable the exercise of appurtenant rights constitute the instream exercise of "traditional and customary" Hawaiian rights.[57]

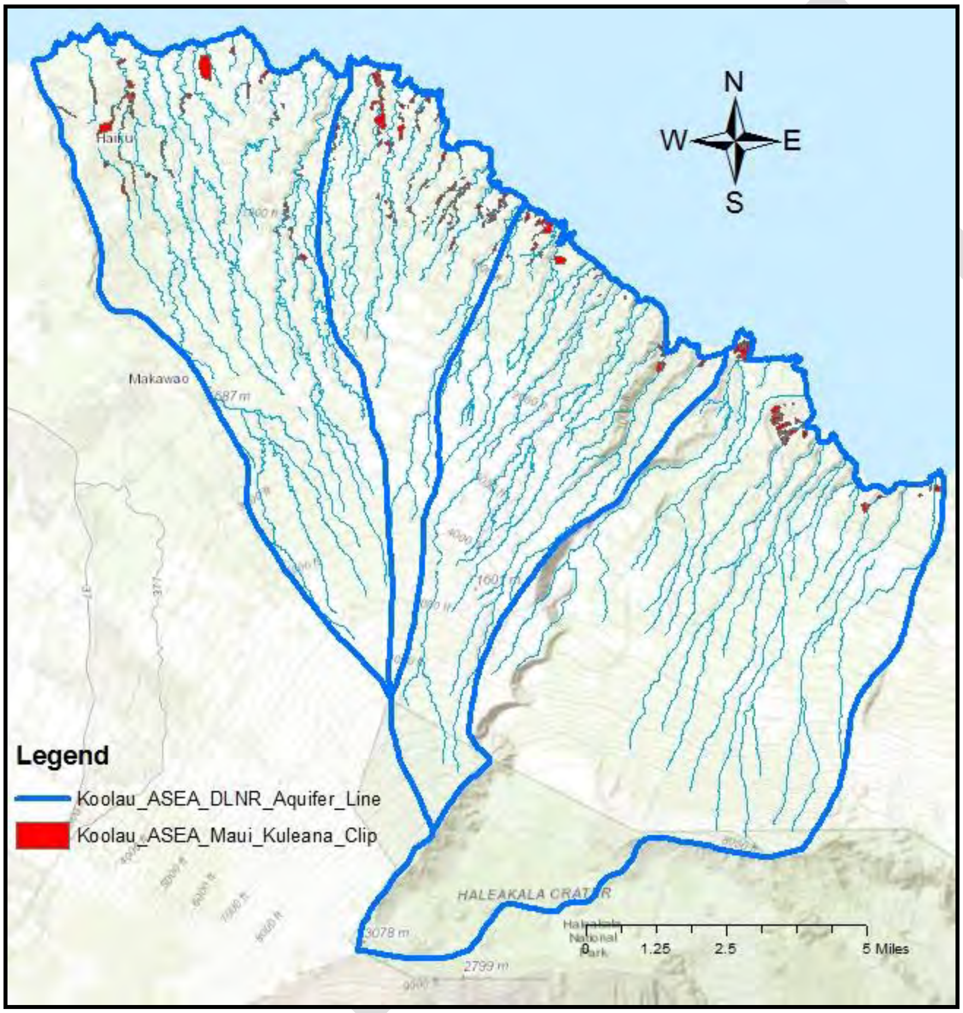
---

[56] Tri-Isle Resource Conservation and Development Council, Inc., Ke`anae Arboretum Taro Project http://tri-isle.org/keanae-arboretum-taro-project/

[57] CWRM East Maui Streams Hearing Officer's Recommended FOF, COL, and D&O, January 15, 2016. Contested Case No. CCH-MA 13-01 http://files.hawaii.gov/dlnr/cwrm/cch/cchma1301/CCHMA1301-20160115-HO-D&O.pdf

Water rights include "appurtenant or kuleana water rights" to use that amount of water from a water source (usually a stream) which was used at the time of the Māhele of 1848 on kuleana and taro lands for the cultivation of taro and other traditional crops and for domestic uses on that land, and "riparian rights," [58] which protect the interests of people who live on land along the banks of rivers or streams to the reasonable use of water from that stream or river on the riparian land subject to other rights of greater value. These rights run with the land.[59]

Figure 16-10 Ko`olau ASEA Kuleana Lands



Source: Office of Hawaiian Affairs.

Although kuleana parcels do exist, their accurate quantification can be difficult. Kuleana rights generally refer to water used at the time land title was initially conveyed to and recorded by the title recipient (a process that began in 1845 and theoretically continued until 1895) may

[58] Haia, Moses. *Protecting and Preserving Native Hawaiian Water Rights.* http://www.Hawaii.edu/ohelo/resources/AluLikeWorkbook/Chap7.pdf

[59] Ola I Ka Wai: A Legal Primer For Water Use And Management In Hawai`i

rightfully be used in connection with the same land in exactly the same way it was used at the time of title conveyance. Broader interpretations vary in their view of the types of titles and conveyances involved; the types of water uses protected; the types of lands protected; transportability of the water to other lands and uses; and transferability and extinction of the rights. Most of the water covered by these rights was used for wetland taro cultivation. During the period of the privatization of land in Hawai`i (1840--1855), "kuleana" usually translated as "native tenant rights," constituted both a right to, and responsibility over, land for Hawaiians. Kuleana rights arose in the mid-1800s and protected the entitlement of Hawaiian tenant farmers and their descendants to, among other things, access landlocked real estate parcels.[60]

Ke`anae DHHL Plans

The Ke`anae tract contains two separate parcels – a two acre parcel along the shoreline on

Ke`anae Peninsula and a 149 acre parcel along Palauhulu Stream mauka of Hāna Highway. The smaller parcel offers opportunities for community use, while the larger piece is appropriate for agricultural homesteads given its gentle slopes, high rainfall, easy access, and rural character. The DHHL plans to develop its small Ke`anae tract with subsistence agricultural homesteads and general agriculture and lo`i kalo uses.[61] The two-acre makai property is within the flood zone, which prohibits homesteading use; therefore, the property will be developed for community use because of its oceanfront location, which presents opportunities for a gathering area and for cultural practices.[62]

Wailua DHHL Plans

Na Moku Aupuni o Ko`olau Hui (NMAKH) represents approximately 500 families who are residents of Wailua and Ke`anae. NMAKH President, Edward Wendt gave a brief presentation to the Maui Island Plan Working Group on March 27, 2003 and submitted a letter dated March 27, 2003. According to the letter, NMAKH does not support the presence of the Hawaiian Home Lands program in Ke`anae and Wailua. According to NMAKH, Ke`anae and Wailua was never included in the original inventory when the Hawaiian Homes Commission Act was passed in 1920. These lands were under the Department of Land and Natural Resources and transferred to DHHL as part of a breach of trust settlement between the State and DHHL in the mid-1990s. NMAKH and its members opposed the transfer at every public hearing held and submitted numerous letters to the Maui Planning Department. According to NMAKH, their concerns were ignored and the lands were eventually transferred to DHHL despite community opposition. NMAKH are concerned that settling DHHL beneficiaries who are unaccustomed to the

[60] [“Ua Koe Ke Kuleana o Na Kanaka” [Reserving the Rights of Native Tenants: Integrating Kuleana Rights and Land Trust Priorities in Hawai`i], Harvard Law Review (2005); Avoiding Trouble in Paradise, Business Law Today [December 2008].

[61] State Water Projects Plan, Advance Report, 2016, Page xvi.

[62] State of Hawai`i, DHHL Maui Island Plan, 2004, page 6-22.

traditional, subsistence lifestyle that has been preserved, protected, and carried on from ancient times in this area will severely disrupt and tear apart the fabric of the community.[63]

Some residents have been attempting for nearly thirty years to gain leases to house lots that were transferred to DHHL. NMAKH feels that it would be damaging to the community if DHHL beneficiaries on the wait list bypass these families. The goal of NMAKH on this matter is to make these lands available to the families from Ke`anae and Wailua in order to continue their present way of life.

DHHL proposed an "Alternative 2" project option to address NMAKH's concerns by designating the entire Wailua tract as a special district. According to the DHHL *General Plan* (2002), the special district designation is applied to areas requiring special attention because of unusual constraints and/or opportunities, natural hazard areas, open space and raw lands far from infrastructure, mixed uses, and greenways. The issues presented by NMAKH are considered unusual constraints and require special attention by DHHL because of the sensitivity of the situation. The special district designation allows opportunities for discussions between DHHL and NMAKH in determining the future of Ke`anae and Wailua. Ultimately, the 2004 DHHL Maui Island Plan chose another project (Alternative 1) option which proposes 28 acres of subsistence agricultural use, 52 acres of general agriculture use, and 10 acres of conservation for the Wailua tract. Therefore, the Special District designation for use by Ke`anae and Wailua residents will not be pursued by the DHHL.[64] According to the DHHL, the rationale for selecting Alternative 1 over Alternative 2 because of the high beneficiary demand for agriculture lots on Maui, and the subsistence agricultural designation also requires that the beneficiary reside on the lot, thus adding to the agricultural community that currently exists in Wailua.[65] The Wailua final land use plan conflicts with issues posed by NMAKH in Alternative 2. However, the intent of DHHL, as determined by the Hawaiian Homes Commission Act (HHCA) passed in 1920, is to provide housing to native Hawaiians on its waiting list. Wailua has 11 readily available lots that could immediately be awarded to beneficiaries on the waiting list, therefore fulfilling the intent of the HHCA. NMAKH's goal of making Wailua available to the families from Ke`anae and Wailua to continue their present way of life is not a goal or objective of DHHL in its use of its Wailua lands. The analysis of the tract illustrates that the lands where agriculture is proposed are well suited for agricultural use due to their existing agricultural use, potentially productive soils (according to the *ALISH* designation), and high rainfall. According to the goals and objectives of DHHL's *General Plan* (2002), suitable agriculture lands should be retained in agriculture use when possible. The agriculture designation follows this objective and proposes the highest and best use for the land.[66] Annual rainfall at Wailua averages between 120 and 200 inches per year. The high rainfall and stream flow from Wailuanui Stream, which runs through Wailua, provides water to the taro crops planted throughout the valley.[67]

[63] Ibid, page 6-31.
[64] State of Hawai`i, DHHL Maui Island Plan, 2004, page 6-32.
[65] Ibid.
[66] Ibid.
[67] Ibid, page 6-26.

Wailua has a long history of taro cultivation. The proposed uses for Wailua aim to replicate the traditional land use pattern established within the valley. In the past, house lots were distributed with detached lots for taro cultivation. DHHL would like to develop a similar program that uses existing lots for residential purposes and adjoining existing lots for taro cultivation. Given the unique character of the area, DHHL would also require that agriculture homestead applicants demonstrate experience in taro cultivation. DHHL plans to use the Wailua tract for general agriculture and lo`i kalo uses–it does not mention a need for potable water.[68] The subsistence agriculture DHHL lots are an effort to integrate beneficiaries whose lifestyle matches Wailua's traditional agricultural ways. Nevertheless, NMAKH is concerned that settling DHHL beneficiaries who are unaccustomed to the traditional, subsistence lifestyle that has been preserved, protected, and carried on from ancient times in this area will cause severe disruptions to Wailua's historic ways.

Native Hawaiian Legal Corporation (NHLC)/Na Moku 'Aupuni *<u>East Maui Streams Litigation</u>*

On May 24, 2001, the Native Hawaiian Legal Corporation (NHLC), on behalf of Na Moku 'Aupuni o Ko`olau Hui (Na Moku), petitioned the CWRM to amend the Interim Instream Flow Standards (Interim IFS) for 27 East Maui streams. In 2008 and 2010, the CWRM approved amendments to the Interim IFS for about half the streams and establishing measurable IIFS of status quo conditions for the remaining streams; only six of the twenty-seven streams had flow restored. In June 2010, the County DWS and the NHLC, on behalf of Na Moku, filed petitions for a contested case hearing before the CWRM. On November 17, 2010, Na Moku appealed the CWRM's decision contending that the CWRM erred in concluding that Na Moku had no right to contest the case hearing and in reaching its underlying decision regarding IIFS amendment for the nineteen streams. On November 30, 2012, the Intermediate Court of Appeals remanded to the CWRM and the contested case hearing began on March 3, 2015. The interest asserted by Na Moku was the right to sufficient stream flow to support the exercise of their traditional and customary native Hawaiian rights to grow kalo and gather in, among, and around east Maui streams and estuaries and the exercise of other rights for religious, cultural, and subsistence purposes. The petition also alleges that the Commission had not carried out its obligations under public trust by failing to require HC&S and EMI to prove: 1) Their actual need; 2) that there are no feasible alternative sources of water to accommodate that need; and 3) the amount of water diverted to accommodate such need does not, in fact, harm a public trust purpose or any potential harm does not rise to a level that would preclude a finding that the requested use is nevertheless reasonably-beneficial.

Subsequent to HC&S announcing cessation of sugar cane cultivation, the CWRM ordered re-opened hearings to address HC&S current and future use of surface water and the impact on the groundwater; the impact on DWS's use of surface water due to cessation of sugar operations; the County's position on future use of sugarcane fields, and issues concerning management of the EMI ditch system. In the September Minute Order No. 21, the CWRM hearings officer reiterated the requirement that CWRM weigh competing instream and

[68] Ibid, page xvii.

offstream uses, including economic impact on offstream uses, in amending the IIFS. Should the contested case decision be unfavorable to certain parties, appeals may prolong the case for months or even years.

16.3.3 Lessons from Native Hawaiian History

The Ko`olau region encompasses an area that is fed by great volumes of stream water. In the past, the area supported a number of Hawaiian villages and a much larger native Hawaiian population, but disease, shifts in demographics and lifestyle preferences, and emigration have caused a drastic shift in the cultural landscape, taking its toll on the area's population and resulting in a significant reduction of Native Hawaiians and cultural practices compared to ancient times.

Ko`olau's carrying capacity has been much greater in the past compared to today. Pre-contact populations in Ko`olau are thought to have significantly exceeded today's population, sustained by rain-fed agriculture and ocean resources.[69] Until relatively recently (mid-1900s), population and agricultural potential for the area was excellent, but re-population of this vast, mostly remote area is not forecast in the County's Maui Island Plan or expected to be supported by economic opportunity or infrastructure. Additionally, like many other remote communities on Maui, populations are generally decreasing, as evidenced by the recent closure of Ke`anae School and the busing of Ke`anae children to Hāna. Should additional water be needed to satisfy an increase in domestic and agricultural use, abundant source water options should be available for expanded needs. And those water resources could theoretically support an increase in Native Hawaiian domestic, cultural, and agricultural uses. During community meetings in connection with formulation of the WUDP, Native Hawaiians and other members of the community in the Ko`olau area expressed concern with the westward transport of water to central and upcountry Maui, and this sentiment underscores the community's perceived connectivity of water resources to their "sense of place." Recent government regulatory actions are supporting the return of some water to the streams and their Native Hawaiian cultural practitioners.

Historically, great efforts were made to allocate water for all needs on Maui. Today, native Hawaiians are challenged with the negative consequences of resource "ownership," with "owners" sometimes lacking sensitivity or requirements to share with others. Perhaps past strategies of sharing distribution and timing of water flows can be adopted in order for all water users to be supplied with this important resource. Consortiums of water partners have been discussed as options to ownership and management of the East Maui Irrigation water system. Possible consortium stakeholders could include watershed management partners, Alexander and Baldwin/HC&S, kuleana water users and native Hawaiian stakeholders.

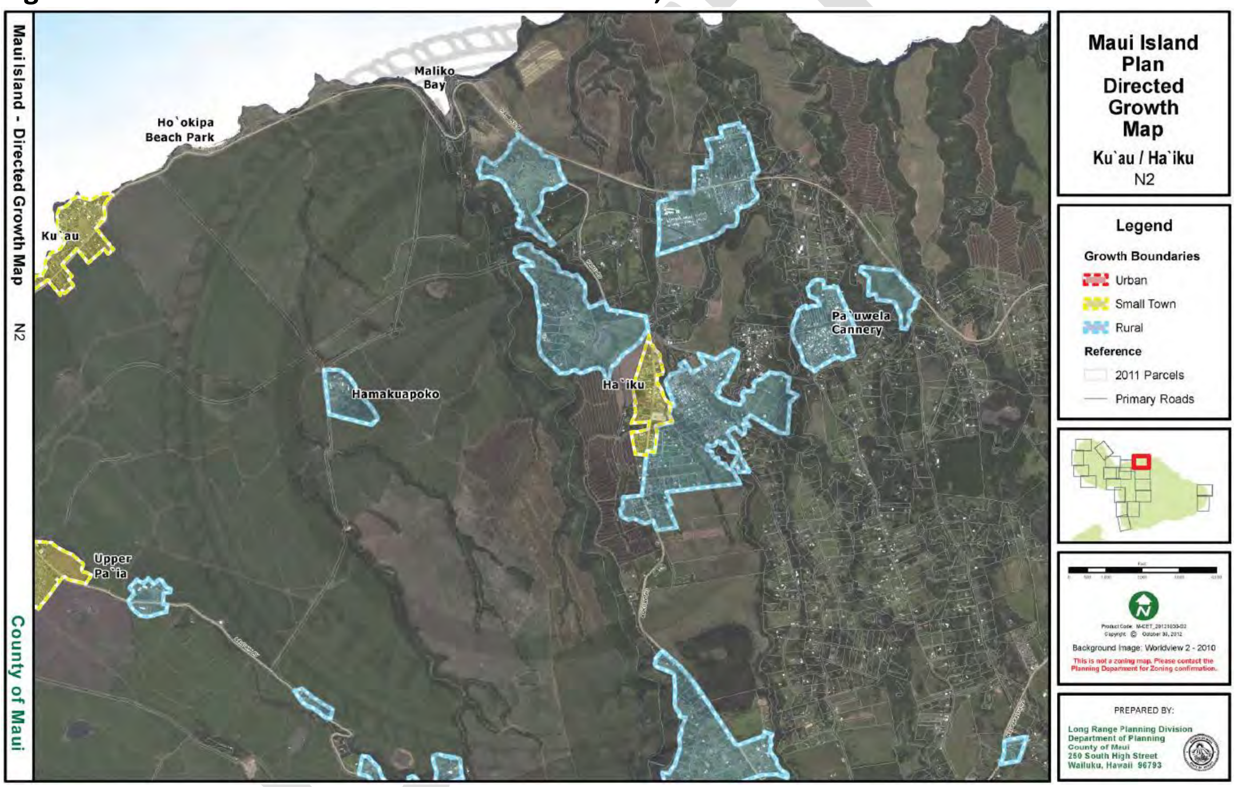
[69] The Nature Conservancy, Office of Hawaiian Affairs, Ladefoged, T.N., et al (2011), and Maui island Plan

16.4 Land Use

16.4.1 Land Use Plans

The land use pattern in the Ha`ikū sub-region is predominantly low-density agricultural subdivisions with a few small pockets of urban settlement at Ha`ikū Town, Pa`uwela and Kuiaha. The Maui Island Plan's (MIP) Directed Growth Plan applicable to the Ko`olau ASEA does not identify any Urban Growth Areas. Ha`ikū is within a Small Town boundary, intended to protect the sense of place, where a lower level of infrastructure can be expected. There are several limited Rural Growth areas where infrastructure expansion that could lead to urbanization should be minimized.

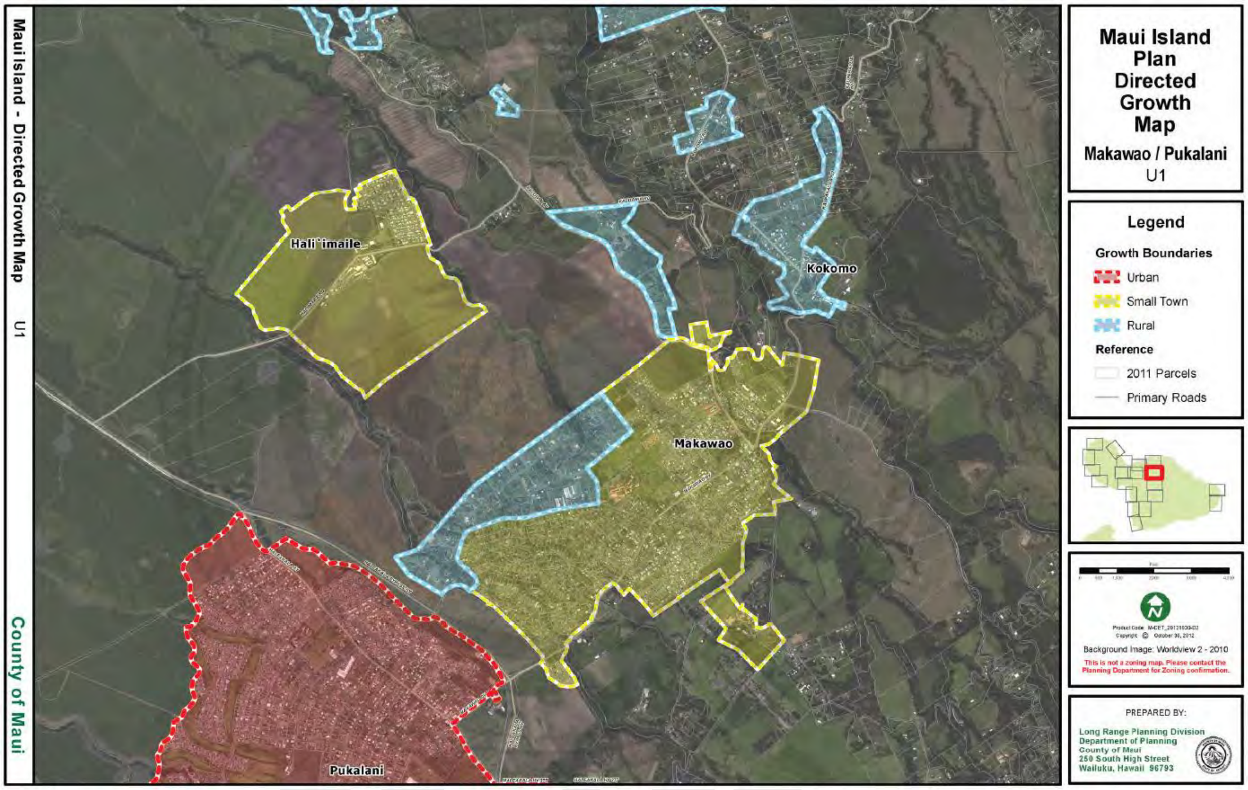
Figure 16-11 Directed Growth Plan: Ko`olau ASEA, Ha`ikū Planned Directed Growth Area



Source: County of Maui, Directed Growth Plan, Kū`au/Ha`ikū – Planned Rural Growth Area

The following Directed Growth Plan Map for the Makawao/Pukalani Planned Directed Growth Area shows some areas partially inside the Ko`olau ASEA, but most within the Central ASEA and addressed in the Central ASEA Report Chapter 15.

Figure 16-12 Directed Growth Plan Map, Ko`olau ASEA, Makawao/Pukalani Planned Directed Growth Area



Source: County of Maui, Directed Grown Plan, Makawao/Pukalani – Planned Rural Growth Area

Community Plans

There are portions of three Community Plans (CP) within the Ko`olau ASEA:

- Pa'ia-Ha`ikū Community Plan (adopted 1995; 80% of CP within Ko`olau ASEA)
- Hāna Community Plan (adopted 1994; 27% of CP within Ko`olau ASEA)
- Makawao-Pukalani-Kula Community Plan (adopted 1996; 8% of CP within Ko`olau ASEA)

The applicable portions of the CP areas are primarily rural with several small town areas. The Maui Island Plan (MIP) and supporting documents provide more recent data, community perspectives and land use guidance than the CPs, although the CP boundaries are used extensively by the County in data collection.

Maui County Zoning

Zoning districts are aggregated by land uses types with similar water use rates for the purpose of projecting potential full build-out water demand. Directed Growth Plan guidance and Community Plan designations are generally used to calculate water demand associated with Interim zoned lands.

Figure 16-13 Ko`olau ASEA County Zoning Districts

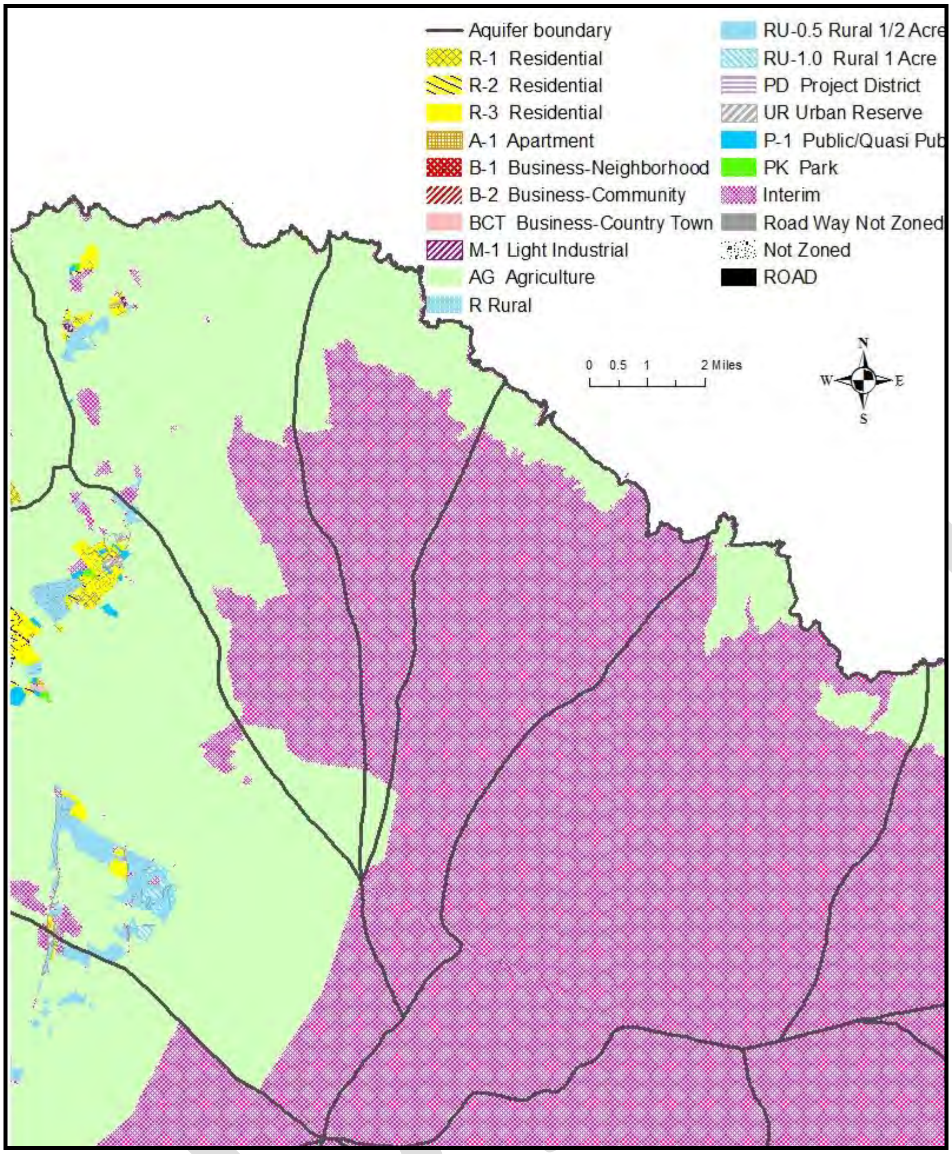


Table 16-5 Summary of Zoning Use Types, Ko`olau ASEA

Zoning Summary	Acres	% of Total
Single Family Residential	187	0.23%
Rural Residential	234	0.29%
Business	4	0%
Industrial	15	0.02%
Agriculture	20,926	26.06%
Public/Quasi-Public	38	0.05%
Park	56	0.07%
Open Space	58,844	73.28%
Total	80,304	100%

Zoning supplied by Maui County Planning Department, Long Range Division, May 2015. Interim and Project District zoning assigned to CWRM categories based on Community Plans and Development Projects. Excludes DHHL lands

The DHHL Maui Island Plan

The Hawaiian Homes Commission adopted its Maui Island Plan as the overarching planning document in 2004. The Department of Hawaiian Homelands (DHHL) East Maui planning region encompasses three tracts totaling 985 acres: Ke`anae, Wākiu, and Wailua. All three tracts are within the Hāna Community Plan designated area.[70] However, only Ke`anae (150.6 acres) and Wailua (91.4 acres) tracts are within the Ko`olau ASEA, covering 242 acres the State Land Use Commission has mostly zoned Agriculture, with a very small percentage zoned Conservation.[71] The County zoning and Community Plan designations for the lands is Agricultural. For the Ke`anae tract, two acres of community use is proposed on the makai property, and 32 three-acre-or-less agricultural lots are proposed on 57 acres of the mauka property. The chosen DHHL project for the Wailua tract proposes 28 acres of subsistence agricultural use, 52 acres of general agriculture use, and 10 acres of conservation.[72]

Table 16-6 DHHL Planned Land Use

Category	Acres or Residential Units	% of Total
Residential (Units)	0	0%
Commercial (Acres)	0	0%
Industrial (Acres)	0	0%
Agriculture (Acres)	230	95%
Community (Acres)	2	0.83%
Open Space (Acres)	10	4.20%
Total (Acres)	**242**	100%

Source: DWS, Water Resources & Planning Division, May 2015, based on DHHL Maui Island Plan and Regional Plans. Open Space includes conservation, cultural protection and similar use types.

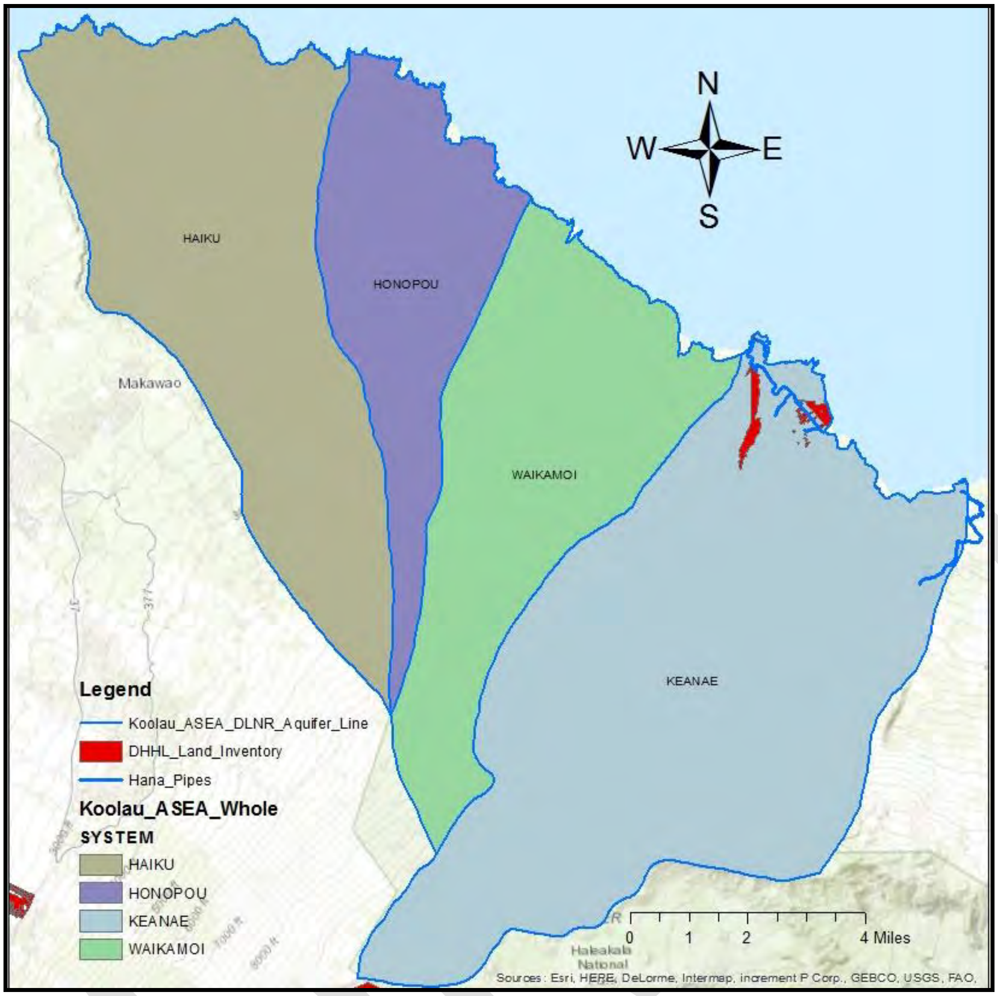
Table 16-7 DHHL Projects and Planned Land Use

Aquifer System	DHHL Project	Total Acres	Community Acres	Agricultural Acres	Open Space Acres
Ke`anae	Ke`anae Tract Final Plan	150.6	2	148.6	0
Wailua	Wailua Tract Final Plan	91.4	0	81.4	10

Table prepared by DWS, Water Resources & Planning Division. Figures are estimates based on DHHL Maui Island Plan and Regional Plans.

[70] State of Hawai`i, DHHL Maui Island Plan, 2004, page 6-1.
[71] Ibid, page 6-17.
[72] Ibid.

Figure 16-14 Ko`olau ASEA Department of Hawaiian Homelands



There is one existing water tank within Ke`anae. Water service to the Ke`anae properties is provided off Hāna Highway by the County Department of Water Supply (MDWS). The MDWS also serves Wailua. In 2004, the MDWS pumped an average of 168,000 gpd, serving an area between Ka`elekū Agriculture Park and Hāmoa Town. The system consists of three deep wells and a surface water source located at Wailua Stream. However, one well and surface water source are presently not in use. The perennial streams currently provide water to the Wailua Valley farms. Additional farms may also be able to use this water. The MDWS water system also has the capacity to serve these lands,[73] but many areas served by the County system have inadequate line capacity to provide fire flow.[74] A six-inch waterline from the highway will be required.[75]

[73] Ibid.
[74] State of Hawai`i, DHHL Maui Island Plan, 2004, page 6-1.
[75] Ibid, page 6-32.

16.5 EXISTING WATER USE

16.5.1 Water Use by Type

The CWRM has established the following water use categories based for the purposes of water use permitting and reporting:

- Domestic (Residential Domestic--includes potable and non-potable water needs; Single and Multi-Family households, including noncommercial gardening; Non-residential Domestic--includes potable [and non-potable] water needs; Commercial Businesses, Office Buildings, Hotels, Schools, Religious Facilities)
- Industrial (Fire Protection, Mining, dust control, Thermoelectric Cooling, Geothermal, Power Development, Hydroelectric Power, Other Industrial Applications)
- Irrigation (Golf Course, Hotels, Landscape and Water Features, Parks, School, Habitat maintenance)
- Agriculture (Aquatic Plants & Animals, Crops Irrigation and Processing, Livestock Water, Pasture Irrigation, and Processing, Ornamental and Nursery Plants, Taro, Other Agricultural Applications)
- Military (all military use)
- Municipal (County, State, Private Public Water Systems--as defined by Department of Health)

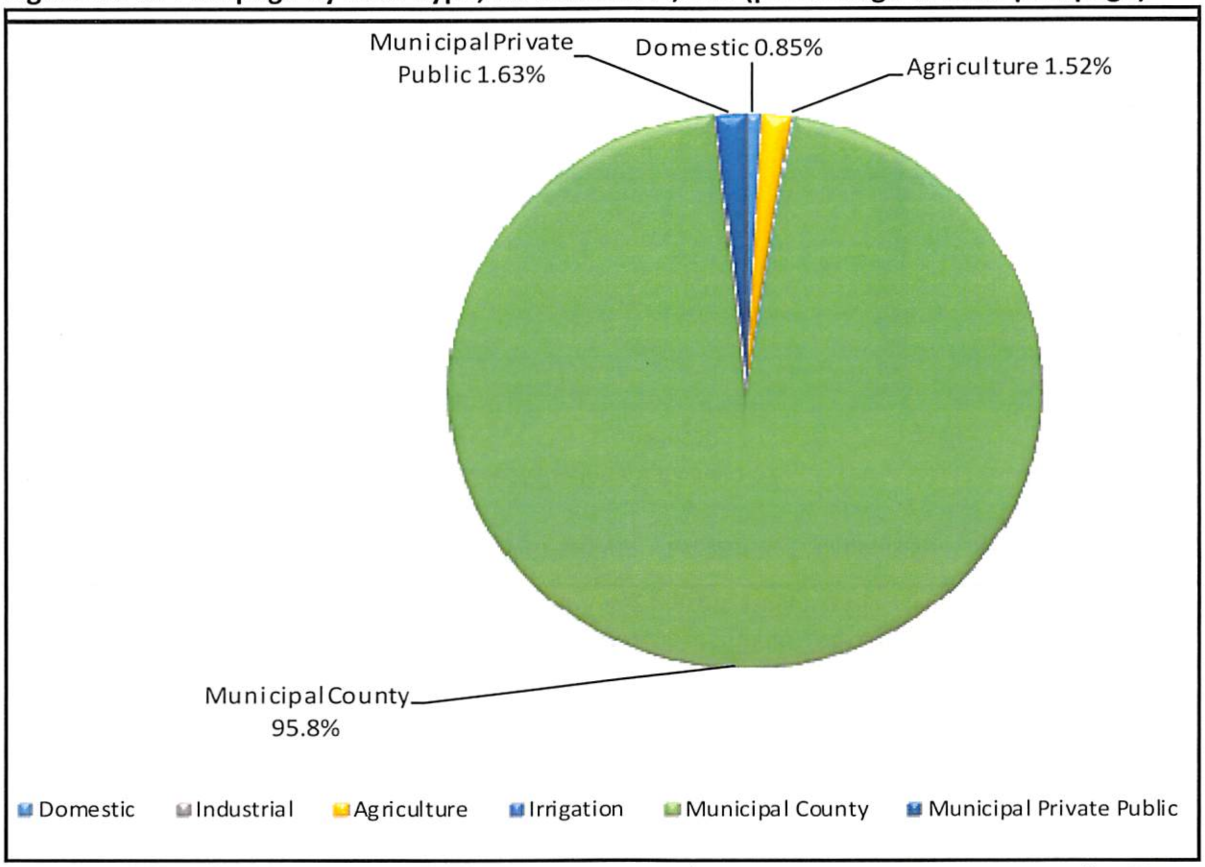
This section presents the estimated water use within the Ko`olau ASEA for the calendar year 2014, or as otherwise stated based CWRM and MDWS reports.

Table 16-8 Reported Pumpage and Surface Water Use by Type, Ko`olau ASEA, 2014 (gpd)

Aquifer	Domestic	Industrial	Agriculture	Irrigation	Municipal	Military	Total
Total # of Wells	59	0	43	22	7	0	131
Ha`ikū	7,143	0	13,942	1,695	816,255	0	839,035
Honopou	652	0	0	0	9,786	0	10,438
Waikamoi	0	0	0	0	0	0	0
Ke`anae	0	0	0	0	66,066	0	66,066
Total Pumpage	**7,795**	**0**	**13,942**	**1,695**	**892,107**	**0**	**915,539**
% of Pumpage	0.85%	0%	1.52%	0.19%	97.44%	0%	100%
Total # of Surface Water Diversions	0	0	324	0	0	0	324
Ko`olau ASEA	0	0	137,203,803*	0	1,847,000**	0	139,050,803
Total Amount Diverted	**0**	**0**	**137,203,803**	**0**	**1,847,000**	**0**	**139,050,803**
% of Surface Water	0%	0%	98.67%	0%	1.33%	0%	100%
TOTAL	**7,795**	**0**	**137,217,745**	**1,695**	**2,739,107**	**0**	**139,966,342**

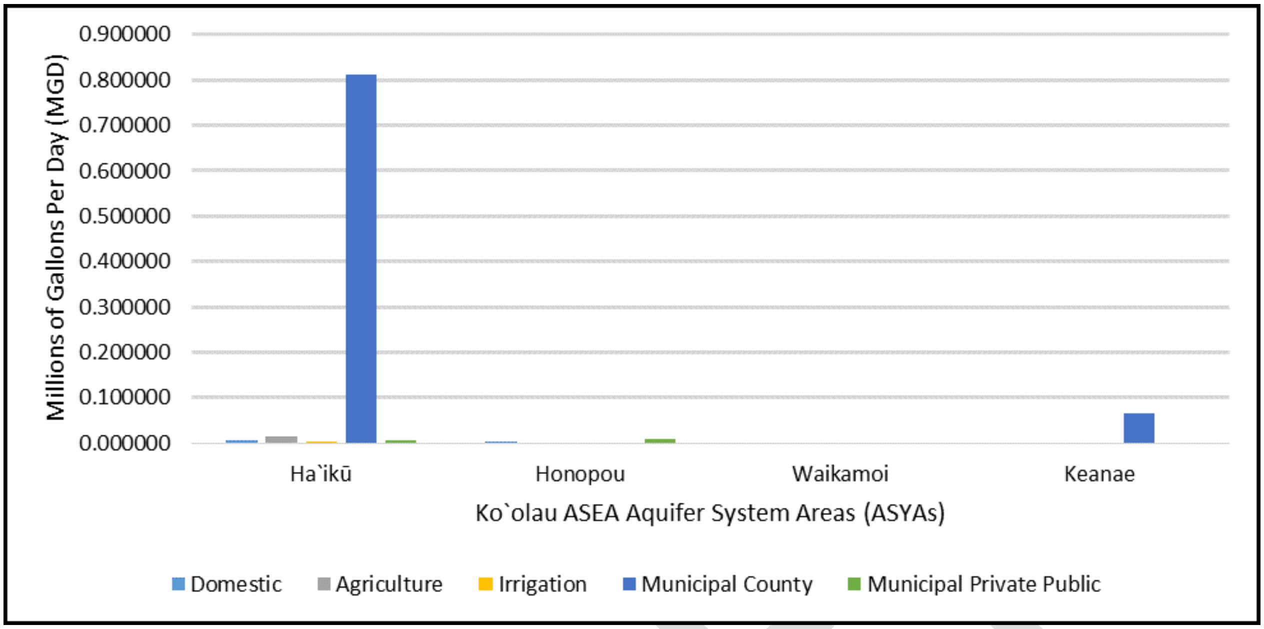
Source: CWRM Well Pump Quantities Database, 2014; 12-month moving average, where data was not reported consecutive months in 2015 were used. Some wells did not report.
CWRM Gages 2011-2015 Average, estimated end use; Municipal use based on MDWS production. 1989 Declarations of Water Use, Circular 123, Volumes 1 and 2, CWRM, September 1992.
*Includes reported water diversions from ML&P and HC&S/EMI, as well as the agricultural water use estimates based on Kuleana, 2015 Ag Baseline and 1989 Declarations of Water Use.
**MDWS Kamole Weir WTP Calendar Year 2014 Production (GPD) provided by EMI diversion. In addition, 102,550 (GPD) of surface water serv MDWS customers located in the Ko`olau ASEA. Some of this amount is served by Kamole Weir, while a separate portion is served by the Upper and Lower Kula MDWS systems.

Figure 16-15 Pumpage by Well Type, Ko`olau ASEA, 201 (percentage of total pumpage)



Source: CWRM Well Pump Quantities Database, 2016; 12-month moving average, January to December 2014; where data was not reported consecutive months in 2015 were used. Some wells did not report.

Figure 16-16 Pumpage by Well Type, Ko`olau ASYAs, 2014 (mgd)



Source: CWRM Well Pump Quantities Database, 2016; 12-month moving average, January to December 2014; where data was not reported consecutive months in 2015 were used. Some wells did not report.

Domestic Use

There are 59 Domestic wells in the Ko`olau ASEA, with a combined reported pumpage of 7,795 gpd, or less than 1 percent (0.85 percent) of the Ko`olau ASEA total pumpage. However, it is likely that domestic use is underreported.

Industrial Use and Military Use

There is no reported pumpage from industrial wells in the Ko`olau ASEA. There are no military wells.

Irrigation Use

Irrigation wells comprised less than 1 percent (0.19 percent) of total Ko`olau ASEA average well pumpage in 2014, averaging 1,695 gpd. In theory, irrigation use by private purveyors can be estimated from reported streamflow diversions and reported or appraised agricultural irrigation. However, this data is unreported for the Ko`olau ASEA, and the exact amount of Ko`olau water exported for irrigation is difficult to determine.

Agricultural Use

CWRM pumpage reports indicate there is 13,942 gpd pumped by agricultural production wells in 2014 within the Ko`olau ASEA. Agricultural uses are primarily supplied by surface water and occasionally augmented with groundwater.

Table 16-9 Estimated Agricultural Water Use, Ko`olau ASEA (Excluding Kuleana Parcels)

Aquifer System	2015 Ag Baseline Crop Category	Est. Acres	Water Standard Consumptive Use (gpd)	Est. Average Water Use Consumptive (gpd)	Streamflow Low 100,000*4 (gpd)	Streamflow Mid (FOF)*2 150,000 (gpd)	Streamflow High 250,000*4 (gpd)	Est. Average Water Use Blended (gpd)*3
Ha`ikū	Banana	4.62	3,400	15,708	--	--	--	15,708
Ha`ikū	Diversified	57.28	3,400	194,752	--	--	--	194,752
Ha`ikū	Flowers / Foliage / Landscape	14.73	3,400	50,082	--	--	--	50,082
Ha`ikū	Pasture	7,037	0* (0-7,400)	0*	--	--	--	0*
Ha`ikū	Taro	1.59	27,500 (15-40K)	43,725	159,000*4	238,500	397,050*4	282,225
Ha`ikū Sub-Total		**7,116**		**304,267**	**159,000*4**	**238,500**	**477,000*4**	**542,667**
Honopou	Diversified	1.28	3,400	4,352	--	--	--	4,352
Honopou	Pasture	3,088	0* (0-7,400)	0*	--	--	--	0*
Honopou Sub-Total		**3,089**		**4,352**	--	--	--	**4,352**
Ke`anae	Diversified	2.51	3,400	8,534	--	--	--	8,534
Ke`anae	Pasture	408	0* (0-7,400)	0*	--	--	--	0*
Ke`anae	Taro	11.91	27,500 (15-40K)	327,525	1,191,000	1,786,500	3,573,000	1,786,500
Ke`anae Sub-Total		**422.75**		**336,059**	**1,191,000**	**1,786,500**	**3,573,000**	**1,795,034**
Waikamoi	Pasture	359.09	0* (0-7,400)	0*	--	--	--	0*
Waikamoi Sub-Total		**359.09**		**0**	--	--	--	**0**
Total		**10,986**		**644,678**	**1,350,000**	**2,025,000**	**4,050,000**	**2,342,153**

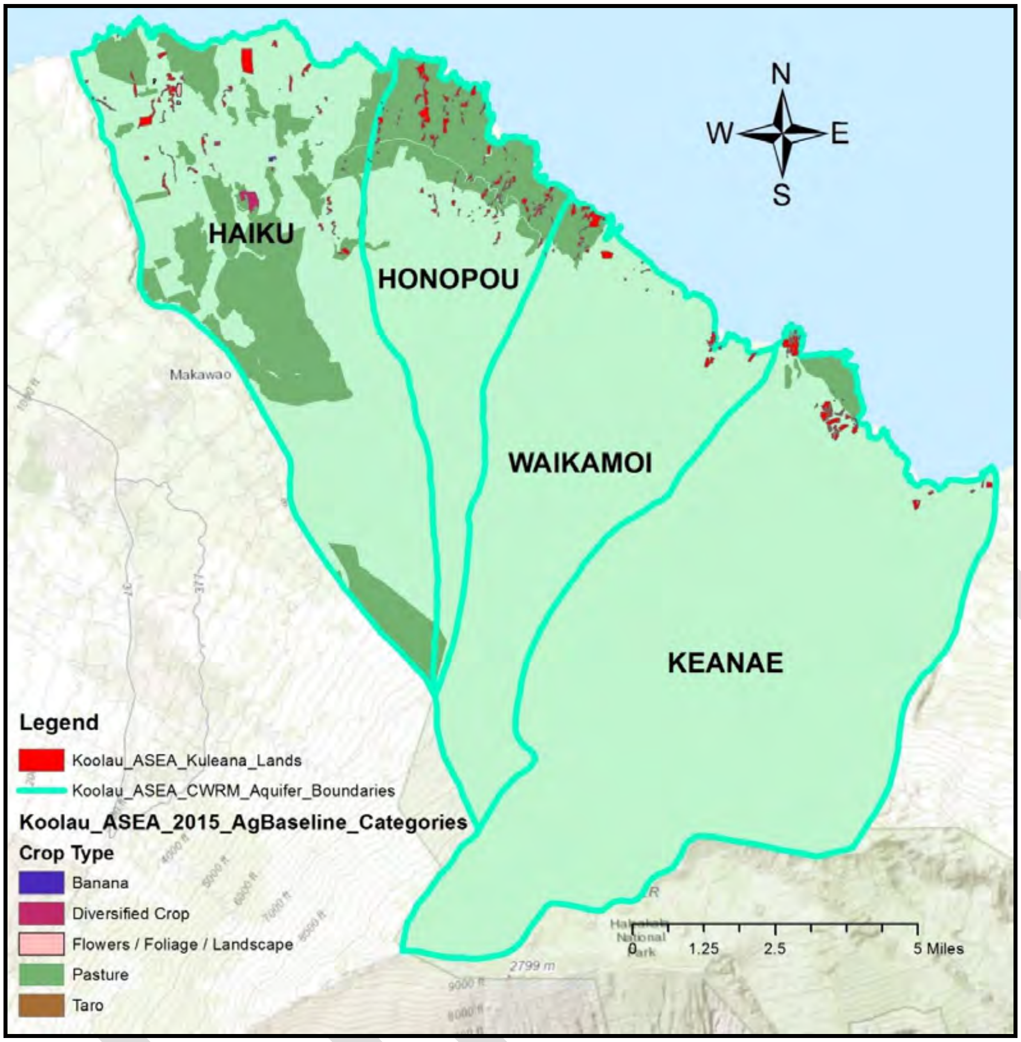
Source: 2015 Statewide Agricultural Baseline GIS, acreages calculated by MDWS. Kuleana parcels included in the 2015 Statewide Agricultural Baseline are not included in this analysis, as they are accounted for in a subsequent analysis within this report.
It is not specified whether taro is dryland or wetland.
Estimated Water Use for taro: average wetland taro consumptive rate. Coffee: 2004 AWUDP Kaua`i Irrigation System- 2500 gpd; 2900 gpd reported by plantation on Oahu per Brian Kau, HDOA, personal communication, 10/12/2016.
*Most pasture is not irrigated and uses no water.
*2Based on streamflow requirements for taro from CWRM Case No. CCH-MA13-01. Hearings Officer's Amended Proposed Findings of Fact, Conclusions of Law, & Decision and Order. August 2017.
*3This "blended" total uses the 150,000 gpd FOF streamflow rate and the HDOA consumptive rate for non-taro crops.
*4100,000 to 250,000 represents the amount of throughflow needed to meet the cooling requirements of the lo`i (Gingerich, Stephen B.; Chiu W. Yeung, Tracy-Joy N. Ibarra, and John A. Engott; Water Use in Wetland Kalo Cultivation in Hawai`i, USGS, Open-File Report 2007–1157).

The characterization and adequacy of streamflow for lo`i kalo and other instream uses is a community concern. Information about existing and potential lo`i kalo and other agricultural uses on Kuleana parcels in the Ko`olau ASEA is not readily available, and despite consultation with the Aha Moku Council and others, quantitative information was not forthcoming through the WUDP process. Other Information from the CWRM reports, 2015 Statewide Agricultural Land Use Baseline, CWRM 1989 Declarations of Water Use, Contested case hearings and other sources were consulted.

Information in the 1989 Declarations of Water Use, Volumes 1 and 2 (CWRM, September 1992), was used to characterize water sources. This information was then correlated with CWRM diversions, Kuleana parcels, contested case hearings info and the 2015 Statewide Agricultural Land Use Baseline. The declarations include water sources and uses made known to the CWRM through a registration process in 1988-1989, and does not include subsequent sources and uses developed and known to the CWRM through its permitting process and water use reporting.[76] The declarations also included claims for future water rights, the proposed future uses of water, and current instream activities. The declarations as well as the summary below have not been verified by the CWRM. While there are many limitations inherent in the declarations (parcels with multiple declarations with conflicting information, some parcels may indicate place of diversion rather than water application, parcel ownership may differ from declarant, etc.), they provides a point of reference to support in a more complete characterization of existing and potential future use.

[76] The 1987 State Water Code, HRS Chapter 174C, required any person making a use of water in any area of the state to file a declaration of that water use, any person owning or operating any well must register the well, and any person owning or operating any stream diversions works must register the diversion.

Figure 16-17 Relationship of Kuleana Parcels and 2015 Statewide Agricultual Land Use Baseline



Source: HDOA 2015 Statewide Agricultural Land Use Baseline, Kuleana parcels (OHA 2009)

A significant number of Kuleana parcels exhibit a declaration of use for either an existing or future use. Estimated demand for land uses in the Declarations of Water Use is 2,461,206 gpd based on the stated assumptions. Given that much of the 2015 Statewide Agricultural Land Use Baseline inventory does not intersect with the declarations, the declarations appear to represent an additional increment of agricultural water use.

An analysis of Kuleana parcels and the 2015 Statewide Agricultural Land Use Baseline indicates that taro and pasture land cultivated on Kuleana parcels in the Ko`olau ASEA totaled about 276.45 acres as shown in the tables below. However, given the purpose of the 2015 Agricultural Land Use Baseline inventory to capture the scale and diversity of commercial agricultural activity, it is likely that most agriculture on Kuleana parcels was not mapped. In the table below, taro is assumed to be wetland taro. The midpoint of the range for consumptive water use for wetland taro is used to calculate estimated average water use. The low and high figures for consumptive water use and streamflow required for healthy plants are also provided.

Table 16-10 Estimated Water Use by Kuleana Parcels *also* located within 2015 Agricultural Land Use Baseline, Ko`olau ASEA (gpd/acre)

Aquifer System	2015 Crop Category	Kuleana Parcels Acreage	Water Standard gpd/acre	Est. Ave. Consumptive Water Use (gpd)	Consumptive Use		Streamflow		
					Low 15,000 (gpd)	**High** 40,000 (gpd)	**Low** 100,000 (gpd)	**Mid (FOF)**** 150,000 (gpd)	**High** 300,000 (gpd)
Ha`ikū	Pasture*	14.11	0* (0-7,400)	**0**	--	--	--	--	--
Honopou	Pasture*	188.71	0* (0-7,400)	**0**	--	--	--	--	--
Ke`anae	Pasture*	3.87	0* (0-7,400)	**0**	--	--	--	--	--
Ke`anae	Taro	27.71	27,500	**762,025**	415,650	1,108,400	2,771,000	4,156,500	8,313,000
Waikamoi	Pasture*	42.05	0* (0-7,400)	**0**	--	--	--	--	--
Total		**276.45**		**762,025**				**4,156,500 *****	

Sources: 2015 Statewide Agricultural Land Use Baseline GIS; Kuleana parcels-OHA, 2009. Approx. agricultural acreages overlying Kuleana parcels calculated by MDWS using GIS intersection of Kuleana parcels (OHA 2009) and 2015 Agricultural Land Use Baseline data.
Water Use Rates: Diversified Ag-HDOA Guidelines; Taro-CWRM Nā Wai ʻEhā and East Maui Streams Contested Case Hearings. Due to proximity of parcels to stream, taro is assumed to be wetland taro. Water standard for taro is average consumptive range of 15,000 to 40,000 gpa.
*Most pasture is not irrigated and uses no water.
**Based on streamflow requirements for taro from CWRM Case No. CCH-MA13-01. Hearings Officer's Amended Proposed Findings of Fact, Conclusions of Law, & Decision and Order. August 2017.
***This "blended" total uses the 150,000 gpd FOF streamflow rate and the HDOA consumptive rate for non-taro crops.

Table 16-11 Estimated Water Use by Kuleana Parcels *not* located in 2015 Agricultural Land Use Baseline, Ko`olau ASEA (gpd/acre)

					Consumptive Use		Streamflow		
Aquifer System	**2015 Crop Category**	**Kuleana Parcels Acreage**	**Water Standard**	**Est. Ave. Water Use**	**Low** 15,000	**High** 40,000	**Low** 100,000	**Mid (FOF)***** 150,000	**High** 300,000
Ha`ikū	Pasture*	195.39	0* (0-7,400)	0*	--	--	--	--	--
Ha`ikū Total		**195.39**		**0**	**--**	**--**	**--**	**--**	**--**
Honopou	Pasture*	33.38	0* (0-7,400)	0*	--	--	--	--	--
Honopou Total		**33.38**		**0**	**--**	**--**	**--**	**--**	**--**
Ke`anae	Pasture*	11.94	0* (0-7,400)	0*	--	--	--	--	--
Ke`anae	Taro**	85.49	27,500	2,350,985 **	1,282,355	3,419,614	8,549,035	12,823,500	25,647,105
Ke`anae Total		**97.43**		**2,350,985**	**1,282,355**	**3,419,614**	**8,549,035**	**12,823,500**	**25,647,105**
Waikamoi	Pasture*	30.85	0* (0-7,400)	0*	--	--	--	--	--
Waikamoi Total		**30.85**		**0**	**--**	**--**	**--**	**--**	**--**
Total		**387.38**		**2,350,985**				**12,823,500*******	

Source: Kuleana parcels-OHA, 2009. Approx. agricultural acreages overlying Kuleana parcels calculated by MDWS using GIS intersection of Kuleana (OHA 2009) and 2015 Agricultural baseline data.

Water Use Rates: Diversified Ag-HDOA Guidelines; Taro-CWRM Nā Wai ʻEhā and East Maui Streams CCH. Due to proximity of parcels to stream, taro is assumed to be wetland taro. Water standard for taro is average consumptive range of 15,000 to 40,000 gpa.

*Most pasture is not irrigated and uses no water acreage in the GIS intersection of Kuleana (OHA 2009) and 2015 Agricultural Baseline data.

**Taro crop cultivation not included in 2015 Ag Baseline data was estimated to be 87.75% of total Ke`anae ASYA acreage based on the ratio of Taro to total Ke`anae ASYA acreage in the GIS intersection of Kuleana parcels (OHA 2009) and 2015 Ag Baseline data. All other ASYAs were assessed at 0% of taro as compared to total ASYA acreage.

***Based on streamflow requirements for taro from CWRM Case No. CCH-MA13-01. Hearings Officer's Amended Proposed Findings of Fact, Conclusions of Law, & Decision and Order. August 2017.

****This "blended" total uses the 150,000 gpd FOF streamflow rate and the HDOA consumptive rate for non-taro crops. Or from following table 16-6 "**These totals reflect the "blended" totaling method described in the above tables, which assess 150,000 gpd of streamflow use for taro acreage as opposed to the 27,500 gpd HDOA consumptive use water rates for taro."

Appendix 16A shows that only 2.416 mgd of water use are currently declared under the 1989 Declarations of Water Use. Many of the diversions have no associated water use quantities declared and several streams have neither diversions nor water use quantities declared. However, many of these areas likely have undeclared diversions in active use and therefore 2.416 mgd is probably an underestimate of water use.

Table 16-12 Summary of Agricultural Water Use Analysis, Ko`olau ASEA

Agricultural Land Areas in Ag Water use Analysis	Estimated Water Use (gpd)
2015 Ag Baseline minus Kuleana Parcels	2,298,428**
Kuleana Included in 2015 Ag Baseline Analysis (Subtracted from the Ag Baseline Total)	4,156,500**
Kuleana not Included in 2015 Ag Baseline	12,823,500**
1989 Declarations of Water Use	1,786,375*
Total Estimated Agricultural Water Use	**21,064,803**

*Calculated by subtracting stream diversion declarations (QDec) located within Kuleana and 2015 Ag Baseline parcels (TMKs) from total Ko`olau ASEA 1989 declarations of water use (QDec). A&B, HC&S, and ML&P declarations are also subtracted from this total as they do not reflect agricultural water use within the Ko`olau ASEA, but instead are exports to other ASEAs (primarily Central ASEA). These water exports are accounted for in the total surface water diversions for the overall Ko`olau ASEA analysis.

**These totals reflect the "blended" totaling method described in the above tables, which assess 150,000 gpd of streamflow use for taro acreage as opposed to the 27,500 gpd HDOA consumptive use water rates for taro.

NOTE: This estimated water use analysis does not account for surface water resources exported outside of the Ko`olau ASEA for agricultural and municipal uses.

Table 16-13 Estimated Agricultural Water Use in Ko`olau ASEA Based on CCH-MA13-01

Location	Acres in Taro	Taro Water Use Rates per Acre (Based on Range of 130,000 to 150,000 gpd)	Acres in Other Ag	Other Ag Water Use Rates per Acre (Based on Range of 3,400 gpd)*	Estimated Total Water Use (gpd)
Ke`anae (Palauhulu Stream)	13.475	150,000	7.000	3,400	2,045,050
Wailua (Waiokamilo & Wailuanui Streams)	30.16	150,000	28.096	3,400	4,619,526
Honopou	6.17	150,000	9.820	3,400	958,888
Hanehoi/Puoloa	2.3	150,000		3,400	345,000
Makapipi	4.17	150,000		3,400	625,500
Total	**56.275**		**44.916**		**8,593,964**

*Water use rate of 3,400 gpd/acre based on Diversified Ag-HDOA Guidelines. Other Ag Water Use shows consumptive use whereas Taro Water Use Rates are based on CCH-MA13-01 (see source below).

Note: This estimated water use analysis does not account for surface water resources exported outside of the Ko`olau ASEA for agricultural use.

Source: CWRM Case No. CCH-MA13-01. Hearings Officer's Amended Proposed Findings of Fact, Conclusions of Law, & Decision and Order. August 2017.

Municipal Use

Municipal use comprised about 96 percent of reported well pumpage in the Ko`olau ASEA, with single-family use dominating. There are eight DOH-designated municipal water systems (systems serving more than 25 people or 15 service connections), or "public water systems" (PWSs); using groundwater within the Ko`olau ASEA summarized in the table below, including eight County of Maui Department of Water Supply (MDWS) subsystems and two privately owned PWSs as defined by the Department of Health.

The MDWS water systems of Kokomo-Kaupakalua (MDWS 311), Kuiaha (MDWS 312), and Ha`ikū-Pa`uwela (MDWS 313), Ke`anae (MDWS 915), and Nahikū (MDWS 913) serve most of the resident population with potable water, including the coastal areas of Wailua, Ke`anae, Nahikū, and Ha`ikū. There is no interconnection between the Nahikū, Ke`anae, and Wailua systems and the Ha`ikū System. The map below shows the general service areas of the public water systems in the region. The charts that follow show the proportion of water consumption by water provider, water use by type for the County's municipal system, and the source of this supply. MDWS systems, The National Park Service public system, and other privately owned PWSs' service connections and average water production are shown in the table below. The National Park Service catchment system is not classified as “municipal” in the CWRM database but is regulated as a public water system based on the number of visitors served.

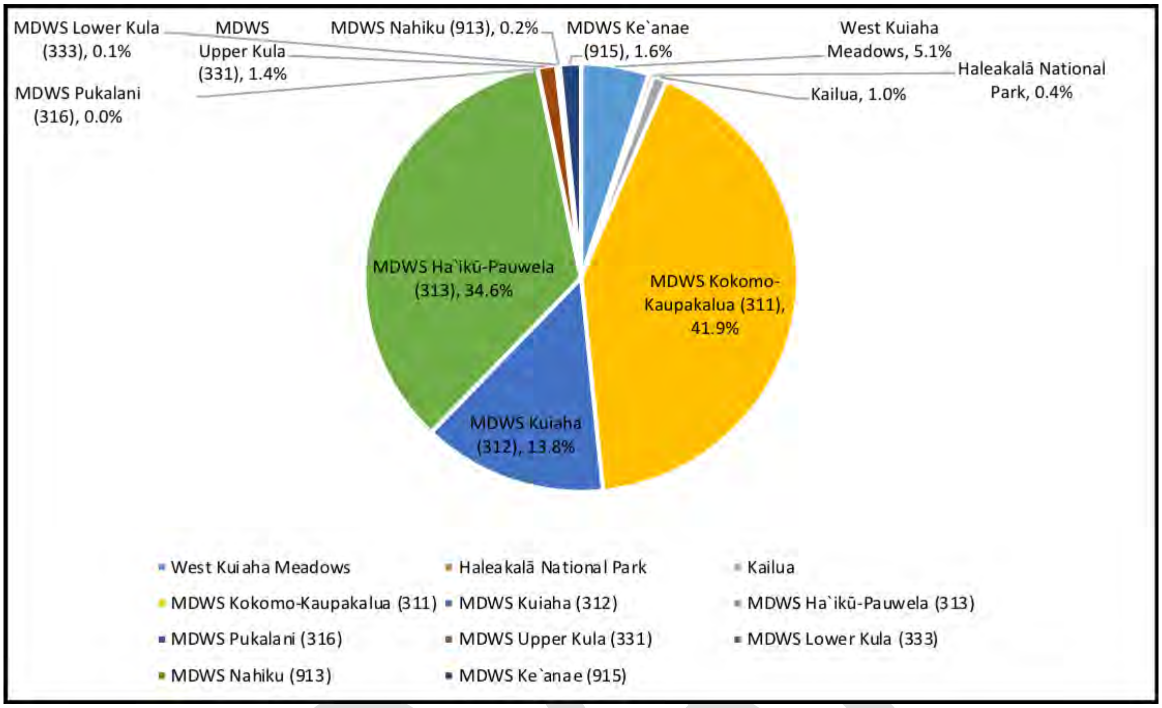
Table 16-14 Public Water Systems by Provider, Ko`olau ASEA

DOH No.	Sytem Name (DWS Number	Operator	Population Served[77]	Service Connections	Average Daily Flow (gpd)	Primary Source
252	West Kuiaha Meadows	West Kuiaha Meadows Homeowners Association	45	15	53,000	Ground
222	Haleakalā National Park	National Park Service	1,200	17	4,000	Catchment
203	Kailua	Ohanui Corporation	90	27	10,500	Ground
213	Kokomo-Kaupakalua (311)	MDWS	3,190	1,085	439,312	Ground
213	Kuiaha (312)	MDWS	888	302	144,192	Ground
213	Ha`ikū-Pa`uwela (313)	MDWS	2,461	837	362,373	Ground
213	Pukalani (316)	MDWS	3	1	249	Surface
215	Upper Kula (331)	MDWS	115	39	14,542	Surface
247	Lower Kula (333)	MDWS	9	3	874	Surface
220	Nahikū (913)	MDWS	29	10	1,882	Ground
219	Ke`anae (915)	MDWS	253	86	16,447	Ground
Total			**8,293**	**2,422**	**1,047,371**	

Source: Department of Health, Safe Drinking Water Branch 2015 based on 2013 survey of water production submitted by providers every three years. All systems are "community" systems, except for DOH No.222 which is a "Transient Non-Community" system.
The above information for MDWS systems includes only data for each system found within the Ko`olau ASEA. Several of these MDWS systems cross over into the Central ASEA and those amounts are accounted for in the Central ASEA analysis.

[77] Based on 2.94 average people per service connection.

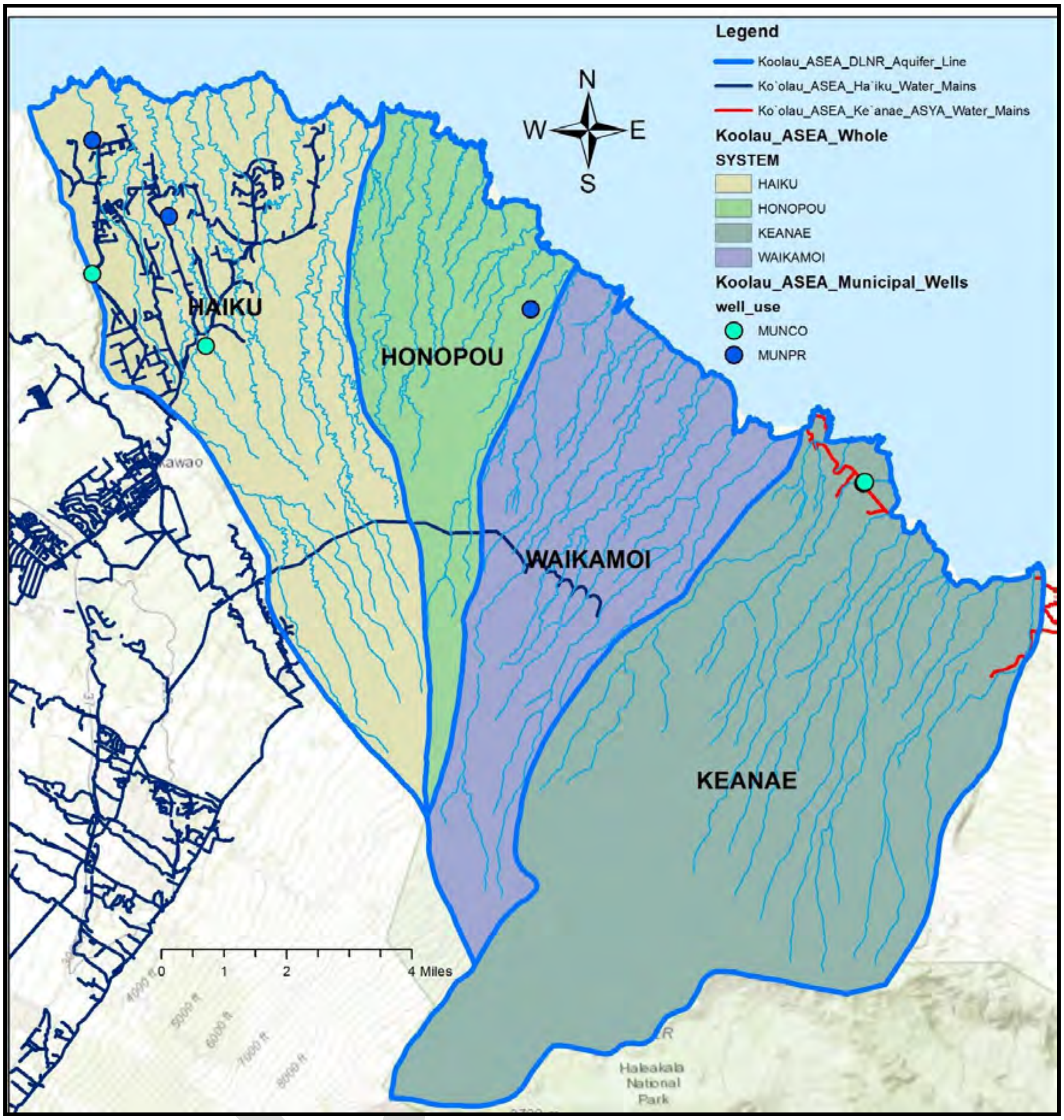
Figure 16-18 Ko`olau ASEA Public Water Purveyors



Source: Department of Health, 2015. MDWS 2017

General locations of the county water mains and wells are shown below. The MDWS Nahikū service area extends into Hāna ASEA.

Figure 16-19 Ko`olau ASEA General Location of Public Water Systems



MDWS Water System

The MDWS systems located within the Ko`olau ASEA generally serve the areas of Nahikū, Wailua, Ke`anae, Makawao, Pā`ia and Ha`ikū. Single-family residential use accounts for the greatest demand. Although the CWRM water use category “Municipal” includes all MDWS billing classes, the table below provides a breakdown of water consumption that closest corresponds to CWRM sub-categories and actual water use. Within the context of CWRM categories, the “Municipal” category represents public, quasi/public and park uses.

Table 16-15 MDWS Service by CWRM Category*

CWRM Categories	GPD	% of Total
Domestic*2	955,189	97.48%
Industrial	0	0.00%
Municipal*3	11,016	1.12%
Agriculture	1507	0.15%
Irrigated	0	0.00%
Military	0	0.00%
Unknown	12,159	1.24%
Total	**979,871**	**100%**

Source: MDWS Metered Consumption Data, 2014 daily average.

*Includes all or portions of the following MDWS Water Use Zone (WUZ) Subdistricts: Kokomo-Kaupakalua (311), Kuiaha (312), Ha`ikū-Pa`uwela (313), Pukalani (316), Upper Kula (331), Lower Kula (333), Nahikū (913), Ke`anae (915)

*2CWRM "Domestic" category represents both residential use and non-residential use, which includes business and hotel use

*3CWRM "Municipal" category represents public, quasi/public and park uses.

The table above reflects billed water consumption, which is different from water pumped and produced. Water production is higher than consumption, due to accounting for distribution, water losses, and unmetered use. Well pumpage is required to be reported to CWRM only for actual periods of pumpage. Reported well pumpage compared to sustainable yield in the Ko`olau ASEA is minimal, with less than 0.6 percent (979,871 gpd) of the total sustainable yield (SY) of 175 mgd pumped. Not all active wells comply with reporting requirements, and pumpage data is especially incomplete for smaller domestic and irrigation wells.

While the base year for this WUDP is 2014, alternative periods were reviewed to determine whether 2014—which exhibited a strong El Nino—is representative of consumption; and the 10-year average was determined to be consistent with the 2014 average daily demand.

Water use varies seasonally, with the low demand months generally reflecting lower outdoor irrigation demands. For MDWS systems, the seasonal fluctuations indicate the potential for outdoor water conservation as well as ways to offset use of potable water for non-potable needs. These conditions are likely to also apply to all public water systems that serve community needs. Water consumption versus production, seasonal and historic trends for the MDWS Upcountry System is analyzed in the Central Aquifer Sector Report, Chapter 15.5.

State Water Systems

Kaumahina State Wayside

The Kaumahina State Wayside Water System is located between Kailua and Wailua along Hāna Highway, 28 miles east of the Kahului Airport on the island of Maui. The system is located in the Ko`olau hydrological sector, and Waikamoi system. The water system is owned and operated by the State of Hawai`i and managed by the DLNR-State Parks. The water system serves a comfort station within the Wayside. The non-potable source for the water system is a stream diversion from the Haipua`ena Stream. The estimated water demand is 0.008 mgd. Information to determine the stream diversion capacity is not available and flow measurements are not recorded. System source capacity adequacy could not be determined. Future water demands for the park were not reported.

Pua`a Ka`a State Wayside Water System

The Pua`a Ka`a Wayside water system is located between Wailua and Nahikū along Hāna Highway, 38 miles East of Kahului Airport. The system overlies the Ke`anae aquifer. The water system is owned and operated by the State of Hawai`i and managed by the DLNR-State Parks. The non-potable source for the water system is a stream diversion from the Waiohue Stream. Stream water is diverted through a 2-inch pipe and stored in a 0.005 MG reservoir. The estimated water demand is 0.006 mgd. Information to determine the stream diversion capacity is not available and flow measurements are not recorded. System source capacity adequacy could not be determined. Future water demands for the park were not reported.

Federal Water Systems

PWS 222 Haleakalā National Park

The Haleakalā National Park Public Water System is owned and operated by the National Park Service and serves approximately 1,200 visitors per day. Two-250,000 gallon tanks are used to store the water. Potable water is supplied entirely by catchment gathered on the Waikamoi Aquifer, which is sand filtered and chlorinated to ensure that drinking water meets the Safe Drinking Water Regulations. The distribution piping is comprised of approximately 1.5 miles of 4-inch ductile iron distributed to 17 meters/service connections. The following table provides the average daily consumption (gpd) per class of customer.

Table 16-16 (PWS 222) Haleakalā National Park Average Gallons per Day Consumption

Class	Average Consumption/gpd
Single Park Visitor	~1,200 Visitors/day
Total Consumption	**4,000**

Source: Department of Health Safe Drinking Water Branch

There have been no EPA violations reported for Haleakalā National Park Public Water System 222 since 2004.[78]

Private Public Water Systems

PWS 203 Kailua: Honopou Aquifer

The Kailua Public Water System is owned and operated by the Ohanui Corporation, a subsidiary of A&B Properties, Inc. East Maui Irrigation Company Limited (EMI) is contracted by agreement to provide operation, maintenance and repair of all Ohanui infrastructure. PWS 203 serves approximately 90 customers and 27 meters/service connections. The Average Daily Flow is 10,500 gallons per day (gpd), and the pump capacity is 24,000 gpd.[79] Potable water is supplied by basal groundwater obtained from a deep well drawing from the Honopou Aquifer. Water is chlorinated to ensure that drinking water meets the Safe Drinking Water Regulations. The Kailua Public Water System has approximately 2,000 length feet of mains and one tank with a storage capacity of 5,400 gallons. There are currently no plans to expand, provide other service connections or develop additional water resources in this area. The following table provides the amount of average daily consumption per class of customer.

Table 16-17 (PWS 203) Kailua Public Water System Average Gallons per Day Consumption

Class	Average Consumption/gpd*
Single Family	10,300
Commercial	200
Total Consumption	**10,500**

Source: Department of Health Safe Drinking Water Branch

From 2004 to 2009, 167 tests were conducted for 94 chemicals, and none were found. There have been no EPA violations reported for the Kailua Public Water System since 2004.[80]

PWS 252 West Kuiaha Meadows: Ha`ikū Aquifer

The West Kuiaha Meadows Public Water System is owned by the West Kuiaha Meadows Homeowners Association, and provides service to approximately 45 customers over 15 service connections/meters stored in a 50,000 gallon tank. The Average Daily Flow is 6,000 gallons per day (gpd). Potable water is supplied by basal groundwater obtained from one deep well

[78] HI DOH SDWB; CWRM; Mr. Rusty Waltrip; http://www.nps.gov/hale/planyourvisit/index.htm; http://Hawai`i .gov; http://www.ewg.org/tap-water/whatsinyourwater/HI/Haleakalā-National-Park/0000222/

[79] Based on pumping 16 hours per day.

[80] HI DOH SDWB; CWRM; Mr. Mark Vaught; http://www.ewg.org/tap-water/whatsinyourwater/HI/Kailua/0000203/

drawing from the Ha`ikū Aquifer. The well has a capacity to produce up to a total of 53,000 gpd. Treatment consists of hypo chloride solution delivered by an LMI pump to maintain a residual chlorine level of about 0.75 ppm and is maintained by water operator to ensure that drinking water meets the Safe Drinking Water Regulations of the EPA and the State of Hawai`i Department of Health. The following table shows consumption per class of customer.

Table 16-18 (PWS 252) West Kuiaha Meadows Average Gallons per Day Consumption

Class	Average Consumption/gpd*
Single Family	6,000
Total Consumption	6,000

Source: Public Water System pumpage reports reported to CWRM

*gpd = gallons per day

To accomplish water conservation, there is a two tier rate in place for PWS 252 West Kuiaha Meadows. Customers are charged a higher rate when they exceed 1,250 gallons a day (gpd). No future expansion is anticipated for the water system. There have been no EPA violations reported for the West Kuiaha Meadows Public Water System since 2004.

<u>Other Potable Water Use</u>

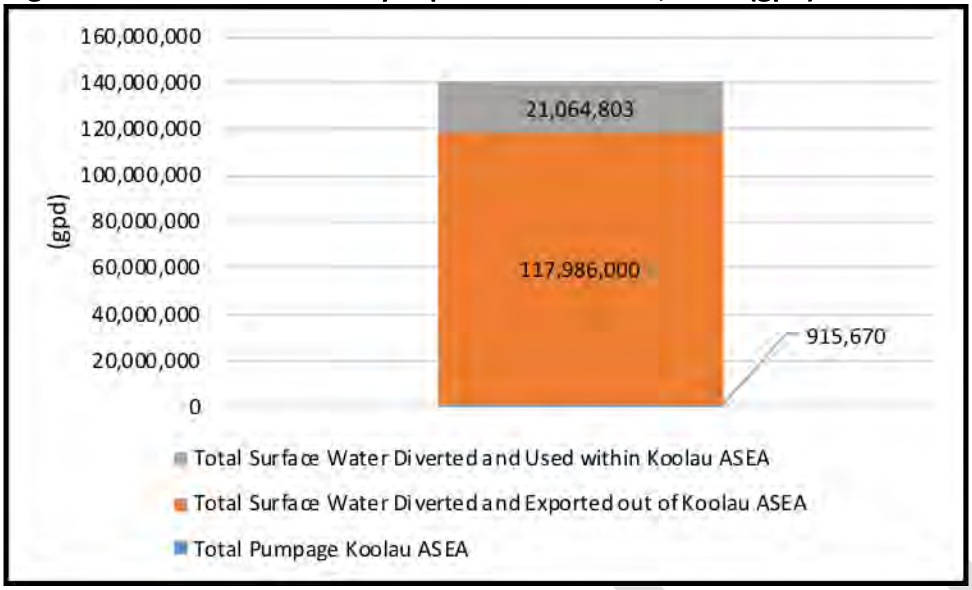
An unknown number of persons are not served by any public water system. Some small developments or groups of development below the DOH threshold or individual households and uses may be served by domestic wells, catchment, streams or other sources. Estimated 'order of magnitude' demand for 2014 of 0.277 mgd for the island of Maui. The estimate is based on island-wide 2010 Census Block population of about 1,190 persons that appeared to be outside public water system purveyor service areas, general location of development and system pipes and an average MDWS per capita rate of 248 gpd.[81] Rural properties located throughout the Ko`olau ASEA may contain a higher proportion of unserved population compared to other areas on Maui. Rainfall is sufficient to sustain catchment systems in areas without water infrastructure.

16.5.2 Water Use by Resource

Water resource use in 2014 comprised about 139,966,473 gpd in the Ko`olau ASEA, with surface water for use within the Ko`olau ASEA accounting for about 15 percent of total water demand, surface water diverted and exported outside of the Ko`olau ASEA comprising approximately 84%, and groundwater accounting for approximately less than 1 percent of total water demand.

[81] 2010 Census Block Group population that appears to be outside public purveyor service areas – approx. 1190; apply average MDWS per capita rate of 248 gpd based on 2010-2014 consumption and interpolated population = 296,144 gpd. Excluding domestic well pumpage of 20,495 gpd results an estimated demand of 276,649 gpd.

Figure 16-20 Water Source by Aquifer Sector Area, 2014 (gpd)



Source: CWRM Well Pumpage Reports. Surface water estimated by MDWS based on diversion amounts reported to CWRM and the agricultural water use analysis using Kuleana, 2015 Agricultural Baseline and 1989 Declarations of Water Use data.

Ground Water Resources

The Ko`olau ASEA includes 131 wells, of which 122 are considered "production" wells, and the remainder (9) are classified as "unused" and do not produce water. While well pumpage is required to be reported to CWRM not all active wells comply with reporting requirements and pumpage data is especially incomplete for smaller domestic and irrigation wells. Only a small fraction of the region’s sustainable yield is developed and even less pumped. Installed pump capacity is not the permitted pumpage, but the maximum capacity of the permitted well in gallons per minute multiplied by 24 hours.

Table 16-19 Pumpage and Pump Capacity of Wells Compared to Sustainable Yield, Ko`olau ASEA (2014)

Aquifer System	MDWS Municipal Pumpage 2014 Ave (mgd)	Private Public Municipal Pumpage 2014 (mgd)	Total Pumpage 2014 Ave (mgd)	Pump Capacity (mgd)	Sustainable Yield (mgd)	% of Aquifer System Pumped	% of Aquifer System Potentially Pumped (MGD)
Ha`ikū	0.811	0.005	0.816	12.592	27	3.02%	46.64
Honopou	0.000	0.010	0.010	0.689	25	0.04%	2.76
Waikamoi	0.000	0.000	0.000	0.000	40	0.0%	0.00
Ke`anae	0.066	0.000	0.066	1.148	83	0.08%	1.38
Total	**0.877**	**0.015**	**0.892**	**14.314**	**175**	**0.51%**	**50.78**

Source: CWRM Well Database; 12-month moving average, January to December 2014; where data was not reported consecutive months in 2015 were used. Some wells not reporting.

<u>Surface Water Resources</u>

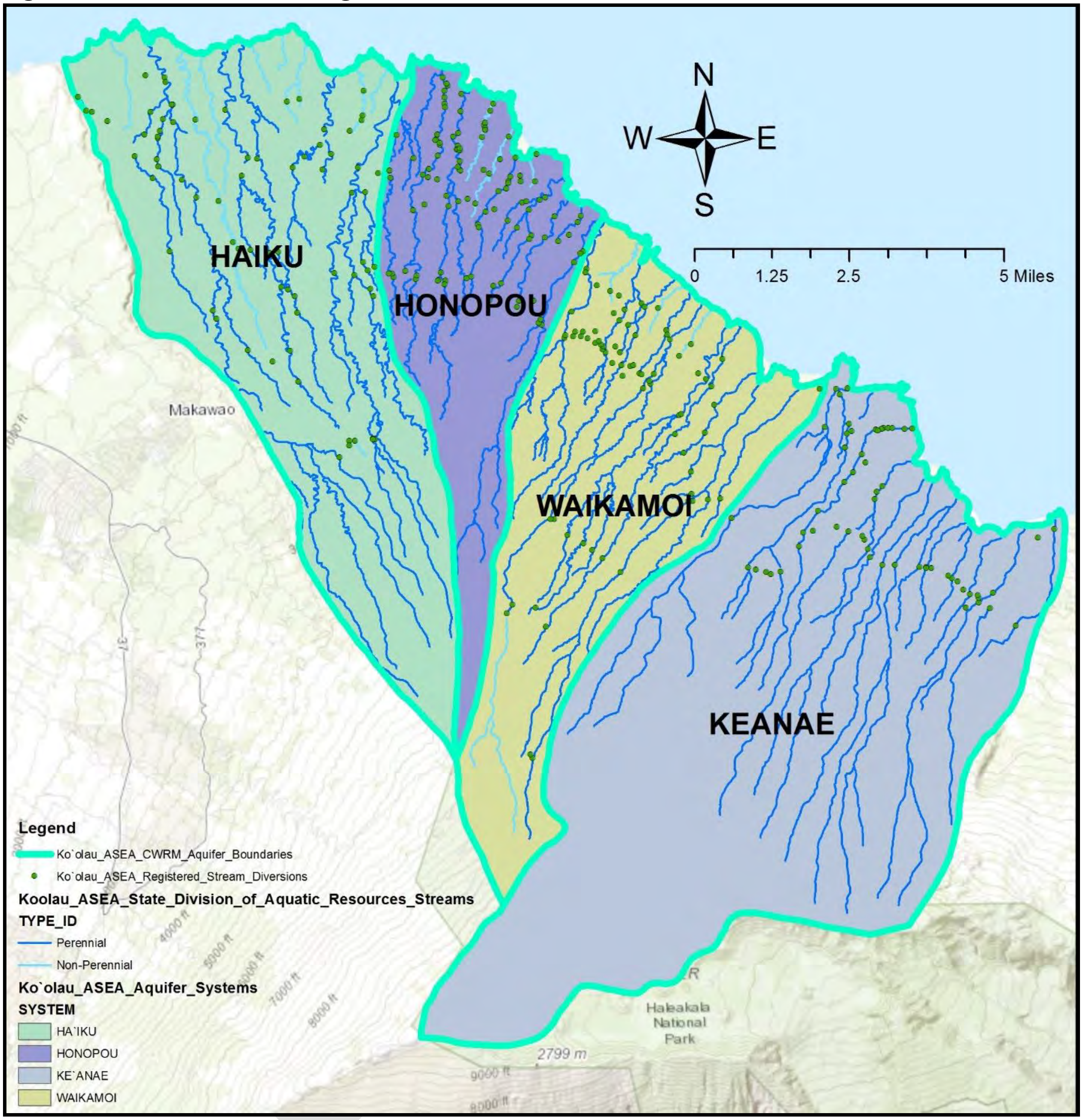
Surface water diversion data reported to CWRM for the Ko`olau ASEA is very limited, other than the 1989 Declarations of Water Use already described in this report and the reported diversions from EMI and ML&P. There are 11 CWRM stream diversion gages located within the Ko`olau ASEA. There is a CWRM gage located at Makapipi Stream within the Ko`olau ASEA, which is a source for the Nahikū MDWS Water System. Registered quantities total 2.416 mgd. The figure illustrates location of diversions and reported diversion amounts throughout the aquifer sector.

Table 16-20 Reported Diversions in Ko`olau ASEA

Registered Diversion Owner	Diversion Description	Reported Diversion Amount (MGD)
Maui Land & Pineapple Co.	Nahiku Stream Pump	0
Maui Land & Pineapple Co.	Opana 12" (Upcountry)	0.223
Maui Land & Pineapple Co.	Opana 2.5" (Upcountry)	0.032
Maui Land & Pineapple Co.	Awalau 4" (Upcountry)	0.061
EMI/HC&S	33 Wailoa Ditch at Honopou	87.075
EMI/HC&S	34 New Hamakua Ditch at Honopou	13.985
EMI/HC&S	35 Lowrie Ditch at Honopou	11.3
EMI/HC&S	36 Haiku Ditch at Honopou	5.309
Total		**117.985**

Source: Based on 2011-2015 averages reported to CWRM.
This total includes the amount diverted by EMI that is then provided to MDWS for treatment at the MDWS Kamole Weir Water Treatment Plant. The total production number for calendar year 2014 for the MDWS Kamole Weir Water Treatment Plant was 1.847 MGD. This amount is slightly below the three year (2012-2014) high of 2.409 MGD at the Kamole Water Treatment plant reflecting a relatively wet year in 2014. This total also includes water delivered to MDWS for use at the Kula Ag Park, which is not treated at the Kamole Weir WTP, but sent on to the Kula Ag Park as non-potable water for the irrigation of crops. The adjusted number to be used for agricultural water use from the above data is 117.985 mgd - 1.847 mgd (Kamole Weir Water Treatment Plant) = 116.139 MGD.

Figure 16-21 Ko`olau ASEA Registered Surface Water Diversions



Alternative Water Resources

Rainwater Catchment

Rainwater catchment is the collection of rainwater from a roof or other surface before it reaches the ground. On average, USGS data indicates rainfall ranges from 101-454 inches per year, making the Ko`olau ASEA Maui Island's rainiest ASEAs and one of the wettest places in Hawai`i. The heaviest rainfall is in the Ke`anae ASYA, where it rains as much as 454 inches per year. The cooler, dryer upper elevations may have as little as 101 inches of rain per year.[82] Rainwater catchment is not as reliable a conventional water resource because it is extremely sensitive to the climate; however, rainwater catchment is a viable option in this region. Rainwater catchment systems are not regulated by the Department of Health, making estimates of their use difficult. No inventory of installed catchment systems throughout the island is available.

Stormwater Reuse

There is no reported stormwater reuse within the Ko`olau ASEA, although a limited number of development projects may have stormwater controls incorporated into project design to reduce runoff and its effects. Stormwater reuse at the parcel scale may also provide an opportunity to offset landscape and other irrigation demand of projects or households.

Desalination

Desalination of ocean or brackish water was studied as an option in the 2013 MDWS study, Maui Island Water Source Development Options for the Central MDWS system, but an assessment has not been conducted for the Ko`olau ASEA, and there are presently no desalination projects within. One major cost to operate a desalination plant is the high energy demand of the process, and the disposal of the brine liquid byproduct creates logistical and environmental challenges that also increase cost. As desalination technology advances and energy costs decrease, brackish and ocean water desalination should continue to be evaluated for their potential as effective future water supply alternatives.

[82] Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially distributed groundwater recharge estimated using a water-budget model for the Island of Maui, Hawai`i, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168, page 38, http://dx.doi.org/10.3133/sir20145168.

16.6 FUTURE WATER NEEDS

16.6.1 General

Two alternative methods were used to project water demand to the year 2035: (1) population growth rates based on 20-year population growth projections in the Socio-Economic Forecast Report (2014) applied to current consumption and build-out—population-based demand takes into account social and economic factors that are anticipated to drive growth over the planning period; and (2) of permitted land use based on County zoning and Department of Hawaiian Homelands land use plans. The second method, full build-out (100% of land utilized for its zoned purpose) of land use based on zoning designations represents a snapshot of ultimate demand. Full build-out is not anticipated or consistent with the Maui General Plan. The selected method to project future water use is based on the population growth-rates for each community plan district established in the 2014 Socio-Economic Forecast.

16.6.2 Water Use Unit Rates

The 2002 Water Use Standards are used for land use based demand projections. Most of the water use in the Ko`olau ASEA is for residential or single-family use. The 2002 Standards for residential use are 600 gallons per day (gpd) per unit, 3,000 gpd per acre for single family/duplex, and 5,000 gpd per acre for multi-family use. System standards factor in outdoor use and are generally higher than empirical use in the region, because irrigation needs are relatively low.

The Maui Island Plan projects a 20-year modest 3.61 percent population increase for the Ko`olau ASEA from 2015 to 2035. The 2015 population of the Ko`olau ASEA was 11,892 residents, which includes: a portion of the population (10,824) of the Pā`ia-Ha`ikū Community Plan (CP) area that amounts to 91 percent of the Ko`olau ASEA's total population; a small portion of the Makawao-Pukalani-Kula CP population (701) that accounts for 5.9 percent of the Ko`olau ASEA population; and a small portion of the Hāna CP area's population (368), which accounts for 3.1 percent of the Ko`olau ASEA's total population. The population of the Ko`olau ASEA is projected to increase by 3.61 percent to 12,321 by 2035.

16.6.3 Land Use Based Full Build-Out Water Demand Projections

Full build-out projections for the Ko`olau area based on County zoning and DHHL land use categories yield a projected water demand of 81.432 million gallons per day (mgd). Full build-out by county zoning designation is neither realistic over the planning period (20 years being too short of a timeframe), nor supported by the County of Maui General Plan. System standard water rates for agricultural zoning are assigned but do not represent regional irrigation needs due to an overestimation of the time required (more than 20 years) and the overly optimistic assumption that 100 percent of zoned lands will eventually realize their zoning designations.

Maui County Zoning

Maui County Zoning for the Ko`olau ASEA is predominantly Interim Use Zone districts (72.48 percent) and to a lesser extent Agriculture (26.62 percent). Interim zoned land (made up mostly of Conservation lands at 99 percent) was assigned a zoning classification, based on Directed Growth Plan guidance and Community Plan land use designations, in order to calculate water demand for these areas. There are over 85,655 zoned acres in the Ko`olau ASEA (excluding DHHL lands, which account for 242 acres). The Interim District encompasses 62,127 acres. The Ko`olau, Pā`ia-Ha`ikū, and Makawao-Pukalani-Kula community plans assign the following land use designations to 62,110 Interim zoned acres (approximately 17 acres are zoned Interim but do not have corresponding CP designations): Business/Commercial (2.52 acres); Park (162 acres); Unzoned Road (0.36 acres); Single Family (32 acres); Agriculture (30 acres); Rural (99 acres); Conservation (61,762 acres); Public (21 acres). Interim zoned areas that are designated by the CPs as Conservation, Open Space, Unzoned Road, and Urban Reserve are all assigned to the "Open Space" zoning district, with no water demand associated with their use. There is a remaining balance of 17 Interim zoned acres that are unassigned to another land use designation by the Community Plans. A summary of the County land use-based demand follows a discussion of DHHL land use-based demand.

Table 16-21 Summary of Zoning and Community Plan (CP) Use/Designation Types, Ko`olau ASEA (Excluding DHHL Lands)

Zoning Summary (Corresponding County Zoning Categories found within the Hāna ASEA in Parentheses)	Acres	% of Total	Water Use Rates (gpd per acre)
Single Family, Duplex (R-3 Residential, RU-0.5 Rural - 1/2 Acre, Service Business Residential)	507.45	0.592%	3,000
Business (B-2 Business - Community, SBR - BCT Business - Country Town)	6.04	0.007%	6,000
Industrial (M-1 Light Industrial)	15.35	0.018%	6,000
Agriculture (AG Agriculture)	23,149.14	27.026%	3,400
Public/Quasi-Public (P-1 Public/Quasi-Public)	29.89	0.035%	1,700
Park (PK Park)	168.15	0.196%	1,700
Open Space* (Conservation, Open Space, Unzoned Road, Urban Reserve)	61,762.25	72.106%	0
Interim*[2]	16.74	0.02%	0
TOTAL excluding DHHL Lands*[3]	**85,655.01**	**100%**	

Source: Table prepared by MDWS, Water Resources & Planning Division. Excludes DHHL lands.
Zoning supplied by Maui County Planning Department, Long Range Division, May 2015.
Interim zoning was assigned to CWRM categories based on Community Plan land use designations.
*Includes Community Plan designations of Open Space and Conservation designated "Interim" in County zoning.
*[2]Acreage represents the difference between County zoning and Community Plan designations for "Interim": 16.74 acres were designated "Interim" in County zoning, but not designated a Community Plan use type, and therefore, remained undesignated "Interim" County zoning, i.e. 16.74 Interim-zoned acres remain unassigned to another land use designation by the Community Plan. Additionally, some "interim" zoned areas may not have a community plan land use designation due to the GIS analysis omitting a narrow band along the coastline due to slightly different geocoordinates between GIS layers' boundaries.
*[3]471.7 acres of DHHL lands zoned Agriculture and 24.18 acres of DHHL land zoned Conservation were excluded from Agricultural and Conservation zoning categories in this table, but they will be addressed later in Table 16-25.

<u>**State Department of Hawaiian Home Lands (DHHL)**</u>

The DHHL maintains land use jurisdiction over Hawaiian Homes and is not subject to county zoning designations. DHHL zoned lands are not accounted for in Table 16-22 above. Water rates used by the State Water Projects Plan Update; DHHL, May 2017, and projected demand based on the DHHL Maui Island and regional land use plans are described in the table below.

Table 16-22 DHHL Land Use, Water Standards for Maui

Land Use	Potable	Non-potable (gal/acre)
Residential	600 gal/unit	None
Subsistence Ag	600 gal/unit	3400 gal/acre
Supplemental Agriculture	None	3400 gal/acre
Pastoral	600 gal/unit	20 gal/acre
General Ag	None	3400 gal/acre
Special District	Varies	Varies
Community Use acres	1,700 gal/acre or 60 gal/student	None
Conservation	None	None
Commercial	3,000 gal/acre or 140 gal/1,000 SF	None
Industrial	6,000 gal/acre	None

Source: DHHL Maui Island Plan

The DHHL Maui Island Plan

The Hawaiian Homes Commission adopted its Maui Island Plan as the overarching planning document in 2004. The Department of Hawaiian Homelands (DHHL) East Maui planning region encompasses three tracts totaling 985 acres: Ke`anae, Wākiu, and Wailua. All three tracts are within the Hāna Community Plan designated area.[83] However, only Ke`anae (150.6 acres) and Wailua (91.4 acres) tracts are within the Ko`olau ASEA, covering 242 acres the State Land Use Commission has mostly zoned Agriculture, with a very small percentage zoned Conservation.[84] The County zoning and Community Plan designations for the lands is Agricultural. For the Ke`anae tract, two acres of community use is proposed on the makai property, and 32 (3-acres or less) agricultural lots are proposed on 57 acres of the mauka property. The chosen DHHL project for the Wailua tract proposes 28 acres of subsistence agricultural use, 52 acres of general agriculture use, and 10 acres of conservation.[85]

[83] State of Hawai`i, DHHL Maui Island Plan, 2004, page 6-1.
[84] Ibid, page 6-17.
[85] State of Hawai`i, DHHL Maui Island Plan, 2004.

Table 16-23 DHHL Planned Land Use

Category	Acres or Residential Units	% of Total
Residential (Units)*	43*	N/A
Commercial (Acres)	0	0%
Industrial (Acres)	0	0%
General Agriculture (Acres)	145	59.92%
Subsistence Agriculture (Acres)[*2]	85[*2]	35.12%
Community (Acres)	2	0.830%
Open Space/Conservation (Acres)	10	4.13%
Total (Acres)	**242**	100%

Source: DWS, Water Resources & Planning Division, May 2015, based on DHHL Maui Island Plan and Regional Plans. Open Space includes conservation, cultural protection and similar use types.
*Residential units to be located on 85 acres of Subsistence Agriculture lots (43 residential/subsistence units).
**Represents 57 Subsistence acres in Ke`anae (3-acre or less lots) and 28 Subsistence acres in Wailua, catchment is proposed for irrigation.[86]

Table 16-24 DHHL Projects and Planned Land Use

Aquifer System	DHHL Project	Total Acres	Community Acres	Agricultural Acres	Open Space Acres
Ke`anae	Ke`anae Tract Final Plan (Maui Island Plan)	151*	2	149	0
Wailua	Wailua Tract Final Plan (Maui Island Plan)	91**	0	81	10

Table prepared by DWS, Water Resources & Planning Division. Figures are estimates based on DHHL Maui Island Plan and Regional Plans.
* State of Hawai`i, DHHL Maui Island Plan, 2004, page 6-23, Ke`anae: General Agriculture (92 acres), Subsistence Agriculture (57 acres)
** State of Hawai`i, DHHL Maui Island Plan, 2004, page 6-32, Wailua Tract: 11 subsistence agricultural lots (28 acres), General Agricultural use (52 acres), Conservation land (10 acres)

Ke`anae DHHL Plans

The Ke`anae tract contains two separate parcels – a two acre parcel along the shoreline on Ke`anae Peninsula and a 149 acre parcel along Palauhulu Stream mauka of Hāna Highway. The smaller parcel offers opportunities for community use, while the larger piece is appropriate for

[86] State of Hawai`i, DHHL Maui Island Plan, 2004, page 6-1, pages 6-24, 6-25, 6-29.

agricultural homesteads given its gentle slopes, high rainfall, easy access, and rural character. The DHHL plans to develop its small Ke`anae tract with subsistence agricultural homesteads and general agriculture and lo`i kalo uses.[87] The two-acre makai property is within the flood zone, which prohibits homesteading use; therefore, the property will be developed for community use because of its oceanfront location, which presents opportunities for a gathering area and for cultural practices.[88]

Wailua DHHL Plans

The 2004 DHHL Maui Island Plan chose the Alternative 1 option, which proposes 28 acres of subsistence agricultural use, 52 acres of general agriculture use, and 10 acres of conservation for the Wailua tract.[89] According to the DHHL, the rationale for selecting Alternative 1 over Alternative 2 was because of the high beneficiary demand for agriculture lots on Maui, and the subsistence agricultural designation also requires that the beneficiary reside on the lot, thus adding to the agricultural community that currently exists in Wailua.[90] Wailua has 11 readily available lots that could immediately be awarded to beneficiaries on the waiting list, therefore fulfilling the intent of the Hawaiian Homes Commission Act (HHCA). The analysis of the tract illustrates that the lands where agriculture is proposed are well suited for agricultural use due to their existing agricultural use, potentially productive soils (according to the *ALISH* designation), and high rainfall. Annual rainfall at Wailua averages between 120 and 200 inches per year. The high rainfall and stream flow from Wailuanui Stream, which runs through Wailua, provides water to the taro crops planted throughout the valley.[91]

In the past, house lots were distributed with detached lots for taro cultivation. DHHL would like to develop a similar program that uses existing lots for residential purposes and adjoining existing lots for taro cultivation. The DHHL plans to use the Wailua tract for general agriculture and lo`i kalo uses–it does not mention a need for potable water.[92] The subsistence agriculture DHHL lots are an effort to integrate beneficiaries whose lifestyle matches Wailua's traditional agricultural ways.

Catchment systems could be used for both consumption and irrigation. The DHHL plans states that MDWS water system has the capacity to serve these lands.[93] The USGS topographic map shows Wailuanui Stream, Waiokamilo Stream (along the western border), and Waikani Falls (along the southern border) within the Wailua tract. Both streams are perennial.

[87] State Water Projects Plan, Advance Report, 2016, Page xvi.
[88] State of Hawai`i, DHHL Maui Island Plan, 2004, page 6-22.
[89] State of Hawai`i, DHHL Maui Island Plan, 2004, page 6-32.
[90] Ibid.
[91] Ibid, page 6-26.
[92] Ibid, page xvii.
[93] Ibid.

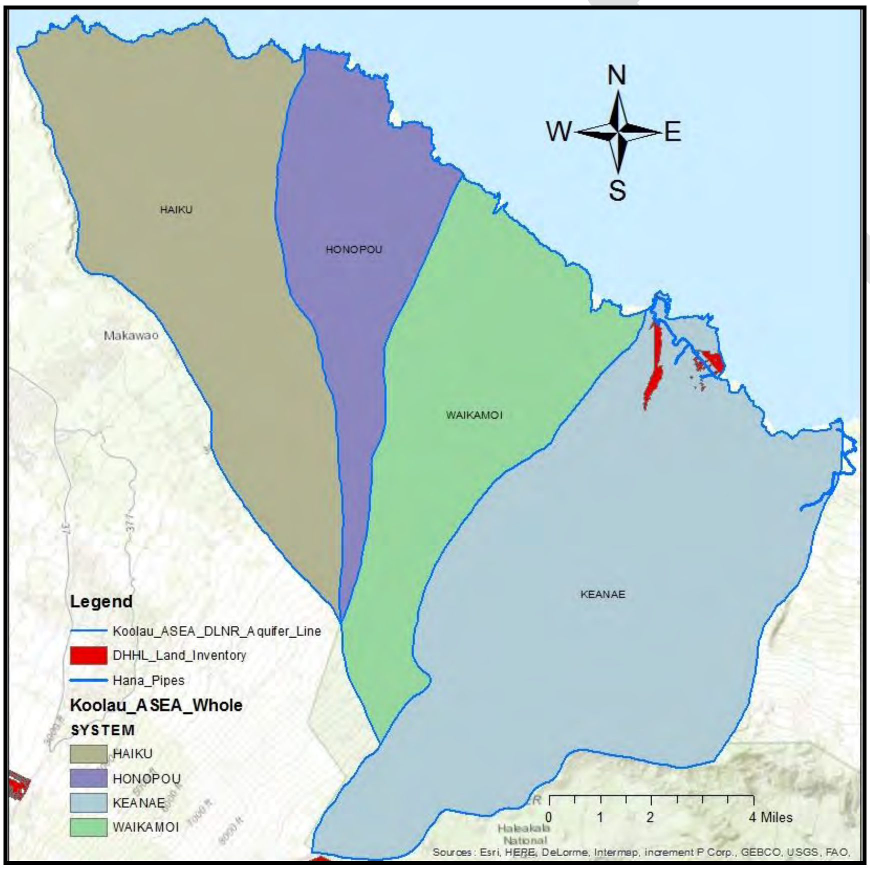
Table 16-25 Ko`olau ASEA DHHL Lands Excluded from Zoning

TOTAL Ko`olau ASEA DHHL ACRES	LAND USE DESIGNATION: AG (ACRES)	WATER STANDARDS/ACRE	TOTAL WATER DEMAND (GPD)
242	230	3,400	782,000

Source: Table prepared by MDWS, Water Resources & Planning Division.

The 2017 State Water Projects Plan (SWPP) has been updated to address DHHL's project needs from 2016 to 2031.[94] There are four DHHL project areas in the East Maui region (Kahikinui, Ke`anae, Wailua, and Hāna), with the Ke`anae and Wailua projects as the only DHHL projects located within the Ko`olau ASEA. Projected water demand and strategies for build-out of the Wailua and Ke`anae projects over the WUDP planning period is discussed under Population Growth Based Water Demand below.

Figure 16-22 Ko`olau ASEA Department of Hawaiian Homelands Land Inventory



The following table summarizes County and DHHL land use/zoning based demand.

[94] State of Hawai`i Department of Hawaiian Homelands, State Water Projects Plan Update, 2017

Table 16-26 Full Build-Out Water Demand Projections by CWRM Use Type, Ko`olau ASEA

CWRM Use Categories	County Zoning Based			DHHL Land Use Category Based				Total Projected Demand (gpd)
	Acres	Projected Demand (gpd)	Water Use Rate (gpd)	DHHL Land Use	Acres / Res Units	Water Use Rate (gpd)	Projected Demand (gpd)	
Domestic-Residential	507.45	1,522,350	3,000	Residential [*3]	43[*3]	600 gal/unit	25,800	**1,548,150**
Domestic Non-Residential *	6.04*	36,240*	6,000 gal/acre	Commercial	0	3,000 gal/acre	0	**36,240***
Industrial	15.35	54,780	6,000 gal/acre	Industrial	0	6,000 gal/acre	0	**54,780**
Agriculture	23,149.14	78,707,076	3,400 gal/acre	Agriculture [*4]	230[*4]	3,400 gal/acre	782,000	**79,489,076**
Open Space	61,762.25	0	0	Open Space	10	0	0	**0**
Municipal[*2]	198.04[*2]	336,668	1,700 gal/acre	Community	2	1,700 gal/acre	3,400	**340,068**
Military	0	0		N/A	N/A	N/A	N/A	**0**
Total	**85,655.01**	**80,620,874**			**242 acres/43 Res. units**		**811,200**	**81,432,074**

Source: MDWS Water Resources & Planning Division. Figures may not add due to rounding. Open space, conservation/cultural protection and similar land use types not included due to lack of water demand.

County Zoning: Based on zoning supplied by Maui County Planning Department, Long Range Planning Division, May 2015. DHHL lands are excluded.

*Composed of (1) BCT Business – Country Town (3.52 acres x 6,000 gallons/acre/day = 21,220 gpd); and (2) Business/Commercial (2.52 acres x 6,000 gallons/acre/day = 15,120 gpd).

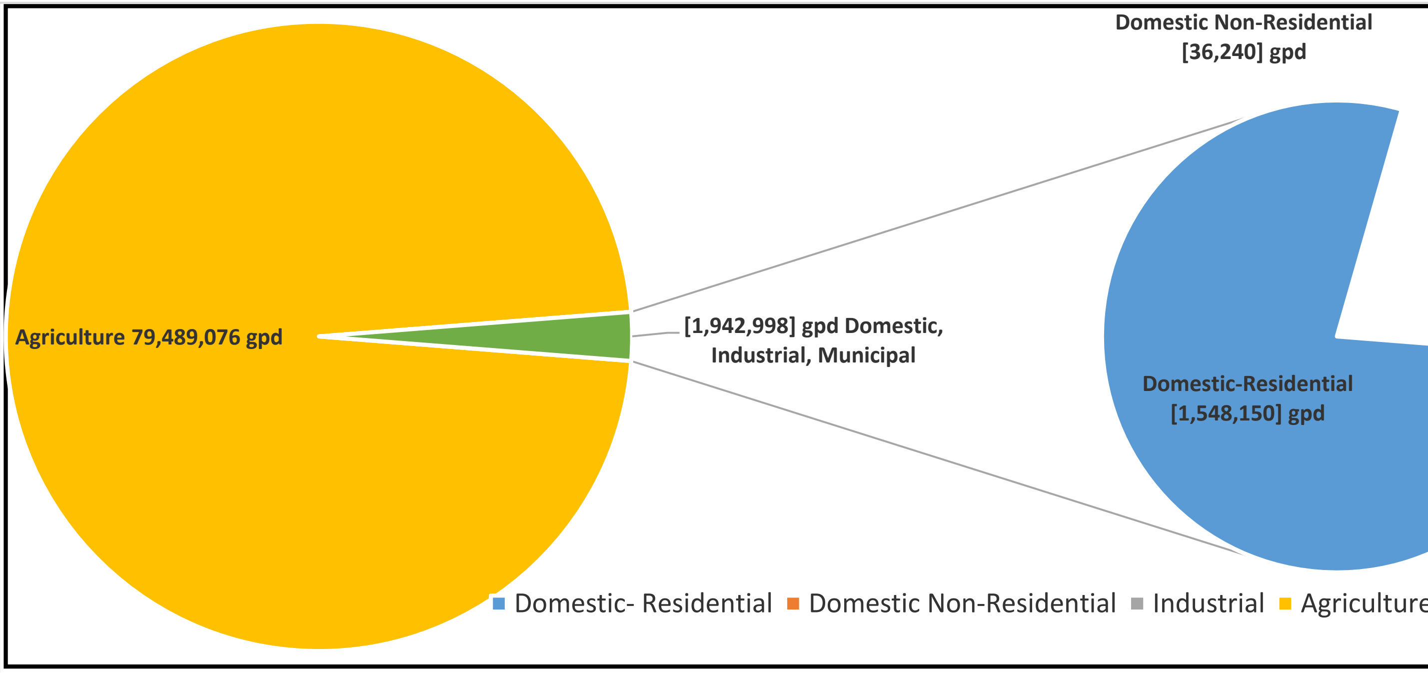
DHHL Lands: Based on DHHL Maui Island Plan and Regional Plans. Future land uses are unknown for some lands.

[*2] Municipal water as defined by CWRM (336,668 gpd) is zoned as: (1) "Public," Interim-zoned/CP designated, "Public/Quasi-Public" (29.89 x 1,700 gpd standard = 50,813 gpd); (2) PK-Park (168.15 acres x 1,700 gpd standard = 285,855 gpd); and Municipal is likely to serve Domestic Residential zoned areas.

[*3] Residential use is based on 32 3-acre subsistence lots in Ke`anae (32 lots x 600 gpd = 19,200 gpd) and eleven 3-acre lots in Wailua (11 lots x 600 gpd = 6,600 gpd).

[*4] The DHHL agricultural water use estimate (230 x 3,400 gpd = 782,000 gpd) is derived from 85 Subsistence Agricultural acres (43 3-acre or less units [32 in Ke`anae, 11 in Wailua]).

Figure 16-23 Full Build-Out Water Demand Projections by CWRM Use Type (including DHHL), Ko`olau ASEA



State Water Projects Plan

The State Water Projects Plan 2017 update only addressed Department of Hawaiian Homelands projects. Other state projects are addressed in the adopted 2004 SWPP. Availability of water required for state projects, excluding DHHL, can be determined through the year 2020 based on the 2004 SWPP Report. Land use-based water demand projections are compared to those in the 2004 SWPP, which projects future water demand to 2020, shown in the table below. According to the SWPP, the Ko`olau ASEA non-DHHL potable demand in 2018 is anticipated to be 7,600 gpd, with no anticipated non-potable demand.[95] The projects are for additional use at the Ha`ikū Elementary School and accounted for within the population-based projections for Ko`olau ASEA. According to the SWPP, an additional 10,000 gpd from 2003 to 2020 are needed to satisfy unmet SWPP Ko`olau Project demand.[96] However, the 10,000 gpd likely includes an amount for "Puakalani Elementary (sic)," which does not exist, and therefore, it is probably meant to be "Pukalani Elementary," which is outside the Ko`olau ASEA.[97]

[95] State Water Projects Plan, Hawai`i Water Plan, Volume 4, SWPP for Islands of Lanai/Maui/Moloka'i, 2003, Table 4-4.
[96] Ibid, Table 4.7, page 4-15.
[97] Ibid, Table 4.4.

Table 16-27: State Water Projects Plan Projected Water Demands to 2018 (Excludes DHHL)

ASEA	ASYA	2018 Non-Potable Demand (gpd)	2018 Potable Demand (gpd)	2018 Total Demand (gpd)
Ko`olau	Ha`ikū	0	7,600	7,600

State Water Projects Plan, Hawai`i Water Plan, Volume 4, SWPP for Islands of Lanai/Maui/Moloka'i, 2003, Table 4.4.

<u>**Agricultural Water Use and Development Plan (AWUDP)**</u>

The 2004 Agricultural Water Use and Development Plan (AWUDP) addressed the East Maui Irrigation (EMI) System and related agricultural irrigation demand sourced from Ko`olau ASEA for use in Central and Upcountry Maui. Other data referenced in the report indicates existing and potential agricultural water use may be closer to the low or midpoint of the range.

Table 16-28 Water Demand Forecast for Diversified Agriculture, Ko`olau ASEA, 2001-2021

Irrigation System	Total Acres	Acreage in Use		Unused Acreage	Acreage Forecast for Diversified Agriculture		Forecasted Water Demand (mgd)	
		Estimated Percent	Acres		Worst Case	Best Case	Worst Case	Best Case
Upcountry Maui	1,751	ND	NA		55	142	0.19	0.48
East Maui	33,026	70	23,118	9,908	200	1,160	0.68	3.94
Ko`olau ASEA Total	**34,777**	**70**	**23,118**	**9,908**	**255**	**1,302**	**0.77**	**4.42**

Source: Compiled based on Tables 6b and 7d, AWUDP, 2003, revised 2004 Water use (diversified ag acreage @ 3,400 gpd per acre). ND = no data, NA = not applicable

16.6.4 Population Growth-Based Water Demand Projections

Population growth rate projections were applied in 5-year increments over the 20-year planning period from 2015 to 2035 for high, medium (base case) and low growth scenarios. Water use for both county and privately owned public water systems, are compared to the incremental water needs for the next 20 years based on the 2014 *Socio-Economic Forecast Report* prepared by the Planning Department and consistent with the Maui Island Plan. Water use and demand based on population growth rates do not account for large-scale agricultural irrigation needs. It is assumed that projects described in the 2004 State Water Projects Plan, excluding DHHL, are accounted for in the population projections. Therefore, information from this document was not used to further refine the population-based demand projections. DHHL projections for build-out of the Wailua and Ke`anae tracts are added to population growth based demand, because it was not specifically addressed in the Maui Island Plan or socio-economic forecast.

The Maui Island Plan projects a 3.61 percent population increase between 2015 and 2035 for the Ko`olau ASEA based on the community plan growth rates in the Socio-Economic Forecast. Water demand (including large agriculture and irrigation needs) is also projected to increase by 3.61 percent from 139,966,473 gpd to 146,555,988 gpd over 20 years. The greatest need, other than for exported agricultural water, is for single-family residential use.

Table 16-29 Projected Population-Based Water Demand for Ko`olau ASEA

Criteria	2014	2015	2020	2025	2030	2035	Total % 2015/2035 Base Increase
Pā`ia-Ha`ikū CP Population Subtotal	10,714	10,824	10,925	11,000	11,074	11,084	2.41%
Makawao-Pukalani-Kula CP Population Subtotal	694	701	751	764	778	788	12.43%
Hāna CP Population Subtotal	364	368	387	406	427	449	22.01%
Total Population Increase	**11,772**	**11,892**	**12,062**	**12,170**	**12,279**	**12,321**	
Total Population Weighted CPs % Increase	4.26%*3	51.02%	1.43%	0.90%	0.89%	0.35%	3.61%
Total Water Demand (*not* including Large ag or exported municipal water use)*2	**21,966,488*4**	**22,190,496**	**22,416,788**	**22,645,388**	**22,876,319**	**23,109,604**	
Total Water Demand (including Large ag and exported municipal)	**139,966,473**	**141,393,810** *5	**143,410,544**	**144,699,130**	**145,986,894**	**146,493,101**	

Source: 2014 Final Draft Socio-Economic Forecast, Maui County Planning Dept., Long Range Planning Division. Water Demand projected by Maui County MDWS, Water Resources & Planning, 2016

*11,292 is the population of the Ko`olau ASEA based on the 2010 Census.

*2 Includes water use from stream diversions that is used for domestic purposes. It is unknown what proportion of the domestic use is for potable versus non-potable uses. This figure also includes a small amount of irrigation well water usage.

*3 4.26 percent represents the cumulative weighted (per relative CP population) percent increase for all CP districts. However, the population increases that follow for 2014 were extrapolated individually from each CP's respective percent increase.

*4 Includes Ko`olau ASEA agricultural water use demand analysis, and irrigation, domestic and municipal pumpage within Ko`olau ASEA; Table 16-16 Summary of Agricultural Water Use Analysis, Ko`olau ASEA gives us the agricultural analysis which yielded a total of 21,064,803 gpd; Irrigation, domestic and municipal pumpage within Ko`olau ASEA is added for a total of 21,966,488 gpd.

*5 The 2014 baseline for the last line of Table 16-37 above (141,393,810 gpd) was determined in Table 16-11.

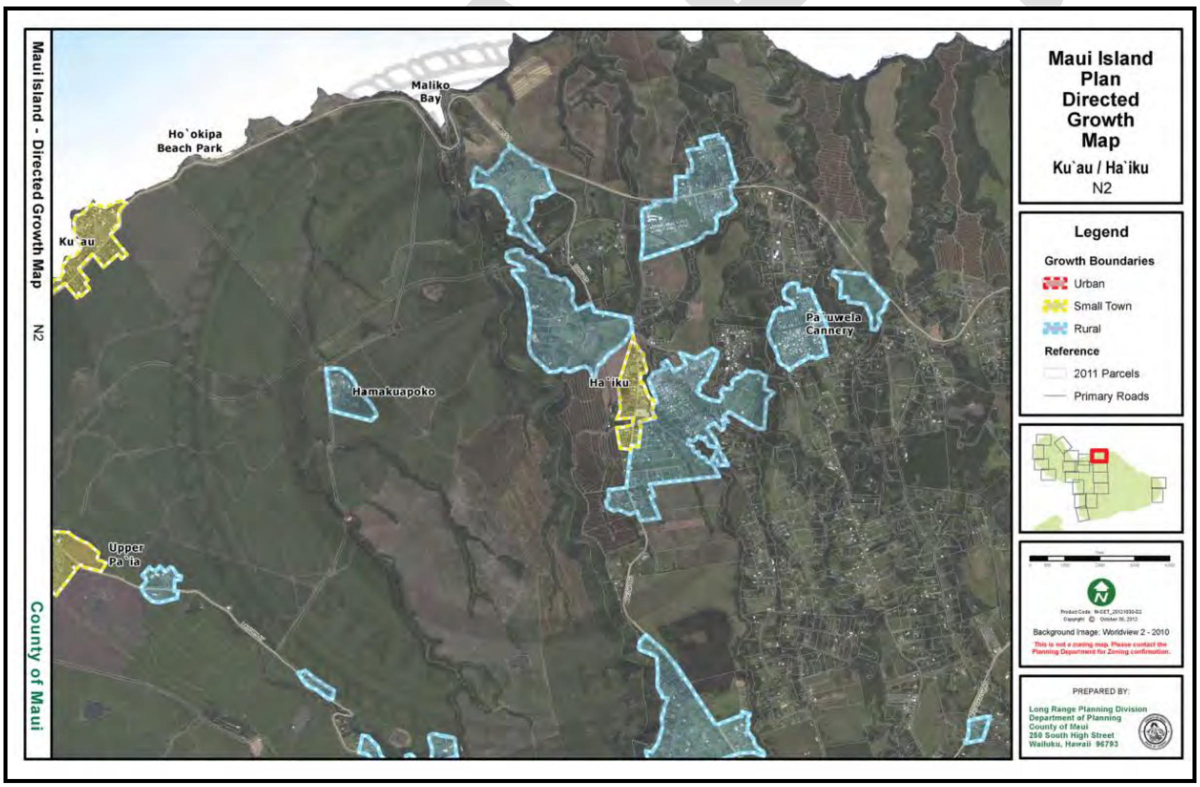
Population Growth Based Demand in Planned Growth Areas

Population growth will be focused within Small Town and Rural growth boundaries where existing infrastructure can indicate which water resources and purveyors are available to serve a development.

The Ko`olau ASEA consists of mostly rural residences. MDWS water system subdistricts in the Ko`olau ASEA supply approximately 96 percent of overall potable water production within the Ko`olau ASEA. Other private and government-operated public water systems provide approximately 4 percent of the potable water to the Ko`olau ASEA

Ha`ikū directed growth areas within the Ko`olau ASEA consist of Small Town and Rural growth boundaries.

Figure 16-24 Ko`olau ASEA Planned Growth Areas, Pā`ia-Ha`ikū CP, Maui Island Plan Directed Growth Map N2: Kū`au/Ha`ikū



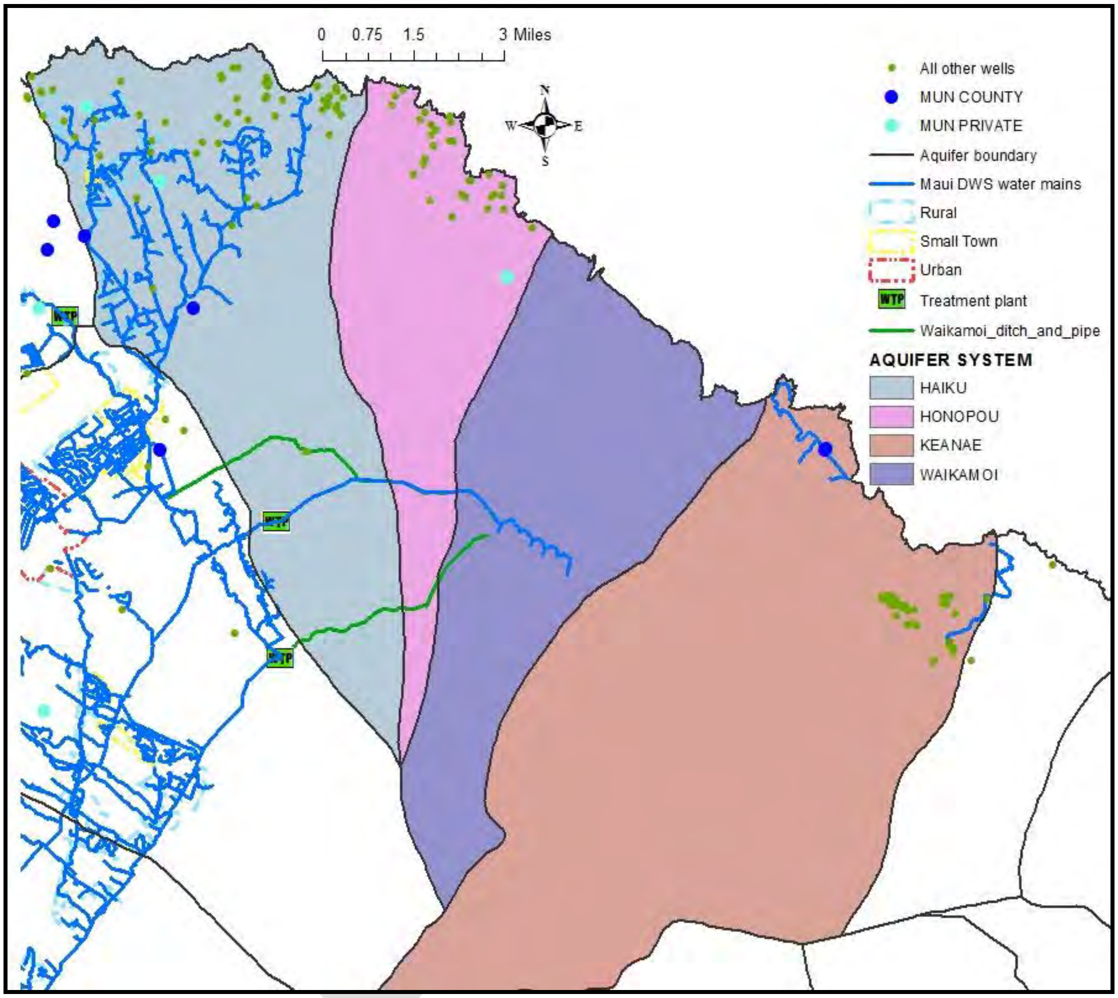
Development Projects

The Planning Department maintains a list of large development projects that have come to their attention, some of which have been entitled, committed or are supported by the Maui

Island Plan but not necessarily the Community Plan. The only development project located within the Ko`olau ASEA is the Ha`ikū Fire Station, but there is no additional water demand anticipated.

The map below shows the Growth Boundaries, municipal water sources and the MDWS Upcountry System.

Figure 16-25 Comparison of Growth Boundaries, Water Systems and Water Resources, Ko`olau ASEA.



DHHL Water Demand Projections

Water service to most existing DHHL development and facilities on Maui is currently provided by the County MDWS systems. There are no DHHL owned and operated water systems on Maui. The 2017 SWPP DHHL Update projects a potable water demand of 3,400 gpd (Ke`anae Tract) which is presently provided by the MDWS, and 6,868,000 gpd of non-potable water: (1) Ke`anae = 312,800 gpd of ambient rainfall irrigation and 4,275,000 of stream diversion; and (2) Wailua = 2,280,200 gpd (180,200 gpd ambient rainfall irrigation + 2,100,000 gpd stream diversion. The DHHL plans to develop its small Ke`anae tract (151 acres) with subsistence agricultural homesteads and general agriculture and lo`i kalo uses.[98] The two-acre makai property is within the flood zone, which prohibits homesteading use; therefore, the property will be developed for community use because of its oceanfront location, which presents opportunities for a gathering area and for cultural practices.[99] The Wailua tract (Alternative 1 option) was selected in the 2004 DHHL Maui Island Plan, which proposes 28 acres of subsistence agricultural use, 52 acres of general agriculture use, and 10 acres of conservation.[100]

The DHHL project phases are scheduled for completion in 2021, 2026 and 2031. The projections in the tables do not take into account alternate sources of water that may be available or developed. Therefore, the values in these tables should not be used to compare project water demands and available source water.

The 2004 DHHL Island Plan states that catchment systems could be used for both consumption and irrigation.[101] However, the MDWS water system also has the capacity to serve these lands.[102] A six-inch waterline from the highway would be required.[103]

Ke`anae

The Ke`anae tract will require 3,400 gpd of potable water, and 4,587,800 gpd of non-potable irrigation water for General Agriculture and loʻi kalo land uses. According to the MIP, the ambient annual rainfall within the tract is 160 inches, which is anticipated to be sufficient to sustain the Subsistence Agriculture and General Agriculture requirements. The Pi`ina`au Stream runs through the lo`i kalo portion of the tract.[104]

Wailua

The Wailua Tract is a small tract consisting of General Agriculture and loʻi kalo land uses. According to the MIP, the ambient annual rainfall within the tract ranges between 120 and 200 inches, which is anticipated to be sufficient to sustain the General Agriculture requirements. The USGS topographic map shows Wailuanui Stream, Waiokamilo Stream (along the western border), and Waikani Falls (along the southern border) within the Wailua Tract. Both streams are perennial. There is a registered stream diversion on the Waiokamilo Stream, but no declared use; however, DHHL has indicated that the area was formerly used for loʻi kalo cultivation and that there is infrastructure in place to provide irrigation water.[105]

[98] State Water Projects Plan, Advance Report, 2016, Page xvi.
[99] State of Hawai`i, DHHL Maui Island Plan, 2004, page 6-22.
[100] State of Hawai`i, DHHL Maui Island Plan, 2004, page 6-32.
[101] Ibid.
[102] Ibid.
[103] Ibid, page 6-32.
[104] State of Hawai`i Department of Hawaiian Homelands, State Water Projects Plan Update, 2017, Page 4-28.
[105] Source: State of Hawai`i Department of Hawaiian Homelands, State Water Projects Plan Update, 2017, Page 4-28.

Table 16-30 Projected Water Demands and Strategies for DHHL Projects in Ko`olau ASEA, (Ke`anae and Wailua tracts Project Future Requirements), 2031 (mgd)

Aquifer System	Project	Potable (gpd)	Potable Strategy	Non-potable (gpd)	Non-potable Strategy
Ke`anae	Ke`anae	3,400	1) Continue to utilize MDWS water for current users 2) Utilize MDWS water for additional potable users 3) Ambient rainfall is sufficient to utilize catchment for potable consumption	4,587,800	1) Ambient rainfall 2) Catchment 3) Stream diversion
Ke`anae	Wailua	N/A	N/A	2,280,200	1) Ambient rainfall irrigation 2) Stream diversion
Total		**3,400**		**6,868,000**	

Source: State of Hawai`i Water Projects Plan (SWPP), May 2017 Final Report, Tables 3.7 and 4.7, Cumulative Average Day Demand (gpd).

According to the 2004 DHHL Island Plan the MDWS water system also has the capacity to serve these lands.[106] A six-inch waterline from the highway would be required.[107] Currently, the MDWS Ke`anae Water System is able to meet the existing potable water demand of 3,400 gpd. The future unidentified water source that will be supply the unmet non-potable demand of 6,868,000 gpd of non-potable demand is expected to sourced from ambient rainfall and stream diversion and will be located within the same hydrologic unit as current potable sources.

State Water Projects Plan Water Demand Projections

State water demand projections are encompassed within the population based projections for Ko`olau ASEA.

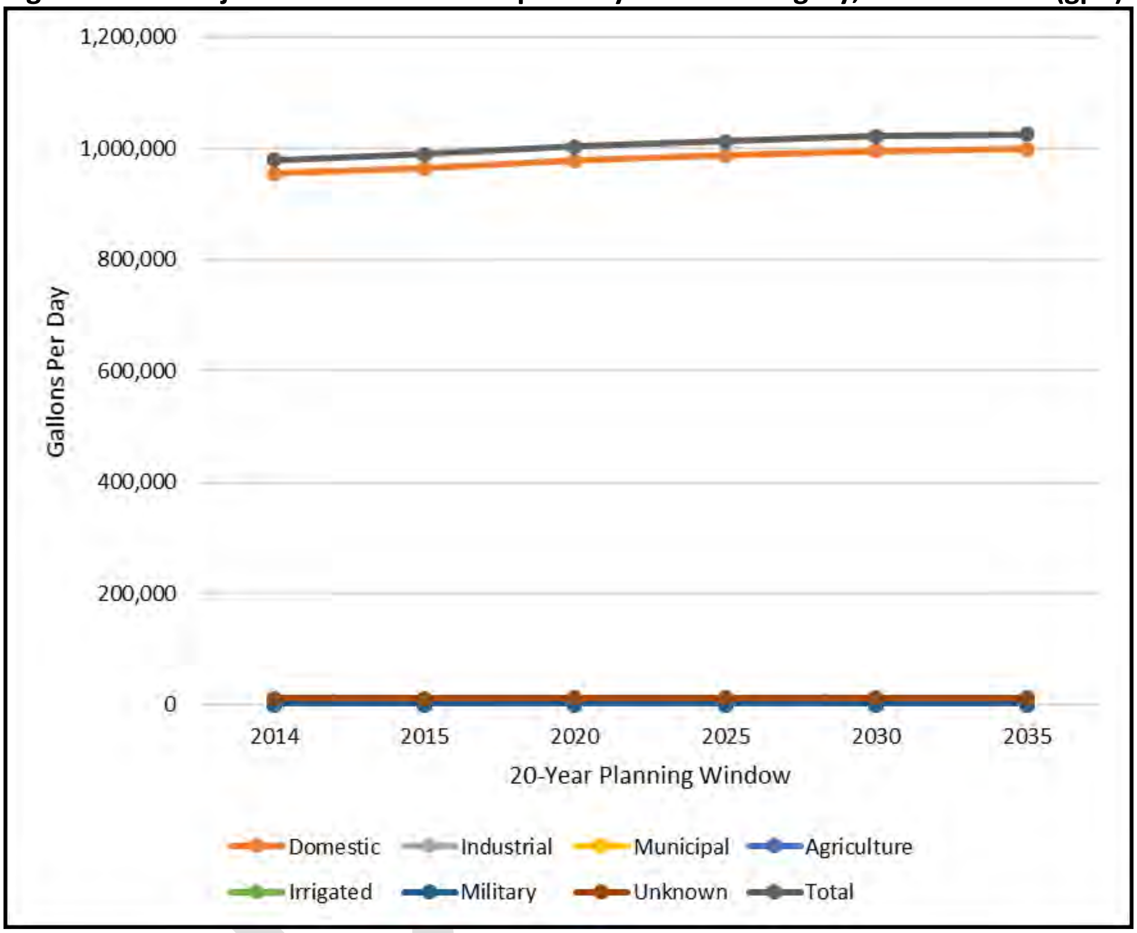
MDWS Water Demand Projections

The extent of the MDWS Upcountry system mostly overlie the Makawao Aquifer within the Central Aquifer Sector. Demand projections and source development needs for the MDWS Upcountry system as a whole is analyzed in the Central ASEA Report Chapter 15.6. Demand for

[106] Ibid.
[107] Ibid, page 6-32.

the portions of the system located within the Ko`olau ASEA is analyzed here only for the purposes of required planning by hydrologic unit. MDWS municipal needs within the Ko`olau ASEA are projected to be approximately 1.02 mgd (not including DHHL needs) by 2035 based on population growth rates established for the community plan districts within Ko`olau ASEA. A growth rate factor was applied to an extrapolation based on the weighting of populations in geographic areas to the Community Plan anticipated growth rates.

Figure 16-26 Projected MDWS Consumption by CWRM Category, Ko`olau ASEA (gpd)*



*Includes water exported to Central ASEA and then supplied to MDWS customers located within Ko`olau ASEA who are served by the MDWS Upcountry System.

Table 16-31 Projected MDWS Consumption by CWRM Category, Ko`olau ASEA to 2035 (gpd)*

CWRM Categories	2014	2015	2020	2025	2030	2035
Domestic	955,189	964,930	978,693	987,487	996,275	999,729
Industrial	0	0	0	0	0	0
Municipal	11,016	11,128	11,287	11,388	11,490	11,530
Agriculture	1507	1,522	1,544	1,558	1,572	1,577
Irrigated	0	0	0	0	0	0
Military	0	0	0	0	0	0
Unknown	12,159	12,283	12,458	12,570	12,682	12,726
Total	**979,871**	**989,863**	**1,003,982**	**1,013,003**	**1,022,018**	**1,025,562**

Source: MDWS. Based on Calendar Year 2014 consumption billing data within the Ko`olau ASEA for MDWS Water Use Zone (WUZ) Subdistricts: Kokomo-Kaupakalua (311), Kuiaha (312), Ha`ikū-Pa`uwela (313), Pukalani (316), Upper Kula (331), Lower Kula (333), Nahikū (913), Ke`anae (915).
*Includes water exported to Central ASEA and then supplied to MDWS customers located within Ko`olau ASEA who are served by the MDWS Upcountry System.

<u>Private Public Water Systems Demand Projections</u>

The private public water systems were requested to provide demand projections but most did not supply information. Therefore, demand of these smaller purveyors is encompassed within the population based projections applied to Maui Island. Disclosed information is incorporated. Public water systems in the region generally do not report billed consumption but groundwater pumped. West Kuiaha Meadows is the largest private public water purveyor in the Ko`olau ASEA, producing 53,000 gpd of groundwater. Ohanui Corporation (Kailua) reported 10,500 of groundwater production.

<u>Other Population-Based Demand Projections</u>

In addition to the public water systems, some persons are not served by public water systems and another component of water use is associated with population and economic demand. An unknown number of persons are not served by any public water system, but rather by wells, catchment and similar means. An estimated 'order of magnitude' demand for 2014 of 0.276

mgd was calculated for Maui Island and is projected to increase at a negligible rate.[108] The Ko`olau ASEA may contain a high proportion of unserved population compared to other areas on Maui.

16.6.5 Agricultural Demand Projections

As discussed under section 16.4, non-potable agricultural irrigation demand is not correlated to population growth within the Ko`olau ASEA and represents additional demand. Based on a hypothetical increase in acreage for the crops in the Crop Summary of 0.916% annually (totaling 20% increase over a 20 year period), projected agricultural water demand within the Ko`olau ASEA over the next 20 years would be 25,294,494 gpd, an increase of 4,215,749 gpd over current estimated demand. This would represent a high growth scenario. An alternative low growth scenario would be further loss of agricultural lands to development.

A mid-growth demand scenario is that agricultural lands currently cultivated stay in production. According to the 2015 Crop Baseline, these lands are all located outside growth boundaries. However, current estimated agricultural irrigation based on reported surface water diversions is less than irrigation demand for identified crops and acreage in the 2015 Baseline. Therefore, current estimated demand of 21,064,803 gpd is considered to include a high growth scenario and no further adjustment is made to account for potential increase in cultivation. It is expected that the AWUDP update will address agricultural irrigation projections in greater detail.

[108] 2010 Census Block Group populations that appear to be outside public purveyor service areas – approx. 1,190; apply average MDWS per capita rate of 248 gpd based on 2010-2014 consumption and interpolated population = 296,144 gpd. Excluding domestic well pumpage of 24.3 gpd results an estimated demand of 275,649 gpd.

Table 16-32 Estimated Agricultural Water Use, Ko`olau ASEA (Excluding Kuleana Parcels), 2035 (gpd)

Aquifer System	2015 Ag Baseline Crop Category	Est. Acres	Water Standard Consumptive Use (gpd)	Est. Average Water Use Consumptive (gpd)	Streamflow Low 100,000 (gpd)	Streamflow Mid (FOF)** 150,000 (gpd)	Streamflow High 300,000 (gpd)	Est. Average Water Use Blended (gpd)***	20% Increase in Water Demand
Ha`ikū	Banana	4.62	3,400	15,708	--	--	--	15,708	18,850
Ha`ikū	Diversified	57.28	3,400	194,752	--	--	--	194,752	233,702
Ha`ikū	Flowers / Foliage / Landscape	14.73	3,400	50,082	--	--	--	50,082	60,098
Ha`ikū	Pasture	7,037	0* (0-7,400)	0*	--	--	--	0*	0
Ha`ikū	Taro	1.59	27,500 (15-40K)	43,725	159,000	238,500	477,000	238,500	286,200
Ha`ikū Sub-Total		**7,116**		**304,267**	**159,000**	**238,500**	**477,000**	**499,042**	598,850
Honopou	Diversified	1.28	3,400	4,352	--	--	--	4,352	5,222
Honopou	Pasture	3,088	0* (0-7,400)	0*	--	--	--	0*	0
Honopou Sub-Total		**3,089**		**4,352**	--	--	--	**4,352**	5,222
Ke`anae	Diversified	2.51	3,400	8,534	--	--	--	8,534	10,241
Ke`anae	Pasture	408	0* (0-7,400)	0*	--	--	--	0*	0
Ke`anae	Taro	11.91	27,500 (15-40K)	327,525	1,191,000	1,786,500	3,573,000	1,786,500	2,143,800
Ke`anae Sub-Total		**422.75**		**336,059**	**1,191,000**	**1,786,500**	**3,573,000**	**1,795,034**	2,154,041
Waikamoi	Pasture	359.09	0* (0-7,400)	0*	--	--	--	0*	0
Waikamoi Sub-Total		**359.09**		**0**	--	--	--	**0**	0
Total		**10,986**		**644,678**	**1,350,000**	**2,025,000**	**4,050,000**	**2,298,428**	**2,758,114**

Source: 2015 Statewide Agricultural Baseline GIS, acreages calculated by MDWS. Kuleana parcels included in the 2015 Statewide Agricultural Baseline are not included in this analysis, as they are accounted for in a subsequent analysis within this report.
It is not specified whether taro is dryland or wetland.
Estimated Water Use for taro: average wetland taro consumptive rate. Coffee: 2004 AWUDP Kaua`i Irrigation System- 2500 gpd; 2900 gpd reported by plantation on Oahu per Brian Kau, HDOA, personal communication, 10/12/2016.
*Most pasture is not irrigated and uses no water.
**Based on streamflow requirements for taro from CWRM Case No. CCH-MA13-01. Hearings Officer's Amended Proposed Findings of Fact, Conclusions of Law, & Decision and Order. August 2017.
***This "blended" total uses the 150,000 gpd FOF streamflow rate and the HDOA consumptive rate for non-taro crops.

Table 16-33 Projected Water Use by Kuleana Parcels *also* located within 2015 Agricultural Land Use Baseline, Ko`olau ASEA 2035 (gpd)

Aquifer System	2015 Crop Category	Kuleana Parcels Acreage	Water Standard (gpd/acre)	Est. Ave. Consumptive Water Use (gpd)	Consumptive Use		Streamflow			20% Increase in Water Demand (2035)
					Low 15,000 (gpd)	High 40,000 (gpd)	Low 100,000 (gpd)	Mid (FOF)** 150,000 (gpd)	High 300,000 (gpd)	
Ha`ikū	Pasture*	14.11	0* (0-7,400)	0	--	--	--	--	--	--
Honopou	Pasture*	188.71	0* (0-7,400)	0	--	--	--	--	--	--
Ke`anae	Pasture*	3.87	0* (0-7,400)	0	--	--	--	--	--	--
Ke`anae	Taro	27.71	27,500	762,025	415,650	1,108,400	2,771,000	4,156,500	8,313,000	4,987,800
Waikamoi	Pasture*	42.05	0* (0-7,400)	0	--	--	--	--	--	--
Total		**276.45**		**762,025**				**4,156,500 *****		**4,987,800**

Sources: 2015 Statewide Agricultural Land Use Baseline GIS; Kuleana parcels-OHA, 2009. Approx. agricultural acreages overlying Kuleana parcels calculated by MDWS using GIS intersection of Kuleana parcels (OHA 2009) and 2015 Agricultural Land Use Baseline data.

Table 16-34 Estimated Water Use by Kuleana Parcels *not* located in 2015 Agricultural Land Use Baseline, Ko`olau ASEA 2035 (gpd/acre)

Aquifer System	2015 Crop Category	Kuleana Parcels Acreage	Water Standard	Est. Ave. Water Use	Consumptive Use		Streamflow			20% Increase in Water Demand (2035)
					Low 15,000	High 40,000	Low 100,000	Mid (FOF)*** 150,000	High 300,000	
Ha`ikū	Pasture*	195.39	0* (0-7,400)	0*	--	--	--	--	--	--
Ha`ikū Total		**195.39**		**0**	**--**	**--**	**--**	**--**	**--**	**--**
Honopou	Pasture*	33.38	0* (0-7,400)	0*	--	--	--	--	--	--
Honopou Total		**33.38**		**0**	**--**	**--**	**--**	**--**	**--**	**--**
Ke`anae	Pasture*	11.94	0* (0-7,400)	0*	--	--	--	--	--	--
Ke`anae	Taro**	85.49	27,500	2,350,985 **	1,282,355	3,419,614	8,549,035	12,823,500	25,647,105	15,388,200
Ke`anae Total		**97.43**		**2,350,985**	**1,282,355**	**3,419,614**	**8,549,035**	**12,823,500**	**25,647,105**	**15,388,200**
Waikamoi	Pasture*	30.85	0* (0-7,400)	0*	--	--	--	--	--	--
Waikamoi Total		**30.85**		**0**	**--**	**--**	**--**	**--**	**--**	**--**
Total		**387.38**		**2,350,985**				**12,823,500 ******		**15,388,200**

Source: Kuleana parcels-OHA, 2009. Approx. agricultural acreages overlying Kuleana parcels calculated by MDWS using GIS intersection of Kuleana (OHA 2009) and 2015 Agricultural baseline data.
Water Use Rates: Diversified Ag-HDOA Guidelines; Taro-CWRM Nā Wai ʻEhā and East Maui Streams CCH. Due to proximity of parcels to stream, taro is assumed to be wetland taro. Water standard for taro is average consumptive range of 15,000 to 40,000 gpa.
*Most pasture is not irrigated and uses no water
acreage in the GIS intersection of Kuleana (OHA 2009) and 2015 Agricultural Baseline data.
**Taro crop cultivation not included in 2015 Ag Baseline data was estimated to be 87.75% of total Ke`anae ASYA acreage based on the ratio of Taro to total Ke`anae ASYA acreage in the GIS intersection of Kuleana parcels (OHA 2009) and 2015 Ag Baseline data. All other ASYAs were assessed at 0% of taro as compared to total ASYA acreage.
***Based on streamflow requirements for taro from CWRM Case No. CCH-MA13-01. Hearings Officer's Amended Proposed Findings of Fact, Conclusions of Law, & Decision and Order. August 2017.
****This "blended" total uses the 150,000 gpd FOF streamflow rate and the HDOA consumptive rate for non-taro crops.

Table 16-35 Summary of Projected Agricultural Water Use Analysis, Ko`olau ASEA

Agricultural Land Areas in Ag Water use Analysis	Estimated Water Use (gpd)	Projected Water Use with 20% Increase, 2035 (gpd)
2015 Ag Baseline minus Kuleana Parcels	2,298,428**	2,758,114**
Kuleana Included in 2015 Ag Baseline Analysis (Subtracted from the Ag Baseline Total)	4,156,500**	4,987,800**
Kuleana not Included in 2015 Ag Baseline	12,823,500**	15,388,200**
1989 Declarations of Water Use	1,786,375*	2,143,650*
Total Estimated Agricultural Water Use	**21,064,803**	**25,277,764**

*Calculated by subtracting stream diversion declarations (QDec) located within Kuleana and 2015 Ag Baseline parcels (TMKs) from total Ko`olau ASEA 1989 declarations of water use (QDec). A&B, HC&S, and ML&P declarations are also subtracted from this total as they do not reflect agricultural water use within the Ko`olau ASEA, but instead are exports to other ASEAs (primarily Central ASEA). These water exports are accounted for in the total surface water diversions for the overall Ko`olau ASEA analysis.
**These totals reflect the "blended" totaling method described in the above tables, which assess 150,000 gpd of streamflow use for taro acreage as opposed to the 27,500 gpd HDOA consumptive use water rates for taro.
Note: This estimated water use analysis does not account for surface water resources exported outside of the Ko`olau ASEA for agricultural and municipal uses.

16.6.6 Irrigation Demand Projections

Landscape irrigation associated with single family homes and most commercial uses are factored into MDWS and private purveyor's municipal water use.

The figure below illustrates the selected projected demand scenario based on population growth, in comparison to the alternative projected demand scenario based on county zoning designations. In consistency with the Maui Island Plan, the mid-growth scenario is selected to guide short term resource needs, to be adjusted as needed within the low-range to high-range projections over a 20 year time horizon. The selected demand scenario combines 20 year population growth, irrigation from surface water sources projected based on existing CWRM declarations of stream diversions, non-potable needs for Department of Hawaiian Homelands, non-potable needs for kuleana and lo`i kalo, and current irrigation demand for other agriculture from surface water sources.

Table 16-36 Projected Water Use by Water Use Category based on Population Growth (Low, Medium and High) and Land Use Full Build-out to 2035 (gpd)

Category/ Growth Scenario	2014	2015	2016	2017	2018	2019	2020	2025	2030	2035
					Population Based					
Domestic	7,795	7,875	7,897	7,919	7,942	7,964	7,987	8,059	8,130	8,158
Industrial	00	00	00	00	00	00	00	00	00	00
Municipal DWS System*	979,871	989,863	992,687	995,511	998,335	1,001,158	1,003,982	1,013,003	1,022,018	1,025,562
Municipal Private PWS[109]	14,793	14,944	14,987	15,029	15,072	15,114	15,157	15,293	15,429	15,483
Military	00	00	00	00	00	00	00	00	00	00
Subtotal Pop. Based Mid	**1,002,459**	**1,012,682**	**1,015,571**	**1,018,459**	**1,021,348**	**1,024,237**	**1,027,126**	**1,036,355**	**1,045,578**	**1,049,204**
TOTAL Mid	**1,002,459**	**1,012,682**	**1,015,571**	**1,018,459**	**1,021,348**	**1,024,237**	**1,027,126**	**1,036,355**	**1,045,578**	**1,049,204**
TOTAL Low	**1,002,459**	**926,111**	**928,753**	**931,395**	**934,037**	**936,678**	**939,320**	**947,760**	**956,195**	**959,511**
TOTAL High	**1,002,459**	**1,092,435**	**1,102,388**	**1,018,459**	**1,021,348**	**1,024,237**	**1,027,126**	**1,036,355**	**1,045,578**	**1,049,204**
Irrigation within Ko`olau ASEA	1,695	1,695	1,695	1,695	1,695	1,695	1,695	1,695	1,695	1,695
DHHL[110]	0	0	0	0	0	0	6,871,400	6,871,400	6,871,400	6,871,400
Agriculture within Ko`olau ASEA (inlcudes ag analysis + ag GW pumpage)	21,078,745	21,078,745	21,271,826	21,466,676	21,663,311	21,861,747	22,062,001	23,091,122	24,168,248	25,294,494[111]
Exported Agricultural & Irrigation Surface Water	116,139,000	116,139,000	116,139,000	83,750,000	83,750,000	83,750,000	83,750,000	83,750,000	83,750,000	83,750,000
Exported Diverted Surface Water for MDWS Kamole Weir	1,847,000	2,006,341	2,179,428	2,367,447	2,571,687	2,793,546	3,034,545	4,589,681	6,941,790	10,500,000
TOTAL[112]	**140,068,899**	**140,238,463**	**140,607,535**	**108,604,309**	**109,008,088**	**109,431,288**	**109,875,446**	**112,469,015**	**115,907,560**	**120,595,732**

[109] Based on 63,000 gpd potable use and 13,500 gpd non-potable use projection from DHHL's SWPP.
[110] Based on SWPP, 2017 Final Report, Tables 3.7 and 4.7. Cumulative Average Day Demand (gpd).
[111] Based on 20% estimated increase in agricultural water demand from 2015 to 2035.
[112] Based on Mid-Growth Projection.

Category/ Growth Scenario	2014	2015	2016	2017	2018	2019	2020	2025	2030	2035
Land Use Full Build-out Based[113]										
County (Zoning) (Excl. AG)	1,913,798	1,913,798	1,913,798	1,913,798	1,913,798	1,913,798	1,913,798	1,913,798	1,913,798	1,913,798
DHHL (Excl. AG)	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000	28,000
Total, (Excl. AG)	**1,941,798**	**1,941,798**	**1,941,798**	**1,941,798**	**1,941,798**	**1,941,798**	**1,941,798**	**1,941,798**	**1,941,798**	**1,941,798**
TOTAL (Incl. AG) *not shown on chart*	81,008,934	81,008,934	81,008,934	81,008,934	81,008,934	81,008,934	81,008,934	81,008,934	81,008,934	81,008,934

*Includes water exported to Central ASEA and then supplied to MDWS customers located within Ko`olau ASEA who are served by the MDWS Upcountry System.

[113] Land Use Full Build-Out Based analysis determined to be less accurate than Population Based analysis (above).

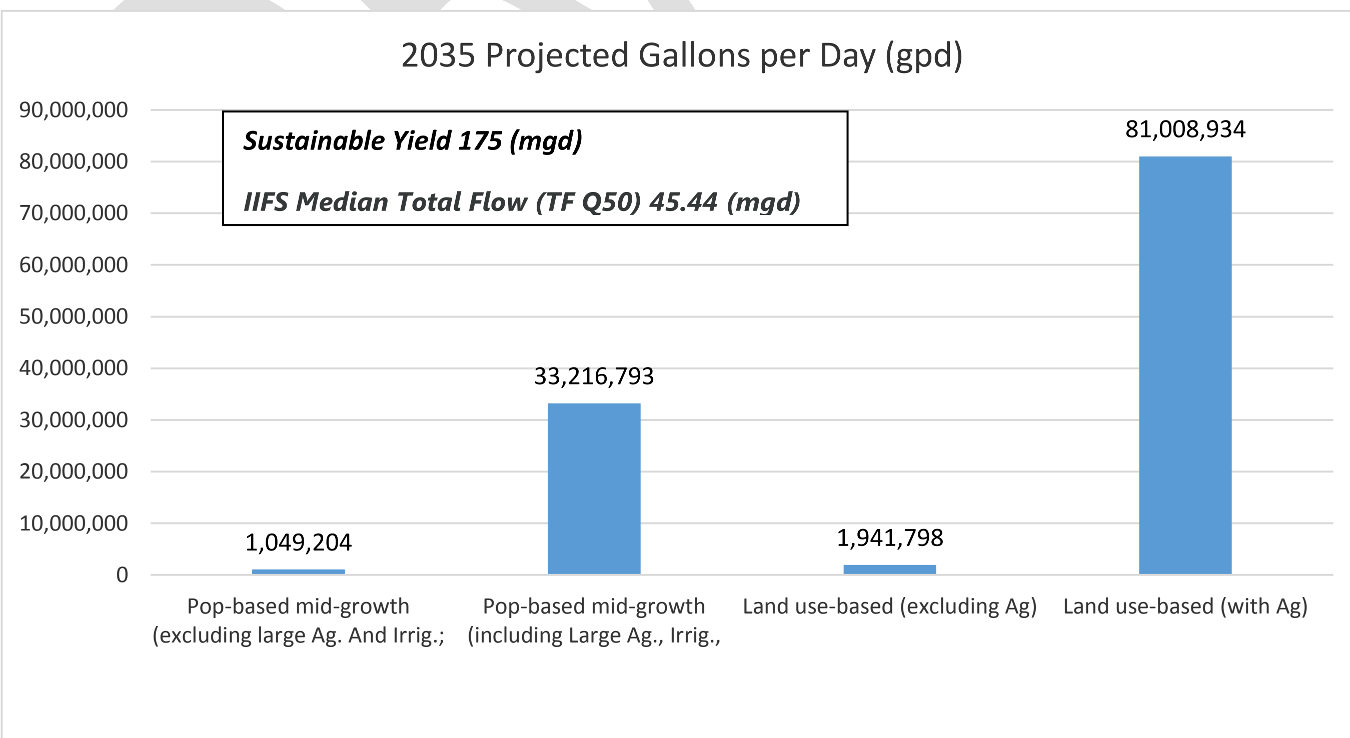
16.7 Water Source Adequacy

The analysis of available resources and projected demand confirm that there are sufficient water resources in the region to meet 20-year demand projected based on population growth under normal and drought conditions. Total pumpage reported to CWRM in 2014 (916,000 gpd) approximately less than one percent of regional Sustainable yield (SY) of 175 million gallons per day (mgd) for the Ko`olau ASEA. Groundwater SY and estimated surface water diverted of 139,050,803 gpd (see Table 16-11, 1989 CWRM declarations of stream diversions and water use) total about 314,050,803 gpd.

16.7.1 Source Adequacy vs. Land Use Full Build-Out Based Water Projections

Full build-out of land use classifications representing 81,432,074 gpd would not exceed the ground and surface water resources of the aquifer sector area as shown below. Excluding agriculture, land use based demand is about 1,942,998 gpd. Planning for adequate source to serve full build out demand is not supported by the Socio-Economic Forecast and could not considered a realistic and efficient use of resources. Agricultural zoned land is generally not irrigated to reflect Department of Agriculture water rate guidance for diversified agriculture. Therefore 79 mgd for agricultural production is not realistic or supported by policy and land use plans for the region.

Figure 16-27 Land Use Full Build-Out and Population Mid Growth Based Water Demand Projections, Ko`olau ASEA, 2035



16.7.2 Source Adequacy vs. Population Growth Based Water Demand Projections (20-Year)

Based on the population growth rate projections, future water demand for the Ko`olau ASEA is anticipated to reach 1.049 mgd by 2035, excluding agricultural irrigation and other non potable needs. Total demand including agricultural, other irrigation and DHHLr non potable needs is projected to 33.2 mgd by 2035. The base case (i.e. mid-growth scenario) is selected as the most probable scenario, assuming that new housing and population growth will be focused in planned growth areas consistent with the 2014 socio-economic forecast for the region. Long-term projections are trends with expected short-term variations. Factors that especially impact growth in the Ko`olau region are small projects in and around Ha`ikū and development of Hawaiian Homelands.[114] Water use is not exactly correlated to population and economic growth but is also impacted by climate change, type of housing development and associated irrigation. It is also expected that more aggressive conservation measures will curb water use per capita. This trend is consistent with overall island-wide decrease in water use per MDWS customer over the last ten years and continued adoption of more efficient irrigation technologies for agriculture and landscape irrigation.

The Ko`olau region has few visitor units, so the rates of increase in resident population will likely be higher than the rate of visitor growth. There is only 13,942 gpd reported agricultural pumpage (likely underreported) and incomplete stream water use reported, so it is not known how much agricultural water is presently being used. Agricultural demand outside the aquifer sector that use surface water from streams in Ko`olau ASEA is analyzed in the Central ASEA report, Chapter 15.7.

[114] 2013 Socio-Economic Forecast

16.8 STRATEGIES TO MEET PLANNING OBJECTIVES

The WUDP update public process generated a set of planning objectives through an iterative process. Multiple resource options to meet planning objectives and projected demand were reviewed and evaluated in regional public meetings and workshops to assess constraints, relative costs and viability.[115] Planning objectives, preliminary strategies and related material reviewed in the final public workshop, November 17, 2016 is attached as Appendix 11. The selected strategies are presented below along with available cost estimates, hydrological, practical and legal constraints that were considered in assessing the viability of a specific resource or strategy.

Key issues for the Ko`olau region were identified in public meetings held in Hāna over 2016. Community concerns overlap with those of the Hāna aquifer sector and relate to watershed management and participation by the local community; maintenance of traditional resource management using the ahupua`a system and ensuring that traditional and customary practices are safe guarded. Community members state that younger generations are returning to Ko`olau and Hāna to establish taro lo`i. Other key issues for the region focus on providing affordable water for future needs, providing for taro lo`i and other public trust uses during droughts, and managing resources in a sustainable way.

Due to resource interdependencies, East Maui (Hāna and Ko`olau ASEAs) community concerns are also related to the primary concerns of Makawao-Pukalani-Kula residents, which center on the limited development of water resources and a distribution system to meet the needs of the region. The proper allocation of water resources is considered essential to, in order of priority: (1) preserve agriculture as the region's principal economic activity, promote diversified agricultural activities, and effectively encourage the development of Department of Hawaiian Home Lands (DHHL) parcels; and (2) ensure the long-term viability of the region's residential and economic base.[116] However, water use in the Upcountry region is recognized as having impacts on the streams of East Maui and the agricultural activities of the central valley. A comprehensive water management strategy must be developed to strike a balance between the various interests and accommodate environmental, agricultural and residential needs of all neighboring regions.[117] The WUDP will further elaborate on Upcountry and East Maui water issues as they relate to each other and the Central Maui ASEA.

All strategies are assumed to include conservation consistent with recommended supply and demand side conservation strategies outlined in Section 12.2. Implementation schedule, estimated costs and potential lead agencies, including funding sources, are summarized in Table 16-xx.

[115] Preliminary Strategies for Hāna Aquifer Sector November 17. 2016
[116] County of Maui, Makawao-Pukalani-Kula Community Plan, 1996, page 12, cited as a "problem."
[117] Ibid, cited as an "interregional issue, page 15.

16.8.1 Resource Management

Planning objectives related to resource management identified in the WUDP update public process include:

- Watershed protection and its prioritization, including invasive alien plant control, ungulate control, and reforestation via watershed partnership programs
- Maintaining access to lands for gathering, hunting and other native Hawaiian traditional and customary practices
- Improving the understanding of the concepts of "precautionary planning" to reduce and adapt to the effects of drought and climate change upon water resource availability and quality
- Consultation and coordination with Native Hawaiian community/moku and local experts on resource management and invasive species removal

The Hāna Community Plan reflects regional issues expressed at the community WUDP meetings. Policies related to water resource management include:

- Protect, preserve and increase natural marine, coastal and inland resources, encouraging comprehensive resource management programs
- Ensure that groundwater and surface water resources are preserved and maintained at capacities and levels to meet the current and future domestic, agricultural, commercial, ecological and traditional cultural demands
- Recognize residents' traditional uses of the region's natural resources which balance environmental protection and self-sufficiency
- Discourage water or land development and activities which degrade the region's existing surface and groundwater quality
- Encourage resource management programs that maintain and re-establish indigenous and endemic flora and fauna
- Protect, restore and preserve native aquatic habitats and resources within and along streams
- Ensure that the development of new water sources does not adversely affect in-stream flows
- Increase water storage capacity with a reserve for drought periods.
- Improve the existing potable water distribution system and develop new potable water sources prior to further expansion of the State Urban District boundary or major subdivision of land in the State Agricultural or Rural Districts.
- Ensure adequate supply of groundwater to residents of the region before water is transported to other regions of the island.

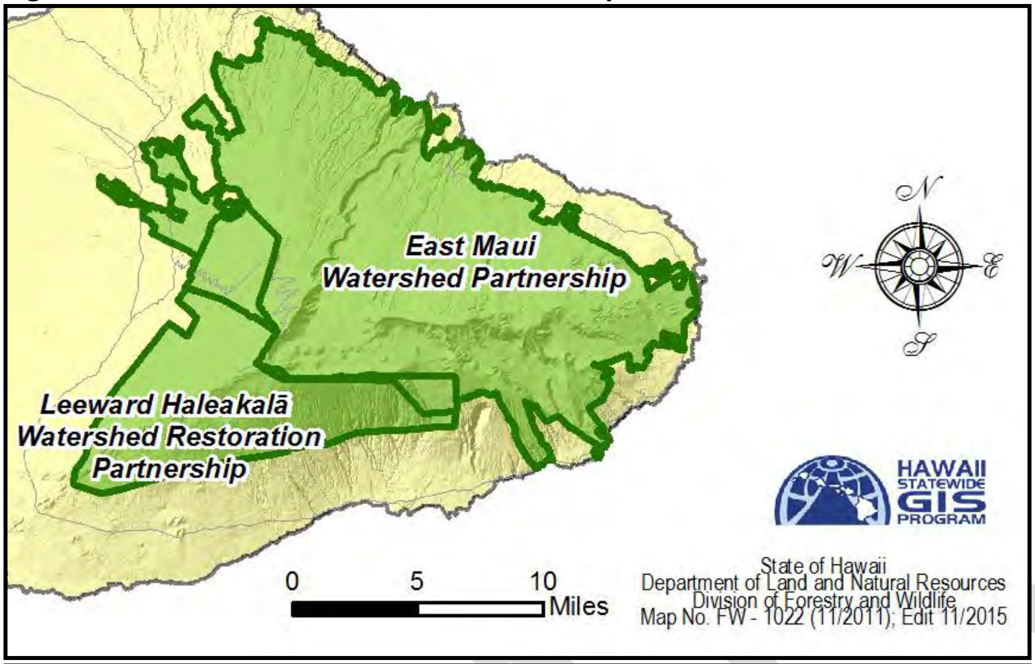
<u>Watershed Protection and Restoration</u>

Issue and Background: East Maui watersheds are predominately vegetated by native Hawaiian rainforest. The plants there evolved over millions of years into the most efficient water collection system for our island's geography. It works in layers – tall ʻōhiʻa and koa trees provide a canopy for shorter trees, while shrubs and ferns fill in underneath, and a thick layer of mosses and leaf litter complete the floor. These layers act like a giant sponge, slowing down heavy raindrops and soaking up water for slow release into underground aquifers. Even during droughts, our watersheds can produce water, pulling water out of the clouds by collecting fog drip. This uniquely evolved, specialized forest is the key to Maui's healthy water supply. [118] The East Maui watersheds are rich in biodiversity and harbor endemic and rare native plant and bird species. The main threats to the native forest and ecosystems are habitat loss and alterations due to feral ungulates (pigs, deer, goats) and invasive plants. These are detrimental both to biodiversity and water supply.

Active management to ensure protection and preservation of these important watershed lands occur on federal, state and community levels. The largest undertaking of watershed management in Ko`olau is the East Maui Watershed Protection Partnership (EMWP). The partnership was the first of its kind formed in the state to work with landowners to protect native forested watersheds. The 119,000 acre watershed is a role model for proactive and effective watershed management on a large scale to ensure freshwater availability in the future. The Nature Conservancy manages lands in Waikamoi, which are key recharge areas for the MDWS Upper and Lower Kula systems. These project not only benefits 1,000 new acres being fenced and managed for the first time but also the entire 12,000 acre core East Maui watershed and water collection area. The 3,721 acre parcel became legally protected under a new perpetual Conservation Easement between East Maui Irrigation Co., Ltd (EMI) and TNC in April 2014.

[118] East Maui Watershed Partnership, FY2015 Final Report to the Maui County Department of Water Supply

Figure 16-28 East Maui Watershed Partnership



Ongoing efforts to protect the watershed include fencing, ungulate control, invertebrate and small mammal control, weed management, rare species protection, removal of invasive species, monitoring, education, public outreach and volunteer recruitment to repair and install fencing, and plant native species. Continuous and consistent funding is paramount to maintain momentum and progress in preserving freshwater supplies and the range of ecosystem services provided by these forested watersheds.

Strategy #1: Seek dedicated, long term and broad based core funding for maintaining and expanding watershed protection areas and providing for watershed maintenance in East Maui watersheds for habitat protection and water security. The annual EMWP budget varies but have been in the range of $0.8M – $1M, with funding from Federal, State, County and private sources.

Community outreach and support is essential for sustainable resource use and protection. Sometimes fencing off areas for ungulate control create conflict with community members that seek access to hunting to maintain their subsistence lifestyle. The Hāna Community Plan policy to “Recognize residents’ traditional uses of the region’s natural resources which balance environmental protection and self-sufficiency” needs to be acknowledged and addressed. Although the communities and watershed managers’ objectives for resource management appear to align, concerns raised by community members in the WUDP public process tell us that improved communication and collaboration with the community is desired. The community is rich in ahupua`a based cultural and resource preservation efforts. The traditional uses of the region’s natural resources makai depend on the sustained watershed management of the mauka lands. The cultural resurgence and repopulation of traditional lands are central to the community.

Strategy#2: Support and promote community grassroots initiatives to collaborate with state and land owner partnerships to increase participation in natural resource management and to ensure adequate access and opportunities for traditional uses of the region's natural resources. Use established moku process to consult on resource management.

16.8.2 Conservation

Encouraging water conservation and maximizing the efficiency of water use are objectives identified in the WUDP public process as well as the 1994 Hāna Community Plan.

The Pā`ia-Ha`ikū Community plan goals and objectives call for improvement the existing potable water distribution system and development of new potable water sources prior to further expansion of the State Urban District boundary or major subdivision of land in the State Agricultural or Rural Districts.

Community plans, public meetings and workshops helped develop qualitative criteria to evaluate and measure resource strategies against this planning objective include:

- Per capita water use decreased
- Potable and irrigation systems water loss decreased
- Community water education increased
- Incentives for water conservation increased
- Renewable energy use increased

Issue and Background: The recommended supply and demand side conservation strategies outlined in Section 12.2 apply island wide. Demand side public education and outreach benefit all water systems and end uses. Billed consumption in the MDWS Ha`ikū area is low compared to other MDWS water systems or districts. Considering abundant rainfall and associated low irrigation needs this is consistent with empirical data in similar wet regions. The average water consumption per single family meter is 425 gallons per day, which is well below the County-wide system standard of 600 gpd per single family unit.

16.8.3 Conventional Water Source Strategies

Conventional water sources include groundwater (wells and tunnels) and surface water (stream diversions). Region specific planning objectives related to ground and surface water use and development identified and confirmed in the WUDP update public process include:

- Improving the understanding of the concepts of "precautionary planning" to reduce and adapt to the effects of drought and climate change upon water resource availability and quality
- Adapting future populations to local water resource conditions, integrating conservation and the use of alternative resources
- Water needs of DHHL in the Ko`olau should be considered in general and in accordance with the 2017 State Water Projects Plan

Planning objectives related to groundwater and surface water source use and development identified to apply island wide include:

- Manage water equitably
- Provide for Department of Hawaiian Homelands needs
- Provide for agricultural needs
- Protect cultural resources
- Provide adequate volume of water supply
- Maximize reliability of water service
- Minimize cost of water supply
- Increase water storage capacity with a reserve for drought periods.
- Ensure that adequate water capacity is available for domestic needs of the region.
- Ensure that the development of new water sources does not adversely affect in-stream flows.
- Improve the existing potable water distribution system and develop new potable water sources prior to further expansion of the State
  Urban District boundary or major subdivision of land in the State
  Agricultural or Rural Districts.
- Ensure adequate supply of groundwater to residents of the region before water is transported to other regions of the island.

Qualitative criteria to evaluate and measure resource strategies against these planning objectives include:

- Public water system water shortages to serve existing customers avoided
- Public water supply drought shortages avoided
- MDWS prioritize DHHL needs over lower priority needs
- Potable water use for non-potable needs decreased
- Contingencies in place to support water supply system functions during emergency conditions
- Water is available to serve Maui Island Plan development
- Strategies to meet all needs incorporated into WUDP

Potable Groundwater Development

Issue and Background: The Maui Island Plan addressed the MDWS system need, excluding private purveyors, irrigation and agricultural demand. The MDWS Ha`ikū sub-system is served by groundwater wells in the Ha`ikū Aquifer. The following objectives derived from the Maui Island Plan should guide groundwater development in the region:

- Provide adequate volume of water to timely serve planned growth in MIP
- Increase capacity of water systems in striving to meet the needs and balance the island's water needs
- More comprehensive approach to water resource planning to effectively protect, recharge and manage water resources
- Ensure stable chloride levels in developed wells

The amount of groundwater that can be developed is limited by the amount of natural recharge and aquifer outflow that contribute to streamflow and to prevent seawater intrusion, established as sustainable yield. Because delineation of aquifer sectors and systems in some cases are based on limited hydrologic information, areas for potential groundwater development must be assessed on its own merits to determine any additional needs for hydrologic studies and interaction with surface water and other sources.

Understanding potential impact of climate change adds to uncertainty in long-term groundwater availability. The primary responsibility to determine potential impacts on water resource availability lies with the State CWRM who in turn relies on studies and predictions by the scientific community and other agencies. Water purveyors need guidance how to mitigate and adjust to potential changes in groundwater availability.

Potential effects of groundwater development on streamflow and on the quality of water pumped from existing wells in a region can be evaluated by robust hydrologic studies and models. Joint funding and collaboration between the municipal and private purveyors, CWRM and the U.S. Geological Survey would focus studies to maximize benefits and prevent conflicts in water development and designation. Aquifer systems in Ko`olau are not extensively studied, as indicated by CWRM's confidence rating in establishing sustainable yield. Ha`ikū aquifer has sufficient yield to serve regional demand and support development of planned growth areas outside Ko`olau. It is recommended that CWRM prioritize hydrological studies and groundwater modeling in Ha`ikū and Honopou regions to guide private and public well development and ensure potential impacts on surface water is addressed first.

Strategy #3: Support collaborative hydrogeological studies to inform impact from climate change and future well development on groundwater health for Ha`ikū and Honopou aquifers.

Honopou is not serviced by public water supply. Limited growth is assumed to continue depend on domestic wells, rainfall catchment systems and surface water for irrigation needs. Ha`ikū Aquifer is the main source for municipal water supply in Ha`ikū. A fraction of the sustainable yield has been developed. Regional basal groundwater can continue to provide for municipal, domestic and irrigation needs, even under drought conditions and a potential high-growth scenario.

Installed pump capacity for private and public water systems in Ha`ikū Aquifer System totals 12.58 mgd, if pumping 24 hours per day. To account for system standards, pumping 16 hours, installed system capacity can provide about 8.39 mgd, shown below as "Estimated Available Capacity."

Table 16-37 Groundwater Source Development to Meet Population Growth Based Demand in Ha`ikū Aquifer System 2035 (mgd)

Aquifer System	Installed Source Capacity	Estimated Available Capacity (16 hours pumpage)	2035 Projected Demand	Sustainable Yield (MGD)	Potential Drought Yield Conditions
Ha`ikū	12.58	8.39	0.878	27	19.26

Source: MDWS Water Resources & Planning Division, 2018

Basal well development to meet out of region demand is addressed in the Central Aquifer Sector report Chapter 15.8.3. Groundwater development by MDWS in Ha`ikū aquifer is also subject to a consent decree that restricts well development from a specified portion of the aquifer.

<u>Department of Hawaiian Homelands Build Out</u>

Issue and Background:

Water service to most existing DHHL development and facilities on Maui is currently provided by the County MDWS systems. There are no DHHL owned and operated water systems on Maui. The 2017 SWPP DHHL Update projects a potable water demand of 3,400 gpd (Ke`anae Tract) which is presently provided by the MDWS, and 6,868,000 gpd of non-potable water: (1) Ke`anae = 312,800 gpd of ambient rainfall irrigation and 4,275,000 gpd of stream diversion; and (2) Wailua = 2,280,200 gpd (180,200 gpd ambient rainfall irrigation + 2,100,000 gpd stream diversion. The DHHL plans to develop its small Ke`anae tract (150.9 acres) with subsistence agricultural homesteads and general agriculture and lo`i kalo uses.[119] The two-acre makai property is within the flood zone, which prohibits homesteading use; therefore, the property will be developed for community use because of its oceanfront location, which presents opportunities for a gathering area and for cultural practices.[120] The Wailua tract (Alternative 1 option) was selected in the 2004 DHHL Maui Island Plan, which proposes 28 acres of subsistence agricultural use, 52 acres of general agriculture use, and 10 acres of conservation.The Wailua Project Alternative 2 option experienced local community opposition

[119] State Water Projects Plan, Advance Report, 2016, Page xvi.
[120] State of Hawai`i, DHHL Maui Island Plan, 2004, page 6-22.

due to the fact that the people already living in Wailua felt that they should have been given land grant priority over those from elsewhere on the DHHL waiting list, and that DHHL "outsiders" (from Wailua) may not be compatible with the area; therefore, concerns arose that the cultural and life ways balance within the Wailua community could be compromised. The projections in the tables do not take into account alternate sources of water that may be available or developed. Therefore, the values in these tables should not be used to compare project water demands and available source water. The 2004 DHHL Island Plan states that catchment systems could be used for both consumption and irrigation.[121][4] However, the MDWS water system also has the capacity to serve these lands.[122][5] A six-inch waterline from the highway would be required.[123]

Table 16-38 DHHL Full Build-Out Water Demand Projections by CWRM Use Type, Ko`olau ASEA

DHHL Land Use Category Based			
DHHL Land Use	**Acres / Res Units**	**Water Use Rate (gpd)**	**Projected Demand (gpd)**
Residential *	43*	600 gal/unit	25,800
Commercial	0	3,000 gal/acre	0
Industrial	0	6,000 gal/acre	0
Agriculture **	230 **	3,400 gal/acre	782,000
Open Space	10	0	0
Community	2	1,700 gal/acre	3,400
Military	0	0	0
Total	**43 Units/242 acres)**		**811,200**

Source: MDWS Water Resources & Planning Division. Figures may not add due to rounding. Open space, conservation/cultural protection and similar land use types not included due to lack of water demand.
County Zoning: Based on zoning supplied by Maui County Planning Department, Long Range Planning Division, May 2015. DHHL lands are excluded.
*Residential use is based on 32 3-acre subsistence lots in Ke`anae (32 lots x 600 gpd = 19,200 gpd) and nine 3-acre lots in Wailua (9 lots x 600 gpd = 5,400).
**The DHHL agricultural water use estimate (106 x 3,400 gpd = 360,400 gpd) is derived from 124 Subsistence Agricultural acres (41 3-acre units [32 in Ke`anae, 11 in Wailua]) subtracted out due to a potable demand of 600 gpd being allocated to residential use and DHHL plans to use catchment for irrigation.

[121] State of Hawai`i, DHHL Maui Island Plan, 2004, page 6-22.
[122] Ibid.
[123] Ibid, page 6-32.

Surface Water Use and Development

Issue and Background: Mauka to makai stream flow is at the core of the traditional and self-sufficient Native Hawaiian livelihood of communities in Ko`olau. Surface water is diverted for a variety of purposes. The community has raised concerns over sufficient stream flow to support taro (lo`i kalo), droughts and climate change impacts, potential new diversions and compliance with the Public Trust Doctrine.

Reliance on Regional Resources vs Water Transports

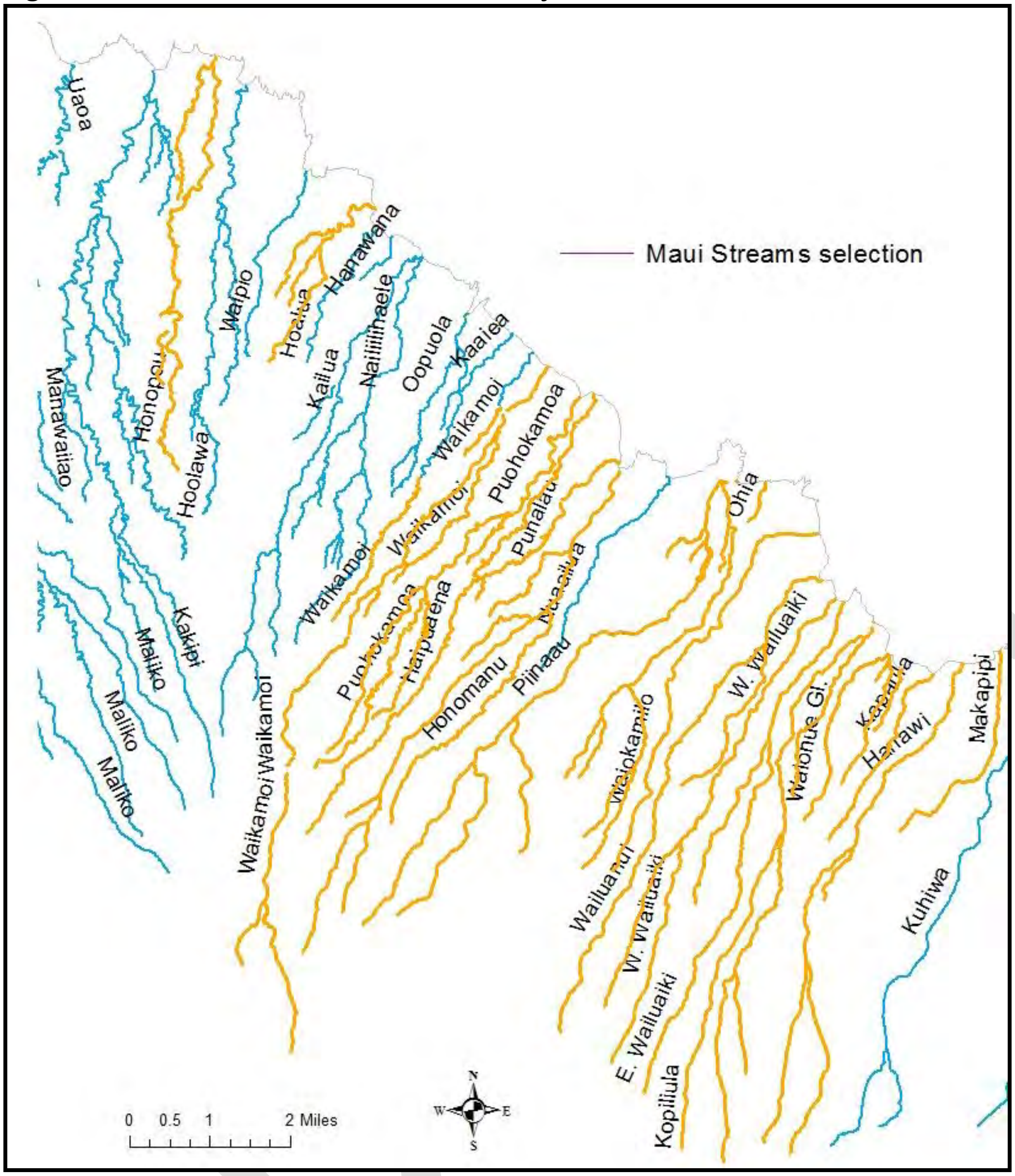
Resources are shared both naturally as hydrogeological units cross community plan boundaries, and mechanically where resources are transported between hydrologic and community plan regions. The contentious nature of mechanical transport from resource rich watersheds to dry growth areas and agricultural lands are important community concerns and a source of water use conflicts throughout Hawai`i . Surface water has been transported from Ko`olau watersheds to the Central isthmus and to Upcountry for over a century. The Commission on Water Resource Management has the difficult task of assessing and quantifying the water needs within a region and individual streams against off-stream needs that are diverted and conveyed for a variety of purposes.

East Maui Streams Contested Case

On May 24, 2001, the Native Hawaiian Legal Corporation (NHLC), on behalf of Na Moku ‘Aupuni o Ko'olau Hui (Na Moku), petitioned the CWRM to amend the Interim Instream Flow Standards (Interim IFS) for 27 East Maui streams. The CWRM later concluded that there are 24, not 27 streams that are subject of the contested case. These are illustrated in the figure below. Kualani (or Hamau) and Wahinepe`e Streams are not named in GIS Stream Data/shown on map.

In 2008 and 2010, the CWRM approved amendments to the Interim IFS for about half the streams and established measurable IIFS of status quo conditions for the remaining streams; only six streams had flow restored. The 2010 CWRM vote amended the IIFS through a seasonal approach to address habitat availability for native stream animals for six of the remaining 19 streams. Together with the additions for the first 8 streams, winter total stream restorations for all 27 (24) streams were 13.95 mgd and summer restoration 5.61 mgd. CWRM estimated EMI diversions to range from 134 mgd in winter months to 268 mgd in summer months. Increasing the IIFS for 12 of the 27 (24) streams resulted in 120 mgd to continue to be diverted in winter months and 262 mgd to be diverted in the dry summer months.

Figure 16-29 Streams in Ko`olau ASEA subject to Contested Case



In June 2010, the MDWS and the NHLC, on behalf of Na Moku, filed petitions for a contested case hearing before the CWRM. In 2014, CWRM voted to conduct the contested case hearing on petitions to amend IIFS for all 27 (24) petitions and streams filed by NHLC. On January 15, 2016 the hearings officer submitted his proposed Findings of Fact (FoF), Conclusions of Law (CoL) and Decision and Order (D&O). Subsequent to HC&S announcing cessation of sugar cane cultivation by the end of 2016, CWRM ordered re-opened hearings to address HC&S current and future use of surface water and the impact on the groundwater; the impact on DWS's use of surface water due to cessation of sugar operations; the County's position on future use of sugarcane fields, and issues concerning management of the EMI ditch system. In April 2016, A&B announced that it had decided to fully and permanently restore the East Maui streams

Honopou, Hanehoi (including Puolua), Waiokamilo, Kualani, Pi`ina`au, Palauhulu, and East and West Wailuanui.

In July 2016, CWRM issued an order regarding interim restoration of stream flow, or remain undiverted until further notice: Waiokamilo, Wailuanui (East and West), Makapipi, Hānawi, Waiohue, Waikamoi, Kopiliula, and Puaka`a. In December 2016, the Board of Land and Natural Resources (BLNR) issued a temporary, one-year holdover of A&B/EMI's water licenses subject to the interim restoration order above, and to EMI ceasing all diversions of Honomanū stream for the duration of the holdover period (through December 2017).

Instream Flow Standards

Interim Instream Flow Standards (IIFS) are established to address and protect instream uses. The CWRM June 20, 2018 decision for the East Maui Streams contested case is assumed to satisfy in-stream flow required for healthy taro cultivation demand. The WUDP Ko`olau Sector Report was drafted and submitted for review prior to the June 20, 2018 CWRM decision for East Maui Streams. However, a summary of IIFS by stream according to the 2018 decision is provided in this sector report as Appendix 16 A.

In accordance with the Water Code, the CWRM establishes and administers instream flow standards on a stream-by-stream basis as necessary to protect the public interest. 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."

The annual mean "Qp" flow is the daily average flow equaled or exceeded "p" percent of the time during the year. Q_{50} is the median or natural base flow for a particular stream segment during a specified period. Base flow is dependent on groundwater discharge while total flow reflects base flow and rainfall runoff.[124] The base flow is a general guideline for the minimal amount of streamflow needed for fish habitat.[125] For perennial streams, the estimated long-term average base flow is 60 to 80 percent and thus 70 percent is used (Q_{70})· Flow exceeded 90% of time (Q_{90} flow) is commonly used to characterize low flows.[126] In revising the IIFS, the CWRM defined minimum viable habitat flow (Hmin) for the maintenance of suitable instream habitat to support growth, reproduction, and recruitment of native stream animals in East Maui streams as 64% of Median Base Flow (0.64 x BFQ_{50}; also defined as H_{90} by USGS studies). For streams without measurable IFS, the IIFS generally reflects the diverted amounts existing when the status quo interim IFS were adopted, or as subsequently amended by CWRM.

While the Hearing Officer's January 2016 and July 2017 Proposed FoF, CoL and D&Os stated the amount of water to be returned to the streams, the June 2018 decision does not. A&B/HC&S would be able to divert water through the EMI system from some of the streams subject to the

[124] Trends in Streamflow Characteristics at Long-Term Gaging Stations, Hawai`i. USGS SIR 2004-5080
[125] CWRM Staff Submittal, Steam Diversion Works Permit (SDWP.4175.6) Wailuku River, Maui, August 16, 2016
[126] Trends in Streamflow Characteristics at Long-Term Gaging Stations, Hawai`i. USGS SIR 2004-5080

contested case. In comparing established IIFS and base flow at various conditions, 20.35 mgd would be available from the streams subject to the contested case as base flow during median flow conditions (Q50) to potentially divert through the EMI system. About 8 mgd would be available from the streams west of Honopou streams through Maliko Gulch. Therefore about 28 mgd would potentially be available from Wailoa Ditch for use at Kamole Weir for MDWS, to Kula Ag Park and for A&B/HC&S diversified agriculture. However, because freshets (high stream flows during flooding events) and stormwater are allowed to be diverted, much more would potentially be available to divert during "normal", or wet season conditions.

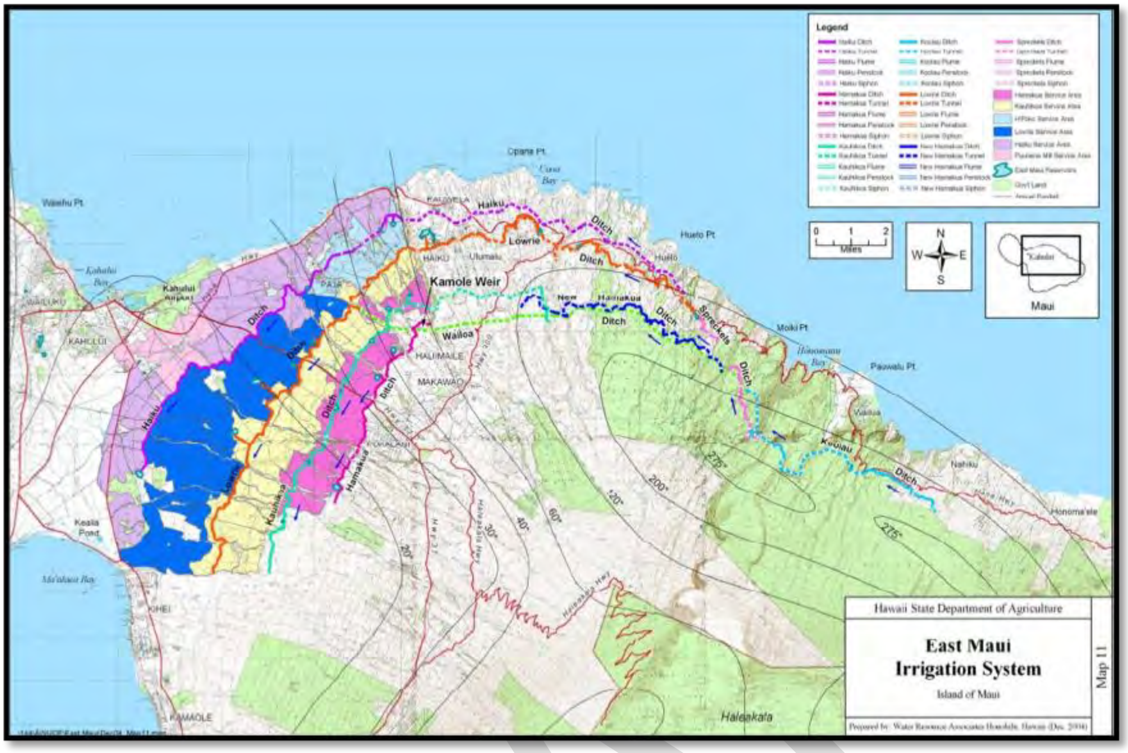
During low flow conditions, or Q90, only 2.21 mgd appears to be available for A&B/HC&S to divert after satisfying IIFS. Because IIFS are monitored on a 12-month moving average basis, any "overdraft" during short periods of droughts may not violate adopted IIFS. It is recognized that requiring a specific amount of stream flow at all times at a specific location is incompatible with the objectives.[127] It appears that the June 2018 Decision does not provide for sufficient diversions during extended droughts to meet proposed demand under the Diversified Agricultural Plan.

Impact on Groundwater Recharge from Surface Water Diversions

The cessation of sugarcane cultivation and heavy irrigation on the Central isthmus have to date unknown impacts on the recharge of Pā`ia and Kahului aquifer systems and the associated use and reliability of that brackish groundwater as a water resource. The figure below illustrates the former HC&S plantation irrigation service areas. HC&S Ag Engineering's March 2016 Diversified Agriculture Plan is attached as an appendix. HC&S reported 28.2 mgd groundwater pumpage from the Kahului aquifer and 29.1 mgd from the Pā`ia aquifer in 2014. The water duty for sugarcane is higher than most other crops, but also comparatively salt tolerant. Irrigation demand for the Diversified Agriculture Plan and the associated return recharge from irrigation is assumed to be significantly less. In his Proposal, the hearing officer determined that brackish well water for HC&S is practicably available up to 23.09 mgd, beyond which increasing well water to levels close to that when sugarcane was being irrigated would reduce the yield or the acreage of the plantation that has access to both surface and well water because of higher salt levels in the irrigation water. Alternatively more acreage would have to be left fallow in the rotation of crops so that less well water would be used.[128] The uncertainty of availability of brackish groundwater throughout the HC&S plantation and various crops' long term tolerance to brackish water should be further addressed in the update of the Agricultural Water Use and Development Plan.

[127] CWRM, June 20, 2018 Findings of Facts, Conclusion of Law and Decision and Order, CCH MA13-01
[128] CCH-MA-13-01 Hearing Officer's Proposed Findings of Fact and Conclusions of Law, August 2017 pp 153

Figure 16-30 East Maui Irrigation System Service Areas



Source: Agricultural Water Use and Development Plan, 2004

Table 16-39 Projected Irrigation Water Use on HC&S Plantation from Ko`olau, Central and Wailuku Aquifer Sectors, including water losses (mgd)

Contested Case Streams	Streams West of Honopou	Central Maui Groundwater (mgd)	Nā Wai ʻEhā Surface Water	Total HC&S Diversified Ag Gross Irrigation Requirement
83.75	8.59	23.09	16.6	**132.03**

<ins>Opana and Awalau Surface Water Source and Economic Analysis</ins>[129]

HC&S, Maui Land & Pineapple Co., and MDWS utilize a surface water source located in the Ha`ikū Aquifer. Water from the Opana and Awalau intakes goes to the 10 MG Kaili`ili Reservoir. Water is transported to near Olinda Road in Makawao and to another reservoir next to ML&P's Field 274.

[129] Source: Maui County Water Use and Development Plan Upcountry District Final Candidate Strategies Report. July 27, 2009. Carl Freedman. Ha`ikū Design & Analysis

The water is used to irrigate pineapple fields in Makawao and Kula. Maui Land & Pineapple Company ceased pineapple operations in 2009 and leased a portion of their Upcountry Maui land to the newly formed Hali`imaile Pineapple Company to continue pineapple farming. This system has three intakes from the Opana and Awalau Streams which yield approximately 0.143 MGD.

A diversion in the Opana stream at an elevation of 2400 feet routes water through a tunnel to the Awalau stream area. A collector box distributes water from the tunnel and an Awalau spring to pipes serving several users including the MDWS. Currently, the majority of the water from this source feeds a 10 million gallon reservoir serving and managed by a partnership of agricultural users. A minor portion of non-potable water is provided to existing DWS customers.

The Opana/Awalau water source was evaluated as a potential resource option as a source for treatment to supplement MDWS potable uses. Several options were evaluated. The recommendation for this source is to maintain it as a non-potable water source and reserve it for possible future source for treatment for potable use.

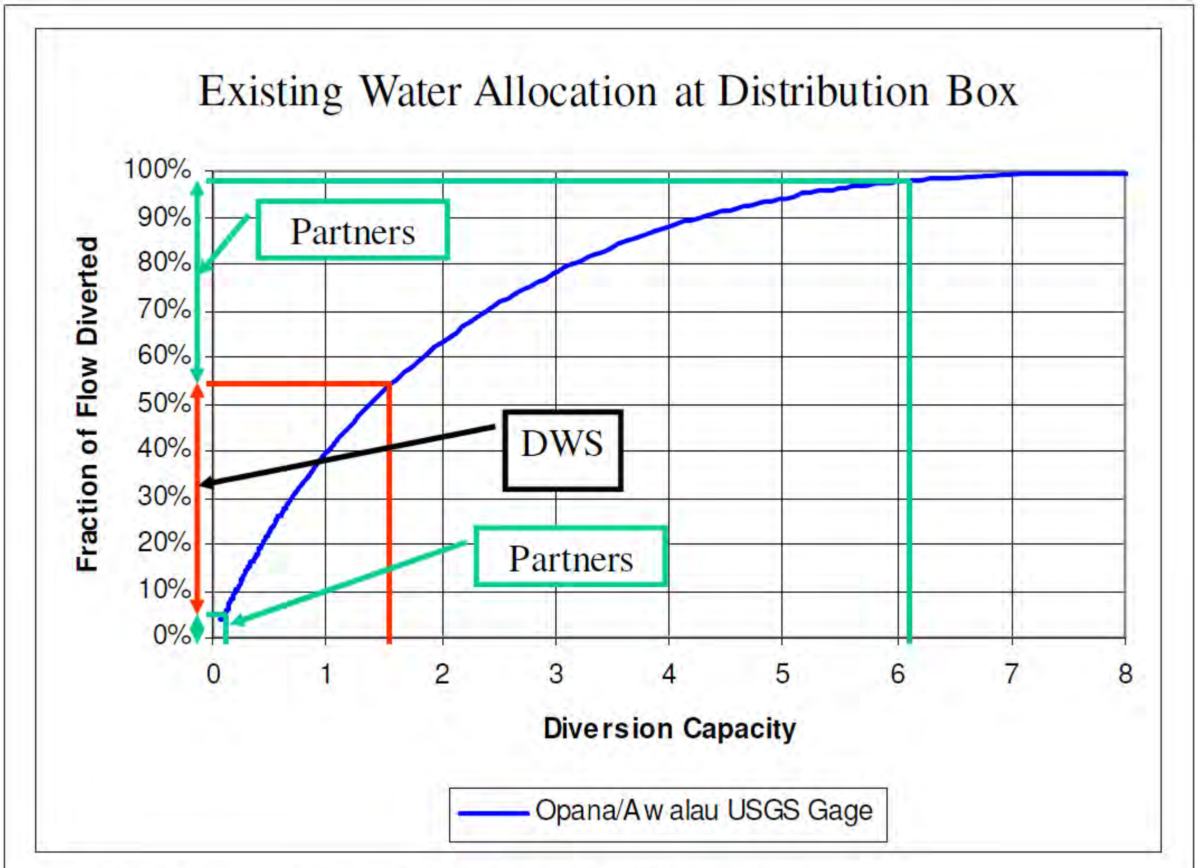
The chart below shows the streamflow characteristics of water emerging from the Opana/Awalau tunnel and the current allocations of water to the DWS and the agricultural partners. Because there are extended periods the analysis was based on providing “semi-reliable yield” in which the reservoir would be empty 10% of the time. As an integral system only small gains in semi-reliable yield would result from additional reservoir capacity. For example, doubling the current 10 MG reservoir capacity would increase the semi-reliable yield of the Opana/ Awalau system by 22%. Based on this analysis it was concluded that it is not practical to provide drought period service reliability to the Upcountry District system by adding reservoir capacity for this resource.

Options for this resource include maintaining the current use as a non-potable agricultural water source or installing a small water treatment unit at the Maluhia tank site. The economics of installing water treatment depends upon the DWS system status and operation. It would be economical to displace water otherwise produced by basal sources or the Kamole WTP, but water from the Opana source would rarely be available in the dry conditions that exist when these more expensive resources are required. Usually when water is available from the Opana source water is also available from the Pi`iholo WTP for this area. It is not currently economic to displace water produced at the Pi`iholo WTP with a new treatment unit at the Maluhia tank site. [130]

Based on this analysis it was concluded that it is not economical to build a water treatment unit for this source to serve potable needs at this time. This source does have value to serve potable uses in the future when more water this area is served by sources from basal wells or water pumped from lower elevations.

[130] Source: Maui County Water Use and Development Plan Upcountry District Final Candidate Strategies Report. July 27, 2009. Carl Freedman. Ha`ikū Design & Analysis

Figure 16-31 Opana/Awalau Source Existing Water Allocation



Opana / Awalau Source Existing Water Allocation

Source: Maui County Water Use and Development Plan Upcountry District Final Candidate Strategies Report. July 27, 2009. Carl Freedman. Ha`ikū Design & Analysis

16.8.4 Climate Adaptation

Issue and Background: Data and research suggest that Hawai'i should be prepared for a future with a warmer climate, diminishing rainfall, declining stream base flows, decreasing groundwater recharge and storage, and increased coastal groundwater salinity, among other impacts associated with drought.

No streamflow projections are available for the coming century but projections include a decline in base flow and low flows, with stream flows becoming more variable and unstable (flashy), especially in wet years.[131] The impact on groundwater recharge will vary locally. A 2017 update to the Hawai`i Drought Plan includes traditional and customary rights and

[131] Summarized from EcoAdapt. 2016. Climate Changes and Trends for Maui, Lāna'i, and Kaho'olawe. Prepared for the Hawaiian Islands Climate Synthesis Project

practices as those potentially impacted by droughts. Reduced rainfall and streamflow reduce available water for domestic uses and irrigation, and degrading aquatic habitats where stream flora and fauna are gathered. Reduced stream flow may impact other cultural and religious practices, and terrestrial plants causing water stress. The Ko`olau region is assumed to rely more heavily on rainwater catchment due to limited infrastructure and extensive rainfall. Rainfall catchment is the collection of rainwater from a roof or other surface before it reaches the ground. Rainfall is sufficient throughout most of the aquifer sector to support traditional catchment systems. Catchment systems are still vulnerable to drought conditions. Another issue is compromised water quality due to flawed design and wear and tear with no regulatory oversight following construction.

Drought risk and vulnerability are assessed by the CWRM to illustrate the spatial extent and severity of drought risk for different impact sectors throughout the state. The statewide "*Drought Risk and Vulnerability Assessment and GIS Mapping Project"* assesses drought risk areas for three impact sectors: 1. water supply; 2. agriculture; and 3. wildland fire. Areas served by groundwater have a lower risk of drought impacts. Communities that are supplied by surface water have a medium drought risk as most have storage capacity to carry them through short term declines in rainfall. The most vulnerable to drought are those households relying solely on rainwater catchment. Areas that are not serviced by municipal supply or other known domestic sources and therefore more reliant on catchment systems are more susceptible to drought.

No specific drought mitigation strategies are developed for this region. However, the 2017 update proposes general drought response and mitigation actions that apply state-wide. Recommended mitigation actions that apply for Ko`olau region include those described in Strategy # 5 and the following:

- Expand current network of rain gages to improve rainfall monitoring.
- Identify areas at risk to drought and plan for regional response actions and strategies.
- Develop additional storage and/or alternative sources of water supply.
- Develop and implement drought-related public awareness programs.
- Develop incentive programs for drought- resistant practices.

Strategy #4: Convene sector-based drought workshops to assist stakeholders in developing or improving their individual drought/water conservation plans. Focus in the Ko`olau sector should be on catchment systems and contingency supply to supplement or substitute catchment when necessary.

16.9 Recommendations

Ko`olau aquifer sector is since ancient times well known for its abundance of water. The diversion of the stream resources is at the root of water use conflicts currently addressed in the ongoing contested case for East Maui Streams. The Water Use and Development Plan will monitor and adjust to the outcomes of the contested case. For now, the most recent 2017 Proposal is assumed to satisfy current and projected instream and off stream water needs *within* the Ko`olau ASEA. Planning for future water use in the Central aquifer sector that rely on surface water needs to consider a range of likely scenarios.

Projected water demands based on the selected scenarios and source strategies are summarized in the table below.

Table 16-40 Ko`olau ASEA Selected Demand Scenario: Projected Water Demand and Supply Options

DEMAND (MGD)	2015	2020	2025	2030	2035
MDWS Potable Groundwater for use Within Koolau ASEA*[1]	*0.82*	*0.831*	*0.839*	*0.846*	*0.849*
Other Potable Demand within Koolau ASEA	0.085	0.086	0.086	0.087	0.088
MDWS Potable Surfacewater for use Within Koolau ASEA[2]*	*0.104*	*0.105*	*0.106*	*0.107*	*0.107*
Potable Surface Water Ko`olau ASEA[1]*	*7.7*	*7.7*	*7.7*	*11.7*	*11.7*
Total Potable Demand (not including MDWS Upcountry System)	**0.085**	**0.086**	**0.086**	**0.087**	**0.088**
Non-Potable Demand within Koolau ASEA	21.08	22.064	23.093	24.17	25.297
DHHL Non-Potable Demand*[5]	0	6.375	6.375	6.375	6.375
Total Non-Potable Demand (Excluding Exports)	**21.08**	**28.439**	**29.468**	**30.545**	**31.672**
Total Demand (excluding exports)	**21.165**	**28.524**	**29.554**	**30.632**	**31.759**
SUPPLY (GPD)	**2015**	**2020**	**2025**	**2030**	**2035**
Haiku ASYA Potable GW*[1]	*0.83*	*0.831*	*0.839*	*0.846*	*0.849*
Other Potable Haiku ASYA	0.005	0.005	0.005	0.005	0.005
Other Potable Honopou ASYA	0.013	0.013	0.013	0.013	0.013
Other Potable Keanae ASYA	0.067	0.068	0.068	0.069	0.069
Potable Surface Water Ko`olau ASEA[2]*	*7.7*	*7.7*	*7.7*	*11.7*	*11.7*
Total Potable Supply (excluding exports)	**0.085**	**0.086**	**0.086**	**0.087**	**0.087**
Non-Potable Groundwater Haiku ASYA*[3]	0.017	0.025	0.037	0.054	0.081
Non-Potable Surface Water for Use Within Koolau ASEA	21.064	22.039	23.056	24.116	25.216
Non-Potable Surface Water for Export to Central ASEA[2] *[4]*	*134.133*	*27.473*	*27.277*	*28.5*	*28.5*
Non-Potable DHHL supply from Pi`ina`au Stream*[5]	0	4.275	4.275	4.275	4.275
Non-Potable DHHL supply from Waiokamilo Stream*[5]	0	2.1	2.1	2.1	2.1
Total Non-Potable Supply (excluding exports)	**21.08**	**28.439**	**29.468**	**30.545**	**31.673**
TOTAL SUPPLY (within Koolau ASEA, excluding exports)	**21.165**	**28.525**	**29.554**	**30.632**	**31.760**

*[1] MDWS Upcountry System demand and supply are accounted for in Table 15-38 of the Central ASEA chapter.
*[2] MDWS surface water exported to Kamole Weir and then used to serve Koolau MDWS customers.
*[3] Includes groundwater used within Koolau ASEA for irrigation and ag pumpage.
*[4] 28.5 mgd base flow. Available stream flow range from <28.5 mgd drought base flow to >78 mgd total flow.
*[5] Based on SWPP, 2017. Totals are entered in table to align with WUDP planning time increments.

The recommended strategies for the Ko`olau aquifer sector address the goals and objectives identified in the Hāna Community Plan and the WUDP public process for the region that evolve around resource protection and management; traditional uses of the region's natural resources and self-sufficiency.

Table 16-59 summarizes recommended strategies and indicates the planning objectives that each strategy supports. Estimated costs are, unless indicated otherwise, life cycle costs for the twenty-year planning period per 1,000 gallons. Life cycle costs include capital, operational and maintenance costs and include inflationary effects. The cost to develop and implement sustainability projects can be difficult to quantify per volume water supply. Lead agency, or organization to implement a strategy is proposed as a starting point. The timeframe for implementation is indicated as short term – less than 5 years, and long term 5 – 20 years. Many strategies are multi-year actions with implementation beginning within 5 years and continuing through the long term (indicated as 1, 2).

Table 16-41 Summary of Recommended Strategies Ko`olau ASEA

	STRATEGY	PLANNING OBJECTIVES	ESTIMATED COST	IMPLEMENTATION 1: Short-term 1 – 5 years 2: Long-term 5 – 20 years	
				AGENCY	TIME-FRAME
	RESOURCE MANAGEMENT				
1	Seek dedicated, long term and broad based core funding for maintaining and expanding watershed protection areas and providing for watershed maintenance in East Maui and Hāna watersheds for habitat protection and water security.	Maintain sustainable resources Protect water resources Protect and restore streams	$0.8M – $1M per year	MDWS Maui County CWRM DLNR	1
2	Support and promote community grassroots initiatives to collaborate with state and land owner partnerships to increase participation in natural resource management and to ensure adequate access and opportunities for traditional uses of the region's natural resources. Use established moku process to consult on resource management	Maintain sustainable resources Protect water resources Protect and restore streams	N/A	Public-private partnerships Aha Moku DLNR Maui County	1
3	Support collaborative hydrogeological studies to inform impact from climate change and future well development on groundwater health for Ha`ikū and Honopou aquifers.	Maintain sustainable resources Protect water resources Protect and restore streams		CWRM USGS MDWS	2
4	Convene sector-based drought workshops to assist stakeholders in developing or improving their individual drought/water conservation plans. Focus in the Ko`olau sector should be on catchment systems and contingency supply to supplement or substitute catchment when necessary.	Provide adequate volume of water supply Maximize reliability of water service	$50K/year	CWRM NRWA	

16.9.1 Implementation Program

In consistency with the Maui Island Plan, strategies recommended and adopted in the WUDP does not legally bind the agencies and organizations to execute. The recommendations provide guidance for land use and infrastructure, including the county CIP program, over the planning period.

Timing and prioritizing of resource strategies are tied to actual population growth. Prioritizing resource management and seeking guidance from the resourceful and knowledgeable community is key to sustain the traditional lifestyle and sense of place.

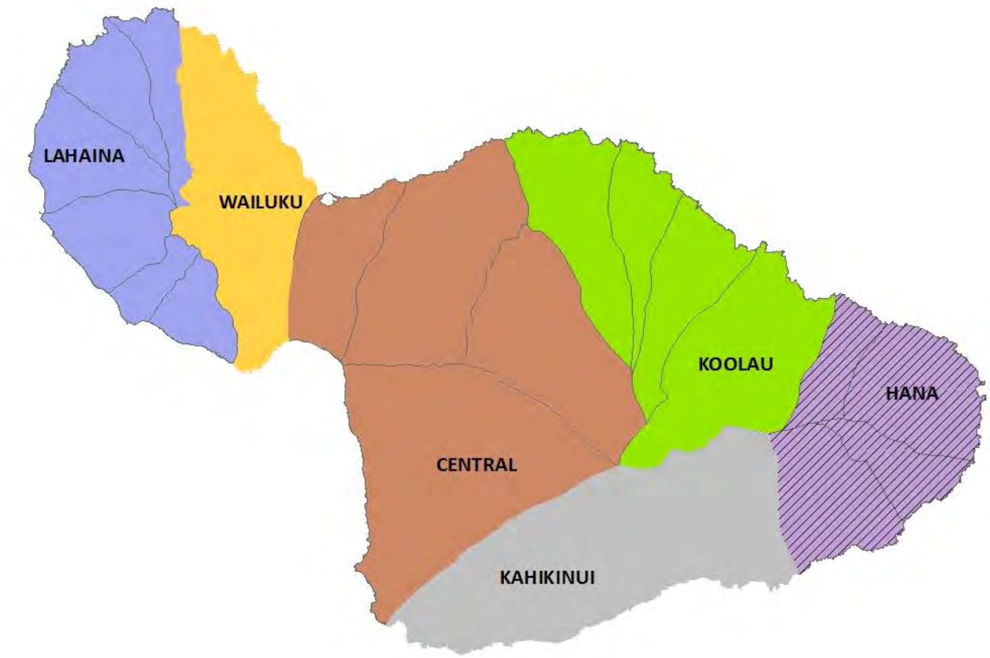
Over the planning period, implementation and performance of the recommended strategies can be assessed using qualitative criteria and quantitative targets formulated in the WUDP Part I, Table 3-3.

APPENDIX 16A East Maui Streams Assessment

Based on June 20, 2018 Findings of Facts, Conclusion of Law, and Decision & Order

Unit	Unit Name	BFQ50 at IIFS (cfs)	BFQ50 at IIFS (mgd)	IIFS (cfs)	IIFS (mgd)	BF Avail. to divert at Q50	BF Avail. to divert at Q90	TFQ50 (cfs)	TFQ50 (mgd)
6027	Maliko								
6028	Kuiaha								
6029	Kaupakulua								
6030	Manawaiiao								
6031	Uaoa								
6032	Keali`i								
6033	Kakipi								
6034	Honopou	6.50	4.20	0.00		0.00	0.00		
6035	Ho`olawa								
6036	Waipio								
6037	Hanehoi	2.54	1.64	0.00	0.00	0.00	0.00		
	Puolua (Huelo) Stream	1.47	0.95	0.00	0.00	0.00	0.00		
6038	Hoalua								
6039	Hanawana								
6040	Kailua								
6041	Naili'ilihaele								
6042	Puehu								
6043	O`opuola								
6044	Ka`aiea								
6045	Punalu`u								
6046	Kolea								
	Alo								
	Wahinepe`e	0.90	0.58	0.90	0.58				
6048	Puohokamoa	8.40	5.43	1.10	0.71	4.72	-0.59	13.00	8.40
6049	Haipuaena	4.90	3.17	1.36	0.88	2.29	-0.88	6.60	4.27
6050	Punalau	4.50	2.91	2.90	1.87	1.03		3.60	2.33
6051	Honomanū	4.20	2.71	4.20	2.71	3.17	0.71	6.20	4.01
6052	Nua'ailua	0.28	0.18	2.20	1.42	-1.24	-1.42	0.56	0.36
6053	Pi`ina`au	14.00	9.05	0.00	0.00	0.00	0.00	21.00	13.57
	Palauhulu Stream	11.00	7.11	0.00	0.00	0.00	0.00	6.10	3.94
6054	Ohia	4.70	3.04	0.00	0.00	3.04			0.00
6055	Waiokamilo	3.90	2.52	0.00	0.00	0.00	0.00	7.00	4.52
6056	Wailuanui	6.10	3.94	0.00	0.00	0.00	0.00		0.00
6057	West Wailuaiki	6.00	3.88	0.00	0.00	0.00		8.50	5.49

6047	Waikamoi	6.70	4.33	3.80	2.46	1.87	-2.44	6.60	4.27
	Waikamoi								0.00
6058	East Wailuaiki	5.80	3.75	3.70	2.39	1.36	-0.58	8.00	5.17
6059	Kopiliula	5.00	3.23	3.20	2.07	1.16	-0.52	8.00	5.17
	Puaka`a Stream	1.10	0.71	0.20	0.13	0.58	-0.13	1.90	1.23
6060	Waiohue	5.00	3.23	0.00	0.00	0.00	0.00	6.20	4.01
6061	Pa`akea	0.90	0.58	0.18	0.12	0.47	-0.12	1.50	0.97
6062	Waia`aka	0.77	0.50	0.77	0.50	0.00	-0.15		0.00
6063	Kapaula	2.80	1.81	0.56	0.36	1.45	1.12	4.90	3.17
6064	Hanawi	4.60	2.97	0.92	0.59	2.38	1.08	7.70	4.98
6065	Makapipi	1.30	0.84	0.00	0.00	0.00	0.00	7.40	4.78
Wailoa Ditch Available to Divert			73.26		16.80	20.35	2.21	62.36	40.30
Petitioned Streams								124.76	80.63
Fully Restored TFQ50								70.31	45.44
IIFS					13.50				
Wailoa Ditch Flow at Honopou 2011 -15 TFQ50								135.26	87.42
New Hamakua Ditch at Honopou 2011 -15 TFQ50								19.34	12.50
Lowrie Ditch at Honopou 2011 -15 TFQ50								16.85	10.89
Haiku Ditch at Honopou 2011 -15 TFQ50								6.46	4.18
Ditch gain between Honopou and Maliko								13.30	8.60
Total Flow diverted prior to IIFS								191.21	123.58
IIFS Restored Streams TFQ50								70.31	**45.44**
Remains to Divert:								120.90	**78.14**
DWS Kamole Weir Average 2014									3.60
Kula Ag Park								2.50	1.62
Remains for HC&S (Est.)									**72.92**
Restoration Status Full									
Restoration Status Connectivity									



MAUI ISLAND WATER USE AND DEVELOPMENT PLAN DRAFT

PART III REGIONAL PLANS

HĀNA AQUIFER SECTOR AREA

Table of Contents

List of Tables

List of Figures

17.0 HĀNA AQUIFER SECTOR AREA

The Hāna Aquifer Sector Area (ASEA) encompasses about 89 square miles, including four groundwater Aquifer System Areas (ASYAs): Kīpahulu, Waiho`i, Kawaipapa, and Kūhiwa underlying both the eastern and southern flanks of the eastern tip of Haleakalā. The 2015 population of the Hāna Community Plan area was 2,408 residents (includes some outlying areas within the Ko`olau and Kahikinui ASEAs), and is projected by the Maui Island Plan to increase by 22 percent to 2,938 residents by 2035.[1] The WUDP uses hydrologic units for presentation and analysis consistent with state requirements for updating the plan; however, the geographic areas of the Hāna Community Plan and moku boundaries differ from the Commission on Water Resource Management's (CWRM) aquifer sectors in the following ways: (1) the Hāna Community Plan also includes portions of the adjacent Ko`olau ASEA and most of Kahikinui ASEA; and (2) it encompasses all or portions of various moku (Ko`olau, Hāna, Kīpahulu, Kaupō, Kahikinui, and Hāmākualoa) and their underlying ahupua`a.

[1] County of Maui, Final Draft Socio-Economic Forecast, Maui County Planning Department, Long Range Planning Division, 2014.

17.1 PLANNING FRAMEWORK

17.1.1 Key Issues

Open public meetings and workshops during 2016 identified key issues and concerns for the Hāna region. Many of the issues raised pertain to stream diversions from the Ko`olau aquifer sector transmitted to Central Maui. Other issues and concerns relate to the leeward Kaupō and Kahikinui areas. These issues are addressed in the Ko`olau and Kahikinui aquifer sector reports respectively. While overlapping, key issues identified for the Hāna community and water resources within the Hāna aquifer sector relate to watershed management and participation by the local community; maintenance of traditional resource management using the ahupua`a system and ensuring that traditional and customary practices are safe guarded. Community members state that younger generations are returning to Ko`olau to establish taro lo`i. Projected public water use is relatively modest even with an anticipated 22 percent increase in population growth for the Hāna Community Plan Area.[2] A key issue for the region is providing affordable water for future needs, providing for taro lo`i and other public trust uses during droughts, and managing resources in a sustainable way. Region specific input received at community meetings, via surveys and at a policy board meetings generally focused on the following issues:

- Watershed protection
- Maintaining access to lands
- Precautionary planning
- DHHL water needs in Hāna
- Adapting future populations to local water resource conditions
- Consultation and coordination with Native Hawaiian community/moku

<u>Watershed protection</u>

Watershed protection and its prioritization, including invasive alien plant control, ungulate control, and reforestation via watershed partnership programs.

<u>Maintaining access to lands</u>

Maintaining access to lands for gathering, hunting and other Native Hawaiian traditional and customary practices.

[2] Ibid.

Precautionary planning

Improving the understanding of the concepts of "precautionary planning" to reduce and adapt to the effects of drought and climate change upon water resource availability and quality.

Adapting future populations to local water resource conditions

Adapting future populations to local water resource conditions, integrating conservation and the use of alternative resources.

DHHL water needs in Hāna

Water needs of DHHL in Hāna should be considered in general and in accordance with the 2017 State Water Projects Plan.

Consultation and coordination with Native Hawaiian community/moku

Consultation and coordination with Native Hawaiian community/moku and local experts on resource management and invasive species removal

17.1.2 Plans, Goals, Objectives and Policies

The Hāna ASEA implements the Maui County General Plan and is subject to the plans, goals, policies and objectives discussed in Chapter 3 of the WUDP. The Maui Island Plan does not identify goals, objectives and policies that are specific to Hāna but rather island-wide. All goals and objectives adopted in Chapter 6.3 of the MIP are consistent with the broad planning objectives of the WUDP as shown in the matrix of WUDP Part I, Appendix 2 *"County Plan Policy and Programs Relevant to the WUDP, and Consistency with the Planning Objectives".*

The 1994 Hāna Community Plan

The 1994 Hāna Community Plan reflects regional issues expressed at the community meetings for the WUDP. Community plan goals and policies related to water resources and use are summarized below.

Water Resources

Goal:

Protection and management of land, water and ocean resources

Objectives and Policies

- Protect, preserve and increase natural marine, coastal and inland resources, encouraging comprehensive resource management programs

- Recognize residents' traditional uses of the region's natural resources, which balance environmental protection and self-sufficiency
- Discourage water or land development and activities which degrade the region's existing surface and groundwater quality
- Encourage resource management programs that maintain and re-establish indigenous and endemic flora and fauna
- Protect, restore and preserve native aquatic habitats and resources within and along streams
- Ensure that groundwater and surface water resources are preserved and maintained at capacities and levels to meet the current and future domestic, agricultural, commercial, ecological and traditional cultural demands of each area in the Hāna District

Water Availability and Use

Goal:

Timely and environmentally sensitive development and maintenance of infrastructure systems, including the provision of domestic water

Objectives and Policies

- Improve water source and delivery facilities to ensure that water supplied to the region's residents and visitors is of the highest quality
- Identify water service area expansion needs in the Hāna region
- Encourage water conservation measures by residents and businesses

17.2 Physical Setting

17.2.1 Climate and Geology

Hāna is located on the younger of Maui Island's two mountain ranges on the East Maui Volcano known as Haleakalā. The volcanism of the area is considered dormant.[3] The rainy eastern slope where the Hāna Aquifer Sector Area (ASEA) is located has valleys that are separated by broad areas and ridges.[4] At middle and lower altitudes of Haleakalā, forests cover much of the wet windward slopes.[5] The lush tropical growth and deep erosion along the Hāna coastline vividly contrast with Haleakalā's dry southwest shore. Most of Hāna's lower areas consist of seacoast cloaked in tropical forest. Mountains obstruct trade-wind air flow and create wetter climates on north- and northeast-facing (windward) mountain slopes where much of Hāna is positioned.[6] Persistent trade winds and orographic lifting of moist air result in recurrent clouds and frequent rainfall on windward slopes and near the peaks of all but the tallest mountains of the Hawaiian Islands.[7] When trade winds are present, the vertical development of clouds is restricted by the trade-wind inversion layer. The altitude of the inversion, however, varies over time and space and is affected by thermal circulation patterns, such as land and sea breezes.[8] Most of Maui is usually immersed in the moist air layer below the inversion. On Haleakalā, mean rainfall exceeds 200 inches per year on mid-altitude windward slopes. Rainfall ranges from 60-400 inches per year in Hāna, with the annual average exceeding 300 inches (7,600 mm) along the lower windward slopes.[9] Hāna is home to some of the wettest places on Earth. At the Big Bog rain gage at 5,400 ft. altitude on windward Haleakalā, mean rainfall is about 404 inches per year, which was among the highest values in the Hawaiian Islands from 1978–2007.[10]

The only road in and out of Hāna, Highway 360, winds past changing landscapes mostly consisting of tropical rainforests perched upon intensely steep cliffs. On at least four occasions,

---

[3] Macdonald, G.A., Abbott, A.T., and Peterson, F.L., 1983, Volcanoes in the sea (2d ed.): Honolulu, Hawaiʻi, University of Hawaiʻi Press, page 517.
[4] Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially distributed groundwater recharge estimated using a water-budget model for the Island of Maui, Hawaiʻi, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168, 53 p., http://dx.doi.org/10.3133/sir20145168.
[5] Ibid, page 7.
[6] Sanderson, Marie, 1993, Introduction, chap. 1 *of* Sanderson, Marie, ed., Prevailing trade winds: Honolulu, Hawaiʻi, University of Hawaiʻi Press, page 1–11.
[7] Giambelluca, T.W., Nullet, M.A., and Schroeder, T.A., 1986, Rainfall atlas of Hawaiʻi: Hawaiʻi Department of Land and Natural Resources, Division of Water and Land Development Report R76, page 267
[8] Giambelluca, T.W., and Nullet, Dennis, 1991, Influence of the trade-wind inversion on the climate of a leeward mountain slope in Hawai`i: Climate Research, v. 1, p. 207–216.
[9] Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially distributed groundwater recharge estimated using a water-budget model for the Island of Maui, Hawaiʻi, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168, 39 p., http://dx.doi.org/10.3133/sir20145168.
[10] Giambelluca, T.W., Chen, Q., Frazier, A.G., Price, J.P., Chen, Y.-L., Chu, P.-S., Eischeid, J.K., and Delparte, D.M., 2013, Online Rainfall Atlas of Hawaiʻi: Bulletin of the American Meteorological Society v. 94, p. 313–316, doi: 10.1175/BAMS-D-11-00228.1, at *http://rainfall.geography.Hawai`i.edu/*.

fluid Hāna lava flows followed Ke`anae Valley to the coast, with the youngest flow, 10,000 years ago, having built most of the modern Ke`anae Peninsula. The landscape changes near milepost 24, where the road passes Haleakalā's east rift zone. Dozens of cinder cones and lava flows of Hāna and Kula basalt create a terrain hundreds of thousands of years younger than the one on older volcanic rocks.[11] Upslope at mid-elevations in north Hāna, relatively recent lava flows (within the last 15,000 years) have created a rugged terrain lacking perennial streams and wet taro terraces. However, dry land taro is abundant due to the combination of humus and eroded lava frequently watered by rainfall, except during occasional droughts.

17.2.2 Water Resources

Climate, hydrology, geology and human activities affect the hydrologic cycle and the surface and ground water systems which are interconnected. Perennial and intermittent streams on windward Haleakalā are generally fed by abundant rainfall and groundwater discharge.[12] Hydrologic data is limited for ground and surface water resources in the aquifer sector. Sustainable yield for aquifer systems adopted by CWRM in 2008 are deemed reasonable for planning purposes until more detailed geologic and hydrologic information is available.[13] Select portions of the groundwater aquifer systems have been studied. Hydrologic reconnaissance in the Kīpahulu Valley reported perched water in saturated zones above basal water, emerging as springs and seeps along the streams and the shoreline.[14] Occurrence of groundwater in the Hānawi watershed in Nāhiku was evaluated extensively as well as groundwater occurrence and contribution to stream flow from Maliko Gulch in the west to Makapipi stream in the east. However, both study areas are regionally located outside the Hāna ASEA, in the adjacent Ko`olau ASEA.

Similarly, stream flow has been extensively assessed in the Ko`olau aquifer sector but there is little data and few gages to quantify stream flow in the Hāna ASEA.

<u>Groundwater Recharge</u>

Groundwater recharge describes the amount of water that travels from the air, through the soil, and ultimately into the groundwater and aquifers. The 2014 USGS study, *Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawai'i, 1978–2007*, reassessed average climate conditions on recharge using 2010 land cover. For this study, direct recharge was defined as water that passes directly to the groundwater system, completely bypassing the plant-root zone. Hence, direct recharge was not

---

[11] Hazlett, Richard W. and Hyndman, Donald W., *Roadside Geology of Hawai'i*, page 129.

[12] Gingerich, S.B., 1999a, Ground water and surface water in the Haiku area, East Maui, Hawai`i: U.S. Geological Survey Water-Resources Investigations Report 98–4142, 38 p.

13 Gingerich, S.B., 1999b, Ground-water occurrence and contribution to streamflow, northeast Maui, Hawai`i: U.S. Geological Survey Water-Resources Investigations Report 99–4090, 69 p.

[13] Commission on Water Resource Management, Water Resources Protection Plan 2008 page 3-87

[14] Souza, William. U.S.Geological Survey. Exploratory Drilling and Aquifer Testing at the Kīpahulu District, Haleakalā National Park, Maui , Hawaii. 1983 Report 83-4066

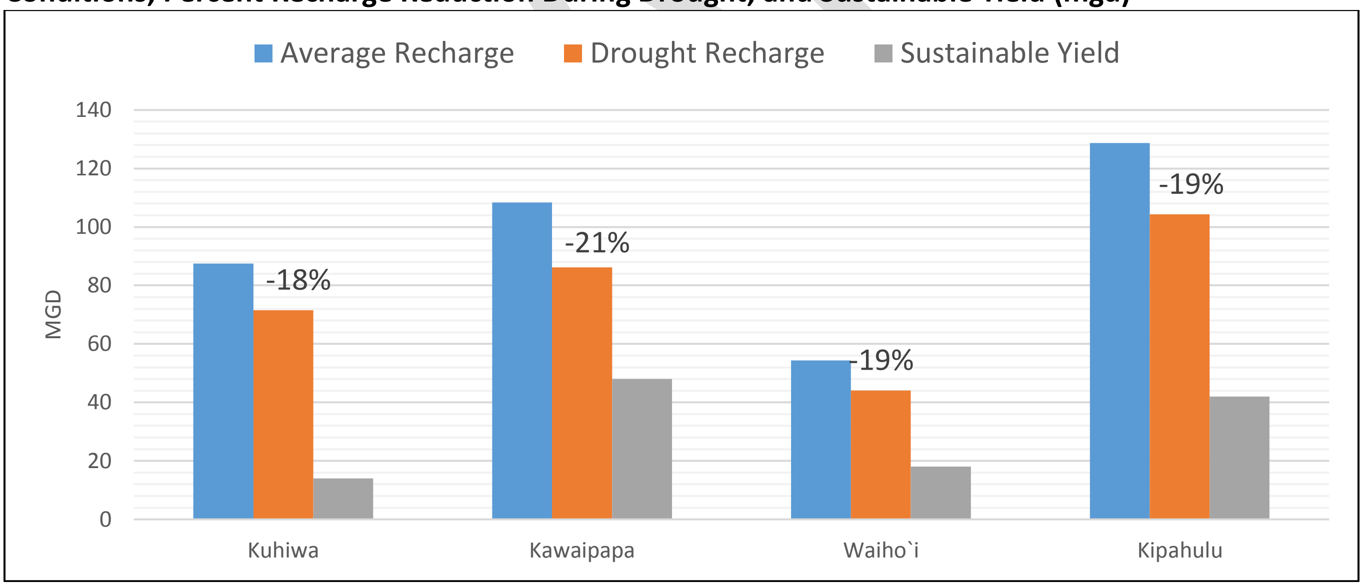
subject to direct runoff or evapotranspiration processes.[15] In 2017, USGS discovered an error in data that affected published groundwater-recharge estimates for Maui and other islands. The recharge estimated for 1978 – 2007 rainfall and 2010 land-use conditions were revised and made available for reference, pending publication of a revised report. The corrected data is reflected in the table and chart below. Of Maui's total mean recharge for average climate conditions, 60 percent occurs in the Ko`olau and Hāna ASEA's on windward Haleakalā.[16] A drought condition scenario modeled for the Hāna ASEA based on rainfall during the 1998–2002 period yielded a 19 percent reduction in recharge sector-wide, compared to average climate conditions.

Table 17-1 Hāna ASEA Groundwater Recharge Estimates Drought and Average Conditions

Recharge Average Climate Conditions (mgd)	Recharge Drought Climate Conditions (mgd)	% Decrease Drought Climate Conditions
379	306	19

Source: Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawaiʻi, 1978–2007.

Figure: 17-1 Hāna ASEA Average Mean Recharge under Average Climate and Drought Conditions, Percent Recharge Reduction During Drought, and Sustainable Yield (mgd)



Source: CWRM 2008 Sustainable Yields; USGS, *Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawai`i, 1978–2007.* The Pacific Regional Integrated Sciences and Assessments' (Pacific RISA) *Maui Groundwater Project* is an interdisciplinary research effort to inform decisions about the sustainability of groundwater resources on the island of Maui

[15] Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially distributed groundwater recharge estimated using a water-budget model for the Island of Maui, Hawaiʻi, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168, 30 p., http://dx.doi.org/10.3133/sir20145168.
[16] Ibid 49 p.

under future climate conditions. A new hydrologic model is being used to assess the impact of changing climate and land cover on groundwater recharge over the island. Preliminarily future climate projections for Maui Island suggest that wet areas get wetter with mean annual rainfall increases. Scientists' confidence in trends and changes to rainfall and associated recharge is relatively low. No stream flow projections are available for the coming century. The impact on recharge and stream flow from climatic changes is at the time of this plan highly uncertain.

Groundwater Availability

The groundwater sustainable yield (SY) is the maximum rate that groundwater can be withdrawn without impairing the water source as determined by the Commission on Water Resources Management (CWRM). Sustainable yield (SY) does not account for water transfers, such as irrigation return flow that percolates back into the aquifer to be potentially re-pumped, and SY accounts for basal, perched, and high-level water. The 2008 sustainable yield for the Hāna aquifer sectors and aquifer systems shown below is 122 mgd: (1) Kūhiwa = 14 mgd; (2) Kawaipapa = 48 mgd; (3) Waiho`i = 18 mgd; and (4) Kīpahulu = 42 mgd. Generally, SY is conservatively set at the low end of the estimated range of predicted sustainable yields for an aquifer. Updated SY for the entire state is under review for the pending 2017 State Water Resource Protection Plan.

Table 17-2 Sustainable Yields for Hāna Aquifer System Areas (ASYAs)

Hāna Aquifer System Area (ASYA)	Aquifer Code	Sustainable Yield Range	2008 WRPP Sustainable Yield (mgd)
Kūhiwa	60501	14*	14
Kawaipapa	60502	48*	48
Waiho`i	60503	18-21	18
Kīpahulu	60504	42*	42

Source: CWRM, *State Water Resource Protection Plan*, June 2008, page 3-66.
*No range given for this

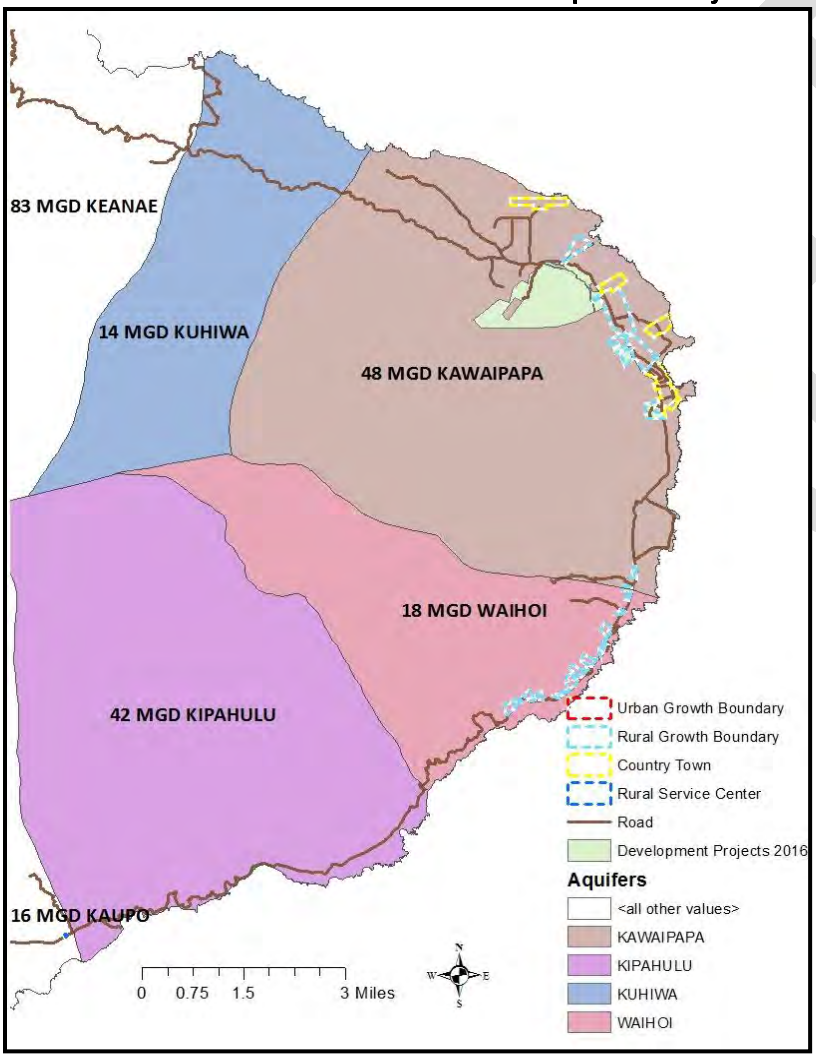
Sustainable Yield calculations are based on the natural recharge for the aquifer. The CWRM ranks the SY values according to the degree of confidence that CWRM places on the number, ranging from (1) most confident to (3) least confident. The degree of confidence is directly related to the type, quality and quantity of hydrologic data used in the SY determination. As noted previously, there are few hydrologic studies done for the aquifer systems within the Hāna Sector. CWRM ranked all aquifer systems in this sector (3) least confident, recognizing that there is significant uncertainty associated with the SY due to the lack of hydrogeologic and pumpage information.[17]

Sustainable yield does not include water transfers, such as irrigation return flow. Groundwater for municipal services is developed in Kawaipapa Aquifer and transmitted within Kawaipapa

[17] CWRM, Water Resources Protection Plan, 2008 pp 3-82

and south to Waiho`i aquifer. Planned growth areas within Country Town and Rural Growth Boundaries and proposed development projects are confined to these aquifer systems. Surface water is generally not transported between aquifer systems in the Hāna sector, except for limited diversions of Manawainui stream at the eastern most boundary of Kīpahulu aquifer system and Nāhiku Tunnel by Makapipi Stream on the boundary of Kūhiwa aquifer and Ke`anae aquifer in the adjacent Ko`olau ASEA. The graphic below shows the relationship between aquifer systems, watersheds, streams, moku, Maui Island Plan growth boundaries and development projects.

Figure 17-2 Hāna ASEA Relationship of Aquifer System Areas and Sustainable Yield to Maui Island Plan Growth Boundaries and Development Projects



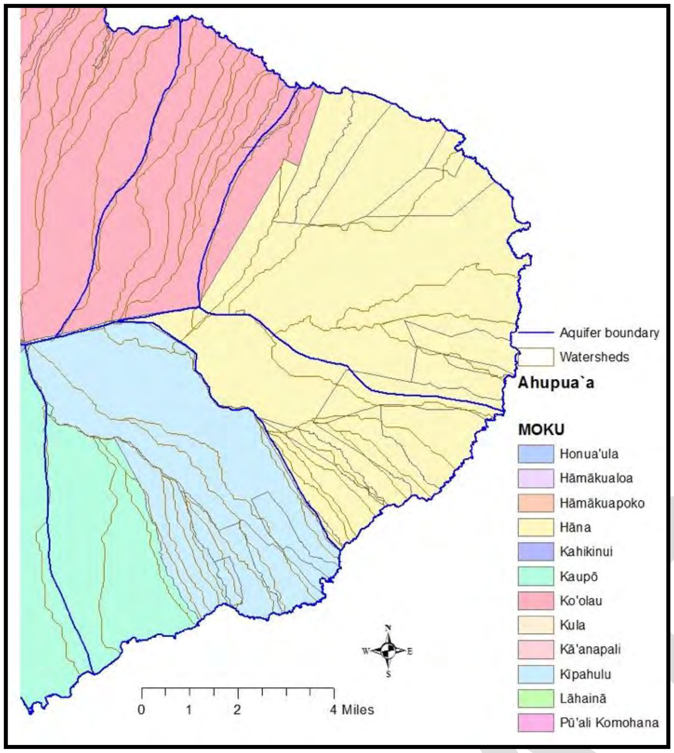


Figure 17-3 Hāna ASEA Relationship of Aquifer System Areas, Watersheds, and Moku

Surface Water Availability

There are 34 surface water units (watershed units) and 25 perennial streams within the area encompassed by the Hāna ASEA.

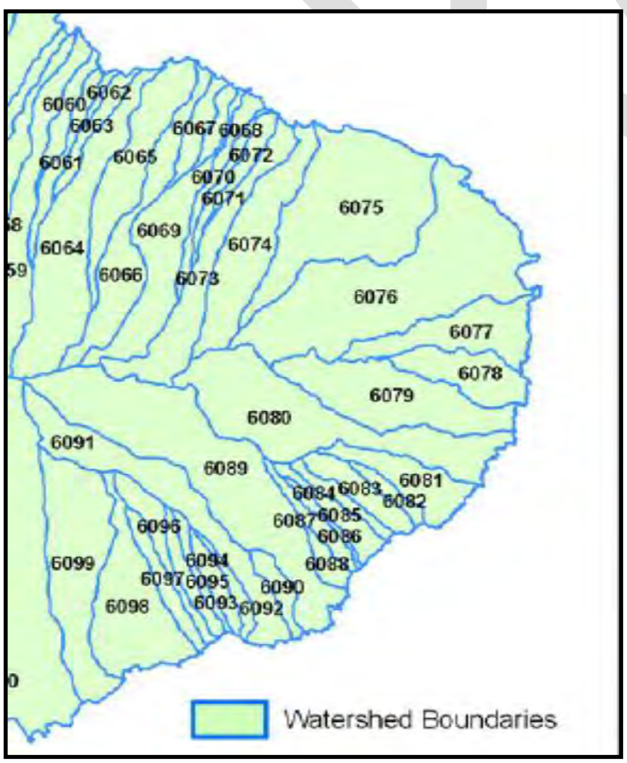
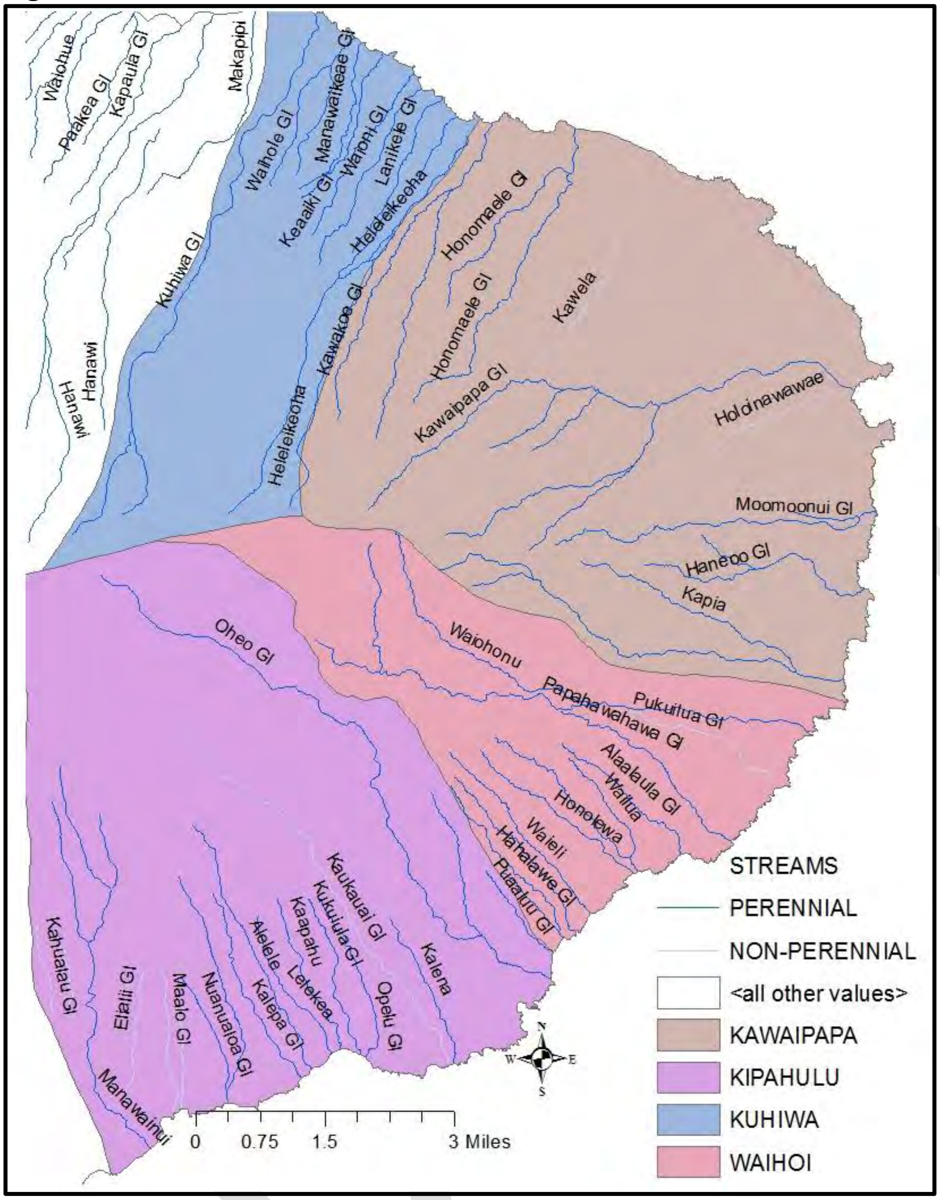


Figure 17-4 Hāna ASEA Hydrological Units/Watersheds

Figure 17-5 Hāna ASEA Perennial and Non-Perennial Streams



Source: Hawai`i Stream Assessment, Report R84, December 1990.

There are 70 declared stream diversions on 21 streams according to the CWRM database and 9 gages, of which, only one is "active" (`Ohe`o). The following table shows the number of diversions and gages for Hāna ASEA streams and the interim instream flow standards (IIFS). The IIFS in the region reflects the diverted amounts existing at the time when the status quo IIFS were adopted in 1988. [18]

[18] Hawai`i Administrative Rules, Section 13-169-46, "Interim Instream Flow Standard for all streams on Hawai`i, 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, 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

Table 17-3 Hāna Stream Diversions, Gages and IIFS by Watershed Unit

Aquifer System	Code Unit	Hydrologic Unit	Area (mi²)	No. of Diversions	No. of Gages	Interim IFS
Kūhiwa	6066	Kūhiwa	3.41	0	0	HAR §13-169-44
Kūhiwa	6067	Waihole	0.88	2	0	HAR §13-169-44
Kūhiwa	6068	Manawaikeae	0.52	0	0	HAR §13-169-44
Kūhiwa	6069	Kahawaihapapa	3.73	0	0	HAR §13-169-44
Kūhiwa	6070	Kea`aiki	1.03	2	0	HAR §13-169-44
Kūhiwa	6071	Waioni	0.63	2	0	HAR §13-169-44
Kūhiwa	6072	Lanikele	0.7	1	0	HAR §13-169-44
Kūhiwa	6073	Heleleikeoha	3.48	14	0	HAR §13-169-44
Kawaipapa	6074	Kawakoe	4.04	15	0	HAR §13-169-44
Kawaipapa	6075	Honomā`ele	7.94	4	1	HAR §13-169-44
Kawaipapa	6076	Kawaipapa	10.7	0	2	HAR §13-169-44
Kawaipapa	6077	Mo`omo`onui	2.95	0	1	HAR §13-169-44
Kawaipapa	6078	Haneo`o	2.13	0	0	HAR §13-169-44
Kawaipapa	6079	Kapia	4.71	3	0	HAR §13-169-44
Waiho`i	6080	Waiohonu	7.15	0	1	HAR §13-169-44
Waiho`i	6081	Papahawahawa	1.96	0	0	HAR §13-169-44
Waiho`i	6082	Ala`alaula	0.48	2	0	HAR §13-169-44
Waiho`i	6083	Wailua	1.26	4	0	HAR §13-169-44
Waiho`i	6084	Honolewa	0.63	1	0	HAR §13-169-44
Waiho`i	6085	Waieli	0.96	0	0	HAR §13-169-44
Waiho`i	6086	Kakiweka	0.34	1	0	HAR §13-169-44
Waiho`i	6087	Hahalawe	0.74	1	1	HAR §13-169-44
Kīpahulu	6088	Pua`alu`u	0.53	4	0	HAR §13-169-44
Kīpahulu	6089	`Ohe`o	9.7	0	2	HAR §13-169-44
Kīpahulu	6090	Kalena	0.71	1	0	HAR §13-169-44
Kīpahulu	6091	Koukouai	4.56	2	0	HAR §13-169-44
Kīpahulu	6092	Opelu	0.53	2	0	HAR §13-169-44
Kīpahulu	6093	Kukui`ula	0.74	1	1	HAR §13-169-44
Kīpahulu	6094	Ka`apahu	0.5	0	0	HAR §13-169-44
Kīpahulu	6095	Lelekea	0.78	0	0	HAR §13-169-44
Kīpahulu	6096	Alelele	1.2	0	0	HAR §13-169-44
Kīpahulu	6097	Kalepa	0.97	2	0	HAR §13-169-44
Kīpahulu	6098	Nuanua`aloa	4.24	3	0	HAR §13-169-44
Kīpahulu	6099	Manawainui	5.17	3	0	HAR §13-169-44

Source: CWRM, *State Water Resources Protection Plan*, 2008.

The 1990 Hawaii Stream Assessment prepared for CWRM inventoried streams state wide. However, data on stream flow is only available through either active gages or stream

diversions, and under the stream conditions existing on the effective date of the standard, except as may be modified by the commission."

assessment and studies. With one known active gage, information on stream flow under various conditions is extremely limited. Where no stream flow data is available, declaration of water use and kuleana parcels can provide some guidance to water availability. The table below shows registered or permitted diversions, available stream flow data, water use declarations and reported kuleana parcels in the pertaining hydrologic unit.

Table 17-4 Hāna Surface Water Units, Natural Streamflow, Diversions, 1989 Declarations of Water Use, and known Kuleana Parcels

Unit Code	Hydrologic Unit Name	Median Flow (Q^{50})* (mgd)	No. of Diversions	Lowest Q^{70*2} Flow (mgd)	1989 Dec. of Water Use (mgd)	Kuleana parcels (OHA 2009 GIS)
6066	Kūhiwa		0		0	
6067	Waihole		2		0.001	
6068	Manawaikeae		0		0	
6069	Kahawaihapapa		0		0	Kahawaihapapa, but not adjacent to stream
6070	Kea`aiki		2		0	
6071	Waioni		2		0	
6072	Lanikele		1		0	
6073	Heleleikeoha		14		0.001	
6074	Kawakoe		15		0.002	
6075	Honomā`ele		4		0	
6076	Kawaipapa		0		0	
6077	Mo`omo`onui		0		0	Mo`omo`onui
6078	Haneo`o		0		0	Haneo`o
6079	Kapia		3		0.002	
6080	Waiohonu		0		0	Waiohonu, Pukuilua
6081	Papahawahawa		0		0	
6082	Ala`alaula		2		0.007	
6083	Wailua		4		0.101*3	Wailua
6084	Honolewa		1		0	Honolewa
6085	Waieli		0		0	
6086	Kakiweka		1		0	
6087	Hahalawe		1		0	
6088	Pua'alu`u		4		0.112	
6089	`Ohe`o	3.68	0	0.00	0	`Ohe`o
6090	Kalena		1		0	
6091	Koukouai		2		0	
6092	Opelu		2		0	

Unit Code	Hydrologic Unit Name	Median Flow (Q^{50})* (mgd)	No. of Diversions	Lowest Q^{70}*2 Flow (mgd)	1989 Dec. of Water Use (mgd)	Kuleana parcels (OHA 2009 GIS)
6093	Kukui`ula		1		0	
6094	Ka`apahu		0		0	
6095	Lelekea		0		0	
6096	Alelele		0		0	
6097	Kalepa		2		0.018	
6098	Nuanua`aloa		3		0	Nuanua`aloa
6099	Manawainui		3		0.004[*4]	
Total		**3.68**	**71**		**0.143**	

Source: Diversions, Declared Use 1989, Reported Water Diverted 2011-2015: CWRM Reports. Discharges (Q figures): USGS Scientific Investigations Report 2016-5103. Kuleana parcels: based on Office of Hawaiian Affairs GIS data, 2009.

*Q^{50} is the amount of water flowing within the stream 50% of the time.

*[2] Q^{70} is the amount of water flowing within the stream 70% of the time.

*[3]Previously declared diversion from MDWS. No longer in use. Not included in total.

*[4]The water use declaration from the Manawainui stream is used to provide non-potable surface water to the Kaupō community within the Kahikinui ASEA. Therefore, it is not counted as water use for the Hāna ASEA analysis.

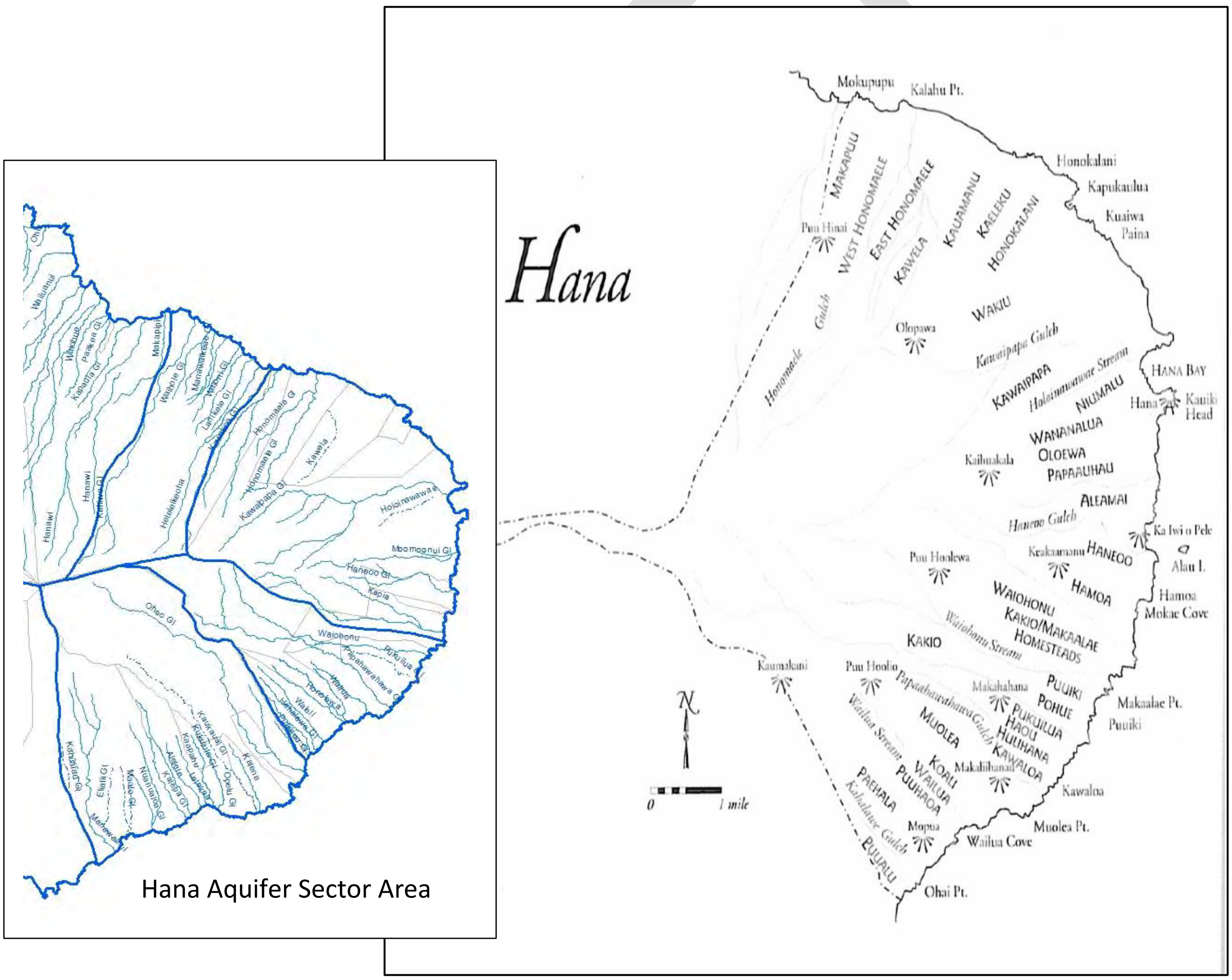
<u>Transport of Stream Water from East Maui</u>

Streams in the Ko`olau ASEA, bordering Kūhiwa aquifer system to the west are diverted by the East Maui Irrigation Company (EMI) and conveyed to Central Maui. Although EMI and its parent company Alexander & Baldwin Inc. own water lease licensed areas located in Nāhiku, there is presently no conveyance infrastructure to move water from the Hāna ASEA to the Ko`olau ASEA for use in Central and Upcountry Maui water systems.

17.3 SETTLEMENT PATTERNS AND CULTURAL RESOURCES

This section strives to acknowledge and highlight how Hawaiian history and cultural practices of the past relate to the present, and can inform options for meeting the future water needs of the people and uses of Maui Island while preserving and celebrating Hawai`i's past. Archaeology and traditional Native Hawaiian historical and cultural information provide a foundation for establishing continuity between past, present and future water use in the Hāna area. The traditional area of Hāna includes the districts of Kaupō, Kīpahulu, Hāna, and Nāhiku, which contrast with the boundaries of the Hāna Aquifer Sector Area (ASEA) used by the WUDP, which do not include Nāhiku and Kaupō.

Figure 17-6 Hāna Region and Hāna Aquifer Sector



Source: Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997.

17.3.1 Historical Context

Hāna is steeped in legend and was a major center of population and political power in ancient Hawai`i. Plantation sugar was cultivated here through the mid-twentieth century, destroying many traditional structures. The ruggedness of the land and the persistence of a large Hawaiian population have contributed to significant preservation efforts. Some of the most intact and extensive native forests left in Hawai`i today occur in the East Maui watershed.[19] Hāna has 32 recorded heiau (temples), including Pi`ilani Hale, the largest heiau in the state.[20]

In ancient times Hāna was well known for an abundance of water, food and people. Hawaiian history prior to European contact can be interpreted though the archaeological record, whose vast walls, fishponds, village foundations, and heiau tell of populations that far exceeded those of today in remote areas such as Hāna. Because Pi`ilani Hale Heiau is located in Hāna, this suggests that a comparatively large population would have evolved at that sacred site and the surrounding areas.

Phrase of Hāna

Today, as one enters the Hāna district, signs along the Hāna Highway still proclaim Hāna to be "Ka 'Aina o Ka Ua Kea," the land of the white misty rain, for the mists that blanket the district day and night.

Agriculture

Historical Native Hawaiian Agriculture and Cultural Resources

Hāna is known for its historical agricultural food productivity: "Hāna was a fertile land where taro, sweet potatoes, bananas, sugar cane, and wild fruits grew in abundance, and there was always much food to be had. Kawaipapa was rich in fish from ponds and from the sea…." [21]

According to Hawaiian ethnobotanist and cultural historian E.S.C Handy, Kīpahulu was a moku with rich and diverse but scattered agricultural resources. Its great valley and lower fringing forests nourished forest taro and other native food plants, as did the lower kula lands above the sea, where the native homes are today. Formerly sugar plantation, this land is now a cattle ranch.[22]

[19] County of Maui, Maui County General Plan 2030, Maui Island Plan, Chapter 8: Directed Growth Plan
[20] ibid

[21] Kamakau, Samuel M. *Ruling Chiefs of Hawai'i.* The Kamehameha Schools Press: Honolulu [2 vols.], 1961, page 24.
[22] Ibid, 156

Taro Culture Dominance

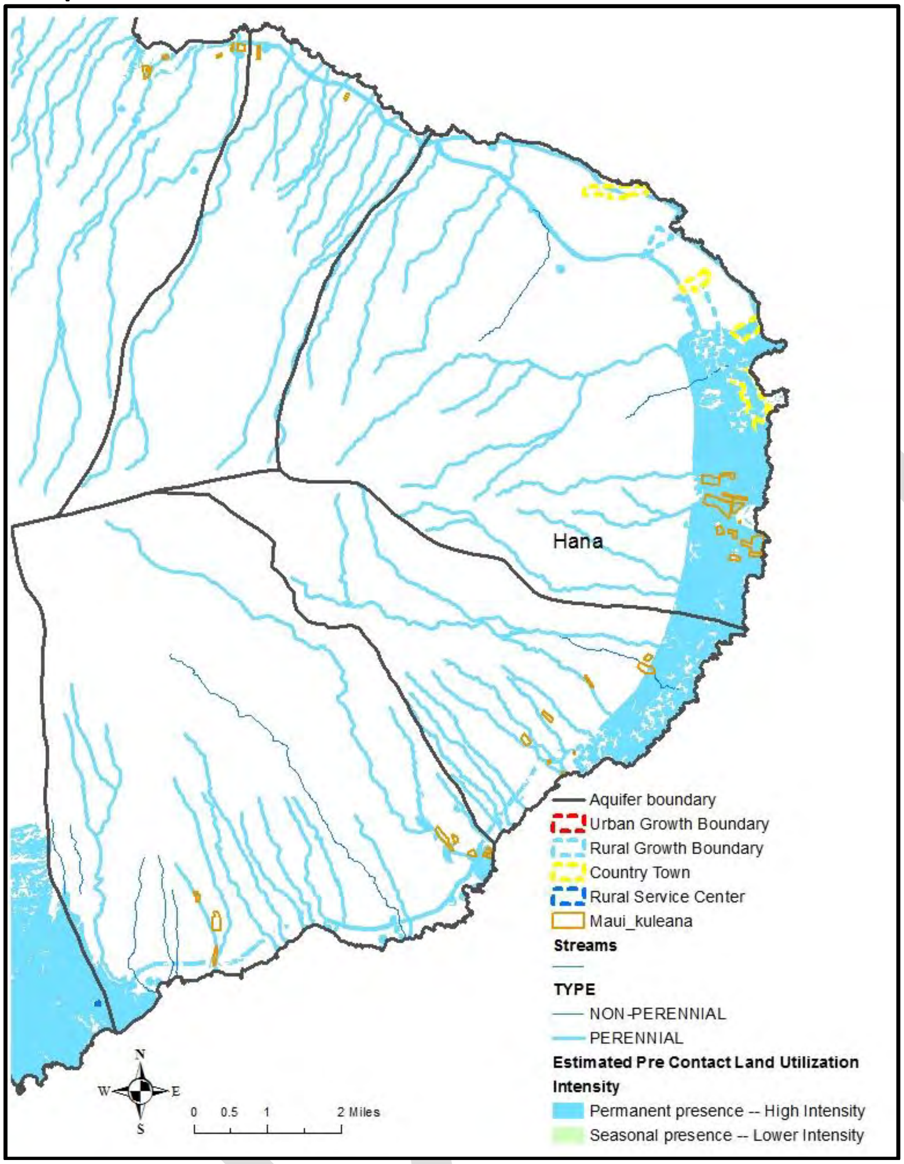
Upslope at the mid-elevations in north Hāna, relatively recent lava flows (within the past 15,000 years) have created a rugged terrain lacking perennial streams and wet taro terraces. However, dry land taro is abundant due to the combination of humus and eroded lava frequently watered by rainfall, except during occasional droughts. Dry taro has been historically planted in Honokalani, a formerly large Native Hawaiian settlement; Helani, inland from Hāna Town; and in the forest above Hāna Town, at about 1,500 feet elevation in a small valley below Olopawa Peak, formerly cultivated in dry land kalo during the dry season.[23]

> *"South of Hāmoa the land is less rugged and streams are more plentiful. The Hawaiian homesteads at Maka`alae, Waiohinu, Pu`uiki, Pohue, Pukuilua, Haou, HuliHāna, Muolea, and Koali have extensive plantations, but only a small proportion of the cultivation is devoted to dry taro. There is no evidence of wet taro cultivation in the Hāna district north of Koali. Here, however, both above and below the road, there are small groups of terraces, some of which are still used for wet taro. The taro terraces nearest Wailua are a picturesque example of high terracing with stone facing on a steep slope."* [24]

Today (2017), kalo is extensively grown in the region. One account from Handy cites the excessive wetness of Hāna as a reason for comparatively little sweet potato cultivation, except in certain areas.[25] The map below shows that the Hāna ASEA had sufficient resources to support a permanent presence, higher population intensity and extensive agricultural use.

[23] Ibid. 111
[24] E.S.C. Handy, Hawaiian Planter, page 111 [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 120].
[25] Ibid.

Figure 17-7 Estimated Native Hawaiian Pre-Contact Land Utilization and Kuleana Lands Compared to Growth Boundaries



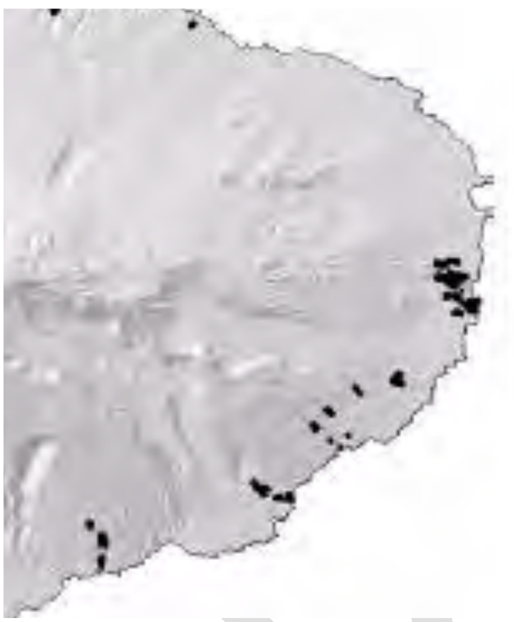
Source: The Nature Conservancy, Ladefoged, T.N. et al (2011), and Maui Island Plan (2012)

Kuleana Parcels

Water rights include “appurtenant or kuleana water rights” to use that amount of water from a water source (usually a stream) which was used at the time of the Māhele of 1848 on kuleana and taro lands for the cultivation of taro and other traditional crops and for domestic uses on that land, and “riparian rights,” which protect the interests of people who live on land along the banks of rivers or streams to the reasonable use of water from that stream or river on the riparian land subject to other rights of greater value.[26] These rights run with the land.[27] The many varied definitions for "kuleana" water users are included under section 10.2 (Ka Pa`akai Analysis).

Traditional and cultural Hawaiian practices are deeply intertwined with the geographical environment of the islands. Prior to the arrival of westerners and the idea of private land ownership, Hawaiians communally managed, accessed and gathered the resources from the land and seas to fulfill their community responsibilities. Traditional and customary Native Hawaiian rights are exercised in the streams in the form of subsistence gathering of native fish, mollusks, and crustaceans, and stream flows are diverted for the cultivation of wetland taro, other agricultural uses, and domestic uses that can be traced back to the Māhele. The maintenance of fish and wildlife habitats to enable gathering of stream animals and increased flows to enable the exercise of appurtenant rights constitute the instream exercise of "traditional and customary" Hawaiian rights.[28]

Figure 17-8 Hāna ASEA Kuleana Lands



Source: Office of Hawaiian Affairs data

Water

Hāna is famous for its rains and extensive spring water. For example, the area in front of the Hāna Kai Hotel is known for the many springs in the ocean that were used by the ancient

---

[26] Haia, Moses. *Protecting and Preserving Native Hawaiian Water Rights.* AluLikeWorkbook
[27] Ola I Ka Wai: A Legal Primer For Water Use And Management In Hawai'i

[28] CWRM East Maui Streams Hearing Officer's Recommended FOF, COL, and D&O, January 15, 2016. Contested Case No. CCH-MA 13-01 http://files.Hawai`i.gov/dlnr/cwrm/cch/cchma1301/CCHMA1301-20160115-HO-D&O.pdf

people, and Hāmoa Beach and Wai`ānapanapa State Park are world renown for their spring water-fed beaches: saltwater/ freshwater mixing zones that in ancient times were used for therapeutic healing.[29] Kauiki Hill is likewise known for an ample supply of spring water that historically supplied the hillside fortress. Other water legends tell of a certain Chief at Kauiki "…that thrust his spear into the heavens for Hāna's fame, as Hāna of the low heavenly rain."[30] "Hāna's famous rain is the 'Ua-kea.' When this rain falls…is after sunrise, at 9 or 10 in the morning ... Then the rain gives us some moisture. It does this to us every day."[31]

The extensive freshwater springs found throughout Hāna demonstrate the upslope precipitation capacity of the mountain.

Hawaiian Culture Today

The sensitivities of the region's residents for the cultural resources which are located within the Hāna district should be recognized. The historic sites and cultural resources provide evidence of Hāna's history and serve as tools for conveying the heritage of the region to its youth as a legacy for the future.[32] Today, numerous events such as the East Maui Taro Festival, Hāna Festivals of Aloha, the Hāna Limu Festival, and community groups such as hula halau and outrigger canoe clubs, help perpetuate the traditional Native Hawaiian culture in Hāna. A few of the cultural organizations and institutions are discussed below.

<u>Hāna Cultural Center</u>

The Hāna Cultural Center features traditional artifacts that were used by the ancient Hawaiian people in their everyday life, worship, fishing, and other aspects of their lives, including the life stories of those who made an impact on Maui and especially Hāna. Established by kupuna (wise elders) to perpetuate the traditional way of life of Hāna and to honor the Hawaiian Cultural Renaissance, the museum houses ancient artifacts including Hawaiian quilt, poi boards, stone implements, Polynesian kapa, fish nets and hooks. Listed on the National Register of the Historic Places, the old Hāna Courthouse is still used today on the grounds alongside Kauhale Village, a replica of a pre-contact chief's compound. Various cultural presentations and events are held regularly and are open to the public.

<u>Kahanu Garden</u>

Kahanu Garden and Preserve is a botanical garden located in Hāna. It is one of five gardens of the non-profit National Tropical Botanical Garden. The garden's ethnobotanical collections

---

[29] Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 127.
[30] Thomas G. Thrum. More Hawaiian Folk Tales, Hawaiian Annual for 1923, pages 68-69 [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997 page 131].
[31]D.S. Kaho'okano, *Hāna and the Country Life There*, La Nupepa Kuakoa, February 27, 1869 Hawaiian ethnological Notes, 1:2978 [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997 page 131].
[32] County of Maui, Hāna Community Plan, 1994, pages 10-11.

focus on plants traditionally used by Pacific Island people. It includes the world's largest breadfruit collection, first established in the 1970s. Today the garden contains accessions of approximately 150 varieties of breadfruit collected from field expeditions to over 17 Pacific Island groups in Polynesia, Micronesia, and Melanesia, as well as Indonesia, the Philippines, and the Seychelles. This colll.;ection is used for research and conservation by NTBG's Breadfruit Institute. Kahanu Garden also contains the 3-acre Pi`ilanihale Heiau, a National Historic Landmark believed to be the largest ancient temple in the Hawaiian Islands.[33] Construction of the main terrace dates back to the 14th century. Wings were later added and rededicated during the 16th century, possibly after high chief Pi`ilani from western Maui conquered the beautiful, fertile, well-watered, and heavily populated Hāna region, thereby unifying the whole island.[34]

Kīpahulu `Ohāna

Like their ancestors, the Kīpahulu `Ohāna are caring for the land so that its abundance may be shared by future generations in perpetuity.

> "Long before the first Europeans arrived on Maui, Kīpahulu was prized by the Hawaiian royalty for its fertile land and ocean. Thousands of people once lived a sustainable lifestyle in this area farming, fishing, and surviving with the resources of the `ahupua`a. In 1995, a small group of Native Hawaiian residents came together to revive, restore, and share the practices of traditional Native Hawaiian culture with others in Kīpahulu. The Kīpahulu `Ohāna is a nonprofit organization dedicated to educating residents and visitors of the "ways of old," through cultural demonstrations and hands-on activities. Using the wisdom and spiritual guidance of their elders, learned teachers, they seek to re-establish a Hawaiian lifestyle in Kīpahulu. By initiating sustainable projects, dividing the labor, and sharing the results, they seek to preserve their Native Hawaiian cultural practices. They operate Kapahu Living Farm, a traditional Hawaiian wetland taro farm located in Haleakalā National Park and managed through a partnership agreement with the park service, where they host educational programs for schools and community groups and distribute poi and other products to the local community. They also manage a state leased parcel with fruit orchard and cattle pasture and conduct feral animal control fencing and invasive plant removal in the Kīpahulu forest."[35]

Kukulu Kumu Hāna

Kukulu Kumu Hāna is a student-based agricultural business on five acres located within the DHHL Wākiu Tract. The five acres along Hāna Highway that is licensed to Kukulu Kumu Hāna for community and cultural uses has been cleared and a cultural center has been erected where

[33] Pi`ilanihale Heiau". National Historic Landmark summary listing. National Park Service. Retrieved 2008-07-04
[34] Kirch, Patrick Vinton (1996). "Piʻilanihale Heiau". Legacy of the Landscape: An Illustrated Guide to Hawaiian Archaeological Sites. Honolulu: University of Hawai`i Press. pp. 72–74. ISBN 0-8248-1739-7.
[35] Kīpahulu Ohana Website (http://Kīpahulu.org/)

they provide Hāna High and Intermediate School students with vocational agricultural based skills and cultural education.[36]

17.3.2 Lessons Learned from the Past

The Hāna region encompasses a vast and diverse rural area. In the past, the area supported many Hawaiian villages and a much larger Native Hawaiian population, but disease, gentrification, and major changes in the cultural and socio-economic landscape has drastically reduced the population and those that live by those cultural traditions. Although Hāna is still considered by many to be one of the most traditional "Hawaiian" places in Hawai`i; contemporary Hāna is undergoing changes that are resulting in social, economic and cultural upheaval, including a revival of ancient Native Hawaiian traditions and practices. Protecting the vast array of cultural resources in the Hāna District is important to not only the people of Hāna, but to the entire Island of Maui and the Hawaiian people. The district's historic sites provide evidence of Hāna's history and serve as tools for conveying the heritage of the region to its youth as a legacy for the future. Great care must be given to ensure that future development is done in a culturally sensitive manner.[37]

History paints a much different picture of Hāna's past carrying capacity when compared to today. Pre-contact populations in Hāna are thought to have significantly exceeded today's population, sustained by rain fed agriculture and ocean resources.[38] Until relatively recently (mid-1900s), population and agricultural potential for the area was excellent, but re-population of this remote area is not forecast in the County's Maui Island Plan or expected to be supported by economic opportunity or infrastructure. Abundant water resources could theoretically support an increase in Native Hawaiian domestic and agricultural uses. During community meetings in connection with formulation of the WUDP, Native Hawaiians and others in the Hāna area expressed concern with the westward transport of "Hāna" water, and this sentiment underscores the community's perceived connectivity of water resources to their "sense of place." As previously mentioned, diversions through the EMI system to Central Maui are within the Ko`olau ASEA, including Makapipi Stream in Nāhiku. Therefore, from a technical standpoint, Hāna water is *not* transported outside of the Hāna ASEA, and may continue to be available for utilization by Native Hawaiian cultural practitioners. While a return to the larger population of the past may not appear imminent, evidence exists of a cultural resurgence taking place that may play a greater role in transforming Hāna today and into the future.

[36] State of Hawai`i, Department of Hawaiian Home Lands, Maui Island Plan, 2004
[37] County of Maui, Maui County General Plan 2030, Maui Island Plan, Chapter 8: Directed Growth Plan
[38] The Nature Conservancy, Office of Hawaiian Affairs, Ladefoged, T.N., et al (2011), and Maui island Plan

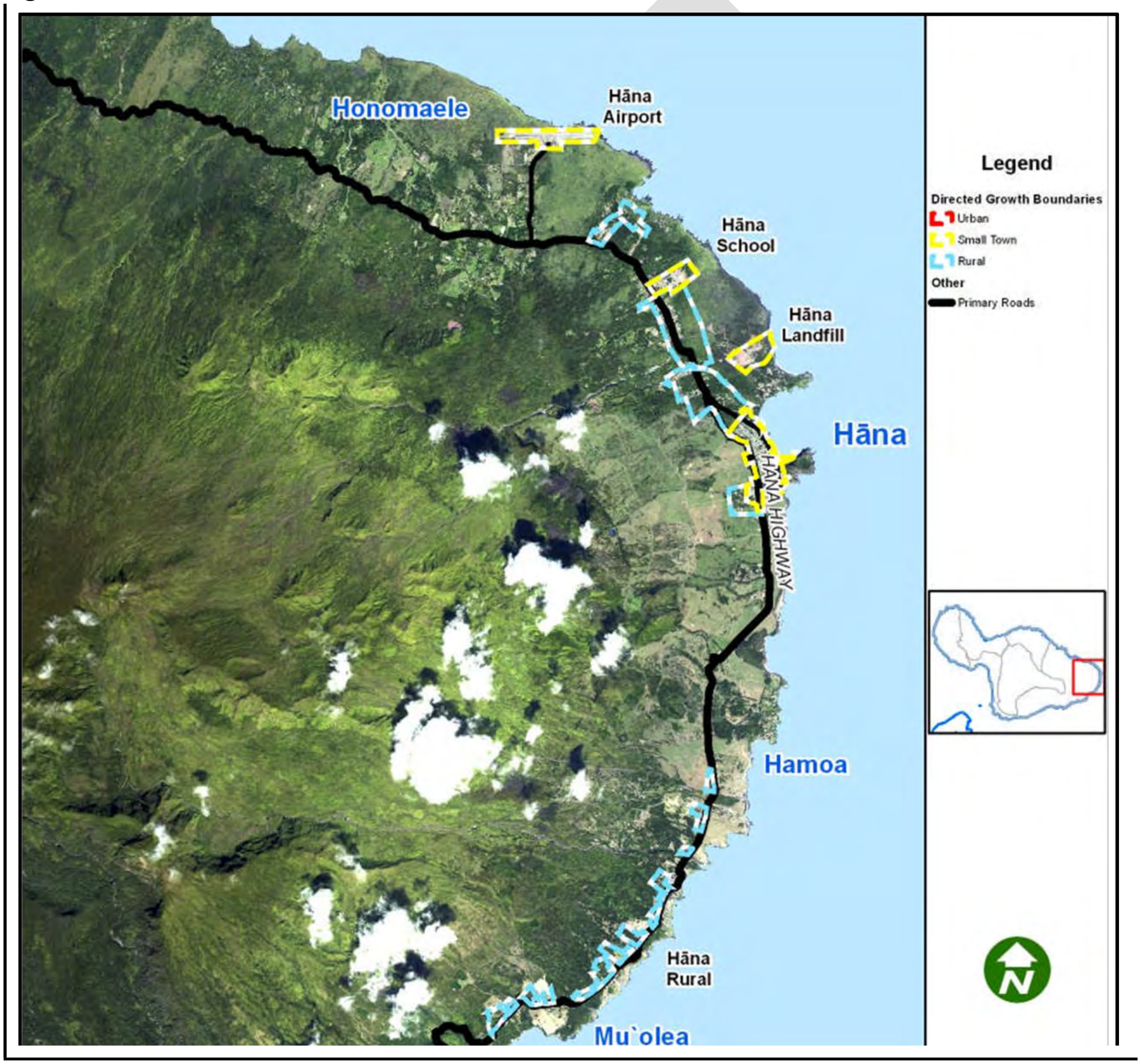
17.4 Land Use

The current land use pattern in the Hāna Aquifer Sector Area (ASEA) is dominated by rural and sparsely populated communities along the coast, with limited development and undeveloped areas mauka.

17.4.1 Land Use Plans

Maui Island Plan directed growth boundaries in the Hāna ASEA are classified as either Small Town or Rural as indicated in the map below.

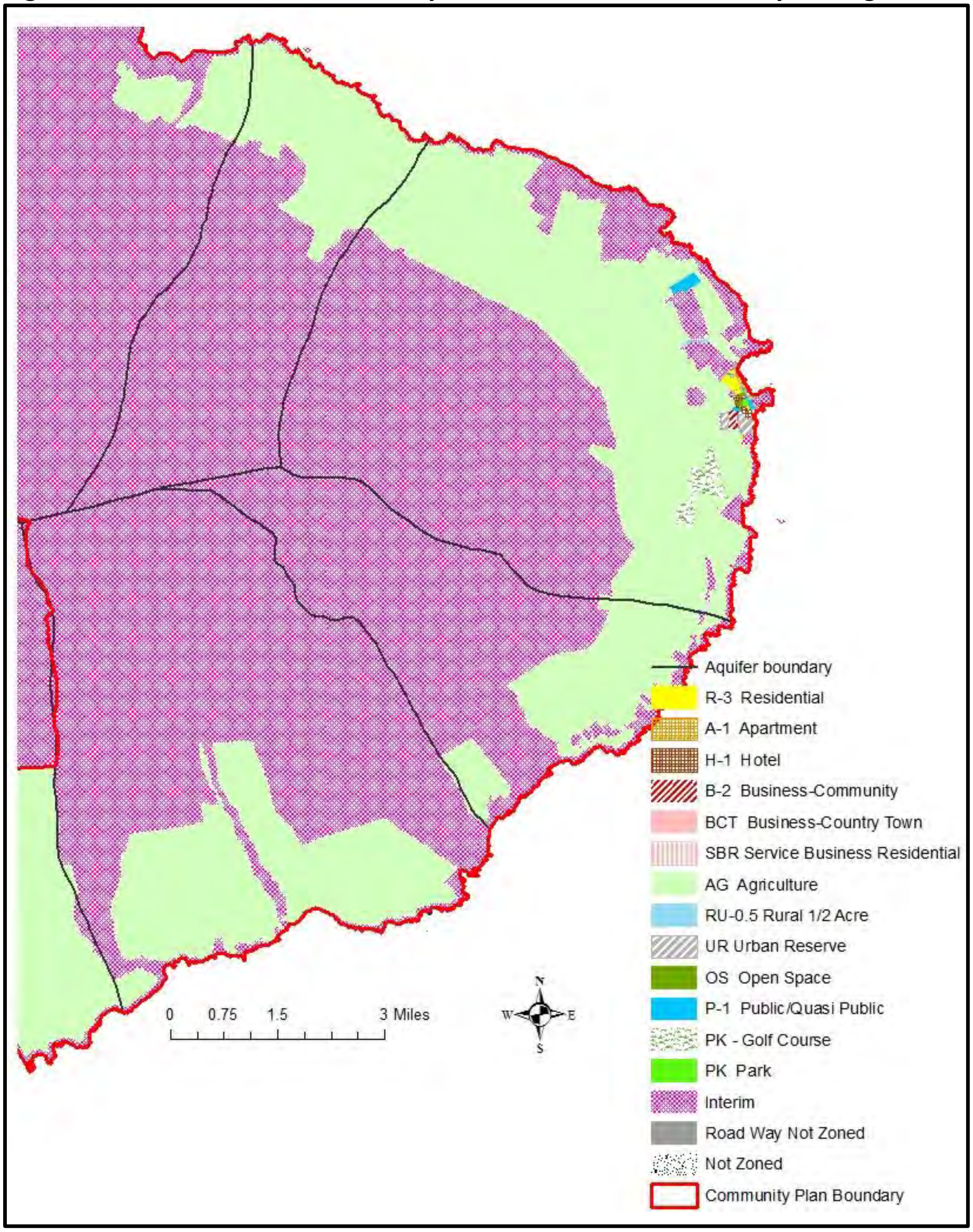
Figure 17-9 Directed Growth Plan: Hāna Planned Rural Growth Area



Source: County of Maui, Directed Grown Plan, Hāna – Planned Rural Growth Area.

The Hāna Community Plan includes approximately half of the Ko`olau ASEA and most of Kahikinui ASEA. It additionally encompasses all or portions of various moku (Ko`olau, Hāna, Kīpahulu, Kaupō, Kahikinui, Hāmākualoa) and their underlying ahupua`a. Outside of the rural coastal areas, most of the land is designated Agricultural and Conservation. The corresponding County Zoning Designation is dominated by Ag and Interim Zoning.

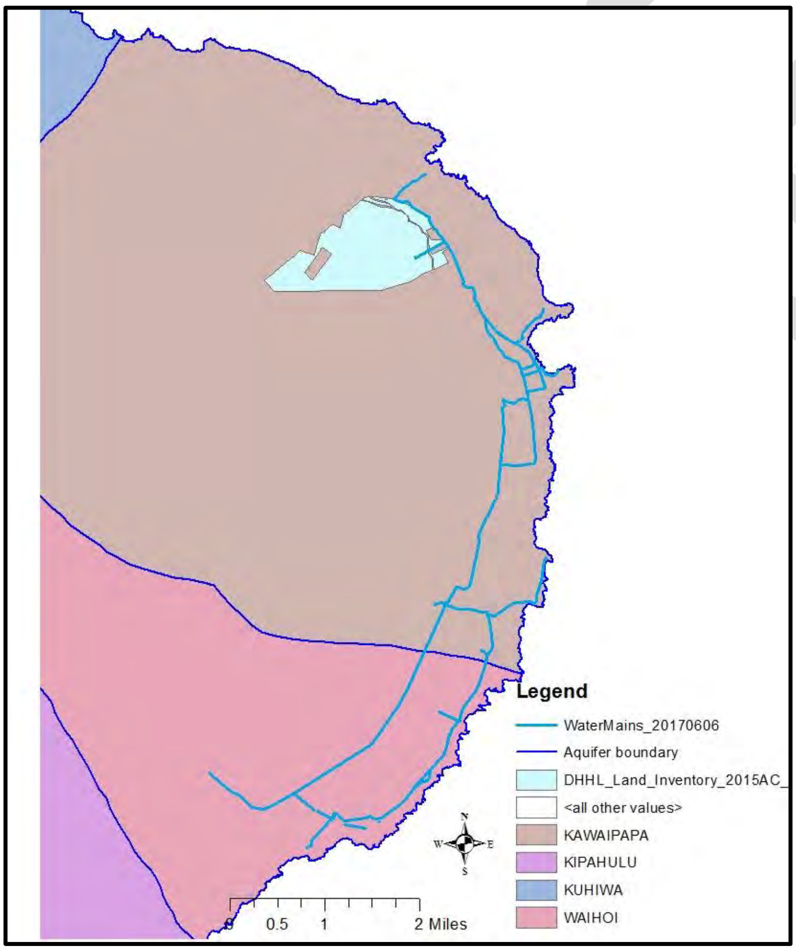
Figure 17-10 Hāna ASEA Community Plan Boundaries and County Zoning Districts



17.4.2 The DHHL Maui Island Plan

The Hawaiian Homes Commission adopted its Maui Island Plan as the overarching planning document in 2004. The Department of Hawaiian Homelands (DHHL) East Maui planning region encompasses three tracts totaling 985 acres: Ke`anae, Wākiu, and Wailua. All three tracts are within the Hāna Community Plan; however, only Wākiu is within the Hāna ASEA, it covers 743 acres, and the tract is zoned Agricultural.[39] The proposed land use for Wākiu includes 46 acres of one-half acre residential lots, 75 acres of three-acre subsistence agricultural lots, five acres of community use, five acres of commercial use, five acres of industrial use, and the balance of the tract (522 acres) in general agriculture.

Figure 17-11 Hāna ASEA Department of Hawaiian Homelands, Hāna ASEA Inventory



[39] State of Hawai`i, DHHL Maui Island Plan, 2004.

HĀNA AQUIFER SECTOR AREA

As discussed by the Water Development Analysis for the Department of Hawaiian Home Lands Tracts on the Island of Maui, there is a Maui Department of Water Supply (MDWS) 0.5 million gallon concrete storage tank on the Hāna side of the Wākiu tract at an elevation of 310 feet. The storage tank is fed by two wells, and a 12-inch water line extends from the tank to Hāna Highway and along Hāna Highway towards Hāna Town. A 6-inch water line runs north along Hāna Highway to Wai`ānapanapa Road. The existing 0.5 MG water tank can service the area along Hāna Highway from an elevation of approximately 140 feet above Mean Sea Level (msl) to 200 feet above msl. Improvements to the water system are needed to service the remaining areas of the tract. The DHHL is asking the MDWS to connect portions of the Wākiu and Hāmoa systems and construct a back-up well to supplement the Hāna system.[40] DHHL is also considering partnering with MDWS in developing a well for the tract.

[40] State of Hawai`i, DHHL Maui Island Plan, 2004, Page 6-1

17.5 EXISTING WATER USE

17.5.1 Water Use by Type

The CWRM has established the following water use categories based for the purposes of water use permitting and reporting:

- Domestic (Residential Domestic; Single and Multi-Family households, including noncommercial gardening; Non-residential Domestic; Commercial Businesses; Office Buildings, Hotels, Schools, and Religious Facilities)
- Industrial (Fire Protection, Mining, Dust Control, Thermoelectric Cooling, Geothermal, Power Development, Hydroelectric Power, and Other Industrial Applications)
- Irrigation (Golf Course, Hotels, Landscape and Water Features, Parks, School, and Habitat Maintenance)
- Agriculture (Aquatic Plants & Animals, Crops Irrigation and Processing, Livestock Water, Pasture Irrigation, and Processing, Ornamental and Nursery Plants, Taro, Other Agricultural Applications)
- Military (all military use)
- Municipal (County, State, Private Public Water Systems as defined by Department of Health)

This section presents the estimated water use within the Hāna ASEA for the calendar year 2014, or as otherwise stated based on CWRM and MDWS reports. County of Maui Municipal well use dominates total well production for the Hāna ASEA at 73%. The Hāna ASEA includes 31 wells, of which 28 are considered "production" wells, the remainder are classified as "unused" and do not produce water.

Table 17-5 Reported Pumpage and Surface Water Use by Type, Hāna ASEA, 2014 (gpd)

Aquifer	Domestic	Industrial	Agriculture	Irrigation	Municipal	Military	Total	Sustainable Yield (gpd)
# Production Wells	14	0	3	5	7	0	29	
Kūhiwa	0	0	0	1,315	0	0	1,315	14,000,000
Kawaipapa	0	0	0	0	600,487	0	600,487	48,000,000
Waiho`i	0	0	0	0	0	0	0	18,000,000*
Kīpahulu	3,976	0	0	0	0	0	3,976	42,000,000
Total Pumpage	**3,976**	**0**	**0**	**1,315**	**600,487**	**0**	**605,778**	**122,000,000**
% of Pumpage	0.65%	0%	0%	0.22%	99.13%	0%	100%	

HĀNA AQUIFER SECTOR AREA

Aquifer	Domestic	Industrial	Agriculture	Irrigation	Municipal	Military	Total	Sustainable Yield (gpd)
# Surface Water Diversions	69	0	0	0	1	0	70	
Kūhiwa	1,408	0	0	0	0	0	1,408	
Kawaipapa	2,047	0	0	0	0	0	2,047	
Waiho`i	49,562	0	0	0	0	0	49.562	
Kīpahulu	93,674	0	0	0	0	0	93,674	
Total Amount Diverted	**146,691**	**0**	**0**	**0**	**0**	**0**	**146,691**	
% Surface Water	100%	0	0	0	0%	0	100%	
TOTAL	**150,667**	**0**	**0**	**1,315**	**600,487**	**0**	**752,469**	

Source: CWRM Well Pump Quantities Database, 2014; 12-month moving average, January to December 2014; where data was not reported consecutive months in 2015 were used. Some wells did not report.
CWRM Gages 2011-2015 Average, estimated end use; Municipal use based on MDWS production. 1989 Declarations of Water Use, Circular 123, Volumes 1 and 2, CWRM, September 1992.
*Waiho`i has a range of 18-21 mgd, but 18 mgd is used in an effort to be conservative.

Figure 17-12 Pumpage by Well Type, Hāna ASEA, 2014

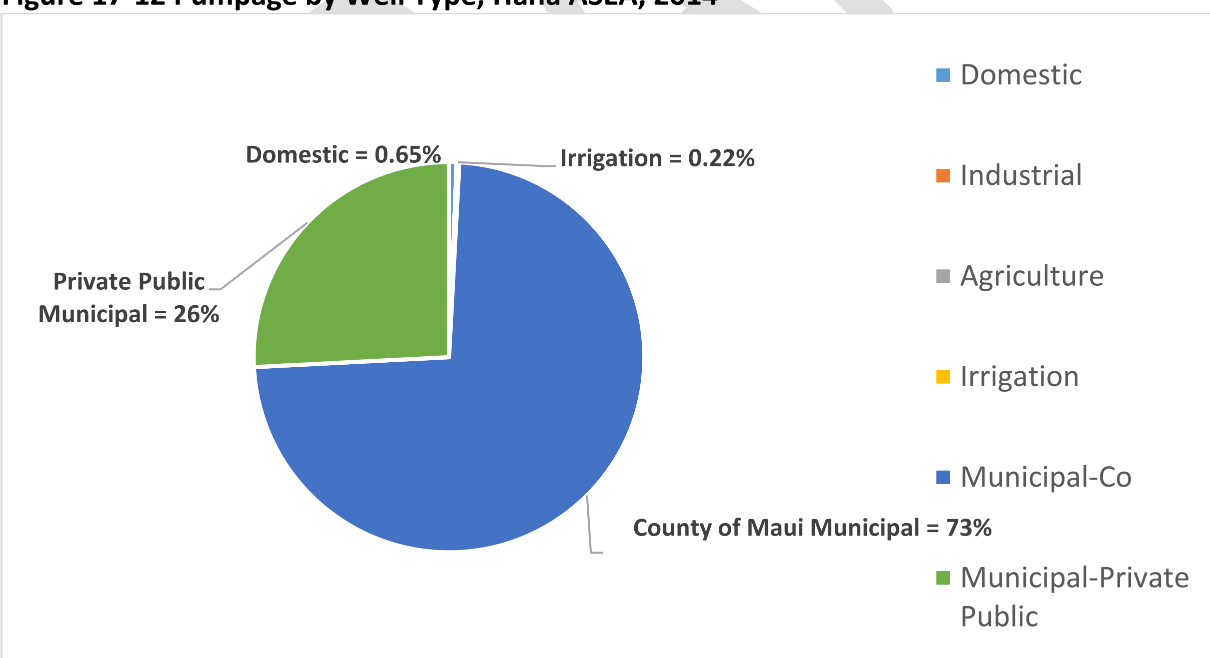
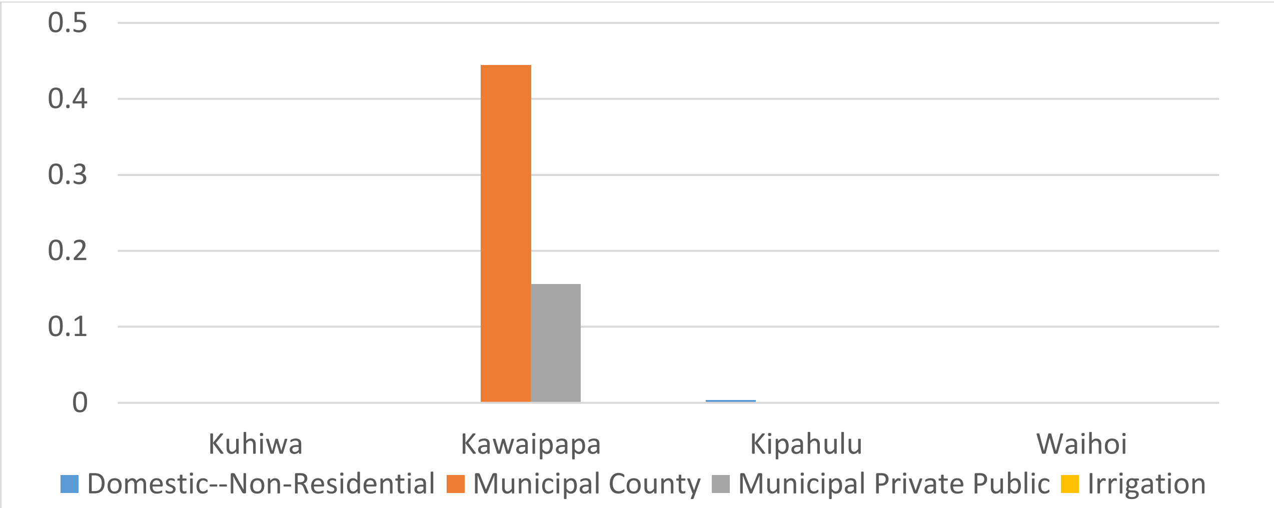


Figure 17-13 Pumpage by Well Type, Hāna ASYAs, 2014 (mgd)



Source: CWRM Well Pump Quantities Database, 2016; 12-month moving average, January to December 2014; where data was not reported consecutive months in 2015 were used. Some wells did not report.

Domestic Use

There are 14 Domestic wells in the Hāna ASEA, all located in Kīpahulu, with a combined reported pumpage of 3,976 gpd, or less than 1% of the Hāna ASEA total pumpage. It is likely that domestic use is underreported.

Industrial Use and Military Use

There is no reported pumpage from industrial wells in the Hāna ASEA. There are no military wells.

Irrigation Use

Irrigation wells comprised less than 1 percent of total Hāna ASEA average well pumpage in 2014, averaging 1,315 gpd. In theory, irrigation use by private purveyors can be estimated from reported streamflow diversions and reported or appraised agricultural irrigation. However, this data is unreported for the Hāna ASEA.

Agricultural Use

CWRM pumpage reports indicate there was essentially no water pumped by agricultural production wells in 2014 in the Hāna ASEA. However, the agricultural well pump capacity for the area is 3.717 mgd. Agricultural uses are primarily supplied by surface water and occasionally augmented with groundwater.

Table 17-6 Estimated Agricultural Water Use, Hāna ASEA (Excluding Kuleana Parcels)

Aquifer System	2015 Ag Baseline Crop Category	Estimated Acreage	Water Standard Gallons/Acre/Day	Estimated Average Water Use (Gallons per Day)
Kīpahulu	Taro	2.56	27,500 (15-40K)	70,400
Kīpahulu	Diversified Crop	2.01	3,400	6,834
Kīpahulu	Commercial Forestry	33.12	4,380	145,065
Kīpahulu	Banana	22.28	3,400	75,752
Kīpahulu	Pasture	1,463.33	0* (0-7,400)	0*
Kīpahulu Sub-Total		**1,523.30**		**298,051**
Waiho`i	Taro	0.51	27,500 (15-40K)	14,025
Waiho`i	Diversified Crop	5.44	3,400	18,496
Waiho`i	Banana	0.36	3,400	1,224.00
Waiho`i	Pasture	157.21	0* (0-7,400)	0*
Waiho`i Sub-Total		**163.52**		**33,745**
Kawaipapa	Diversified Crop	30.33	3,400	103,122
Kawaipapa	Tropical Fruits	47.93	10,000	479,300
Kawaipapa	Pasture	2,377.50	0* (0-7,400)	0*
Kawaipapa Sub-Total		**2,455.76**		**582,422**
Kūhiwa Sub-Total	Pasture	**159.96**	0* (0-7,400)	**0***
Total		**4,142.58**		**914,218**

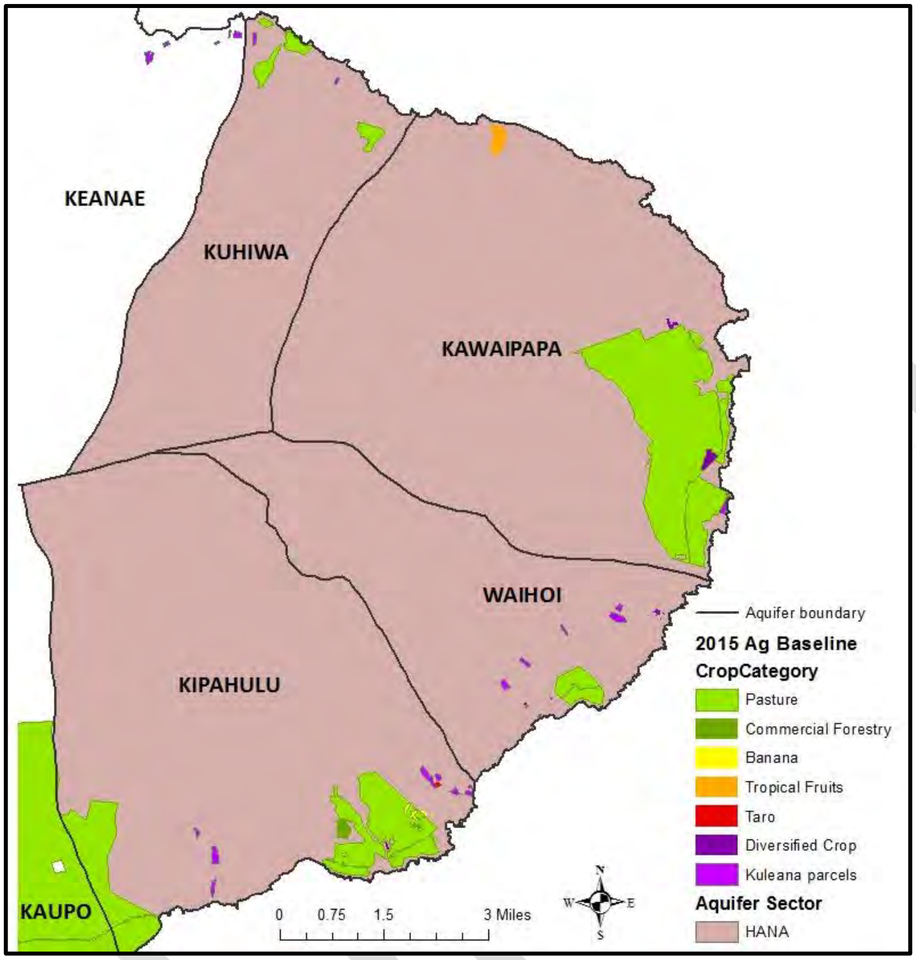
Source: 2015 Statewide Agricultural Baseline GIS, acreages calculated by MDWS. Kuleana parcels included in the 2015 Statewide Agricultural Baseline are not included in this analysis, as they are accounted for in a subsequent analysis within this report.
It is not specified whether taro is dryland or wetland. Estimated Water Use for taro: average wetland taro consumptive rate.
*Most pasture is not irrigated.

The characterization and adequacy of streamflow for lo`i kalo and other instream uses is a community concern. Information about existing and potential lo`i kalo and other agricultural uses on Kuleana parcels in the Hāna ASEA is not readily available, and despite consultation with the Aha Moku Council and others, quantitative information was not forthcoming through the WUDP process. Other Information from the CWRM reports, 2015 Statewide Agricultural Land Use Baseline, CWRM 1989 Declarations of Water Use, and other sources were consulted.

Information in the 1989 Declarations of Water Use, Volumes 1 and 2 (CWRM, September 1992), was used to characterize water sources. This information was then correlated with CWRM diversions, Kuleana parcels, and the 2015 Statewide Agricultural Land Use Baseline. The declarations include water sources and uses made known to the CWRM through a registration process in 1988-1989, and does not include subsequent sources and uses developed and known to the CWRM through its permitting process and water use reporting.[41] The declarations also included claims for future water rights, the proposed future uses of water, and current instream activities. The declarations as well as the summary below have not been verified by the CWRM. While there are many limitations inherent in the declarations (parcels with multiple declarations with conflicting information, some parcels may indicate place of diversion rather than water application, parcel ownership may differ from declarant, etc.), they provides a point of reference to support a more complete characterization of existing and potential future use.

[41] The 1987 State Water Code, HRS Chapter 174C, required any person making a use of water in any area of the state to file a declaration of that water use, any person owning or operating any well must register the well, and any person owning or operating any stream diversions works must register the diversion.

Figure 17-14 Relationship of Kuleana Parcels and 2015 Statewide Agricultural Land Use Baseline



Source: HDOA 2015 Statewide Agricultural Land Use Baseline, Kuleana parcels (OHA 2009)

A significant number of Kuleana parcels exhibit a declaration of use for either an existing or future use. Estimated demand for land uses in the Declarations of Water Use is 0.248 mgd based on the stated assumptions. Given that much of the 2015 Statewide Agricultural Land Use Baseline inventory does not intersect with the declarations, the declarations appear to represent an additional increment of agricultural water use.

An analysis of Kuleana parcels and the 2015 Statewide Agricultural Land Use Baseline indicates that taro and diversified crops cultivated on Kuleana parcels in the Hāna ASEA totaled about 18.53 acres as shown in the tables below. However, given the purpose of the 2015 Agricultural Land Use Baseline inventory to capture the scale and diversity of commercial agricultural activity, it is likely that most agriculture on Kuleana parcels was not mapped. In the table below, taro is assumed to be wetland taro. The midpoint of the range for consumptive water use for wetland taro is used to calculate estimated average water use. The low and high figures for consumptive water use and streamflow required for healthy plants are also provided.

Table 17-7 Estimated Water Use by Kuleana Parcels *also* located within 2015 Agricultural Land Use Baseline, Hāna ASEA (Gallons/Acre/Day)

Aquifer System	2015 Crop Category	Kuleana Parcels Acreage	Water Standard Gallons/Acre /Day	Est. Ave. Water Use (gpd)	Consumptive Use		Streamflow	
					Low 15,000	**High** 40,000	**Low** 100,000	**High** 300,000
Kawaipapa	Pasture*	104.51	0* (0-7,400)	**0**	--	--	--	--
Kawaipapa	Diversified	8.30	3,400	**28,220**	--	--	--	--
Waiho`i	Taro	0.13	27,500	**3,575**	1,950	5,200	13,000	39,000
Total		**112.94**		**31,795**				

Sources: 2015 Statewide Agricultural Land Use Baseline GIS; Kuleana parcels-OHA, 2009. Approx. agricultural acreages overlying Kuleana parcels calculated by MDWS using GIS intersection of Kuleana parcels (OHA 2009) and 2015 Agricultural Land Use Baseline data.
Water Use Rates: Diversified Ag-HDOA Guidelines; Taro-CWRM Na Wai `Eha and East Maui Streams Contested Case Hearings. Due to proximity of parcels to stream, taro is assumed to be wetland taro. Water standard for taro is average consumptive range of 15,000 to 40,000 gpa.
*Most pasture is not irrigated and uses no water

Table 17-8 Estimated Water Use by Kuleana Parcels *not* located in 2015 Agricultural Land Use Baseline, Hāna ASEA (Gallons/Acre/Day)

Aquifer System	2015 Crop Category	Kuleana Parcels Acreage	Water Standard (gal/acre/ day)	Est. Ave. Water Use	Consumptive Use		Streamflow	
					Low 15,000	High 40,000	Low 100,000	High 300,000
Kawaipapa	Pasture*	7.95	0* (0-7,400)	0*	--	--	--	--
Kawaipapa	Diversified**	0.63	3,400	2,146**	--	--	--	--
Kawaipapa	Taro***	0.01	27,500	272***	148	396	989	2,966
Sub Total		**8.59**		**2,418**	**148**	**396**	**989**	**2,966**
Kīpahulu	Pasture*	53.46	0* (0-7,400)	0*	--	--	--	--
Kīpahulu	Diversified**	4.24	3,400	14,435**	--	--	--	--
Kīpahulu	Taro***	0.07	27,500	1,829***	997	2,660	6,650	19,949
Sub Total		**57.77**		**16,264**	**997**	**2,660**	**6,650**	**19,949**
Kūhiwa	Pasture*	6.51	0* (0-7,400)	0*	--	--	--	--
Kūhiwa	Diversified**	0.52	3,400	1,757**	--	--	--	--
Kūhiwa	Taro***	0.008	27,500	223***	121	324	809	2,428
Sub Total		**7.038**		**1,979**	**121**	**324**	**809**	**2,428**
Waiho`i	Pasture*	30.85	0* (0-7,400)	0*	--	--	--	--
Waiho`i	Diversified**	2.45	3,400	8,331	--	--	--	--
Waiho`i	Taro***	0.04	27,500	1,055	576	1,535	3,838	11,513
Sub Total		**33.34**		**9,386**	**576**	**1,535**	**3,838**	**11,513**
Total		**106.738**		**30,047**				

Source: Kuleana parcels-OHA, 2009. Approx. agricultural acreages overlying Kuleana parcels calculated by MDWS using GIS intersection of Kuleana (OHA 2009) and 2015 Agricultural baseline data.
Water Use Rates: Diversified Ag-HDOA Guidelines; Taro-CWRM Na Wai `Eha and East Maui Streams CCH. Due to proximity of parcels to stream, taro is assumed to be wetland taro. Water standard for taro is average consumptive range of 15,000 to 40,000 gpa.
*Most pasture is not irrigated
**Div Ag not included in 2015 Ag Baseline data estimated to be 7.35% of total acreage based on the ratio of Div to total acreage in the GIS intersection of Kuleana (OHA 2009) and 2015 Agricultural Baseline data.
***Taro crop cultivation not included in 2015 Ag Baseline data was estimated to be 0.12% of total acreage based on the ratio of Taro to total acreage in the GIS intersection of Kuleana parcels (OHA 2009) and 2015 Ag Baseline data.

Table 17-9 1989 Declarations of Water Use and Surface Water Diversions, Hāna ASEA

Stream Source	1989 Dec. of Water Use (mgd)	No. of Diversions
Kūhiwa	0	0
Waihole	0.001	2
Manawaikeae	0	0
Kahawaihapapa	0	0
Kea`aiki	0	2
Waioni	0	2
Lanikele	0	1
Heleleikeoha	0.001	14
Kawakoe	0.002	15
Honomā`ele	0	4
Kawaipapa	0	0
Mo`omo`onui	0	0
Haneo`o	0	0
Kapia	0.002	3
Waiohonu	0	0
Papahawahawa	0	0
Ala`alaula	0.007	2
Wailua	0.101**	4
Honolewa	0	1
Wai`eli	0	0
Kakiweka	0	1
Hahalawe	0	1
Pua`alu`u	0.112	4
`Ohe`o	0	0
Kalena	0	1
Koukouai	0	2
Opelu	0	2
Kukui`ula	0	1
Ka`apahu	0	0
Lelekea	0	0
Alelele	0	0
Kalepa	0.018	2
Nuanua`aloa	0	3
Manawainui	0.004*	3
Total	**0.143**	**70**

Source: 1989 Declarations of Water Use, Circular 123, Volumes 1 and 2, CWRM, September 1992.

*The water use declaration from the Manawainui stream is used to provide non-potable surface water to the Kaupō community within the Kahikinui ASEA. Therefore, it is not counted as water use for the Hāna ASEA analysis.

**Previously declared diversion from MDWS. No longer in use. Not included in total.

The above table shows that only 143,000 gpd of water use are currently declared under the 1989 Declarations of Water Use. Many of the diversions have no associated water use quantities declared and several streams have neither diversions nor water use quantities declared. However, many of these areas likely have undeclared diversions in active use and therefore 143,000 gpd is probably an underestimate of water use.

In all, the estimated agricultural water use in the Hāna ASEA is approximately 1,119,060 gpd.

Table 17-10 Summary of Agricultural Water Use Analysis, Hāna ASEA

Agricultural Land Areas in Ag Water use Analysis	Estimated Water Use (gpd)
2015 Ag Baseline minus Kuleana Parcels	914,218
Kuleana Included in 2015 Ag Baseline Analysis (Subtracted from the Ag Baseline Total)	31,795
Kuleana not Included in 2015 Ag Baseline	30,047
1989 Declarations of Water Use*	143,000
Total Estimated Agricultural Water Use	**1,119,060**

*Previously declared diversion from MDWS of 101,000 gpd in Waiho`i no longer in use and not included in total.

Municipal Use

Municipal use comprised about 99 percent of reported well pumpage in the Hāna ASEA, with single-family use dominating. MDWS wells accounted for approximately 73 percent of water withdrawn.

There are four municipal water systems using ground water within the Hāna ASEA. The County Department of Water Supply (MDWS), The National Park Service, and privately owned "public water systems" (PWS) as defined by the Department of Health (systems serving more than 25 people or 15 service connections) are summarized below.

The MDWS Hāna Water System serves most of the resident population with potable water, including the coastal areas of Hāmoa, Hāna Town, and Nāhiku. There is no interconnection between the Hāna Town/Hāmoa system and the Nāhiku system. The map below shows the general service areas of the public water systems in the region. The charts below show the proportion of water consumption by water provider, water use by type for the County's municipal system, and the source of this supply.

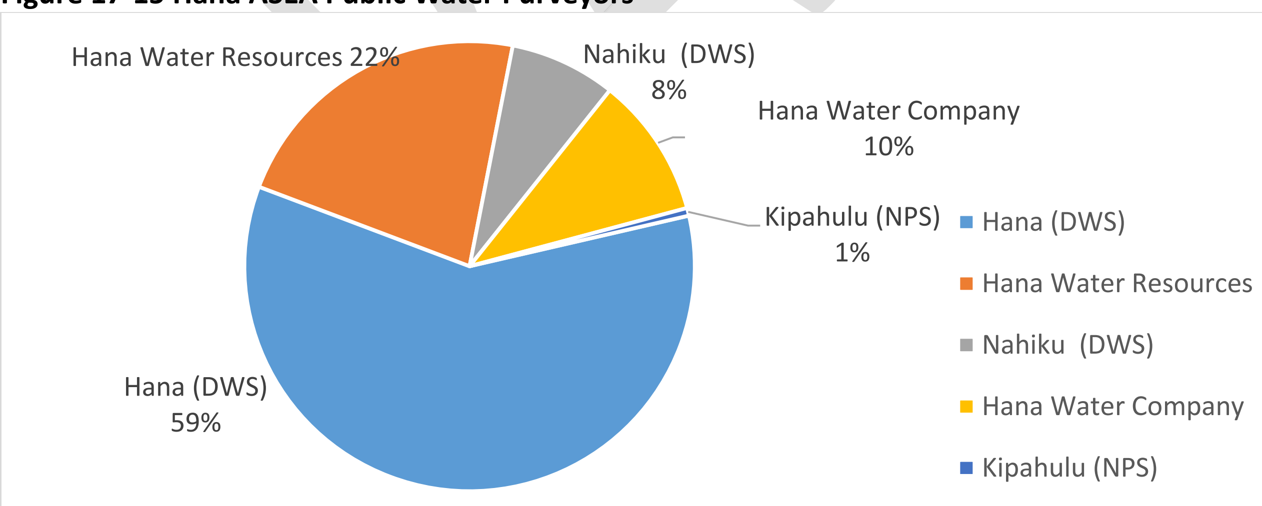
All potable systems in Hāna use groundwater. MDWS systems, The National Park Service public system, and other privately owned PWSs service connections and average water production are shown in the table below.

Table 17-11 Public Water Systems by Provider, Hāna ASEA

DOH No.	System Name	Operator	Population Served	Service Connections	Average Daily Flow (gpd)	Source
217	Hāna	MDWS	1,101	367	319,000	Ground
201	Hāna Water Resources	Hāna Water Resources	816	88	120,000	Ground
220	Nāhiku	MDWS	107	43	41,000	Ground
243	Hāna Water Company	Hāna Water Company	160	99	54,426	Ground
260	Kīpahulu	National Park Service	2,000	4	3,000	Ground
	Total				**537,426**	

Source: Department of Health, Safe Drinking Water Branch 2015 based on 2013 survey of water production submitted by providers every three years. All systems are "community" systems, except for DOH No.260 which is a "Transient Non-Community" system.

Figure 17-15 Hāna ASEA Public Water Purveyors

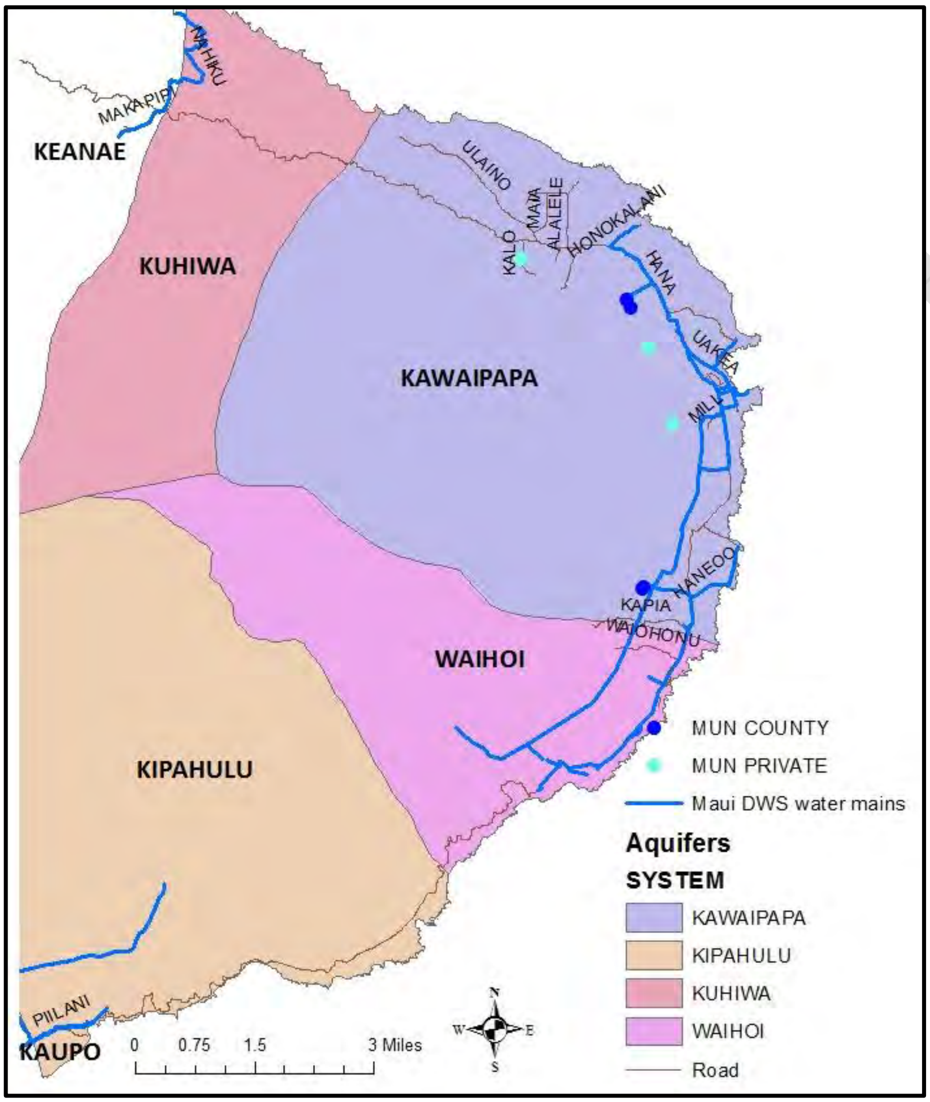


Source: Department of Health, 2015, data is updated every three years.

General locations of the MDWS water mains, county and private municipal wells are shown below. The Hāna Ranch PWS and the MDWS service area overlap but are not connected. The

Nāhiku service area extends into Ko`olau ASEA. Portions of Kaupō hybrid system extends into Kīpahulu (addressed in the Kahikinui Aquifer Sector report). The National Park Service well is not classified as "municipal" in the CWRM database but regulated as a public water system based on the number of visitors served.

Figure 17-16 Hāna ASEA General Location of Public Water Systems



MDWS Water System

The MDWS Hāna system generally serves the areas of Wākiu and Hāmoa. Single-family residential use accounts for the greatest demand. Although the CWRM water use category

"Municipal" includes all MDWS billing classes, the table below provides a breakdown of water consumption that closest corresponds to CWRM sub-categories and actual water use. The table below shows billed water use, which is lower than water produced.

Table 17-12 MDWS Service by CWRM Category, Hāna ASEA

CWRM Categories	GPD	% of Total
Domestic	101,152	76.1%
Industrial	0	0.0%
Municipal	30,364	22.8%
Agriculture	30	0.0%
Irrigated	0	0.0%
Military	0	0.0%
Unknown	1,389	1.0%
Total	**132,935**	**100.0%**

(Includes Kawaipapa 911 and Kūhiwa/Nāhiku 913 Subdistricts)

Reported well pumpage compared to sustainable yield in East Maui is minimal, with less than 0.3 % of sustainable yield pumped. While not all active wells comply with reporting requirements, and pumpage data is especially incomplete for smaller domestic and irrigation wells, there is little pressure on groundwater resources in the Hāna ASEA.

While the base year for this WUDP is 2014, alternative periods were reviewed to determine whether 2014—which exhibited a strong El Niño—is representative of consumption; and the 10-year average was determined to be consistent with the 2014 average daily demand.

Table 17-13 Consumption by MDWS Hāna System Subdistricts, 2014

ASYA/(Sub-District)	GPD	MGD	% of Total	Single Family (gpd)	Single Family % of Total
Kūhiwa (Nāhiku)	5,745	0.006	4.32%	5,745	100.00%
Kawaipapa(Hāna)	127,190	0.127	95.68%	69,262	52.10%
Total	**132,935**	**0.133**	**100%**	**75,007**	**56.42%**

Source: MDWS Metered Consumption Data, 2014 daily average.

Table 17-14 MDWS Hāna System Comparison of Consumption Variation Over Time (gpd)

MDWS District	2014 Daily Ave	3-Yr Ave 2012-14	10-Yr Ave 2005-14	Variation 10-Yr Ave / 2014 Ave
East/Hāna	155,000	174,000	184,000	19%

MDWS Metered Consumption, 2014 is Calendar Year; other periods are fiscal year.
High year 2005-2014 ave = annual averages for 2012, 2013 and 2014. High year may vary by district.
10 year ave = annual averages, 2005-2014.

Water consumption varies seasonally, with the low demand months generally reflecting lower outdoor irrigation demands.

Table 17-15 Comparison of High and Low Month by MDWS, East/Hāna DWS District, 2011 to 2015 (mgd)

District	High Month	Low Month	Variation	% Variation
East/Hāna	0.188	0.117	0.071	61%

Source: MDWS Billed Consumption (mgd). High and low months, fiscal years 2011-2015 (mgd). Agricultural Services not included. The figures for the East district are provided but are not indicative of climate conditions.

Water production is higher than consumption accounting for distribution, water losses, and unmetered use. The difference between MDWS production (i.e. well pumpage) and consumption (customer metered use) is significant, and may be due to leaks in the MDWS distribution system, other water losses and reporting errors. As shown in the following table, the 2014 and 10-year water production totals are fairly consistent.

The 2016 Hāna system water quality monitoring report shows no exceeding of drinking water standards. MDWS Hāna water systems are 100% sourced by groundwater, no surface water is used.

Table 17-16 Average Daily (AD) Production, MDWS Hāna District (East/ Hāna), 2014 (mgd)

Year	Total AD Production	Total High Month AD	Surface Water High Month AD	Groundwater High Month AD	Low Month AD Production	% Variation High/Low Month
2014	0.504	0.538	0	0.538	0.464	16%
10-Year Average	0.380	0.610	0	0.610		31%

Source: MDWS, 2014 Calendar Year. High month production varies by district. High month consumption is August 2014. Low month AD production used as baseline to determine percent change (variation).

HĀNA AQUIFER SECTOR AREA

The MDWS "East Maui District" includes the non-connected subsystems Ke`anae, Nāhiku, Hāna and Kaupō . The Ke`anae subsystem is located within the Ko`olau aquifer sector and is addressed separately in the Ko`olau ASEA report. The Kaupō system is addressed in the Kahikinui ASEA report. Hāna and Nāhiku sub-systems are described below.

PWS 217: Hāna Subsystem

MDWS has developed five wells in the Kawaipapa aquifer system in two well fields: Hāmoa and Wākiu. One well in each well fields is for contingency back up only. The original backup well for Wākiu is no longer active and a replacement well has been developed. The wells withdraw from basal groundwater. There is no caprock along the coast. Wellhead protection assessment surveys indicate that the MDWS wells are at low risk of contamination. The majority of land in the capture zones of the wells are in forested conservation land and low intensity agriculture.

There are 402 municipal services in this system providing water service from Honokalani Road to Koali area. The average consumption for single family services in Hāna is 337 gpd, which indicates little irrigation demand. There are two agricultural services on the 4-inch line mauka of Koali area served by the Wailua stream. The municipal system is chlorinated at the storage tanks of the Hāmoa and Wākiu well fields.

PWS 220: Nāhiku Subsystem

The Nāhiku area overlies the Ke`anae and the Kūhiwa aquifers and is an area of high rainfall, 219 inches annually at the highway and 287 inches annually at 3,100 feet. MDWS purchases water for domestic supply from the East Maui Irrigation (EMI) Company's West Makapipi Tunnel 2, Well No. 4806-07. The source is known as "Nāhiku tunnel". A Memorandum of Understanding, originally entered into in 1973 and last amended in 1994, allows DWS to take up to 20,000 gpd.

Twenty-two tunnels have been driven in the Nāhiku area by EMI in the 1930s and 1940s. The total yield of the tunnels during average periods was about 5.83 mgd in the 1930s. The Nāhiku tunnel has supplied domestic water to Nāhiku community since the 1940s. Estimated average flow in 1940 was 50,000 gpd. Average discharge per EMI data from 1932 to 1936 was 60,000 to 150,000 gpd. [42] According to EMI, the tunnel flow is currently not gaged. After MDWS withdrawals the overflow empties into Ko`olau Ditch. The intake elevation is at approximately 1,250 feet. The Department serves about 40 meters along Nāhiku Road. One is classified as agricultural use and all others single family use. The tunnel water is chlorinated at the Upper Nāhiku tank.

[42] Stearn & McDonald, 1946 pp 266 and 269

HĀNA AQUIFER SECTOR AREA

State Water Systems

There are no state water systems.

Federal Water Systems

PWS 260: Kīpahulu System of the Hāna ASEA

The Kīpahulu Public Water System is owned and operated by the National Park Service and serves approximately 2,000 transient non-community customers. According to the Safe Drinking Water Branch of the Hawai`i Department of Health, the Average Daily Flow is 3,000 gallons per day (gpd). Based on the reported daily flow and number of visitors, average consumption would be about 1.5 gpd per visitor.

Potable water is supplied by basal groundwater obtained from a deepwell drawing on the Kīpahulu aquifer. Water is chlorinated and electricity for the well pump is generated by a photovoltaic system. There is no back up well to the Kīpahulu well, with a capacity of 8,000 gpd (based on 8 hours daily pumpage). There are three storage tanks with a total capacity of 8,000 gallons. There are 4 service connections and approximately 0.5 miles of 3- and 4-inch HDPE piping, which is being replaced with 4-inch ductile iron.[43]

Private Public Water Systems

There are two private public water systems regulated by the Department of Health within the Kawaipapa ASYA of the Hāna ASEA. Both are owned by Hāna Ranch Partners, LLC and managed by the Hāna Water Systems, LLC. However, an application has been filed with the Public Utilities Commission to transfer ownership from Hāna Ranch Partners, LLC to Hāna Water Systems, LLC.

PWS 201: Kawaipapa ASYA, Hāna Water Resources

Operated by Hāna Water Resources, water for this system is supplied by basal groundwater obtained from deepwells, with an Average Daily Flow of 120,000 gallons per day (gpd), according to the Safe Drinking Water Branch of the Hawai`i Department of Health.

Drinking water sources include Wananalua Well and Wākiu-Hāna Ranch Well drawing from the Kawaipapa Aquifer. Water from the wells is chlorinated. The system has one backup well with a total capacity of 288,000 gpd, based on 16 hours pumpage. Storage capacity is 500,000 gallons. The system services 88 meters distributed through 11 miles of main pipes. The table below summarizes consumption by customer class in PWS 201.

[43] HI DOH SDWB; CWRM; http://Hawaii.gov

Table 17-17 (PWS 201) Hāna Water Resources Water Consumption

Class	Average Consumption/gallons per day
Residential Use	~34,000
Commercial/Resort	~51,000
Total Consumption	~85,000

Source: HI DOH SDWB; CWRM

PWS 243: Kawaipapa ASYA, Hāna Water Company:

The second of the two privately owned public water systems within the Kawaipapa aquifer system is Hāna Water Company, owned by Hāna Ranch Partners, LLC. Water for this system is supplied by basal groundwater obtained from a deepwell, with an Average Daily Flow of 54,426 gpd. The Kaeleku-Hāna Well has a capacity of 114,240 gpd, based on 16 hours daily pumpage.

The Hāna Water Company's water supply is stored in a tri-level system of tanks with a total storage capacity of 52,500 gallons. The system services 99 meters through a distribution system of 13 miles of main pipes. Approximately 160 people are served by the Hāna Water Company. The following table summarizes consumption by customer class.

Table 17-18 (PWS 243) Hāna Water Company Water Consumption

Class	Average Consumption/gallons per day
Residential Use	~30,875
Commercial	~30,875
Agriculture	~3,250
Total Consumption	~65,000

Sources: HI DOH SDWB; CWRM

During a period from 2004 to 2009, one contaminant, nitrate, was found at the tap, which did not exceed the legal limit. There have been no drinking water standard violations reported for the Hāna Public Water System since 2004.

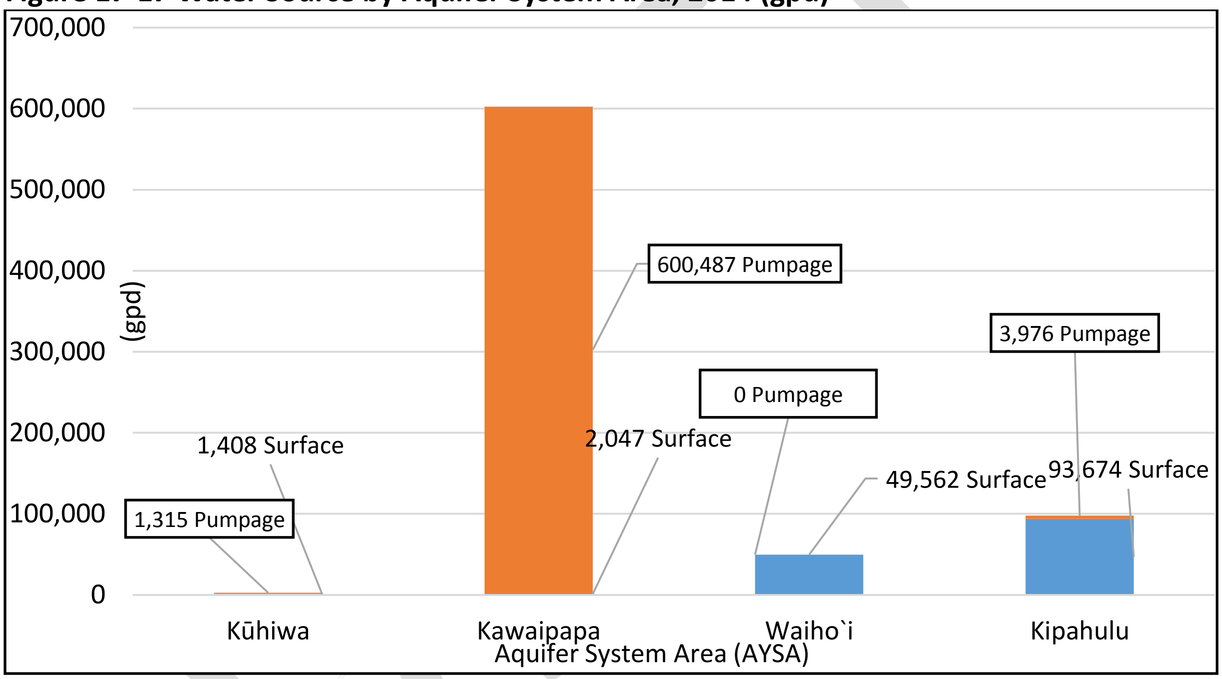
Other Potable Water Use

An unknown number of persons are not served by any public water system. Some small developments or groups of development below the DOH threshold or individual households and uses may be served by domestic wells, catchment, streams or other sources. Estimated 'order of magnitude' demand for 2014 of 0.277 mgd for Maui island. The estimate is based on island-wide 2010 Census Block population of about 1,190 persons that appeared to be outside public water system purveyor service areas, general location of development and system pipes and an average MDWS per capita rate of 248 gpd.[44] Rural properties located throughout the Hāna ASEA may contain a higher proportion of unserved population compared to other areas on Maui. Rainfall is sufficient to sustain catchment systems in areas without water infrastructure.

17.5.2 Water Use by Resource

Water produced or reported in 2014 is assessed to 752,469 gpd in the Hāna ASEA, with surface water accounting for about 29 percent of total water demand and groundwater accounting for approximately 71 percent of total water demand, and includes water use from stream diversions that is used for domestic purposes. It is unknown what proportion of the domestic use is for potable versus non-potable uses.

Figure 17-17 Water Source by Aquifer System Area, 2014 (gpd)



Source: CWRM Well Pumpage Reports. Surface water estimated by MDWS based on CWRM 1989 Declarations of Water Use.

Ground Water Resources

There are 31 wells within the sector; 28 are reported as production wells and the remaining 3 are categorized as Unused according to the CWRM database in August 2015. While well pumpage is required to be reported to CWRM not all active wells comply with reporting requirements and pumpage data is especially incomplete for smaller domestic and irrigation

[44] 2010 Census Block Group population that appears to be outside public purveyor service areas – approx. 1190; apply average MDWS per capita rate of 248 gpd based on 2010-2014 consumption and interpolated population = 296,144 gpd. Excluding domestic well pumpage of 20,495 gpd results an estimated demand of 276,649 gpd.

wells. Only a small fraction of the region's sustainable yield is developed and even less pumped. Installed pump capacity is not the permitted pumpage, but the maximum capacity of the permitted well in gallons per minute multiplied by 24 hours. Sustainable Yield is given in million gallons per day while pump capacity and pumpage is given in gallons per day in the table below.

Table 17-19 MDWS Pumpage and Pump Capacity of Wells Compared to Sustainable Yield (SY), Hāna ASEA (2014)

	Pumpage (GPD)						Pump Capacity (GPD)	
Aquifer System/SY (MGD)	**MDWS**	**Private Municipal**	**Domestic**	**Irrigation**	**Total**	**As % of SY**	**Installed**	**% of SY**
Kūhiwa (14)	5,745	0	0	1315	7,060	0.05%	36,000	0.26%
Kawaipapa (48)	444,264	156,223	0	0	600,487	1.25%	2,424,000	5.05%
Waiho`i (18)	0	0	0	0	0	0.00%	69,000	0.38%
Kīpahulu (42)	0	3,000	3,976	0	6,976	0.02%	815,000	1.94%
Total (122)	**450,009**	**159,223**	**3,976**	**1,315**	**614,523**	**0.50%**	**3,344,000**	**2.74%**

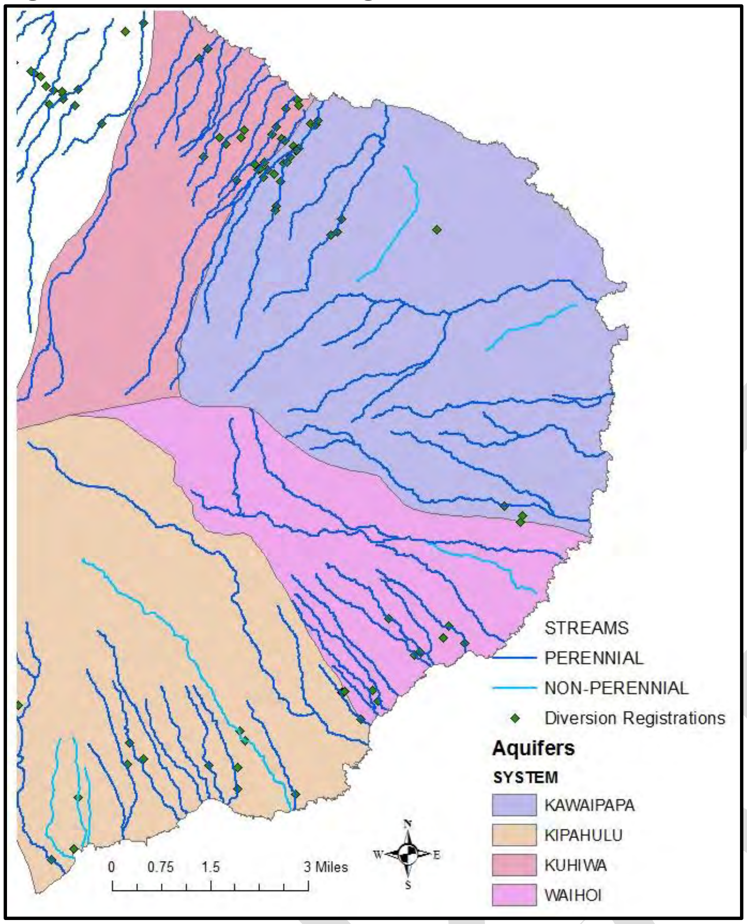
Source: CWRM Well Index 5/29/2015 for production wells and 2014 pumpage reports, 12-month moving average.

Surface Water Resources

Surface water is diverted for a variety of purposes; however, surface water diversion data reported to CWRM for the Hāna ASEA is very limited, other than the 1989 Declarations of Water Use already described in this report.

There are no CWRM stream diversion gages located within the Hāna ASEA. However, there is a CWRM gage located at Makapipi Stream within the Ko`olau ASEA, which is a source for the Nāhiku MDWS Water System located within the Hāna ASEA. Diversions registrations and available data is summarized in Appendix 17 A. Registered quantities are in million gallons per year (MGY), totaling 53.5 MGY. The figure below illustrates location of diversions throughout the aquifer sector.

Figure 17-18 Hāna ASEA Registered Surface Water Diversions



Alternative Water Resources

Rainwater Catchment

Rainwater catchment is the collection of rainwater from a roof or other surface before it reaches the ground. Rainfall ranges from 60-400 inches per year in Hāna.[45] Rainwater catchment is not as reliable a conventional water resource because it is extremely sensitive to the climate; however, rainwater catchment is a viable option in this region. Rainwater catchment systems are not regulated by the Department of Health, making estimates of their use difficult. No inventory of installed catchment systems throughout the island is available.

[45] Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially distributed groundwater recharge estimated using a water-budget model for the Island of Maui, Hawaiʻi, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168, 53 p., http://dx.doi.org/10.3133/sir20145168.

Stormwater Reuse

There is no reported stormwater reuse within the Hāna ASEA, although a limited number of development projects may have stormwater controls incorporated into project design to reduce runoff and its effects. Stormwater reuse at the parcel scale may also provide an opportunity to offset landscape and other irrigation demand of projects or households.

Desalination

Desalination of ocean or brackish water was studied as an option in the 2013 MDWS study, Maui Island Water Source Development Options for the Central MDWS system, but an assessment has not been conducted for the Hāna ASEA, and there are presently no desalination projects within. One major cost to operate a desalination plant is the high energy demand of the process, and the disposal of the brine liquid byproduct creates logistical and environmental challenges that also increase cost. As desalination technology advances and energy costs decrease, brackish and ocean water desalination should continue to be evaluated for their potential as effective future water supply alternatives.

17.6 FUTURE WATER NEEDS

17.6.1 General

Two alternative methods were used to project water demand to the year 2035: (1) population growth rates based on 20-year population growth projections in the Socio-Economic Forecast Report (2014) applied to current consumption and build-out—population-based demand takes into account social and economic factors that are anticipated to drive growth over the planning period; and (2) of permitted land use based on County zoning and Department of Hawaiian Homelands land use plans. The second method, full build-out (100% of land utilized for its zoned purpose) of land use based on zoning designations represents a snapshot of ultimate demand, but the population growth-based method is the preferred method.

17.6.2 Water Use Unit Rates

The 2002 Water Use Standards are used for land use based demand projections. Most of the water use in the Hāna ASEA is for residential or single-family use; the 2002 Standards for residential use is 600 gallons per day (gpd) per unit and 3,000 gpd per acre for single family/duplex and 5,000 gpd per acre for multi-family use. System standards factor in outdoor use and are generally higher than empirical use in the region, as irrigation needs are relatively low.

17.6.3 Land Use Based Full Build-Out Water Demand Projections

Full build-out projections for the Hāna area based on County zoning and DHHL land use categories yield a projected water demand of 65,416,545 gpd, or 65 million gallons per day. Full build-out by county zoning designation is neither realistic over the planning period or supported by the county general plan. System standard water rates for agricultural zoning are theoretically assigned but do not represent regional irrigation needs.

Maui County Zoning

Maui County Zoning for the Hāna ASEA includes predominantly Agriculture and to a lesser extent Interim Use Zone Districts. Interim zoned land (mostly Conservation) was assigned a zone based on Directed Growth Plan guidance and Community Plan land use designations in order to calculate water demand. There are over 56,521 zoned acres in the Hāna ASEA (excluding DHHL lands [743 acres]). The Interim District encompasses 38,378 acres. The Hāna Community Plan assigns the following land use designations to the 38,378 Interim zoned acres: Light Industrial (9.13 acres); Airport (60.93 acres); Park (290.71 acres); Road (12.05 acres); Single Family (89.77 acres); Multi-Family (6.01 acres); Agriculture (27.97 acres); Rural (538.20 acres); Open Space (52.47 acres); Conservation (37,236.70 acres); Public/Quasi-Public (65.93 acres). Interim zoned areas that are designated by the Hāna Community Plan as Conservation, Open Space, Unzoned Road, and Urban Reserve are all assigned to the "Open Space" zoning district, with no water demand associated with their use. There is a remaining balance of 259 Interim zoned acres that is unassigned to another land use designation by the Community Plan. A summary of the County land use based demand follows a discussion of DHHL land use based demand. Percentage zoned acres of total is rounded.

Table 17-20 Summary of Zoning Use Types, Hāna ASEA (Excluding DHHL Lands)

Zoning Summary (Corresponding County Zoning Categories found within the Hāna ASEA in Parentheses)	Acres	% of Total	Water Use Rates (gpd per acre)
Single Family, Duplex (R-3 Residential, RU-0.5 Rural - 1/2 Acre, Service Business Residential)	681.36	1.21%	3,000
Apartment, Multifamily (A-1 Apartment)	6.80	0.01%	5,000
Hotel (H-1 Hotel)	20.28	0.03%	17,000
Business (B-2 Business - Community, SBR - BCT Business - Country Town)	22.48	0.03%	6,000
Industrial (M-1 Light Industrial)	9.13	0.02%	6,000
Airport	60.93	0.11%	6,000
Agriculture (AG Agriculture)	17,508.67	31.00%	3,400
Golf Course (PK-4 Park - Golf Course)	191.80	0.34%	1,700
Public/Quasi-Public (P-1 Public/Quasi-Public)	116.92	0.21%	1,700
Park (PK-2 Park – Community, PK-3 Park – Regional)	298.57	0.53%	1,700
Open Space** (Conservation, Open Space, Unzoned Road, Urban Reserve)	37,382.16	66.04%	0
Interim***	259.42	0.46%	
TOTAL excluding DHHL Lands** **	56,521	100%	

Source: Table prepared by MDWS, Water Resources & Planning Division. Excludes DHHL lands.
Zoning supplied by Maui County Planning Department, May 2015.
Interim zoning was assigned to CWRM categories based on Community Plan land use designations.
*Includes Community Plan designations of Open Space and Conservation designated "Interim" in County zoning.
**Acreage represents the difference between County zoning and Community Plan designations for "Interim": 259 acres were designated "Interim" in County zoning, but not designated a Community Plan use type, and therefore, remained undesignated "Interim" County zoning.
***The balance of 259 Interim acres remains unassigned to another land use designation by the Community Plan.
****743 acres of DHHL lands zoned Agriculture excluded from Agricultural zoning category.

State Department of Hawaiian Home Lands (DHHL)

DHHL maintains land use jurisdiction over Hawaiian Homes and are not subject to county zoning designations. DHHL zoned lands are not accounted for in the table above. Water rates used by the State Water Projects Plan Update; DHHL, May 2017, are as follows

Table 17-21 DHHL Land Use, Water Standards for Maui

Land Use	Potable	Non-potable
Residential	600 gal/unit	None
Subsistence Ag	600 gal/unit	3400 gal/acre
Supplemental Agriculture	None	3400 gal/acre
Pastoral	600 gal/unit	20 gal/acre
General Ag	None	3400 gal/acre
Special District	Varies	Varies
Community Use acres	1,700 gal/acre or 60 gal/student	None
Conservation	None	None
Commercial	3,000 gal/acre or 140 gal/1,000 SF	None
Industrial	6,000 gal/acre	None

Source: DHHL Maui Island Plan

Projected demand based on the DHHL Maui Island and regional land use plans are summarized below for 743 acres zoned Agriculture by the County of Maui.

Table 17-22 Hāna ASEA DHHL Lands Excluded from Zoning

TOTAL DHHL ACRES	LAND USE DESIGNATION: AG (ACRES)	WATER STANDARDS/ACRE	TOTAL WATER DEMAND (GPD)
743	743	3,400	2,526,200

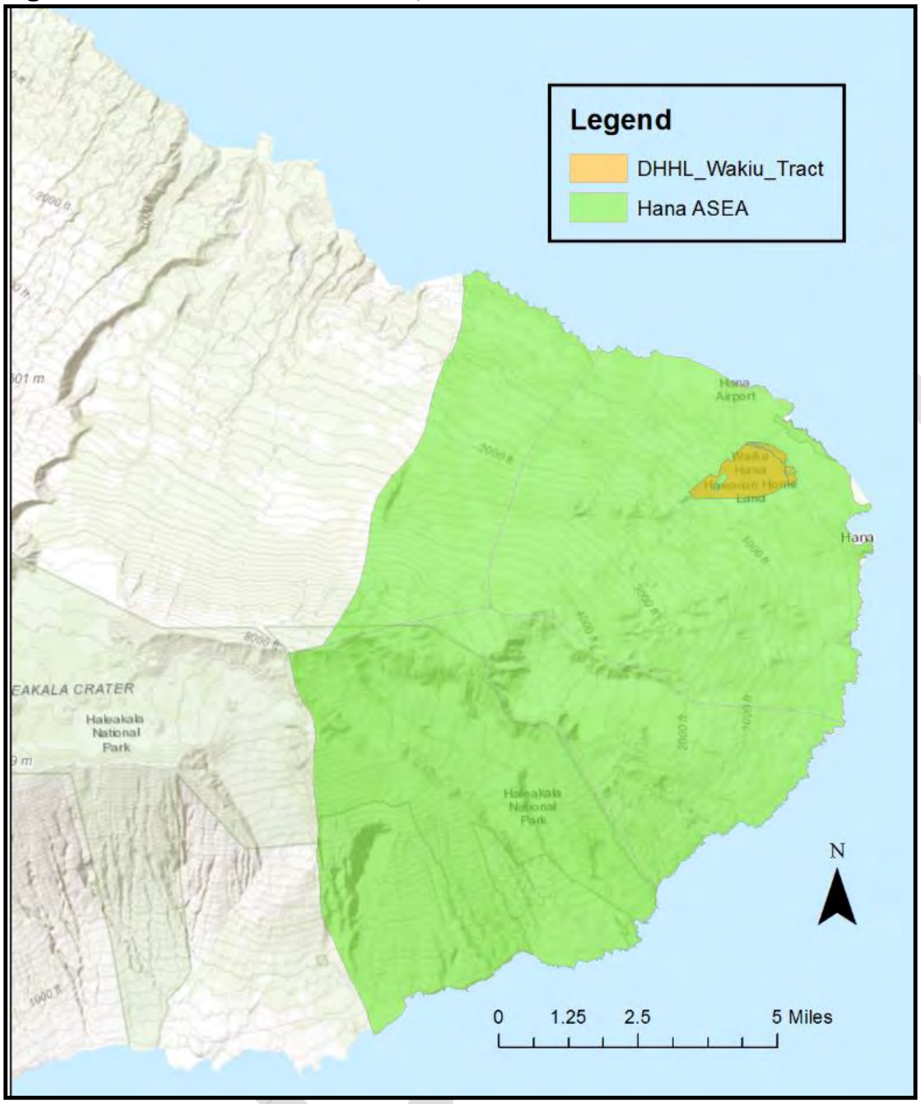
Source: Table prepared by DWS, Water Resources & Planning Division.
Interim and Project District zoning assigned to zoning districts based on Community Plans and Development Projects.

The 2017 State Water Projects Plan (SWPP) has been updated to address DHHL's project needs from 2016 to 2031.[46] There are four DHHL project areas in the East Maui region (Kahikinui, Ke`anae, Wailua, and Hāna), with the 743 acre DHHL Wākiu Project as the only DHHL project located within the Hāna ASEA. Projected water demand and strategies for build-out of the

[46] State of Hawai`i Department of Hawaiian Homelands, State Water Projects Plan Update, 2017

Wākiu Project over the WUDP planning period is discussed under Population Growth Based Water Demand below.

Figure 17-19 DHHL Wākiu Tract, Hāna ASEA



The following table summarizes County and DHHL land use/zoning based demand.

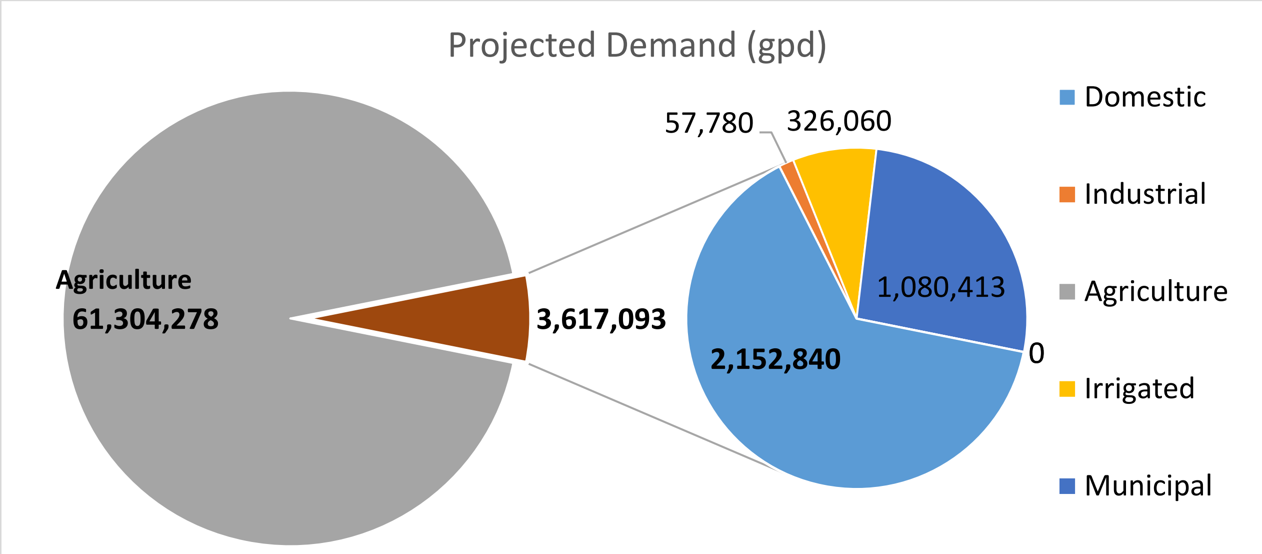
Table 17-23 Full Build-Out Water Demand Projections by CWRM Use Type, Hāna ASEA

CWRM Use Categories	County Zoning Based			DHHL Land Use Category Based				Total Projected Demand (gpd)
	Acres	Projected Demand (gpd)	Water Use Rate (gpd)	DHHL Land Use	Acres / Res Units	Water Use Rate (gpd)	Projected Demand (gpd)	
Domestic-Residential *	689.68*	2,082,640	3,000-5,000*	Residential *****	121/ 117	600 gal/unit	70,200	**2,152,840 (unit-based)**
Domestic Non-Residential **	42.79**	480,174	6,000 gal/acre	Commercial	5	3,000 gal/acre	15,000	495,174
Industrial	9.13	54,780	6,000 gal/acre	Industrial	5	6,000 gal/acre	3,000	**57,780**
Agriculture	17,508.67	59,529,478	3,400 gal/acre	Agriculture	522	3,400 gal/acre	1,774,800	**61,304,278**
Open Space	37,382	0	0	Open Space[47]	85	0	0	**0**
Irrigated***	191.80***	326,060	1,700	N/A	N/A	N/A	N/A	**326,060**
Municipal****	476.42 ****	1,071,913	1,700 gal/acre	Community	5	1,700 gal/acre	8,500	**1,080,413**
Military	0	0		N/A	N/A	N/A	N/A	**0**
Total	**18,918.49**	**63,545,045**			**743**		**2,004,500**	**65,549,545**

Source: MDWS Water Resources & Planning Division. Figures may not add due to rounding. Open space, conservation/cultural protection and similar land use types not included due to lack of water demand.
County Zoning: Maui County Planning Department, Long Range Planning Division, May 2015. Excl. DHHL lands
DHHL Lands: DHHL Maui Island Plan and Regional Plans.
*2,082,640 gpd Domestic-Residential--potable and non-potable needs: (1) Single Family Residential Duplex, Rural, Residential-3, SBR - Service Business Residential (682.88 acres x 3,000 gpd/acre standard) = 2,048,640 gpd); (2) A-1 Apartment, Multifamily Residential (6.80 acres x 5,000 gpd/acre standard) = 34,000 gpd
** Domestic Non-Residential--potable and non-potable needs (480,174 gpd): (1) Business (B-2 Business – Community, BCT Business-Country Town [22.48 acres x 6,000 gpd standard = 134,904 gpd]); (2) Hotel (20.31 acres H-1 Hotel x 17,000 gpd standard = 345,270 gpd)
***"Irrigated" (326,060 gpd) includes ONLY PK-4 Park-Golf Course (191.80 ac x 1,700 gallons per ac = 326,060 gpd)
**** Municipal water as defined by CWRM (1,071,913 gpd) is zoned as: (1) Interim-zoned/CP designated "Airport" (60.93 acres x 6,000gpd/acre standard = 365,580 gpd); (2) "Public," Interim-zoned/CP designated, "Public/Quasi-Public" (116.92 x 1,700 gpd standard = 198,764 gpd); (3) PK-2 Park-Community, PK-3 Park-Regional zoning districts (298.57 acres x 1,700 gpd standard = 507,569 gpd); and Municipal is likely to serve Domestic Residential zoned
*****The proposed land use for Wākiu includes 46 acres of one-half acre residential lots and 75 acres of three-acre subsistence agricultural lots (DHHL Maui Island Plan, 2004, page 6-9)

[47] Open Space acreage for DHHL is the unaccounted for balance of total of 743 designated acres for the Wakiu Tract minus the designated uses identified in the 2004 DHHL Maui Island Plan.

Figure 17-20 Full Build-Out Water Demand Projections by CWRM Use Type, Hāna ASEA



State Water Projects Plan

The State Water Projects Plan 2017 update only addressed Department of Hawaiian Homelands' projects. Other state projects are addressed in the adopted 2004 SWPP. Availability of water required for state projects, excluding DHHL, can be determined through the year 2020 based on the 2004 SWPP Report. Land use-based water demand projections are compared to those in the 2004 SWPP, which projects future water demand to 2020, shown in the table below. According to the SWPP, Hāna ASEA non-DHHL potable demand in 2018 is anticipated to be 5,680 gpd, with no anticipated non-potable demand.[48] The projects are additional use at the high school and airport and accounted for within the population-based projections for Hāna ASEA.

Table 17-24: State Water Projects Plan Projected Water: Hāna ASEA Demands to 2018 (Excludes DHHL Projects)

ASEA	ASYA	2018 Non-Potable Demand (gpd)	2018 Potable Demand (gpd)	2018 Total Demand (gpd)
Hāna	Kawaipapa	0	5,680	5,680

State Water Projects Plan, Hawai`i Water Plan, Volume 4, SWPP for Islands of Lanai/Maui/Moloka'i, 2003.

Agricultural Water Use and Development Plan (AWUDP)

The 2004 Agricultural Water Use and Development Plan (AWUDP) addressed the East Maui Irrigation System and related agricultural irrigation demand sourced from Ko`olau aquifer

[48] State Water Projects Plan, Hawai`i Water Plan, Volume 4, SWPP for Islands of Lana'i/Maui/Moloka'i, 2003, page 3-10

sector for use in Central and Upcountry Maui. The AWUDP does not address agricultural use and projections for the Hāna ASEA.

17.6.4 Population Growth-Based Water Demand Projections

Population growth rate projections were applied in 5-year increments over the 20-year planning period from 2015 to 2035 for high, medium (base case) and low growth scenarios. Water use (production) for both county and privately owned public water systems, are compared to the incremental water needs for the next 20 years based on the 2014 *Socio-Economic Forecast Report* prepared by the Planning Department and consistent with the Maui Island Plan. Water use and demand based on population growth rates do not account for large-scale agricultural irrigation needs. It's assumed that projects described in the 2004 State Water Projects Plan, excluding DHHL, are accounted for by the population projections. Therefore, information from this document was not used to further refine the population-based demand projections. DHHL projection for build-out of the Wākiu tract is added to population growth based demand as it was not specifically addressed in the Maui Island Plan or socio-economic forecast.

The Maui Island Plan projects a 22 percent population increase between 2015 and 2035 for the Hāna ASEA based on the community plan growth rates in the Socio-Economic Forecast. Water demand (excluding large agriculture and irrigation needs) is also projected to increase by 22 percent over 20 years. The greatest need is for single-family residential use.

Table 17-25 Projected Population-Based Water Demand for Hāna ASEA

Criteria	2010	2014	2015	2020	2025	2030	2035	20-Year Increase
% Increase	N/A	N/A	1.06%	5.10%	5.11%	5.07%	5.14%	22.04%
Population	2,081*	2,173	2,196	2,308	2,426	2,549	2,680	484
Water Demand (gpd)	N/A	752,469	760,433	799,217	840,078	882,671	928,034	167,600

Source: 2014 Final Draft Socio-Economic Forecast, Maui County Planning Dept., Long Range Planning Division. Water Demand projected by Maui County MDWS, Water Resources & Planning, 2016

*2,081 is the population of the Hāna ASEA based on the 2010 Census. The Hāna Community Plan Area in comparison had a population of 2,291 based on the 2010 Census, due to differing geographic boundaries of the Census and Hāna Community Plan.

** includes water use from stream diversions that is used for domestic purposes. It is unknown what proportion of the domestic use is for potable versus non-potable uses. This figure also includes a small amount of irrigation well water usage.

The table below indicates 3 different scenarios for increasing water demand into the future: (1) the base case is the expected growth rate (between 5.08% and 5.5% increases); (2) A high-growth scenario (7.9% increase); and (3) a low-growth scenario (8.6% decrease). The growth rates correspond to projected low, medium and high population growth rates for the Hāna community plan district per the 2014 Socio-Economic Forecast. [49]

Table 17-26 Projected Low, Base and High Population Based Water Demand to 2035, Hāna ASEA (gpd)

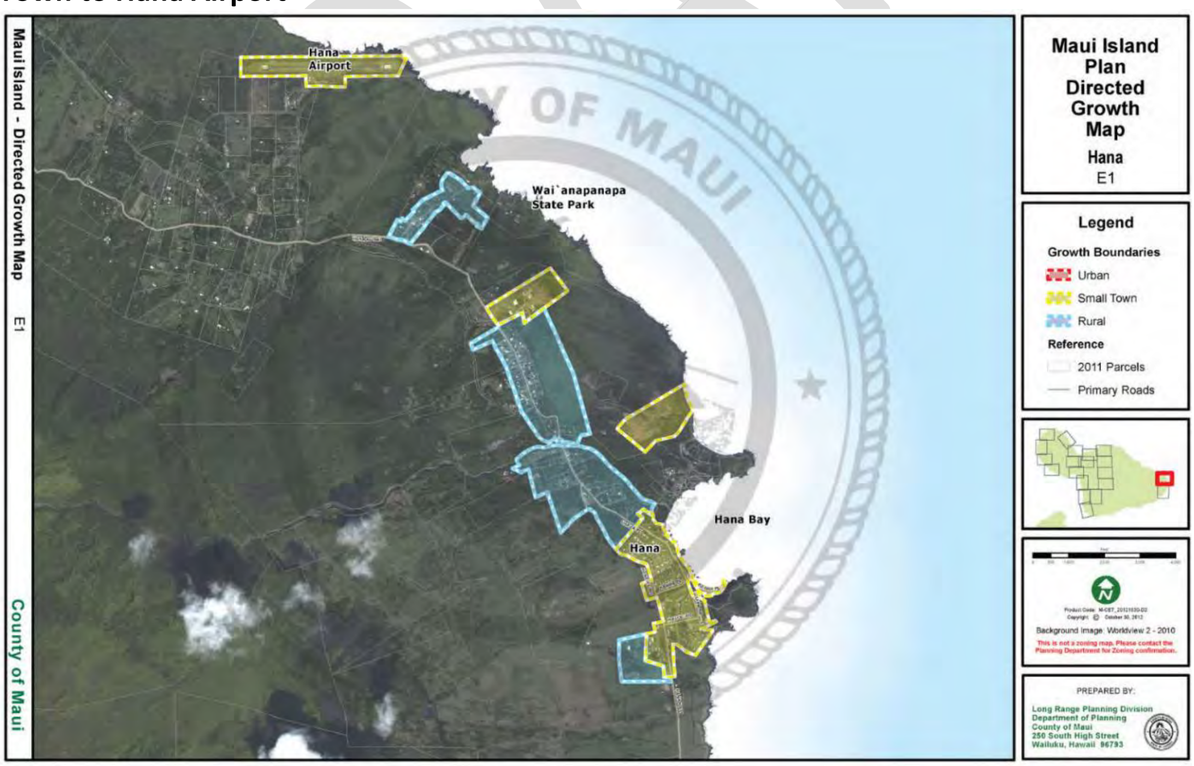
Case	2015	2016	2017	2018	2019	2020	2025	2030	2035
Base Case	760,433	768,190	776,026	783,942	791,938	800,016	840,918	883,554	928,962
Low Case	695,416	702,510	709,676	716,915	724,228	731,615	769,020	808,010	849,535
High Case	820,356	828,724	837,177	845,716	854,343	863,058	907,183	953,178	1,002,164

Source: MDWS, 2017.

Population Growth Based Demand in Planned Growth Areas

The Maui Island Plan includes the Hāna Affordable Residential planned growth area with a full build-out of approximately 200 affordable residential units and community facilities. It is expected that population growth will be focused within country town and rural growth boundaries where existing infrastructure can indicate which water resources and purveyors are available to serve a development.

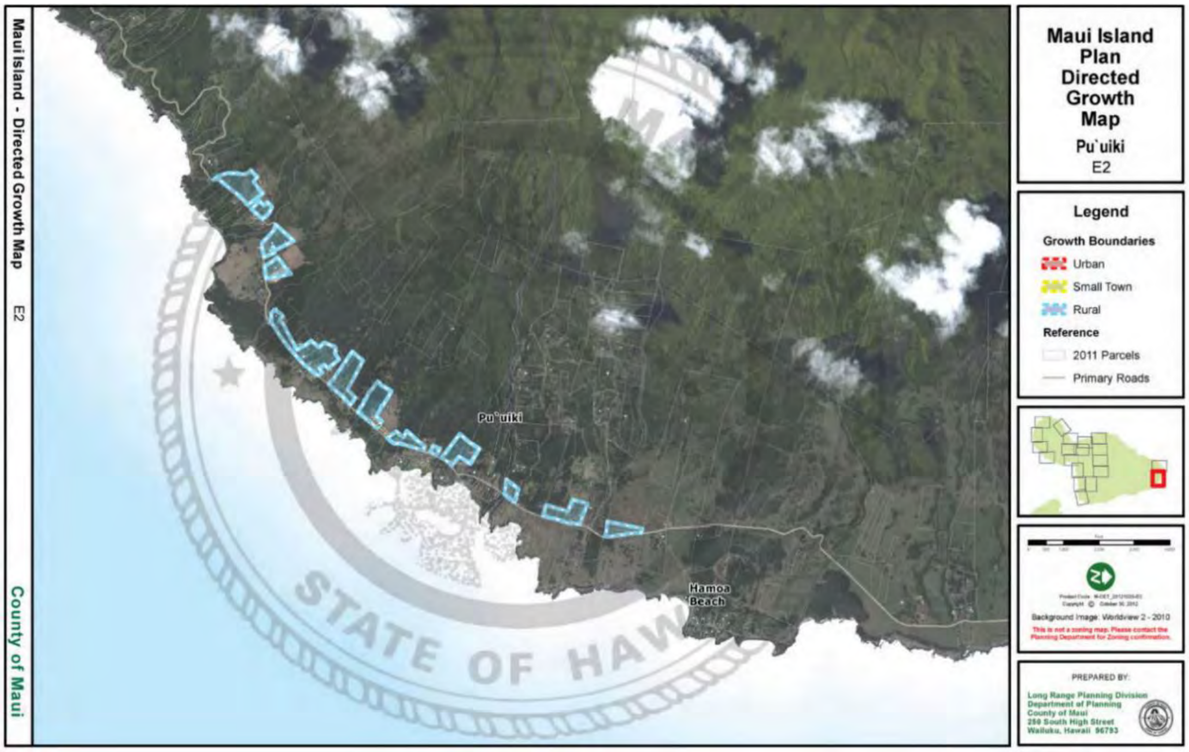
Figure 17-21 Hāna Planned Growth Areas, Maui Island Plan Directed Growth Map E1: Hāna Town to Hāna Airport



[49] 2014 Socio-Economic Forecast Report, Maui County Planning Department. September 2014. Table 2

The directed growth areas from Hāmoa to the Kīpahulu consist entirely of Rural growth boundaries.

Figure 17-22 Pu`uiki Planned Growth Areas, Hāmoa to Kīpahulu



Development Projects List

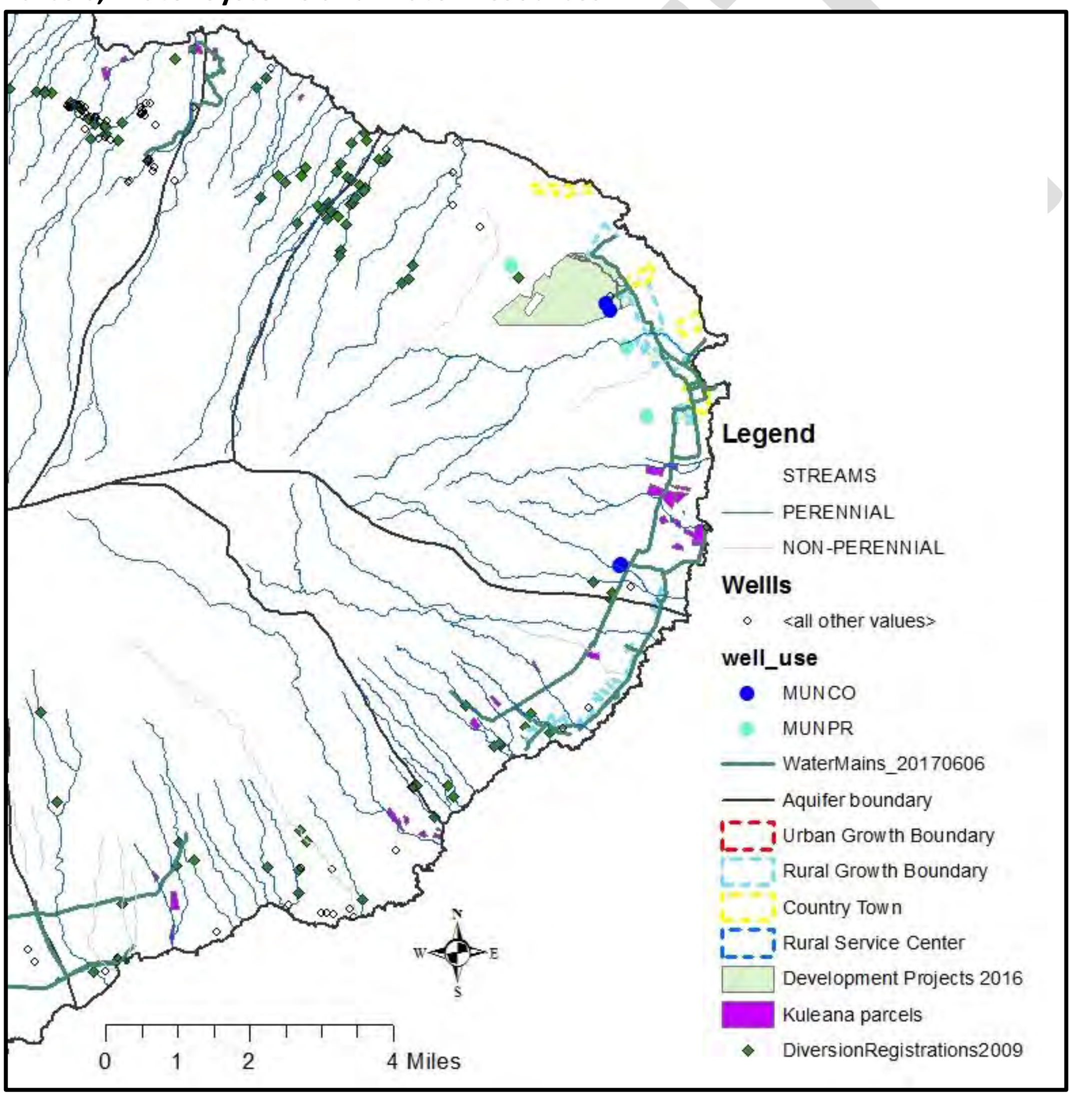
The Planning Department maintains a list of large development projects that have come to their attention, some of which have been entitled, committed or are supported by the Maui Island Plan but not necessarily the Community Plan. Development projects located within the Hāna ASEA include 102 homes planned for DHHL's Wākiu Hāna Homes Project, 43 homes at Hāna Ranch Affordable Housing, 21 units at Hāna Community Health and Wellness Village, and the Hāna Ranch Store Project. The map below shows the Growth Boundaries, public water systems, groundwater wells, registered surface water diversions, and the location of projects on the 2016 Development Projects list. Projected demand to serve the 2016 list alone, based on dwelling units, is 109,500 gpd. While projects may not be approved as proposed, or constructed once approved, the List is instructive as to location and planning for water sources. The 2035 population growth based water demand, not accounting for agricultural use, is compared to the demand representing known Development Projects in the table below.

Table 17-27 Population-Based Demand 2035 Compared to 2016 Development Projects List (mgd)

Hāna Aquifer System Area	2035 Demand	2016 Development Projects List		
		Entitled	Not Entitled MIP and/or CP	Total
Kawaipapa	0.926	0.072	0.0375	0.1095
Kūhiwa	0.01	0	0	0
Waiho`i	0	0	0	0
Kīpahulu	0.01	0	0	0
Total	**0.928**	**0.072**	**0.0375**	**0.1095**

Source: County of Maui MDWS

Figure 17-23 Comparison of Growth Boundaries, 2016 Development Project List, Kuleana Parcels, Water Systems and Water Resources



Source: Maui Island Plan, Planning Department Development Projects List (projects that have come to the attention of the Planning Department), OHA Data 2009, MDWS, Water Resources & Planning.

DHHL Water Demand Projections

Water service to most existing DHHL development and facilities on Maui is currently provided by the County MDWS systems. There are no DHHL owned and operated water systems on Maui. The 2017 SWPP DHHL Update projects a demand of 117,700 gpd of potable water and 255,000 gpd of non-potable water for new projects in the Hāna ASEA. The Wākiu tract is planned as a small residential and subsistence agricultural community mauka of Hāna Highway. The MDWS Hāna Water System has one production well and a backup well within the Wākiu tract. A previously used well "Wākiu A" has been taken out of production. The 2017 SWPP states that DHHL is negotiating a water credit agreement with MDWS for all project phases in exchange for the use of DHHL land for the MDWS wells. The DHHL project phases are scheduled for completion in 2021, 2026 and 2031. The 2004 DHHL Island Plan states that the first phase can be serviced by the existing MDWS storage at Wākiu. The DHHL anticipates rainfall should be adequate for projected future non-potable agricultural use.[50]

The projections in the tables do not take into account alternate sources of water that may be available or developed. Therefore, the values in these tables should not be used to compare project water demands and available source water. There are no perennial streams nor ditch systems in the area. However, the ambient rainfall within the tract ranges from 40-inches during summer months to 120-inches during winter months, which is anticipated to be sufficient to sustain crops within the Subsistence Agriculture areas.

Table 17-28 Projected Water Demands and Strategies for DHHL Projects in Hāna ASEA, (Wākiu Tract Project Future Requirements), 2031 (mgd)

Aquifer System	Project	Potable (gpd)	Potable Strategy	Non-potable (gpd)	Non-potable Strategy
Kawaipapa	Wākiu	117,700	Water Credit Agreement MDWS (61,200 gpd); coordinate with MDWS / source not identified (56,500 gpd)	255,000	Rainfall

Source: State of Hawai`i Water Projects Plan (SWPP), May 2017 Final Report, Tables 3.7 and 4.7, Cumulative Average Day Demand (gpd).

According to the SWPP, the existing MDWS Hāna Water System lacks capacity to serve the total potable demand for the proposed Wākiu development. Currently, the MDWS Hāna Water System is able to meet the existing potable water demand of 61,200 gpd, resulting in a future unmet demand of 56,500 gpd. The future unidentified water source that will be supply the unmet demand of 56,500 gpd is expected to be located within the same hydrologic unit as current potable sources. The Wākiu development will proceed in three phases scheduled for

[50] State of Hawai`i Department of Hawaiian Homelands, State Water Projects Plan Update, 2017, Page 4-28.

completion in 2021, 2026 and 2031, respectively; the first phase can be serviced by the existing MDWS Hāna Water System.[51] A large proportion of the funding to provide water for these projects would be allocated to the development of new sources and infrastructure, or towards payment of a proportional cost for new source development and infrastructure expansions and connection to County MDWS water systems.

Table 17-29 DHHL Hāna ASEA Wākiu Long-Term Water Projection

Water Development Strategy	Cumulative Average Day Demand (MGD) – Medium Projection							
	Short-Term						Long-Term	
	2012	**2013**	**2014**	**2015**	**2016**	**2021**	**2026**	**2031**
COUNTY-CREDIT	0	0	0	0	0	0.0240	0.0480	0.0612
REMAIN – Maui DWS	0	0	0	0	0	0.0085	0.0085	0.0565
Total Potable	**0**	**0**	**0**	**0**	**0**	0.0325	0.0565	0.1177
None – Ambient Rainfall Irrigation	0	0	0	0	0	0	0	0.2550
Total Non-Potable	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.2550**

SWPP, 2017 Final Report, Tables 3.7 and 4.7. Cumulative Average Day Demand (gpd)

State Water Projects Plan Water Demand Projections

State water demand projections are encompassed within the population based projections for Hāna ASEA.

MDWS Water Demand Projections

MDWS can geographically service the Hāna ASEA planned growth area between Hāna Town and Nāhiku. Water *consumption* in the table below is the volume water billed. Water produced is significantly higher for the MDWS Hāna system. MDWS *production* needs are projected to be about 548,467 gpd (not including DHHL needs) by 2035. Excluding Agricultural use, Residential use accounts for the greatest demand. Although the CWRM water use category "Municipal" includes all MDWS billing classes, Figure 17-23 provides a breakdown of water consumption that closest corresponds to CWRM sub-categories and actual water use.

[51] Ibid.

Figure 17-24 Projected MDWS Consumption by CWRM Category, Hāna ASEA to 2035

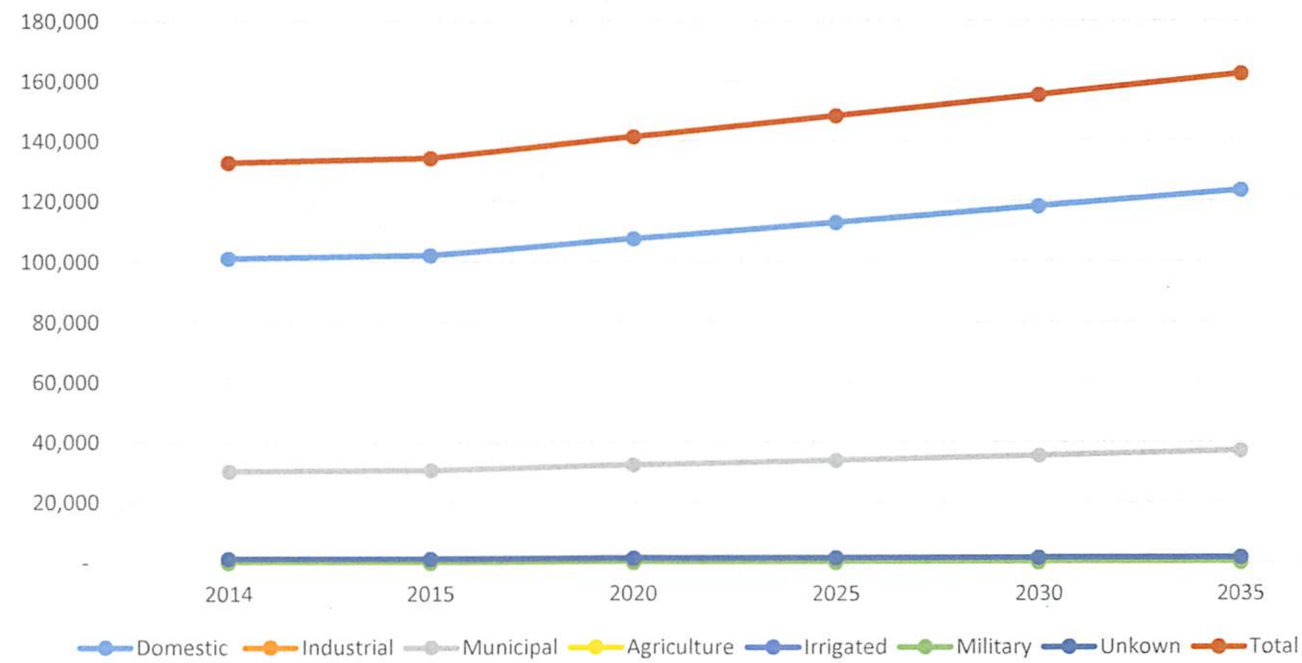


Table 17-30: Projected MDWS Consumption by CWRM Categories, Hāna ASEA

CWRM Categories	2014	2015	2020	2025	2030	2035
Domestic	**101,152**	**102,212**	**107,513**	**112,814**	**118,115**	**123,416**
Industrial	-	-	-	-	-	-
Municipal	**30,364**	**30,683**	**32,274**	**33,865**	**35,456**	**37,048**
Agriculture	**30**	**30**	**32**	**33**	**35**	**37**
Irrigated	-	-	-	-	-	-
Military	-	-	-	-	-	-
Unknown	**1,389**	**1,404**	**1,476**	**1,549**	**1,622**	**1,695**
Total	**132,935**	**134,329**	**141,295**	**148,262**	**155,228**	**162,195**

Source: MDWS. Based on Calendar Year 2014 consumption billing data for Nāhiku 913 and Hāna 911 MDWS Water Systems.

Private Public Water Systems Demand Projections

The private public water systems were requested to provide demand projections but most did not supply information. Therefore, demand of these smaller purveyors is encompassed within the population based projections applied to Maui Island. Disclosed information is incorporated.

Public water systems in the region generally do not report billed consumption but groundwater pumped. Hāna Water Resources is the largest private public water purveyor in the Hāna ASEA, producing 120,000 gpd of groundwater. Hāna Water Company reported 54,426 of groundwater production.

Other Population-Based Demand Projections

In addition to the public water systems, some persons are not served by public water systems and another component of water use is associated with population and economic demand. An unknown number of persons are not served by any public water system, but rather by wells, catchment and similar means. An estimated 'order of magnitude' demand for 2014 of 0.276 mgd was calculated and is projected to increase at a negligible rate.[52] Other population-based demand includes persons using domestic wells as well as landscape irrigation and industrial wells which are not included within public system supplies. Rates of increase are based on the community plan growth rates. The Hāna ASEA may contain a high proportion of unserved population compared to other areas on Maui.

17.6.5 Agricultural Demand Projections

As discussed under section 17.4, non-potable agricultural irrigation demand is not correlated to population growth and represents additional demand. Based on a hypothetical increase in acreage for the crops in the Crop Summary of 1% annually, projected agricultural water demand over the next 20 years would be 1,097,062 gpd, an increase of 182,843 over current estimated demand as shown below. This would represent a high growth scenario. An alternative low growth scenario would be further loss of agricultural lands to development.

A mid-growth demand scenario is that agricultural lands currently cultivated stay in production. According to the 2015 Crop Baseline, these lands are all located outside growth boundaries. However, current estimated agricultural irrigation based on reported surface water diversions (143,000 gpd) is less than irrigation demand for identified crops and acreage in the 2015 Baseline (1,220,722 gpd). Therefore, current estimated demand of 1,220,722 gpd is considered to include a high growth scenario and no further adjustment is made to account for potential increase in cultivation. It is expected that the AWUDP update will address agricultural irrigation projections in greater detail.

[52] 2010 Census Block Group populations that appear to be outside public purveyor service areas – approx. 1,190; apply average MDWS per capita rate of 248 gpd based on 2010-2014 consumption and interpolated population = 296,144 gpd. Excluding domestic well pumpage of 24.3 gpd results an estimated demand of 275,649 gpd.

Table 17-31 Projected Agricultural Demand Based On 2015 Agricultural Baseline (Not Including Kuleana Parcels), Hāna ASEA 2035

Aquifer System	Crop Category	Estimated Acreage	Water Standard (gpd)	Estimated Water Use (gpd)	20% Increase in Water Demand
Kīpahulu	Taro	2.56	27,500 (15-40K)	70,400	84,480.00
Kīpahulu	Diversified Crop	2.01	3,400	6,834	8,200.80
Kīpahulu	Commercial Forestry	33.12	4,400	145,728	174,873.60
Kīpahulu	Banana	22.28	3,400	75,752	90,902.40
Kīpahulu	Pasture*	1,463.33	0* (0-7,400)	0*	0.00
Kīpahulu Sub-Total		**1,523.30**		**298,714**	**358,456.80**
Waiho`i	Taro	0.51	27,500 (15-40K)	14,025	16,830.00
Waiho`i	Diversified Crop	5.44	3,400	18,496	22,195.20
Waiho`i	Banana	0.36	3,400	1,224.00	1,468.80
Waiho`i	Pasture*	157.21	0* (0-7,400)	0*	0.00
Waiho`i Sub-Total		**163.52**		**33,745**	**40,494.00**
Kawaipapa	Diversified Crop	30.33	3,400	103,122	123,746.40
Kawaipapa	Tropical Fruits	47.93	10,000	479,300	575,160.00
Kawaipapa	Pasture*	2,377.50	0* (0-7,400)	0*	0.00
Kawaipapa Sub-Total		**2,455.76**		**582,422**	**698,906.40**
Kūhiwa Sub-Total	Pasture*	**159.96**	0* (0-7,400)	0*	0.00
Total		**4,142.58**		**914,880.40**	**1,097,856.48**

Source: 2015 Statewide Agricultural Baseline, acreages calculated by MDWS.
It is not specified whether taro is dryland or wetland. Excluded crops from the above table are the 2015 Statewide Agricultural Baseline Taro, Diversified Agriculture, and Pasture crops that intersect Kuleana parcels. Estimated Water Use for taro: average wetland taro consumptive rate., Diversified Ag-HDOA Guidelines, 2004 AWUDP
*Most pasture is not irrigated and uses no water

Table 17-32 Projected Water Use by Kuleana Parcels *also* located within 2015 Agricultural Land Use Baseline, Hāna ASEA 2035 (gpd/acre)

Aquifer System	2015 Crop Category	Kuleana Parcels Acreage	Water Standard	Est. Ave. Water Use	Projected Ave. Water Use (2035) 20% Increase
Kawaipapa	Pasture*	104.51	0* (0-7,400)	0	0
Kawaipapa	Diversified	8.30	3,400	28,220	33,864
Waiho`i	Taro	0.13	27,500	3,575	4,290
Total		**112.94**		**31,795**	**38,154**

Sources: 2015 Statewide Agricultural Land Use Baseline; Kuleana parcels-OHA, 2009. Approx. agricultural acreages overlying Kuleana parcels calculated by MDWS
Water Use Rates: Diversified Ag-HDOA Guidelines; Taro-CWRM Na Wai `Eha and East Maui Streams Contested Case Hearings. Due to proximity of parcels to stream, taro is assumed to be wetland taro. Water standard for taro is average consumptive range of 15,000 to 40,000 gpa.
*Most pasture is not irrigated and uses no water

Table 17-33 Estimated Water Use by Kuleana Parcels *not* located in 2015 Agricultural Land Use Baseline, Hāna ASEA (gpd/acre)

Aquifer System	2015 Crop Category	Kuleana Parcels Acreage	Water Standard	Est. Ave. Water Use	Projected Ave Water Use (2035) 20% Increase
Kawaipapa	Pasture*	7.95	0* (0-7,400)	0*	0*
Kawaipapa	Diversified**	0.63	3,400	2,146**	2,575**
Kawaipapa	Taro***	0.01	27,500	272***	327***
Kawaipapa Total		**8.59**		**2,418**	**2,902**
Kīpahulu	Pasture*	53.46	0* (0-7,400)	0*	0*
Kīpahulu	Diversified**	4.24	3,400	14,435**	17,322**
Kīpahulu	Taro***	0.07	27,500	1,829***	2,195***
Kīpahulu Total		**57.77**		**16,264**	**19,517**
Kūhiwa	Pasture*	6.51	0* (0-7,400)	0*	0*
Kūhiwa	Diversified**	0.52	3,400	1,757**	2,108**
Kūhiwa	Taro***	0.008	27,500	223***	267***
Kūhiwa Total		**7.038**		**1,979**	**2,375**
Waiho`i	Pasture*	30.85	0* (0-7,400)	0*	0*
Waiho`i	Diversified**	2.45	3,400	8,331	9,997
Waiho`i	Taro***	0.04	27,500	1,055	1,266
Waiho`i Total		**33.34**		**9,386**	**11,263**
Total		**106.738**		**30,047**	**36,057**

Source: Kuleana parcels-OHA, 2009. Approx. Ag acreages overlying Kuleana parcels calculated by MDWS
Water Use Rates: (1) HDOA Agricultural Water Use and Development Plan (AGWUDP), page 163, 2004, based on unpublished data compiled from various sources by the HDOA, Irrigation Program Administrator and Planning Office, Office of Chairperson, 1985 – 2001; (2) Taro-CWRM Na Wai `Eha and East Maui Streams Contested Case Hearings, due to proximity of parcels to stream, taro is assumed to be wetland taro--water standard for taro is average consumptive range of 15,000 to 40,000 gpa.

*Most pasture is not irrigated

**Diversified Ag not included in 2015 Ag Baseline data estimated to be 7.35% of total acreage based on the ratio of Diversified to total acreage in the GIS intersection of Kuleana (OHA 2009) and 2015 Ag Baseline data.

***Taro crop cultivation not included in 2015 Ag Baseline data was estimated to be 0.12% of total acreage based on the ratio of Taro to total acreage in the GIS intersection of Kuleana parcels and 2015 Ag Baseline data.

Table 17-34 Summary of Projected Agricultural Water Use Analysis, Hāna ASEA

Agricultural Land Areas in Ag Water use Analysis	Estimated Water Use (gpd)	Projected 20% Increase Water Use, 2035 (gpd)
2015 Ag Baseline minus Kuleana Parcels	914,880	1,097,857
Kuleana Included in 2015 Ag Baseline Analysis (Subtracted from the Ag Baseline Total)	31,795	38,154
Kuleana not Included in 2015 Ag Baseline	30,047	36,057
1989 Declarations of Water Use	244,000	292,800
Total Estimated Agricultural Water Use	**1,220,722**	**1,464,868**

17.6.6 Irrigation Demand Projections

Landscape irrigation associated with single family homes and most commercial uses are factored into MDWS and private purveyor’s municipal water use. Little information is available on end use locations of surface water diversions and it is difficult to verify that reported “diverted” water is not double counted at multiple locations. Large scale irrigation is anticipated to be minimal within the Hāna ASEA due to natural rainfall. Reported pumpage of 1,315 gpd is projected to increase along with municipal and domestic uses based on population growth rates.

The figure below illustrates the selected projected demand scenario based on population growth, in comparison to the alternative projected demand scenario based on county zoning designations. In consistency with the Maui Island Plan, the mid-growth scenario is selected to guide short-term resource needs, to be adjusted as needed within the low-range to high-range projections over a 20 year time horizon. The selected demand scenario combines 20 year population growth, irrigation from surface water sources projected based on existing CWRM declarations of stream diversions, non-potable needs for Department of Hawaiian Homelands, non-potable needs for kuleana and lo`i kalo, and current irrigation demand for other agriculture from surface water sources.

Figure 17-25 Hāna ASEA Projected Population Growth and Land Use Build-Out Based Water Demand, 2015-2035

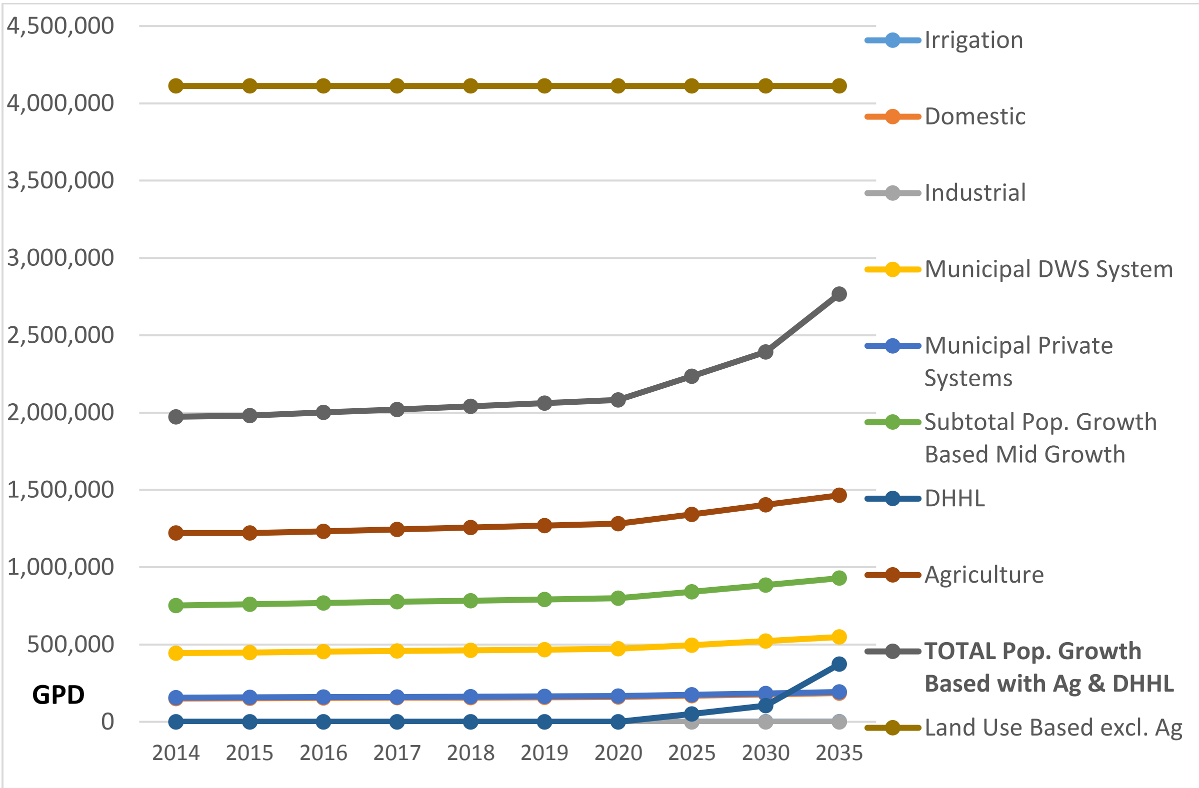


Table 17-35 Projected Water Use by Water Use Category based on Population Growth (Low, Medium and High) and Land Use Full Build-Out to 2035 (gpd)

Category/ Growth Scenario	2014	2015	2016	2017	2018	2019	2020	2025	2030	2035
Population Based										
Domestic	150,667	152,262	153,815	155,384	156,969	158,570	160,187	168,377	176,914	186,006
Industrial	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal DWS System	444,264	448,966	453,546	458,172	462,846	467,567	472,336	496,485	521,657	548,467
Municipal Private PWS[53]	156,223	157,877	159,487	161,114	162,757	164,417	166,094	174,586	183,438	192,865
Irrigation	1,315	1,329	1,342	1,356	1,370	1,384	1,398	1,470	1,544	1,623
Military	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL Pop. Based Mid	**752,469**	**760,433**	**768,190**	**776,026**	**783,942**	**791,938**	**800,016**	**840,918**	**883,554**	**928,962**
TOTAL Low	752,469	695,416	702,510	709,676	716,915	724,228	731,615	769,020	808,010	849,535
TOTAL High	752,469	820,356	828,724	837,177	845,716	854,343	863,058	907,183	953,178	1,002,164
DHHL[54]	0	0	0	0	0	0	0	51,700	105,460	372,700
Agriculture	1,220,722	1,220,722	1,232,261	1,244,461	1,256,662	1,268,862	1,281,063	1,342,066	1,403,069	1,464,868[55]
TOTAL[56]	1,973,191	1,981,155	2,000,451	2,020,487	2,040,604	2,060,800	2,081,079	2,234,684	2,392,083	2,766,530
Land Use Full Build-out Based[57]										
County (Zoning) (Excl. AG)	4,015,567	4,015,567	4,015,567	4,015,567	4,015,567	4,015,567	4,015,567	4,015,567	4,015,567	4,015,567
DHHL (Excl. AG)	229,700	229,700	229,700	229,700	229,700	229,700	229,700	229,700	229,700	229,700
Total, (Excl. AG)	**4,245,267**	**4,245,267**	**4,245,267**	**4,245,267**	**4,245,267**	**4,245,267**	**4,245,267**	**4,245,267**	**4,245,267**	**4,245,267**
TOTAL (Incl. AG) *not shown on chart*	65,549,545	65,549,545	65,549,545	65,549,545	65,549,545	65,549,545	65,549,545	65,549,545	65,549,545	65,549,545

[53] Based on 63,000 gpd potable use and 13,500 gpd non-potable use projection from DHHL's SWPP.
[54] Based on SWPP, 2017 Final Report, Tables 3.7 and 4.7. Cumulative Average Day Demand (gpd).
[55] Based on 20% estimated increase in agricultural water demand from 2015 to 2035.
[56] Based on Mid-Growth Projection.
[57] Land Use Full Build-Out Based analysis determined to be less accurate than Population Based analysis (above).

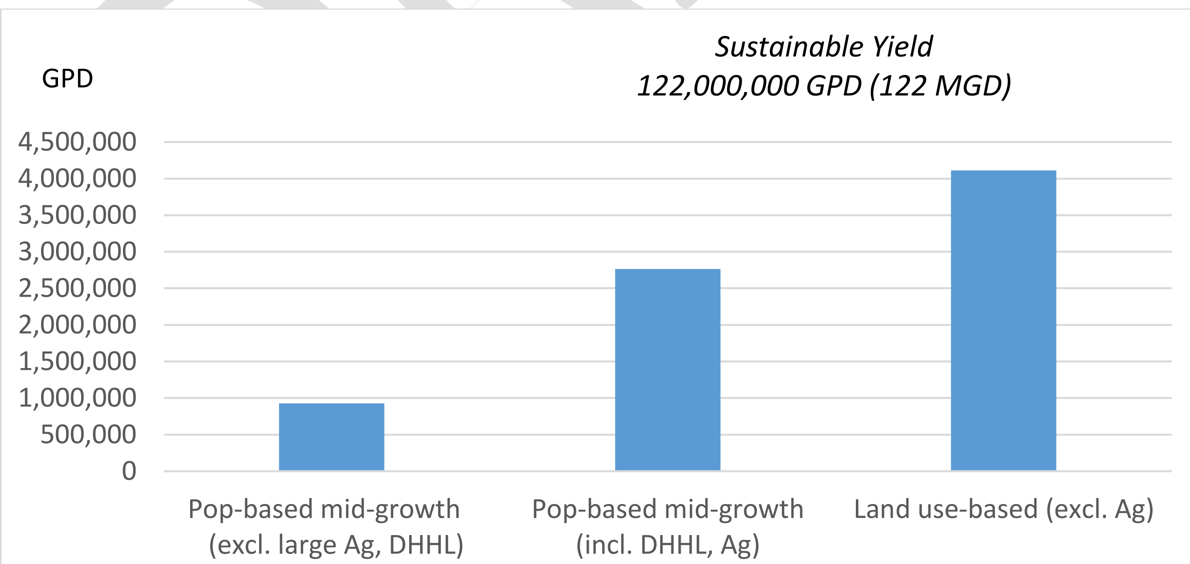
17.7 Water Source Adequacy

The analysis of available resources and projected demand confirm that there are sufficient water resources in the region to meet 20-year demand projected based on population growth under normal and drought conditions. Total pumpage reported to CWRM in 2014 did not exceed 5 percent of regional Sustainable Yield (SY) for the Hāna ASEA. Groundwater SY and estimated surface water diverted of 143,000 gpd (1989 CWRM declarations of stream diversions and water use) total about 122,143,000 gpd. The SY was conservatively set at the low end of the estimated range. A hypothetical reduction in SY under long term drought conditions was assessed in response to climate change and community concerns advocating an additional buffer to groundwater development. A "drought yield" of 98.3 mgd would also provide for 2035 population growth, and agricultural demands, currently served by diverted surface water.

17.7.1 Source Adequacy vs. Land Use Full Build-Out Based Water Projections

Full build-out of land use classifications representing 65,549,545 gpd would not exceed the ground and surface water resources of the aquifer sector area as shown below. Excluding agriculture, land use based demand is about 4,245,267 gpd. Planning for adequate source to serve full build out demand is not supported by the Socio-Economic Forecast and could not considered a realistic and efficient use of resources. Agricultural zoned land is generally not irrigated to reflect Department of Agriculture water rate guidance for diversified agriculture. Therefore 61,304,278 gpd for agricultural production is not realistic or supported by policy and land use plans for the region.

Figure 17-26 Land Use Full Build-Out and Population Mid-Growth Based Water Demand Projections, Hāna ASEA, 2035



17.7.2 Source Adequacy vs. Population Growth-Based Water Demand Projections (20-Year)

Based on the MIP population projections, future water demand for the Hāna region is anticipated to increase from 1,981,155 gpd in 2015 (including irrigation, agriculture and DHHL) to 2,766,530 gpd by 2035, within a range of 2,687,103 (low growth) – 2,839,732 (high growth) gpd by 2035. The base case (i.e. mid-growth scenario) is selected as the most probable scenario, assuming that new housing and population growth will be focused in planned growth areas consistent with the 2014 socio-economic forecast for the region. Long-term projections are trends with expected short-term variations. Factors that especially impact growth in the Hāna region are small projects in and around Hāna Town and development of Hawaiian Homelands.[58] Water use is not exactly correlated to population and economic growth but is also impacted by climate change, type of housing development and associated irrigation. It is also expected that more aggressive conservation measures will curb water use per capita. This trend is consistent with overall island-wide decrease in water use per MDWS customer over the last ten years and continued adoption of more efficient irrigation technologies for agriculture and landscape irrigation.

The Hāna region has few visitor units, so the rates of increase in resident population will likely be higher than the rate of visitor growth, although those daily visitors who do not stay in Hāna overnight are also likely to increase. Because there is no presently reported agricultural pumpage and incomplete stream water use reported, it is not known how much agricultural water is presently being used. However, the growth in agricultural water demand within the Hāna ASEA is not anticipated to exceed the anticipated population growth of 22 % by year 2035.

[58] 2013 Socio-Economic Forecast

17.8 Strategies to Meet Planning Objectives

The WUDP update public process generated a set of planning objectives through an iterative process. Multiple resource options to meet planning objectives and projected demand were reviewed and evaluated in regional public meetings and workshops to assess constraints, relative costs and viability.[59] Planning objectives, preliminary strategies and related material reviewed in the final public workshop, November 17, 2016 is attached as Appendix 11. The selected strategies are presented below along with available cost estimates, hydrological, practical and legal constraints that were considered in assessing the viability of a specific resource or strategy.

Key issues identified for the Hāna community and water resources within the Hāna aquifer sector relate to watershed management and participation by the local community; maintenance of traditional resource management using the ahupua`a system and ensuring that traditional and customary practices are safe guarded. Community members state that younger generations are returning to Hāna to establish taro lo`i. Projected water demand associated with population growth is relatively modest even with an anticipated 22 percent increase in population for the Hāna Community Plan Area. Other key issues for the region focus on providing affordable water for future needs, providing for taro lo`i and other public trust uses during droughts, and managing resources in a sustainable way.

Recommended alternatives include resource management as well as development of conventional and alternative resources. All strategies are assumed to include conservation consistent with recommended supply and demand side conservation strategies outlined in Section 12.2. Implementation schedule, estimated costs and potential lead agencies, including funding sources, are summarized in Table 17-38.

17.8.1 Resource Management

Planning objectives related to resource management identified in the WUDP update public process include:

- Watershed protection and its prioritization, including invasive alien plant control, ungulate control, and reforestation via watershed partnership programs
- Maintaining access to lands for gathering, hunting and other native Hawaiian traditional and customary practices
- Improving the understanding of the concepts of "precautionary planning" to reduce and adapt to the effects of drought and climate change upon water resource availability and quality
- Consultation and coordination with Native Hawaiian community/moku and local experts on resource management and invasive species removal

The Hāna Community Plan reflects regional issues expressed at the community WUDP meetings. Policies related to water resource management include:

[59] Preliminary Strategies for Hana Aquifer Sector November 17. 2016

- Protect, preserve and increase natural marine, coastal and inland resources, encouraging comprehensive resource management programs
- Ensure that groundwater and surface water resources are preserved and maintained at capacities and levels to meet the current and future domestic, agricultural, commercial, ecological and traditional cultural demands
- Recognize residents' traditional uses of the region's natural resources which balance environmental protection and self-sufficiency
- Discourage water or land development and activities which degrade the region's existing surface and groundwater quality
- Encourage resource management programs that maintain and re-establish indigenous and endemic flora and fauna
- Protect, restore and preserve native aquatic habitats and resources within and along streams

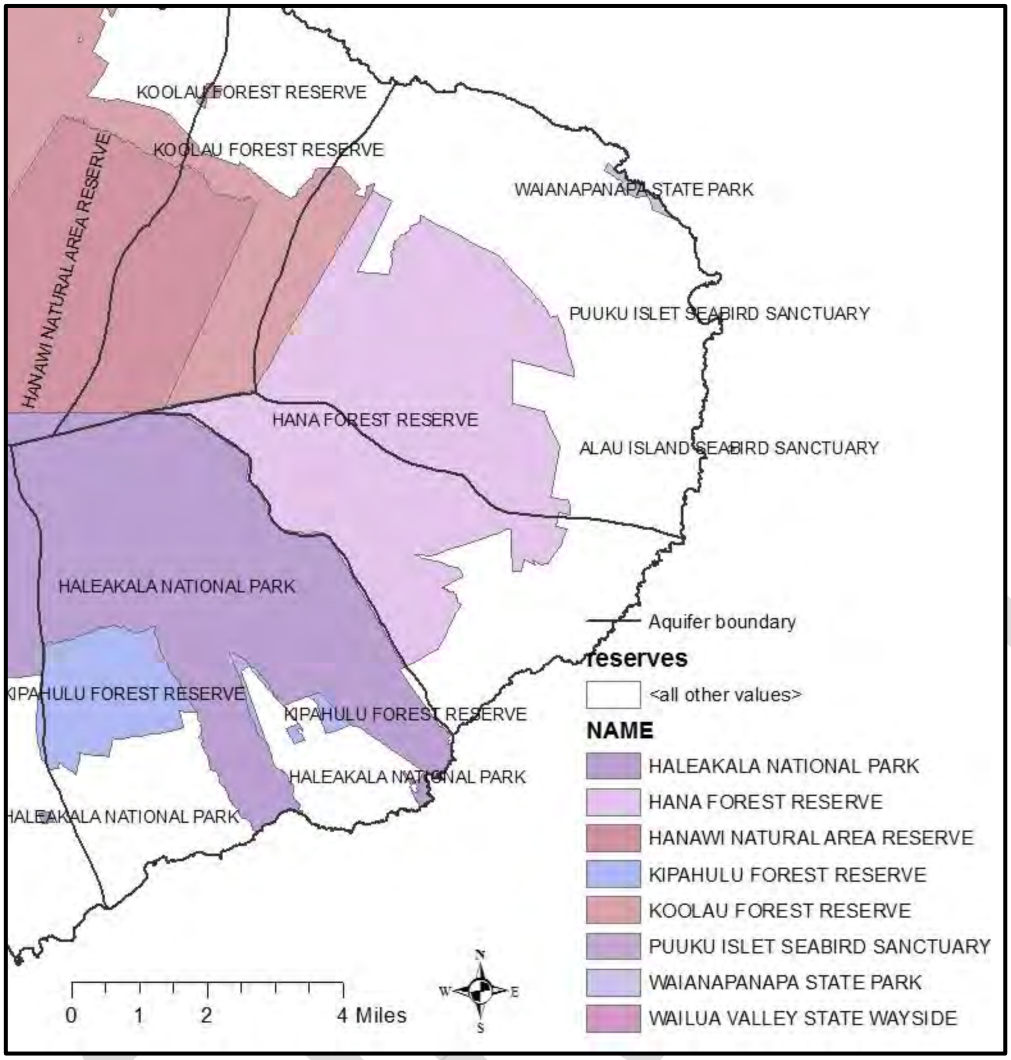
Watershed Protection and Restoration

Issue and Background: East Maui watersheds are predominately vegetated by Native Hawaiian rainforest. The plants there evolved over millions of years into the most efficient water collection system for our island's geography. It works in layers – tall ʻōhiʻa and koa trees provide a canopy for shorter trees, while shrubs and ferns fill in underneath, and a thick layer of mosses and leaf litter complete the floor. These layers act like a giant sponge, slowing down heavy raindrops and soaking up water for slow release into underground aquifers. Even during droughts, our watersheds can produce water, pulling water out of the clouds by collecting fog drip. This uniquely evolved, specialized forest is the key to Maui's healthy water supply. [60] The East Maui watersheds are rich in biodiversity and harbor endemic and rare native plant and bird species. The main threats to the native forest and ecosystems are habitat loss and alterations due to feral ungulates (pigs, deer, goats) and invasive plants. These are detrimental both to biodiversity and water supply.

Hāna ASEA contains multiple watershed and forest management areas. DLNR's forest reserve systems are managed by the Division of Forestry and Wildlife (DOFAW) to protect and enhance important forested mauka lands for their abundance of public benefits and values.[61] The national park is funded and managed on a federal level. The state and federal efforts and objectives to protect native habitat and forested recharge areas benefit the county and the regional communities.

[60] East Maui Watershed Partnership, FY2015 Final Report to the Maui County Department of Water Supply
[61] http://dlnr.hawaii.gov/forestry/frs/

Figure 17-27 Managed Lands and Forest Reserves, Hāna ASEA



DLNR and the National Park Service are partners of the East Maui Watershed Protection Partnership (EMWP). The partnership was the first of its kind formed in the state to work with landowners to protect native forested watersheds. The figures below illustrate the major land holdings and extent of the EMWP. The 119,000 acre watershed is a role model for proactive and effective watershed management on a large scale to ensure future freshwater resources. To the south-west, the Leeward Haleakalā Watershed Restoration Partnership buffers the influx of invasive plant species into the national park and Kīpahulu Forest Reserve.

Figure 17-28 East Maui Watershed Partnership Major Land Holdings

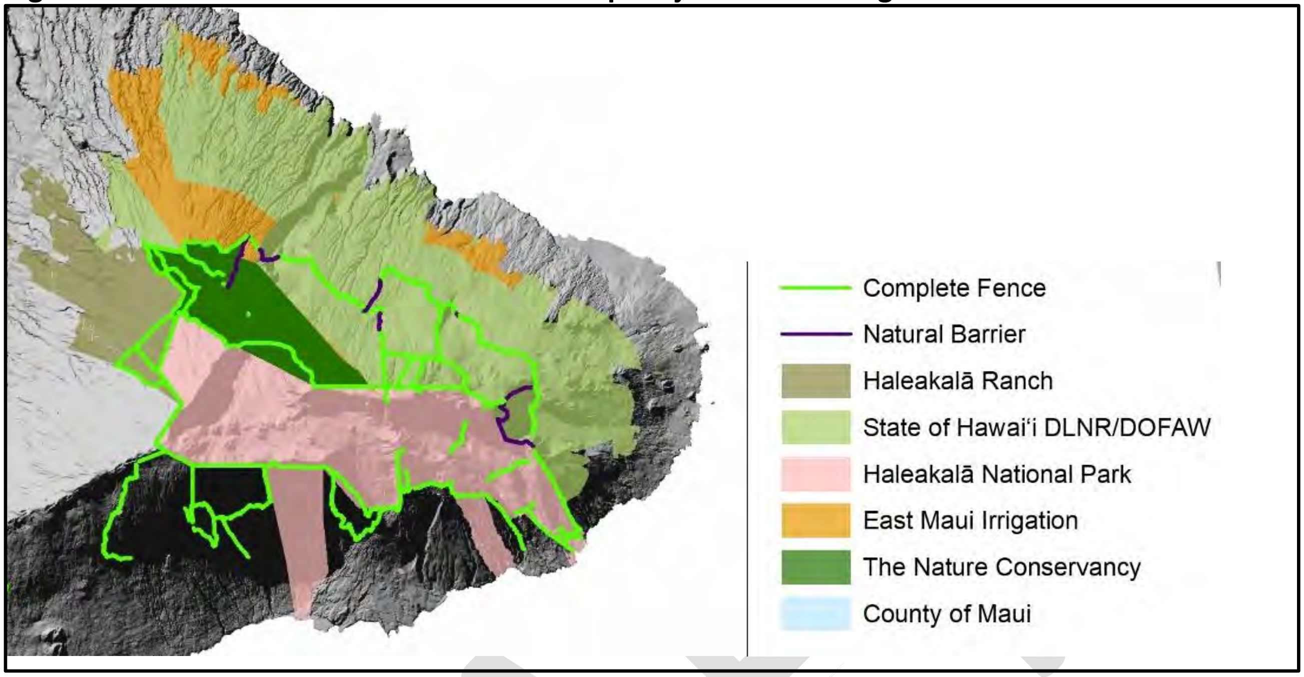
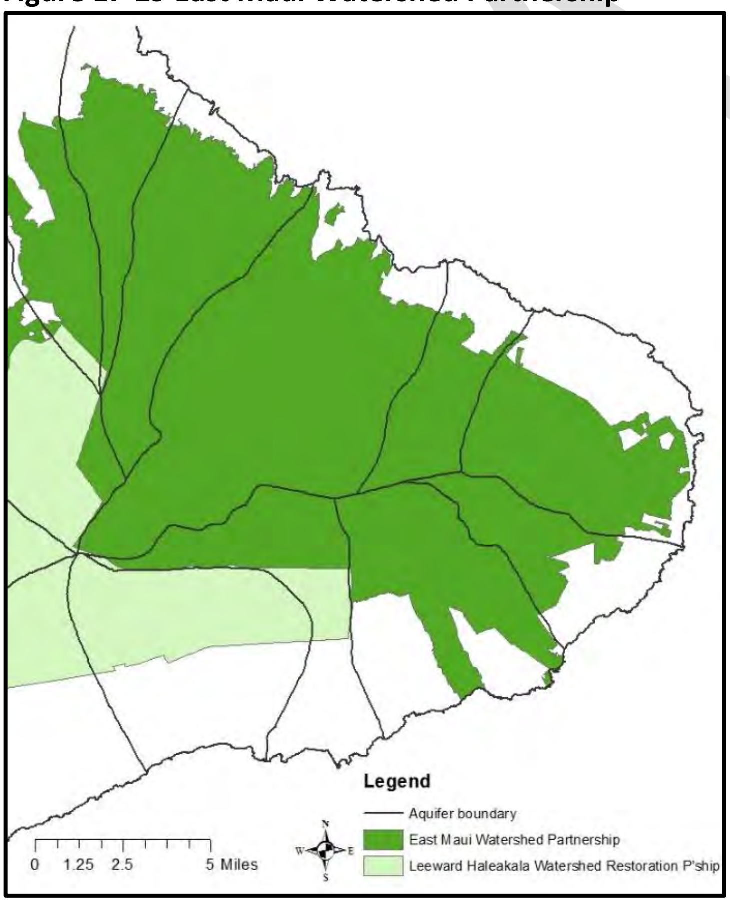


Figure 17-29 East Maui Watershed Partnership



Ongoing efforts to protect the watershed include fencing, ungulate control, invertebrate and small mammal control, weed management, rare species protection, removal of invasive species, monitoring, education, public outreach and volunteer recruitment to repair and install fencing, and plant native species. Continuous and consistent funding is paramount to maintain momentum and progress in preserving freshwater supplies and the range of ecosystem services provided by these forested watersheds.

Strategy #1: Seek dedicated, long-term and broad based core funding for maintaining and expanding watershed protection areas and providing for watershed maintenance in East Maui and Hāna watersheds for habitat protection and water security. The annual EMWP budget varies but has been in the range of $0.8M – $1M, with funding from Federal, State, County and private sources.

Community outreach and support is essential for sustainable resource use and protection. Sometimes fencing off areas for ungulate control create conflict with community members that seek access to hunting to maintain their subsistence lifestyle. The Hāna Community Plan policy to “Recognize residents’ traditional uses of the region’s natural resources which balance environmental protection and self-sufficiency” needs to be acknowledged and addressed. Community concerns also relate to impact from fencing on animal migration, dead animals have been reportedly ending up in streams, possibly polluting water. Watershed managers, including EMWP, the National Park Service and the DLNR Division of Forestry and Wildlife recognize that community participation and input is key to successful resource management. Although the communities and watershed managers’ objectives for resource management appear to align, concerns raised by community members in the WUDP public process tell us that improved communication and collaboration with the community is desired. The community is rich in ahupua`a based cultural and resource preservation efforts. The traditional uses of the region’s natural resources makai depend on the sustained watershed management of the mauka lands. Although not forecasted in current policy and land use plans, the cultural resurgence and repopulation of traditional lands are central to this community.

Strategy #2: Support and promote community grassroots initiatives to collaborate with state and land owner partnerships to increase participation in natural resource management and to ensure adequate access and opportunities for traditional uses of the region’s natural resources. Use established moku process to consult on resource management.

17.8.2 Conservation

Encouraging water conservation and maximizing the efficiency of water use are objectives identified in the WUDP public process as well as the 1994 Hāna Community Plan.

Qualitative criteria to evaluate and measure resource strategies against this planning objective include:

- Per capita water use decreased
- Potable and irrigation systems water loss decreased

- Community water education increased
- Incentives for water conservation increased
- Renewable energy use increased

Issue and Background: The recommended supply and demand side conservation strategies outlined in Section 12.2 apply island wide. Demand side public education and outreach benefit all water systems and end uses. Water uses per service in the county MDWS Hāna water system is low compared to other MDWS water systems or districts. Considering abundant rainfall and associated low irrigation needs this is consistent with empirical data in similar wet regions. The average water consumption per single family meter is 275 gallons per day, which is well below system standard of 600 gpd per single family unit. Customers in Hāna have also taken advantage of free low flow fixture give away opportunities and conservation educational programs when made available in the community. Current water use in the region is well below the per capita goal of 305 gpd per person set forth in the Hawaii Freshwater Blueprint.

The MDWS Hāna water system has periodically shown significant discrepancies between water produced and water billed. A water audit in 2017 revealed a water loss of about 63%. Although the volume of water produced in this system is relatively small, the cumulative loss over time can be significant. However, the cause of the discrepancy is not identified and requires further investigation. An apparent water loss can be due to errors in billing data, the production flow meters, distribution system leaks, water theft and other possible causes. An investigation, including physical leak detection, is underway by MDWS to identify and resolve the disproportionate system losses. Supply side measures including water audits and leak detection programs can be implemented for small private systems as well.

17.8.3 Conventional Water Source Strategies

Conventional water sources include groundwater (wells and tunnels) and surface water (stream diversions). Region specific planning objectives related to ground and surface water use and development identified and confirmed in the WUDP update public process include:

- Improving the understanding of the concepts of "precautionary planning" to reduce and adapt to the effects of drought and climate change upon water resource availability and quality
- Adapting future populations to local water resource conditions, integrating conservation and the use of alternative resources
- Water needs of DHHL in Hāna should be considered in general and in accordance with the 2017 State Water Projects Plan

Planning objectives related to groundwater and surface water source use and development identified to apply island wide include:

- Manage water equitably

- Provide for Department of Hawaiian Homelands needs
- Provide for agricultural needs
- Protect cultural resources
- Provide adequate volume of water supply
- Maximize reliability of water service
- Minimize cost of water supply

In addition, the Hāna Community Plan identified the objective to “Improve water source and delivery facilities to ensure that water supplied to the region's residents and visitors is of the highest quality”.

Qualitative criteria to evaluate and measure resource strategies against these planning objectives include:

- Public water system water shortages to serve existing customers avoided
- Public water supply drought shortages avoided
- MDWS prioritize DHHL needs over lower priority needs
- Potable water use for non-potable needs decreased
- Contingencies in place to support water supply system functions during emergency conditions
- Water is available to serve Maui Island Plan development
- Strategies to meet all needs incorporated into WUDP

Potable Groundwater Development

Issue and Background: The Maui Island Plan addressed the MDWS system need, excluding private purveyors, irrigation and agricultural demand. The MDWS system currently receives all water from groundwater wells in the Kawaipapa aquifer. The two private water systems, Hāna Water Resources and Hāna Water Company, produces 0.156 mgd, 26% of municipal supply. The following objectives derived from the Maui Island Plan should guide groundwater development in the region:

- Provide adequate volume of water to timely serve planned growth in MIP
- Increase capacity of water systems in striving to meet the needs and balance the island’s water needs
- More comprehensive approach to water resource planning to effectively protect, recharge and manage water resources
- Ensure stable chloride levels in developed wells

The MDWS system supplies the rural and country town growth areas and is assumed to absorb most of growth and associated water use. As shown in the previous sections, 2035 total potable water needs (excluding agricultural non-potable irrigation totaling 1.464 mgd) is projected to about 1.036 mgd. The majority of growth is anticipated to occur within growth boundaries throughout Kawaipapa and Waiho`i aquifer systems. The MDWS service area spans from Kawaipapa to Waiho`i with 100 percent supply sourced from Kawaipapa aquifer system.

Regional groundwater can continue to provide for municipal, domestic and irrigation needs, even under drought conditions and a potential high growth scenario. Source development must account for peak use and water losses. Comparing MDWS base production for 2014 and high production months over 10 years, there is a 31 % variation. However, recognizing the current water losses and high discrepancy between production and billed consumption will be adjusted, 20% is added to average projected production to ensure adequate source capacity. This is consistent with other MDWS systems relying on groundwater source. The adjusted demand represent an additional 0.207 mgd. Total demand needed is therefore 1.243 mgd (1.036 + .207 mgd).

Installed pump capacity for the MDWS Hāna sub system, including the Wākiu and Hāmoa well fields totals 1.2 mgd. To account for system standards, pumping 16 hours and the largest pump out of service, the system can provide about 0.5 mgd. Installed pump capacity for private municipal wells are adjusted to 16 hours pumpage, shown below as "Estimated Available Capacity". To meet peak demand, a modest 0.1 mgd additional source will be needed by 2035.

Table 17-36 Groundwater Source Development to Meet Population Growth Based Demand in Hāna ASEA 2035 (mgd)

Aquifer System	Installed Source Capacity	Estimated Available Capacity (16 h pumpage)	2035 Projected Demand	Source Need**	Sustainable Yield	Potential Drought Yield Conditions
Kawaipapa	2.424	1.5	0.8 – 1.1	0.1 (0.5 mgd to Waiho`i)	48	*39.4*
Kūhiwa	0.036	0.02	0.01 – 0.02	0	14	*12.5*
Waiho`i	0.069	0.04	0.07 – 0.5	(0.5 mgd from Kawaipapa)	18	*14.6*
Kīpahulu	0.815	0.054	0.03 – 0.07	0	42	*34*
Total	**3.344**	**1.614**	**1.243**	**0.1**	**122**	*100.5*

*Projected demand, including DHHL and irrigation wells 1,036 mgd, adding 20 % to account for peak demand (1.243 mgd)
** Source need is projected demand less developed source capacity for region
Source: MDWS Water Resources & Planning Division, 2017

Optimization studies have not been performed for the MDWS Hāna water system. A source development analysis is therefore needed. The analysis should address costs of infrastructure improvements needed to meet system standards. It's possible that a combination of low growth, aggressive conservation and increased production efficiencies will avoid the need to develop source over the planning period.

Strategy #3: Complete optimization studies/source development analysis for the MDWS Hāna subsystem (PWS 217) in order to assess basal well development needs by 2025. Costs of regional well development have not been assessed but is comparable to 20 year life cycle costs estimated for Haiku/Central well development at $3.55 per 1,000 gallons.

Department of Hawaiian Homelands Wākiu Tract Build-Out

Issue and Background: The 2017 State Water Projects Plan Update for DHHL projects a demand of 117,700 gpd of potable water and 255,000 gpd of non-potable water for new projects in the Hāna ASEA. The 2017 SWPP states that DHHL is negotiating a water credit agreement with MDWS for all project phases in exchange for the use of DHHL land for the MDWS wells. As a technical matter, it is MDWS policy that issuance of water credits is generally not an appropriate direct compensation for use of land, but rather cooperative source development/funding arrangements. DHHL potable demand is accounted for in the demand projections and source development needs above. Available capacity can currently serve the project potable needs. However, remaining capacity must be reassessed for DHHL scheduled project phases 2021 – 2031. Sustainable yield of the Kawaipapa aquifer can support new source development, whether private or collaboratively with MDWS.

DHHL non-potable needs of 255,000 gpd can be sustained by ambient rainfall within the tract, ranging from 40-inches during summer months to 120-inches during winter months. This is the non-potable strategy recommended in the SWPP update.

Nāhiku Water Service

Issue and Background: The MDWS supplies about 40 meters along Nāhiku Road, which runs along the boundary of Kūhiwa Aquifer System (ASYA) in the Hāna ASEA and the Ke`anae ASYA in the Ko`olau ASEA. The MDWS purchases water for domestic supply from the East Maui Irrigation (EMI) Company's West Makapipi Tunnel 2. The source is known as the "Nāhiku Tunnel." A Memorandum of Understanding allows DWS to take up to 20,000 gpd.

There are Nāhiku residents close to the county system that are not able to connect due to cost of extending the line. There is one irrigation well and no identified domestic wells on the Hāna ASEA side of Nāhiku. The Kūhiwa Well, owned by Maui Land & Pineapple Company is classified as Agricultural. It is unclear whether portions and what portions of the community are possibly served by the Kūhiwa Well. Approximately 60 – 100 families in the Makapipi area are without water and have to haul it in or have it hauled in. There were also concerns that lack of water in Makapipi stream affects local springs on which people depend for their water.

Extending MDWS service area by installation of new mains and laterals are subject to MDWS rules and the cost borne by the meter applicant. Based on water use on the Nāhiku system, there is sufficient source to accept new meter service applications. Currently the Water System Development Fee (WSDF) is set by meter size and does not differentiate by service area or customer class. Therefore new customers that apply for water service in an area with adequate source, storage and transmission helps pay for water service in areas that require source and infrastructure development to take on new customers. Input during the WUDP update public process indicated that the current WSDF structure supports equity (growth pay for growth, districts share burden equally) rather than recommending an overhaul to the WSDF structure.

Non-potable Surface Water Use and Development

Issue and Background: Surface water is diverted for a variety of purposes; however, surface water diversion data reported to CWRM for the Hāna ASEA is very limited, other than the 1989 Declarations of Water Use already described in this report. There are no CWRM stream diversion gages located within the Hāna ASEA. Because there are no existing or proposed diversions to convey surface water out of Hāna ASEA or for other purposes than regional domestic and agricultural needs, studies of stream flow and establishing numerical instream flow standards have not been urged. Nevertheless, the community has raised concerns over sufficient stream flow to support taro (lo`i Kalo), droughts and climate change impacts, potential new diversions and compliance with the Public Trust Doctrine.

Mauka to makai stream flow is at the core of the traditional and self-sufficient Native Hawaiian livelihood of the region. Although there are no known competing needs for surface water diversions in the Hāna ASEA, stream flow data, especially during dry conditions is needed to assess long term adequate inflow for healthy lo`i Kalo and any impact on stream life and the near coastal environment. It’s therefore recommended that CWRM undertake streamflow studies and establish numerical IFS over the planning period.

Strategy #4: The Commission on Water Resource Management to establish Instream Flow Standards on a stream-by-stream basis to protect the public interests of the Hāna aquifer sector. Recognizing that other regions with competing off-stream needs must be prioritized, this strategy is proposed as a medium to long-term implementation time frame.

Providing for Non-Potable Agricultural Needs

Historically and currently, Hāna is known for its agricultural food productivity. As discussed under section 11.4, non-potable agricultural irrigation demand is not correlated to population growth and represents additional demand. No inventory exists of irrigation versus reliance on ambient rainfall in the region. Current estimated agricultural irrigation based on reported surface water diversions far exceeds irrigation demand calculated by applying a water use coefficient for identified crops and acreage in the 2015 Crop Baseline. Pasture land is not currently irrigated, it is possible that more intensive use such as grass-fed livestock would merit irrigation. No agricultural well pumpage is reported but could potentially supply future crops from existing installed or new agricultural production wells.

Because stream flow is not gaged it’s difficult to assess whether available surface water can sustain projected agricultural needs. Anecdotal information of locally inadequate stream flow must be addressed in Strategy #4 above.

Climate Adaptation

Issue and Background: Data and research suggest that Hawai'i should be prepared for a future with a warmer climate, diminishing rainfall, declining stream base flows, decreasing groundwater recharge and storage, and increased coastal groundwater salinity, among other impacts associated with drought.

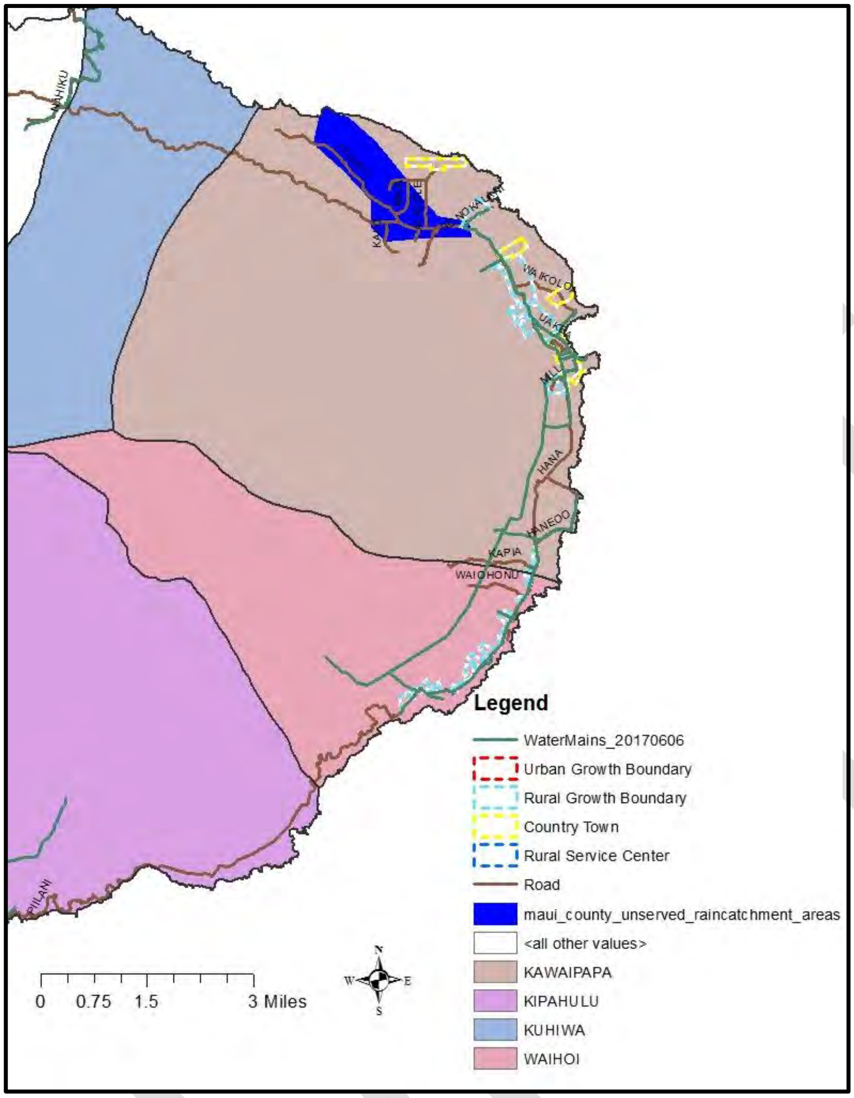
No streamflow projections are available for the coming century but projections include a decline in base flow and low flows, with stream flows becoming more variable and unstable (flashy), especially in wet years. [62] The impact on groundwater recharge will vary locally. A 2017 update to the Hawaii Drought Plan includes traditional and customary rights and practices as those potentially impacted by droughts. Reduced rainfall and streamflow reduce available water for domestic uses and irrigation, and degrading aquatic habitats where stream flora and fauna are gathered. Reduced stream flow may impact other cultural and religious practices, and terrestrial plants causing water stress.

Drought risk and vulnerability are assessed by the CWRM to illustrate the spatial extent and severity of drought risk for different impact sectors throughout the state. The statewide "*Drought Risk and Vulnerability Assessment and GIS Mapping Project"* assesses drought risk areas for three impact sectors: 1. water supply; 2. agriculture; and 3. wildland fire. Hāna is identified at moderate risk for water supply. [63] Areas served by groundwater have a lower risk of drought impacts. Communities that are supplied by surface water have a medium drought risk as most have storage capacity to carry them through short term declines in rainfall. The most vulnerable to drought are those households relying solely on rainwater catchment. The map below shows the general area within Hāna region that is not serviced by municipal supply or other known domestic sources and therefore more reliant on catchment systems.

[62] Summarized from EcoAdapt. 2016. Climate Changes and Trends for Maui, Lāna'i, and Kaho'olawe. Prepared for the Hawaiian Islands Climate Synthesis Project

[63] Wilson Okamoto Corp, County of Maui Drought Mitigation Strategies, 2012 Update

Figure 17-30 Hāna ASEA, Water Supply Drought Risk Area



No specific drought mitigation strategies are developed for this region. However, the 2017 update proposes general drought response and mitigation actions that apply state-wide. Recommended mitigation actions that apply for Hāna region include the following:

- Expand current network of rain gages to improve rainfall monitoring.
- Establish contingency water-hauling programs for livestock.
- Identify areas at risk to drought and plan for regional response actions and strategies.
- Develop additional storage and/or alternative sources of water supply.
- Develop and implement drought-related public awareness programs.
- Develop incentive programs for drought-resistant practices.

Strategy #5: Similar to other island sectors deemed at moderate to high risk of drought, convene sector-based drought workshops to assist stakeholders in developing or improving their individual drought/water conservation plans. Focus in the Hāna sector should be on catchment systems and contingency supply to supplement or substitute catchment when necessary. Cost estimate for other Maui sectors was about $50,000 with CWRM as proposed lead agency. It's recommended that CWRM with participation by MDWS and DOH (which regulates catchment systems) convene regional workshops as part of continuous updates of the State Water Plan.

17.8.4 Alternative Water Source Strategies

The Hāna Community Plan does not specifically address alternative water sources, such as gray water, catchment systems or stormwater capture. Surveys and input from the Hāna community as part of the WUDP update revealed strong support for the island-wide alternative resource strategies (WUDP Part II, Chapter 11.2), including increased stormwater reuse and recycled water use. Opportunities for exploring and adopting available alternative source options are discussed below but no strategies for implementation are proposed for water purveyors in the region.

Rainwater Catchment

Rainwater catchment is the collection of rainwater from a roof or other surface before it reaches the ground. Rainfall is sufficient throughout most of the aquifer sector to support traditional catchment systems. As discussed above, catchment systems are still vulnerable to drought conditions. Another issue is compromised water quality due to flawed design, wear and tear with no regulatory oversight once constructed. The recommended strategy above to convene workshops in East Maui to address catchment systems is also an opportunity for public education on proper design and maintenance to ensure safe water quality.

Recycled Wastewater

There is no wastewater reclamation in the Hāna region. Homes are served by septic systems and cesspools.

Stormwater Reuse

There are no large scale stormwater reclamation projects identified for Hāna. Stormwater reuse at the parcel scale may provide an opportunity to offset landscape agricultural uses within the region.

Desalination

Desalination is not feasible as alternative source as sufficient rainfall, ground and surface water resources are available.

17.9 Recommendations

Hāna is endowed with plentiful ground and surface water resources. As in ancient times, it's well known for its abundance of water and food. The challenge is to sustain and protect these natural resources that also traditional and cultural practices depend upon. The island wide strategies that address water quality (wellhead protection and well siting), conservation and energy efficiency measures will benefit the Hāna region and support the statewide initiatives to increase water security over the next decades.

Projected water demands based on the selected scenario and source strategies are summarized in the table below.

Table 17-37 Hāna ASEA Selected Demand Scenario: Projected Water Demand and Supply Options

DEMAND (GPD)	**2015**	**2020**	**2025**	**2030**	**2035**
MDWS Potable	448,966	472,336	496,485	521,657	548,467
Municipal Private Potable	157,877	166,094	174,586	183,438	192,865
DHHL Potable	0	0	51,700	105,460	117,700
Domestic Potable	152,262	160,187	168,377	176,914	186,006
Total Potable:	**759,105**	**798,617**	**891,148**	**987,469**	**1,045,038**
Irrigation Non-Potable	1,329	1,398	1,470	1,544	1,623
Agriculture, Non-Potable	1,220,722	1,281,063	1,342,066	1,403,069	1,464,868
DHHL, Non-Potable	0	0	0	0	255,000
Total Non-Potable	**1,222,051**	**1,282,461**	**1,343,536**	**1,404,613**	**1,721,491**
TOTAL DEMAND	**1,981,156**	**2,081,078**	**2,234,684**	**2,392,082**	**2,766,530**
SUPPLY (GPD)					
Potable Groundwater	**759,105**	**798,617**	**891,148**	**987,469**	**1,045,038**
Kīpahulu Aquifer	3,976	13,496	21,686	30,223	39,315
Kawaipapa Aquifer	608,438	638,430	722,771	810,555	859,032
Non-Potable Groundwater	1,329	1,398	1,470	1,544	1,623
Kūhiwa Aquifer	1,329	1,398	1,470	1,544	1,623
Non-potable surface water	1,220,722	1,281,063	1,342,066	1,403,069	1,464,868
Ambient rainfall	0	0	0	0	255000
TOTAL SUPPLY	**1,981,156**	**2,081,078**	**2,234,684**	**2,392,082**	**2,766,530**

The recommended strategies for the Hāna Aquifer Sector address the goals and objectives identified in the Hāna Community Plan and the WUDP public process for the region that evolve around resource protection and management; traditional uses of the region's natural resources and self-sufficiency.

The table below summarizes recommended strategies and indicates the planning objectives that each strategy supports. Estimated costs are, unless indicated otherwise, life cycle costs for the twenty-year planning period per 1,000 gallons. Life cycle costs include capital, operational and maintenance costs and include inflationary effects. The cost to develop and implement sustainability projects can be difficult to quantify per volume water supply. Lead agency, or organization to implement a strategy is proposed as a starting point. The time frame for implementation is indicated as short-term – less than 5 years, and long-term – 5–20 years. Many strategies are multi-year actions with implementation beginning within 5 years and continuing through the long-term (indicated as 1, 2).

Table 17-38 Summary of Recommended Strategies, Hāna ASEA

	STRATEGY	PLANNING OBJECTIVES	ESTIMATED COST	IMPLEMENTATION 1: Short-term 1 – 5 years 2: Long-term 5 – 20 years	
				AGENCY	TIME-FRAME
	RESOURCE MANAGEMENT				
1.	Seek dedicated, long-term and broad based core funding for maintaining and expanding watershed protection areas and providing for watershed maintenance in East Maui and Hāna watersheds for habitat protection and water security.	Maintain sustainable resources Protect water resources Protect and restore streams	$0.8M – $1M per year	MDWS Maui County CWRM DLNR	1
2.	Support and promote community grassroots initiatives to collaborate with state and land owner partnerships to increase participation in natural resource management and to ensure adequate access and opportunities for traditional uses of the region's natural resources. Use established moku process to consult on resource management	Maintain sustainable resources Protect water resources Protect and restore streams	N/A	Public-private partnerships Aha Moku DLNR Maui County	1
	CONVENTIONAL WATER SOURCE STRATEGIES				
3.	Complete optimization studies/source development analysis for the MDWS Hāna subsystem (PWS 217) in order to assess basal well development needs by 2025. Costs of regional well development is not assessed. Compare to 20 year life cycle costs estimated for Haiku/Central well development	Provide adequate volume of water supply Maximize reliability of water service Minimize adverse environmental impacts Provide for DHHL needs	$3.55 per 1,000 gallons	MDWS DHHL	2

4.	The Commission on Water Resource Management to establish Instream Flow Standards on a stream-by-stream basis to protect the public interests of the Hāna aquifer sector. Recognizing that other regions with competing off-stream needs must be prioritized, this strategy is proposed as a medium to long-term implementation time frame.	Protect and restore streams Protect cultural resources Maintain sustainable resources Protect water resources	N/A	CWRM USGS	2
5.	Convene sector-based drought workshops to assist stakeholders in developing or improving their individual drought/water conservation plans. Focus in the Hāna sector should be on catchment systems and contingency supply to supplement or substitute catchment when necessary.		$50,000	MDWS CWRM DOH	2

17.9.1 Implementation Program

In consistency with the Maui Island Plan, strategies recommended and adopted in the WUDP do not legally bind the agencies and organizations to execute. The recommendations provide guidance for land use and infrastructure, including the county CIP program, over the planning period.

Timing and prioritizing of resource strategies, particularly groundwater development are tied to actual population growth in this region. One key to sustain the traditional lifestyle and sense of place is prioritizing resource management and seeking guidance from the larger resourceful and knowledgeable community.

Over the planning period, implementation and performance of the recommended strategies can be assessed using qualitative criteria and quantitative targets formulated in the WUDP Part I, Table 3-3.

APPENDIX 17 A

Hāna ASEA Registered Surface Water Diversions

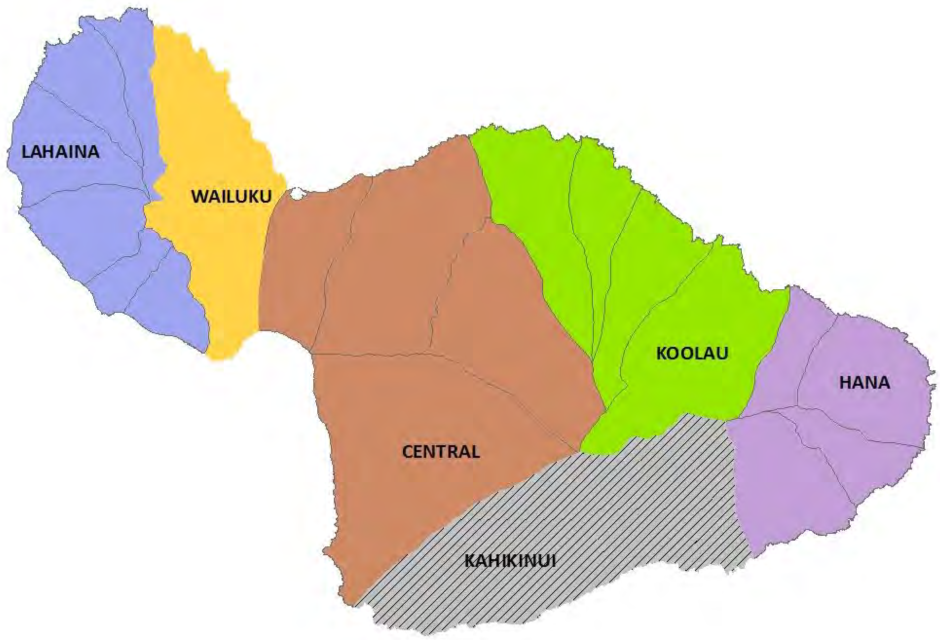
AQUIFER SYSTEM	Description	Q* (MGY)	HYDROLOGIC UNIT	LOCATION
KAWAIPAPA	Spring diversion, pump from Ho`opai Trough.	0.000	Heleleikeoha	Kawakoe Gulch
KAWAIPAPA	Stream diversion, pipe from unnamed stream. Three different maps are provided in the file with discrepancies as to the location of intake.	0.000	Heleleikeoha	Unmapped
KAWAIPAPA	Stream diversion, pipe from Honomā`ele Gulch (new entry).	0.000	Honomā`ele	Honomā`ele Gulch
KAWAIPAPA	Stream diversion, pipe from Honomā`ele Gulch. Filed in PARKER S file.	0.000	Honomā`ele	Honomā`ele Gulch
KAWAIPAPA	Spring diversion, taro lo`i, ditch, and rights claim.	0.000	Honomā`ele	Unmapped
KAWAIPAPA	Stream diversion, hose & bucket from Kapia Stream.	0.000	Kapia	Kapia
KAWAIPAPA	Stream diversion, from Kapia Stream tributary.	0.000	Kapia	Unmapped Tributary to Kapia
KAWAIPAPA	Stream diversion, pipe from Kawakoe Gulch.	0.100	Kawakoe	Kawakoe Gulch
KAWAIPAPA	Stream diversion, pipe from Kawakoe Stream.	0.000	Kawakoe	Kawakoe Gulch
KAWAIPAPA	Stream diversion, from Kawakoe Stream (new entry).	0.000	Kawakoe	Kawakoe Gulch
KAWAIPAPA	Stream diversion, pipe from Mokulehua Stream.	0.000	Kawakoe	Kawakoe Gulch
KAWAIPAPA	Stream diversion, pipe from Kawakoe Gulch Stream. SYKOS S&L is an end user and co-operator.	0.000	Kawakoe	Kawakoe Gulch
KAWAIPAPA	Stream diversion, pipe from Mokulehua Stream.	0.527	Kawakoe	Mokulehua Gulch
KAWAIPAPA	Stream diversion, 2 pipes from Mokulehua Stream.	0.000	Kawakoe	Mokulehua Gulch
KAWAIPAPA	Stream diversion, from Mokuleia Stream diversion. Location of water use is probably on parcel #14.	0.000	Kawakoe	Mokulehua Gulch
KAWAIPAPA	Stream diversion, from Mokulehua Stream (new entry).	0.000	Kawakoe	Mokulehua Gulch
KAWAIPAPA	Stream diversion, from Mokulehua Stream (new entry).	0.000	Kawakoe	Mokulehua Gulch

AQUIFER SYSTEM	Description	Q* (MGY)	HYDROLOGIC UNIT	LOCATION
KAWAIPAPA	Stream diversion, from Mokulehua Stream (new entry).	0.000	Kawakoe	Mokulehua Gulch
KAWAIPAPA	Stream diversion, from Mokulehua Stream (new entry).	0.000	Kawakoe	Mokulehua Gulch
KAWAIPAPA	Stream diversion, pipe from Mokulehua Stream.	0.120	Kawakoe	Mokulehua Gulch
KAWAIPAPA	Spring diversion, pipe from Unnamed spring.	0.000	Kawakoe	Mokulehua Gulch
KAWAIPAPA	Stream diversion, from Kawakoe Stream (new entry).	0.000	Kawakoe	Unmapped Tributary to Kawakoe Gulch
KĪPAHULU	Stream diversion, pipe from Pu`ualu`u Stream.	0.000	Kalena	Kalena
KĪPAHULU	Stream diversion, Kalepa Intake from Kalepa Gulch. Method for determining quantity of use not provided.	1.326	Kalepa	Kalepa Gulch
KĪPAHULU	Stream diversion, pipe from Kalepa Stream tributary. Q was estimated from pipe output.	5.256	Kalepa	Unmapped Tributary to Kalepa Gulch
KĪPAHULU	Stream diversion, pipe from Koukouai Stream. Declared Q was measured with bucket and stop watch.	0.090	Koukouai	Kaukauai Gulch
KĪPAHULU	Stream diversion, pipe from Kaukauai Stream.	0.073	Koukouai	Kaukauai Gulch
KĪPAHULU	Stream diversion, probably hand-carry from Kukui`ula Stream for irrigation. No diversion structure.	0.000	Kukui`ula	Kukui`ula Gulch
KĪPAHULU	Stream diversion, pump from Manawainui and rights claim.	0.000	Manawainui	Manawainui
KĪPAHULU	Stream diversion, from Panileihulu and Healani Streams. Method for determining quantity of use not provided.	1.326	Manawainui	Tributary to Manawainui
KĪPAHULU	Spring diversion, pump from Manawainui Spring.	0.000	Manawainui	Unnamed Spring
KĪPAHULU	Spring diversion, pipe from Pa`anene and rights claim.	0.000	Nuanua`aloa	Pa`anene Spring
KĪPAHULU	Spring diversion, pump from Punahoa Spring.	0.000	Nuanua`aloa	Punahoa Spring
KĪPAHULU	Spring diversion, pipe from Maili Spring and rights claim.	0.000	Nuanua`aloa	Unmapped Spring
KĪPAHULU	Stream diversion, pump from Opelu Stream and rights claim.	0.000	Opelu	Opelu Gulch
KĪPAHULU	Stream diversion, from seepage with pipe.	0.000	Opelu	Unmapped Spring

AQUIFER SYSTEM	Description	Q* (MGY)	HYDROLOGIC UNIT	LOCATION
KĪPAHULU	Stream diversion, pipe from Pua'alu`u Stream.	0.570	Pua`alu`u	Pua`alu`u Gulch
KĪPAHULU	Stream diversion, pipe from Pua`alu`u Stream. According to info in the KĪPAHULU HUI file, the ASSOC gets water from TMK 1-5-11:07. Method for determining quantity not provided.	10.950	Pua`alu`u	Pua`alu`u Gulch
KĪPAHULU	Spring diversion, pipe from Unnamed spring. Q was estimated with 5-gallon bucket. Declared Q or 14.600 MG is the total for both of declarant's diversions.	14.600	Pua`alu`u	Unmapped Spring
KŪHIWA	Stream diversion, hand carry from Heleleikeoho Stream and rights claim.	0.000	Heleleikeoha	Heleleikeoha
KŪHIWA	Stream diversion, hand carry from Heleleikeoho Stream and rights claim.	0.000	Heleleikeoha	Heleleikeoha
KŪHIWA	Stream diversion, from Heleleikeoha Stream.	0.050	Heleleikeoha	Heleleikeoha
KŪHIWA	Stream diversion, pipe from Heleleikeoho Stream. Filed under ESTOCADO WWP.	0.000	Heleleikeoha	Heleleikeoha
KŪHIWA	Stream diversion, hand carry from Kakamalaole Stream and rights claim.	0.000	Heleleikeoha	Unmapped
KŪHIWA	Spring diversion, hand carry from Unnamed stream and rights claim.	0.000	Heleleikeoha	Unmapped Spring
KŪHIWA	Spring diversion, pipe from Unnamed Stream. May be unused or intended.	0.000	Heleleikeoha	Unmapped Spring
KŪHIWA	Stream diversion, hand carry from Kakamalaole and rights claim.	0.000	Heleleikeoha	Unmapped Tributary to Heleleikeoha
KŪHIWA	Stream diversion, carry from Koala`alaole and rights claim.	0.000	Heleleikeoha	Unnamed
KŪHIWA	Stream diversion, hand carry from Koala`alaole Stream and rights claim.	0.000	Heleleikeoha	Unnamed
KŪHIWA	Stream diversion, from unnamed stream and rights claim. See also new entries.	0.000	Heleleikeoha	Unnamed
KŪHIWA	Stream diversion, pipe from Koala`alaole Gulch. Declared Q is the total amount used from 4 diversions, however, three of these appear to be end uses.	0.204	Heleleikeoha	Unnamed
KŪHIWA	Stream diversion, pipe from Unnamed stream. May be unused.	0.000	Kea`aiki	Kea`aiki Gulch
KŪHIWA	Stream diversion, pipe from Kea`aiki Tributary.	0.000	Kea`aiki	Unmapped Tributary to Kea`aiki Gulch

AQUIFER SYSTEM	Description	Q* (MGY)	HYDROLOGIC UNIT	LOCATION
KŪHIWA	Spring diversion, from unmapped spring-fed pond.	0.050	Lanikele	Unmapped Spring/Pond
KŪHIWA	Stream diversion, pipe from Kahalaoka Gulch.	0.210	Waihole	Waihole Gulch
KŪHIWA	Stream diversion, pipe from Waihole Stream.	0.000	Waihole	Waihole Gulch
KŪHIWA	Stream diversion, pipe from Waione Stream and rights claim.	0.000	Waioni	Unmapped Tributary to Waioni Gulch
KŪHIWA	Stream diversion, pipe from Waioni Stream and rights claim.	0.000	Waioni	Waioni Gulch
WAIHO`I	Stream diversion, auwai from Ala`alaula Stream and rights claim.	0.000	Ala`alaula	Ala`alaula Gulch
WAIHO`I	Spring diversion, pipe from Unnamed spring. Q was estimated with a bucket and stop watch.	2.628	Ala`alaula	Unmapped Spring
WAIHO`I	Stream diversion, pipe from Hahalawe Gulch.	0.000	Hahalawe	Hahalawe Gulch
WAIHO`I	Stream diversion, pipe from Kakiweka Stream.	0.012	Kakiweka	Unmapped Pond
WAIHO`I	Stream diversion, pipe from Kapia Tributary. Q was estimated with a meter.	0.840	Kapia	Unmapped Tributary to Kapia
WAIHO`I	Spring diversion, pipe from Unnamed spring. Q was estimated with 5-gallon bucket. Declared Q or 14.600 MG is the total for both of declarant's diversions.	14.600	Puaalu`u	Unmapped Spring
WAIHO`I	Stream diversion, from Unnamed Spring. Declared Q was estimated from a 5-gal bucket. While the diversion is located within the Wailua Watershed, the property is also within the Ala`alaula Watershed.	0.010	Wailua	Unmapped Spring
WAIHO`I	Stream diversion, auwai from Unnamed stream and rights claim.	0.000	Wailua	Wailua
WAIHO`I	Stream diversion, pipe from Wailua Stream. May be unused or intended.	0.000	Wailua	Wailua
	TOTAL	**53.542**		

* Quantity of water use declared through Registration



MAUI ISLAND WATER USE AND DEVELOPMENT PLAN DRAFT

PART III REGIONAL PLANS

KAHIKINUI AQUIFER SECTOR AREA

Table of Contents

List of Tables

List of Figures

18.0 KAHIKINUI AQUIFER SECTOR AREA

This CWRM aquifer sector combines the Kaupō, Kahikinui and Kanaio community areas into three groundwater aquifer system areas--Kaupō, Nakula, Luala`ilua respectively--that comprise the Kahikinui Aquifer Sector Area (ASEA). The Kahikinui ASEA encompasses about 113 square miles. The population of the much smaller Kahikinui place name area within the ASEA, which excludes Kaupō and Kanaio, and is entirely comprised of Department of Hawaiian Homelands (DHHL) homesteaders, was estimated to be 32.[1] The population of Kaupō is estimated to be approximately 59 residents, and the population in the scattered residences in Kanaio is also estimated to be approximately 59 residents.[2] The total population of the Kahikinui ASEA is estimated to be 150.

The WUDP uses hydrologic units for analysis to be consistent with State requirements for updating the plan. The Kahikinui ASEA is mostly contained within the Hāna Community Plan boundary, with the exception of small areas on the southwest tip of Maui Island which are contained within the Makawao-Pukalani-Kula and Kīhei -Mākena Community Plans. The Kahikinui ASEA also extends into the moku of Honua`ula and Kaupō. The DHHL Kahikinui Kuleana Homestead Program created 104 lots over the last 20 years, making that area one of the three most populated communities in the Kahikinui ASEA. Approximately 75 homesteaders have accepted the leases of 10-20 acres each in the mid-elevation levels between 2,000–4,000 feet, but many of them are residents of other areas and only live in Kahikinui part-time. About 13 families currently reside on the property full-time and approximately 20 homes have been constructed. The projected population increase by 2035 is anticipated to be negligible. According to the Maui Island Plan, the 75 kuleana lots in Kahikinui are off-grid and lack public water, electricity, sewer, or cable systems. These residents have built homes on the rough terrain and live a life that is far removed from the typical Maui resident.

[1] Department of Hawaiian Homelands, Kahikinui Regional Plan, July 2011, page 5

[2] Maui County Data Book 2014, average 2.94 persons per single family household 2010-2014 multiplied by the 20 MDWS single family dwelling water meter connections

18.1 PLANNING FRAMEWORK

18.1.1 Key Issues

The Kahikinui region needs to successfully assess and implement alternative ways to meet their present and future water needs. Given their remote and sparse rural population, water resources and infrastructure are relatively undeveloped. Climatic changes could result in a significantly decreased recharge of groundwater and available surface water currently relied upon for non-potable needs. Region-specific input received at community meetings and workshops generally focused on the following issues:

General Issues

- Improve understanding of the concepts of "precautionary planning" to reduce and adapt to the effects of drought and climate change upon water resource availability and quality.
- Adapt future populations to local water resource conditions, integrating conservation and the use of alternative resources.
- It is important to maintain access to lands for gathering, hunting and other native Hawaiian traditional and customary practices.
- Water needs of DHHL in Kahikinui should be considered in accordance with the 2016 State Water Projects Plan.
- Watershed protection should be implemented, including invasive alien plant control, ungulate control, and reforestation via watershed partnership programs.
- Mutual benefits could be gained from the State and National Park Service engaging in consultation and coordination with Native Hawaiian moku/community and local experts on resource management.

Kaupō-Specific Issues

- The Kaupō Rule is a special rule prohibiting the approval of subdivisions and building permits, and the issuance of water meters in the interim regulation area: defined as all areas where water to the public is or is to be supplied from Kalepa Gulch, Healani Intake, and Puanohoa Pump water sources in Kaupō.
- The Kaupō system has evolved as a non-potable hybrid system owned by MDWS and the Kaupō Ranch with undefined responsibilities for management and repairs.
- Potential impact on animal migration and local hunting from fencing to reduce ungulates in Kaupō/Kahikinui areas. Dead animals reported in streams that could pollute the water.
- Community desires improved information and participation to reduce feral goat population, and especially information on aerial hunting to ensure safety.
- Engaging Moku and the community associations in resource conservation and protection projects undertaken by government and other organizations.

18.1.2 Plans, Goals, Objectives and Policies

The Kahikinui ASEA implements the Maui County General Plan and is subject to the plans, goals, policies and objectives discussed in Chapter 3 of the WUDP. The Hāna Community Plan reflects regional issues expressed at the community WUDP meetings and relevant goals and policies of the Hāna Community Plan are summarized below.

1994 Hāna Community Plan

Community Plan goals related to water resources are:

- Protection and management of land, water and ocean resources
- Timely and environmentally sensitive development and maintenance of infrastructure systems, including the provision of domestic water

Objectives and policies related to water resources include:

- Protect, preserve and increase natural marine, coastal and inland resources, encouraging comprehensive resource management programs
- Ensure that groundwater and surface water resources are preserved and maintained at capacities and levels to meet the current and future domestic, agricultural, commercial, ecological and traditional cultural demands

Objectives and policies related to water availability and use include:

- Recognize residents' traditional uses of the region's natural resources which balance environmental protection and self-sufficiency
- Discourage water or land development and activities which degrade the region's existing surface and groundwater quality
- Encourage resource management programs that maintain and re-establish indigenous and endemic flora and fauna
- Protect, restore and preserve native aquatic habitats and resources within and along streams
- Improve water source and delivery facilities to ensure that water supplied to the region's residents and visitors is of the highest quality
- Encourage water conservation measures by residents and businesses

18.2 PHYSICAL SETTING

Haleakalā was built primarily by volcanic eruptions and layers of lava flows.[3] The drier western slope is less incised and retains the broad, shield shape of the volcano.[4] The Kahikinui Aquifer Sector Area (ASEA) is located on the southern flank of Haleakalā Mountain, which rises 9,700 feet above sea level, and it is a rural, sparsely-populated region which is remote and lacks typical infrastructure for the existing or future populations. The residents often rely on local resources to meet their needs, and the area is famously dry compared to other areas of Maui Island. Kaupō is located along the southeastern shore of Maui, bordering the western side of Kipahulu and the eastern side of Kahikinui. The Kahikinui Forest Reserve is located in the area, as well as a section of Haleakalā National Park. A trail leads from near the summit of Haleakalā through Kaupō Gap and allows mauka-to-makai foot or horse travel from the top of Haleakalā to the ocean. Kaupō is connected to the rest of the island—Kula to the North and Hāna to the east--via the Pi`ilani Highway (Hawai`i Route 31), a primarily one lane wide highway that is unpaved in some sections.

18.2.1 Climate and Geology

The mountains of the Hawaiian Islands typically obstruct northeastern trade-wind air flow in the drier climates on southwest-facing (leeward) mountain slopes found in the Kahikinui ASEA.[5] Loss of moisture from air that ascends windward slopes leads to relatively drier climates along leeward slopes because they are in the rain shadow of the mountains.[6] Mean rainfall is less than 25 inches/year for most leeward areas along the coastline.[7] The Kahikinui ASEA contains a freshwater-lens system that consists of a lens-shaped freshwater body, an intermediate brackish-water transition zone, and underlying saltwater. Fresh groundwater within the freshwater-lens system generally flows in a seaward direction toward the coast from inland areas of Kahikinui, Kanaio and Kaupō. Wedges of low-permeability sedimentary caprock impede the seaward flow of fresh groundwater in freshwater-lens systems. Kahikinui encompasses a vast arid area composed of the most recent lava flows of the now dormant/extinct Haleakalā caldera. Although Haleakalā first rose above sea level about 900,000 years ago as a vast shield of olivine theoliite basalt lava flows, about 700,000 years ago, shield growth slowed, and explosive eruptions began to dominate the landscape, as can be seen with the many pu`u and cinder cone craters that now dot the coastline. The southern flank of Haleakalā slopes seaward at an angle of more than 20 degrees: steeply enough to suggest that sliding may have contributed, although no evidence of

---

[3] Langenheim, V.A.M., and Clague, D.A., 1987, The Hawaiian-Emperor volcanic chain, part II, stratigraphic framework of volcanic rocks of the Hawaiian Islands, chap. 1 *of* Decker, R.W., Wright, T.L., and Stauffer, P.H., eds., Volcanism in Hawaii: U.S. Geological Survey Professional Paper 1350, v. 1, p. 55–84. Leavesley, G.H., Lichty,

[4] Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai`i, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168, 53 p., http://dx.doi.org/10.3133/sir20145168.

[5] Sanderson, Marie, 1993, Introduction, chap. 1 *of* Sanderson, Marie, ed., Prevailing trade winds: Honolulu, Hawaiʻi, University of Hawaiʻi Press, p. 1–11.

[6] Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially distributed groundwater recharge estimated using a water-budget model for the Island of Maui, Hawaiʻi, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168, 53 p., http://dx.doi.org/10.3133/sir20145168.

[7] Ibid.

sliding has been found on the adjacent ocean floor. The most "recent" volcanic activity around Kahikinui may have been noted first in 1786, when French explorer La Perouse mapped an embayment near the southern cape of the island in the vicinity of Mākena and Kanaio, opposite Kaho`olawe. Later, in 1793, George Vancouver, sailing the same waters, found a peninsula of fresh lava entering the ocean where La Perouse had mapped a bay. These observations coincide with native Hawaiian culture-history accounts of a recent visit by Pele, the Hawaiian fire goddess, indicating that an eruption had recently taken place. Recent activity that has taken place within 230 years will not be the last.[8]

18.2.2 Water Resources

The Kahikinui ASEA water budget is reliant on fog and sparse rainfall for most of the groundwater recharge. The Kanaio, Kaupō and Kahikinui community areas are located on a very rugged and dry side of the island, where the rainfall is typically between 20 and 50 inches.[9] For southeast Haleakalā, information related to groundwater systems is sparse in the area encompassing the Kahikinui ASEA, although perched and freshwater lens systems are expected to be present.[10] Global climatic change and drought may cause future water availability conditions to dramatically decrease in this already dry area. Compared to other areas on Maui, the Kahikinui ASEA is expected to suffer the most drought-related reductions in available water. Groundwater recharge during drought conditions is predicted to be potentially reduced by 37 percent, compared to an island-wide average of about 23 percent.

Table 18-1 Recharge for Average and Drought Climate Conditions, Kahikinui ASEA

May 2017 Corrected Recharge Average Climate Conditions	Recharge Drought Climate Conditions	% Drought Recharge Reduction (USGS)
85 mgd*	56 mgd	37%

Source: USGS, Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for The Island of Maui, Hawai`i, 1978–2007

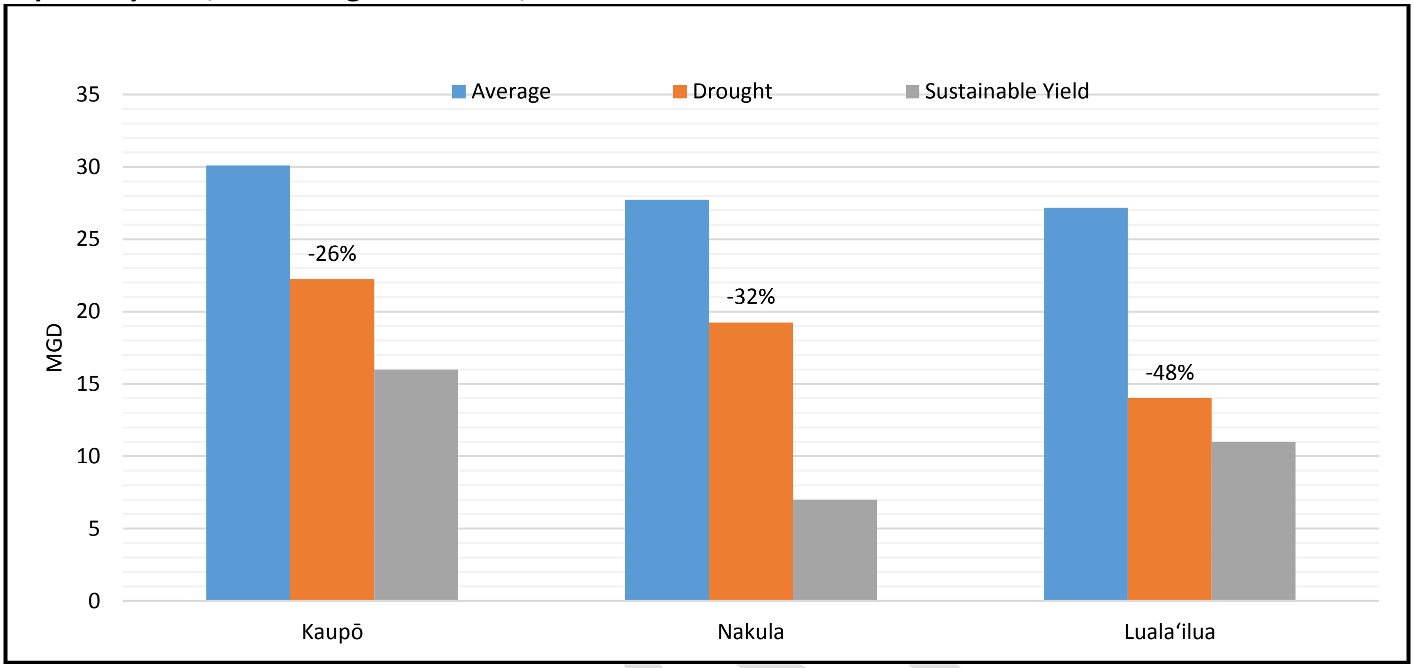
* In 2017, USGS discovered an error in data that affected published groundwater-recharge estimates for Maui and other islands. The recharge estimated for 1978 – 2007 rainfall and 2010 land-use conditions were revised and available on May 16, 2017

Groundwater Recharge

Groundwater recharge describes the amount of water that gets from the air, through the soil, and ultimately into the groundwater and aquifers. The 2014 USGS study, *Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawai'i, 1978–2007*, reassessed average climate conditions on recharge using 2010 land cover.

[8] Hazlett, Richard W. and Hyndman, Donald W., *Roadside Geology of Hawai`i*, page 129.
[9] Johnson, Adam G, John A. Engott, and Bassiouni, Maoya, 2014, Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai'i, 1978–2007, U.S. Department of the Interior, U.S. Geological Survey Scientific Investigations Report 2014–5168.
[10] Ibid.

Figure 18-1 Kahikinui ASEA: Average Mean Recharge under Average Climate and Drought Conditions by Aquifer System, % Recharge Reduction, and Sustainable Yield



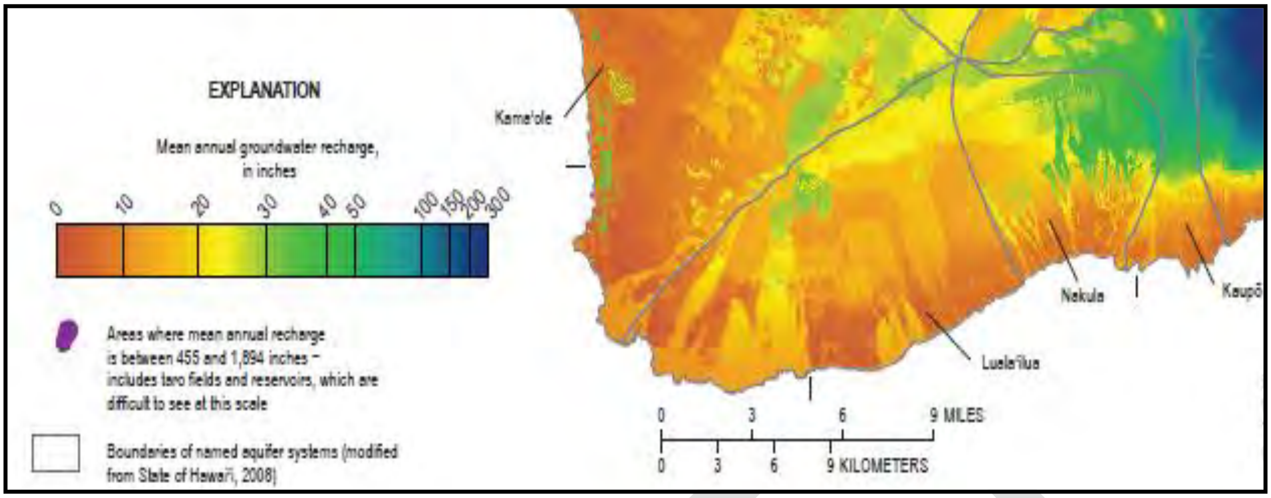
Source: USGS Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawaiʻi, 1978–2007, Tables 7 and 8; Scenario A, Average climate conditions are 1978–2007 rainfall and 2010 land cover. Drought conditions are 1998–2002 rainfall and 2010 land cover. WRPP- 1990, updated 2008 from CWRM, natural conditions are 1916–83 mean rainfall and a uniform, unirrigated land cover. Scenario study areas are larger than WRPP areas. Total Inflow includes rain, fog, irrigation, septic leachate, and direct recharge which may be from external sources, including groundwater and imported streamflow.

Maui has experienced drought conditions in recent years. For example, based on the 1978–2007 monthly rainfall datasets, annual rainfall for the island of Maui was below average 8 out of the last 10 years from 1998 to 2007.[11] Global climatic change and drought conditions may cause future water conditions to dramatically decrease in an already dry area. The impacts of changing climate and weather patterns may have a significant effect on the Kahikinui area. For the study data that follows, direct recharge was defined as water that passes directly to the groundwater system, completely bypassing the plant-root zone. Hence, direct recharge was not subject to direct runoff or evapotranspiration processes.[12] The three Maui Island aquifer systems with the least recharge are located on leeward Haleakalā and include Kahikinui's Luala`ilua.[13]

As Indicated in Figure 18-2 below, Kahikinui Aquifer Sector encompasses some of the dryer areas of Maui Island and recharge has decreased dramatically in the 21st century, especially in the lower elevations.

[11] Frazier, A., 2012, Month-year rainfall maps of the Hawaiian Islands: Honolulu, University of Hawaiʻi, M.A. thesis, 81 p.
[12] Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially distributed groundwater recharge estimated using a water-budget model for the Island of Maui, Hawaiʻi, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168, 30.p
[13] Ibid 34 p.

Figure 18-2 Kahikinui ASEA: Distribution of Mean Annual Groundwater Recharge for Average Climate Conditions



Source: USGS, Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai'i, 1978–2007.

The spatial pattern of mean annual recharge for drought conditions on the Island of Maui resembles that for average climate conditions; however, recharge for most areas is lower for drought conditions.[14] Recharge estimates for dry aquifer systems in Kahikinui (e.g., Luala'ilua) are more sensitive to parameters related to evapotranspiration**.** Scientific investigation and downscaling of climate projections by Pacific Regional Integrated Sciences and Assessments (RISA) and others suggest that leeward areas such as the Kahikinui ASEA will get drier.

Groundwater Availability

The groundwater sustainable yield (SY) is the maximum rate that groundwater can be withdrawn without impairing the water source, as determined by the Commission on Water Resource Management (CWRM). Sustainable yield accounts only for basal ground water and ignores any importation of water from outside the aquifer, if it exists, and SY accounts for basal, perched, and high-level water. Because very little of Kahikinui ASEA pumpage is reported, only a tiny fraction of the Kahikinui ASEA sustainable yield appears utilized. The 2008 sustainable yield for the Kahikinui ASEA is 34 mgd: (1) Luala`ilua 11 mgd; (2) Nakula 7 mgd; and (3) Kaupō 16 mgd.[15]

[14] Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai'i, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168, 45 p.

[15] CWRM, *State Water Resource Protection Plan*, June 2008

Table 18-2 Sustainable Yields of Aquifer System Areas

Kahikinui Aquifer System Area	Aquifer Code	2008 WRPP Sustainable Yield (mgd)
Kaupō	60601	16
Nakula	60602	7
Luala`ilua	60603	11

Source: CWRM, *State Water Resource Protection Plan*, June 2008.

Surface Water Availability

There are no perennial streams within the Kahikinui ASEA. The USGS topographic map shows intermittent streams of Kama`ole, Kepuni, Palaha and Manawainui within the Kahikinui ASEA.[16] As the map below indicates, stream reaches on leeward Haleakalā tend to be very "intermittent" and short-lasting. Perennial stream resources in the Kahikinui Aquifer System area are almost non-existent, with few perennials except three in Kaupō Aquifer System, which sometimes lack mauka-to-makai flow.

Only one Kahikinui ASEA stream is diverted. The table below shows registered or permitted diversions, gages and Interim Instream Flow Standards (IIFS). No numerical IIFS are established for the Kahikinui region.

Table 18-3 Kahikinui ASEA Stream Diversions, Gages and IIFS by Watershed Unit

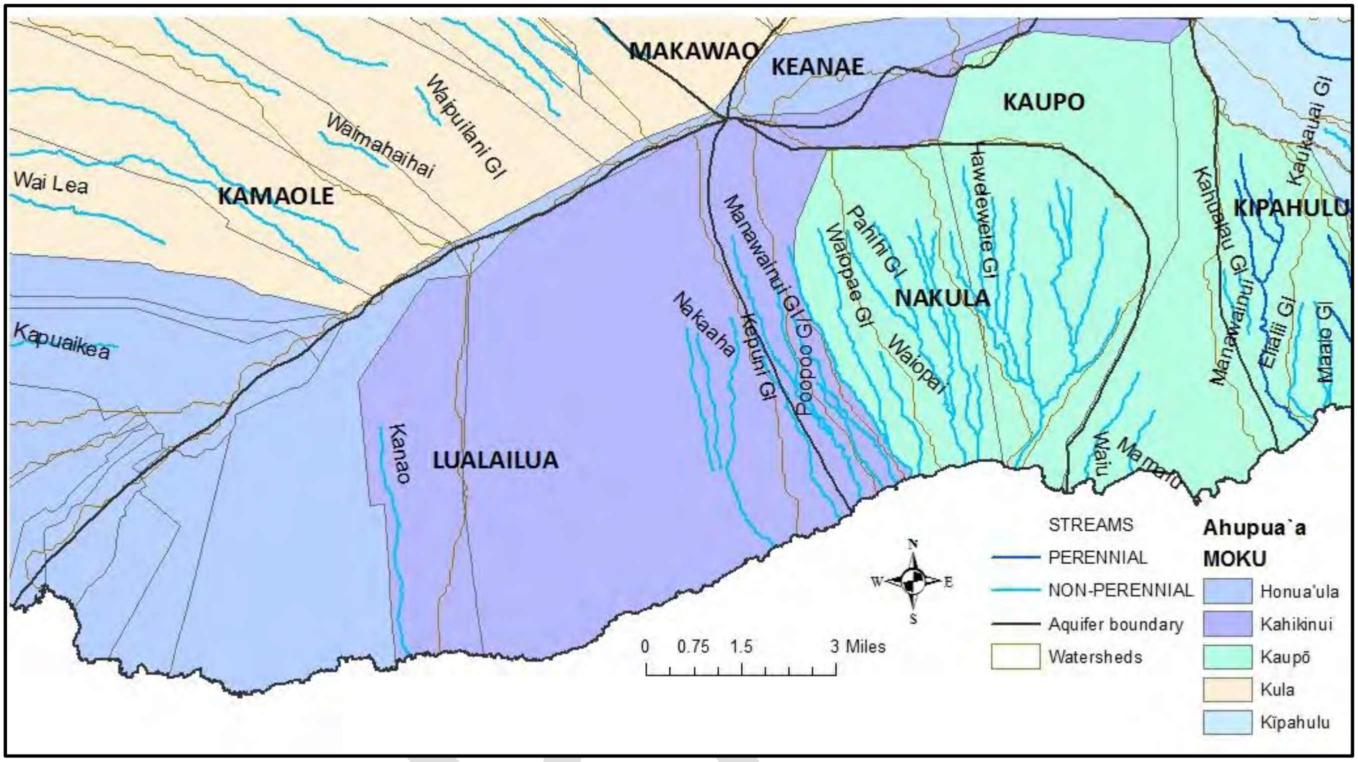
Code Unit	Hydrologic Unit Name	Aquifer System	Area (mi^2)	No. of Diversions	No. of Gages	Active Gages	Interim IFS
6100	Kaupō	Kaupō	22.5	1	0	0	HAR §13-169-44
6101	Nu`u	Nakula	10.48	0	1	0	HAR §13-169-44
6102	Pahihi	Nakula	7.85	0	0	0	HAR §13-169-44
6103	Wai`ōpai	Nakula	5.38	0	0	0	HAR §13-169-44
6104	Po`opo`o	Nakula	1.92	0	0	0	HAR §13-169-44
6105	Manawainui Gulch	Nakula	6.07	0	0	0	HAR §13-169-44
6106	Kipapa	Luala`ilua	28.42	0	1	0	HAR §13-169-44
6107	Kanaio	Luala`ilua	34.11	0	0	0	HAR §13-169-44

Source: CWRM, *State Water Resources Protection Plan*, 2008.

[16] Department of Hawaiian Homelands, Kahikinui Regional Plan, July 2011, page 21.

The figure below shows perennial and non perennial streams, and the relationship between aquifer systems, ahupua`a, moku and watersheds boundaries.

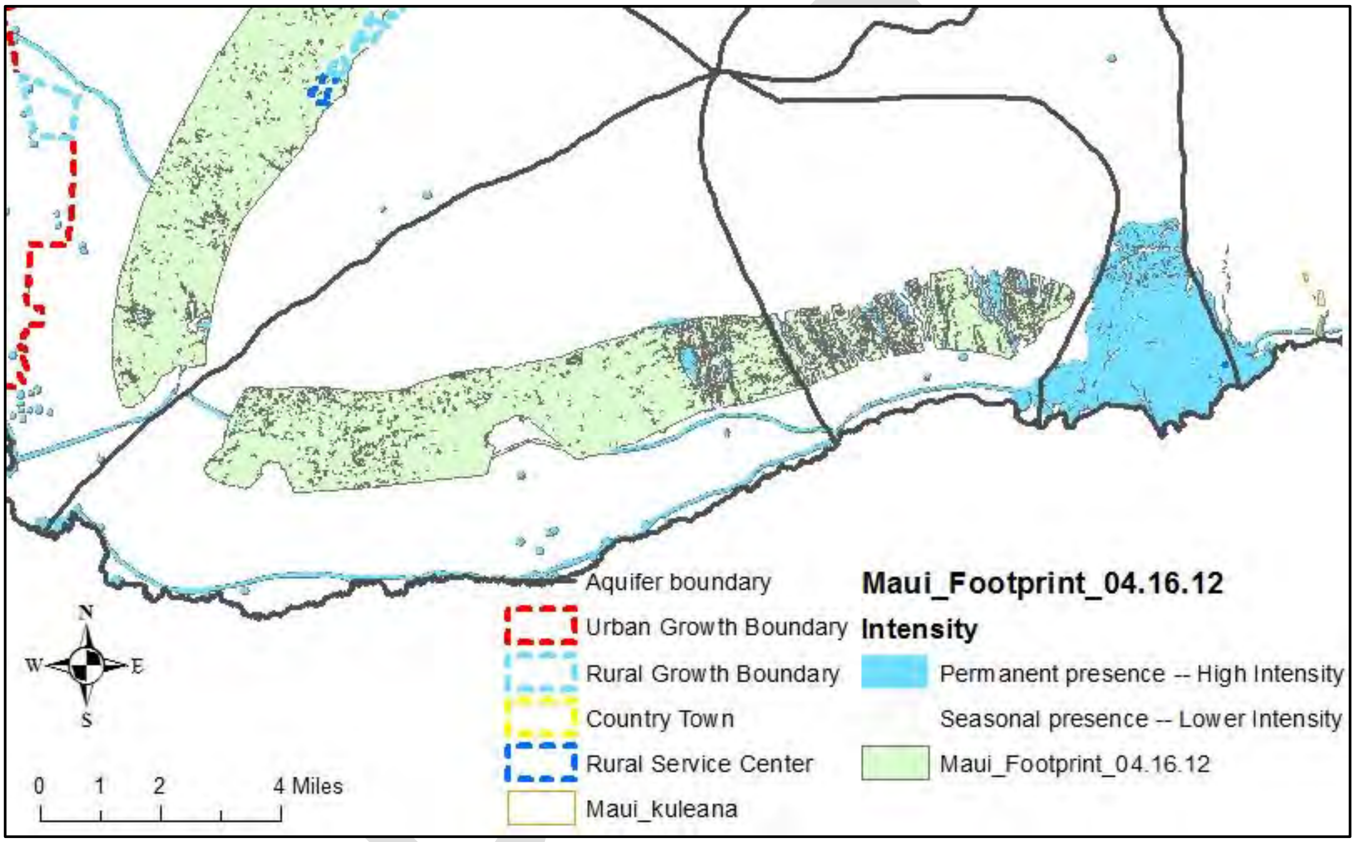
Figure 18-3 Kahikinui ASEA: Relationship of Aquifer System Areas, Watersheds, Moku and Streams



18.3 SETTLEMENT PATTERNS AND CULTURAL RESOURCES

This section strives to acknowledge and highlight how Hawaiian history and cultural practices of the past relate to the present. History can inform options for meeting the future water needs of the people and uses of Maui Island, while preserving and celebrating Hawai`i's past. Archaeology and traditional Native Hawaiian historic and cultural information provides a foundation for establishing continuity between past, present and future water use. The figure below shows estimated pre-contact land utilization in this aquifer sector.

Figure 18-4 Estimated Native Hawaiian Pre-Contact Land Utilization and Kuleana Lands Compared to Growth Boundaries



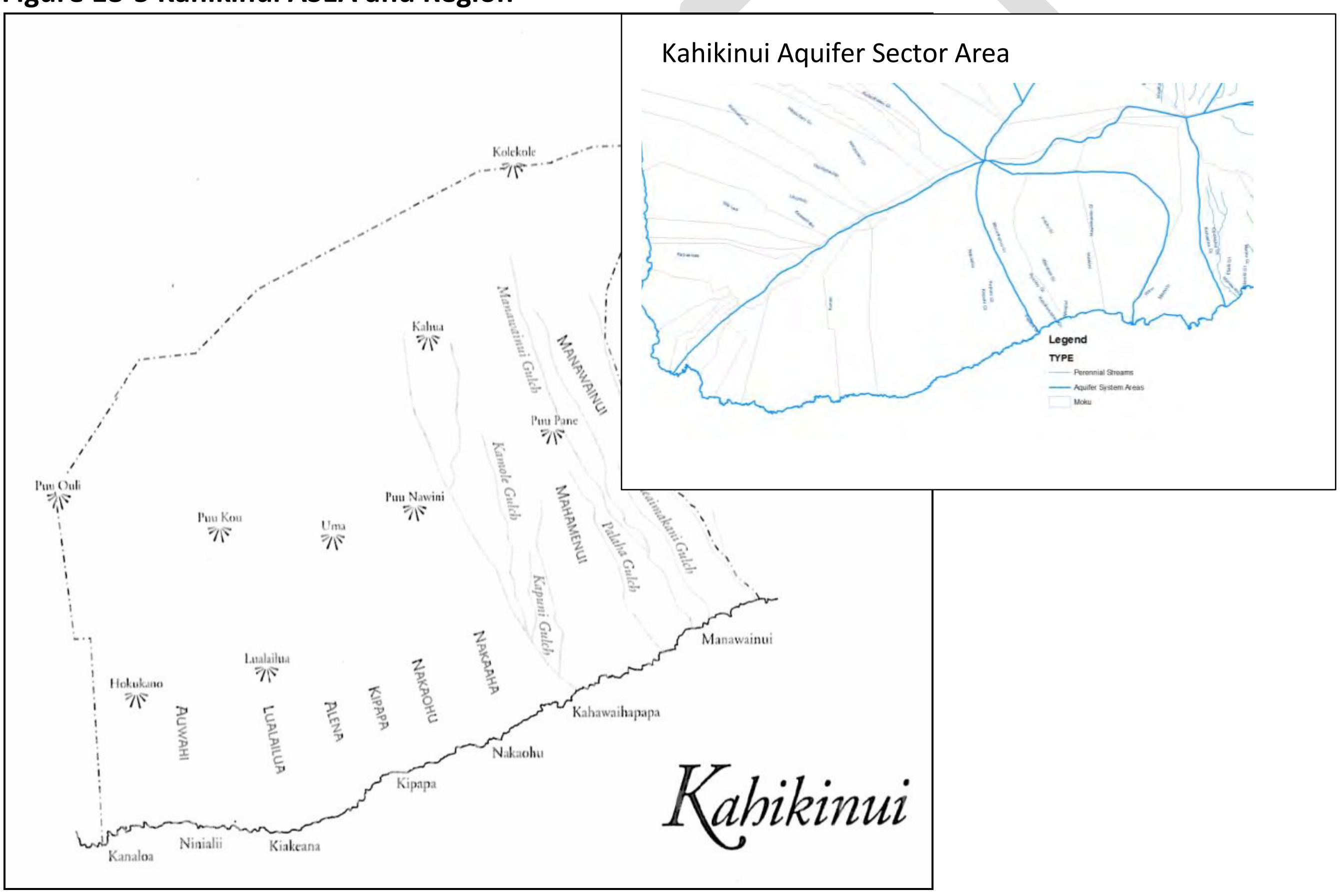
Source: The Nature Conservancy, Ladefoged, T.N. et al (2011), and Maui County Island Plan

18.3.1 Historical Cultural Resources and Boundaries

Historical and contemporary boundary delineations of Kahikinui differ from the boundaries defined by the Kahikinui ASEA used in the WUDP. The historical delineation begins at Auwahi at the far western boundary, moving eastward to Wai`opae Gulch on the border of Kaupō. The Kahikinui ASEA includes the eastern half of the moku of Honua`ula, all of the moku of Kaupō, and the western portion of Kipahulu up to the ahupua`a of Ka`apahu.

Ancient history provides evidence that the now sparsely populated area of Kahikinui once had a sizable population. Walker`s study of Kahikinui estimates a population of 1,500 to 1,800 along the south coast.[17] His archaeological survey describes the villages as quite numerous and indicating an extensive population, although he noted at the time of his writing (early 1900s) "there is not a man living within twenty miles." The Hāna Community Plan indicates many intact village sites and heiau remain in Kahikinui.[18] Because of the rugged terrain, the vast, arid and windy district in traditional times isolated communities of Native Hawaiians who inhabited the predominantly rugged lava landscapes along the shoreline or further inland where fresh water could be found. Sterling notes, "Many of the shore villages possessed stone-lined wells which supplied brackish water for drinking purposes. In one or two places along the Kahikinui shore, small rivulets had been dammed to impound some other water which came down with the freshets [stormflow]." Sterling also cites the lack of drinkable water available in Kahikinui in a recorded missionary journey, "No sweet water on this part of the island."[19] The comparatively larger historical population and increasing scarcity of water may speak to the potential the area has today for conventional water resources and repopulation.

Figure 18-5 Kahikinui ASEA and Region



Source: Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997.

---

[17] Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 193

[18] County of Maui Hāna Community Plan, 1994

[19] Richards, Andrews, and Gren, *Tours around Maui and Molokai*, August 27, 1828, Missionary letters 3:877, Hawaiian Mission Children's Society Library {Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 197]

18.3.2 Historic Agriculture

Kahikinui's cultural history describes isolated pre-history Hawaiian villages cultivating crops within the inland forest zone, where forests along the southern wall of Haleakalā formerly extended much lower due to more plentiful rainfall. Sweet potato was the staple food for much of the historical Kahikinui population, and it was supplemented with dry taro grown in the low forest zones, making the area the greatest continuous dry planting area in the Hawaiian Islands; however, by the 1890s, the ancient subsistence agriculture had completely vanished from the vast slopes and had been replaced by cattle ranching.[20] This description of historic dryland agriculture may also be considered testimony to the relative scarcity of fresh water in the area, and it may lend insight into the agricultural potential that could be realized today and in the future. The Hāna Community Plan indicates that Kahikinui is said to have been heavily wooded and populated before devastating lava flows and fires in the mid-1800s, and over-grazing destroyed much of the high altitude dryland forests in the early 20th Century.[21]

Honua`ula

According to Handy, there was probably little human settlement in ancient times before European contact between Kīhei and Mākena.[22] The moku of Honua`ula straddles the Maui Department of Water Supply's (MDWS) Central Aquifer Sector's Kama`ole System and Kahikinui ASEA's Luala`ilua System. At the time of the census in 1831, Honua`ula was the 4th largest population center on Maui; however, today the area within the Kahikinui Aquifer Sector's Luala`ilua System is one of the least populated areas on Maui.[23] E.S.C Handy notes that prior to the introduction of cattle, the forest zone of this region was much lower and rainfall more abundant. Forest zone plants grew profusely in this area, and dryland taro and sweet potatoes were cultivated.[24]

Kaupō

Many villages were built in the rough lava areas in order to leave every possible bit of good soil for the growing of sweet potatoes and gourds.[25] Although Kaupō is relatively arid along the seacoast, it receives moderate rainfall 3 or 4 miles inland at an elevation of about 2,000 feet, where "anything may be grown in the rich volcanic soil," and there were terraces in Waiha and Punalu`u, above the present homesteads.[26] Almost a hundred years ago E.S.C Handy wrote about perceived climatic and cultural changes when reminiscing on Kaupō's agricultural past,

[20] E. S. C. Handy. *Hawaiian Planter*, The Museum, 1892, page 161.
[21] Maui County Council, *Hāna Community Plan*, 1994.
[22] E. S. C. Handy. *Hawaiian Planter*, The Museum, 1892, page 159.
[23] Kawa`a, Luana, *Cultural Survey & Moku Inventory: Moku of Kipahulu and Hāna, Island of Maui* (Draft), Ka Piko O Ka Na'auao (The Hawaiian Learning Center), 2009, page 3.
[24] ibid, page 7.
[25] W.M. Walker, Archaeology of Maui, page 71.
[26] E. S. C. Handy. *Hawaiian Planter*, The Museum, 1892, page 113.

> "Kaupō has been famous for its sweet potatoes, both in ancient times and recent years. Sweet potatoes can be cultivated from sea level up to about 2,000 feet in the rich pulverized lava of this district. This old culture is unfortunately vanishing here, due to a combination of economic and climatic circumstances." [27]

Manawainui Stream

The former abundance of the Manawainui Stream area of Kaupō was noted by Handy, "Indeed, no taro is grown in Kaupō except for a few dry taro plants around home sites; but formerly great quantities of dry taro were planted in the lower forest belt from one end of the district to the other. Now the district is almost wholly ranch land."[28]

Kamoamoa Village

Agriculture in some areas was more challenging than others, depending on rainfall. Walker describes water scarcity at Kamoamoa Village, which includes 20 sites: "Many of the village sites in Kahikinui have structures to store water. This was important as water was scarce in this district."[29]

18.3.3 Native Hawaiian Culture Today

Kahikinui remained uninhabited for decades, but within the last 20 years there has been a repopulation of the region. With the Department of Hawaiian Homelands (DHHL) awarding agricultural lots in Kahikinui and other families who have chosen to return to their familial lands; the Kahikinui `Ohāna was organized and people once again live in the moku of Kahikinui. Currently, there is very little infrastructure to support larger populations in this area. There is no MDWS water system in the Kahikinui ASEA, except in Kaupō, with the Upcountry system ending at Kanaio.

Kahikinui remains remote and residents often rely on local resources to meet their needs. According to the County's Maui Island Plan, the 75 kuleana lots in Kahikinui are off-grid and lack public water, electric, sewer, or cable systems; and of those 75 lots, only a handful of residents permanently live in Kahikinui. The homesteaders use independent living techniques to meet their basic needs, and conventional techniques such as water catchment, windmills, and septic tanks are also utilized. Other methods are being used or evaluated, including “fog-drip” systems to capture water from passing clouds and composting toilets.

Contemporary cultural resources in the form of native plants exist within Pu`u Mahoe, a cinder cone located about halfway between Ulupalakua and Kanaio, in the moku of Honua`ula. In 1950, David Thomas Fleming established the D.T. Fleming Arboretum atop Pu`u Mahoe--dedicated to preserving Native Hawaiian plants.

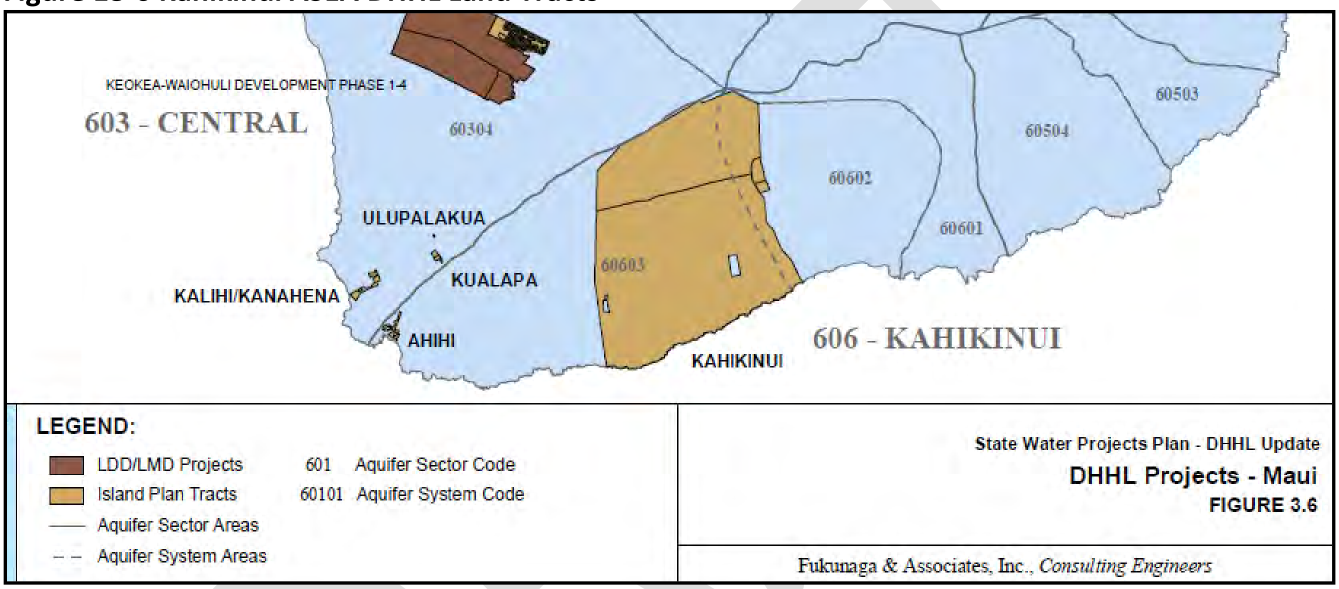
[27] Ibid, page 161.
[28] E. S. C. Handy. *Hawaiian Planter*, The Museum, 1892, page 113.
[29] Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 199.

Today, the arboretum is Hawai`i's oldest and largest of its kind and protects 92 species, 26 of which are rare or endangered.

DHHL Kahikinui Tract

Kahikinui's 22,860.9 acres of DHHL lands accounts for approximately 72 percent of all DHHL lands on Maui Island. DHHL's Kahikinui Regional Plan designates a Special District that encompasses the existing Kuleana homesteads (675 acres) with the remaining area designated Conservation.[30] Although rainfall is not sufficient to support traditional catchment systems, DHHL is exploring the option of fog drip catchment systems as supported by the Regional Plan, supplemented by truck hauling to provide fire protection.

Figure 18-6 Kahikinui ASEA DHHL Land Tracts



Source: State of Hawai`i, State Water Projects Plan DHHL Update

Ideally, native Hawaiian beneficiaries will oversee these lands and use them to create a Hawaiian sense of place for all beneficiaries living on Maui. Special Districts play an important role in the ahupua`a as well. Often Special District areas will provide the corridor for pathways or linkages between mountain and ocean resources. In some cases the Special District designation protects water sources such as irrigation ditches and other special features.

Ka `Ohāna O Kahikinui

While Kahikinui remained uninhabited for many years, within the last 25 years there has been a re-population of the region with families who have chosen to return to their ancestral lands with the Department of Hawaiian Homelands award of agricultural lots in Kahikinui. Ka `Ohāna O Kahikinui (Ka `Ohāna), the homestead association for Kahikinui, was organized and can be considered a major driving force behind the development of the Kahikinui tract. Ka `Ohāna wanted not only to bring back native plants, but also to restore

[30] Department of Hawaiian Homelands, Kahikinui Regional Plan, July 2011.

the native Hawaiian cultural life that had survived for ages until the start of ranching. Ka `Ohāna offered a plan to create an "intentional community," and with the assistance the Office of State Planning and DHHL, they wrote a land management plan and the requisite state rules that would allow the kuleana leases to go forward. The DHHL adopted the rules in October of 1998. Since then, seventy-six families have obtained 99-year leases for $1 a year, but only about 25 percent of them live there full time.[31] Additional source water will likely be necessary to realize a full range of cultural and economic opportunities including agricultural potential.

Kahikinui Forest Reserve

The upland forest of Kahikinui, known to harbor 11 rare or endangered plants and 10 native bird species, has been reduced to 20 percent of its original size. Ka Ohāna's forest protection plan initiated the creation of the 7,500 acre Kahikinui Forest Reserve and prompted DHHL to license this reserve to Living Indigenous Forest Ecosystems, Inc. (LIFE), an independent non-profit organization of citizens and Kahikinui homesteaders.[32]

Auwahi Forest Reserve

Auwahi today is a remnant of a native dry forest. A multi-agency partnership along with the Leeward Haleakalā Watershed Restoration Partnership now leads efforts to preserve and restore the Auwahi Forest. Native plants present include extensive plantings of Hawaiian koa trees planted by organized groups of volunteers committed to continued restoration efforts. The restoration of native koa will replenish the depleted watershed. Forest restoration increases fog interception and hydraulic lift, which enhances nutrient cycling, moderates water runoff, and increases soil moisture, leaf litter and soil nitrogen. This process changes the vegetation and such changes will both increases the amount and quality of water. Healthy, properly functioning mountain watersheds help provide for agricultural and potable water demands. Restoring forest cover also adds additional opportunities for water storage by increasing the days that water is present and available in streams and springs. Auwahi leeward forest was previously known to be among the most diverse of Hawaiian ecosystems. Currently, Auwahi is among the world's most endangered tropical dry forests with 9 species listed as endangered with USFWS and 7 listed as endangered with IUCN Red List status. Culturally, leeward forests are highly valued by native Hawaiians for ethnobotanical source materials, especially durable hardwoods for tools and weapons, and species with utilitarian, medicinal or religious significance.[33]

18.3.4 Perennial Streams

Perennial stream resources in the Kahikinui area are almost non-existent, with few perennials except three in Kaupō, which sometimes lack mauka-to-makai flow.

[31]Environment Hawai`i, Building a Bridge to the Future on the Stones of Kahikinui, February, 2002.
[32] Ibid.
[33] Auwahi Forest Restoration Project Website, Loss of Native and Dry Forests, retrieved 09-15-2017, http://www.auwahi.org/status-of-hawaiian-dry-forest/

18.3.5 Kuleana Lands

Although islandwide, kuleana land parcels are scatttered, Kahikinui has none verified as defined by CWRM designation of appurtenant water rights.

18.3.6 Lessons Learned from the Past

The Kahikinui region encompasses an expansive and arid rural region. Although in the past, the area supported a number of Hawaiian villages and a much larger population, reductions in the inland forest zone and rainfall, disease and major changes in the cultural and socio-economic landscape have drastically reduced the population and those that live by Native Hawaiian cultural traditions. Pre-European contact populations along the south coast likely utilized springs, brackish water from shallow wells, and small impoundments of stormwater flows. Protecting the vast array of cultural resources in the Kahikinui District is important to not only the people of Kahikinui, but to the entire Island of Maui and the Hawaiian people. The district's historic sites provide evidence of Hāna's history and serve as tools for conveying the heritage of the region to its youth as a legacy for the future. Great care must be given to ensure that future development is done in a culturally sensitive manner.[34]

As in ancient times, a variety of methods to utilize and enhance scarce resources may be considered to supply the small projected increase in population. With rainfall below 60 inches per year (between 20 and 50 inches), catchment systems could supply only limited needs. DHHL is considering a fog drip system supplemented by truck-hauled water. To help the settlers find other sources of water, a geographer from the University of Hawai`i researched the amount of water that could be collected by fog nets on the upper slopes. At 4,800 feet elevation, a 20 x 25-foot screen draws 1,500 gallons per day from the passing clouds, while a net at 7,800 feet reaps 4,500 gallons a day.

In 2017, the planning for the 10,000 gpd project implementation has resumed, and DHHL is going to invest in this type of fog catchment system in the near future. Efforts to increase fog and rainfall are being undertaken by the Leeward Haleakalā Watershed Restoration Partnership and is especially important to the long-term sustainability of this region. The ancient Hawaiians of the area used to harvest soil out of the arid, rocky landscape by damming the gulches with small terraces and removing the soil that got stuck/filtered out of the stormwater runoff. One permutation of that concept--the feasibility of small impoundments to capture stormwater runoff--could additionally be explored, but that option is likely to be cost-prohibitive.

Ka `Ohāna O Kahikinui

Much like their ancestors, resourceful Ka `OHāna O Kahikinui homesteaders have found ways to build their community by being able to find a supply of water and become a connected community to solidify their bond with Kahikinui. Despite the arid landscape, settlers want to support themselves with community gardens. To do this, they are considering growing crops hydroponically, which uses less water than more traditional in-ground plantings. They want to develop a nursery as well to provide seedlings for the upper forest and for an

[34] County of Maui, Maui County General Plan 2030, Maui Island Plan, Chapter 8: Directed Growth Plan

`iliahi (sandalwood) which will provide benefits to the watershed and groundwater recharge rates. These conditions can be considered models of a sustainable and intelligently constructed community, and this community may be a perfect model for a "demonstration project" to DHHL that you can live off-the-grid affordably without expensive infrastructure. Ancient Hawaiians were 100 percent self-sufficient, and the Ka `Ohāna O Kahikinui example shows how the practices of indigenous people could be included in the planning and management of land in Hawai`i. The efforts of these restoration groups are not only about reforesting the forest, but they provide for the sustainability of our island in perpetuity.[35]

[35] Kawa'a, Luana, Cultural Survey of the Moku of Maui: Na Wai Eha (Waikapu, Wailuku, Wailuku, Waiehu, Waihe'e) Kula, Honua'ula, Kahikinui, Kaupō, Kipahulu, and Hāna, Volumes 1-4, Ka Piko O Ka Na'auao (The Hawaiian Learning Center), 2009, page 72.

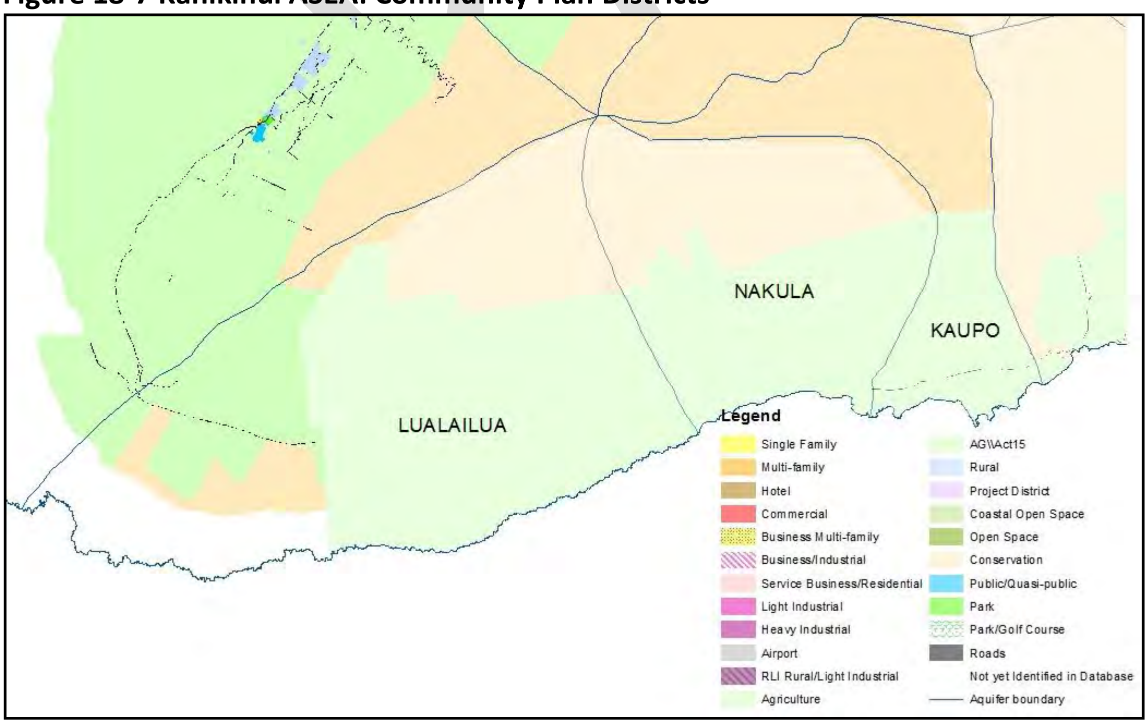
18.4 LAND USE

The current land use pattern in the Kahikinui ASEA land is dominated by undeveloped rural areas along the coast and mauka. Other than the few residents who sparsely inhabit the area adjacent to the main road and mauka on a few private roads, the land is primarily made up of large tracts owned by State, Federal, DHHL, Maui County and private land owners. The population of Kahikinui mostly lives in pastoral/agricultural subdivisions, and residential patterns remain small and scattered from the cluster near Kaupō Store in the east to the far-separated residences at Kanaio. Although in the past, the area used to support a number of Hawaiian villages and a much larger population, changes in forestation and weather patterns are likely to have caused a significant reduction in the amount of water produced in the area, contributing to diminishing populations. Cattle grazing throughout Kaupō Ranch pastures continue here since over a century.

18.4.1 Land Use Plans

The Maui Island Plan's Directed Growth Plan does not identify any planned growth areas in the Kahikinui ASEA. The directed growth plan designates substantial lands in the region as "Sensitive Land", which contain development constraints including steep slopes, floodplains, significant drainage features, and adjacent intact forested areas. Kahikinui lands are composed of State Conservation (Interim) and Agricultural districts. Both Maui County Zoning and the Hāna Community Plan (adopted in 1994) designate Kahikinui as Conservation and Agricultural zones. The coastal portions of Kahikinui are in the County Special Management Area.

Figure 18-7 Kahikinui ASEA: Community Plan Districts



Source: County of Maui Dept. of Planning, 2007

The DHHL Maui Island Plan

The Hawaiian Homes Commission adopted its Maui Island Plan as the overarching planning document in 2004. Regional plans specify land uses and proposed development plans which are summarized in this plan to ensure water sources are adequate for future development. Subsequently, the Kahikinui Plan was adopted. DHHL owned 31,337 acres on Maui in 2013, within five planning regions, and Kahikinui's 22,860.9 acres of DHHL lands significantly account for approximately 72 percent of all DHHL lands on Maui Island, making it the largest tract of land owned by DHHL on Maui.[36] The DHHL Kahikinui Kuleana Homestead Program created 104 lots over the last 20 years. Approximately 75 homesteaders have accepted the leases of 10-20 acres each in the mid-elevation levels between 2,000–4,000 feet, but many of them are residents of other areas and only live in Kahikinui part-time. About 13 families currently reside on the property full-time and approximately 20 homes have been constructed.[37] The projected population increase by 2035 is anticipated to be small. According to the Maui Island Plan, the 75 kuleana lots in Kahikinui are off-grid and lack public water, electricity, sewer, or cable systems. These residents have built homes on the rough terrain and live a life that is far removed from the typical Maui resident. The DHHL Maui Island Plan designates only two categories of land use in Kahikinui: Special District (15,485 acres) and Conservation (7,086 acres). The Kahikinui Homestead area is located in the mid-elevation Special District area. DHHL Special District designation is for land with special opportunities such as natural, cultural or historic resources or severe constraints such as flood control or endangered species. This category is applied to environmentally or culturally sensitive land that requires some conservation principles but can also be used for compatible activities if managed correctly.

Table 18-4 DHHL Land Use Categories and Acreage

Land Use Category	Acreage	Percent of Kahikinui Total
Conservation	7,086	31%
Special District (mauka)	11,202	49%
Special District (makai)	4,572	20%
Total	22,860	100%

Source: Department of Hawaiian Homelands, Kahikinui Regional Plan, July 2011

The 675 acres of the Homestead parcels are entirely within the DHHL Special District area, designated for ecologically and culturally sensitive lands, or lands with natural hazards.

DHHL homesteaders and other local residents utilize traditional subsistence agricultural techniques to feed their families. Due to the fact electricity is generated by the residents themselves, subsistence crops are important, because the trees and plants also function as food storage, much like a refrigerator. The only type of large-scale "agriculture" in the Kahikinui ASEA is pasture land for cattle ranching.

[36] Department of Business Economic Development and Tourism, State of Hawai`i Data Book, 2014.
[37] Department of Hawaiian Homelands, Kahikinui Regional Plan, July 2011, page 5.

18.5 EXISTING WATER USE

18.5.1 Water Use by Type

The CWRM has established the following water use categories based for the purposes of water use permitting and reporting:

- Domestic (Residential Domestic--includes potable and non-potable water needs; Single and Multi-Family households, including noncommercial gardening; Non-residential Domestic--includes potable [and non-potable] water needs; Commercial Businesses, Office Buildings, Hotels, Schools, Religious Facilities)
- Industrial (Fire Protection, Mining, Dust control, Thermoelectric Cooling, Geothermal, Power Development, Hydroelectric Power, Other Industrial Applications)
- Irrigation (Golf Course, Hotels, Landscape and Water Features, Parks, School, Habitat Maintenance)
- Agriculture (Aquatic Plants & Animals, Crops Irrigation and Processing, Livestock Water, Pasture Irrigation, and Processing, Ornamental and Nursery Plants, Taro, Other Agricultural Applications)
- Military (all military use)
- Municipal (County, State, Private Public Water Systems--as defined by Department of Health)

This section presents the estimated water use within the Kahikinui sector during calendar year 2014, or as otherwise stated based on CWRM and MDWS reports. A combination of municipal well use and surface water comprises water production in this aquifer sector. Present agricultural water demand in Kahikinui is primarily used to satisfy the 36,893 acres of cattle grazing pasture land. There are 8 wells registered with CWRM that could be utilized within the Kahikinui ASEA, but according to the CWRM's data, no well pumpage was reported for these wells during the 2014-2015 timeframe. Well pumpage required to be reported to the CWRM reflects actual periods of pumpage. Not all active wells comply with reporting requirements, and pumpage data is especially incomplete for smaller domestic and irrigation wells. Unless indicated otherwise, this section will utilize the convention "gallons per day" (gpd) instead of "millions of gallons per day" (mgd), due to the low levels of water consumption. There is one agricultural well and one MDWS Upcountry System domestic well that occasionally transports water to the Kahikinui ASEA.

There is also surface water serving the Kaupō and Kanaio communities for agricultural, potable and other non-potable uses. Stream diversion and well pumpage data is not reported and therefore, unavailable. The only available data is DWS billed consumption data in Kaupō and Kanaio. The non-potable sources for the Kaupō Ranch/MDWS Kaupō System are well water and stream diversion, owned by Kaupō Ranch. Pumpage and diversions are unreported, so only billed consumption for the MDWS non-potable meters is known.

Kanaio is serviced by the MDWS Upcountry system for 20 meters. The MDWS Upcountry System spans from less than 300 feet elevation in lower Haiku within the Ko`olau Aquifer Sector up to 4,000 feet elevation in Upper Kula in the Central Aquifer Sector. The southern end of the system extends into Kahikinui Aquifer Sector. The Upcountry System is divided into sub-systems, based on source: the Makawao system, the Lower Kula System and the Upper Kula System. Kanaio is served by the Upper Kula System. The sources for the Upper Kula system include surface water from the Ko`olau aquifer sector: Haipua`ena, Waikamaoi and Puohokamoa streams. Diverted water is conveyed via Waikamoi Flume and treated at the Olinda treatment facility. The MDWS Upcountry system and sources will be further described in the Central Aquifer Sector report of the WUDP.

Figure 18-8 MDWS Kanaio and Kaupō Water Systems, Wells, Registered Diversions, Kahikinui ASEA

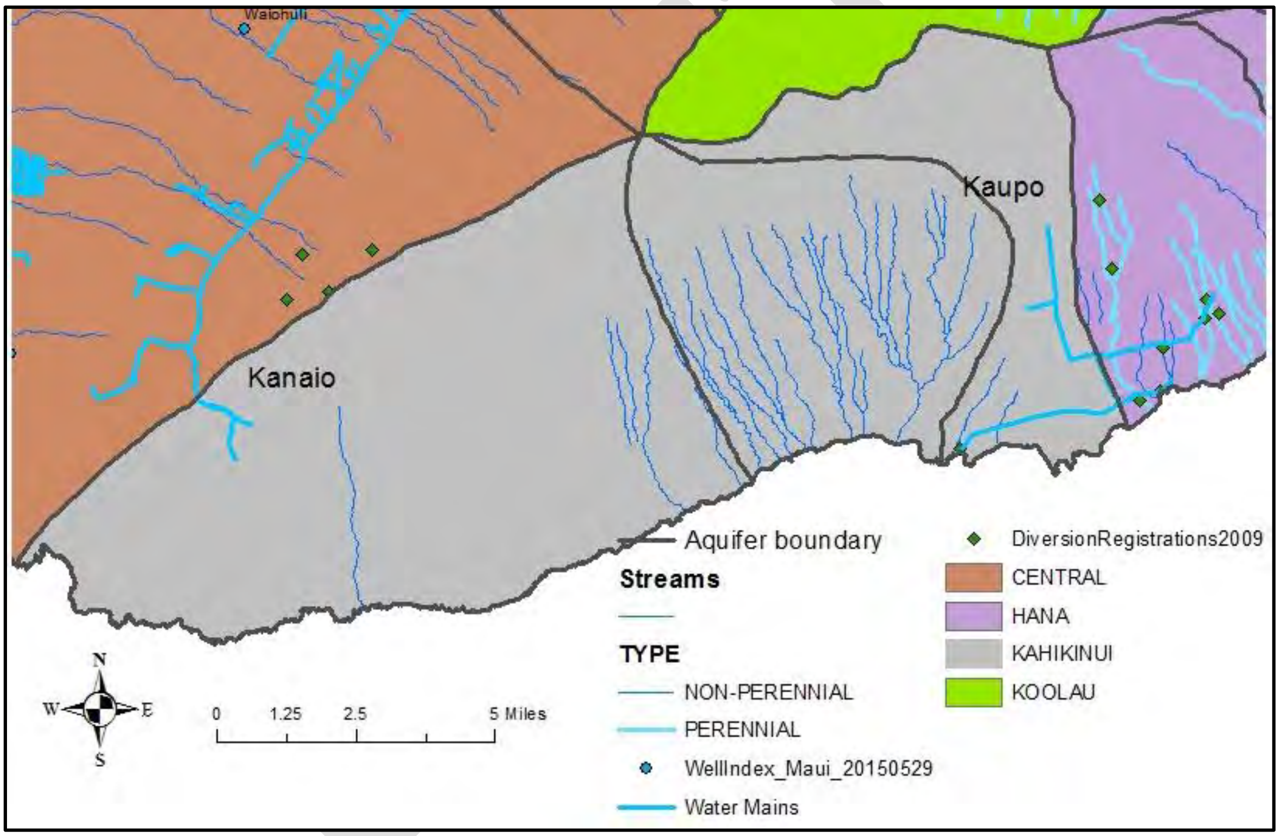


Table 18-5 Reported Pumpage and Surface Water Use by Type, Water Imported into Kahikinui ASEA, 2014 (gpd)

	Domestic	Industrial	Agriculture	Irrigation	Municipal	Military	Total
No. of Wells	4	0	2	1	0	0	7
Kaupō	0	0	0	0	*	0	0
Nakula	0	0	0	0	0	0	0
Luala`ilua	0	0	0	0	0	0	0
Total Pumpage	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Surface Water							
Healani Intake	n/a	0	n/a	n/a	*	0	
Waiu Stream Spring	n/a	0	n/a	n/a	**	0	
Total Diversions	**2***						
Imported							
Imported to Kaupō from Outside ASEA	n/a	0	0	n/a	5,222*	0	
Imported to Kanaio from Outside ASEA	n/a	0	n/a	n/a	35,223	0	
TOTAL					**40,445**		

Source: CWRM Well Pump Quantities Database, 2014; CWRM Gages 2011-2015 Average. No reported pumpage
*Kaupō services sourced from Healani Intake and Maua Well
**spring used for cattle, unknown quantity used
***diversion located in Hāna ASEA, but imported into Kahikinui ASEA

Table 18-6 Kahikinui ASEA Installed Well Capacity, 2014

Well Use	Year Installed	Aquifer System	Pump Capacity (gpd)
Domestic	2008	Kaupō	36,000
Agriculture: Livestock & Processing, Pasture	2008	Kaupō	144,000
Agriculture: Crops and Processing	1994	Nakula	36,000
Other	2001	Nakula	28,000
Domestic	0	Nakula	
Other	2013	Luala`ilua	
Domestic: Non-Residential	0	Luala`ilua	216,000
IRR	0	Luala`ilua	

Source: CWRM WellIndex_Maui_20150529

Domestic Use

Reported pumpage based on well type indicates there is no domestic well use. It is likely that domestic use is unreported.

Industrial and Military Use

There is no reported pumpage from industrial wells. There are no military wells.

Irrigation Use

No irrigation use is reported. All water supplied to the Kaupō subdistrict was billed as non-potable, consisting of 5,222 gpd, which is likely used for irrigation.

Agricultural Use

Although there was no reported agricultural well pumpage, the existing pump capacity within the Kahikinui ASEA is 180,000 gpd.

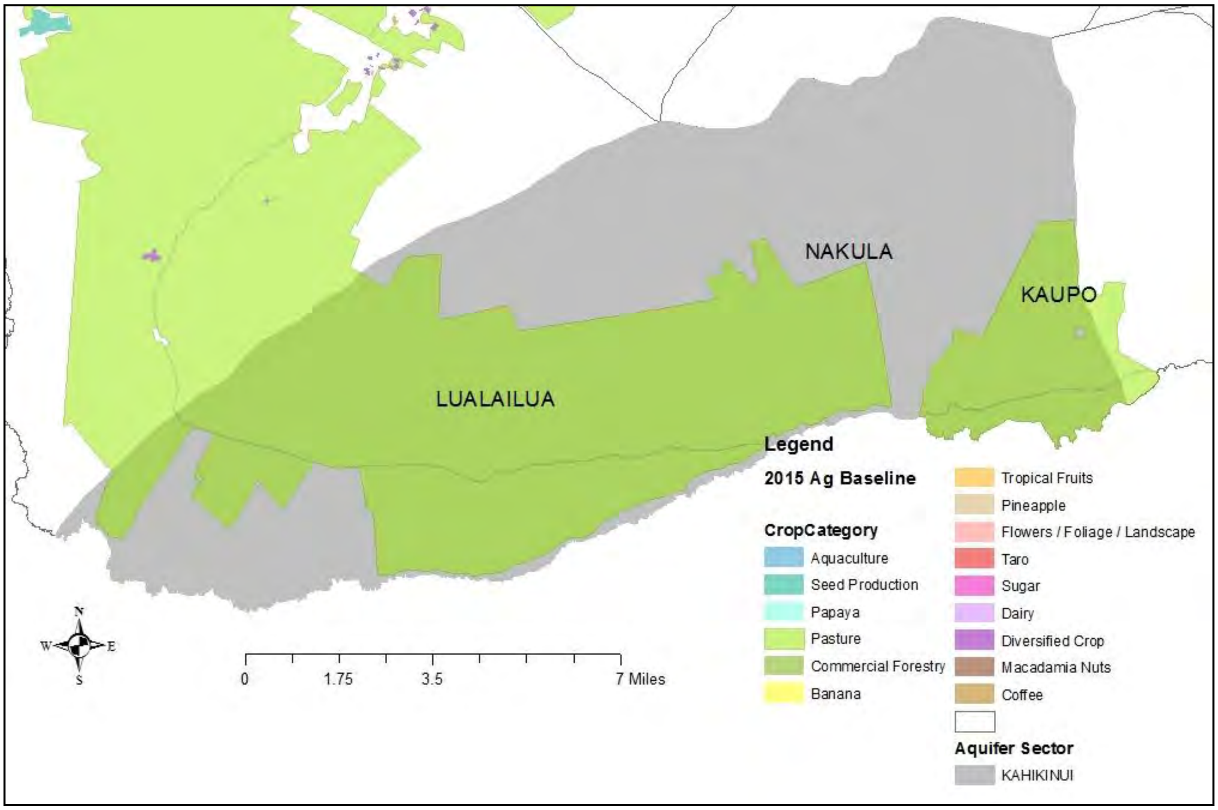
Table 18-7 Kahikinui ASEA Pump Capacity of Agriculture Wells (gpd)

Aquifer System	Pump Capacity				
	Total	Crops & Processing	Livestock & Processing, and Pasture	Ornamental & Nursery Plants	Aquatic Plants & Animals
Kaupō	144,000	0	144,000	0	0
Nakula	36,000	36,000	0	0	0
Luala`ilua	0	0	0	0	0
TOTAL	**180,000**	**36,000**	**144,000**	**0**	**0**

Source: CWRM Well Database; pump capacity of AGR use types 5/29/2015

The 2015 Statewide Agricultural Land Use Baseline indicates that pasture encompasses 36,893 acres, or 100 percent of total Kahikinui ASEA cropland. Pastures are assumed to be unirrigated. Cattle herds are subject to available water supply and are temporarily reduced under drought conditions. Kaupō Ranch grazes between 1,300 – 1,800 head of cattle. Some agricultural pumpage is assumed to occur for livestock watering and other agricultural irrigation.

Figure 18-9 Kahikinui ASEA 2015 Statewide Agricultural Land Use Baseline



Source: HDOA 2015 Statewide Agricultural Land Use Baseline

Municipal Use

State Water Use
There are no state water systems in the Kahikinui ASEA.

Federal Water Use
There are no federal water systems in the Kahikinui ASEA.

Private Public Water Systems
There are no privately owned public water systems within the Kahikinui ASEA.

MDWS Kanaio Water System

The MDWS Upcountry System services 20 Kanaio meters within the Kahikinui ASEA.
MDWS Kanaio service within the Luala`ilua ASYA shows metered use of 35,223 gpd. The MDWS Upcountry system that services the Kanaio area within the Kahikinui ASEA is comprised of the following MDWS billing categories: Single Family, Agriculture, Multi-Family and Religious Uses.

<u>MDWS/ Kaupō Ranch Hybrid Water System</u>

Kaupō is a "hybrid" system developed and expanded over time that could be classified as a CWRM category Municipal and subcategory "County" and "Private" as ownership and management is shared between the County and Kaupō Ranch (KR). The system spans into the Hāna aquifer sector. KR provides non-potable water from a well and a stream diversion to portions of the ranch. MDWS provides limited non-potable water service to 21 meters in the Kaupō community, starting from Waiu Stream in the West, to Mikimiki Gulch in the East. According to Maui County Administrative Rule Title 16, Chapter 7, "Rules for Charges for Water Service" (Water Service Rules), Kaupō customers are considered 'non-potable' water agricultural consumers, defined as agricultural consumers using non-potable water.[38] If MDWS Kaupō Water System provides water for human consumption, the system would be subject to the Department of Health Rules Relating to Public Water Systems. According to the Hawai`i Administrative Rules, Title 11, Chapter 20*,* Rules Relating to Public Water Systems (HAR 11-20), a water system which provides water for human consumption is deemed a "public water system" (PWS) if it serves at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year.[39]

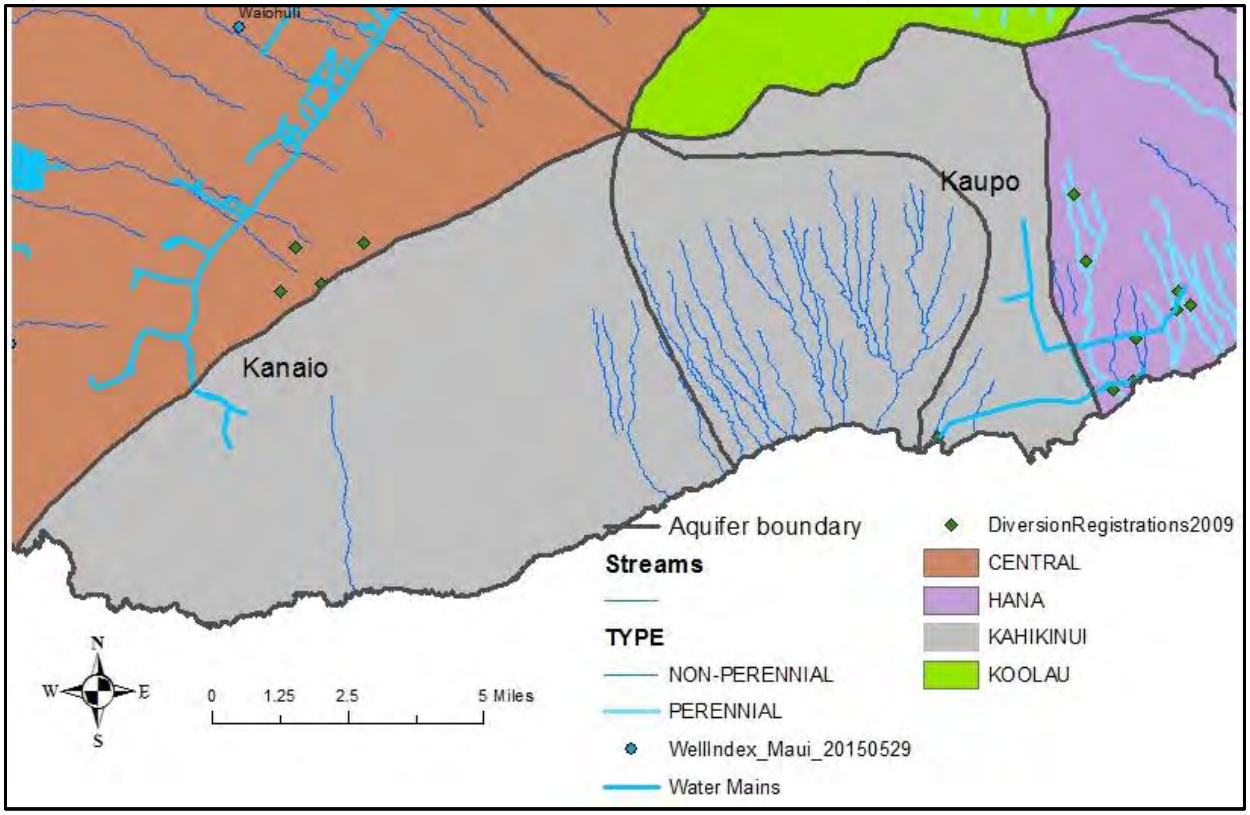
In 1993, the State Department of Health performed a sanitary survey and determined that Healani Intake (5,200 ft.) diverts water from Healani Stream to a pipeline that leads into a 40,000 gallon tank that supplies the Kaupō Ranch/MDWS system. Healani stream and intake are located east of Kahikinui ASEA in the Hāna aquifer sector. See figure below.

The MDWS provides materials for small repairs and chlorine tablets to Kaupō Ranch and performs larger repairs as needed on the MDWS portion of the system. The two primary sources of water are surface water from stream intakes at 3,200 feet supplying a 3.2 MG open reservoir and a deep well owned by KR. The well is used during times of drought to supplement the water supply. Well water is also booster pumped up to the 1,200-foot elevation tanks to provide source for Kaupō Ranch use. Chlorination continues at the 3,600 gallon tank at the 1,200-foot elevation; however, there is no chlorination at the Maua Well Site and the water serving the meters downstream of the Maua Well Site is not chlorinated during well use.

The MDWS bills an average of 5,222 gpd to Kaupō. Daily 2014 MDWS use for 21 meters averaged 249 gpd per meter.[40] The KR Manager indicates that total MDWS Kaupō usage ranges from 4,000 gpd to 7,000 gpd, but there are other users that are not metered by MDWS, particularly in the Ranch Village.[41] Because diverted surface water at the Healani intake and pumped groundwater from KR wells are not reported it is difficult to qualify and quantify the source for the hybrid system. The only available water use data is from MDWS billed water meters.

[38] Fukunaga & Associates, Inc., Kaupō Valley Conceptual Water Source Analysis, 2014, page 2
[39] Ibid, page 2
[40] County of Maui, Department of Water Supply. Billing Data, 2014
[41] Fukunaga & Associates, Inc., Kaupō Valley Conceptual Water Source Analysis, 2014, page 3.

Figure 18-10 MDWS Kanaio and Kaupō Water Systems, Wells, Registered Diversions, Kahikinui ASEA



<u>Private Public Water Systems</u>
There are no private public water systems in the Kahikinui ASEA.

<u>Other Potable Water Use</u>

An unknown number of persons are not served by any public water system. Several small developments or development clusters located below the DOH threshold, as well as individual households and uses may also be served by private domestic wells, rainwater catchment, streams or other sources. Estimated 'order of magnitude' demand for 2014 of 277,000 gpd islandwide was based on the 2010 Census Block population of about 1,190 persons that appeared to be outside public water system purveyor service areas based on general location of development and system pipes and an average MDWS per capita rate of 248 gpd.[42] The Kahikinui ASEA may contain a high proportion of unserved population compared to other areas on Maui. The County Department of Water Supply (DWS) does not provide water service to Kahikinui region residents extending from Kanaio to Kaupō, including DHHL Kahikinui homesteaders, who instead, rely on catchment of water and/or haul their own water for drinking and household purposes. Homesteaders currently truck in their water from the nearest source seven miles away.[43]

---

[42] 2010 Census Block Group population that appears to be outside public purveyor service areas – approx. 1190; apply average MDWS per capita rate of 248 gpd based on 2010-2014 consumption and interpolated population = 296,144 gpd. Excluding domestic well pumpage of 20,495 gpd results an estimated demand of 276,649 gpd.
[43] Department of Hawaiian Homelands, Kahikinui Regional Plan, July 2011, page 21.

18.5.2 Water Use by Resource

Water demand in 2014 comprised approximately 35,223 in the Kahikinui ASEA, with surface water and well water accounting for 100 percent of the total, although the proportions of each are difficult to quantify.

Ground Water Resources

There are 8 wells within the Kahikinui ASEA, but none have reported pumpage. Installed pump capacity is not the permitted pumpage, but the maximum capacity of the permitted well in gallons per minute multiplied by 24 hours.

Table 18-8 Pumpage and Pump Capacity of Wells Compared to Sustainable Yield (SY), Kahikinui ASEA

Aquifer System	MDWS Pumpage	Private Public Municipal Pumpage	Total Pumpage	Installed Pump Capacity (gpd)	SY (mgd)	Pumpage as % of SY	Installed Pump Capacity as % of SY
Kaupō	N/A	0	N/A	144,000	16	N/A	0.009%
Nakula	N/A	0	N/A	64,000	7	N/A	0.009%
Luala`ilua	N/A	0	N/A	216,000	11	N/A	0.020%
Total	**0**	**0**	**N/A**	**180,000**	**34**	**N/A**	**0.038%**

Source: CWRM Well Index 5/29/2015 for production wells and 2014 pumpage reports

Surface Water Resources

Information of surface water in the region is limited. Waiu Stream Spring is the only known surface water resource both originating and utilized within the Kahikinui ASEA, from which an unknown quantity is used for cattle. Healani Intake is a Manawainui Stream tributary with its intake located outside of the Kahikinui ASEA, and within the Kipahulu aquifer system, Hāna ASEA, and it provides an unknown quantity to the MDWS/Kaupō Ranch System within the Kahikinui ASEA.

Alternative Water Resources

<u>**Rainwater Catchment**</u>

Rainwater catchment is the collection of rainwater from a roof or other surface before it reaches the ground. The Kahikinui ASEA rainfall is typically between 20 and 50 inches.[44] Rainwater catchment is not as reliable a conventional water resource because it is extremely sensitive to the climate. Rainwater

[44] Johnson, Adam G, John A. Engott, and Bassiouni, Maoya, 2014, Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawaiʻi, 1978–2007, U.S. Department of the Interior, U.S. Geological Survey Scientific Investigations Report 2014–5168.

catchment systems are not regulated by the Department of Health, making estimates of their use difficult. No inventory of installed catchment systems throughout the island is available. DHHL Kahikinui homesteaders presently rely to some extent on rainfall catchment to supplement their own water for drinking and household purposes.[45]

Recycled Wastewater

There is no wastewater reclamation in the Kahikinui region. Homes are served by septic systems and cesspools.

Stormwater Reuse

There is no reported stormwater reuse within the Kahikinui ASEA. Stormwater reuse at the parcel scale may provide an opportunity to offset landscape agricultural uses within this region.

Desalination

There are no desalination projects in the Kahikinui ASEA. One major cost to operate a desalination plant is the high energy (electrical) demand of the process, and the disposal of the brine liquid byproduct creates logistical challenges that also increase cost. As desalination technology advances and energy costs decrease, desalination should continue to be evaluated for its potential as an effective future alternative.

[45] Department of Hawaiian Homelands, Kahikinui Regional Plan, July 2011, page 21.

18.6 FUTURE WATER NEEDS

18.6.1 General

Two alternative methods were used to project water demand to the year 2035: (1) Population growth rates based on 20-year population growth projections in the Socio-Economic Forecast Report (2014) applied to current consumption; and (2) build-out of permitted land use based on County zoning and Department of Hawaiian Homelands (DHHL) land use plans. Population-based demand takes into account social and economic factors that are anticipated to drive or inhibit growth over the planning period.

18.6.2 Water Use Unit Rates

The 2002 Water Use Standards are used for land use-based demand projections. Most of the water use in the Kahikinui Aquifer Sector Area (ASEA) is for residential single-family use and agricultural use. The 2002 MDWS water use standards for water use are 600 gallons per unit and 3,000 gpd per acre for single family/duplex, and 5,000 gpd per acre for agricultural use. An adjusted water rate standard for agricultural use was applied, as shown in WUDP Part I, Table 9-1 to be consistent with the Agricultural Water Use & Development Plan. Depending on the density of dwelling units as determined by residential zoning type (e.g. R-0, R-1, R-2 or R-3), demand can range from 2,400 to 4,800 gallons per acre. The average water consumption in the Mākena area, where all of the R-3 zoned properties within the Kahikinui ASEA are located, is approximately 2,500 gpd per MDWS water meter. The single family zoned properties in the Kahikinui ASEA are not serviced by the MDWS system. Projected land-use based demand is based on the per acre standards, as adjusted.

18.6.3 Land Use Based Full Build-Out Demand Projections

Full build-out projections for the Kahikinui ASEA based on County zoning and DHHL land use categories yield a projected water demand of about 54,689,130 gpd. Land use-based demand projections reflect the potential full build-out applying current County zoning and the DHHL land use plan designations. Full build-out assumes that all agricultural land is irrigated, applying an average water duty of 3,400 gpd per acre, regardless of available water resources in the region. Since full build-out is unlikely over the 20-year planning period and not supported in the Maui Island Plan, this method is not deemed to provide an accurate projection of future water demand.

Maui County Zoning

Maui County zoning for the Kahikinui ASEA includes predominantly Agriculture and Interim Use Zone Districts. Interim zoned land was assigned a zone based on Directed Growth Plan guidance and Community Plan designations in order to calculate water demand. There are approximately 25,478 zoned acres in this ASEA (excluding DHHL lands). Approximately 9,543 acres are in the Interim District; since most are designated Conservation or Sensitive in the Community Plan, they are accordingly assigned to the 'Open Space' zoning districts. Over 15,842 acres are in the Agriculture District. R-3 Residential accounts for 11.3 acres in the lower Mākena shoreline area within the Kahikinui ASEA, Park zoning accounts for just over 78 acres, 2.7 acres are zoned Proposed Road, and 0.7 acres are zoned Beach Right-of-Way. A summary of the land use based demand follows a discussion of DHHL land use demand.

Table 18-9 Summary of Zoning Use Types, Excluding DHHL Lands, Kahikinui ASEA

Zoning Summary	Acres	% of Total	Water Use Rates*(gpd per acre)
Single Family, Duplex (R-3)	11.3	0.04%	3,000
Agriculture	15,842.1	62.18%	3,400
Public/Quasi-Public	3.4	0.01%	1,700
Park	78.3	0.31%	1,700
Open Space (Interim)	9,542.8	37.46%	0
Total	**25,477.9**	100%	

Source: Table prepared by MDWS, Water Resources & Planning Division. Excludes DHHL lands.
Zoning supplied by Maui County Planning Department, Long Range Division, May 2015.
Interim District zoning assigned to CWRM categories based on Community Plans and Development Projects.
*Based on 2002 MDWS Water Use Rate System Standards.

State Department of Hawaiian Home Lands (DHHL)

DHHL's projected demands are incorporated into population and land use based demand projections as indicated in the relevant sections. Water rates used by the State Water Projects Plan Update: DHHL, May 2017 are as follows:

Table 18-10 DHHL Land Use, Water Standards for Maui

Land Use	Potable	Non-potable
Residential	600 gal/unit	None
Subsistence Ag	600 gal/unit	3400 gal/acre
Supplemental Agriculture	None	3400 gal/acre
Pastoral	600 gal/unit	20 gal/acre
General Ag	None	3400 gal/acre
Special District	Varies	Varies
Community Use acres	1,700 gal/acre or 60 gal/student	None
Conservation	None	None
Commercial	3,000 gal/acre or 140 gal/1,000 SF	None
Industrial	6,000 gal/acre	None

Source: DHHL Maui Island Plan.

The 2017 DHHL SWPP Update[46] projects a demand of 63,000 gpd of potable water and an additional 13,500 gpd of potable water to be used for non-potable use for new projects in the Kahikinui ASEA, all within the DHHL Kahikinui Homestead Tract. According to the 2004 DHHL Maui Island Plan, the region is not expected to be developed for its zoned General Ag use in the near future. As stated on page 7-20 of the DHHL Maui Island Plan: "With the exception of the *kuleana* leases in Kahikinui, the majority of the proposed homesteading uses on Maui will be focused primarily in the Upcountry, West and East regions of Maui. Based on these factors,

[46] State of Hawai`i Department of Hawaiian Homelands, State Water Projects Plan Update, 2017.

the Ahihi tract should remain vacant and DHHL's homesteading efforts should be focused on other more readily developable tracts."

Per the 2017 DHHL SWPP Update "The water requirement for the Kahikinui tract is entirely from Pastoral land use, with a potable requirement of 0.063 MGD and a non-potable requirement of 0.0135 MGD. Because there are no known surface water sources in the area and considering the small magnitude of the stock water requirement, it is anticipated that the selected potable source will supply the non-potable water also. The ambient annual rainfall is between 20 and 50 inches. Although this is not sufficient to support traditional catchment systems, DHHL is exploring the option of utilizing fog drip catchment systems supplemented by truck hauling to provide fire protection."[47]

Table 18-11 Projected Water Demands and Strategies for DHHL Projects in Kahikinui ASEA, 2035 (gpd)

Aquifer System	Project	Potable (gpd)	Potable Strategy	Non-potable (gpd)	Non-potable Strategy
Luala`ilua	Kahikinui Homesteads	63,000	Fog Drip Catchment, Truck Haul	13,500	Fog Drip Catchment, Truck Haul

Source: State Water Projects Plan: DHHL, May 2017.

Total projected future water demand of 76,500 gpd for the planning period to 2035 are added to the alternative county zoning based demand scenario. DHHL water use projections indicate equal demand from 2016 to 2031, as forecasted in the 2017 State Water Projects Plan. This 2016 DHHL water use is not accounted for elsewhere by reported or estimated water use in the region and is therefore added to the population growth based demand scenario. The following table summarizes County and DHHL land use based demand. Projected non-potable demand for 675 acres at Kahikinui Homesteads is 13,500 gpd at 20 gpd per acre for pastoral use.

[47] State of Hawai`i Department of Hawaiian Homelands, State Water Projects Plan Update, 2017. Pg. 4-29.

Table 18-12 Full Build-Out Water Demand Projections by CWRM Use Type, Kahikinui ASEA (gpd)

CWRM Use Categories	County Zoning Based		DHHL Land Use Category Based				Total Projected Demand (gpd)
	Acres	Projected Demand (gpd)	DHHL Land Use	Acres/ Residential Units	Water Use Rate (gpd)	Projected Demand (gpd)	
Domestic-Residential	11.3	33,900	Residential/ Subsistence	104[48]	600	62,400	**96,300**
Domestic-Non-Residential	0	0	Commercial	0	6,000	0	**0**
Industrial	0	0	Industrial	0	6,000	0	**0**
Agriculture	15,842	53,863,140	Agriculture	75[49]	3,400	255,000	**54,118,140**
Irrigated	0	0	N/A	--	--	--	**0**
Municipal	81.7	138,890	Community	0	1,700	0	**138,890**
Military	0	0	N/A	--	--	--	**0**
Total	**15,935**	**54,035,930**		**N/A**		**317,400**	**54,353,330**

Source: MDWS Water Resources & Planning Division. Figures may not add due to rounding. Open space, conservation/cultural protection and similar land use types not included due to lack of water demand.
County Zoning: Based on zoning supplied by Maui County Planning Department, Long Range Planning Division, May 2015. DHHL lands are excluded. Irrigated includes Park-Golf Course and Golf Course zoning districts.
DHHL Lands: Based on DHHL Maui Island Plan and Regional Plans. Future land uses are unknown for some lands.

State Water Projects Plan (SWPP)

Excluding DHHL projects, there is no forecasted water demand over the planning period for state projects in the region, per the State Water Projects Plan (SWPP).

Agricultural Water Use and Development Plan (AWUDP)

The 2004 AWUDP does not address Kahikinui. County and State planning documents do not project increased agricultural production in the Kahikinui ASEA.

[48] Based on 104 lots (units) in the DHHL Kahikinui Homesteads referenced in DHHL Kahikinui Regional Plan.

[49] Based on Figure 7-19 of DHHL Maui Island Plan. 2004. This land area is not expected to be developed for its zoned General Ag use in the near future. As stated on page 7-20 of the DHHL Maui Island Plan: "With the exception of the *kuleana* leases in Kahikinui, the majority of the proposed homesteading uses on Maui will be focused primarily in the Upcountry, West and East regions of Maui. Based on these factors, the Ahihi tract should remain vacant and DHHL's homesteading efforts should be focused on other more readily developable tracts."

18.6.4 Population Growth Based Water Demand Projections (20-Year)

Population growth rate projections were applied in 5-year increments over the 20-year planning period from 2015 to 2035 for high, medium (base case) and low-growth scenarios. Water consumption, including both public and private water systems, are compared to the incremental water needs for the next 20 years based on the *Socio-Economic Forecast Report, 2014* prepared by the Planning Department and consistent with the Maui Island Plan. It was assumed that population growth, and thus water use, from projects described in the State Water Projects Plan, including DHHL, are already accounted for by the population projections. Therefore, information from these documents was not used to further refine the population-based demand projections, but the information was used to better inform locations for anticipated source and infrastructure needs within the aquifer sector.

The 2014 Socio-Economic Forecast[50] projects a 22 percent population increase between 2015 and 2035 for the Hāna Community Plan area, which includes a large section of the Kahikinui ASEA. As specific population data for Kahikinui ASEA is not available, the Hāna population projection rate of increase will be applied to Kahikinui. Water demand excluding large agriculture and irrigation needs is projected to increase from approximately 40,849 gpd to 49,840 gpd over 20 years for the Kahikinui ASEA. The greatest needs within the Kahikinui ASEA are for single-family residential and homestead lots and associated agricultural use.

Table 18-13 Projected Population and Water Demand to 2035, Kahikinui ASEA

Criteria	2014	2015	2020	2025	2030	2035	20 Year	Annual Ave
% Increase	N/A	N/A	5.11%	5.10%	5.08%	5.12%	22.01%	1.10%
Population		153	161	169	178	187	34	1.68
Water Demand (gpd)	40,445	40,849	42,936	45,124	47,414	49,840	8,991	449.55

Source: Population Forecast: 2014 Socio-Economic Forecast, Maui County Planning Department, Long Range Planning Division, Table R-1, Hāna Community Plan area. Water Demand: MDWS, Water Resources & Planning. The 2015 population estimate developed by MDWS is based on an average of 2.94 residents per water meter (based on the Maui County average number of residents per household) and the Kahikinui Homesteads population (32 residents) indicated in the DHHL Kahikinui Regional Plan (2.94 residents x 41 water meters = 120.54 residents).[51]

Table 18-14 Projected Low, Base and High Population Based Water Demand to 2035, Kahikinui ASEA (gpd)

Case	2015	2016	2017	2018	2019	2020	2025	2030	2035
Base Case	40,849	41,267	41,684	42,101	42,519	42,936	45,124	47,414	49,840
High Case	44,068	44,519	44,969	45,419	45,869	46,319	48,680	51,151	53,768
Low Case	37,357	37,738	38,120	38,502	38,883	39,265	41,266	43,361	45,579

Source: MDWS, 2017.

Population Growth-Based Demand in Planned Growth Areas

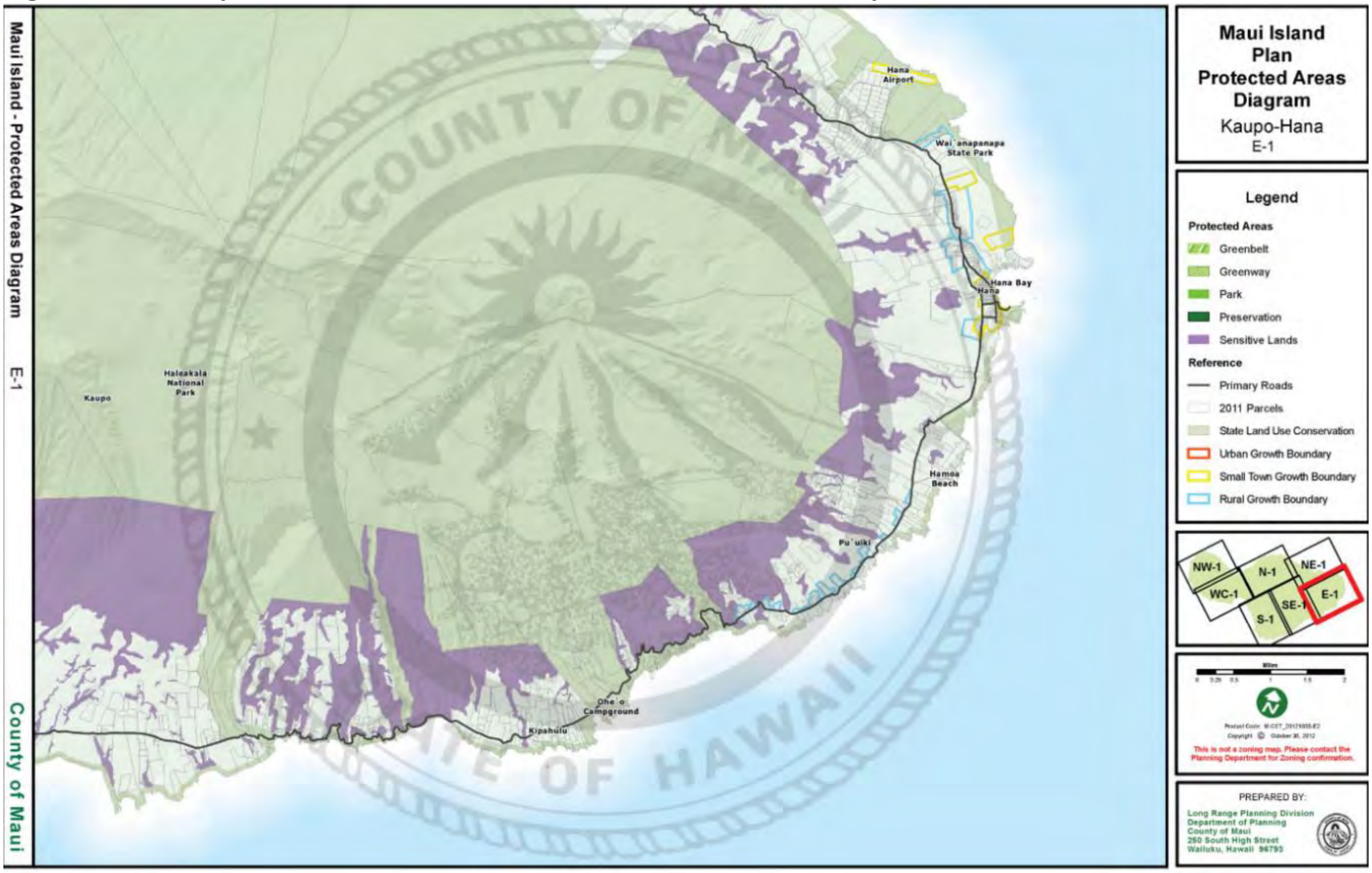
The Planning Department maintains a list of large development projects that have come to their attention, some of which have been entitled, committed or are supported by the Maui Island Plan but not necessarily

[50] Population Forecast: 2014 Socio-Economic Forecast, Maui County Planning Department, Long Range Planning Division, Table R-1, Hāna Community Plan area.

[51] Kahikinui Regional Plan. DHHL. July 2011. Page 5.

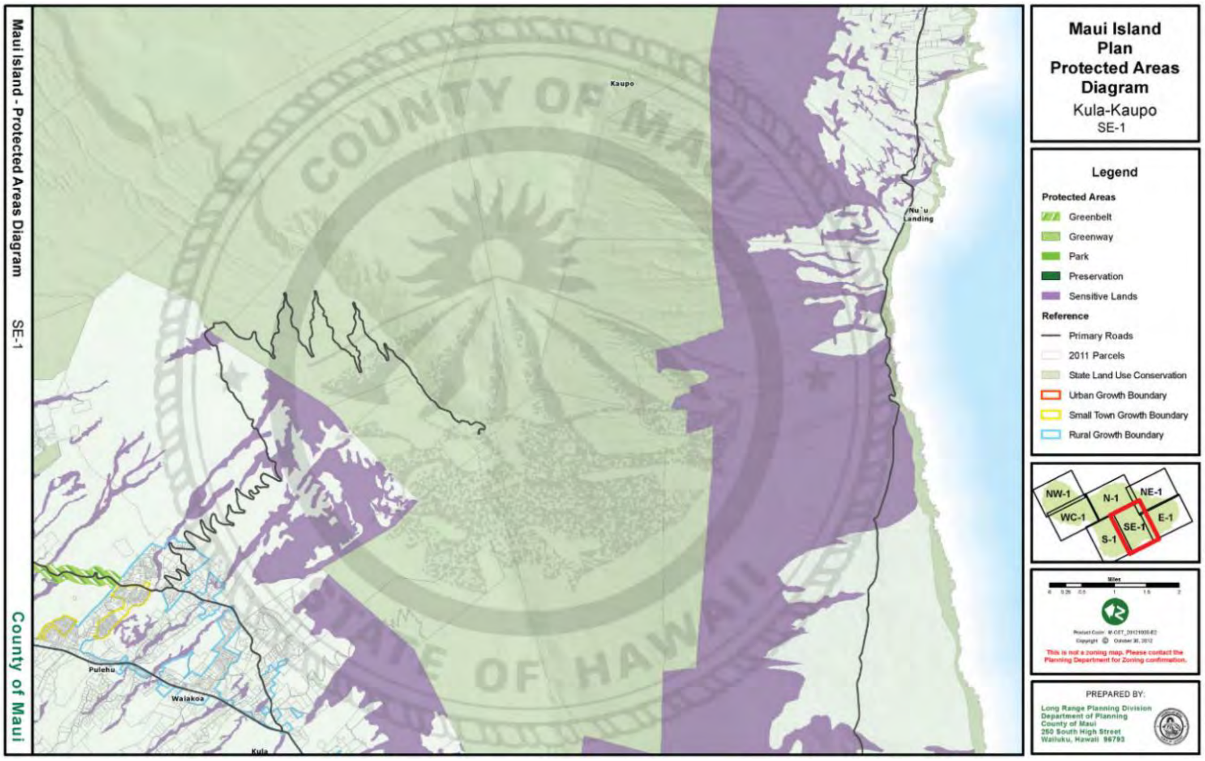
the Community Plans. No development projects are listed for the Kahikinui ASEA, primarily due land constraints, limited infrastructure and water resources. The figures below show Maui Island Plan mapping of Sensitive Lands designated for the purpose of protecting areas with significant development constraints

Figure 18-11 Kaupō ASYA Protected Areas and Directed Growth Maps



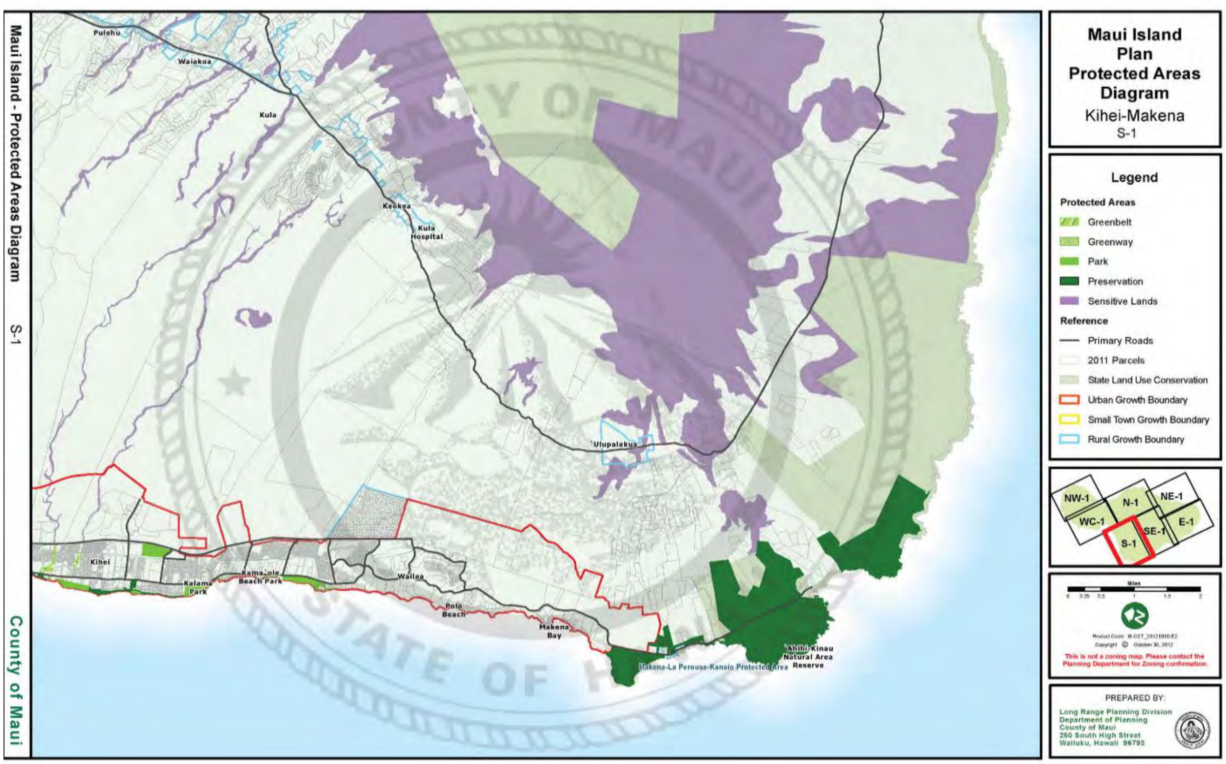
Source: Maui Island Plan

Figure 18-12 Nakula ASYA Protected Areas and Directed Growth Maps



Source: Maui Island Plan

Figure 18-13 Luala`ilua ASYA Protected Areas and Directed Growth Maps



DHHL Water Demand Projections

Current DHHL use is not reflected in 2014-2015 billed or otherwise estimated water use. Because 2014-2015 water use serves as the basis to forecast future water use increases using population growth rate, DHHL demand would not be accounted for in the population growth based scenario for Kahikinui. DHHL water use projections from 2016 to 2031, as forecasted in the 2017 State Water Projects Plan are added to the population growth scenario. The projections include potable and non-potable uses supplied by potable source identified in DHHL's SWPP for the Kahikinui Homesteads. The potable water demand projection for 2031 is 76,500 gpd. The 104 lots identified for DHHL's Kahikinui Homesteads full build-out is estimated to use 62,400 gpd at 600 gpd per lot, which is very close to the SWPP's 63,000 gpd projection (i.e. 600 gpd difference). The 675 acres that make up the Kahikinui Homesteads are attributed a rate of 20 gpd for non-potable pastoral, resulting in 13,500 gpd. Total projected 76,500 gpd is added to the population based demand projections for Kanaio and Kaupō.

Kaupō Water System Water Demand Projections

Kaupō Water System needs are projected to be about 6,435 gpd by 2035. Based on MDWS billing categories, all meters are categorized residential, except for one commercial. It is assumed that most water use is for subsistence farming and any potable needs are either provided by delivery of other sourced water supply, and/or treated using household water filters. The table below provides a theoretical breakdown of water consumption that most closely corresponds to CWRM categories, although end uses are unknown.

Table 18-15 Kaupō Water System Demand Projections by CWRM Categories (gpd)

CWRM CATEGORY	2014	2015	2020	2025	2030	2035
Domestic Residential	4,354	4,397	4,622	4,857	5,104	5,365
Domestic Non-Residential	868	877	922	969	1,018	1,070
Industrial	-	-	-	-	-	-
Municipal	-	-	-	-	-	-
Agriculture	-	-	-	-	-	-
Irrigated	-	-	-	-	-	-
Military	-	-	-	-	-	-
Unknown	-	-	-	-	-	-
TOTAL	5,222	5,274	5,544	5,826	6,122	6,435

MDWS Kanaio Water Demand Projections

Kanaio Water System needs are projected to be about 43,405 gpd by 2035. As shown below, agricultural use accounts for the greatest demand with domestic residential use closely following. Given the rural nature of the Kanaio area and its relatively dry climate, it is likely that a large portion of the residential water use is used for subsistence farming and landscape irrigation. Although the MDWS Upcountry system falls under CWRM water use category "Municipal," the table below provides a breakdown of MDWS billing classes that most closely corresponds to CWRM categories and actual water use.

Table 18-16 MDWS Kanaio Water System Demand Projections by CWRM Categories (gpd)

CWRM CATEGORY	2014	2015	2020	2025	2030	2035
Domestic Residential	16,994	17,164	18,041	18,960	19,922	20,942
Domestic Non-Residential	-	-	-	-	-	-
Industrial	-	-	-	-	-	-
Municipal	-	-	-	-	-	-
Agriculture	18,229	18,411	19,352	20,338	21,370	22,464
Irrigated	-	-	-	-	-	-
Military	-	-	-	-	-	-
Unknown	-	-	-	-	-	-
TOTAL	35,223	35,575	37,392	39,298	41,293	43,405

<u>Other Population-Based Demand Projections</u>

The Kahikinui ASEA may contain a higher proportion of unserved population compared to other areas of Maui. Therefore, the proportion of the island-wide 276,000 gpd attributable to Kahikinui likely exceeds Kahikinui's per capita portion of Maui Island's population. However, the exact number of residents unserved with water service is not quantified.

18.6.5 Agricultural Demand Projections

Non-potable agricultural irrigation demand is not correlated to population growth and represents additional demand. Livestock and other agricultural uses have not been quantified but is highly dependent on regional climate and water resources with few options for water transport. The Kaupō and Kahikinui region is identified by the Maui Drought Committee as grazing having the highest drought risk with impact on water supply, agriculture and wildland fires. [52]

Kaupō Ranch has a livestock carrying capacity of 1,800 heads under controlled grazing, which mitigates the acreage needed.[53] Due to limited water supply, no increase in livestock is projected over the planning period. A "mid-growth" demand scenario is represented by that agricultural lands, consisting of 36,893.89 acres of pasture is considered static. There are two wells: (1) one well is designated for "Livestock & Processing, and Pasture," with pump capacity of 144,000 gpd for watering livestock; and (2) one well is designated for "Crops & Processing" with a pump capacity of 36,000 gpd. If each head consumes up to 25 gpd, a herd of 1,800 heads would require 45,000 gpd, which can represent the low range projected water use. There is presently no

[52] Wilson Okamoto Corp, County of Maui Drought Mitigation Strategies, 2012 Update
[53] L. Read, The Furrow "Kaupō Ranch: Maui's Wild West"

reported pump usage for either well. It is assumed that water for livestock is provided for from existing wells with no projected additional agricultural non-potable demand, except for DHHL.

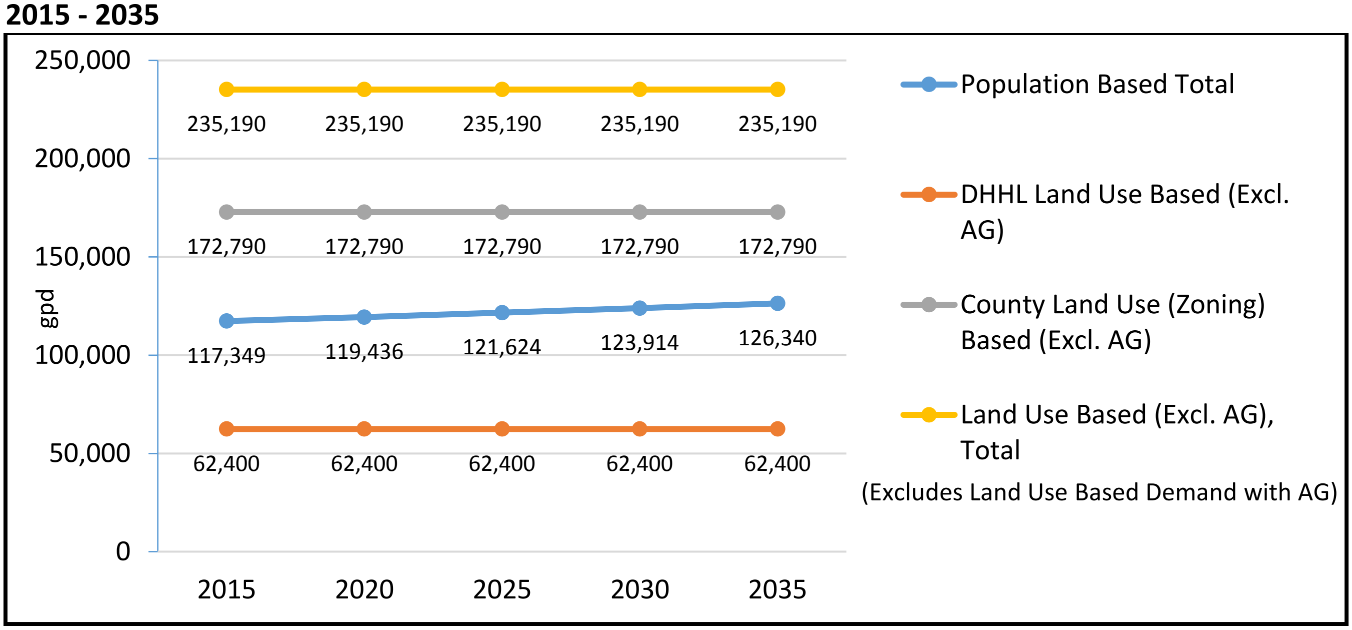
Table 18-17 Kahikinui ASEA: Agricultural Wells Pump Capacity and Projected Demand (gpd)

ASYA	Pump Capacity		Acreage Pasture Water Standard/Use	
	Crops & Processing	Livestock & Processing, and Pasture		
Kaupō	0	144,000	36,893	0 - 7400
Nakula	36,000	0		
Luala`ilua	0	0		
Total	**36,000**	**144,000**	**36,893 acres**	**45,000 - 180,000***

*Low range is 25 gal/head cattle livestock x ranch capacity (1,800 head of cattle). High range is max well pump capacity.
Source: CWRM Well Database; pump capacity of AGR use types 5/29/2015; 2015 Statewide Agricultural Land Use Baseline GIS, water use rates per Diversified Ag-HDOA Guidelines

The figure below illustrates the selected projected demand scenario based on population growth, in comparison to the alternative projected demand scenario based on county zoning designations. In consistency with the Maui Island Plan, the mid-growth scenario is selected to guide short-term resource needs, to be adjusted as needed within the low to high range projections over a 20 year time horizon. The selected demand scenario combines 20 year population growth, estimated agricultural use and non-potable needs for Department of Hawaiian Homelands. Although DHHL's SWPP uses a time range of 2016-2031, the 2016 DHHL SWPP projections have been used as a part of the 2015 total population based projections and the 2031 DHHL SWPP projections have been applied to the 2035 total population based water demand projections.

Figure 18-14 Kahikinui ASEA Projected Population Growth and Land Use Build-Out Based Water Demand, 2015 - 2035



The table below breaks down current water use and projected demand by CWRM category.

Table 18-18 Projected Water Use by Water Use Category based on Population Growth (Low, Medium and High) and Land Use Full Build-Out to 2035 (gpd)

	2014	2015	2016	2017	2018	2019	2020	2025	2030	2035
Population Based										
Domestic*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Agriculture	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Irrigation*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal DWS System**	40,445	40,849	41,267	41,684	42,101	42,519	42,936	45,124	47,414	49,840
Municipal Private PWS[54]	0	0	76,500	**76,500**	76,500	76,500	76,500	76,500	76,500	76,500
Military	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Subtotal Pop. Based Mid Growth	**40,445**	**40,849**	**117,767**	**118,184**	**118,601**	**119,019**	**119,436**	**121,624**	**123,914**	**126,340**
Agriculture	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000
TOTAL Mid Growth	**220,445**	**220,849**	**297,767**	**298,184**	**298,601**	**299,019**	**299,436**	**301,624**	**303,914**	**306,340**
TOTAL Low Growth	**220,445**	**217,357**	**294,238**	**294,620**	**295,002**	**295,383**	**295,765**	**297,766**	**299,861**	**302,079**
TOTAL High Growth	**220,445**	**224,068**	**301,019**	**301,469**	**301,919**	**302,369**	**302,819**	**305,180**	**307,651**	**310,268**
Land Use Full Build-out Based										
County (Zoning) (Excl. AG)	172,790	172,790	172,790	172,790	172,790	172,790	172,790	172,790	172,790	172,790
DHHL (Excl. AG)	62,400[55]	62,400	62,400	62,400	62,400	62,400	62,400	62,400	62,400	62,400
Total, (Excl. AG)	**235,190**	**235,190**	**235,190**	**235,190**	**235,190**	**235,190**	**235,190**	**235,190**	**235,190**	**235,190**
TOTAL (Incl. AG) *not shown on chart*	54,353,330	54,353,330	54,353,330	54,353,330	54,353,330	54,353,330	54,353,330	54,353,330	54,353,330	54,353,330

*Estimated; not served by any PWS. No pumpage reported.
**Includes non-potable water provided by Kaupō hybrid water system.
Source: MDWS Water Resources & Planning; CWRM reports, MDWS reports. All Other Population Based Demand includes other wells and estimated population unserved by public water systems.

[54] Based on 63,000 gpd potable use and 13,500 gpd non-potable use projection from DHHL's SWPP.
[55] Based on 104 projected lots in Kahikinui Homesteads at 600 gpd water use rate per lot (or unit).

18.7 Water Source Adequacy

Water demand based on population growth rates in the Kahikinui ASEA would require less than 10,000 gpd of additional supply. A basic analysis of available groundwater resources and projected demand would indicate that there is sufficient groundwater to sustain all water needs over the 20 year planning period. Although the region's water budget is reliant on fog and sparse rainfall for most of the groundwater recharge, very little of the 34 mgd sustainable yield has been developed. Even under drought conditions, groundwater resources can provide the region's needs. Resource availability is not as much constraint as existing infrastructure, including electrical power for pumpage. The constraints and challenges are very different for the communities at upper elevations of Kanaio and DHHL lands, and the coastal communities around Kaupō.

Alternative resources to be considered include rainwater catchment, fog screen catchment, grey water systems, stormwater reuse, conservation, resource augmentation, and various regulatory and planning strategies. Not all these strategies are available, feasible or necessary in the Kahikinui ASEA region.

18.7.1 Source Adequacy vs. Land Use Full Build-Out Based Water Projections

Full build-out of land use classifications representing 54.5 mgd was considered as an alternative demand scenario but not considered realistic for the region. Agricultural zoned land encompassing about 16,000 acres are not used or planned for agricultural cultivation but limited to pasture use. Excluding agriculture, land use based demand would be about 235,000 gpd, or 0.235 mgd. Land with zoning designation "Park" represents 139,000 gpd, or 0.139 mgd. The subject properties are located at the shoreline of La Perouse Bay. County and state documents do not support or project build out to county zoning designations.

Full build-out of DHHL lands, including General Ag use represents 317,000 gpd, or 0.317 mgd. According to the 2004 DHHL Maui Island Plan, the region is not expected to be developed for its zoned General Ag use in the near future. Build-out of the DHHL Kahikinui Homestead Tract in accordance with the 2017 SWPP is added to the population growth based demand scenario below.

18.7.2 Source Adequacy vs. Population Growth Based Water Demand Projections (20-Year)

The 2014 Socio-Economic Forecast does not specifically address Kahikinui subregion of the Hāna Community Plan. Factors that impact job opportunities in Hāna does not necessarily echo the self-sufficient off the grid communities in Kahikinui. The modest growth rate for Hāna Community Plan would increase non DHHL water use by about 9,000 gpd, for a total of 40,840 gpd. DHHL water use projections from 2016 to 2031, as forecasted in the 2017 State Water Projects Plan are added to the population growth scenario. The projections include potable and non-potable uses supplied by potable source identified in DHHL's SWPP for the Kahikinui Homesteads. The potable water demand projection for 2031 is 76,500 gpd.

Finally, with no reported water use or anticipated increase in agricultural needs, installed pump capacity for agricultural wells in the region of 180,000 gpd is added. The selected demand scenario is considered conservatively high, within a range of 302,000 – 310,000 gpd. Available groundwater resources far exceed projected demand. The constraints to supply the rural communities in Kahikinui, such as development and pumpage costs are discussed under Conventional Water Source Strategies below.

18.8 Strategies to Meet Planning Objectives

The WUDP update public process generated a set of planning objectives through an iterative process. Multiple resource options to meet planning objectives and projected demand were reviewed and evaluated in regional public meetings and workshops to assess constraints, relative costs and viability.[56] Planning objectives, preliminary strategies and related material reviewed in the final public workshop, November 17, 2016 is attached as Appendix 11. The selected strategies are presented below along with available cost estimates, hydrological, practical and legal constraints that were considered in assessing the viability of a specific resource or strategy.

Key issues identified in the WUDP public process for Kahikinui focused on the region's need to successfully manage and improve watersheds, assess and implement alternative ways to meet their present and future water needs; potentially significant decrease in water supply from climatic changes; limited water resources and infrastructure; and managing water resources in a sustainable way.

Recommended alternatives include resource management as well as development of conventional and alternative resources. All strategies are assumed to include conservation consistent with recommended supply and demand side conservation strategies outlined in Section 12.2. Implementation schedule, estimated costs and potential lead agencies, including funding sources, are summarized in Table 18-25. It should be emphasized that the WUDP provides guidance for resource use and infrastructure development. Actions to realize the intent of the policies and strategies should be developed over the twenty-year planning period. Estimated timeframes for implementation are indicated, allowing for flexibility to re-scope, prioritize and adjust to available funding.

18.8.1 Resource Management

Planning objectives related to resource management identified in the WUDP update public process include:

- Improve understanding of the concepts of "precautionary planning" to reduce and adapt to the effects of drought and climate change upon water resource availability and quality.
- Maintain access to lands for gathering, hunting and other native Hawaiian traditional and customary practices.
- Watershed protection should be implemented, including invasive alien plant control, ungulate control, and reforestation via watershed partnership programs.
- Mutual benefits could be gained from the State and National Park Service engaging in consultation and coordination with Native Hawaiian moku/community and local experts on resource management.

The Hāna Community Plan reflects regional issues expressed at the community WUDP meetings. Policies related to water resource management include:

[56] Preliminary Strategies for Hāna Aquifer Sector November 17. 2016

- Protect, preserve and increase natural marine, coastal and inland resources, encouraging comprehensive resource management programs
- Ensure that groundwater and surface water resources are preserved and maintained at capacities and levels to meet the current and future domestic, agricultural, commercial, ecological and traditional cultural demands
- Recognize residents' traditional uses of the region's natural resources which balance environmental protection and self-sufficiency
- Discourage water or land development and activities which degrade the region's existing surface and groundwater quality
- Encourage resource management programs that maintain and re-establish indigenous and endemic flora and fauna
- Protect, restore and preserve native aquatic habitats and resources within and along streams

Watershed Protection and Restoration

Issue and Background: Leeward Haleakalā once supported some of the most extensive and diverse native forests in Hawaii. The region has suffered significant extinctions and degradation. [57] Kahikinui is inhabited by many feral goats and other ungulates. Goats, pigs and feral cattle contribute to degradation of the watershed and erosion, with impact on ground and surface water resources. At Kaupō, populations of Strawberry Guava and Australian Tree Fern spread into windward forests of Haleakalā National Park and Kipahulu, posing threats to intact native forests. Despite this, many conditions present an opportunity for landscape level restoration. As degraded land is converted to functional ecosystems, the ability to reduce runoff, provide consistent sources of freshwater to streams, and recharge groundwater can be improved. [58]

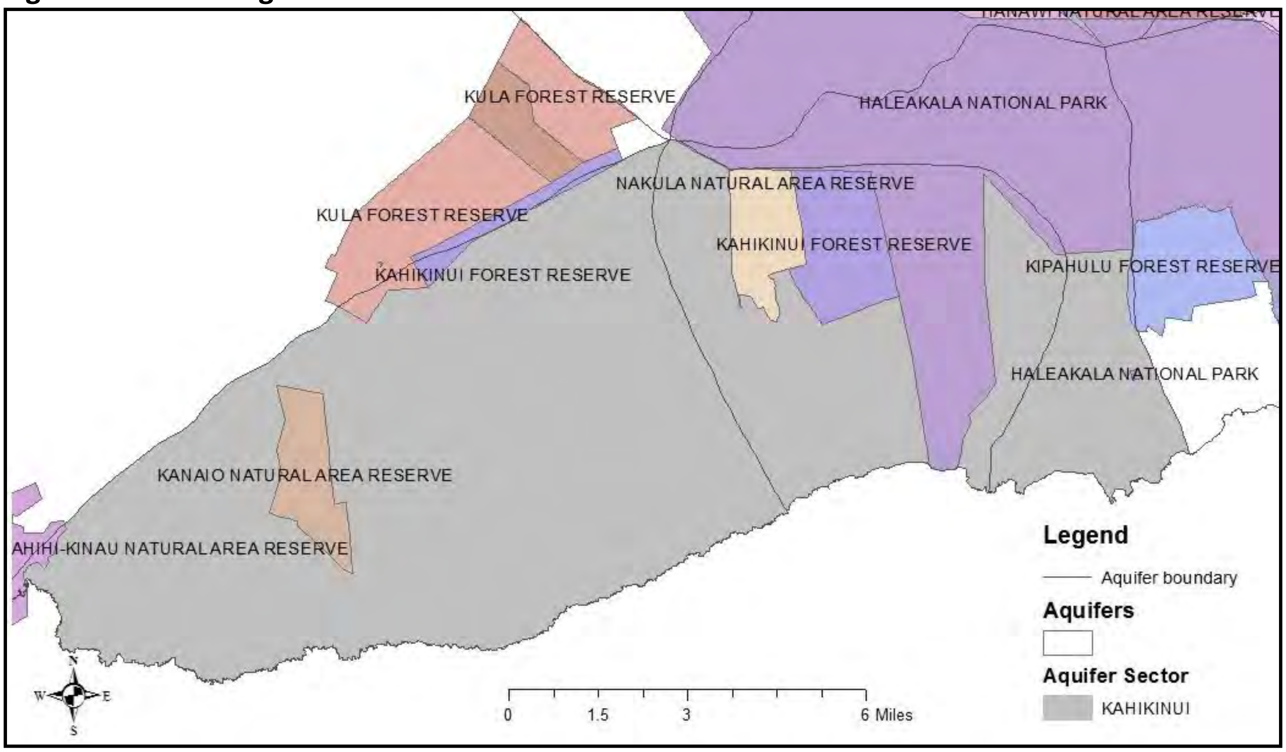
Kahikinui ASEA contains multiple watershed and forest management areas. See the figure below. DLNR's forest reserve systems are managed by the Division of Forestry and Wildlife (DOFAW) to protect and enhance important forested mauka lands for their abundance of public benefits and values. [59] The Kahikinui Forest Reserve (FR), which includes Papa`anui, was established in 1929. Significant withdrawals of land have reduced the reserve. Only portions of the Papa`anui and Nakula ahupua`a are today included in the Kahikinui FR. Papa`anui extends into a small portion of the Northwest boundary of Luala'ilua aquifer and is addressed in the 2017 Kula Forest Reserve Management Plan. The Nakula portion of the Kahikinui FR will be addressed in a separate plan at a later date.[60] Some of the current management activities by DOFAW include weed management, boundary fence and rare plant exclosure maintenance, native and threatened and endangered outplanting; native plant seed collection and storage; firebreak/fuelbreak maintenance; and predator control (mongoose, rat, and cats). Watershed values and game animal management are part of management priorities. Tactical goals include to control ungulate (cattle, goats, pigs) populations at levels consistent with watershed protection needs with the action item to encourage public hunting through outreach. A tactical

[57] Leeward Haleakalā Watershed Restoration Partnership, Project Proposal to MDWS, August 2016
[58] ibid
[59] http://dlnr.hawaii.gov/forestry/frs/
[60] State of Hawaii DLNR DOFAW Kula Forest and Papa`anui Tract of Kahikinui Forest Reserve Management Plan, 2017

goal for game animal management is to improve hunter access with action items to conduct animal population surveys and hunter participation surveys, continue hunter education program and other public outreach.[61]

The Nakula Natural Area Reserve is managed to protect rare plants and habitat for endangered birds, the Hawaiian hoary bat and an endangered moth. DOFAW is fencing the area to keep out feral ungulates.

Figure 18-15 Managed Lands and Forest Reserves Kahikinui ASEA

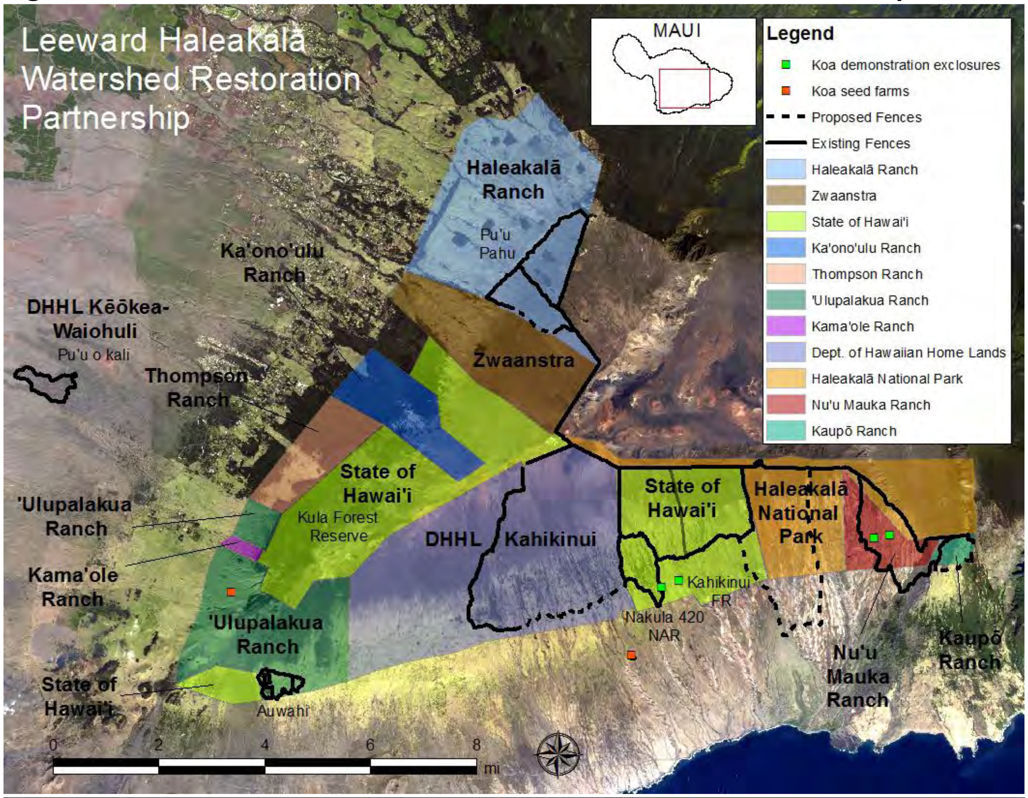


The Leeward Haleakalā Watershed Restoration Partnership (LHWRP) works with landowners in this region to address invasive species and restoring native habitat to improve ecosystem services and freshwater availability in the future. Figure 18-14 shows the landowners and partners that work together to affect change in this dry but promising region.

Active forest restoration is undertaken by strategic outplantings of native species. The picture below shows a restoration site on Kaupō Ranch with native shrubs and grasses established to slow runoff and erosion. In 2016 LHWRP planted over 3,000 native seedlings at Nu`u Mauka.

[61] Ibid

Figure 18-16 Leeward Haleakalā Watershed Restoration Partnership



Credit: LHWRP, 2016

Figure 18-17 Leeward Haleakalā Watershed Restoration

Credit: LHWRP, 2016

The comprehensive management approach integrates professional watershed management practices with scientific and cultural research, outreach and environmental education. The efforts by LHWRP, partners and landowners in Kahikinui ASEA have long term impacts that are less tangible than preserving remaining intact native forests on the island that provide critical recharge of ground and surface water supply. Focused efforts can provide future water source, mitigate impacts from climatic changes to this drought prone area, and address invasive species transition into native forests. Continuous funding is needed to benefit the region's residents, farmers, ranchers and gatherers.

Strategy #1: Support and provide broad based funding to sustain and expand watershed protection and restoration on a landscape level on leeward Haleakalā for long term habitat augmentation and water security. The current annual LHWRP budget is approximately $950,000, with funding from Federal, State, County and private sources.

Community outreach and support is essential for sustainable resource use and protection. Sometimes fencing off areas for ungulate control create conflict with community members that seek access to hunting to maintain their subsistence lifestyle. The Hāna Community Plan policy to "Recognize residents' traditional uses of the region's natural resources which balance environmental protection and self-sufficiency" calls for a balance that can be difficult to achieve. Community members recommend that private interests and the State work together to reduce the goat population and reduce liabilities. Ideas from the community include the National Park Service to consider involving hunting clubs by engaging with the local community, possibly exchanging something for protection, e.g. hunters could work in coordination with the community and the government in exchange for access to gathering animal products. Other community concerns relate to impact from fencing on animal migration, dead animals have been reportedly ending up in streams, possibly polluting water. The DOFAW goals and action items in the region's forest reserves generally align with the concerns and suggestions raised by community members in the WUDP public process. However, the community clearly desires increased communication and opportunities to participate and have a say in regional watershed management. Organized moku and grassroots efforts occur throughout Kahikinui. For example, the Helekunihi Cultural Foundation reforestation project at 1,800 feet helps to capture moisture, which drains to the ground and increases moisture in the soil to support plants. DHHL's 2011 Kahikinui Regional Plan identifies an eradication program partnership to remove the alien Gorse species in Kahikinui, Maui. The plan calls for the homestead community to be included in the partnerships with DHHL to assist with eradication of Gorse while it is still manageable in Kahikinui.

DHHL specifies watershed resource management policies and objectives for their Kahikinui lands that supplement DOFAW and LHWRP efforts and are a critical component in landscape level management for this region.

Strategy #2: Support and promote regional grassroots, homestead community and moku initiatives to collaborate with state and land owner partnerships to ensure participation and adequate access and opportunities for traditional uses of the region's natural resources.

18.8.2 Conservation

Encouraging water conservation and maximizing the efficiency of water use are objectives identified in the WUDP public process as well as the 1994 Hāna Community Plan.

Qualitative criteria to evaluate and measure resource strategies against this planning objective include:

- Per capita water use decreased
- Potable and irrigation systems water loss decreased
- Community water education increased
- Incentives for water conservation increased
- Renewable energy use increased

Issue and Background: Little data is available to identify water efficiencies and water use trends in Kahikinui. Kaupō customers on the MDWS non potable system average 249 gpd (per meter), which is well below the per capita goal of 305 gpd per person set forth in the Hawaii Freshwater Blueprint. Non-potable water is probably supplemented with hauled or purchased potable supply. Water use per meter in Kanaio area is higher and properties served generally larger.

The recommended supply and demand side conservation strategies outlined in Section 12.2 apply island wide. Demand side public education and outreach benefit all water systems and end uses. Educating and supporting proper use of rainwater catchment and rainwater harvesting are especially suited for the Kahikinui region. Supply side measures including water audits and leak detection programs are in place for MDWS systems and can be implemented for small private systems as well.

18.8.3 Conventional Water Source Strategies

Conventional water sources include groundwater (wells and tunnels) and surface water (stream diversions). Planning objectives related to ground and surface water use and development identified and confirmed in the WUDP update public process include:

- Improve understanding of the concepts of "precautionary planning" to reduce and adapt to the effects of drought and climate change upon water resource availability and quality.
- Adapt future populations to local water resource conditions, integrating conservation and the use of alternative resources.
- Water needs of DHHL in Kahikinui should be considered in accordance with the 2016 State Water Projects Plan.

Planning objectives related to groundwater and surface water source use and development identified in the WUDP update public process include:

- Manage water equitably
- Provide for Department of Hawaiian Homelands needs
- Provide for agricultural needs

- Protect cultural resources
- Provide adequate volume of water supply
- Maximize reliability of water service
- Minimize cost of water supply

In addition, the Hāna Community Plan identified the objective to “Improve water source and delivery facilities to ensure that water supplied to the region's residents and visitors is of the highest quality”.

Qualitative criteria to evaluate and measure resource strategies against this planning objective include:

- Public water system water shortages to serve existing customers avoided
- Public water supply drought shortages avoided
- MDWS prioritize DHHL needs over lower priority needs
- Potable water use for non-potable needs decreased
- Contingencies in place to support water supply system functions during emergency conditions
- Water is available to serve Maui Island Plan development
- Strategies to meet all needs incorporated into WUDP

The region’s source needs are focused in three main areas:

- Development of DHHL homestead lands.
- Adequate water service for Kanaio region, including applications on the MDWS Priority List for the Upcountry System
- Adequate water service for the Kaupō Community

State Department of Hawaiian Homelands Water Strategies for Kahikinui

Issue and Background: DHHL projects a potable requirement of 0.063 mgd and a non-potable requirement of 0.0135 mgd. Development of water resources and a distribution/storage system to meet the needs of the region is a concern. The proper allocation of water resources is considered essential to facilitate homestead development on the DHHL lands and improve fire protection in the region. Additionally, there are hopes that a reliable water system will help develop a new kind of stewardship economy to the region, based on prudent and innovative uses of water.[62]

The MDWS Kula Water System ends at Kanaio. The source for the Upper Kula System is the Waikamoi watershed and intakes at the Hapuaena, Puohokamoa and Waikamoi streams. Because the subsystem is reliant on surface water, it is vulnerable to droughts. It’s not feasible that the Upper Kula System would be extended further out to Kahikinui without additional groundwater contingency sources. Groundwater backup for the entire MDWS Upcountry System is further addressed in the Central and Ko`olau ASEA regional reports.

The 2017 State Water Projects Plan DHHL Water Development Strategy consider three options. Because there are only intermittent stream resources in the area, and considering the small magnitude of the stock water

[62] Department of Hawaiian Homelands, Kahikinui Regional Plan, July 2011, page 21.

requirement, it is anticipated that the selected potable source will supply the non-potable water also. The ambient annual rainfall between 20 and 50 inches across the tract is too low to recommend the use of catchment systems, which are typically used in areas that receive more than 60 inches of annual rainfall. Conventional catchment is therefore not a feasible option. Although rainfall is not sufficient to support traditional catchment systems, DHHL is exploring the option of utilizing fog drip catchment systems supplemented by truck hauling to provide fire protection.

A second option considered is extension of the MDWS Kula Water System. The costs would need to be further examined in order to assess the feasibility of this alternative. A third alternative is groundwater development of the underlying Luala`ilua aquifer system.

A Final Environmental Assessment for Kahikinui DHHL lands, completed in 1995, found that groundwater resources do exist and can be developed by beneficiaries at a cost of $1.2 million in 1995 dollars, which translates to $1,695,677 in 2009.[63] Very little of Luala`ilua aquifer sustainable yield has been developed. The cost to pump water at a ground elevation of about 2,000 feet can an issue for a small customer base. Hydrological studies of the Luala`ilua aquifer system is lacking. A domestic well of 0.216 mgd capacity was developed in 2013 at about 1,350 foot elevation adjacent to DHHL regional land holdings. Chloride levels appear to be slightly above potable quality.

Strategy #3: The proposed strategies in the 2017 State Water Projects Plan are incorporated. A combination of fog drip catchment system and groundwater development may be the most feasible strategies to supply build-out of DHHL Kahikinui homesteads. Depending on groundwater quality, desalination of brackish groundwater should be considered.

Kanaio Water Source Strategies

Issue and Background: The MDWS Upcountry System spans from less than 300 feet elevation in lower Haiku within the Ko`olau Aquifer Sector up to 4,000 feet elevation in Upper Kula in the Central Aquifer Sector. The southern end of the system exends into Kahikinui Aquifer Sector with 20 services in Kanaio. The Upcountry System is divided into sub-systems, based on source: the Makawao system, the Lower Kula System and the Upper Kula System. Kanaio is served by the Upper Kula System. Projected demand and source development for the MDWS Upcountry system as a whole is addressed in the Central and Ko`olau Aquifer Sector reports.

The source for the Upper Kula sub-system extending to Kanaio is surface water originating in Waikamoi watershed within the Ko`olau aquifer sector. Surface water is treated at the Olinda water treatment facility at an elevation of 4,100 feet and conveyed over 15 miles to Kanaio at the southern end of the service area. Roughly half of current water use in Kanaio is for domestic purposes and half for agricultural customers, based on MDWS customer classes. Only potable supply is available from the MDWS Upper Kula system.

There are seven applications for meter service on the "Upcountry Priority List". In March 1993, the department determined that the existing Upcountry water system had insufficient water supply developed for

[63] Ibid

fire protection, domestic and irrigation purposes to add new or additional water service without detriment to those already served. Consequently, MDWS created and maintained a list of Upcountry properties, by date of application, who requested new and additional water service. The procedure for processing applications is defined in Maui County Code Chapter 14.13 “Water Meter Issuance Provisions for the Upcountry Water System”. As additional source becomes available, the department processes water service requests from the priority list in their list order. Offers for water service (meters) are sometimes refused by the list applicant due to the cost of needed system upgrades to obtain adequate service and fire protection to the subject property. Projected demand for the seven applications in Kanaio, assuming 100 percent of applicants would accept service, represents about 4,200 gpd. No new applications are accepted to the priority list. Because the MDWS Upper Kula system is the only available water service, the priority list is practically the limiting factor to growth of the Kanaio region. Based on population growth rate, demand would increase from about 35,000 gpd to 43,000 gpd over the planning period. The Kanaio community is geographically within the Makawao-Pukalani-Kula Community Plan district. Water availability is contingent on source development for the MDWS Upcountry System.

Groundwater has not been developed in the Kanaio region of the Luala’ilua aquifer system. A private municipal well was developed about 2 miles west within the Kama`ole Aquifer System. The 1,300 deep well has potable quality and provides around 65,000 gallons per day. Potable groundwater development for domestic purposes is an alternative option where the MDWS system does not have sufficient source capacity. However, pumpage costs to supply development at 2,100 – 2,800 foot elevation is a constraint.

Non potable needs can potentially be met, or supplemented by traditional or fog-drip catchment systems. Rainfall in Kanaio ranges from 30 – 40 inches.

Strategy #4: It is assumed that the Upper Kula system can accommodate the existing applications on the priority list. Any additional population growth based increase, a modest 4,000 gpd would require that either new applications were accepted on the MDWS system, or development of regional groundwater sources. Non potable demand can potentially be supplemented by catchment systems, including fog drip.

Adequate Water Service for the Kaupō Community

Issue and Background: The Kaupō system has evolved as a non-potable hybrid system owned by MDWS and the Kaupō Ranch. MDWS bills 21 Kaupō meters at non-potable agricultural rates, which does not allow use for general potable purposes. Domestic uses are assumed to be supplied by other sources hauled or supplied commercially, and/or individual household filters. The latter would strictly be in violation of county rules for use of non-potable supply. If the Kaupō system would qualify as a public water system, subject to the Department of Health Rules additional treatment of water served for potable purposes would be required. A water system which provides water for human consumption is deemed a "public water system" (PWS) if it serves at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year. (HAR 11-20) A PWS that uses a surface water source must provide filtration treatment, in addition to disinfection. A PWS may be exempt from treatment requirements under certain conditions. Several issues affect the ability to supply reliable potable water in this remote community:

1. Absence of reliable electric power: The community is not connected to the Maui Electric Company grid
2. Small customer base: As with any infrastructure improvements, the cost to service small remote communities is not always feasible
3. The existing system was developed and expanded over time, with no current agreement defining responsibilities for management and repairs

Due to the challenges in providing county water service to the region, the Kaupō Rule was adopted in 1978 by the Board of Water Supply. The purpose of the rule was prohibiting the approval of subdivisions and building permits, and the issuance of water meters in the interim regulation area: defined as all areas where water to the public is or is to be supplied from Kalepa Gulch, Healani Intake, and Puanohoa Pump water sources in Kaupō. MDWS has often had to repair a leaky 40,000 gal tank in Kaupō.

Alternative Analyses and Strategies

Fukunaga & Associates, Inc. undertook a conceptual water source analysis of the Kaupō water system in 2014. The report deemed the existing system "very complicated," with a Kaupō Ranch (KR) Manager having most knowledge of the intricacies.[64] The system was considered to consist of two primary sources of water: stream intakes at 3,200 feet feeding a 3.2 MG open reservoir and a deep well. The system includes several storage tanks; and an array of small piping laid on the ground. MDWS owns 2- 3,600 gallon steel tanks and a 40,000 gallon steel tank. Kaupō Ranch (KR) owns the other 40,000 gallon steel tank and has several meters used to monitor leaks or breaks in the system. The KR Manager indicated that the MDWS 40,000 gallon tank needs to be replaced due to continued leaking and repairs over the years. The lower portion of the system from KR's Maua Well Site is located at about 620 feet elevation, and KR has a 42,000 gallon steel tank.

Maua Well is used during times of drought to supplement the water supply. When the well is in use, the 2" line from the "Outside Meter" is isolated from the Maua Well Site by a valve located at the well site. The well water is pumped into the Maua Well 42,000 gallon Tank where it serves the "K-1" and "K-2" meters. Well water is also booster pumped up to the 1,200-foot elevation tanks to provide source for Kaupō Ranch use ("Inside" meter). Chlorination continues at the 3,600 gallon tank at the 1,200-foot elevation; however, there is no chlorination at the Maua Well Site and the water serving the meters downstream of the Maua Well Site is not chlorinated during well use.

The KR Manager indicates that meter demand served by MDWS is about 1,500 gpd for meters east of the valley road, and is monitored by the "K-1" meter; and 2,500 to 5,500 gpd for the meters west of the valley road monitored by the "County/School" meter. Total MDWS Kaupō usage ranges from 4,000 gpd to 7,000 gpd, but there are other users that are not metered by MDWS, particularly in the Ranch Village.[65]

[64] Fukunaga & Associates, Inc., Kaupō Valley Conceptual Water Source Analysis, 2014.
[65] Fukunaga & Associates, Inc., Kaupō Valley Conceptual Water Source Analysis, 2014, page 3.

MDWS bills approximately 21 Kaupō meters at Non-Potable Agricultural Rates ($1.00/1000 gal). According to Maui County Administrative Rule Title 16, Chapter 7, "Rules for Charges for Water Service" (Water Service Rules), Kaupō customers are considered "non-potable water agricultural consumers," which is defined as agricultural consumers using non-potable water. The MDWS Water Service Rules, 16-7-4 states the following with respect to non-potable agricultural rates: (d) General or Agricultural water service will not be allowed from a meter for which the non-potable agricultural rate is approved; "(e) The penalty for using non-potable agriculture water service to supply general uses is removal of the meter."

If the customers supplied by the MDWS meters utilizes supply for human consumption, the system would be subject to the Department of Health Rules Relating to Public Water Systems, including filtration if the source for potable supply is surface water, or groundwater under the influence of surface water.

According to HAR Section 11-20-23 <u>Requirements for an exemption</u>:

(a) The director may exempt any public water system from any MCL requirement or any treatment technique requirement, or from both, of an applicable state primary drinking water regulation upon finding that:
   (1) Due to compelling factors (which may include economic factors), the public water system is unable to comply with such contaminant level or treatment technique requirement;
   (2) The public water system was in operation on the effective date of such contaminant level or treatment technique requirement; and
   (3) The granting of the exemption will not result in an unreasonable risk to health.
(b) The director will not exempt any surface water system or a ground water system under the direct influence of surface water from the requirements to provide disinfection for the water entering the distribution system.
(c) The director will not grant any exemption to the MCL for total coliform.

A dedicated potable system would have high capital, operation and maintenance costs, in addition to a high risk of cross-connection. Alternative improvements of the non-potable system that were evaluated and deemed viable for 20-year life cycle cost include:

1. Upgrade leaky tank to 100,000 gal steel tank.
2. Separate potable system, require well pump, generator, disinfection, tank and approximately 1 mile of pipe. Cross-connections risks high.
3. Potable water delivery, assuming one tanker/day
4. Individual water treatment systems owned and maintained by MDWS or contractor: Provide potable service at general rates.

Conceptual level costs for initial capital improvements and the present worth 20-year life cycle cost (LCC) were also evaluated for each alternative. The 20-year LCC accounts for operation and maintenance of the new facilities over 20 years, including such items as fuel for generator, repainting the tank, refurbishing the well pump motor, replacing the impeller and bearings in the pump, escalation of hauling water, *etc.,* as applicable. The 20-year LCC projections are converted to present worth or present value for comparison of the investment required in present dollars.

Alternative #1. No Action

The no action alternative would be to maintain status quo without any system improvements. No additional cost would be incurred. Non-potable water would be delivered without a current agreement with KR and the existing MDWS 40,000 gallon tank would continue to leak and require repair.

Alternative #2. Improve Existing Non-potable Water System

System reliability of the existing non-potable water system can be improved by updating the agreement with KR and replacing MDWS 40,000 gallon tank. The initial conceptual cost and present worth 20-year LCC are summarized below:

Table 18-19 Kaupō System Alternative #2A

System Description	Initial Cost	Present Worth 20-year LCC
100,000 gallon Steel Tank	$500,000	
Total	$500,000	$550,000
Cost per meter (based on 21 meters)	$23,800	$26,200

If MDWS Kaupō Water System was to be classified as a public water system while continuing the existing operation of the system, DOH approval of the PWS exemption requirements would be needed, specifically:

There are compelling factors (including economic factors) justifying PWS is unable to comply with primary drinking water regulations;

1. There is no unreasonable risk to health;
2. The surface water is disinfected; and
3. The total coliform level is below Maximum Contaminant Level (MCL).

Chlorine tablets are added to the system for disinfection. Information on the total coliform level was not available. If the above can be confirmed to meet the exemption requirements and DOH allows supply of the non-potable water for human consumption, an agreement between MDWS and KR would be necessary and potentially replacing the existing 40,000 gallon MDWS tank as indicated above. In addition, during well use, disinfection of the well water at the Maua Well Site upstream of the "K-1" and "K-2" meters is needed. The initial conceptual cost and present worth 20- year LCC for a new tank and chlorination system are listed below:

Table 18-20 Kaupō System Alternative #2B

System Description	Initial Cost	Present Worth 20-year LCC
100,000 gallon Steel Tank	$500,000	
Chlorination System	$100,000	
Total	$600,000	$750,000
Cost per meter (based on 21 meters)	$28,600	$35,800

Alternative #3. Potable Water System- Ground Water Source

A dual water system could be implemented with a potable well providing for potable needs as a separate system, and a non-potable system remaining to be served by surface water for agricultural use.

The existing KR well purportedly has very good quality. KR Manager indicates that the Maua Well located at 620 feet elevation is rated for 105 gpm, 653 feet of head, and has a 25 HP motor. The Commission on Water Resource Management has no record of this well.

A second well near the Maua Well at 620 feet elevation could be installed with the existing KR Maua Well as a backup source. Assuming the well would prove to be similar to the existing well and rated for 100 gpm, a 10,000 gallon control tank would be needed to control the well and maintain constant system pressure. A 100 kW generator would be needed for power.

Transmission lines would need to be added to facilitate separation of the potable system from the non-potable system. The waterline serving the west side meters off of the "County/School" meter is isolated from KR use. The waterline metered by the "K-1" meter serves the east side meters and also delivers a few hundred gpd for KR use. Approximately 1 mile of pipe would be needed to interconnect the highest customer before the "County/School" meter to the "K-1" meter line near the well site.

Cross-connection risks need to be addressed. As mentioned, the potable tanks and transmission lines need to be isolated from the non-potable tanks and transmission lines, and clearly identified. The ranch and other consumers need to be educated on the potable and non-potable water systems and on preventing cross-connections. The initial conceptual cost and present worth 20-year LCC are summarized below. The conceptual LCC includes cost for operation and maintenance of the tank, pump motor, pump, generator and disinfection system. KR Manager has indicated that they spend about $12 for fuel for every 1000 gallons produced. This amounts to about $85 per day for fuel alone to produce 7000 gpd, without consideration for the difficulty of transporting the fuel to this remote area. A photovoltaic system could be considered.

Table 18-21 Kaupō System Alternative #3

System Description	Initial Cost	Present Worth 20-year LCC
Deep Well	$1,000,000	
Generator	$100,000	
Chlorination System	$100,000	
10,000 gallon Steel Tank	$200,000	
Transmission Lines	$100,000	
Retrofit Tank Lines	$100,000	
Total	$1,600,000	$2,600,000
Cost per meter	$76,200	$123,900

Alternative #4. Potable Water System- Surface Water Treatment

If surface water is utilized for potable needs, the potable water system would require costly surface water treatment and monitoring. Because groundwater supply is a viable option for potable water source, surface water treatment is impractical and not considered further.

Alternative# 5. Potable Water Delivery

Potable water delivery may not be a practical option due to the remote location and difficult access. Assuming one tanker truck per day, the initial conceptual cost and present worth 20-year LCC are as follows:

Table 18-22 Kaupō System Alternative #5

System Description	Initial Cost	Present Worth 20-year LCC
Tanker truck per day	$500/day	$4,850,000
Cost per meter (based on 21 meters)	$25/day	$231,000

Alternative #6. Individual Water Treatment Systems

Individual water treatment systems can be used to treat non-potable water, and can either be at the point of entry (POE) into a home, or at the point of use (POU) at the faucets where potable water quality is desired. Sampling of the water source would be prudent to determine what type of treatment is required. If MDWS uses individual water treatment systems to comply with PWS regulations, the units must be owned, controlled and maintained by MDWS or by a contractor hired by MDWS to ensure proper operation and maintenance of the devices and compliance with water quality regulations. MDWS would need to develop a monitoring plan and obtain DOH approval. Detailed information on these requirements can be found in EPA document "EPA 815-R-06-010 Point-of-Use or Point-of Entry Treatment Options for Small Drinking Water Systems."

MDWS customers technically should not be using individual treatment systems to treat non-potable water to potable water quality for human consumption. As stated earlier, the Water Service Rules does not allow general or agricultural use from a non-potable meter.

A POE device would be sized to treat approximately 100-300 gpd depending on the household size, and may cost on the order of $1000. POU systems are more economical since treatment is limited to the water that will be directly consumed or used for cooking, such as in the kitchen and bathrooms. Reverse osmosis (RO) and activated carbon units are common POU devices, and provide a few gallons of potable water a day, with cost ranging around $300-$500. These devices are usually installed at the sink and connected to the plumbing. Disinfection should be considered; UV add-ons are available for under $200.

These systems require power and substantial maintenance and replacement parts, particularly replacement filters. Of note, RO units only treat about 5 to 10 percent of the flow through the unit and waste the remainder. This wasted flow would need to be accommodated.

Table 18-23 Kaupō System Alternative #6

System Description	Initial Cost	Present Worth 20-year LCC
Individual Treatment Units	$21,000	$147,000
Cost per meter	$1,000	$7,000

Strategy #5: A dedicated potable water· system may be difficult to achieve in this remote community, with the high initial capital costs and operation and maintenance costs, in addition to the high risk of cross-connection. The lack of reliable power supply is an impediment and a potable system would entail potable water rates for the community with an associated household increase of 100 % - 400% in water charges, depending on intensity of use. It is recommended that MDWS and KR collaboratively explore alternatives # 2 and 3 above to provide adequate service to the Kaupō community. This strategy is a collaborative effort by MDWS, KR and the DOH Safe Drinking Water Branch and also include exploration of technical and financial assistance provided by the Rural Community Assistance Corporation (RCAC) and the Hawai`i Rural Water Association (HRWA). Grant opportunities for ranch and agricultural operations are available through the Soil and Conservation District and the U.S. Department of Agriculture.

Climate Adaptation

Issue and Background: Data and research suggest that Hawai'i should be prepared for a future with a warmer climate, diminishing rainfall, declining stream base flows, decreasing groundwater recharge and storage, and increased coastal groundwater salinity, among other impacts associated with drought.

Kanaio region’s reliance on surface water, as part of the Upcountry MDWS system, will become more uncertain in a future of longer droughts and varying rainfall. No streamflow projections are available for the coming century but projections include a decline in base flow and low flows, with stream flows becoming more variable and unstable (flashy), especially in wet years. [66] Kanaio has been subject over the years to mandatory water restrictions for non-agriculture customers. The impact on groundwater recharge will vary locally. Drought risk and vulnerability are assessed by the CWRM to illustrate the spatial extent and severity of drought risk for different impact sectors throughout the state. The statewide "*Drought Risk and Vulnerability Assessment and GIS Mapping Project"* assesses drought risk areas for three impact sectors: 1. water supply; 2. agriculture; and 3. wildland fire. Kaupō and Kahikinui regions are identified as drought risk for all three impact sectors. [67] The Maui Drought Committee identified current mitigating actions in response to drought summarized in the 2012 report "*Maui County Drought Mitigation Strategies*". Measures that address agriculture and commerce impact include monitoring water availability, emergency water conservation, and USDA post disaster programs. Response actions for water supply impacts include voluntary and mandatory water use restrictions, public outreach activities, and operational controls. The Maui Drought Committee developed the following mitigation projects to address drought impacts in the Kahikinui region:

Wildfire Mitigation:

1. Develop a coordinated grazing program to reduce wildfire risk
2. Develop a water system to utilize for wildfire response
3. Develop access points for fire fighting vehicles, including heavy equipment
4. Allow for procurement, construction and/or access to open water storage facilities for wildland fire suppression

Agricultural Mitigation:

1. Extend the current water system or develop a well. Wind energy may be an opportunity for pump electricity needs

Water Supply Mitigation (applies to Upcountry MDWS system as a whole)

1. Construct 50 - 100 million gallon lined storage reservoirs
2. Improve surface water sources. The MDWS two upper systems have inadequate surface water intakes
3. Improve surface water transmission systems. If the intakes are upgraded, then transmission must also be upgraded
4. Develop ground-water sources. Groundwater sources could supplement surface water supply during periods of drought
5. Expand the water conservation outreach and education program, promote xeriscaping, etc.
6. Conduct a review of the current rate structure to provide incentives for conservation. Also provide ideas on how to prioritize uses

[66] Summarized from EcoAdapt. 2016. Climate Changes and Trends for Maui, Lāna'i, and Kaho'olawe. Prepared for the Hawaiian Islands Climate Synthesis Project
[67] Wilson Okamoto Corp, County of Maui Drought Mitigation Strategies, 2012 Update

7. Continue development of a separate water supply system for agriculture.

The statewide Multi-Hazard Mitigation Plan is updated by the Hawaii Emergency Management Agency. A drought hazard chapter is currently being drafted that address the water supply, agricultural and commerce sectors. The 2017 update proposes the following future mitigation actions for water supply:

1. Convene sector-based drought workshops to assist stakeholders in developing or improving their individual drought/water conservation plans. Includes retaining experts in respective sectors. Cost estimate $50,000
2. Upcountry Maui Agriculture Pipeline Extension: Install a separate agricultural water distribution system to supply untreated water for irrigation purposes to farmers in the upper Kula area. The water source will be Kahakapao Reservoir. Cost estimate $5M to $8M.
3. Construct new 100 to 200 MG storage reservoir: Construct open lined reservoir(s) after the intakes for Kamole WTP or the Piʻiholo WTP. The reservoir(s) would provide continuous supply to DWS customers in times of drought. Cost estimate $30M to $60M
4. Improve Surface Water Sources in Upcountry Maui: Improve existing intakes to capture higher percentage of surface water. This may involve adding intakes at known water sources. The intakes must also be maintained for maximum operational safety. Cost estimate $5M to $10M
5. Improve Surface Water Transmission in Upcountry Maui: Improve the surface water transmission system and improve the flow of water for agriculture, domestic supply, and fire protection. Cost estimate $5M to $10M

As of October 2017, the sponsors of the Upcountry Maui Agriculture Pipeline Extension have decided to suspend the project. The “dual line” would compete for the same surface water source in Kahakapao as the potable needs of the Upper Kula system and would not have added additional source.

The 2012 recommendations by the Maui Drought Committee to expand the water conservation outreach and education program, promote xeriscaping, and conduct a review of the current rate structure to provide incentives for conservation are all incorporated under Part II, Chapter 12.2 “Conservation”.

Raw water storage, surface water intake and transmission improvements for the Upcountry system is addressed in the report for Central Aquifer Sector. Two raw water reservoirs at Kamole water treatment facility are proposed to augment source for Upcountry, which will benefit reliable capacity for Kanaio. The 2012 recommendation by the Maui Drought Committee to develop groundwater is also included in the report for the Central Aquifer Sector. The remaining proposed water supply drought mitigation effort to establish sector based drought workshops is incorporated here for Kahikinui ASEA as a strategy to address climate change:

Strategy #6: Convene sector-based drought workshops to assist stakeholders in developing or improving their individual drought/water conservation plans. Focus in Kahikinui region is on ranching and may include retaining experts in respective sectors. Cost estimate $50,000. Proposed lead agency is CWRM with participation by DLNR DOFAW, NRCS, DOA, DHHL, MDWS, USDA Farm Services Agency and the region’s ranches (Kaupō Ranch, Ulupalakua Ranch, Haleakalā Ranch).

18.8.4 Alternative Water Source Strategies

The Hāna Community Plan does not specifically address alternative water sources, such as gray water, catchment systems or stormwater capture. Opportunities for exploring and adopting available alternative source options are discussed below but no strategies for implementation are proposed for water purveyors in the region.

Rainwater Catchment

Rainwater catchment is the collection of rainwater from a roof or other surface before it reaches the ground. The Kahikinui ASEA rainfall is typically between 20 and 50 inches.[68] Rainwater catchment is not as reliable a conventional water resource because it is extremely sensitive to the climate. DHHL Kahikinui homesteaders presently rely to some extent on rainfall catchment to supplement their own water for drinking and household purposes.[69]

Fog harvesting is not technically rainwater catchment but provides an alternative source of freshwater in dry regions through relatively simple and low-cost collection systems. Fog harvesting can consist of a single or double layer mesh net supported by two posts as shown in the photo below. Water droplets that collect on the mesh run downwards and drip into a gutter at the bottom of the net from where they are channeled via pipes to a storage tank. Typical water production rates from a fog collector range from 200 – 1,000 liters per day.[70] Data is not available to estimate whether fog harvesting can supply potable needs projected by the Department of Hawaiian Homelands for build-out of Kahikinui Homesteads. However, alternative emerging technologies can play an important role in supplying potable needs in the region.

[68] Johnson, Adam G, John A. Engott, and Bassiouni, Maoya, 2014, Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawaiʻi, 1978–2007, U.S. Department of the Interior, U.S. Geological Survey Scientific Investigations Report 2014–5168.
[69] Department of Hawaiian Homelands, Kahikinui Regional Plan, July 2011, page 21.
[70] http://www.climatetechwiki.org/content/fog-harvesting

Figure 18-18 Example of Fog Drip Harvesting

Source: ClimatePrep

Recycled Wastewater

There is no wastewater reclamation in the Kahikinui region. Homes are served by septic systems and cesspools.

Stormwater Reuse

There are no large scale stormwater reclamation projects identified for Kahikinui. Stormwater reuse at the parcel scale may provide an opportunity to offset landscape agricultural uses within the region.

Desalination

Should exploratory groundwater development result in brackish, or nearly brackish water quality, desalination could become necessary to provide potable water quality. As the technology advances and energy costs decrease, desalination should continue to be evaluated for its potential to utilize groundwater in Luala`ilua, Nakula and Kaupō aquifer systems.

18.9 Recommendations

The challenges to provide reliable water supply to the small communities and modest anticipated growth in this region are not a lack of groundwater resources, but the cost and practicability of infrastructure development. Lesson learned from the Auwahi Forest Restoration Project's success and the promising results of reforestation by the Leeward Haleakalā Watershed Partnership are that water resources can be improved and augmented in the long run. These efforts require patience, dedication and consistent funding to maintain and expand efforts and rehabilitate the once forested watershed.

The Kaupō community needs sufficient groundwater to supply domestic needs with adequate water quality. Ranching operations should be prepared to address future longer droughts and factor in the cost of groundwater pumpage when stream flow is insufficient.

Department of Hawaiian Homelands' strategies for build-out of Kahikinui homesteads include fog drip catchment and truck haul. It is recommended that groundwater development is further explored as supplemental potable source.

Reliable and affordable water supply for the Kanaio community is directly dependent on source development for the MDWS Upcountry System, and especially groundwater contingency sources for the Upper Kula subsystem. As mentioned earlier, the MDWS Upcountry system is addressed in the Central Aquifer Sector report.

Projected water demands based on the selected scenario and source strategies are summarized in the table below.

Table 18-24 Kahikinui Selected Demand Scenario: Projected Water Demand and Supply Options

DEMAND (GPD)	2015	2020	2025	2030	2035
MDWS Potable*	35,575	37,392	39,298	41,293	43,405
DHHL Potable	0	63,000	63,000	63,000	63,000
Total Potable:	**35,575**	**100,392**	**102,298**	**104,293**	**106,405**
MDWS Non-Potable**	5,274	5,544	5,826	6,122	6,435
DHHL Non-Potable	0	13,500	13,500	13,500	13,500
Agriculture, Non-Potable	180,000	180,000	180,000	180,000	180,000
Total Non-Potable	**185,274**	**199,044**	**199,326**	**199,622**	**199,935**
TOTAL DEMAND	**220,849**	**299,436**	**301,624**	**303,915**	**306,340**
SUPPLY (GPD)					
DHHL Fog Drip Catchment and Truck Haul		76,500	76,500	76,500	76,500
Potable surface water transport from Central/Ko`olau ASEAs***	35,575	37,392	39,298	41,293	43,405
Non-Potable Groundwater Kaupō ASYA	**180.000**	**180.000**	**180.000**	**180.000**	**180.000**
Non-Potable Surface Water Kaupō ASYA	**5,274**	**5,544**	**5,826**	**6,122**	**6,435**
TOTAL SUPPLY	**220,849**	**299,436**	**301,624**	**303,915**	**306,340**

*Kanaio

**Kaupō. Surface water is supplemented with non groundwater when needed.

*** Po`okela well in Central ASEA can backup Upper Kula System which receives Ko`olau ASEA surface water from Haipuaena, Waikamoi, and Puohokamua streams. Estimated ratio 15%, or 6,400 gpd

The recommended strategies for the Kahikinui aquifer sector address the goals and objectives identified in the Hāna Community Plan and the WUDP public process for the region that evolve around resource protection and management; traditional uses of the region's natural resources and self-sufficiency.

Table 18-25 summarizes recommended strategies and indicates the planning objectives that each strategy supports. Estimated costs are, unless indicated otherwise, life cycle costs for the twenty-year planning period per 1,000 gallons. Life cycle costs include capital, operational and maintenance costs and include inflationary effects. The cost to develop and implement sustainability projects can be difficult to quantify per volume water supply. Lead agency, or organization to implement a strategy is proposed as a starting point. The timeframe for implementation is indicated as short term – less than 5 years, and long term 5 – 20 years. Many strategies are multi-year actions with implementation beginning within 5 years and continuing through the long term. (Indicated as 1, 2)

Table 18-25 Summary of Recommended Strategies Kahikinui ASEA

STRATEGY		PLANNING OBJECTIVES	ESTIMATED COST	IMPLEMENTATION 1: Short-term 1 – 5 years 2: Long-term 5 – 20 years	
				AGENCY	TIME-FRAME
	RESOURCE MANAGEMENT				
1.	Support and provide broad based funding to sustain and expand watershed protection and restoration on a landscape level on leeward Haleakalā for long term habitat augmentation and water security	Maintain sustainable resources Protect water resources Protect and restore streams	$950,000 per year	MDWS Maui County	1
2.	Support and promote regional grassroots, homestead community and moku initiatives to collaborate with state and land owner partnerships to ensure participation and adequate access and opportunities for traditional uses of the region's natural resources.	Maintain sustainable resources Protect water resources Protect and restore streams	N/A	Public-private partnerships Aha Moku DLNR Maui County	1
	CONVENTIONAL WATER SOURCE STRATEGIES				
3.	DHHL proposed strategies in the 2017 State Water Projects Plan: fog drip catchment system. Recommendation is to combine with groundwater development to supply build-out of Kahikinui homesteads.	Provide for DHHL needs Provide adequate volume of water supply Maximize reliability of water service Minimize adverse environmental impacts	$1.8M capital cost	DHHL	1, 2
4.	MDWS Upper Kula system accommodate existing priority list applications. Potential additional demand (4,000 gpd) depend on MDWS groundwater source development for Upcountry System. Regional domestic groundwater development and catchment systems, including fog drip supplement supply	Provide adequate volume of water supply Maximize reliability of water service	N/A	MDWS	1,2

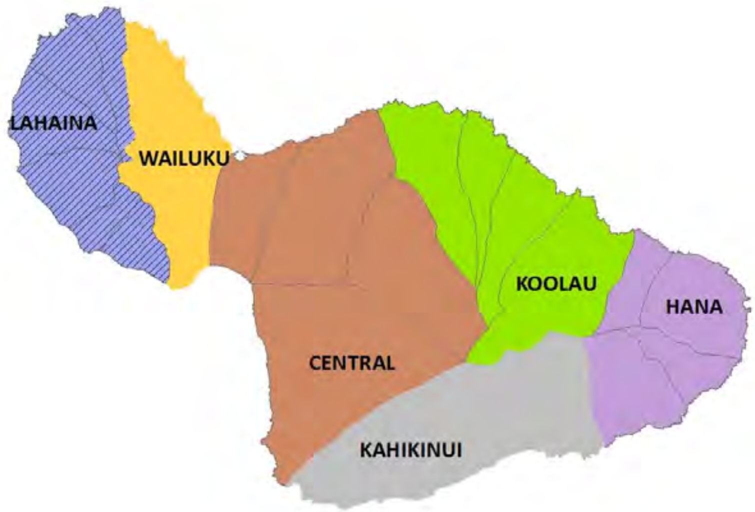
5.	MDWS and KR collaboratively explore two alternatives: a) improving the existing non-potable system; and b) dual water system with a potable well providing for potable needs as a separate system, and a non-potable system remain to be served by surface water for agricultural use. Explore technical and financial assistance and grant opportunities		Non-potable system $750K, $35,8K per meter Potable system $2.6M, $123.9K per meter	MDWS Kaupō Ranch DOH SDWB RCAC HRWA	
6.	Convene sector-based drought workshops to assist stakeholders in developing or improving their individual drought/water conservation plans. Focus on ranching and may include retaining experts in respective sectors.		$50,000	CWRM DLNR DOFAW, NRCS, DOA, DHHL, MDWS, USDA Farm Services Agency Kaupō Ranch, Ulupalakua Ranch, Haleakalā Ranch	

18.9.1 Implementation Program

In consistency with the Maui Island Plan, strategies recommended and adopted in the WUDP does not legally bind the agencies and organizations to execute. The recommendations provide guidance for land use and infrastructure, including the county CIP program, over the planning period.

Timing and prioritizing of resource strategies, particularly groundwater development are tied to actual population growth in this sparsely populated region. Rehabilitation of this once extensive and diverse forested area would greatly improve the land and freshwater resources to sustain population growth and self-sufficient communities in Kahikinui. Prioritizing resource management and augmentation strategies are key to future build-out and supported by the DLNR watershed initiative program "The Rain Follows the Forest." This initiative seeks to double the acreage of protected watershed forests by 2021.

Over the planning period, implementation and performance of the recommended strategies can be assessed using qualitative criteria and quantitative targets formulated in the WUDP Part I, Table 3-3.



LAHAINA AQUIFER SECTOR AREA

MAUI ISLAND WATER USE AND DEVELOPMENT PLAN DRAFT

PART III REGIONAL PLANS

Table of Contents

List of Tables

List of Figures

ABBREVIATIONS:

CWRM	Commission on Water Resource Management
DHHL	State of Hawai`i Department of Hawaiian Home Lands
DLNR	State of Hawai`i Department of Land and Natural Resources
DOA	State of Hawai`i Department of Agriculture
DOH	State of Hawai`i Department of Health
HRWA	Hawai`i Rural Water Association
Maui County	Maui County Administration and Maui County Council
MDEM	Maui County Department of Environmental Management
MDP	Maui County Department of Planning
MDPW	Maui County Department of Public Works
MDWS	Maui County Department of Water Supply
SWCD	Soil and Water Conservation District
UH CTAHR	University of Hawai`i College of Tropical Agriculture and Human Resources
USDA	U.S. Department of Agriculture
USGS	U.S. Department of the Interior, U.S. Geological Survey
WWC	Wailuku Water Company

19.0 LAHAINA AQUIFER SECTOR AREA

The Lahaina Aquifer Sector Area (ASEA) encompasses about 96 square miles including six groundwater aquifer system areas underlying the western flank of the West Maui volcano, Mauna Kahalawai. Pu`u Kukui summit rises 5,788 feet above sea level.

The Water Use and Development Plan (WUDP) uses hydrologic units for presentation and analysis consistent with state requirements for updating the plan. Unlike other areas of Maui, the West Maui Community Plan and Lahaina Aquifer Sector Area boundaries are the same. The Lahaina and Kā`anapali moku overlay and extend beyond the Lahaina Aquifer Sector Area.

The population of West Maui was estimated to be 24,373 people in 2015 and is projected by the Maui Island Plan to increase by 64 percent to 39,911 people by 2035. All water supply used in the region, including groundwater and surface water, is generated within the Lahaina Aquifer Sector. While most public water supply on the island is provided by the Maui Department of Water Supply, the Lahaina region is also served by multiple privately owned water purveyors that provide potable and non-potable water.

19.1 PLANNING FRAMEWORK

19.1.1 Key Issues

A key issue for the Lahaina region is assessing alternative ways to meet the future water needs of public trust and other local uses in the region given increased growth, climatic changes and potential decreased water supplies, while managing resources in a sustainable way. Region specific input received at the community meetings, surveys and policy board meetings generally focused on the following issues:

- Restoration and protection of streamflow to support Native Hawaiian rights and traditional and customary practices. Measurement of streamflow, protection of undocumented kuleana uses, and the delay in developing instream flow standards are also concerns.
- Watershed protection and its prioritization, maintaining access to lands for gathering, hunting and other Native Hawaiian traditional and customary practices, and reducing the adverse effects of runoff and sedimentation on streams and the near shore environment.
- Improved understanding of ground and surface water resources and the effects of water use on resource availability over a prolonged period of time, and enhanced transparency and controls on water withdrawals.
- Improved understanding of and precautionary planning to reduce and adapt to the effects of drought and climate change on water resource availability and quality.

- Adapting economic and population growth and the existing and future built environment to local water resource conditions, integrating conservation and the use of alternative resources.

19.1.2 Plans, Goals, Objectives and Policies

The Lahaina Aquifer Sector Area implements the Maui County General Plan and is subject to the plans, goals, policies and objectives discussed in Chapter 3 of the WUDP. While the West Maui Community Plan is currently under revision, the plan does reflect regional issues and remains in effect. Relevant goals and policies of the West Maui Community Plan are summarized below.

Water Resources

- Protect ground water resources.
- Protect and enhance native forest and vegetation. Establish and maintain programs which control invasive alien plant and animal species.
- Protect cultural sites: plantation ditch systems, fishponds, significant native vegetation zones, stream valley areas, lo`i and `auwai.
- Establish a watershed protection overlay plan for West Maui to protect quantity and quality of drinking water supplies, quality of coastal waters and marine resources, and the long term economic viability of the community.

Water Availability and Use

- Support sufficient water to support agriculture and Native Hawaiian water rights and traditional practices. Recognize Native Hawaiian water rights and traditional access.
- Encourage maintenance and development of water sources for agricultural uses that do not conflict with domestic demand for potable water.
- Coordinate water system development to support development within urban growth boundaries.
- Reduce potable water consumption outside urban areas.
- Improve the quality of domestic water.

Supply Augmentation / Demand Controls

- Encourage landscape and agricultural use of reclaimed wastewater.
- Promote water conservation.
- Incorporate drought-tolerant plant species into future landscape planting.

19.2 Physical Setting

19.2.1 Climate and Geology

West Maui volcano rises about 5,790 feet above sea level. The leeward slopes of the West Maui Mountains are dry and the coastal areas are dominated by sea and valley breezes, although trade winds often occur to the north at Kā`anapali and south at Olowalu. Rainfall in West Maui is characterized by steep gradients with increasing altitude, ranging from about 366 inches at Pu`u Kukui to less than 50 inches in the coastal areas.[1]

West Maui Mountain was built primarily by volcanic eruptions and layers of lava flows intruded in places by dikes. In the inland region of West Maui Mountain, near-vertical dikes radiating in all directions from the summit impound groundwater in compartments of volcanic rock in the caldera and permeable lava flows on the flanks. The water table of the dike-impounded groundwater systems in the West Maui Mountain interior may be more than 3,500 feet above sea level. Seaward of the dike-impounded systems, freshwater-lens groundwater systems exist in the dike-free high-permeability volcanic rocks and sedimentary deposits.[2]

A freshwater-lens system consists of a lens-shaped freshwater body, an intermediate brackish-water transition zone, and underlying saltwater. Water levels of groundwater bodies in the dike-free volcanic rocks of West Maui Mountain are typically less than a few tens of feet above sea level. Fresh groundwater within the freshwater-lens system generally flows in a seaward direction from inland areas of West Maui Mountain toward the coast. Wedges of low-permeability sedimentary caprock impede the seaward flow of fresh groundwater in freshwater-lens systems along parts of the northeast and southwest flanks of West Maui Mountain.[3] Most of the public water supply in west Maui is pumped from this freshwater lens. Most streams on West Maui Volcano receive groundwater discharge from the dike-impounded water body, but much of this water is diverted for offstream uses.

19.2.2 Water Resources

The Lahaina Aquifer water budget is reliant on rain and fog for about 96 percent of groundwater recharge, with the remainder from irrigation and other activities. The uplands of the West Maui Mountains exhibit high recharge due to high rainfall, as well as considerable fog interception and low evapotranspiration due to persistent cloud cover.[4] Recharge to the Lahaina Aquifer Sector Area decreased dramatically in the 21st century especially in the lower elevations. Estimated recharge declined 43 percent between the periods 1926–79 and 2000–04 due to decreases in irrigation and its return flows and low rainfall. After 1980, recharge has

[1] USGS, *Low-flow Characteristics of Streams in the Lahaina District, West Maui, Hawai`i.*
[2] CWRM, *State Water Resources Protection Plan*, 2008.
[3] State Water Resources Protection Plan, 2008
[4] USGS*, Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawai`i, 1978–2007*. Due to an error in the study, recharge has been recalculated in the USGS *Revision to Groundwater Recharge for the Islands of O`ahu, Maui, and Kaua`i*, May 16, 2017, resulting in a decrease in recharge from 163.4 mgd to 163.3 mgd, and equally minor changes to recharge for the various aquifer system areas (ASEAs).

been augmented by direct injection of treated wastewater near the coast; however, the future use of injection wells is uncertain due to potential effects on nearshore waters. Total average base flow during 1913–2005 upstream of any diversions from the nine gaged streams in the study area was about 35 million gallons per day (mgd). Discharge from the Lahaina aquifers occurs as withdrawals from wells, base flow to streams, and diffuse seepage to the ocean.[5]

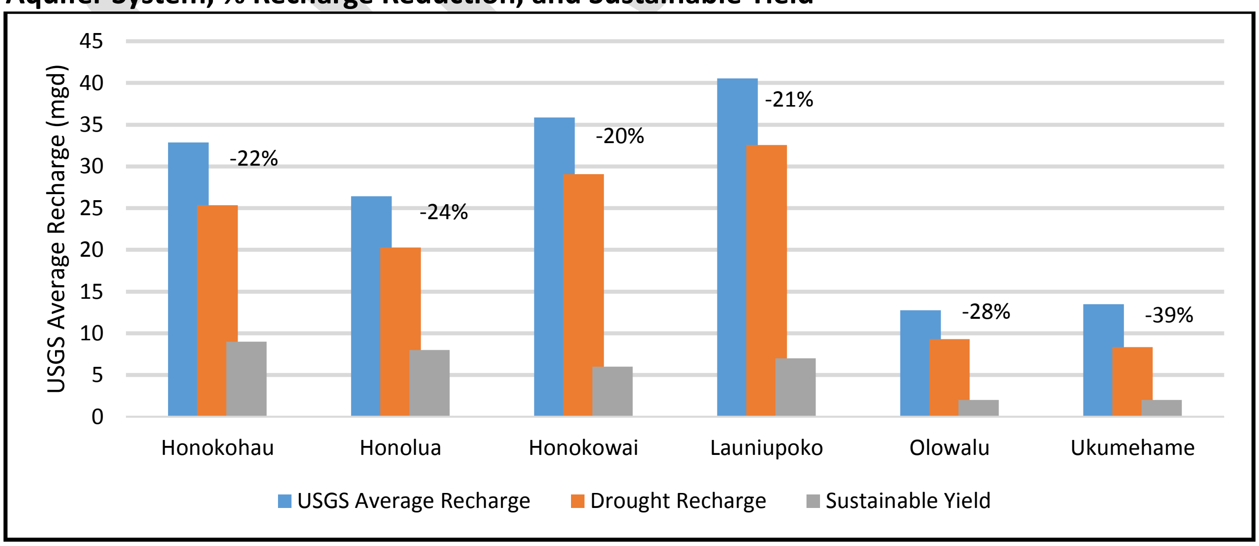
A drought condition scenario modeled for the Lahaina Aquifer Sector Area based on rainfall during the 1998–2002 period yielded a 24 percent reduction in recharge sector-wide compared to average climate conditions. However, recharge declined from 20 to 39 percent by aquifer system area. The 2014 USGS study, *Spatially Distributed Groundwater Recharge Estimated Using a Water-Budget Model for the Island of Maui, Hawai`i, 1978–2007*, reassessed average climate conditions on recharge using 2010 land cover. In 2017, USGS discovered an error in data that affected published groundwater-recharge estimates for Maui and other islands. The recharge estimated for 1978 – 2007 rainfall and 2010 land-use conditions were revised and available on May 16, 2017 and are reflected in the table below. Recharge for drought conditions and associated reports and datasets were not available yet at the time of completing this WUDP draft. The percentage drought recharge reduction is assumed to not change significantly. Corrected recharge for Lahaina sector is a net decrease of 0.1 mgd.

Table 19-1 Recharge for Lahaina Aquifer Sector (mgd)

Recharge - Average Climate Conditions	Recharge - Drought Climate Conditions	% Decrease – Drought Climate Conditions
162	*126*	24%

Source: USGS, *Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawai`i, 1978–2007.*

Figure 19-1 Average Mean Recharge under Average Climate and Drought Conditions by Aquifer System, % Recharge Reduction, and Sustainable Yield



[5] USGS, *Groundwater Availability in the Lahaina District, West Maui, Hawai`i*, 2012

Source: CWRM 2008 Sustainable Yields; USGS, *Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawai`i, 1978–2007.* Water-budget-area B, entire aquifer-system area including caprock, excluding areas seaward of 0-ft elevation contour of the top of the Wailuku Basalt, average climate conditions. The USGS recalculation of recharge results in immaterial changes that should not affect the representation in this figure.

Scientific investigation and downscaling of climate projections by Pacific Regional Integrated Sciences and Assessments (RISA) and others suggest that leeward areas will get drier, while recharge in the wettest areas may exhibit the greatest increases or decreases.

Groundwater Availability

The 2008 sustainable yield for the Lahaina Aquifer Sector Area (ASEA) is 34 mgd. Sustainable yield was conservatively set at the low end of the estimated range as shown in the table below. Sustainable yield is under review for the 2016 (now 2019) State Water Resource Protection Plan.

Table 19-2 Sustainable Yields of Aquifer System Areas

Aquifer System	Aquifer Code	Sustainable Yield Range	Sustainable Yield
Honokōhau	60201	9-17	9
Honolua	60202	8-10	8
Honokōwai	60203	6-11	6
Launiupoko	60204	7-14	7
Olowalu	60205	2-7	2
Ukumehame	60206	2-6	2

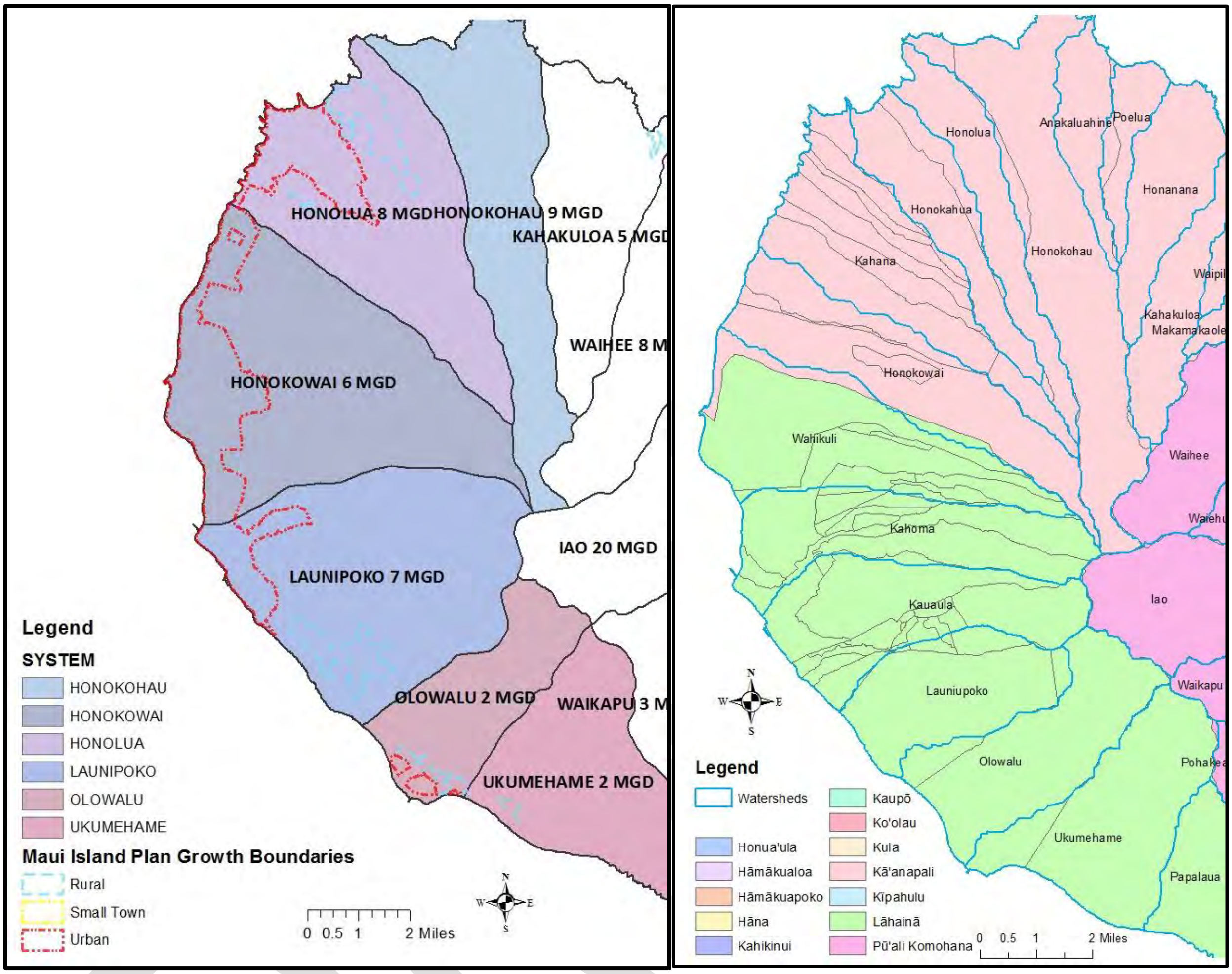
Source: CWRM, *State Water Resource Protection Plan*, June 2008.

Sustainable yield accounts only for basal groundwater and ignores any importation of water from outside the aquifer system area. While groundwater is not transported into or from the Lahaina Aquifer Sector, localized transport of water from wells and streams between aquifer systems to areas of demand occurs due to water system design, inadequate sustainable yield to serve all demand, chloride or other water quality issues, and cost-effectiveness, among other reasons. Pumpage has not exceeded half of the sustainable yield.[6] Projected development in the Honokōwai aquifer system could exceed sustainable yield if withdrawals from that aquifer were exclusively used to meet projected demand. The figure below shows the relationship of various units.

The traditional watershed divisions of ahupua`a and larger moku do not correspond with other hydrologic unit boundaries such as aquifer systems or watersheds. The figure below illustrates the relationship between aquifer system areas, Maui Island Plan (MIP) growth boundaries and moku in the Lahaina Aquifer Sector.

[6] USGS webpage, Recent hydrologic conditions, Lahaina District, Maui, Hawai`i. Pumpage in aquifer systems. http://hi.water.usgs.gov/recent/Lahainā/pumpage.html)

Figure 19-2 Relationship of Aquifer System Areas and Sustainable Yield to MIP Growth Boundaries, Watersheds and Moku

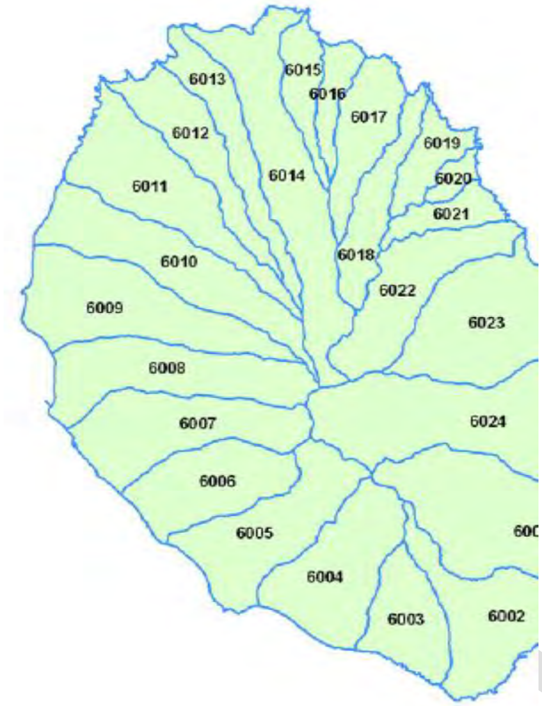


Surface Water Availability

The surface water hydrologic units, generally referred to as watersheds, are shown below primarily for reference purposes. There are 14 surface water units within the area encompassed by the Lahaina Aquifer Sector Area.

There are 11 perennial streams within the Lahaina Aquifer Sector Area. Of these, Honokahua, Honolua and Honokōhau flow continuously, while the others flow only intermittently at lower elevations. Streams flow from the wet interior of the West Maui Mountains into the low-permeability volcanic dike compartments which impound groundwater to high altitudes.

Figure 19-3 Hydrological Units and Perennial Streams



Hydrologic Units

6003	Pāpalaua
6004	Ukumehame
6005	Olowalu
6006	Launiupoko
6007	Kaua`ula
6008	Kahoma
6009	Wahikuli
6010	Honokōwai
6011	Kahana
6012	Honokahua
6013	Honolua
6014	Honokōhau
6015	Anakaluahine

Perennial Streams

6101	Ukumehame
6102	Olowalu
6103	Launiupoko
6104	Kaua`ula
6105	Kahoma
6106	Wahikuli
6107	Honokōwai
6108	Kahana
6109	Honokahua
6110	Honolua
6111	Honokōhau

Source: Hawai`i Stream Assessment, Report R84, December 1990.

Groundwater leaking from these breached dike compartments provides base flow in the streams even during prolonged periods of little or no rainfall. Downstream many of the streams are diverted and the water is transported by tunnels and ditches for agriculture and domestic needs.[7] Within the Lahaina Aquifer Sector Area, nine tunnels were constructed from 1900–1926 to increase streamflow by developing water from the dike-impounded water bodies, although the effects on streamflow remain undetermined.[8]

Within the Lahaina Aquifer Sector Area there are 27 declared stream diversions in the CWRM database and 10 USGS gages, although only the gage on Honokōhau Stream is currently operational. Diversion systems (with eight separate collection systems within the watersheds from Honokōhau to Ukumehame) that transported water to the former plantations continue to support agricultural, municipal and domestic needs. The following table shows the interim instream flow standards (IIFS), number of diversions and gages for Lahaina Aquifer Sector streams as of 2017. The IIFS generally reflects the diverted amounts existing when the status quo interim IFS were adopted, or as subsequently amended by CWRM.

[7] Recent hydrologic conditions, Lahaina District, Maui, Hawai`i. Pumpage in aquifer systems, USGS, http://hi.water.usgs.gov/recent/Lahainā/pumpage.html

[8] USGS, *Groundwater Availability in the Lahaina District, West Maui, Hawai`i*, 2012. Tunnels are categorized as wells in the CWRM database.

Table 19-3 Stream Diversions, Gages and IIFS by Watershed Unit

Aquifer System	Unit No.	Hydrologic Unit	Area (mi^2)	No. of Diversions	No. of Gages	Interim IFS
Ukumehame	6003	Pāpalaua	4.88	0	0	HAR §13-169-48
Ukumehame	6004	Ukumehame	8.28	1	2	HAR §13-169-48
Olowalu	6005	Olowalu	8.4	2	3	HAR §13-169-48
Launiupoko	6006	Launiupoko	6.6	1	1	HAR §13-169-48
Launiupoko	6007	Kaua`ula	8.44	1	5	HAR §13-169-48
Launiupoko	6008	Kahoma	8.5	7	8	HAR §13-169-48
Honokōwai	6009	Wahikuli	9.79	0	0	HAR §13-169-48, amended 8/17/1994
Honokōwai	6010	Honokōwai	8.86	2	6	HAR §13-169-48
Honokahua	6011	Kahana	9.07	1	1	HAR §13-169-48
Honokahua	6012	Honokahua	5.35	0	0	HAR §13-169-48
Honolua	6013	Honolua	4.79	4	4	HAR §13-169-48
Honokōhau	6014	Honokōhau	11.58	8	2	HAR §13-169-48
Honokōhau	6015	Anakaluahine	2.73	0	0	HAR §13-169-48

Source: CWRM, *State Water Resources Protection Plan*, 2008.

Diverted streams can affect streamflow which can adversely impact kuleana and appurtenant rights, Native Hawaiian traditional and customary practices, stream ecology, water quality, recreational activities, and aesthetics. The CWRM adopted interim instream flow standards for West Maui streams in 1988 reflecting diversions at that time.[9] In August 2006, Maui Pineapple Company petitioned the CWRM to establish amended instream flow standards (IFS) for Honokōhau and Honolua Streams. In November 2008, the CWRM notified Maui Pineapple Company that petitions would be delayed due to the demands of the Nā Wai `Ehā Contested Case. The CWRM has prepared stream assessments to provide scientific information needed to establish technically defensible numerical IFS that will support equitable, reasonable, and beneficial allocation of the water resources in West Maui region.

A key issue for the WUDP has been community input on options and policies as a basis for water use planning and for consideration during CWRM's instream flow standards process. There are a variety of related and unresolved issues pertaining to West Maui streams and water rights that CWRM has attempted to address through the IFS, restoring streamflow mauka to makai, restoration of instream species, maintaining access for Native Hawaiian traditional and

[9] Hawai`i Administrative Rules, Section 13-169-46, "Interim Instream Flow Standard for all streams on Hawai`i, 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, 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."

customary uses, and engaging ahupua`a residents to manage the land traditionally supports improved land management. Of contention is the Kanahā Stream intake supplying MWDS and Lahainaluna schools, which is indicated to adversely affect taro patches and domestic kuleana uses.[10] Prioritizing the establishment of IFS for Kanahā Stream and other diverted streams with kuleana parcels would assist in resolving conflicts and facilitating future water management and use consistent with the public trust doctrine.

The 2014 USGS study, *Low-Flow Characteristics of Streams in the Lahaina District, West Maui, Hawai`i* quantified streamflow for 10 streams under natural (unregulated) streamflow conditions and characterized seepage gains and losses downstream of diversions on a subset of streams. Many of the streams in the study area flow perennially in the upper reaches due to persistent groundwater discharge to the streams. Downstream from diversions in the lower reaches the streams generally lose water primarily through infiltration to the underlying aquifer. Future work involving additional measurements is recommended by the study.

Table 19-4 Streamflow Supported Under Natural-flow Conditions

Stream	Flow supported	% of Time
Honolua	mauka to makai	< 80%
Honokōwai	mauka to makai	< 50%
Kahoma	continuously from upper diversion intake to confluence with Kanahā Stream	85 – 90%
Kanahā	to confluence with Kahoma Stream	$\geq$ 95%
Kaua`ula, Olowalu, Ukumehame Gulch	mauka to makai	$\geq$ 95%

Source: *Low-Flow Characteristics of Streams in the Lahaina District, West Maui, Hawai`i: U.S. Geological Survey Scientific Investigations Report 2014–5087.*

Table 19-5 shows the daily mean flow equaled or exceeded 50 percent of the time (Q_{50}), the estimated long-term average base flow which is commonly exceeded less than 70 percent of the time for perennial streams (Q_{70}), low-flow conditions (Q_{90}), and drought conditions (Q_{95}). Declared water use (1989) and estimated water use of individuals (excluding municipal, commercial, quasi-public, homeowner association landscape irrigation, etc.) is interpreted and summarized here for reference only since the 1989 data and interpretations have not been verified by the CWRM. Total average base flow during the period 1913–2005 upstream of any diversions from nine gaged streams was about 35 mgd.[11] Average base flow of the remaining streams is minimal. The CWRM has defined minimum viable habitat flow for the maintenance of suitable instream habitat to support growth, reproduction, and recruitment of native stream

[10] Maui County Council, Water Resources Committee, Testimony in regard to Agenda Item WR-27, March 8, 2017.
[11] Oki, D.S., 2004a, Trends in streamflow characteristics at long-term gaging stations, Hawaii: U.S. Geological Survey Scientific Investigations Report 2004–5080, 116 p.

animals in the Nā Wai `Ehā and East Maui streams Contested Cases as 64 percent of Median Base Flow (BFQ_{50}), also defined as H_{90} by USGS studies.[12]

Table 19-5 Surface Water Units, Natural Streamflow, Diversions, and 1989 Declarations of Water Use

Unit Code	Hydrologic Unit Name	Lowest Median Stream-flow Q50 (mgd)	Lowest Q70 (mgd)	Lowest Q90 (mgd)	Lowest Q95 (mgd)	No. of Diver-sions	Water Reported Diverted 2011-2015 Ave. (mgd)	Declared Water Use 1989 (mgd)	Estimated Water Use of Individuals Interpreta-tion of 1989 Dec. of Water Use (mgd)	Kuleana Parcels
6003	Pāpalaua	0	0	0	0	0	0	0		
6004	Ukumehame	3.23	2.585	2.067	1.938	1	0	4.888		Yes
6005	Olowalu	3.940	2.908	2.196	2.003	2	1.622	4.556	0.002	Yes
6006	Launiupoko	0.304	0.265	0.226	0.220	1	0.405	0.728		
6007	Kaua`ula	6.137	4.589	3.359	3.101	1	2.610	6.008	0.0267	Yes
6008	Kahoma	3.747	3.490	1.873	1.292	7	0.416	5.626		Yes
	Kanahā	3.165	2.908	2.649	2.584	0	1.6216	0	0.0795	
6009	Wahikuli	Dry at least 50% of the time				0				
6010	Honokōwai	3.488	2.908	2.326	2.196	2	0	0		Yes
6011	Kahana	Dry at least 50% of the time				0				
6012	Honokahua	Dry at least 50% of the time				0				
6013	Honolua	2.455	0.776	0	0	4	0	0	0.023	Yes
6014	Honokōhau	13.566	10.341	7.752	7.106	8	13.540	0.011	0.316	Yes
6015	Anakaluahine	0	0	0	0	0	0	0		
Total		**40.033**	**30.771**	**22.449**	**20.439**	**27**	**20.215**	**22.916**	**0.447**	

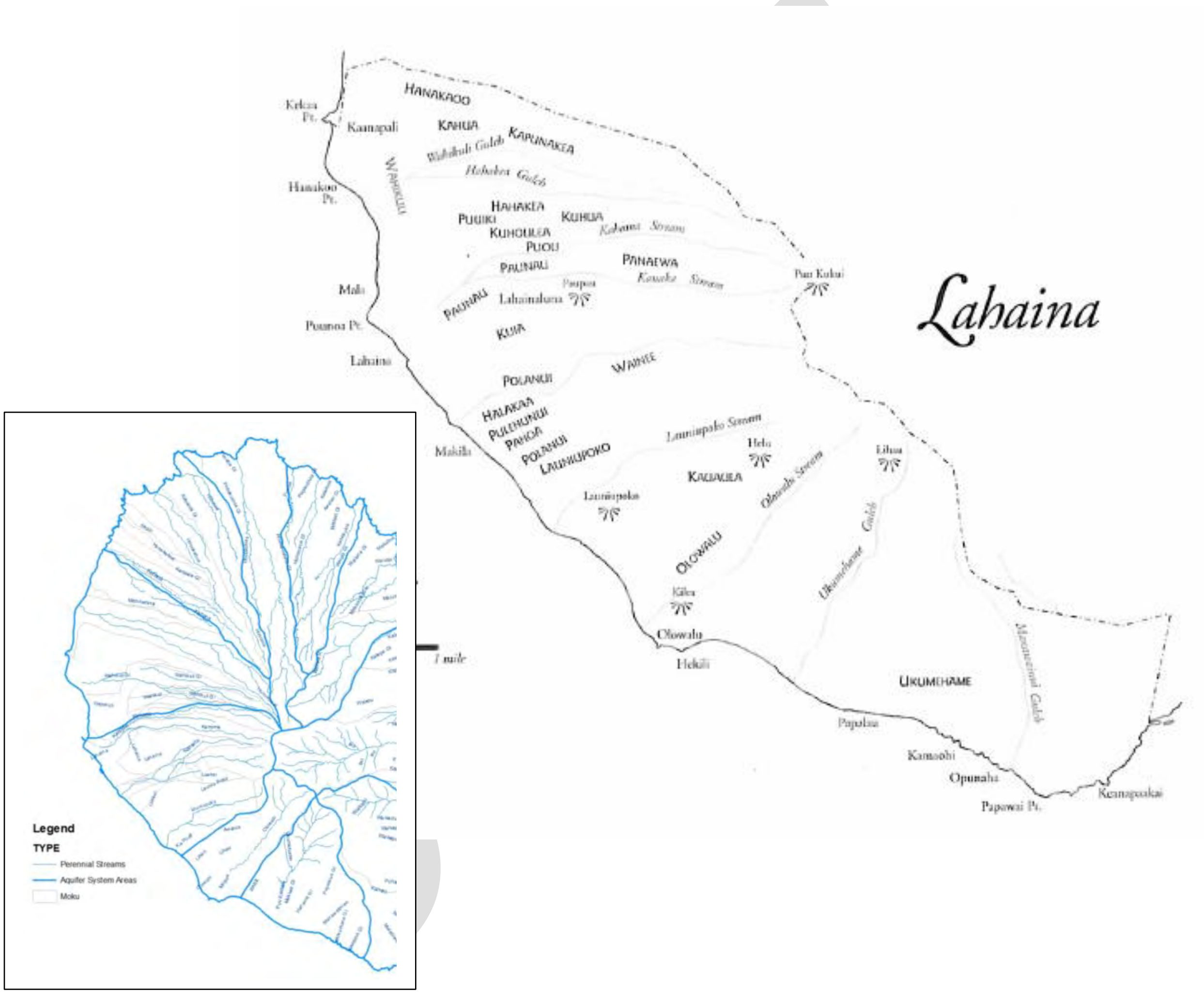
Source: Diversions, Declared Use 1989, Reported Water Diverted 2011-2015: CWRM Reports. Discharges (Q figures): USGS Scientific Investigations Report 2016-5103. Kuleana parcels-MDWS interpretation of location based on Office of Hawaiian Affairs GIS data, 2009. Est. Water Use—interpretation of 1989 Dec. of Water Use (Individuals): Interpreted and summarized by MDWS based on 1989 Declarations of Water Use, Circular 123, Volumes 1 and 2, CWRM, September 1992, for individuals (excludes municipal, commercial, quasi-public, homeowner association landscape irrigation, etc.); duplicated claims of use are counted once; livestock watering operations are not counted. Declarations and MDWS interpretation has not been verified by CWRM

[12] CWRM's Findings of Fact, Conclusions of Law, and Decision and Order in the matter of the `Īao Ground Water Management Area High-Level Source Water-Use Permit Applications and Petition to Amend Interim Instream Flow MAO6-O1).

19.3 Settlement Patterns and Cultural Resources

This section strives to acknowledge and highlight how Hawaiian history and cultural practices of the past relate to the present; and how they can inform options for meeting the future water needs of the people of Maui Island, while preserving and celebrating Hawai`i's past. Archaeology and traditional Native Hawaiian historic and cultural information provides a foundation for establishing continuity between past, present and future water use in the Lahaina area.

Figure 19-4 Lahaina Region and Lahaina Aquifer Sector



Source: Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997

Throughout history, the name "Lahaina" has been interpreted in various ways, most hinting of a lack of rain, drought, and a hot sun in the area. One story of why Lahaina is believed to have been known as "cruel sun" is because there was a baldheaded man who went in the sun and his head became sore ("haina" = cruelty; "lā" = sun). Another version quotes writer J.N.K. Keola: "a thin-haired chief who lived at Kaua`ula Valley, while going to and fro without a hat, felt annoyed at the effects of the scorching rays of the sun. He looked up and gazed into the heavens and cursed at the sun thus: 'he kū oi kēia o kala hainā!' (What an unmerciful sun!)," and Lahaina took its name from this incident.[13] According to Mary Kawena Pukui, both Ilalaole and Mo'okini say it refers to a time of terrible drought when the sun was so cruel to the people that it caused everything to wither and dry. This no doubt refers to the time of the infamous Chief Hua of Lahaina who ruled prior to the 10th century, whose killing of his priest brought on the terrible drought.[14]

19.3.1 Historical Native Hawaiian Agriculture and Cultural Resources

The Lahaina shoreline was abundant with fish, akule and `opelu. There were extensive *lo`i* (taro fields) in Honokōwai and Honokōhau, which were all linked by *ala loa* (long path). In 1823, the entire district was covered with groves of breadfruit, kou, and sugarcane, kalo patches and fish ponds, kapa trees, banana, potato and melon patches, all watered by streams from mountains.[15] The southern shores of western Maui were perhaps second only to Puna, Hawai`i, as a favorable locality for breadfruit culture. Lahaina is referred to in mele's as *ka malu ulu o Lele*, "the breadfruit-shade of Lele." There was also much breadfruit in the lower inhabited areas of the great valleys.[16]

Sweet Potatoes and Taro

> "Although a considerable amount of taro was grown… it is reasonable to suppose that the large fishing population which presumably inhabited this leeward coast ate more sweet potatoes than taro with their fish…From this point [Olowalu] along the leeward coast, through Kā`anapali, the *kula* lands now used for sugar cane and pineapple would have been ideal for sweet potato culture. Some accounts indicate, however, that potato planting was practiced only as an adjunct to the taro culture in and below the great valleys."[17]

Taro Culture Dominance

> "Olowalu is the largest and deepest valley on the southwest side of Maui and used to support extensive terraced cultivation. The lower ranges of terraces have been completely obliterated by cane fields; but just where the sugar cane ends and the valley begins there is a little spot where five Hawaiian families, all of them intermarried, raise several varieties of taro in flourishing wet patches. Some of it is sold, but most is pounded by hand for family poi. There are said to be abandoned terraces far up in Olowalu.[18]

[13] Albert Pierce Taylor, Lahaina: The Versailles of Old Hawai`i, 37th Annual Report of the Hawaiian Historical Society for the year 1928, 36. [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 16]
[14] Mrs. Pia Cockett, Audio Collection HAW 84.3.2 [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 16]
[15] DHHL Regional Plans [P10]
[16] E.S.C. Handy, *Hawaiian Planter, 190* [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 17
[17] E.S.C. Handy, *Hawaiian Planter, 159-160* [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 17])
[18] E.S.C. Handy, *Hawaiian Planter*, 103 Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 24

"Although there is a sizable stream bed and deep valley here, there is no visible evidence of wet taro cultivation, and the Hawaiian planters at Olowalu say that *lo`i* never existed in Launiupoko. It is possible that there may have been a few terraces on the level land at the base of the valley, but this is wholly arid land now and covered with dense brush."[19]

"Above the Pioneer Plantation reservoirs, terraces cover the flatland just below the entrance to Ukumehame Canyon. Only a few of these are now under cultivation. The upper terraces have been long abandoned, and those just above the reservoirs are only half used-that half unsuccessfully, because of insufficient water for flooding. The terraces used to extend well down over the land below the valley, but, with the exception of one tiny taro plantation standing like an island in the midst of the cane, all vestiges of the ancient cultivation have been plowed under. This is excellent wet taro soil. "[20]

Whaling Agriculture

In the 1830's, Hawai`i emerged as the principal stopover for whaling and Lahaina developed into an important whaling town. Native Hawaiian agriculture was gradually replaced with crops such as Irish potatoes to sell as provisions for the whaling ships, which had different food preferences than Native Hawaiians.

Sugarcane

By the 1840s, the whaling industry's dominance subsided. At mid-century, sugarcane emerged as the prominent crop and economic driver. In 1859, Henry Dickenson began a sugar plantation in Hanaka`ō`ō and the success of the Lahaina Sugar Company led to growth of a second plantation, on vast acreages to the south, run by Pioneer Mill.

19.3.2 Historic Water Scarcity

Lahaina gets little rainfall but receives stream water originating deep within the West Maui Mountains. Although Lahaina's rainfall is minimal, orographic precipitation (warm ocean air moving up the steep mountains into cooler altitudes) is created in the center of the mountains and valleys and produces some of the highest average daily precipitation in the world at Pu'u Kukui. Drought conditions and competition for Lahaina's limited water supply is not new.

"Alleging a controversy between plaintiffs and defendants in respect to the amount of water, method and time of its use upon lands owned or held by both parties…The entire stream [Kaua`ula] is taken up and used upon land in the valley on both sides of the stream for irrigating crops of kalo and on the flats below for sugar cane...Doubtless the stream itself has diminished somewhat in quantity during the last half century from reasons that are conjectural. Mr. James Campbell says that the freshets or storm waters which everyone could use at will to fill all their patches are much less frequent now than when he was a resident of Lahaina from 1851-1876."[21]

[19] Ibid, page 27
[20] Ibid
[21] Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 30

Historical Dividing and Sharing of Water

Intricate practices were undertaken to ensure sharing and providing an adequate water supply to various users.

> "…the ancient method of dividing and distributing the water of Kaua'ula stream was by length of time and use. In order to irrigate these lands, small ditches or `auwai's were dug, in very ancient times, through which the waters led from the main stream on to the lands…Division one, for example, had the water during the day, and Division two during the night, the day being from 5 o'clock a.m. to 5 o'clock p.m. and the night being the remainder of the twenty-four hours…The ancient method of using the water was this: When the 'day' of a certain ahupua'a, named `Ko`oka` for example, came around, the kalo patches belonging to it and bearing the same name, being mauka, had the water first run into them by the lateral `auwai until they were filled, then the water would be turned back into the main stream and then taken out on to the land below named 'Ko`oka.'"[22]

Konohiki's Mitigate Drought

> "…The konohiki endeavored to secure equality of division and to avoid troublesome quarrels between tenants; and when the quantum of water in the stream was diminished through drought he saw to it that the quantity used by each was divided equally. The water from the `auwai was subdivided among the various cultivators according to the amount of land cultivated and the needs of each. But when one kuleana seemed to need more water than others at any particular time the konohiki would on request allow a constant small stream of water to continue to run in the particular `auwai, after the patches were filled and while the main body of the land below was receiving its assigned supply. This is called "*koi`i wai*," and witnesses say that when their patches were dry they would ask and obtain a little water from the konohiki and their own neighbors".[23]

Historic Drought Effects on Water Management

Droughts have been common in Hawaiian history, and are a part of Hawaiian lore.

> "Hua figures prominently in Hawai`i and Maui traditions, the one here referred to being: in a dispute with his priest and prophet Luaho`omoe, on East Maui, about some `uwa`u birds, he became so angry that he vowed death to the priest. Aware of his coming fate Luaho`omoe directed his sons to safety while he perished in flames. Immediately the rains ceased, streams and springs dried up so that famine and desolation spread, from the continuous drought."[24]

[22] Horner v. Kumuli`ili`i, Hawaiian Reports, 10:174 182 (Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 30)
[23] Ibid
[24] Fornander, *Collection*, 5:660, See Fornander, *Account of the Polynesian Race*, 2:41, for more detailed version [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 30])

Eleven Day System

An "eleven day system" was found to be an effective means of distributing scarce water resources during normal weather conditions; but in times of drought, even this established system of distribution was not sufficient.

> "The testimony of those familiar with the “eleven day” system say (and it was so found by the commissioner) that when the water day of a certain land came around all the water of the Kaua'ula Stream was entitled to be turned into the particular `auwai leading the water to the said land…Mr. Campbell says that supplying kalo patches with water but once in eleven days is not now sufficient to keep the crop in good growing condition, and he attributes the success of the old eleven day system when he was a resident of Lahaina to the freshet or storm water which came down more frequently then than now….It is evident from the testimony that the intent and spirit of the ingenious “eleven day” system of water supply in this locality, elaborated from long experience by men whose aim was to secure equal rights to all and to avoid quarrels, was to give the mauka lands in rotation sufficient water for the successful growing of kalo. And it must be remembered that the mauka lands were to have their water first…These two principal divisions take the water for eleven consecutive days, one division by day and the other by night, and when the eleven days are completed the division taking the water by day takes it at night and vice verso, in endless rotation. In each principal division each of the lands comprising it is entitled to the water for twelve hours, by day or night as the case may be, in rotation in the order as their names are given above…The lands of Kaua`ula and Makila above the head of Pi`ilani `auwai are entitled to water whenever needed without reference for 'days'…The kalo patches mauka are first to be filled full to the top of the kuāuna’s (banks), and the `auwai to be then closed at its head and the water remaining in the `auwai is to run down to the patches then just filled, and not to the land whose turn comes next. When these mauka patches are fully supplied and the `auwai closed, the water will continue on in the bed of the stream to the lands of the same name below during the rest of the 'day.'[25]

19.3.3 Kuleana Parcels

Water rights include “appurtenant or kuleana water rights” to use that amount of water from a water source (usually a stream) which was used at the time of the Māhele of 1848 on kuleana and taro lands for the cultivation of taro and other traditional crops and for domestic uses on that land, and “riparian rights” which protect the interests of people who live on land along the banks of rivers or streams to the reasonable use of water from that stream or river on the riparian land subject to other rights of greater value. These rights run with the land. [26,27]

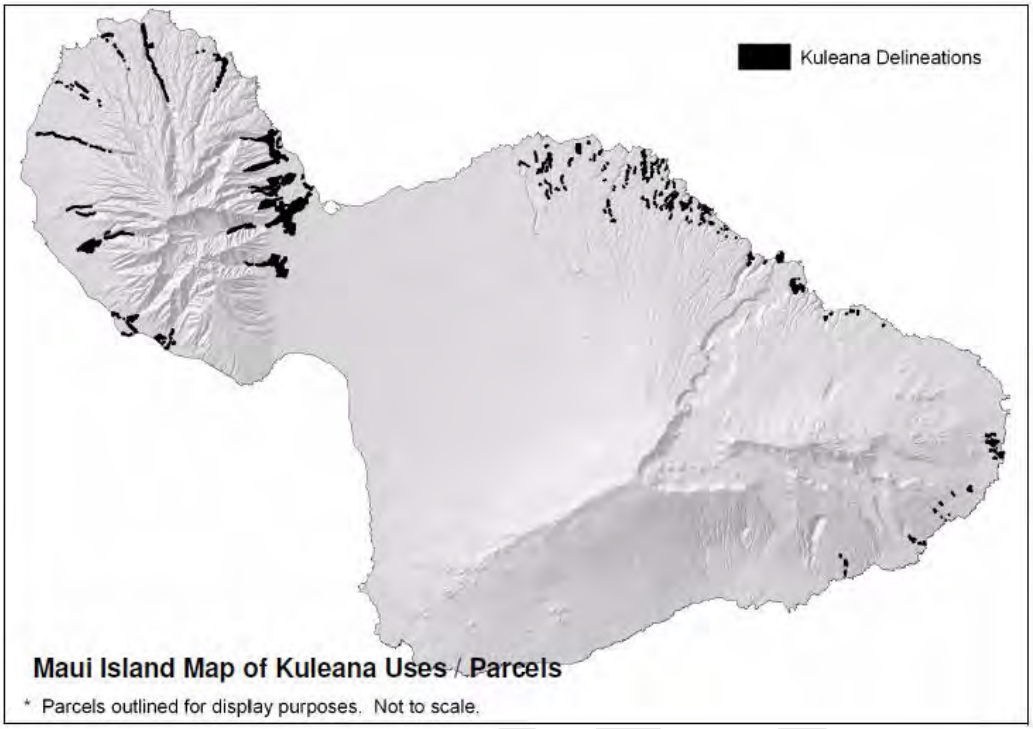
---

[25] Horner v. Kumuli`ili`i, Hawaiian Reports, 10:174 182, C.F.Horner and Paul R. Isenberg, Pioneer Mill owners (Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 30)

[26] Haia, Moses. *Protecting and Preserving Native Hawaiian Water Rights.* http://www.Hawai`i.edu/ohelo/resources/AluLikeWorkbook/Chap7.pdf

[27] Ola I Ka Wai: A Legal Primer For Water Use And Management In Hawai`i

Figure 19–5 Kuleana Lands



Source: Office of Hawaiian Affairs data

Traditional and cultural Hawaiian practices are deeply intertwined with the geographical environment of the islands. Prior to the arrival of Westerners and the idea of private land ownership, Hawaiians communally managed, accessed and gathered the resources from the land and seas to fulfill their community responsibilities. Traditional and customary Native Hawaiian rights are exercised in the streams in the form of subsistence gathering of native fish, mollusks, and crustaceans, and stream flows are diverted for the cultivation of wetland taro, other agricultural uses, and domestic uses that can be traced back to the Māhele. The maintenance of fish and wildlife habitats to enable gathering of stream animals and increased flows to enable the exercise of appurtenant rights constitute the instream exercise of "traditional and customary" Hawaiian rights.[28] The many varied definitions for "kuleana" water users are included under section 10.2 (Ka Pa`akai Analysis).

19.3.4 Hawaiian Culture Today

<u>Honokōhau Valley Taro Restoration</u>

The Honokōhau Valley Association is restoring taro patches utilizing volunteers to help plant taro. Volunteers learn how to use the rocks, soil and water resources in the valley to recreate a traditional *lo'i kalo* (taro patch).

[28] CWRM East Maui Streams Hearing Officer's Recommended FOF, COL, and D&O, January 15, 2016. Contested Case No. CCH-MA 13-01 http://files.hawaii.gov/dlnr/cwrm/cch/cchma1301/CCHMA1301-20160115-HO-D&O.pdf

Kahoma Valley Taro Restoration

Hawaiians with ancestral ties to Kahoma Valley for more than five generations are planning taro restoration projects. Because it was the only valley in Lahaina to have a lo`i for many years and there are ancestral connections, access to the valley is important. Since Kahoma Valley water has been restored, there are `o`opu swimming mauka for the first time in years. Testimony to the Maui County Council Water Resources Committee indicated that the water table has risen, 30 percent of the groundwater is flowing to Kahoma Stream, there are no dry stream spots where the water does not flow, and that today water flows through the whole stream. Where the river enters the ocean, 'ōpae have returned and fish are spawning in the ocean. According to testimony, `o`opu "recruits" are now found at Mala Wharf that will eventually get upstream.

Testimony on behalf of `Aha Moku O Maui, Inc., stated that not many watershed management representatives are coordinating with `Aha Moku and do not prioritize managing resources, and that too much control lies with large private landowners. (Maui County Council Water Resources Committee Meeting, March 3, 2017). Stream restoration supporters are led by Archie Kalepa, who commented,

> "The goal is to keep everybody educated and work with the families. But more important, work with families from every valley, every gulch, every family that has kuleana rights, that has lineal right, that has cultural rights, and work with them for them to understand that we all need each other. We need to work together, so that we can support what's happening up in Kahoma. Even if your family is not from there, come and support us, because somewhere down the line the same thing will happen to you and your family's land."[29]

Kanahā

Native Hawaiians have complained that the State and County are continuing to issue water permits without addressing families that have native Hawaiian water rights. Practitioners asked the Maui County Council Water Resources Committee at the March 3, 2017 meeting, to refrain from issuing any more water permits before Native Hawaiian water rights are restored to practice traditional and cultural uses.

19.3.5 Lessons Learned from the Past

Pre-1778 populations along the coast likely used springs, brackish water from shallow wells, stream water originating from deep within the mountains, and small impoundments of stormwater flows to irrigate lo'i kalo and supply brackish water fishponds. Although, in the past, the area supported a number of Hawaiian villages and a much larger population, reductions in the inland forest zone and rainfall are likely to have caused a significant decrease in available water resources available to larger populations today.[30]

[29] (Lahaina News, *West Maui Families to Protest Sale of Kahoma Valley Land,* April 7, 2016)
[30] Maui Regional Plan, DHHL Regional Plans, page 10

Historically, great efforts were made to allocate water for all needs. Today, Native Hawaiians are challenged with the negative consequences of resource "ownership," with "owners" often lacking sensitivity or not being required to share with others. Perhaps past strategies of utilizing varied timed diversion schedules to share flows can be adopted in order for all water users to benefit from provisions of an adequate supply of this important resource. Ahupua'a and watershed management strategies could also be implemented in order to provide more vibrant natural ecosystems and abundant Native Hawaiian resources from mauka to makai. Consortiums of water partners have been discussed as options to management and use of the diverted waters. Possible consortium stakeholders could include watershed management partners, west Maui landowners and private water systems, and kuleana water users and Native Hawaiian stakeholders.

19.4 Land Use

The current land use pattern in the West Maui subregion is dominated by development along the coast, with limited development, fallow fields, and undeveloped areas mauka.

19.4.1 Land Use Plans

The Maui Island Plan's Directed Growth Plan identifies four distinct subregions and seven planned growth areas: Kā`anapali Town, Lahaina Town North, Lahaina Infill, Lahaina Town South, Kahoma Infill, Makila, and Olowalu Town. The West Maui Community Plan was adopted in 1996 and is being updated. The boundary of the Community Plan area is essentially the same as the Lahaina Aquifer Sector Area. Outside the coastal urbanized areas, most of the area is designated Agricultural and Conservation. Information on land use, zoning and the Directed Growth Plan is provided below.

Figure 19-6 Lahaina ASEA, Community Plan and Directed Growth Boundaries

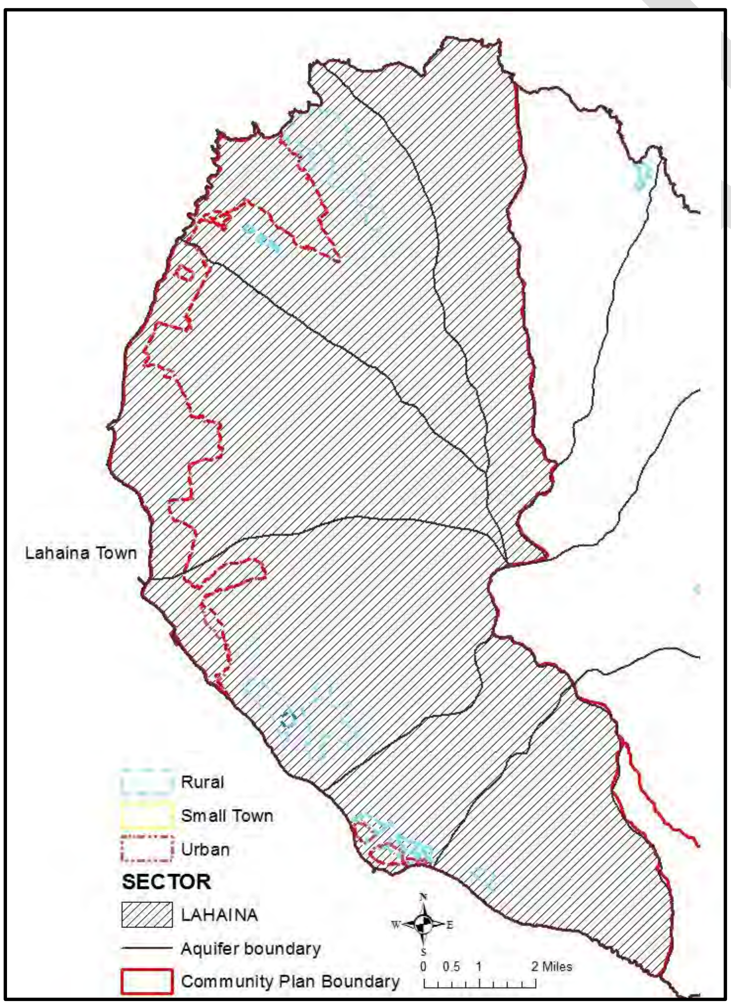
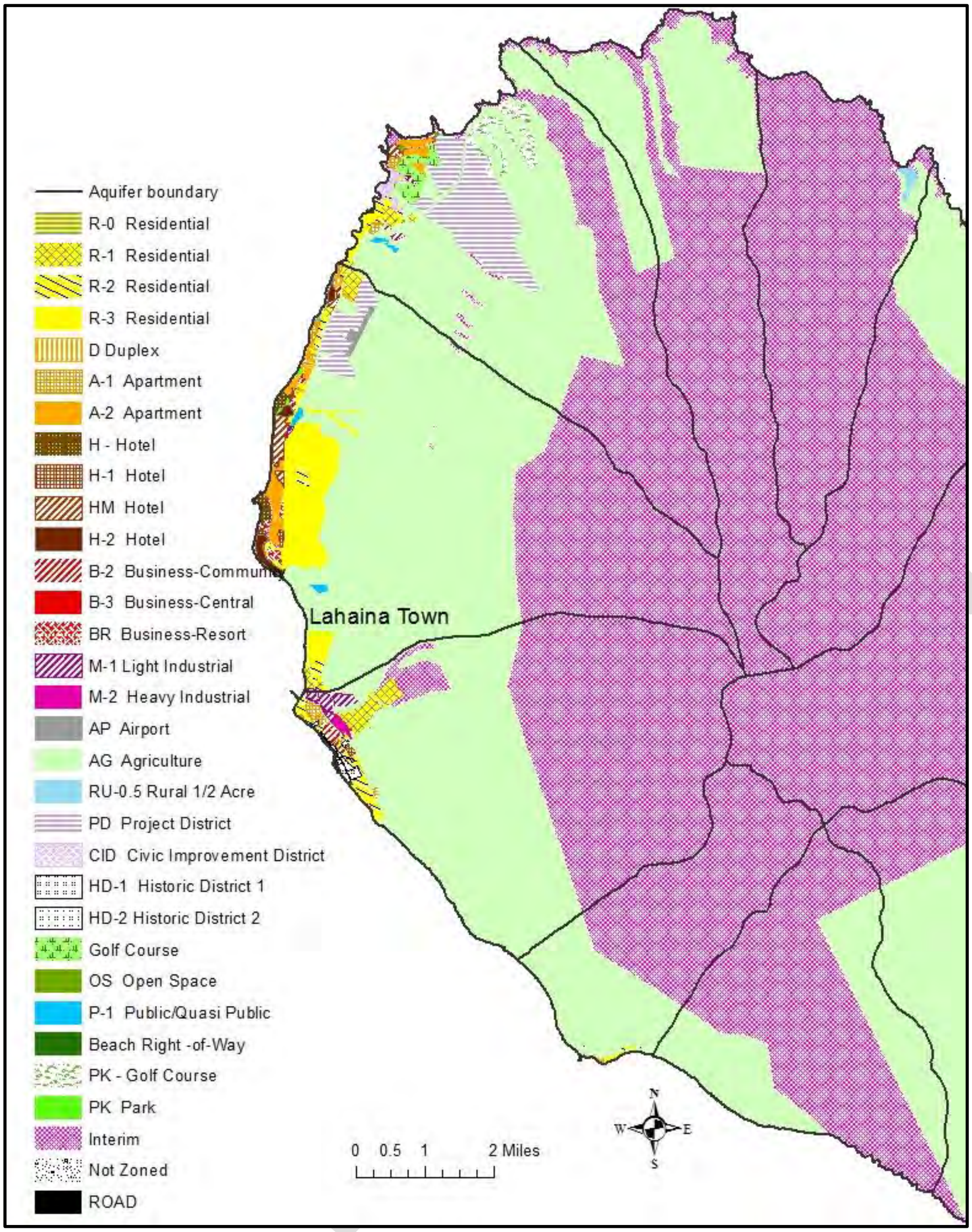


Figure 19-7 Lahaina ASEA County Zoning Designations



19.5 Existing Water Use

19.5.1 Water Use by Type

The CWRM has established the following water use categories based for the purposes of water use permitting and reporting:

- 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)

This section presents the estimated water use within the Lahaina sector for the calendar year 2014 or as otherwise stated based on CWRM and MDWS reports. Municipal well use dominates total well production. Surface water diversions were largely reported for agricultural, irrigation and municipal end uses.

Table 19-6 Reported Pumpage, Estimated Surface Water Use and Reclaimed Wastewater by Type, Lahaina ASEA, 2014 (mgd)

Aquifer	Domestic	Industrial	Agriculture	Irrigation	Municipal	Military	Total
Total No. of Production Wells	4	0	6	32	40	0	82
Honokōhau	0	0	0	0	0	0	0
Honolua	0	0	0	0.035	2.566	0	2.601
Honokōwai	0	0	0	0.049	3.003	0	3.052
Launiupoko	0	0	0	0.119	0.360	0	0.479
Olowalu	0	0	0	0.069	0.000	0	0.069
Ukumehame	0	0	0	0.000	0.007	0	0.007
Total Pumpage	**0**	**0**	**0**	**0.271**	**5.936**	**0**	**6.208**
% of Pumpage	0%	0%	0%	4%	96%	0%	100%
Surface Water	**--**	**--**	**4**	**13**	**3.3**	**--**	**20.3**
Honokōhau							
Launiupoko							
Olowalu							
Total Diversions	**--**	**--**	**4**	**13**	**3.3**	**--**	**20.3**
Percent of Surface Water			20%	64%	16%		100%
Reclaimed WW	**--**	**--**	--	**0.63**	--	--	**0.63**
TOTAL			**4**	**13.901**	**9.236**		**27.138**

Source: CWRM Well Pump Quantities Database, 2014; CWRM Gages 2011-2015 Average, estimated end use; Municipal use based on MDWS Treatment Facilities production.
12-month moving average, January to December 2014; where data was not reported consecutive months in 2015 were used. Some wells did not report.

Figure 19-8 Pumpage by Well Type, Lahaina ASEA, 2014 (mgd)

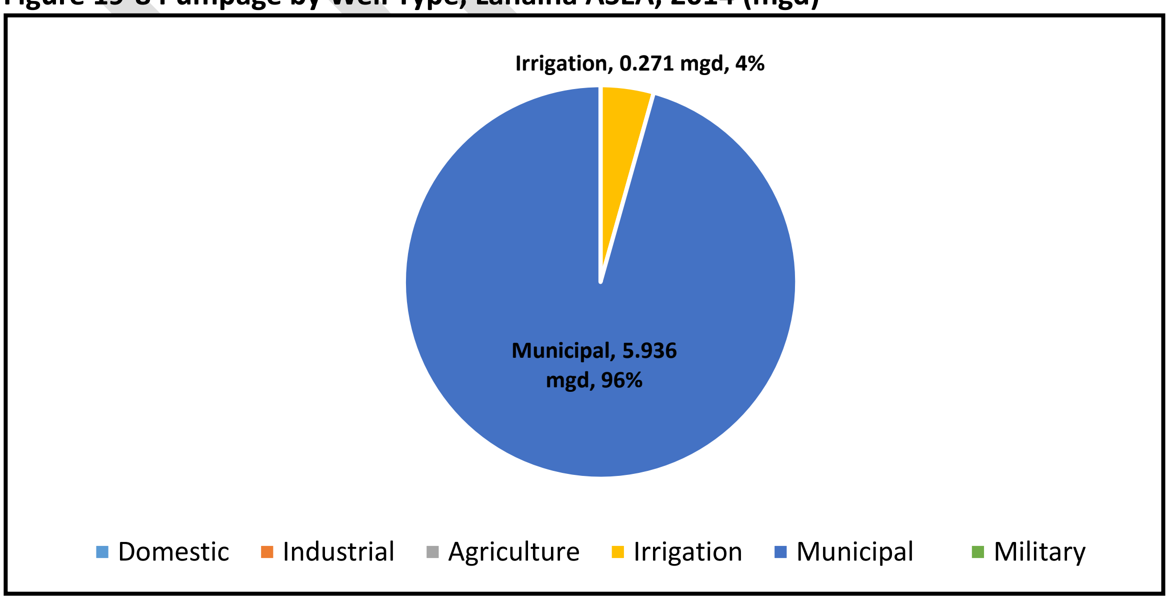


Figure 19-9 Pumpage by Well Type, Lahaina ASEA, 2014 (mgd)

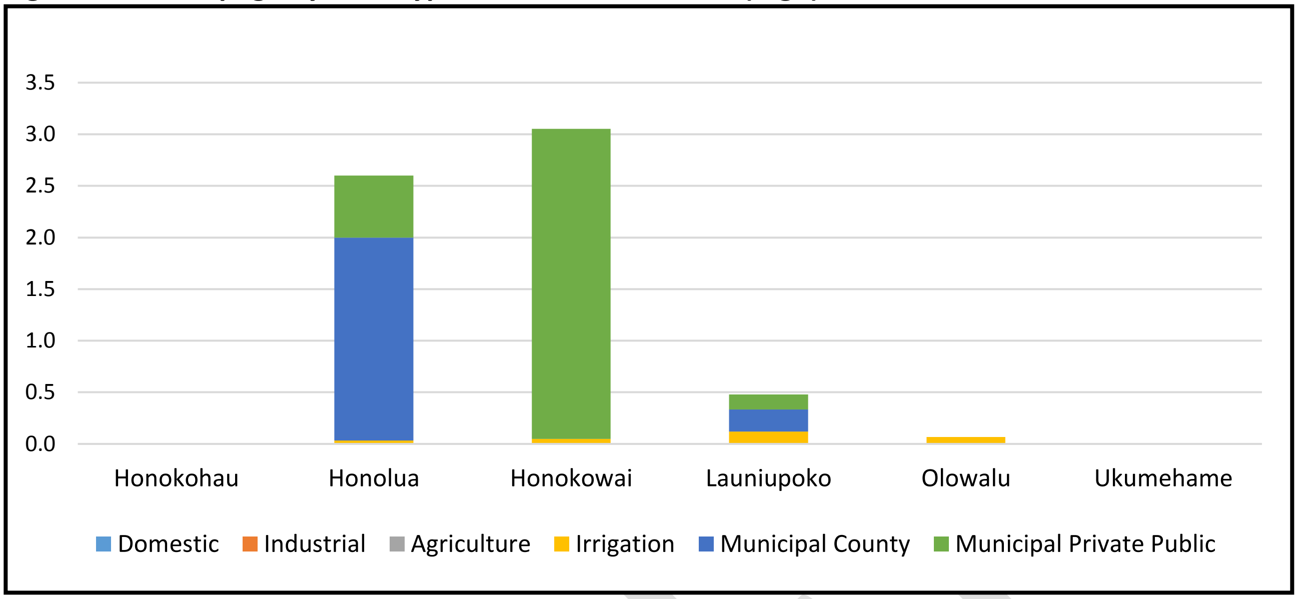


Table 19-7 Estimated End Use of Surface Water Diversions

Use Type	End Use (est. mgd)	Percent
Irrigation	13	64
Agriculture	4	20
Municipal	3.3	16
Total	20.3	100

Source: Estimated by MDWS based on CWRM Gages, 2011-2015 averages.

Domestic Use

Reported pumpage based on well type indicates there is no domestic well use. It is likely that domestic use is underreported.

Industrial and Military Use

There is no reported pumpage from industrial wells. There are no military wells.

Irrigation Use

Irrigation wells comprised less than 5 percent of average well pumpage in 2014. Some pumpage is assumed to occur at irrigation wells drilled in recent decades even though no pumpage is reported to CWRM. Surface and recycled water supply most of the irrigation needs, primarily for landscaping, golf courses and parks. Of about 20.2 mgd of surface water diversions, it is estimated that about 64 percent was used for irrigation, with the remainder used for agriculture and municipal purposes. Irrigation use by private purveyors can be estimated from reported streamflow diversions, reported or appraised agricultural irrigation but needs to be further defined.

Agricultural Use

Agricultural water is mainly supplied by surface water conveyed by the Maui Land & Pineapple (MLP) and Pioneer Mill (PM) ditch systems extending from Honokōhau Intake to Wahikuli Reservoir, which is occasionally augmented with ground water from wells. However, CWRM pumpage reports indicate there was essentially no water pumped by agricultural production wells in 2014. Discounting water used for municipal, landscape irrigation and similar uses, it is estimated that roughly 2 to 4 mgd may be used for agriculture. Agricultural uses are primarily supplied by surface water conveyed by the ditch systems and occasionally augmented with groundwater.

The MLP/PM system had an historical estimated surface water diversion of 50 mgd according to the Hawai`i Stream Assessment, Report R84. The 2004 Agricultural Water Use and Development Plan (AWUDP) cites the then-current conditions as a maximum diversion of 42 mgd, average flow of 20 mgd, storage of 48 mgd, and water use of 2.6 mgd (the latter does not include MLP). The AWUDP states that flows are often insufficient during low-flow periods for users on the end of the system, and this could be remedied by restoring the capacities of some pumps and reservoirs. Surface water diverted by MLP from Honokōhau Ditch has been primarily used to irrigate small-scale diversified agricultural lots and golf courses, for raising livestock, providing for domestic water supply, and supporting reforestation efforts.

The Lahainaluna Ditch stretching 4.4 miles from Wahikuli Reservoir to Launiupoko utilized both Honolua-Honokōhau ditch water and surface water sources south of Lahaina (Kanahā, Kaua`ula, Launiupoko, Olowalu and Ukumehame Streams). The Lahainaluna ditch system was not studied in the 2004 AWUDP as it did not meet the criteria of involving State water or land ownership. [31]

West Maui Land Co manages the Launiupoko Irrigation Company, Inc., established by Makila Land Company, LLC, and non-potable irrigation water from Olowalu Water Company, Inc. West Maui Land Company indicated that about one mgd is released back to stream for "cultural" uses, with two mgd diverted for agricultural use, including cacao, livestock and landscaping, including Kamehameha School property.[32]

Water diverted from Honokōhau Ditch is treated at the MDWS Māhinahina Water Treatment Facility (2014 average of 1.5 mgd). Part of the Honokōwai Stream, Wahikuli Gulch and the Honokōwai diversion system is currently owned by Kā`anapali Land Management Corp.[33] The MLP/PM system is fragmented as to function and use, ownership and management, and system connectivity, which hampers the ability to resolve responsibilities for operation and maintenance of the entire system.

[31] State Agricultural Water Use and Development Plan, 2004
[32] Dave Minami, West Maui Land Co., personal communication, 2016.
[33] State Agricultural Water Use and Development Plan, 2004

Figure 19-10 Maui Land & Pineapple/Pioneer Mill Irrigation System

Source: AWUDP (2004)

Table 19-8 Capabilities of Maui Land & Pineapple/Pioneer Mill Irrigation System (mgd)

Intake	Historic Average Diversion	DITCH	Capacity	Reservoir	Storage
Honokōhau Intake	34	Honolua Ditch	70	Reservoir 140	N/A
Kaluanui Intake	1	Honokōhau Ditch	42	Field 3	N/A
Honolua Intake	3	Wahikuli Ditch	10	B-1	0.5
Pump M	5	Kahoma Ditch		Wahikuli	17
		Kanahā Ditch		New	5
		Kaua`ula Ditch	25.5	Crater Reservoir	25
		Olowalu Ditch	11	Pu`ukoli`i	N/A
		Ukumehame Ditch	15		

Source: State Agricultural Water Use and Development Plan, 2004

The 2015 Statewide Agricultural Land Use Baseline indicates that coffee crops encompass 535 acres, or 31 percent of total West Maui cropland. Current water use based on the stated water use standards in the table below is 2.3 mgd.

Table 19-9 Estimated Agricultural Water Use, Lahaina ASEA (mgd)

Aquifer System	2015 Ag Baseline Crop Category	Estimated Acreage	Water Standard (gpd)	Estimated Average Water Use
Honokōhau	Taro	3.13	27500 (15-40K)	0.0860
Honokōhau	Diversified	6.41	3400	0.0218
Honokōhau	Pasture	630.77	0 (0-7400)	0.0000
Honokōhau		**640.31**		**0.1078**
Honokōwai	Coffee	**534.77**	2900	1.5508
Honolua	Diversified	19.33	3400	0.0657
Honolua	Tropical Fruits	4.15	10000 (3700-10K)	0.0415
Honolua		23.48		**0.1072**
Launiupoko	FFL	13.88	6000 (4000-6000)	0.0833
Launiupoko	Diversified	12.04	3400	0.0409
Launiupoko	Taro	0.38	27500 (15-40K)	0.0105
Launiupoko	Tropical Fruits	30.04	10000 (3700-10K)	0.3004
Launiupoko	Pasture	465.72	0 (0-7400)	0.0000
Launiupoko		522.07		**0.4350**
Olowalu	Diversified	21.07	3400	0.0717
Ukumehame	FFL	7.10	6000 (4000-6000)	**0.0420**
Total		**1748.81**		**2.3154**

Source: 2015 Statewide Agricultural Baseline GIS, acreages calculated by MDWS. It is not specified whether taro is dryland or wetland.
FFL=Flowers, Foliage, Landscape Water Use Rates: HDOA Guidelines; Estimated Water Use for taro: average wetland taro consumptive rate. Coffee: 2004 AWUDP Kaua`i Irrigation System- 2500 gpd; 2900 gpd reported by plantation on Oahu per Brian Kau, HDOA, personal communication, 10/12/2016.

The characterization and adequacy of streamflow for lo`i kalo and other instream uses is a significant community concern. Information about existing and potential lo`i kalo and other agricultural uses on kuleana parcels in the Lahaina region is not readily available and despite consultation with the moku and others quantitative information was not forthcoming through the WUDP process. The 1992 Hawai`i Stream Assessment's characterization of the presence of taro indicated taro was 'part of the large landscape' of the Kaua`ula valley, testimony by a kupuna stated there used to be 40 taro patches in Kanahā valley,[34] and other historical accounts in Section 19.3 provide a foundation for continuing investigation. Information from the CWRM reports, 2015 Statewide Agricultural Land Use Baseline, CWRM 1989 Declarations of Water Use, and other sources were consulted.

The intersection of kuleana parcels and the 2015 Statewide Agricultural Land Use Baseline indicates that taro and diversified crops cultivated wholly or partially on kuleana parcels in the Lahaina Aquifer Sector totaled about 7.7 acres as shown in the table below. However, given the purpose of the 2015 Baseline inventory to capture the scale and diversity of commercial agricultural activity, it is likely that most agriculture on kuleana parcels was not mapped. In the table below, taro is assumed to be wetland taro based on the proximity of the parcels to

[34] Maui County Council, Water Resources Committee, Agenda Item WR-27, March 8, 2017.

streams. The midpoint of the range for consumptive water use for wetland taro is used to calculate estimated average water use. The low and high figures for consumptive water use and streamflow required for healthy plants are also provided.

Table 19-10 Estimated Water Use by Kuleana Parcels in 2015 Agricultural Land Use Baseline (gpd/acre)

Aquifer System	2015 Crop Category	Kuleana Parcels Acreage	Water Standard	Est. Ave. Water Use	Consumptive Use		Streamflow	
					Low 15,000	**High** 40,000	**Low** 100,000	**High** 300,000
Honokōhau	Taro	3.129	27,500	**86,045**	46,934	125,156	312,890	938,670
Launiupoko	Taro	0.191 (0.38*50%)	27,500	**5,253**	2,865	7,640	19,100	57,300
Olowalu	Diversified	4.21 (21.07* 20%)	3,400	**14,314**	--	--	--	--

Source: 2015 Statewide Agricultural Land Use Baseline GIS; Kuleana parcels-OHA, 2009. Approx. agricultural acreages overlying kuleana parcels calculated by MDWS. Water Use Rates: Diversified Ag-HDOA Guidelines; Taro-CWRM Nā Wai `Ehā and East Maui Streams Contested Case Hearings. Due to proximity of parcels to stream, taro is assumed to be wetland taro. Water standard for taro is average consumptive range of 15,000 to 40,000 gpa (gallons per acre).

Information in the 1989 Declarations of Water Use, Volumes 1 and 2 (CWRM, September 1992), was used to characterize existing and potential future agricultural uses and water sources. Declarations by parties other than individuals, such as commercial, quasi-public, homeowner associations, and similar users, were excluded to the extent they could be determined. This information was then correlated with CWRM diversions, kuleana parcels, and the 2015 Statewide Agricultural Land Use Baseline. The declarations include water sources and uses made known to the CWRM through a registration process in 1988-1989, and does not include subsequent sources and uses developed and known to the CWRM through its permitting process and water use reporting.[35] The declarations also included claims for future water rights, the proposed future uses of water, and current instream activities. The declarations as well as the summary below have not been verified by the CWRM. While there are many limitations inherent in the declarations (parcels with multiple declarations with conflicting information, some parcels may indicate place of diversion rather than water application, parcel ownership may differ from declarant, etc.), they provides a point of reference to support in a more complete characterization of existing and potential future use. Where information about existing use is conflicting, the most intensive use is represented.

Existing agricultural use, acreage, and instream activities summarized in the table below are based on the use statements in the Declarations of Water Use, declaring about 72 acres of agricultural activity, of which about eight acres were indicated to be taro, or taro and other

[35] The 1987 State Water Code, HRS Chapter 174C, required any person making a use of water in any area of the state to file a declaration of that water use, any person owning or operating any well must register the well, and any person owning or operating any stream diversions works must register the diversion.

crops, while the remainder is used for crops such as dryland taro, bananas, papayas, ti leaf, guava, mango, avocado, coconuts, lychee, fruit trees, chestnut trees, vegetables, and tropical flowers. By far, the greatest number, acreage and density of declarant claims for existing uses are located along Honokōhau Stream. Applying standard water use rates by crop type, total demand may be close to 0.5 mgd based on the stated assumptions.

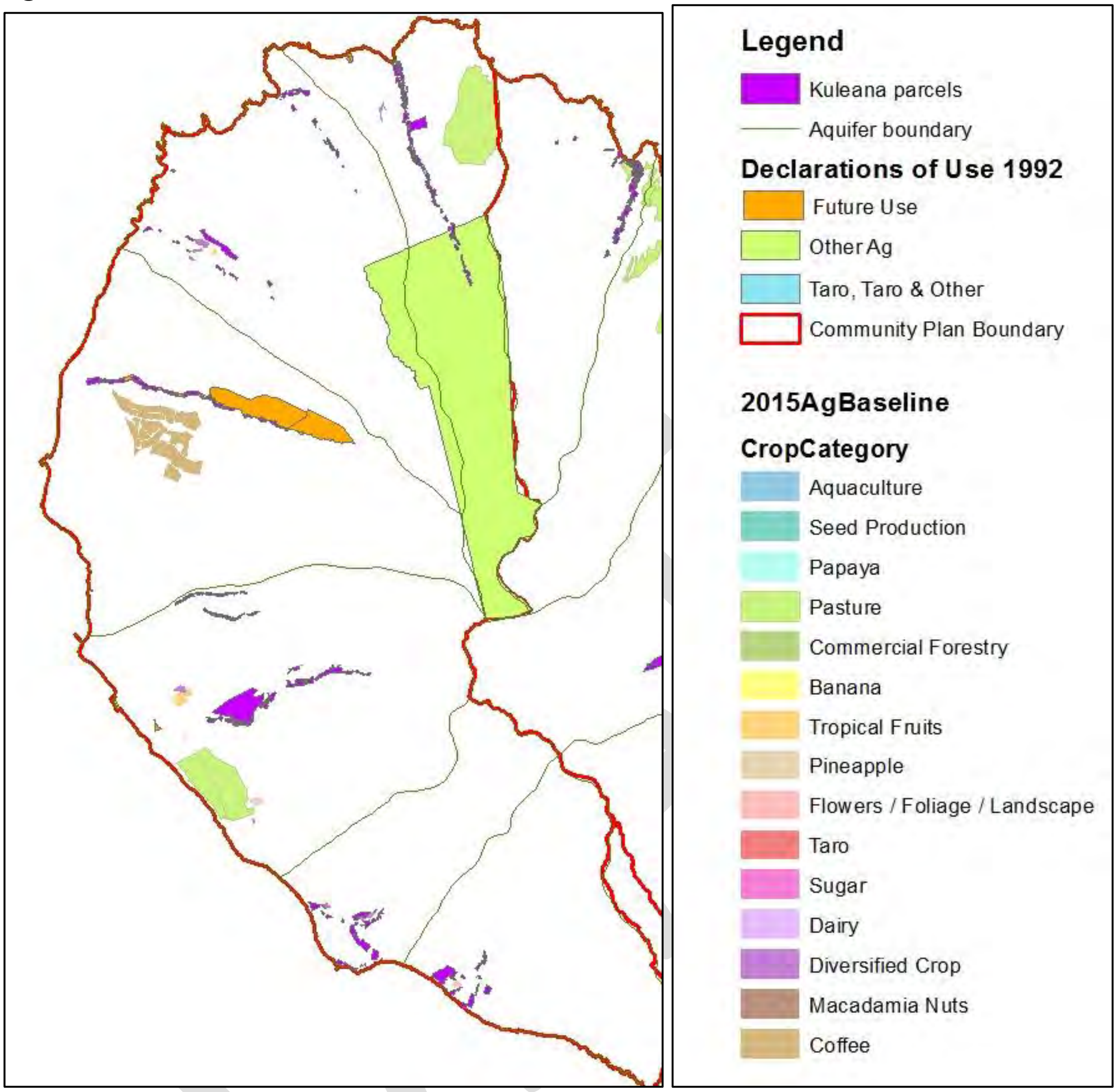
Most declarants indicate water is diverted from the stream directly onto the land or into a pipe or `auwai or similar conveyance. A smaller number of declarants state that water is conveyed by Honolua Ditch or the Pioneer Mill system. There are six diversions in the CWRM database for small users in the Lahaina region, on Honokōhau (3), Honolua (1), and Kanahā (2) Streams. Traditional and customary use claims stated in the Declarations included fishing, gathering prawns, aquaculture, gathering, recreation, swimming, washing, bathing, and aesthetic values. The figure below show the relationship of agricultural use stated in the Declarations of Water Use to kuleana parcels. For this analysis, the stated existing uses were categorized as "taro, taro and other," "other agriculture" (excluding grazing), or "future use" including parcels with only rights claims or incomplete information regarding an existing use. Because declarations are mapped by Tax May Key in the figures below, they appear significantly larger than indicated by the acreages in the table below.

Table 19-11 Interpretation and Summary of Existing Uses in the 1989 Declarations of Water Use (acres)

Stream Source	Taro Only	Taro & Other Ag	Other Ag	Traditional & Customary Uses	Direct Diversion	Honolua Ditch (MLP)	Pioneer Mill System	Est. Water Use (gpd)
Honokōhau	6.15	2.33	40.2	Yes	28.76	19.92		316,057
Honolua		0.92	5.7	Yes	4.93	0.15		23,428
Kanahā	2.13		6.14	Yes	6.14		2.13	79,451
Kahoma				Yes				
Kapahili, Quarry Site				Yes				
Kaua`ula		0.75	6.89				7.64	26,726
Olowalu			0.5				0.5	1,700
Ukumehame				Yes				
Total	**8.28**	**4.00**	**59.43**	**n/a**	**39.83**	**20.07**	**10.27**	
Est. Water Use (GPD)	227,700	17,600	202,062					**447,362**
Water Use Standard	27,500	5,400 & 3,400	3,400					

Source: Interpreted and summarized by MDWS based on 1989 Declarations of Water Use, Circular 123, Volumes 1 and 2, CWRM, September 1992, for individuals (excludes municipal, commercial, quasi-public, homeowner association landscape irrigation, etc.); duplicated claims of use are counted once; livestock watering operations are not counted. Declarations and MDWS interpretation has not been verified by CWRM. Water Use Standard (gpd/ac): Taro only-assume wetland, 27,500 taro consumptive use midpoint of range, taro and other-assume 50% dryland @5,400 gpd per acre (gpa) plus 50% diversified@3400 gpa; other agricultural- 3400 gpa diversified agricultural.

Figure 19-11 Relationship of Declarations of Water Use, Kuleana Parcels, and 2015 Statewide Agricultual Land Use Baseline



Source: HDOA 2015 Statewide Agricultural Land Use Baseline; CWRM, Declarations of Water Use, Circular 123, Volumes 1 and 2, September 1992.

A significant number of kuleana parcels exhibit a declaration of use for either an existing or future use. The identification of lands where declarants state a rights claim for a future use is provided solely to characterize the locations and scale of potential future uses, recognizing that identification in the WUDP does not create any legal basis for use or guarantee that a beneficial use will actually occur. As stated above, estimated demand for land uses in the Declarations of Water Use is close to 0.5 mgd based on the stated assumptions. Given that much of the 2015 Statewide Agricultural Land Use Baseline inventory is not coterminous with the declarations, the declarations appear to represent an additional increment of agricultural water use.

Municipal Use

Municipal use comprised about 96 percent of reported pumpage in the Lahaina ASEA, with single-family use dominating. Residential and commercial uses comprise the majority of the Municipal use category. MDWS wells accounted for approximately 35 percent of water withdrawn. The MDWS system accounted for about 15 percent of surface water use.

There are six municipal water systems using either surface water, groundwater, or both. The County Department of Water Supply (MDWS) and privately owned "public water systems" as defined by the Department of Health (systems serving more than 25 people or 15 service connections) are summarized as follows.

Table 19-12 Public Water Systems, Lahaina ASEA

DOH No.	System Name	Operator	Population Served	Service Connections	Average Daily Flow (gpd)	Source
204	Kapalua	Kapalua Water Company, Ltd.	4,200	555	450,000	Ground
205	Kā`anapali	Hawai`i Water Service Co.	8,000*	700	2,800,000	Ground
218	Honokōhau	MDWS	42	15	13,000	Ground (DOH 204-Kapalua)
214	Lahaina	MDWS	18,122	3,236	5,522,000	54% Surface/ 46% Ground
251	Mahanalua Nui Subdivision	Launiupoko Water Co., Inc.	587	275	100,000	Ground
209	Olowalu	Olowalu `Elua Associates	100	38	52,000	Ground
	Total		**31,051**	**4,819**	**8,937,000**	

Source: State Dept. of Health, 2015 based on 2013 survey of water production submitted by providers every three years.

*The Kā`anapali system serves a large visitor population and 1,500 permanent residents, for a total equivalent of 8,000 persons.

The MDWS Lahaina Water System serves most of the resident population with potable water, including the coastal areas of Launiupoko (beach park), Lahaina, Kā`anapali, Honokōwai, Nāpili and Kapalua. The resort areas of Kā`anapali and Kapalua are served by Hawai`i Water Service and Kapalua Water Company. The Mahanalua Nui, Olowalu and Ukumehame Systems serve areas south of Lahaina town. There are no interconnections between systems, and each system is independently operated and maintained. The map below shows the general service areas of the public water systems in the region. The charts below show the proportion of water consumption by water provider, water use by type for the County's municipal system, and the source of this supply.

Figure 19-12 Comparison of Public Water System Consumption, 2014

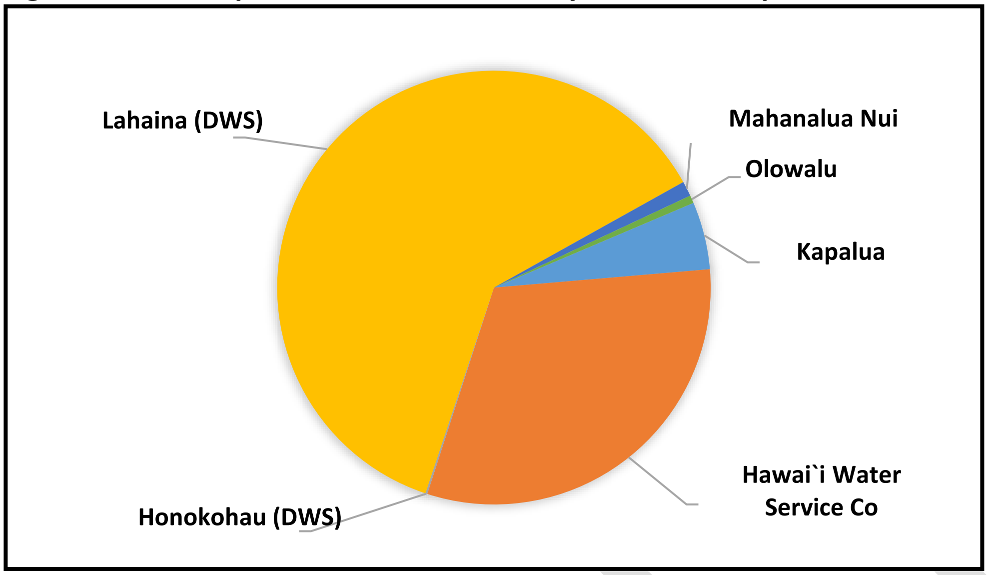
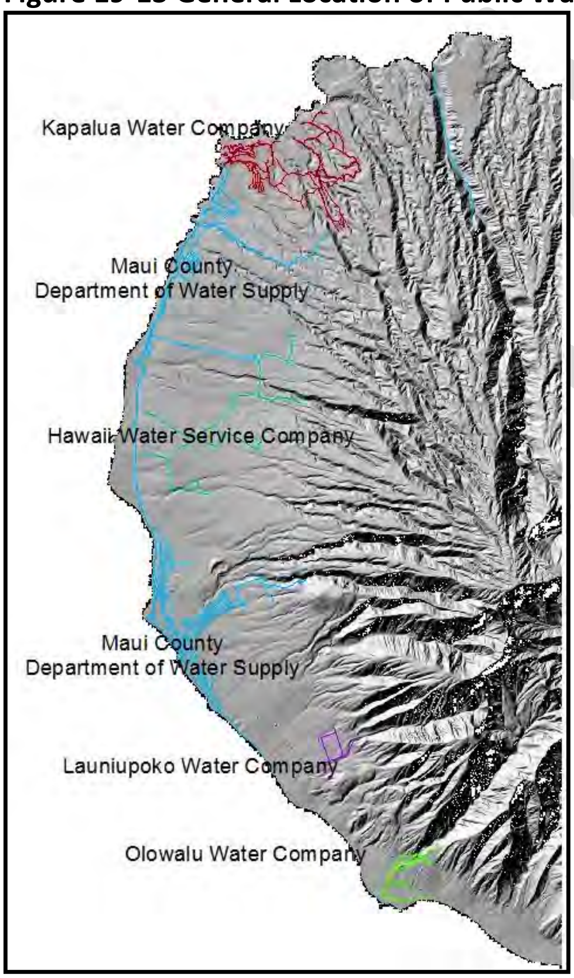


Figure 19-13 General Location of Public Water Systems



MDWS Water System

The MDWS Lahaina-Nāpili (West Maui) System generally serves the area extending from Honokōhau to Launiupoko. Single-family use accounts for the greatest demand. Although the CWRM water use category "Municipal" includes all MDWS billing classes, Table 19-13 provides a breakdown of billed water consumption that closest corresponds to CWRM sub-categories and actual water use.

Figure 19-14 MDWS Lahaina System

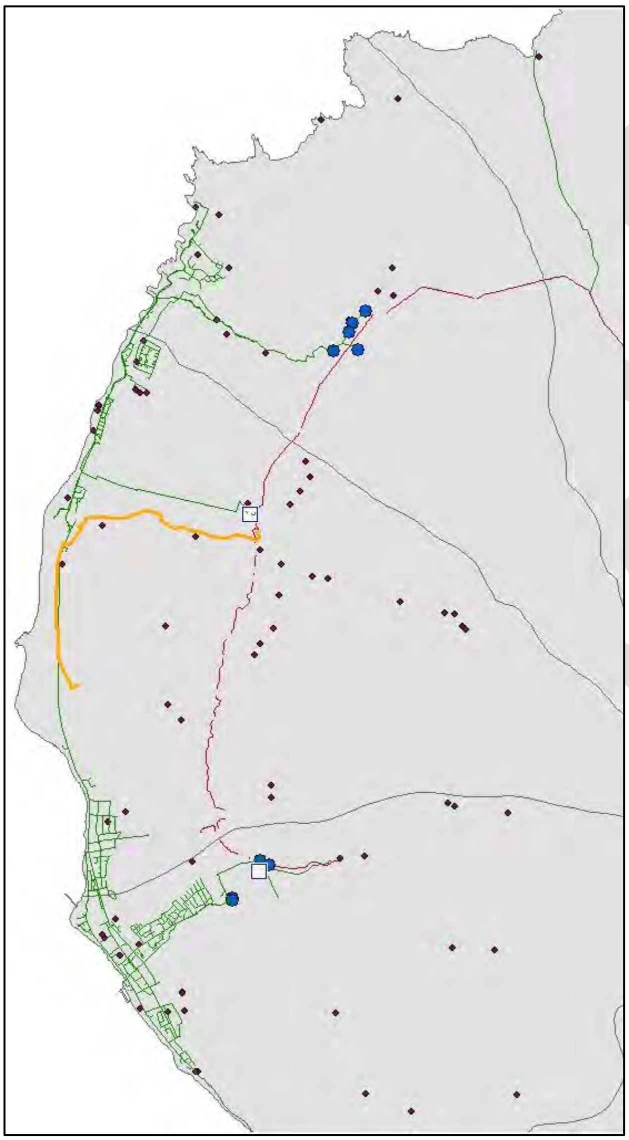


Table 19-13 MDWS Water Consumption by CWRM Category, Lahaina System, 2014

CWRM Categories	MGD	% of Total
Domestic	5.082	94.3%
Industrial	0.153	2.6%
Municipal	0.14	2.4%
Agriculture	0.005	0.1%
Irrigated	0.005	0.1%
Military (Usm)	0.002	0.0%
Unknown	0.002	0.0%
Total	**5.388**	**100.0%**

Source: MDWS Metered Consumption Data, 2014

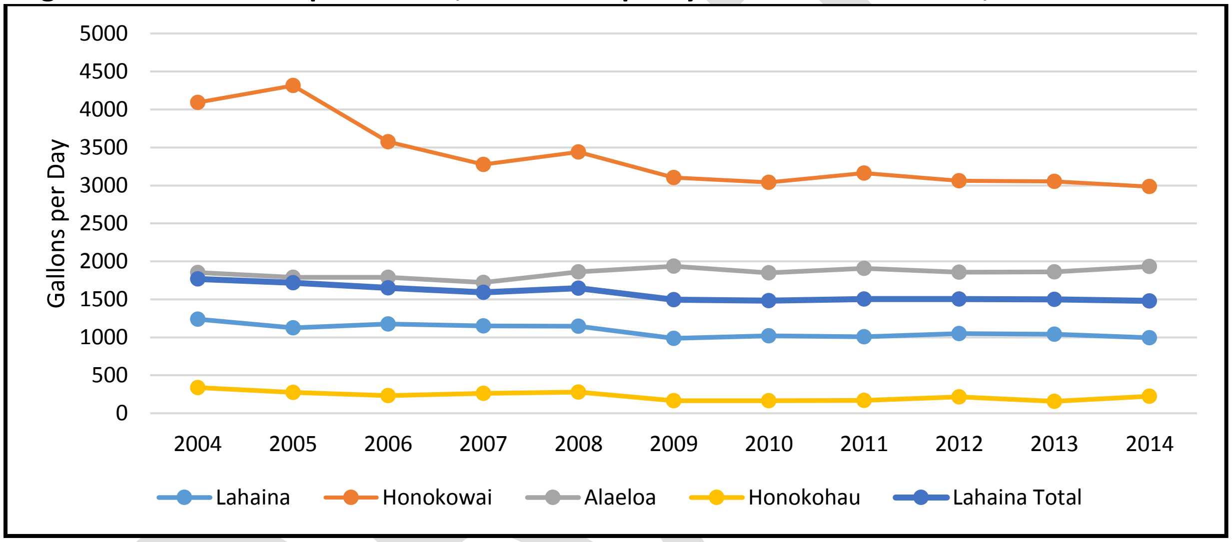
The Lahaina-Nāpili System is divided into sub districts as described below.

Table 19-14 Consumption by MDWS Lahaina-Nāpili System Subdistricts, 2014

Subdistricts	GPD	MGD	% of Total	Single Family (gpd)	Single Family % of Total Use
Lahaina 511	2,355,746	2.356	44%	435,098	8%
Honokōwai 513	2,022,400	2.022	38%	179,658	3%
`Alaeloa 515	1,007,878	1.008	19%	417,639	8%
Honokōhau 517	2,378	0.002	0%	2,378	0%
Total	**5,388,402**	**5.388**	**100%**	**1,034,773**	**19%**

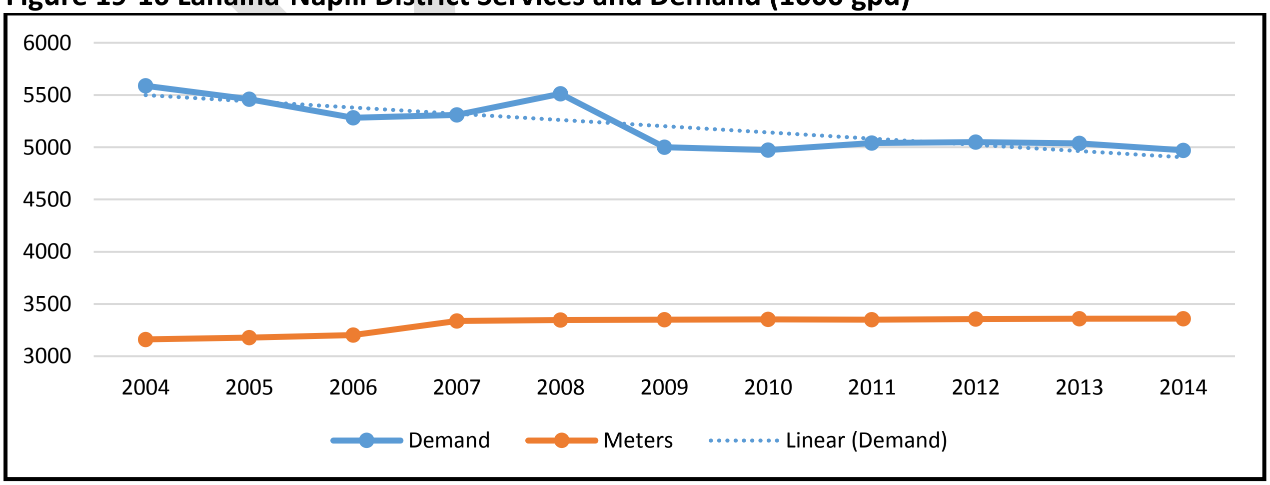
Source: MDWS Metered Consumption Data, 2014 daily average.

Figure 19-15 Demand per Service, Lahaina-Nāpili System and Subdistricts, 2004 - 2014



The figure below indicates that the number of meters has increased from 2004 to 2014, but water use has decreased, suggesting that the average use per meter has decreased, presumably as a result of increased efficiency through education and conservation.

Figure 19-16 Lahaina-Nāpili District Services and Demand (1000 gpd)



Honokōhau System (PWS 218)

In 2014, the Honokōhau system had 13 connections providing an average daily flow of 2,378 gallons (0.002 mgd) as a consecutive system to the Kapalua Water Company system. Currently, Kapalua Wells No 1 and 2 owned by the Kapalua Water Company serve both the Kapalua and Honokōhau water systems. Storage is provided by 8,000 and 30,000 gallon storage tanks. MDWS is exploring the potential to source water for this system from a Honokōhau tunnel on ML&P land which currently flows at about one mgd, but will need to address source development, transmission and maintenance, and power needs, in addition to other regulatory requirements.[36]

Lahaina System (PWS 214)

The Nāpili, Honokōwai and Lahaina communities are served by the Lahaina-Nāpili System which is comprised of two subsystems. This area is served with water from the west Maui leeward region within the Launiupoko, Honokōwai and Honolua aquifer systems. The System consists of 2 surface sources, 9 wells, two treatment facilities and 14 storage facilities. There were 3,251 service connections supplying about 18,164 people and uses with an average consumption of 5.3 mgd in 2014.

The Nāpili subsystem consists of 5 groundwater wells (Honokahua A and B and Nāpili A, B and C), and the Māhinahina surface water treatment facility. The subsystem is operated maintaining 2 wells as backup. The `Alaeloa and Honokōhau intakes withdraw surface water from Maui Pineapple Company's Honokōhau ditch comprised of about 12 miles of tunnels, ditches, and siphons from an intake at Honokōhau Stream. The tunnel begins in Honokōhau Valley at the 870 foot level and ends at Māhinahina at the 720 foot elevation, where the tunnel transitions into a ditch. Maui Pineapple Company also diverts water from the tunnel for irrigation, while Kapalua also uses the source for its private domestic water supply. The ditch system has an average flow of 25 mgd. From `Alaeloa to the north side of Lahainaluna Road in Lahaina Town, water is obtained from Honokōhau Ditch and the Nāpili wells. Reservoirs in `Alaeloa, Honokōwai, and Wahikuli are connected by a 16-inch main along Honoapi`ilani Highway. The Māhinahina Water Treatment Facility near the Kapalua Airport draws surface water from the Honokōhau, Honolua, and Kahana Streams. Average treatment production was 1.966 mgd in 2014 while capacity is 2.5 mgd. Water consumption for 2014 was an average of 3.291 mgd (Lahaina/ Honolua and Lahaina/Honokōwai subdistricts).

The Lahaina subsystem in the Lahaina Town area east of Honoapi`ilani Highway and south of Lahainaluna Road consists of 4 basal wells, 5 storage tanks and one finish water tank, and the Lahaina Water Treatment Facility to treat the surface water from Kanahā Stream. Kanahā surface water is shared by the County and the Lahainaluna School. County water is transmitted to the 0.3 MG Kanahā Reservoir, then to reservoirs along Lahainaluna Road. The Lahaina WTF, constructed in 1997, uses a microfiltration process to treat surface water. The subsystem maintains two wells as backup. The wells have high chloride content and need to have their

[36] MDWS, December 2016.

water blended with the surface water to an acceptable chloride level. The Lahaina WTP had an average production of 1.763 mgd in 2014, while capacity is 1.5 mgd. The water consumption in 2014 was an average of 2.63 mgd.[37]

Water consumption varies seasonally, with the low demand months most significantly reflecting lower outdoor irrigation demands. For the MDWS Lahaina-Nāpili system, the large seasonal fluctuations indicate the potential for outdoor water conservation as well as ways to offset use of potable water for non-potable needs. These conditions are likely to also apply to the private public districts that serve community needs.

Table 19-15 Comparison of High and Low Month Consumption, MDWS Lahaina System, 2011 to 2015 Average (mgd)

High Month	Low Month	Variation	% Variation
5.859	3.491	2.368	68%

Source: MDWS FY Billed Consumption, average mgd. Agricultural Services not included.

Water production is higher than consumption accounting for distribution, water losses, and unmetered use. As shown in the following table, the 2014 and 10-year water production totals are fairly consistent.

Table 19-16 MDWS Lahaina Water Production Average Daily (AD) Demand (mgd)

Year	Total Average Daily (AD)	Total High Month AD	Surface Water High Month AD	Groundwater High Month AD	% Variation High/Ave Month Total
2014	5.51	6.58	3.92	2.66	17%
10-Year Ave	5.58	6.77	3.92	3.30	18%

Source: MDWS Data, average mgd.

Both surface and ground water supply the MDWS Lahaina-Nāpili System, while the other public private water systems are reliant on groundwater. Continued use of surface water when the base flow and kuleana and ecosystem needs are not defined and instream flow standards not established is an ongoing community concern.

Table 19-17 MDWS Water Treatment Facilities, Annual and Average Daily Production (1,000s of gallons)

Facility	2010 Annual	2010 Average Daily Production	2013 Annual	2013 Average Daily Production	2014 Annual	2014 Average Daily Production
Māhinahina	554,790	1,520	638,740	1,751	560,700	1,536
Lahaina	525,758	1,439	557,061	1,526	643,360	1,763
Total	1,080,548	2,959	1,195,801	3,277	1,204,060	3,299

Source: MDWS Water Treatment Facilities Reports.

[37] MDWS, *Maui Island Water Source Development Options for the Lahaina-Nāpili Area, 2013.*

The 2014 Lahaina system water quality monitoring report did not exceed any EPA standards.

State Water Systems

There are no state water systems.

Federal Water Systems

There are no federal water systems.

Private Public Water Systems

Kapalua System (PWS 204)

The Kapalua Water Company operated by the Maui Land and Pineapple Company serves approximately 4,200 people with an average daily flow of 450,000 gpd supplied by basal groundwater obtained from deep wells drawn from the Honolua aquifer. The potable system serves Kapalua Resort and residential uses, including Plantation Estates and Honolua Ridge. The system consists of three wells; the two in operation are Kapalua Wells 1 and 2, each with a capacity of 1.0 mgd for a total of 2 mgd. Kapalua well 3B is cased and capped. The system also provides non-potable water to Kapalua resort for irrigation purposes, deriving its source from a diversion at Honokōhau Stream and Honolua Ditch. Water storage includes a 100,000 gallon tank and 1.0 mg reservoir for total capacity of 1.1 mg.

The Kapalua system water quality monitoring report for 2014 listed a violation of the total coliform standard because the system had two positives in December 2013 and no more than one positive is allowed; a hose bib was removed and replaced with a sampling station as corrective action.

Kā`anapali System (PWS 205)

Hawai`i Water Service Company (HWSC) has served Kā`anapali since 2003. HWSC serves about 1,500 permanent residents with a population equivalent estimated at 8,000 Kā`anapali customers on 669 service connections, including several large resorts and condominium complexes. The water system service area extends north to Honokōwai Stream, south approximately 2,000 feet south of Hāhākea Gulch, and east almost one mile makai. The system provides potable, fire protection and irrigation water for developed areas, excluding irrigation water for the golf courses and agricultural fields. Irrigation water requirements for the golf courses and agricultural fields are met by separate systems that include surface water, non-potable well water, R-1 effluent from the County of Maui's Lahaina Wastewater Reclamation Facility, and separate golf course water sources.

The system is served by nine active groundwater wells on the mauka side of Kā`anapali, and stored in eight tanks until needed. Potable water is supplied by basal groundwater obtained from deep wells drawing from the Honokōwai System, with an average water use of 2.97 mgd. Reported pumpage in 2014 was 2.8 mgd. The wells (Hāhākea, Honokōwai B and Kā`anapali P-1 though P6 and P-5a) have a total maximum pump capacity of 5.022 mgd. The system also includes a series of storage tanks which are defined by service level with a combined storage capacity of 4.91 MG. Average daily consumption per customer class is reported as follows. Water losses are estimated at 6 percent. The district has begun a conservation program aimed at its high use customers.

Table 19-18 Average Daily Consumption, Kā`anapali System, 2014

Customer Class	Average Daily Consumption (mgd)
Single Family	0.63
Multi-Family	0.54
Resort	1.46
Other Public	0.03
Commercial	0.31
Total Consumption	**2.97**

Source: Hawai`i Water Service Company, 2015.

Wells P-4, P-5 and P-6 have been found to produce water which contains levels of the chemical Dibromochloropropane (DBCP) ranging from 110 to 250 parts per trillion (ppt).[38] The State DOH limit for DBCP is 40 ppt at the point of entry into the distribution system. A water treatment facility near Well P-4 is being used to remove DBCP from these wells so they can be used to capacity. Levels of chloride ranging from 80 to 400 mg/l have been detected in most of the wells. Blending the water from different wells reduces the chloride concentration to just slightly below or above 200 mg/L. The 2014 Kā`anapali water quality monitoring report did not exceed any EPA standards.

Launiupoko Water System (PWS 251)

The Launiupoko Water Company (LWC) was established in 2002 to provide potable water to within a 6,000 acre region south of Lahaina, including Mahanalua Nui, Makila Plantation and Pu`unoa Subdivisions. Potable water for the Launiupoko region is supplied by basal groundwater obtained from deep wells drawing from the Launiupoko Aquifer, supplying 274 services with a 2014 average daily flow of 100,000 gpd (DOH, 2013). Mahanalua Nui Well 1 is in service, Mahanalua Nui Well No. 2 acts as a backup to Well No. 1, and Well No. 3 is currently in the development stage. Storage is provided by 400,000 and 100,000 gallon tanks. The 2014 average daily pumpage reported to CWRM was 0.147 mgd compared to pump capacity of 1.584 mgd. The 2014 system water quality monitoring report did not exceed any EPA standards.

[38] A Study to Investigate the Operation of the Kā`anapali Water Corporation Domestic Water System, December 11, 1998

Olowalu System (PWS 209)

The Olowalu public water system is owned by Olowalu Elua Associates and operated by the Olowalu Water Company, LLC (OWC). The OWC received a Certificate of Public Convenience and Necessity from the PUC to provide potable water service to the Olowalu village area in August of 2000. In 2003, the PUC granted a request to additionally sell non-potable water. OWC relies on groundwater drawn from the Olowalu aquifer to provide drinking and irrigation water to its approximately 100 customers on 38 service connections within the 700 acre service area.

OWC has developed the Olowalu Elua well with an average daily flow of approximately 52,000 gpd for drinking water. Two storage tanks provide a total capacity of 550,000 gallons. The system also utilizes Olowalu stream flow for irrigation needs. The reported 2014 average daily pumpage was 0.069 mgd compared to pump capacity of 0.360 mgd; it is noted that the well is classified as Irrigation-Landscape in the CWRM well database. Irrigation and other non-potable uses are not reported but can be estimated to approximately 1.54 mgd based on diverted stream water of 1.62 mgd, agricultural end uses estimated at about 0.07 mgd and kuleana uses of about 0.014 mgd. “Other” non-potable uses (1.54 mgd) besides agriculture and kuleana users could potentially include: (1) industrial; (2) landscaping; (3) parks; (4) recreational areas; (5) road shoulders and medians; (6) shopping centers; (7) condominiums; (8) schools; (9) golf courses; (10) dust control; (11) fire control; (12) agricultural irrigation; (13) seed corn; (14) composting; (15) cooling; (17) street cleaning; (18) soil conservation; (19) wildlife habitat; and (20) drinking water for cattle. Four irrigation reservoirs were constructed to support the past sugar cultivation activities of Pioneer Mill. Historically, approximately 4 mgd were diverted from Olowalu Stream.[39] The 2014 Olowalu system water quality monitoring report shows no EPA standards were exceeded.

Ukumehame System

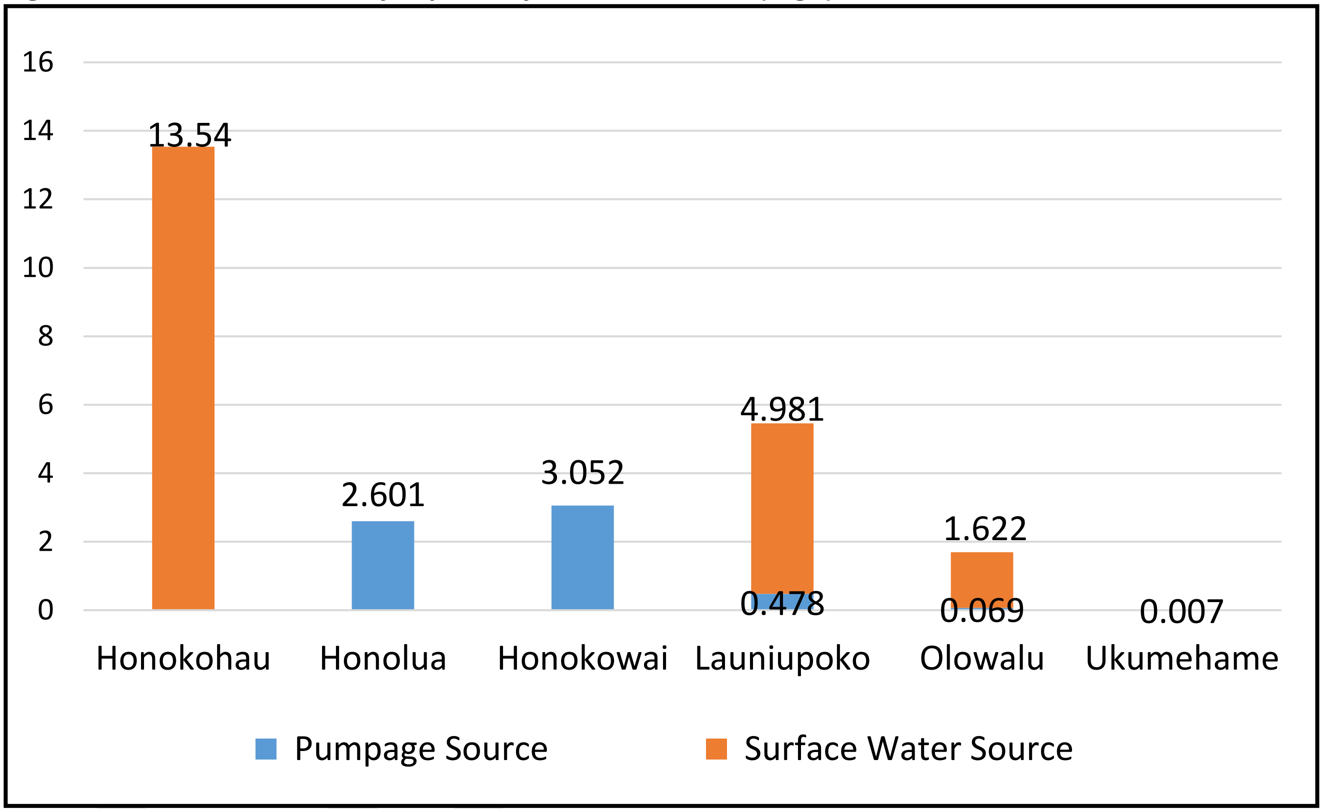
The Ukumehame Subdivision Potable Water System serves a 46-lot agricultural subdivision and draws water from the Ukumehame aquifer system. The system consists of Ukumehame Shaft (aka Pioneer Mill Pump P), Ukumehame Well 1 which is thermal and brackish, and Wells 2 and 3. Wells 2 and 3 currently serve the domestic uses of the subdivision; each lot is allowed a maximum of two single family dwellings. The 2014 average pumpage was reported at 0.006 mgd with pump capacity of 0.638. There is a separate agricultural water system designed to accommodate all agricultural uses. The system has not been classified as a public water system per the Department of Health classification (A system serving more than 15 service connections or 25 persons).

[39] Munekiyo & Hiraga, Inc, Draft Environmental Impact Statement, Proposed Olowalu Town Master Plan, February 2012

19.5.2 Water Use by Resource

Water demand in 2014 comprised about 26 mgd in the Lahaina ASEA, with surface water accounting for about 76 percent of the total. Based on reporting of diversions, pumpage and water use, the vast majority of surface water used originates in the Honokōhau aquifer system area.

Figure 19-17 Water Source by Aquifer System Area, 2014 (mgd)



Source: CWRM Well Pumpage Reports. Surface water Estimated by MDWS based on CWRM Gages, 2011-2015 averages. Municipal diversions based on MDWS Water Treatment Facilities Production.

Ground Water Resources

There are 116 wells within this aquifer sector; 82 are reported as production wells and the remaining are categorized as observation (14), abandoned (3), other (2), unused (3) and not specified (4) according to the CWRM database in August 2015. While well pumpage is required to be reported to CWRM not all active wells comply with reporting requirements and pumpage data is especially incomplete for smaller domestic and irrigation wells. The Honokōwai aquifer reached 51 percent pumpage on average in 2014. In the table below installed pump capacity is not the permitted pumpage, but the maximum capacity of the permitted well in gallons per minute multiplied by 24 hours.

Table 19-19 Pumpage and Pump Capacity of Wells Compared to Sustainable Yield, Lahaina ASEA (2014 mgd)

Aquifer System	MDWS Pumpage	Private Municipal Pumpage	Total Pumpage	Installed Pump Capacity	SY	Pumpage as % of SY	Installed Pump Capacity as % of SY
Honokōhau	0	0	0	0.012	9	0%	0%
Honolua	1.966	0.601	2.601	7.682	8	33%	96%
Honokōwai	0	3.003	3.052	13.407	6	51%	223%
Launiupoko	0.213	0.147	0.479	26.251	7	7%	375%
Olowalu	0	0	0.069	0.36	2	3%	18%
Ukumehame	0	0.007	0.007	5.469	2	0%	273%
Total	**2.179**	**3.757**	**6.208**	**53.181**	**34**	**18%**	**156%**

Source: CWRM Well Index 5/29/2015 for production wells and 2014 pumpage reports, 12-month moving average.

In the Lahaina ASEA, chloride concentrations in some of the pumped wells appear to increase directly in response to increased pumping at those wells. Chloride concentration of the pumped water from some MDWS wells has exceeded the USEPA secondary maximum contaminant level of 250 mg/L at increased pumping rates.

<u>Surface Water Resources</u>

Surface water is diverted for a variety of purposes. Surface water diversion data reported to CWRM indicates that on average more than 18 mgd was diverted in recent years from streams in the Lahaina region. It is unknown how much of this water is used for agriculture, and not all diversions are reported. It is estimated that about 17 mgd was used for agricultural and large irrigation uses. Surface water diverted by Maui Land and Pineapple Company (ML&P) has been primarily used to irrigate small-scale diversified agricultural lots, for raising livestock, as well as for golf courses, domestic water supply, and supporting reforestation efforts. Discounting water used for municipal, landscape irrigation and similar uses, it is estimated that roughly 2 to 4 mgd may be used for agriculture. West Maui Land Company indicates that about 1 mgd is released back to the streams for "cultural" uses.[40] The MDWS Lahaina system is the only public system in the West Maui region that uses both surface and ground water; the majority of production in 2014 was surface water (60 percent, 3.3 mgd), while 40 percent (2.2 mgd) was groundwater. The table below shows surface water diversion reported to CWRM and end uses as best determined; the diversion figures in italics are also accounted for in Gage 82 MLP #1 Intake Honokōhau. Some of the water from diversions may be conveyed to other end users.

[40] Dave Minami, West Maui Land Co, personal communication, 2016.

Table 19-20 Surface Water Diversions (mgd)

Gage	Diversion	Time Period
19 Launiupoko Irrigation	0.405	2011-2015
20 Kahoma Irrigation	0.416	2011-2015
21 Kaua`ula Irrigation	2.610	2011-2015, 4 months no data
22 Olowalu Irrigation	1.622	2011-2015, 7 months no data
39 Kapalua Water Irrigation	**1.094*	2011-2013; no data 2014 -15
40 MLP Troon (Golf Irrigation)	**0.914*	2011-Feb 2014, 3 months no data
41 MLP Agricultural Irrigation	**0.425*	2011-Feb 2014, 3 months no data
42 MDWS Māhinahina (Municipal)	**1.718*	2011-Feb 2014, 3 months no data
43 Kā`anapali Development Co. Irrigation	**5.450*	2011-Feb 2014, 3 months no data
82 MLP #1 Intake Honokōhau	13.540	Mar 2014-Apr 2015
MDWS Kanahā Intake (Municipal)	1.6216	2011-2015
Total	**20.214**	

Source: CWRM Gage Reports. *End use accounted for in 6-82: MLP #1. Not double counted in total.

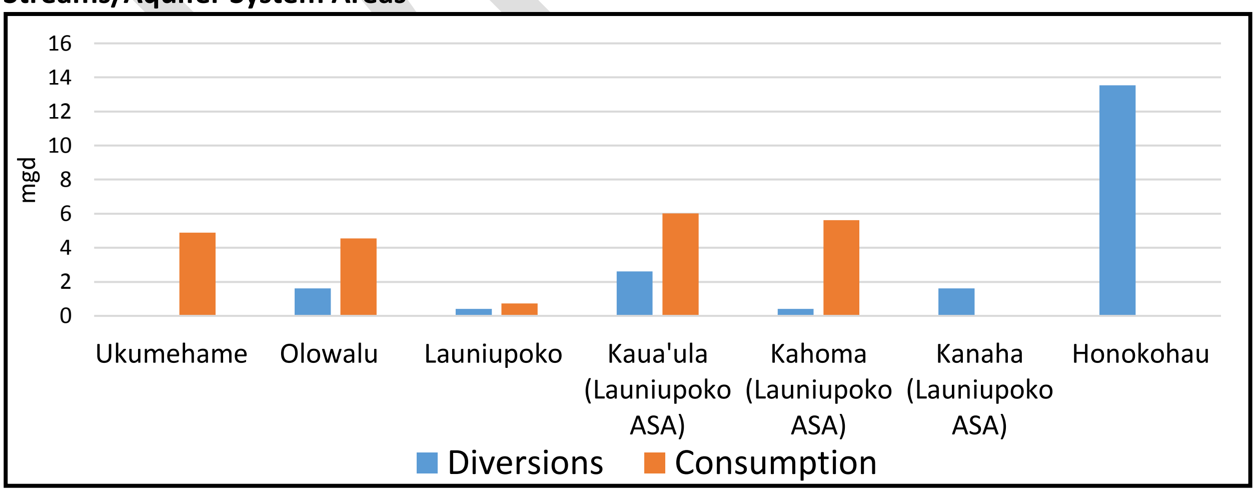
Table 19-21 Estimated Surface Water End Use, Lahaina ASEA

Use Type	2014 End Use (est. mgd)	Percent
Irrigation	13	64
Agriculture	4	20
Municipal	3.3	16
Total	20.2	100

Source: Estimated by MDWS based on CWRM Gages, 2011-2015 averages. Municipal based on MDWS Production.

The following figure illustrates the majority of the water was diverted from Honokōhau Stream for use in aquifer systems to the south.

Figure 19-18 Comparison of Estimated Surface Water Diversions and End Use, Lahaina Region Streams/Aquifer System Areas



Source: CWRM Gages, MDWS Water Treatment Facilities Production, 2011-2015 averages. End use of gaged data interpreted by MDWS in consultation with CWRM surface water branch.

Alternative Water Resources

Rainwater Catchment

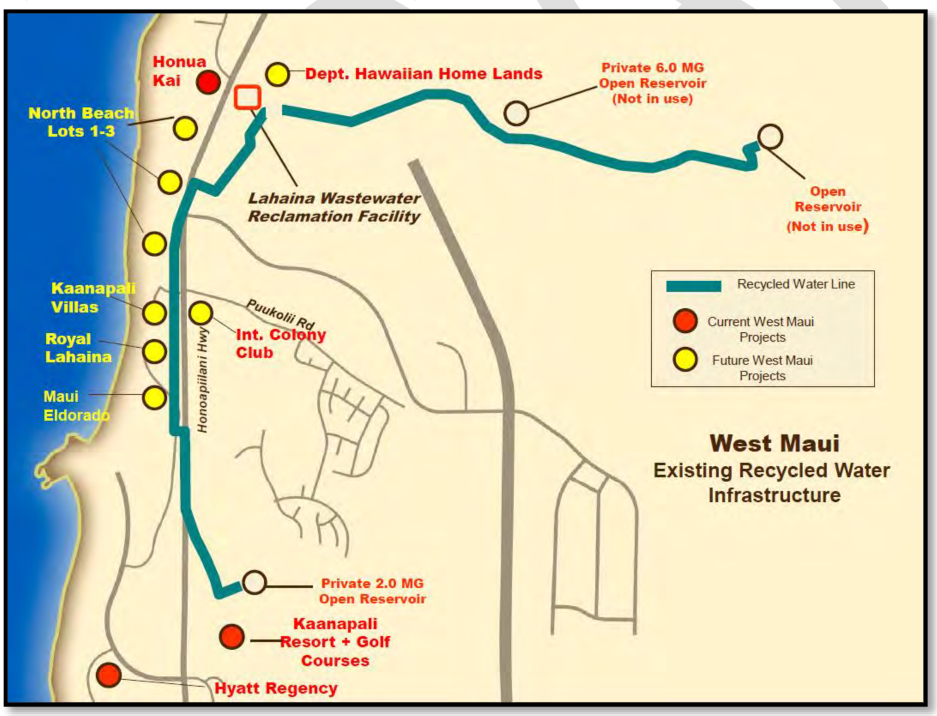
Annual rainfall ranges from about 50 to 366 inches. It assumed that because of the abundant rainfall in the Lahaina ASEA some small-scale rain catchment exists but records are not maintained.

Rainwater catchment is not as reliable as conventional water resources because it is extremely sensitive to the climate. Rain barrels, cisterns or infiltration wells could supplement irrigation on a very limited basis in the Lahaina region.

Recycled Wastewater

The County's Lahaina Wastewater Reclamation Facility (WWRF) serves the West Maui area from Kapalua to the Kā`anapali area and has a current dry weather treatment capacity of 9.0 mgd. Resorts use the majority of the recycled water; the largest user is Kā`anapali Resort.[41] The average production in 2014 was 4.2 mgd, however, only a portion of the facility's effluent is treated to R-1 water quality. During peak summer demand, close to 40 percent of the R-1 recycled water produced or 1.5 mgd was used.

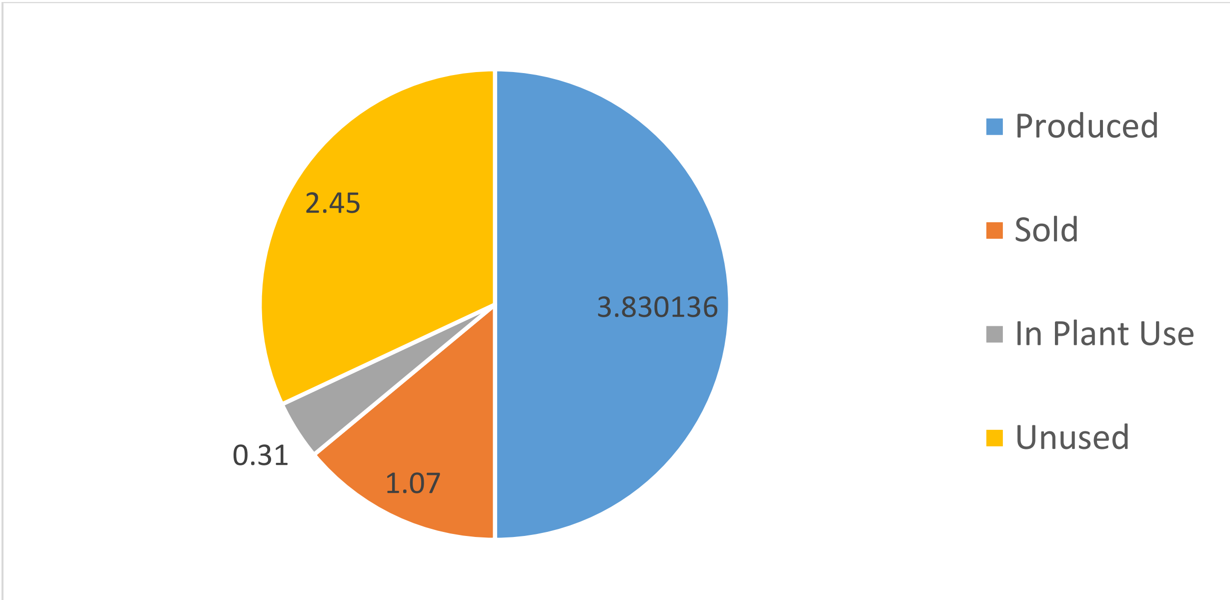
Figure 19-19 West Maui Existing Recycled Water Infrastructure



Source: County of Maui, Department of Environmental Management, Wastewater Reclamation Division, 2013.

[41] County of Maui, Environmental Management, Wastewater Reclamation Division data.

Figure 19-20 Recycled Water Use, Lahaina WWRF, 2012-2014 Average (mgd)



Source: County of Maui, Environmental Management, Wastewater Reclamation Division data.

Table 19-22 Lahaina Wastewater Reclamation Facility, 2014 (mgd)

Treatment Level	Design Capacity	Flow Processed (Produced)	Recycled Water Used	Recycled Water Sold	% of Produced Used	% of Design Capacity Used	Primary Applications
R-1	9	3.84	0.89	0.63	22.9%	9.8%	Golf Course & Landscape Irrigation
High Month August	9	4.0	1.51	--	38.0%	19.6%	--
Low Month November	9	3.8	0.62	--	16.4%	6.9%	--

Source: County of Maui, Environmental Management, Wastewater Reclamation Division, 2014 Average. % of Total Produced Used includes in-plant use.

Use compared to production varied from about 16 to 38 percent per month in 2014. Private purveyor recycled water averaged 0.88 mgd. The chart below shows existing and projected use for the municipal Lahaina WWRF and private recycled water production.

Table 19-23 Existing and Projected Recycled Water Use, Lahaina ASEA

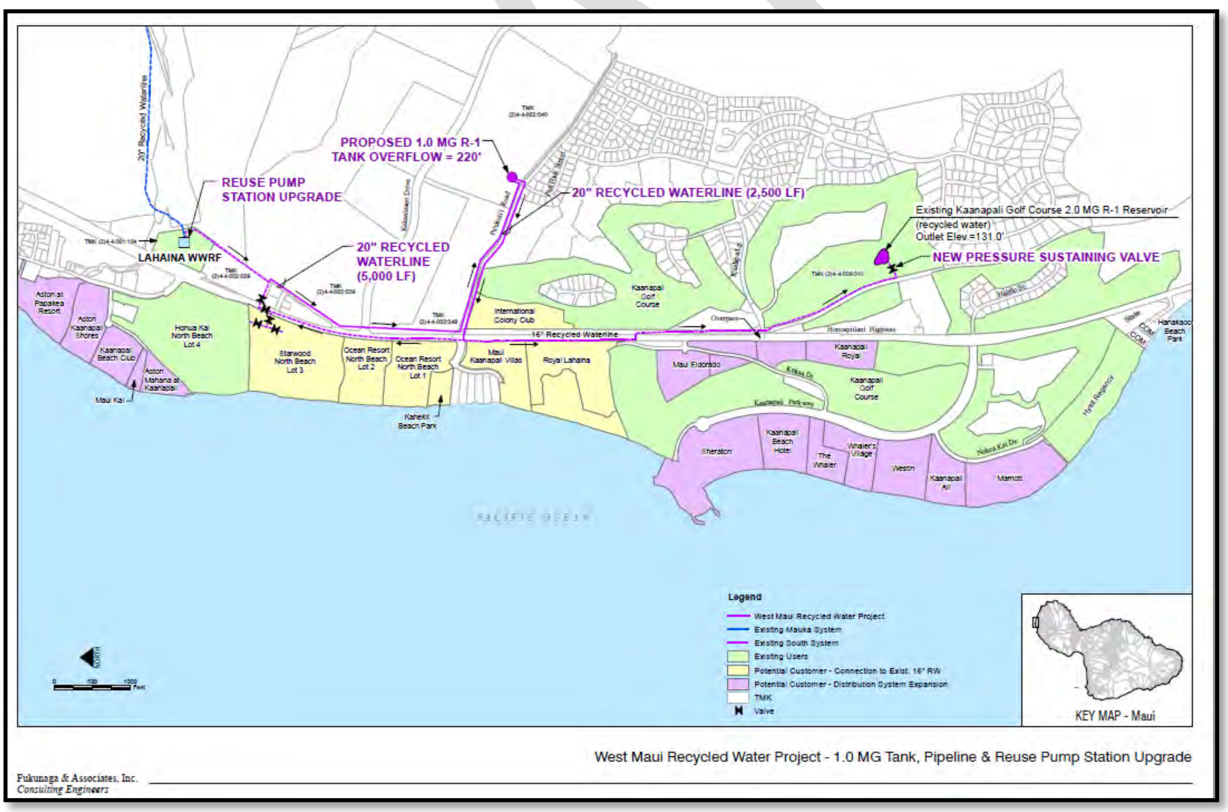
	Lahaina WWRF Existing/ Proposed	Lahaina WWRFF Total	WWRF Existing/ Proposed	Private WWRF Total	MUNICIPAL AND PRIVATE Total
Recycled Water Use (Ave. MGD)	0.88 / 1.84	**2.72**	0.45 / 1.7*	**2.15**	**4.87**

County of Maui Environmental Management Dept., Wastewater Reclamation Division, September 28, 2015
*Does not include potential bioenergy crop irrigation project or projects lacking recycled water use projections.

Construction of infrastructure (storage tanks, transmission lines, distribution lines) and additional UV disinfection capability and system expansion will increase R-1 water distribution capability and allow provision of recycled water to condominiums and resorts in the Kā`anapali area. R-1 water can also be made available to future DHHL commercial and industrial developments in the West Maui area for landscape irrigation purposes. Current storage is inadequate to support peak use at some times and is a limiting factor.

Excess recycled water is sent down injection wells; community and agency concerns over effluent disposal continues to be a factor affecting the Lahaina WWRF. All agricultural uses of R-1 water from the Lahaina WWRF ceased in 2006 when Maui Land and Pineapple Company phased-out pineapple production in West Maui. The Wastewater Reclamation Division has considered land application for pasture irrigation, however, economic feasibility and consideration of elevation changes are necessary to engage a private partner. Locations makai of the highway in the recycled wastewater master plan can be served but those mauka of the highway are contingent on a higher elevation storage tank. An exception may be the DHHL project north of the WWTF which has the benefit of pumps and a reservoir that could be supplied with recycled water without the tank. Another possible option for use of recycled water is to convey the water directly to the MDWS water treatment plant.

Figure 19-21 West Maui Recycled Water Project Upgrade



Source: Fukunaga & Associates, Inc., West Maui Recycled Water Project Upgrade

Stormwater Reuse

There is no reported stormwater reuse, although some development projects may have stormwater controls incorporated into project design to reduce runoff and its effects. The *Study Element 3: An Appraisal of Stormwater Reclamation and Reuse Opportunities in Hawai`i*, September 2008, identified the Lahaina Flood Control project as a possible opportunity to use an existing stormwater drainage channel and detention pond located adjacent to the Lahaina WWRF. The project would collect stormwater for conveyance to agricultural areas to the north, south, and east to augment agricultural irrigation water diverted from Maui streams along with other benefits. Stormwater reuse at the parcel scale may also provide an opportunity to offset landscape and other irrigation demand of projects or households.

Desalination

There are no desalination projects in the Lahaina ASEA. Desalination of ocean or brackish water was studied as an option in the MDWS study*, Maui Island Water Source Development Options for the Lahaina-Nāpili Area, 2013*. The cost to operate a desalination plant is high due to the high energy (electrical) demand of the process. The disposal of the brine liquid, which is a byproduct of the process, has not been resolved. These are the main issues that render desalination as not an effective option.

19.6 FUTURE WATER NEEDS

19.6.1 General

Two alternative methods were used to project water demand to the year 2035: (1) Population growth rates based on 20-year population growth projections in the Socio-Economic Forecast Report (2014) applied to current consumption; and (2) build-out of permitted land use based on County zoning and Department of Hawaiian Homelands' land use plans. Population based demand takes into account social and economic factors that are anticipated to drive growth over the planning period.

19.6.2 Water Use Unit Rates

The Domestic Consumption Guidelines in the 2002 County of Maui Water System Standards are used for land use based demand projections. Most of the water use in the Lahaina ASEA is for residential or single-family use; the 2002 Standards for residential use is 600 gallons per unit, 3,000 gpd per acre for single family/duplex and 5,000 gpd per acre for multi-family use. Depending on density of dwelling units as determined by residential zoning type (R-0, R-1, R-2 or R-3) demand can range from 2,400 to 4,800 gallons per acre. Projected demand is based on the per acre standards, which is generally consistent with empirical data for the region.

19.6.3 Land Use Based Full Build-Out Water Demand Projections

Full build-out projections for the Lahaina area based on County zoning and Department of Hawaiian Homelands (DHHL) land use categories yield a projected water demand of about 113 mgd.

Maui County Zoning

Maui County zoning for the Lahaina ASEA includes a range of resource, rural and urban Use Zone Districts that constitute a "full-build-out" methodology, based on realization of development of land space to 100% of its potential. Interim and Project District zoned land were assigned a zone based on Directed Growth Plan guidance and Community Plan designations in order to calculate water demand. There are over 59,900 zoned acres in this ASEA (excluding DHHL lands). About 29,000 acres are in the Interim district; since most are designated Conservation in the Community Plan they are accordingly assigned to the 'Open Space' zoning district. Over 26,500 acres are in the Agriculture district. Less than 4,200 acres are zoned for urban uses. A summary of the land use based demand follows a discussion of DHHL land use demand.

Table 19-24 Summary of Zoning Use Types, Lahaina ASEA

Zoning Summary	Acres	% of Total	Water Use Rates (gpd per acre)
Single Family, Duplex	2,235	3.73%	3,000
Apartment, Multifamily	880	1.47%	5,000
Hotel	297	0.50%	17,000
Business	113	0.19%	6,000
Industrial	148	0.25%	6,000
Airport	50	0.08%	6,000
Agriculture	26,557	44.31%	3,400
Golf Course	454	0.76%	1,700
Public/Quasi-Public	45	0.08%	1,700
Park	5	0.01%	1700
Open Space	29,147	48.63%	0
Total	**59,931**	100%	

Source: Table prepared by MDWS, Water Resources & Planning Division. Excludes DHHL lands.
Zoning supplied by Maui County Planning Department, Long Range Division, May 2015.
Interim and Project District zoning assigned to CWRM categories based on Community Plans and Development Projects.

State Department of Hawaiian Home Lands (DHHL)

DHHL's projected demands are incorporated into population and land use based demand projections as indicated in the relevant sections. Water rates used by the State Water Projects Plan Update: DHHL, May 2017 are as follows:

Table 19-25 DHHL Land Use, Water Standards for Maui

Land Use	Potable	Non-potable
Residential	600 gal/unit	None
Subsidence Ag	600 gal/unit	3400 gal/acre
Supplemental Agriculture	None	3400 gal/acre
Pastoral	600 gal/unit	20 gal/acre
General Ag	None	3400 gal/acre
Special District	Varies	Varies
Community Use acres	1,700 gal/acre or 60 gal/student	None
Conservation	None	None
Commercial	3,000 gal/acre or 140 gal/1,000 SF	None
Industrial	6,000 gal/acre	None

Source: DHHL Maui Island Plan.

The 2017 SWPP Update projects a demand of 0.7696 mgd of potable water and 2.0808 mgd non-potable water for new projects in the Lahaina ASEA. The Kā`anapali tract involves 50 acres of Commercial and Industrial development. The Leali`i tract and the remainder of the Honokōwai tract include Residential, Subsistence Ag and Community Use land uses. The existing MDWS Lahaina Water System lacks capacity to serve potable demand from these developments. DHHL is in the process of developing a potable water well mauka of the Honokōwai tract, along with water transmission alternatives to integrate this well with the MDWS system and to provide service to the Honokōwai tract, the Leali`i tract and potentially future MDWS demands in the area.

The County of Maui Lahaina Wastewater Reclamation Facility has capacity to provide 2.08 mgd of R-1 water to serve the Supplemental Ag and General Ag land use areas; however, the facility currently only receives an average of 4 mgd and the distribution system is inadequate. The County of Maui has plans to modify and expand the distribution system. DHHL and the County have had discussions regarding servicing options in exchange for infrastructure within the Honokōwai Tract and an agreement is pending.

Table 19-26 Projected Water Demands and Strategies for DHHL Projects in Lahaina ASEA, 2035 (mgd)

Aquifer System	Project	Potable	Potable Strategy	Non-potable	Non-potable Strategy
Honokōwai	Honokōwai/ Kā`anapali	0.6179	New and/or planned State wells	2.0808	MLP Irrigation System (or possibly R-1 water)
Honokōwai	Leali`i B	0.1517	New and/or planned State wells	0	--

Source: State Water Projects Plan: DHHL, May 2017.

The following table summarizes County and DHHL land use based demand. Projected non-potable demand for 128 acres at Honokōwai (2.081 mgd at >16,000 gpd per acre) is significantly higher than evidenced by the agricultural rates (0.435 mgd at 3400 gpd per acre). Substituting 2.081 for 0.435 mgd, total land use based demand would incrementally increase demand over 112 gpd.[42]

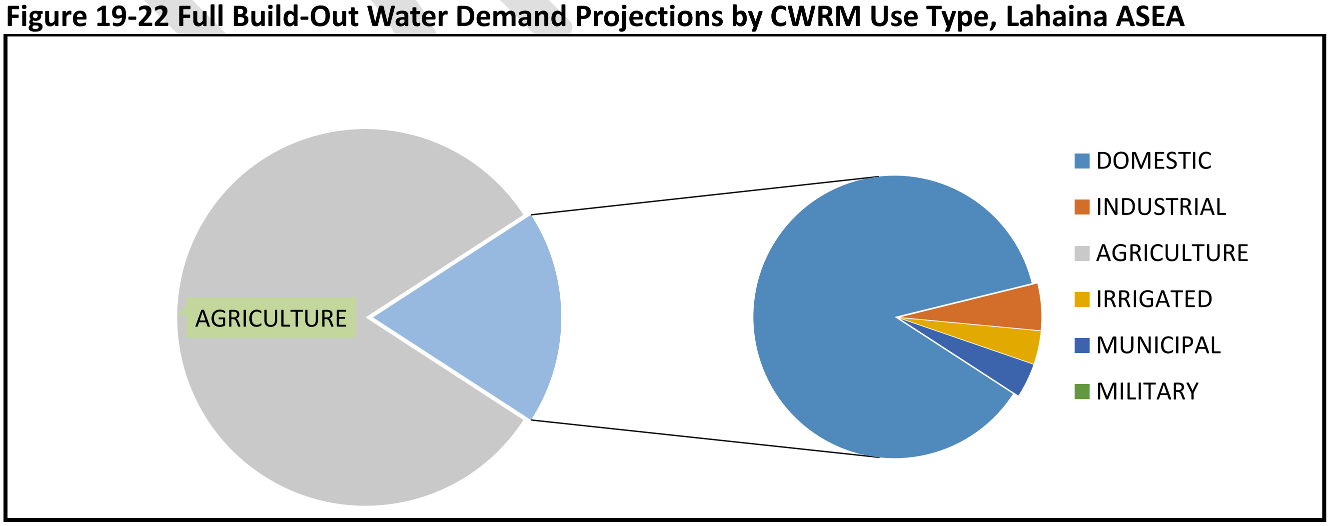
[42] Non-potable demand for 128 acres at Honokōwai (2.081 mgd at >16,000 gpd per acre) is significantly higher than evidenced by the agricultural rates (0.435 mgd at 3400 gpd per acre). It is possible that higher figures are used for subsistence agriculture as well.

Table 19-27 Full Build-Out Water Demand Projections by CWRM Use Type, Lahaina ASEA (mgd)

CWRM Use Categories	County Zoning Based			DHHL Land Use Category Based				Total Projected Demand (mgd)
	Water Use Rate (gpd)	Acres	Projected Demand (mgd)	DHHL Land Use	Acres / Residential Units	Water Use Rate (mgd)	Projected Demand (mgd)	
Domestic-Residential	3,000-5,000	3,115.42	11.106	Residential	1331	600	0.7986	**11.905**
Domestic-Non-residential	6,000 gal/ac (Business) or 17,000 gal/ac (Resort)	410.21	5.729	Commercial	14	6,000	0.084	**5.813**
Industrial	6,000 gal/ac	147.55	0.885	Industrial	33	6000	0.198	**1.083**
Agriculture	3,400 gal/ac	26,557.27	90.295	Agriculture	128	3400	0.4352 *2.0808*	**90.730** *92.376*
Open Space	0							
Irrigated	1,700	453.64	0.771	N/A		--	0	**0.771**
Municipal	1,700 gal/ac	100	0.579	Community	126	1700	0.2142	**0.793**
Military	N/A	0	0	N/A		--	0	**0.000**
Total	**N/A**	**30,784.09**	**109.365**				**1.73** *3.766*	**111.095** *112.741*

Source: MDWS Water Resources & Planning Division. Figures may not add due to rounding. Open space, conservation/cultural protection w/o water demand excluded.
County Zoning: Based on zoning supplied by Maui County Planning Department, Long Range Planning Division, May 2015. DHHL lands are excluded. Irrigated includes Park-Golf Course and Golf Course zoning districts.
DHHL Lands: Based on DHHL Maui Island Plan and Regional Plans. Future land uses are unknown for some lands.
Red text- adjustment to non-potable demand per State Water Projects Plan Update: DHHL, May 2017.

Figure 19-22 Full Build-Out Water Demand Projections by CWRM Use Type, Lahaina ASEA



Agricultural demand is largely sourced from surface water. County and state planning documents do not project increased agricultural production in the West Maui region.

State Water Projects Plan

State projects in the State Water Projects Plan (2003) forecast potable demand of 1.15 mgd and non-potable demand of 1.29 for a total demand of 2.4 mgd for the planning period to 2020 (excluding DHHL projects). An insignificant amount is associated with school classroom expansions. The remaining demand is associated with master plan housing and therefore assumed to be accounted for by population growth based demand for the region. Non DHHL state projects are incorporated into population based demand projections without adjustment.

Table 19-28 SWPP Projected Water Demands to 2020 (Excludes DHHL)

Aquifer Sector	Non-potable Demand (mgd)	Potable Demand (mgd)	Total Demand (mgd)
Lahaina	1.289	1.157	2.446

Source: State Water Projects Plan, Hawai`i Water Plan, Volume 4, SWPP for Islands of Lanai/Maui/Molokai, 2003

Agricultural Water Use and Development Plan (AWUDP)

The 2004 AWUDP water demand forecast for diversified agriculture below does not include Maui Land & Pineapple figures. Other data referenced in the report indicates existing and potential agricultural water use may be closer to the low or midpoint of the range. The AWUDP projections for diversified agriculture in West Maui do not correlate well with current 2015 actual crop baseline assessment discussed under 19.6.5 below. No adjustment based on the 2004 AWUDP is made.

Table 19-29 Water Demand Forecast for Diversified Agriculture, Lahaina ASEA, 2001-2021

Irrigation System	Total Acres	Acreage in Use		Unused Acreage	Acreage Forecast for Diversified Agriculture		Forecasted Water Demand (mgd)	
		Estimated Percent	Acres		Worst Case	Best Case	Worst Case	Best Case
Pioneer Mill*	3,533	30	1,060	2,473	422	1,350	1.43	4.59
West Maui	5,400	60	3,240	2,160	214	892	0.73	3.03
Total	**8,933**		**4,300**	**4,633**	**636**	**2,242**	**2.16**	**7.62**

Source: Complied based on Tables 6b and 7d, AWUDP, 2003, revised 2004
* Does not include Maui Land & Pineapple figures.
Water use – acreage@3400 gpd per acre.

19.6.4 Population Growth Based Water Demand Projections (20-Year)

Population growth rate projections were applied in 5-year increments over the 20-year planning period from 2015 to 2035 for high, medium (base case) and low growth scenarios. Water consumption, including both public and private water systems, are compared to the incremental water needs for the next 20 years based on the *Socio-Economic Forecast Report, 2014* prepared by the Planning Department consistent with the Maui Island Plan. Water consumption and demand based on population growth rates do not account for large-scale agricultural irrigation. However, recycled water that is the end product of metered consumption would be included. It was assumed that population growth, and thus potable water use, from projects described in the State Water Projects Plan and update for Department of Hawaiian Homelands (DHHL) are already accounted for by the population projections. Non-potable DHHL needs are considered to represent additional demand.

The Maui Island Plan projects a 64 percent increase population increase between 2015 and 2035 for West Maui based on the community plan growth rates in the Socio-Economic Forecast. Water demand excluding large agriculture and irrigation needs is projected to increase by from about 9.4 to 15.7 mgd over 20 years. The greatest needs are for single-family residential and hotel/resort use.

Table 19-30 Projected Population and Water Demand to 2035, Lahaina ASEA (mgd)

Criteria	2010	2014	2015	2020	2025	2030	2035	20 Year Increase	Annual Ave (mgd)
% Increase		N/A	10.01%	13.90%	16.41%	11.73%	10.53%	63.75%	3.2%
Population	22,156		24,373	27,762	32,318	36,110	39,911	15,538	777
Water Demand (mgd)		**9.416**	**10.359**	**11.798**	**13.735**	**15.346**	**16.962**	**6.603**	**0.330**

Source: Population Forecast: 2014 Socio-Economic Forecast, Maui County Planning Department, Long Range Planning Division, Table R-1, West Maui Community Plan area. Water Demand: MDWS, Water Resources & Planning.

Table 19-31 Projected Low, Base and High Population Based Water Demand to 2035, Lahaina ASEA (mgd)

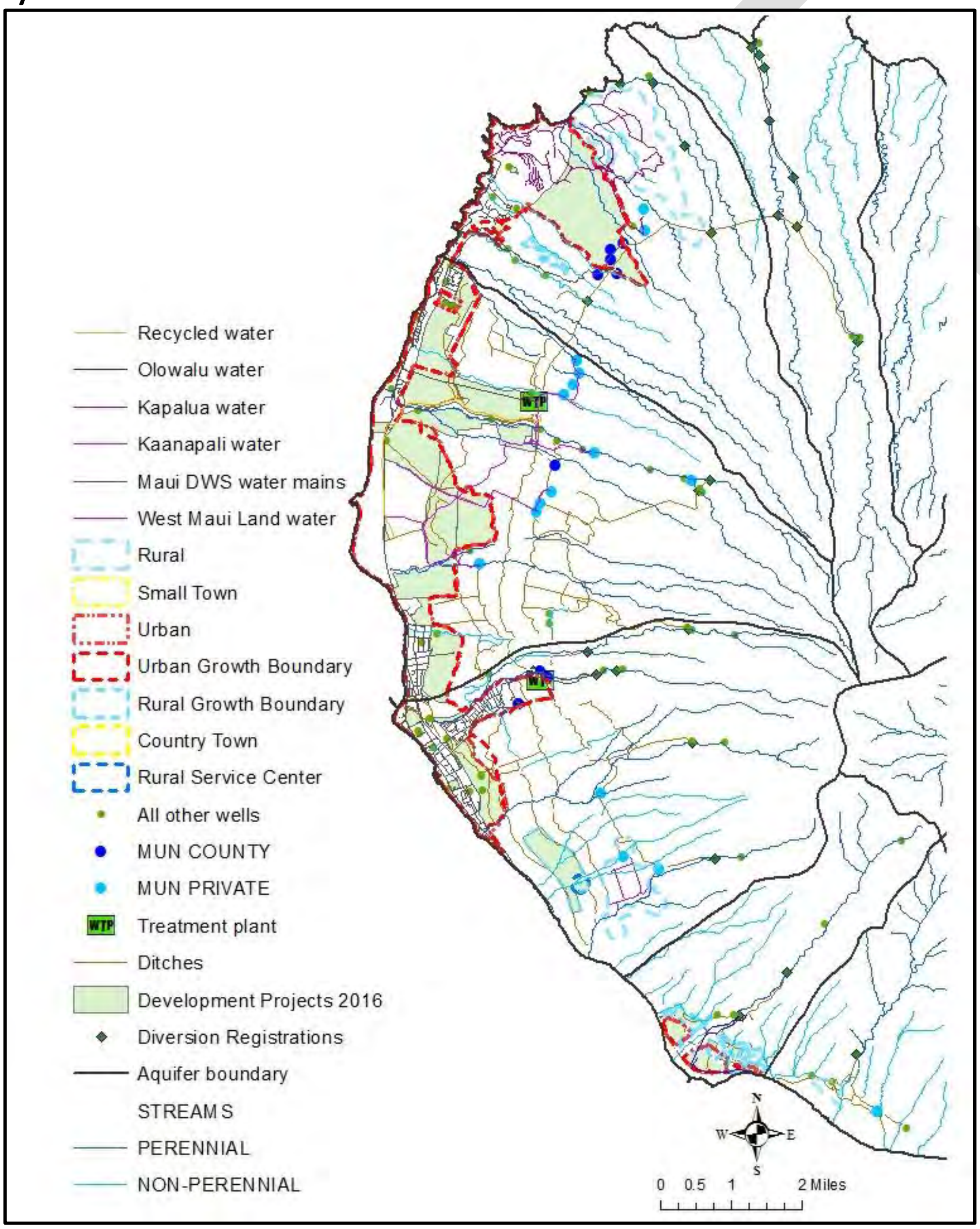
Case	2015	2016	2017	2018	2019	2020	2025	2030	2035
Base Case	9.604	9.871	10.138	10.405	10.672	12.734	12.734	14.228	15.726
High Case	9.604	10.649	10.937	11.225	11.513	11.801	13.378	15.349	19.966
Low Case	9.604	9.027	9.271	9.515	9.760	10.004	11.646	13.012	14.382

Source: MDWS, 2017.

<u>Population Growth Based Demand in Planned Growth Areas</u>

Within designated growth areas, proposed development projects and existing infrastructure can indicate which water resource will likely be pursued. However, multiple factors determine the realization and sequence of development that makes source and infrastructure development difficult to predict. The Planning Department maintains a list of large development projects that have come to their attention, some of which have been entitled, committed or are supported by the Maui Island Plan but not necessarily the Community Plan. The map below shows the Growth Boundaries, the location of projects on the 2016 Development Projects list, public water systems, Lahaina recycled water system, wells, stream diversions and ditches.

Figure 19-23 Comparison of Growth Boundaries, 2016 Development Project List, Water Systems and Water Resources, Recycled Water System, and Plantation Irrigation Ditch Systems



Source: Maui Island Plan, Planning Department Development Projects List, MDWS, Water Resources & Planning.

The Kā`anapali to Kapalua area consists of a band of urban settlement within an extensive Urban Growth Boundary focused on the visitor industry, including the Kā`anapali Town Planned Growth Area of about 1800 dwelling units. In the Lahaina area the extensive Urban Growth boundary includes several Planned Growth Areas encompassing nearly 1400 dwelling units. The MDWS Lahaina Water System serves most of the resident population with potable water. The system serves the coastal areas from Launiupoko to Kā`anapali, and from Honokōwai to Nāpili. The resort areas of Kā`anapali and Kapalua are served by Hawai`i Water Service and the Kapalua System.

Olowalu consists of limited commercial services and sparse residential uses including a limited Urban Growth boundary with Planned Growth Areas extending outside that boundary. In this area there are several Rural Growth Boundaries. Ukumehame consists of small agricultural lots with residential and small scale agricultural uses. The Mahanalua Nui, Olowalu and Ukumehame Systems serve development in these areas.

Figure 19-24 Kapalua Planned Growth Areas, Lahaina ASEA

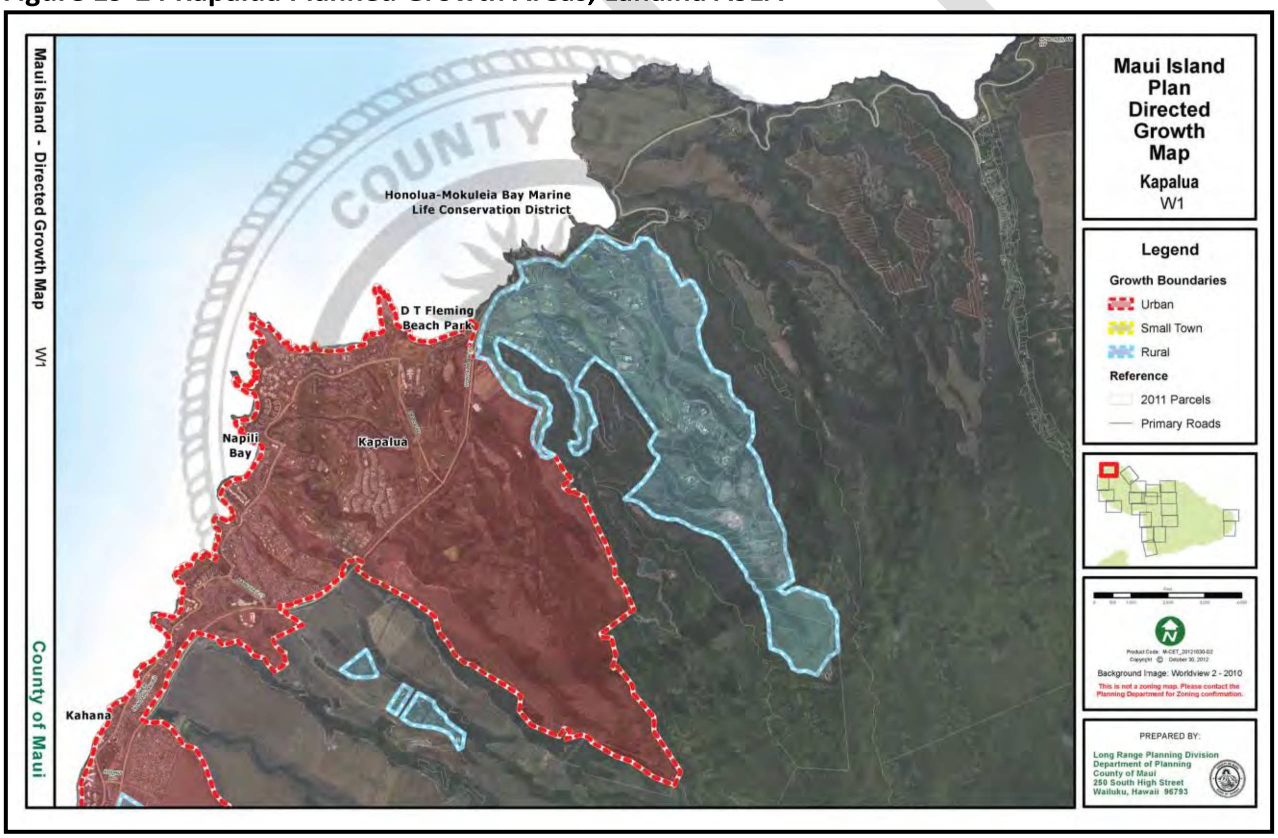


Figure 19-25 Kā`anapali Planned Growth Areas, Lahaina ASEA

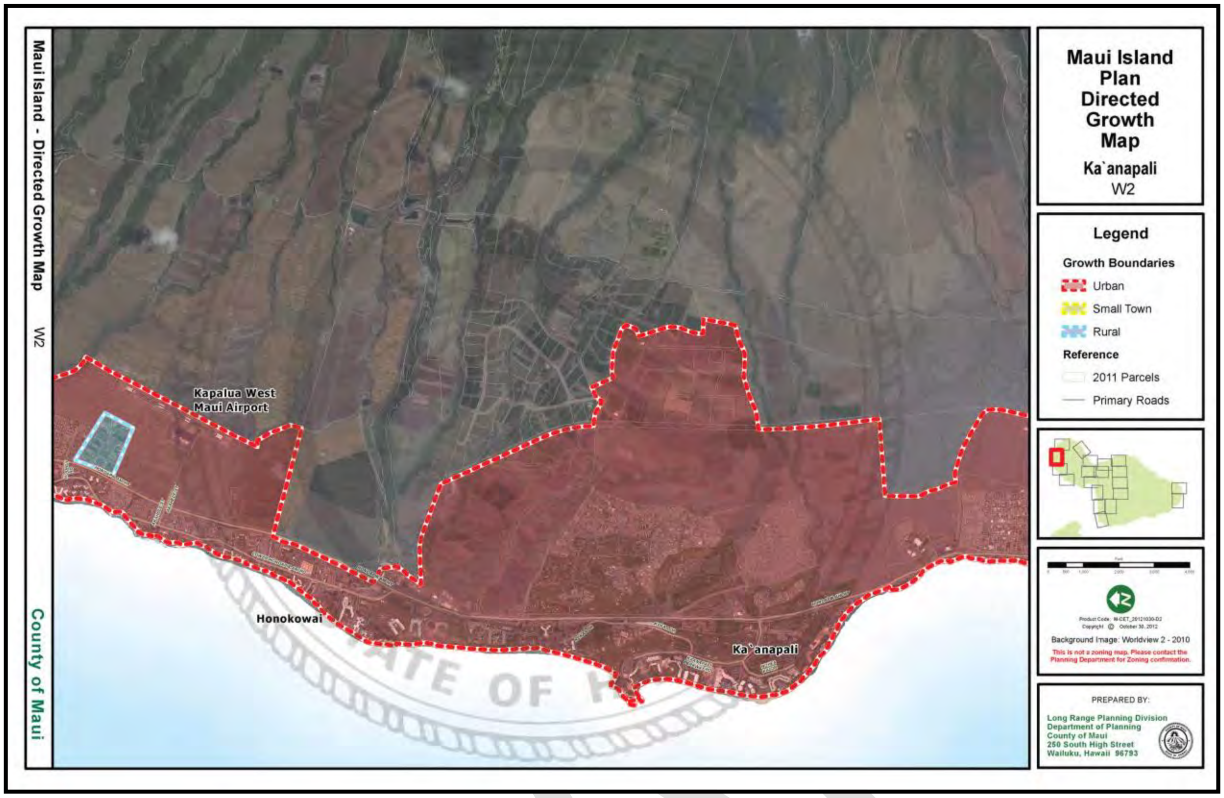


Figure 19-26 Lahaina Town Planned Growth Areas, Lahaina ASEA

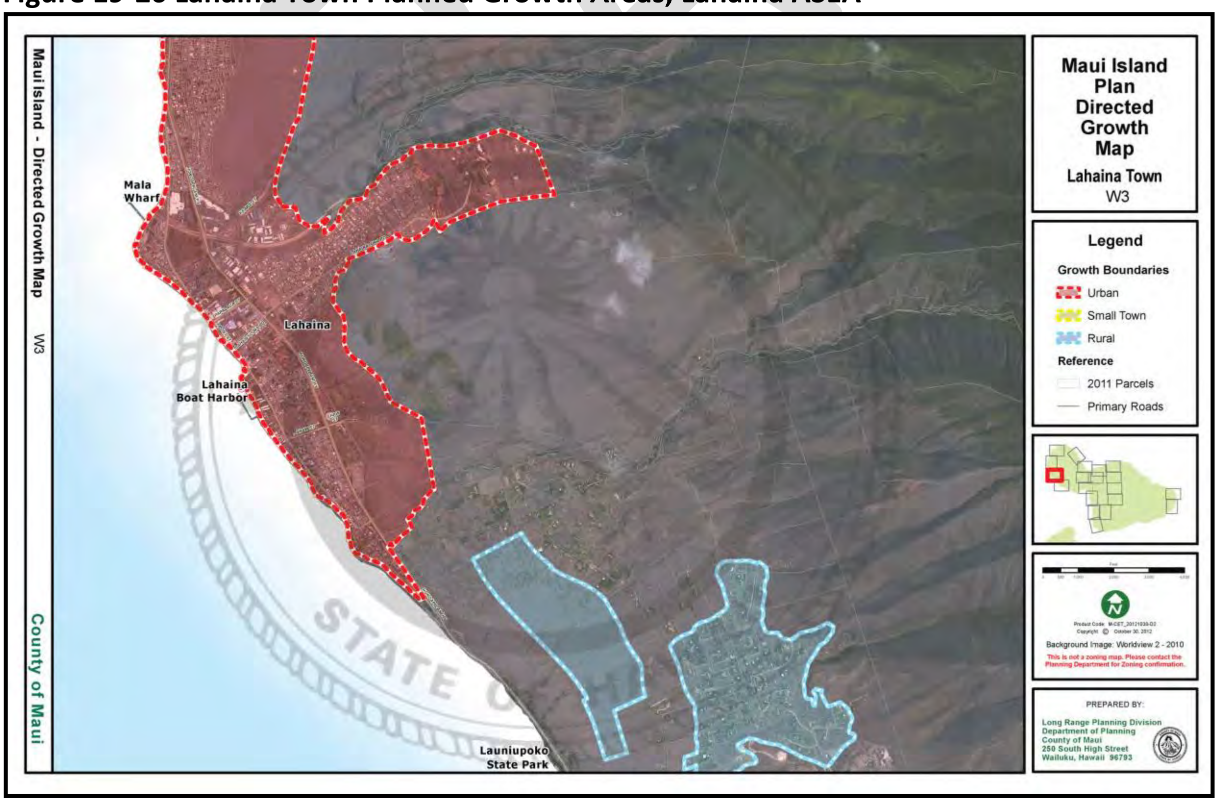
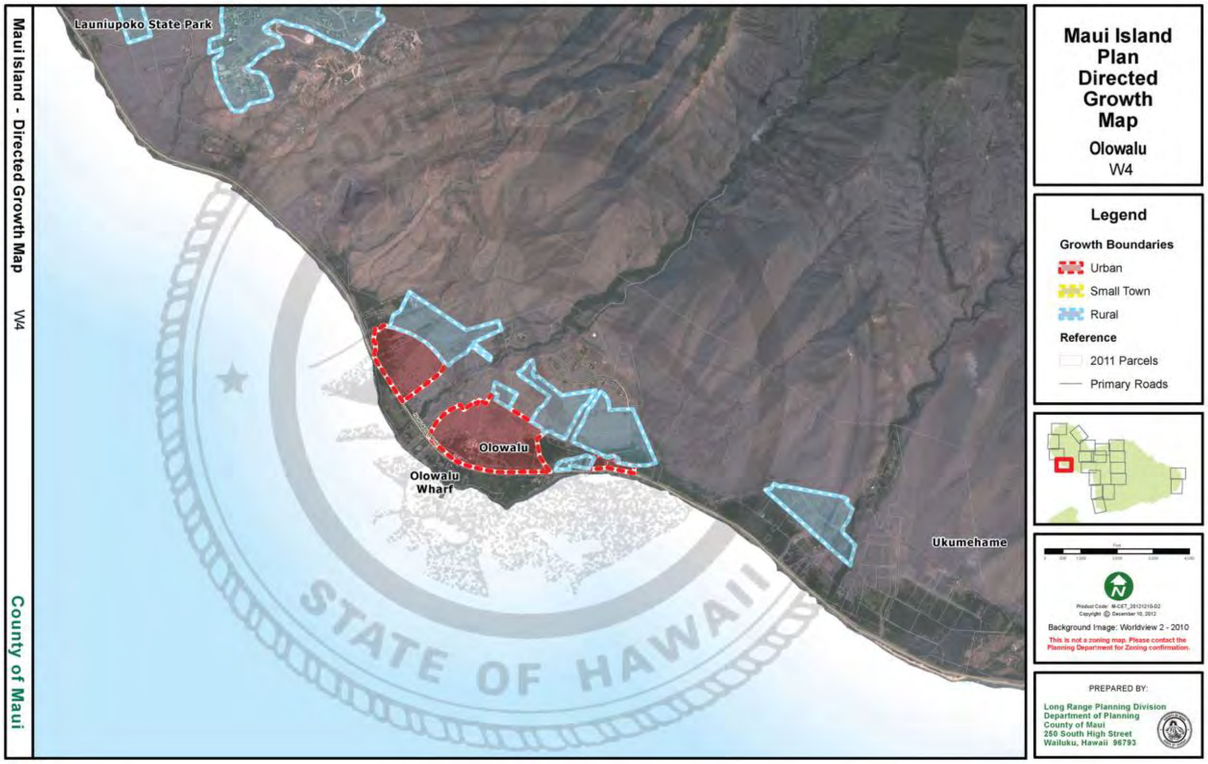


Figure 19-27 Olowalu Planned Growth Areas, Lahaina ASEA



The 2016 Development Projects list (based on Maui County Planning Department, Long Range Planning Division anticipated projects) indicates the potential for over 10,000 housing units including some hotel and timeshare units, which equates to over 20,000 people based on the average size of households, in addition to infill development. Projected demand to serve the 2016 list alone, based on dwelling units, is 6.2 mgd. While unlikely all projects will be approved as proposed, or constructed once approved, the List is instructive as to location and planning for water sources. The population growth based demand of a projected 15.7 mgd by 2035 is compared to the residential demand of Development Projects in the table below.

Table 19-32 Population Based Demand 2035 Compared to 2016 Development Projects List (mgd)

Lahaina Aquifer System Area	2035 Demand	2016 Development Projects List		
		Entitled	Not Entitled	Total
Honokōhau	0.000			
Honolua	2.748	0.526		0.526
Honokōwai	8.474	2.317	1.780	4.097
Launiupoko	4.378	0.158	0.538	0.696
Olowalu	0.115		0.900	0.900
Ukumehame	0.011			
Total	**15.726**	**3.002**	**3.218**	**6.219**

Source: MDWS, Maui County Planning Department, Long Range Planning Division.

DHHL Water Demand Projections

The State Water Projects Plan updated demand for the Department of Hawaiian Homelands in the 2017 Final Report. [43] Potable DHHL water demand projections are encompassed within the population based projections for Lahaina ASEA. Non-potable demands are added to population growth based projections.

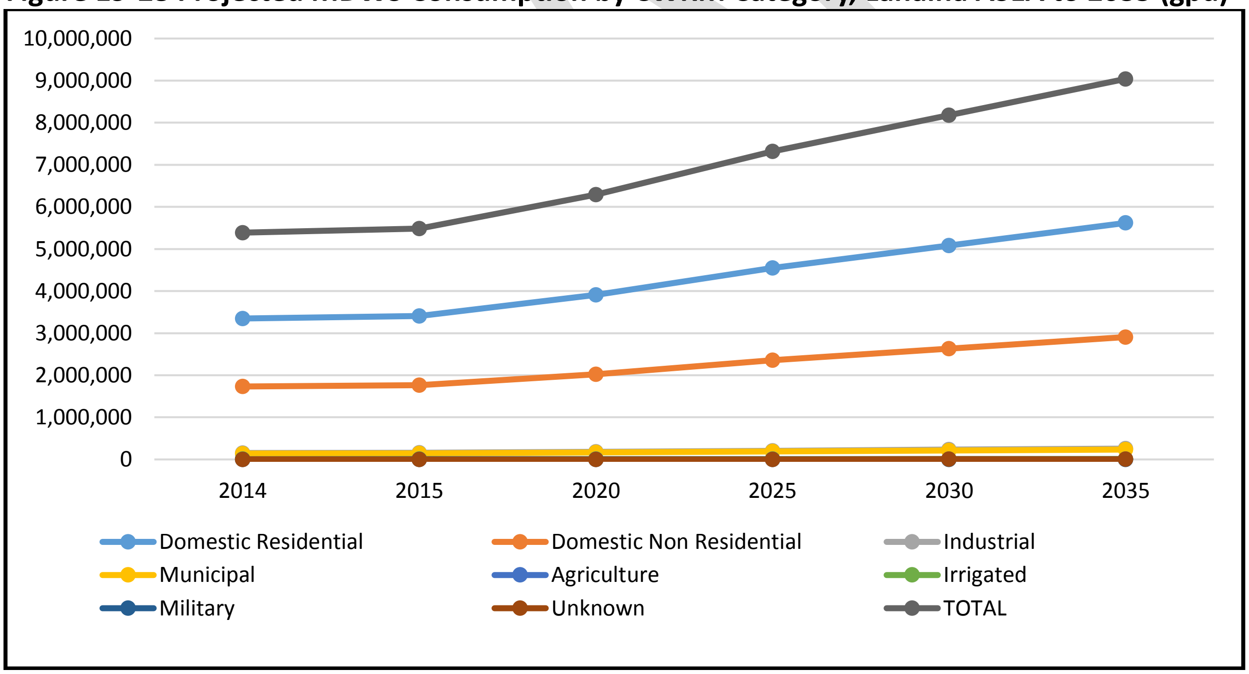
State Water Projects Plan Water Demand Projections

Other state water demand projections are encompassed within the population based projections for Lahaina ASEA.

MDWS Water Demand Projections

MDWS water consumption is projected to be about 9 mgd by 2035. As shown below residential use accounts for the greatest demand. Although the CWRM water use category "Municipal" includes all MDWS billing classes, the figure below provides a breakdown of water consumption that closest corresponds to CWRM sub-categories and actual water use. MDWS meters with no assigned billing class are shown as "unknown". Billed consumption shown in the chart and table below is lower than water produced due to water losses.

Figure 19-28 Projected MDWS Consumption by CWRM Category, Lahaina ASEA to 2035 (gpd)



[43] Fukunaga & Associates, Inc. State Water Projects Plan, Final Report May 2017

Table 19-33 Projected MDWS Consumption by CWRM Category, Lahaina ASEA to 2035(gpd)

	2014	2015	2020	2025	2030	2035
Domestic Residential	3,348,723	3,407,325	3,908,019	4,549,325	5,082,961	5,618,197
Domestic Non Residential	1,732,974	1,763,301	2,022,412	2,354,290	2,630,448	2,907,434
Industrial	153,207	155,888	178,795	208,136	232,550	257,037
Municipal	139,741	142,187	163,081	189,842	212,111	234,446
Agriculture	4,818	4,902	5,622	6,545	7,313	8,083
Irrigated	5,144	5,234	6,004	6,989	7,808	8,631
Military	1,675	1,704	1,955	2,276	2,542	2,810
Unknown	2,119	2,156	2,473	2,879	3,217	3,555
TOTAL	**5,388,401**	**5,482,698**	**6,288,360**	**7,320,280**	**8,178,949**	**9,040,193**

Private Public Water Systems Demand Projections

The private public water systems were requested to provide demand projections but most did not supply information. Therefore, demand of these smaller purveyors is encompassed within the population based projections applied to Maui Island. Since many of the smaller private public systems serve specific development projects, significant increases would not be anticipated. Disclosed information is incorporated. Public water systems in the region generally do not report billed consumption but groundwater pumped and surface water diverted. Hawai`i Water Service Company is the largest private public water purveyor on Maui Island. Water for new development under the 2020 Kā`anapali Master Plan was estimated at 1.8 mgd for Lower Honokōwai and 0.51 for middle Honokōwai, for a total of 2.31 mgd. It was anticipated that water for lower, east and middle Honokōwai will be supplied by MDWS, with water for lower north Honokōwai to be provided by HWS.[44] An estimated 13 mgd of surface water is used for various irrigation purposes throughout the region. It is assumed that irrigation of resort landscaping and various commercial non-potable irrigation needs are at least partially correlated to growth in the visitor industry. The growth rate for the de facto population, which includes visitors, is less than the population growth rate. Irrigation demand is therefore considered as demand in addition to municipal and other public water system end uses and accounted for in population growth based projections over the 20 year period.

Other Population Based Demand Projections

In addition to the public water systems, some persons are not served by public water systems and another component of water use is associated with population and economic demand. An unknown number of persons are not served by any public water system, but rather by wells, catchment and similar means; an estimated 'order of magnitude' demand for 2014 of 0.276 mgd island wide was calculated and is projected to increase at a negligible rate.[45] Other

[44] Kā`anapali 2020 Plan NOP EIS (2005).

[45] 2010 Census Block Group populations that appear to be outside public purveyor service areas – approx. 1,190; apply average MDWS per capita rate of 248 gpd based on 2010-2014 consumption and interpolated population = 296,144 gpd. Excluding domestic well pumpage of 20,495 gpd results an estimated demand of 275,649 gpd.

population based demand includes persons using domestic wells as well as landscape irrigation and industrial wells which are not included within public system supplies. Rates of increase are based on the community plan growth rates.

19.6.5 Agricultural Demand Projections

As discussed under section 11.4, non-potable agricultural irrigation demand is not coordinated to population growth and represents additional demand. Based on a hypothetical increase in acreage for the crops in the Crop Summary of one percent annually, projected agricultural water demand over the next 20 years would be 2.8 mgd, an increase of less than 0.5 mgd over current estimated demand as shown below. This method is consistent with demand projections in other aquifer sectors to represent a high growth scenario.

An alternative scenario would be further loss of agricultural lands to development. The most productive lands located in the vicinity of Lahaina, Kā`anapali and Kapalua face tremendous pressure for urbanization.[46]

A mid-growth demand scenario is represented by currently cultivated agricultural lands stay in production. According to the 2015 Crop Baseline, these lands are all located outside growth boundaries. However, current estimated agricultural irrigation based on reported surface water diversions far exceeds irrigation demand calculated by applying a water use coefficient for identified crops and acreage in the 2015 Crop Baseline. Therefore, current irrigation needs of 4 mgd (calculated based on reported diversions that appear to serve an agricultural end use) is considered to include a high growth scenario and no further adjustment is made to account for potential increase in cultivation. It is expected that the AWUDP update will address agricultural irrigation projections in greater detail.

Table 19-34 Projected Agricultural Demand, Lahaina ASEA 2035 (mgd)

Aquifer System	2015 Ag Baseline Crop Category	Acres	Water Standard (gpd)	Est. Average Water Use	20% Increase In Water Demand
Honokōhau	Taro	3.13	27500 (15-40K)	0.0860	0.1033
Honokōhau	Diversified	6.41	3400	0.0218	0.0262
Honokōhau	Pasture	630.77	0 (0-7400)	0.0000	0.0000
Honokōhau		640.31		0.1078	0.1294
Honokōwai	Coffee	534.77	2900	1.5508	1.8610
Honolua	Diversified	19.33	3400	0.0657	0.0789
Honolua	Tropical Fruits	4.15	10000 (3700-10K)	0.0415	0.0498
Honolua		23.48		0.1072	0.1287
Launiupoko	FFL	13.88	6000 (4000-6000)	0.0833	0.0999
Launiupoko	Diversified	12.04	3400	0.0409	0.0491
Launiupoko	Taro	0.38	27500 (15-40K)	0.0105	0.0126
Launiupoko	Tropical Fruits	30.04	10000 (3700-10K)	0.3004	0.3605

[46] Maui County General Plan 2030 Agricultural Resources Technical Issue Paper, September 2007

Aquifer System	2015 Ag Baseline Crop Category	Acres	Water Standard (gpd)	Est. Average Water Use	20% Increase In Water Demand
Launiupoko	Pasture	465.72	0 (0-7400)	0.0000	0.0000
Launiupoko		522.07		0.4350	0.5220
Olowalu	Diversified	21.07	3400	0.0717	0.0860
Ukumehame	FFL	7.10	6000 (4000-6000)	0.0420	0.0504
Total		**1748.81**		**2.3154**	**2.7743**

Source: 2015 Statewide Agricultural Baseline GIS, acreages calculated by MDWS. It is not specified whether taro is dryland or wetland.
FFL=Flowers, Foliage, and Landscape Water Use Rates: HDOA Guidelines; Estimated Water Use for taro: average wetland taro consumptive rate. Coffee: 2004 AWUDP Kaua`i Irrigation System- 2500 gpd; 2900 gpd reported by plantation on Oahu per Brian Kau, HDOA, personal communication, 10/12/2016.

19.6.6 Irrigation Demand Projections

Landscape irrigation associated with single family homes and most commercial uses are factored into MDWS and private purveyor's municipal water use. Large landscaped areas for resort areas and golf courses using untreated surface water and recycled water are not factored into municipal demand. Estimated water use for these end uses is 13 mgd, based on reported surface water diversions. Little information is available on end use locations and it is difficult to verify that reported "diverted" water is not double counted at multiple gages in Honolua/Honokōhau ditch. Projecting future irrigation needs using population growth rates would increase demand over the 20 year period significantly. It could be argued that irrigation is not well correlated to visitor and population growth and will remain flat or decrease with water conserving design in build out. On an island basis, visitor counts will increase by about 1.15 percent annually over the long term. The number of visitor units is projected to grow about 14 percent in West Maui over 20 years. [47] Because de facto population (actual number of residents, non-residents and visitors) moves among the community plan regions on a daily basis, the growth in visitor units is assumed to more realistically account for growth in regional large scale irrigation. Climate change and decrease in rainfall could further increase irrigation needs long term. Conservation strategies and the use of alternative water resources to address an increase in non-potable irrigation demand is discussed under Resource Strategies.

Growth Scenarios: Population Growth versus County Zoning Designations

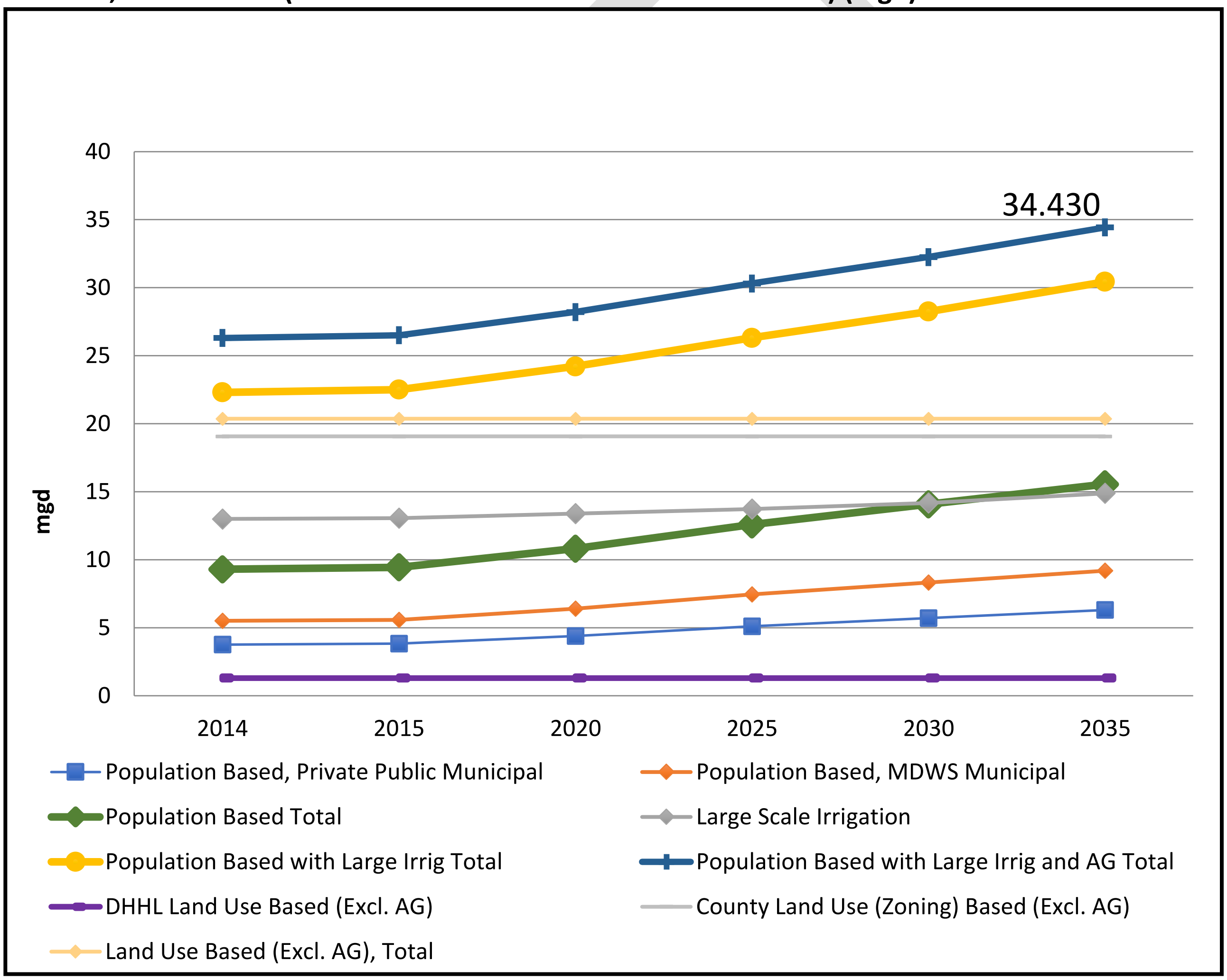
The figure below illustrates the selected projected demand scenario based on population growth, in comparison to the alternative projected demand scenario based on county zoning designations. Consistent with the Maui Island Plan, the mid-growth scenario is selected to guide short term resource needs, to be adjusted as needed within the low-to-high range projections

[47] Maui County Socio-Economic Forecast Report, 2014

over a 20-year time horizon. The selected demand scenario constitutes the following components:

1. Potable demands based on 20 year population growth for the Lahaina Community Plan district.
2. Non-potable irrigation demand (mostly surface water sources) projected based on visitor unit growth
3. Non-potable needs for Department of Hawaiian Homelands
4. Non-potable needs for kuleana and lo`i kalo
5. Flat growth of current agricultural irrigation demand (4 mgd) for diversified agriculture (mostly surface water sources)

Figure 19-29 Lahaina ASEA Projected Population Growth and Land Use Build-Out Based Water Demand, 2015 – 2035 (Excludes Land Use Based Demand with AG) (mgd)



The table below (Table 19-35) breaks down current water use (production) and projected demand by CWRM water use categories for all purveyors. It should be noted that billed consumption for MDWS system can be broken down by subcategories or billing classes. Because other public water systems in the region generally do not report billed consumption but water diverted or groundwater pumped, production instead of consumption is applied for consistency. Production is higher than consumption accounting for distribution, water losses, and unmetered use.

Table 19-35 Projected Water Use by Water Use Category based on Population Growth (Low, Mid and High) and Land Use Full Build-Out to 2035 (mgd)

	2014	2015	2016	2017	2018	2019	2020	2025	2030	2035
Population Based										
Domestic*	0.036	0.037	0.038	0.039	0.040	0.041	0.042	0.049	0.055	0.060
Industrial	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Agriculture **	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Irrigation***	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Municipal DWS System	5.478	5.574	5.729	5.888	6.052	6.220	6.393	7.442	8.315	9.191
Municipal Private PWS	3.757	3.823	3.929	4.038	4.151	4.266	4.384	5.104	5.703	6.303
Military	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Subtotal Pop. Based Mid Growth excl. large irrigation and agriculture	**9.271**	**9.433**	**9.695**	**9.965**	**10.242**	**10.527**	**10.819**	**12.595**	**14.072**	**15.554**
Irrigation, large scale	13.0	13.065	13.130	13.196	13.261	13.326	13.392	13.720	14.178	14.876
Agriculture (flat growth)	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000
TOTAL Mid Growth	**26.271**	**26.498**	**26.826**	**27.161**	**27.503**	**27.853**	**28.211**	**30.314**	**32.250**	**34.430**
TOTAL Low Growth	**26.271**	**22.684**	**22.998**	**23.311**	**23.626**	**23.939**	**24.253**	**26.243**	**28.097**	**30.209**
TOTAL High Growth	**26.271**	**28.262**	**28.620**	**28.977**	**29.335**	**29.692**	**30.050**	**32.335**	**34.434**	**36.793**
Land Use Full Build-out Based										
County (Zoning) (Excl. AG)	19.070	19.070	19.070	19.070	19.070	19.070	19.070	19.070	19.070	19.070
DHHL (Excl. AG)	1.295	1.295	1.295	1.295	1.295	1.295	1.295	1.295	1.295	1.295
Total, (Excl. AG)	**20.365**	**20.365**	**20.365**	**20.365**	**20.365**	**20.365**	**20.365**	**20.365**	**20.365**	**20.365**
TOTAL (Incl. AG) *not shown on chart*	**112.7**	**112.7**	**112.7**	**112.7**	**112.7**	**112.7**	**112.7**	**112.7**	**112.7**	**112.7**

*Estimated not served by any PWS
** No pumpage reported. Estimated end use based on reported diversions and assumed flat growth.
*** No pumpage reported. Estimated end use based on reported diversions. Projected growth based on visitor units
Source: MDWS Water Resources & Planning; CWRM reports, MDWS reports. All Other Population Based Demand includes other wells and estimated population unserved by public water systems. Large AG/IRR includes rough estimation of end use per CWRM surface water gage reports, excluding double counted flows and MDWS use which is reflected in the population based demand excluding large AG/IRR.

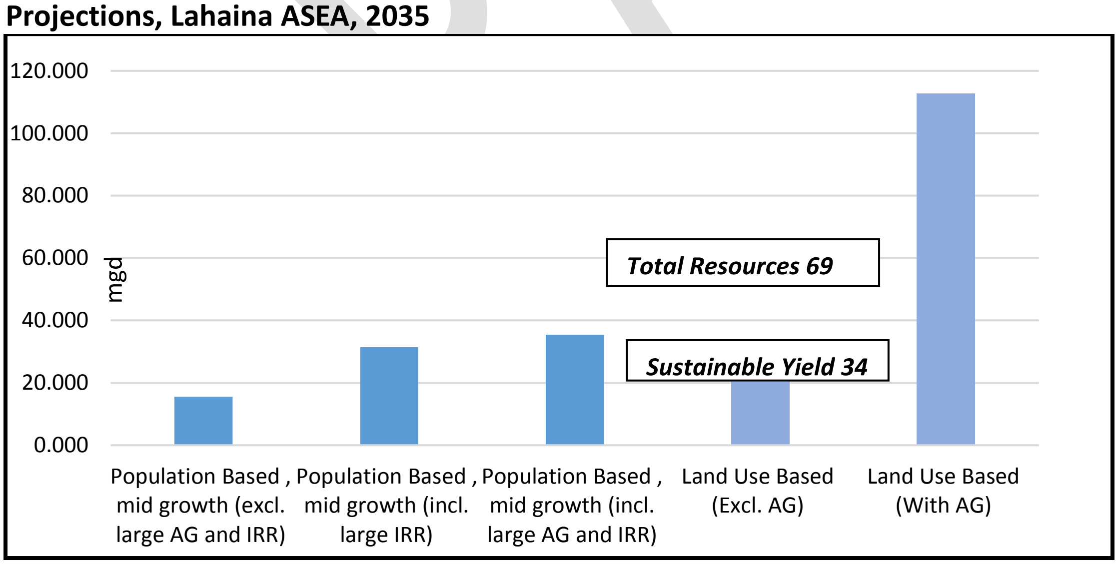
19.7 Water Source Adequacy

The analysis of available resources and projected demand confirm that there are sufficient water resources in the region to meet 20-year demand projected based on population growth under normal and drought conditions. The 2014 pumpage did not exceed 18% of regional Sustainable yield (SY). Groundwater SY, surface water at the lowest estimated Q^{70} base flow, and currently processed recycled water flow (low month) provide a combined total of approximately 69 mgd. A hypothetical reduction in SY under long term drought conditions was assessed in response to climate change and community concerns advocating an additional buffer to groundwater development. A “drought yield” of 26 mgd would also provide for 2035 population growth, not accounting for large scale irrigation and agriculture currently served by diverted surface water.

19.7.1 Source Adequacy vs. Land Use Full Build-Out Based Water Projections

Full build-out of land use classifications representing 113 mgd would exceed the ground and surface water resources of the aquifer sector area as shown below. Excluding agriculture, land use based demand is about 20 mgd. Planning for adequate source to serve full build out of zoning designations is not supported by the Socio-Economic Forecast and is therefore an unrealistic and inefficient use of resources. Planning for a demand of 92 mgd for agricultural production is likewise unsupported. County and state planning documents do not project increased agricultural production in the west Maui region.

Figure 19-30 Land Use Full Build-Out and Population Mid-Growth Based Water Demand Projections, Lahaina ASEA, 2035



19.7.2 Source Adequacy vs. Population Growth Based Water Demand Projections (20-Year)

Based on the Maui Island Plan population projections, future water demand for the west Maui region will increase from 9 mgd to about 16 mgd by 2035, within a range of 14 – 17 mgd. The base case or the mid growth scenario is selected as the most probable scenario, assuming that new housing and population growth will be focused in planned growth areas consistent with the 2014 socio-economic forecast for the region. Long term projections are trends with expected short-term variations. Factors that especially impact growth in the Lahaina region are time-share projects, large master-planned communities, and development of Hawaiian Homelands.[48] Water use is not exactly correlated to population and economic growth but is also impacted by climate change, type of housing development and associated irrigation. Affordable housing development as a key priority in the region could result in increased residential densities which mitigates irrigation demand. It is also expected that more aggressive conservation and potential reallocation of available water resources will curb water use per capita. This trend is consistent with the decrease in water use per MDWS customer over the last ten years and continued adoption of more efficient irrigation technologies for agriculture and landscape irrigation.

Even though the Lahaina region has a high number of visitor units, the rates of increase in resident population are higher than the rate of visitor growth. Assuming that current large scale irrigation demand grows at an equal rate as visitor units, regional water demand will increase to approximately 31 mgd. The growth in irrigation demand currently served by surface and recycled water is highly uncertain, but is included in the selected water demand scenario. Finally, with no anticipated increase in agricultural irrigation, estimated to about 4 mgd, total 2035 demand will be about 34.5 mgd.

[48] 2013 Socio-Economic Forecast

19.8 Strategies to Meet Planning Objectives

The WUDP update public process generated a set of planning objectives through an iterative process. Multiple resource options to meet planning objectives and projected demand were reviewed and evaluated in regional public meetings and workshops to assess constraints, relative costs, implementation risk and viability[49]. Planning objectives, preliminary strategies and related material reviewed in the final public workshop, November 28, 2016 is attached as Appendix 12. The selected strategies are presented below along with available cost estimates, hydrological, practical and legal constraints, opportunities and risks that were considered in assessing the viability of a specific resource or strategy. Life cycle costs are estimated for conventional and alternative resource strategies where engineering studies and reports were available, including capital, operation and maintenance costs per 1,000 gallons supply.

Key issues identified in the WUDP public process for the region focused on restoration and protection of streamflow to support Native Hawaiian rights and traditional and customary practices; watershed protection; long term effects of water use on resource availability and enhanced transparency and controls on water withdrawals. The community voiced support for precautionary planning to reduce and adapt to the effects of drought and climate change on water resource availability and quality, and adapting economic and population growth and the built environment to local water resource conditions, integrating conservation and the use of alternative resources. Recommended alternatives include resource management as well as development of conventional and alternative resources. All strategies are assumed to include conservation consistent with recommended supply and demand side conservation strategies outlined in Section 12.2. Implementation schedule, estimated costs and potential lead agencies, including funding sources, are summarized in Table 19-40.

19.8.1 Resource Management

Planning objectives related to resource management identified and confirmed in the WUDP update public process include:

- Maintain sustainable resources
- Protect water resources
- Protect and restore streams
- Minimize adverse environmental impacts

[49] Preliminary Strategies for Lahaina Aquifer Sector November 28. 2016

Qualitative criteria to evaluate and measure resource strategies against these planning objectives include:

- Groundwater sustainable yield levels are maintained over time
- Stream flows restored to level supporting stream ecosystems
- Watershed protected from invasive animals and plants
- Interim in-stream flow standards adopted for watersheds
- Scientific studies for aquifer systems complete
- Water resources and water system use consider aquifer recharge and stream flows under drought conditions
- Chloride levels in wells remain stable

Planning objectives and policies related to water resource management adopted in the 1996 West Maui Community Plan are:

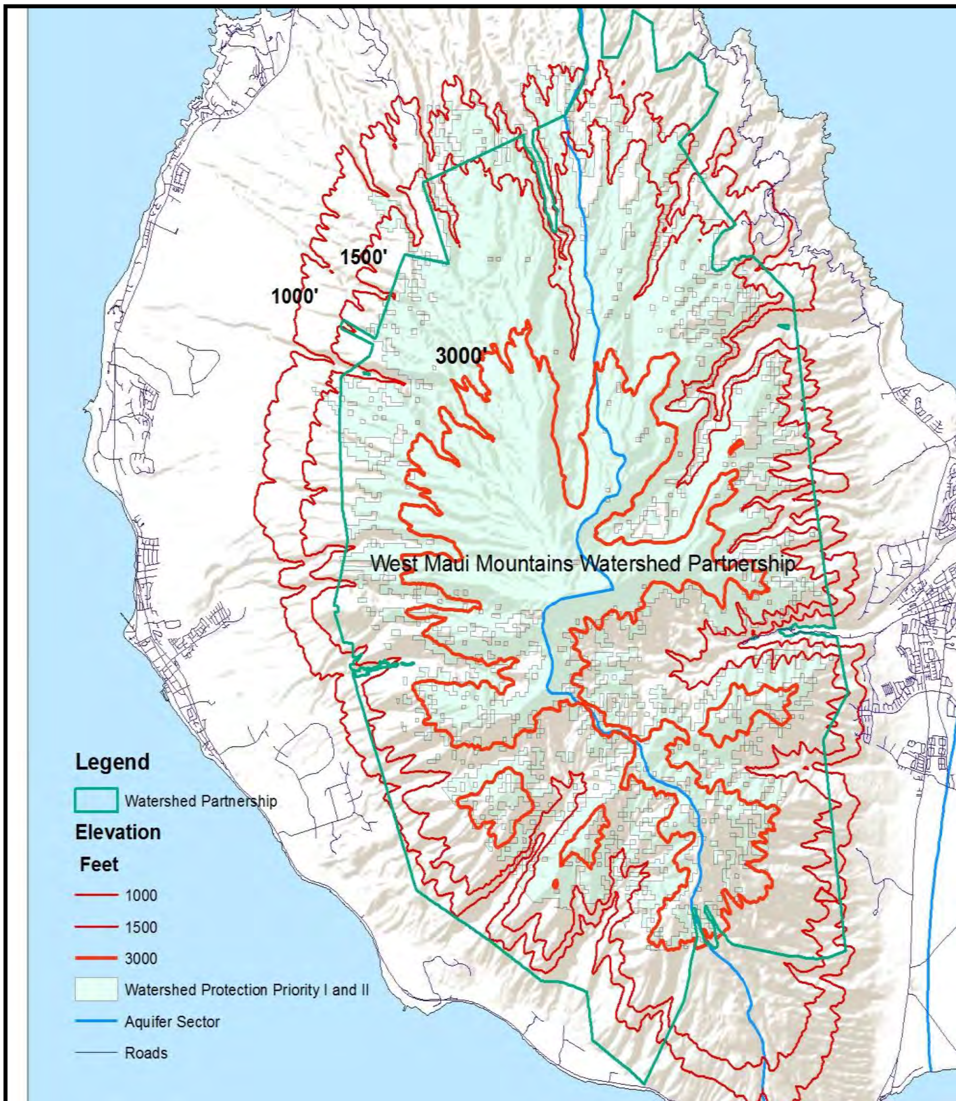
- Protect ground water resources.
- Protect and enhance native forest and vegetation. Establish and maintain programs which control invasive alien plant and animal species.
- Protect cultural sites: plantation ditch systems, fishponds, significant native vegetation zones, stream valley areas, lo`i and `auwai.
- Establish a watershed protection overlay plan for West Maui to protect quantity and quality of drinking water supplies, quality of coastal waters and marine resources, and the long term economic viability of the community.
- Improve the quality of domestic water.

<u>**Watershed Protection**</u>

Issue and Background: West Maui serves as a role model in many aspects of resource protection. The West Maui Mountains Watershed Partnership, the Nature Conservancy at Kapunakea, and the Pu`u Kukui Watershed Preserve focus their efforts on protection of the upper critical watersheds. The Ridge to Reef initiative seeks to restore and enhance the health and resiliency of the region's coral reefs and near-shore waters, guided by traditional ahupua`a management techniques. Watershed management plans are in place for watersheds from Honolua to Wahikuli. Grassroots efforts to manage and restore stream flow and lo`i in Kahoma Valley is an example of ahupua`a management. The West Maui Watershed Owners' Manual, completed in 1997 by the West Maui Advisory Committee, provides further guidance to landowners large and small.

The Department of Land and Natural Resources has identified "Priority Watershed Areas" which are areas of highest rainfall and resupply, based on climatic conditions that provide high recharge and fog capture. West Maui priority areas are shown in the figure below. Currently protective measures are focused above the 3,000 foot elevation with direct benefit to makai lands and the nearshore environment. Over 47,321 acres of the West Maui Mountains is being protected and preserved. The major threats to this watershed are feral ungulates, invasive weeds, human disturbances and wildfires. Ongoing efforts include ungulate control through fence construction, retrofitting and regular trap checks weed management, planting and enclosures, monitoring, and human activities management through outreach and education.

Figure 19-31 Watershed Partnerships, Priority Areas and Elevations, Lahaina ASEA



Strategy #1: Continue Maui County financial support for watershed management partnerships' fencing and weed eradication efforts. Funding and supporting watershed protection provides a strategy for effectively protecting and restoring the resilience of natural aquatic ecosystems and thereby protecting ground and surface water resources and a range of ecosystem services. The watershed management approach fosters partnerships that involve the people most affected by allowing them to participate in key management decisions. This ensures that environmental objectives are well integrated with cultural, social and economic goals.

Annual costs for priority tasks to control invasive weeds and ungulates in the actively managed watershed areas of West Maui ranged from $1.1M to $1.7M over fiscal years 2014 to 2016 based on county, state and leveraged funding for West Maui Mountains Watershed Partnership and the Pu`u Kukui Watershed Preserve. Management efforts are directly linked to available subsidies where a gap in consistent funding levels jeopardizes decades of progress in keeping major threats at bay.

Ahupua`a Management

Issue and Background: Traditional and customary Native Hawaiian rights are exercised in the streams in the form of subsistence gathering of native fish, mollusks, and crustaceans, and stream flows are diverted for the cultivation of wetland taro, other agricultural uses, and domestic uses that can be traced back to the Māhele. The maintenance of fish and wildlife habitats to enable gathering of stream animals and increased flows to enable the exercise of appurtenant rights constitute the instream exercise of "traditional and customary" Hawaiian rights.[50] Active restoration of traditional *lo'i kalo* (taro patch) is undertaken in Honokōhau Valley (The Honokōhau Valley Association) and Kahoma Valley. There is strong interest for re-establishing stream flow and *lo'i kalo* along Kanahā stream. Lessons to learn from the past include allocating water for all needs and implementing ahupua'a management strategies in order to provide more vibrant natural ecosystems and abundant Native Hawaiian resources from mauka to makai. Consortiums of water partners have been discussed as options to management and use of the diverted waters that could include watershed management partners, west Maui landowners and private water systems, kuleana water users and Native Hawaiian stakeholders.

Ahupua`a management complements existing watershed protection efforts to include the low elevation lands, coastal zone, near shore waters and coral reefs. The "Ridge to Reef" Initiative. encompasses 24,000 acres from Kā`anapali northward to Honolua and from the summit of Pu`u Kukui to the outer reef seeks to restore and enhance the health and resiliency of West Maui coral reefs and near-shore waters through the reduction of land-based pollution threats, guided by the values and traditions of West Maui. In July 2008 the U.S. Army Corps of Engineers (USACE) expressed interest in developing a West Maui Watershed Plan with the assistance of the DLNR, DOH and various other federal agencies. The Hawai`i Coral Reef Strategy, with DLNR Division of Aquatic Resources as lead agency, identified the coral reef ecosystem along the West Maui region as a priority management area. In April 2015, West Maui was designated as a Resilient Land and Waters Initiative site by the Department of the Interior, the Environmental Protection Agency and the National Oceanic and Atmospheric Administration. The Watershed Management Plan for Wahikuli and Honokōwai was completed in 2012 and the plan for Kahana, Honokahua and Honolua Watersheds is under development. [51]

Strategy #2: Support local initiatives that seek mauka to makai land management guided by traditional ahupua`a management techniques. Educate and raise public awareness of ahupua`a

[50] CWRM East Maui Streams Hearing Officer's Recommended FOF, COL, and D&O, January 15, 2016. Contested Case No. CCH-MA 13-01 http://files.hawaii.gov/dlnr/cwrm/cch/cchma1301/CCHMA1301-20160115-HO-D&O.pdf
[51] http://www.westmauir2r.com/

management to foster partnerships or consortiums for use and management of stream waters that merge traditional and contemporary needs.

Water Quality

Issue and Background: Community concerns regarding groundwater and domestic water quality relate to continued detections of contaminants from historic agricultural activities in West Maui groundwater sources. Blending and granular activated carbon treatment ensure that potable water supply meets all safe drinking water standards. Proactive strategies are needed to protect existing potable wells from potential sources of contamination and by developing new wells in areas that do not unnecessarily put public health at risk. Wellhead protection and future well siting are addressed under island-wide strategies #6 "Implementing well siting criteria to avoid contaminated groundwater supplies and unnecessary risks to public health" and #7 "Adopt wellhead protection measures for potable wells."

19.8.2 Conservation

The WUDP public process identified the planning objective "Maximize efficiency of water use".

Qualitative criteria to evaluate and measure resource strategies against this planning objective include:

- Per capita water use decreased
- Potable and irrigation systems water loss decreased
- Community water education increased
- Incentives for water conservation increased
- Renewable energy use increased

Planning objectives and policies related to water conservation adopted in the 1996 West Maui Community Plan are:

- Promote water conservation
- Promote conservation of potable water via use of reclaimed water for irrigation
- Incorporate drought-tolerant plant species into future landscape planting

Issue and Background: The Lahaina region shows the same downward trend in water use per service as other MDWS systems. However, little data is available to identify water efficiencies and water use trends for other public water systems in the region, and especially for non-potable irrigation uses of surface water. Based on estimated irrigation end uses and water intensive landscaping in hotel/resort and common areas of a relatively dry region, there is great potential for further savings in the use of conventional water resources.

The recommended supply and demand side conservation strategies outlined in Section 12.2 apply island wide. A conservation target to reduce residential water use by 8 percent per capita by 2035 would result in 760,000 gpd in potable water savings for the region. The cost-effectiveness of conservation strategies is an important consideration in developing and sustaining a conservation program. As discussed under Section 12.2, cost-effectiveness compares the costs of a portfolio of programs to promote water savings with the costs the utility and its customers would otherwise incur. In evaluating cost-effectiveness, MDWS compared the costs to develop and deliver new sources of water to meet future demand with the savings attributed to conservation. Cost savings vary with the portfolio of conservation programs selected, market penetration, timeframe and other assumptions, and could be demonstrated for both basic and aggressive programs assisted by the economies of scale MDWS enjoys as the largest purveyor. A preliminary analysis of the proposed conservation measure portfolio outlined in Section 12.2 shows that doubling current investments (MDWS annual FY14 – FY17 conservation budget, excluding leak detection is $170,000) would result in net capital and operational savings. The potential for a net savings is also expected for the West Maui/Lahaina MDWS system due to the need for new source development.

Recommended demand side conservation measures at all levels and type of use for public water systems and non-agricultural irrigation systems outlined in table 13-1 (strategies # 10 – 25) apply to the Lahaina ASEA. Measures that target non-potable uses to reduce reliance on surface water should be prioritized, including the following strategies:

- Revise county code to require high efficiency fixtures in all new construction. Develop a comprehensive water conservation ordinance to include xeriscaping regulations.
- Landscaping and irrigation system incentives, targeting dry areas.
- Revise County Code and/or incentivize water- efficient building design that integrates alternative sources (grey water, catchment).

The sustainable and efficient use of water resources, as well as the capacity and integrity of water systems, can be improved by accounting for water as it moves through the system and taking actions to ensure that water loss is prevented and reduced to the extent feasible.

A water audit provides a data driven analysis of water flowing through a water system from source to customer point-of-service and is the critical first step in determining water supply efficiency and responsible actions to manage and reduce water loss consistent with available source, operational and financial resources.[52] AWWA's *Free Water Audit* software and manual M36 required by Act 169 provides a system to calculate water loss throughout water systems. Comprehensive audits for all MDWS systems are performed annually. Public water systems serving a population of 1,000 or more and those within water management areas regardless of population served are required to submit annual water audits beginning July 1, 2020.[53] This includes the Kapalua Water Company and the Kā`anapali Water System. Regardless of size, water systems should evaluate the system production data against metered or billed end uses

[52] USEPA. Using Water Audits to Understand Water Loss. A Joint Presentation of the USEPA Office of Groundwater and Drinking Water and the American Water Works Association, 1/26/2012. https://www3.epa.gov/.../waterinfrastructure/docs/water-audits_presentation_01-2012.pdf *Accessed March 29, 201*

[53] State of Hawai`i, ACT 169, SB2645 SD2 HD1 CD1, 6/30/2016

to identify potential water losses. The average water loss for public water systems in the United States is 16 percent, with up to 75 percent of that loss able to be recovered.[54] Part II Strategy # 26, applicable island wide, calls for annual comprehensive water audits by all public water systems. However, purveyor staff time can be burdensome for small utilities.

Based on the results of a comprehensive water audit, water purveyors can better identify appropriate rehabilitation, maintenance and preventive measures, including leak detection and repair programs. Part II Strategy # 27 addresses funding and implementation of leak detection programs for MDWS and large public water systems on an island wide basis. Part II Strategy # 28 addresses water system maintenance and operations to minimize sources of water loss.

Agricultural Water Systems Water Loss Mitigation

Issue and Background: The West Maui plantation ditch systems are focal points for the objectives that seek to provide sufficient water to support agriculture and to increase water conservation. Reliable and affordable water is needed to sustain and possibly increase agriculture in the West Maui region. Based on reported groundwater pumpage and surface water diversions, it appears that essentially all agricultural irrigation in West Maui is supplied by surface water conveyed by the Maui Land & Pineapple (MLP) and former Pioneer Mill ditch systems extending from Honokōhau Intake to Wahikuli Reservoir, and the Lahainaluna Ditch stretching 4.4 miles from Wahikuli Reservoir to Launiupoko. Water losses and inefficiencies of the plantation ditch systems and reservoirs are unknown but can be assumed to be on a similar scale as the East Maui Irrigation System (22 percent of gross diverted supply). Actual end uses for Lahainaluna Ditch diverting Honolua-Honokōhau ditch, Kanahā, Kaua`ula, Launiupoko, Olowalu and Ukumehame Streams are not qualified but they potentially serve recreational and other non-agricultural irrigation needs throughout development of Makila lands (Makila Plantation, Makila Ridge, Makila Nui, Makila Rural, Kahoma Residential) and Kahoma Ranch. West Maui Land is actively restoring and augmenting the preexisting plantation infrastructure systems.[55] Community support was expressed for maintaining the ditch and reservoirs systems, for the purpose of agricultural needs. To address the fragmented function and use, ownership and management of the Maui Land & Pine and West Maui Land ditch systems, it is recommended that the State Department of Agriculture assesses the systems in collaboration with the ditch operators.

Strategy #3: A comprehensive study should be undertaken in the update of the Agricultural Water Use and Development Plan of the Maui Land & Pineapple and the former Pioneer Mill ditch systems, including the Lahainaluna Ditch in order to resolve operational and maintenance needs of the entire system for the benefit of agricultural use in the Lahaina region. This strategy is consistent with the Hawai`i Water Plan requirements to inventory and identify rehabilitation needs for private irrigation water systems in the AWUDP (HRS 174C-31[e]). The 2004 AWUDP assessed capital costs for rehabilitating the MLP/PMIS to about $9 million (2004 dollars). The

[54] US EPA, Water Audits and Water Loss Control for Public Water Systems https://www.epa.gov/sites/production/files/2015-04/documents/epa816f13002.pdf Accessed March 24, 2017.
[55] http://www.westmauiland.com/index/land-development/

State Department of Land & Natural Resources is a major land owner and could assist purveyors along with the State Department of Agriculture in coordinating the ditch system as a whole.

19.8.3 Conventional Water Source Strategies

Conventional water sources include groundwater (wells and tunnels) and surface water (stream diversions).

Planning objectives related to groundwater and surface water source use and development identified in the WUDP update public process include:

- Manage water equitably
- Provide for Department of Hawaiian Homelands needs
- Provide for agricultural needs
- Protect cultural resources
- Provide adequate volume of water supply
- Maximize reliability of water service
- Minimize cost of water supply

Qualitative criteria to evaluate and measure resource strategies against this planning objective include:

- Public water system water shortages to serve existing customers avoided
- Public water supply drought shortages avoided
- MDWS prioritize DHHL needs over lower priority needs
- Potable water use for non-potable needs decreased
- Contingencies in place to support water supply system functions during emergency conditions
- Water is available to serve Maui Island Plan development
- Strategies to meet all needs incorporated into WUDP

Planning objectives and policies related to water availability and use identified in the West Maui Community Plan are:

- Support sufficient water to support agriculture and Native Hawaiian water rights and traditional practices. Recognize Native Hawaiian water rights and traditional access.
- Encourage maintenance and development of water sources for agricultural uses that do not conflict with domestic demand for potable water.
- Coordinate water system development to support development within urban growth boundaries.
- Reduce potable water consumption outside urban areas.

- Improve and expand the West Maui water development program projected by the County to meet future residential expansion needs and establish water treatment facilities where necessary.
- Study the feasibility of integrating all regional water systems into a public water system to be managed and operated by the County.
- Encourage reasonable rates for water and public utility services.

Potable Groundwater Development

The following objectives derived from the Maui Island Plan should guide groundwater development in the region:

- Provide adequate volume of water to timely serve planned growth in MIP
- Increase capacity of water systems in striving to meet the needs and balance the island's water needs
- More comprehensive approach to water resource planning to effectively protect, recharge and manage water resources
- Ensure stable chloride levels in developed wells

The 4-year study, *Groundwater Availability in the Lahaina District, West Maui, Hawai`i, 2012,* estimated the effects of several hypothetical withdrawal scenarios on long-term sustainability of withdrawals from existing and proposed wells in the Lahaina ASEA, noting that the model is indicative of salinity at the regional scale. The salinity of water withdrawn from wells generally increases with depth, proximity to the coast, and withdrawal rate. Based on the model, projected withdrawals focused in the Honolua and Honokōwai aquifers would result in many wells pumping water in excess of one percent salinity, and in some cases in excess of drinking-water standards. Redistributing withdrawals among several aquifer systems especially to the Launiupoko aquifer system and optimization of wells operations, showed the best outcome with all wells in the acceptable range; the study indicated the Launiupoko aquifer system may be suitable for development of as much as 10 mgd of freshwater. Eliminating wastewater injection recharge—which creates a barrier to inflow of saltwater—resulted in increased salinity in the cautionary and threatened range. Drought also results in increased salinity in the cautionary and threatened range, but the effects would be temporary if rainfall returns to normal. Restoring streamflow along loosing reaches increases recharge and moderates salinity increases near streams, but to a lesser degree than redistribution of withdrawals.

Well development in Honolua and Honokōwai aquifer of an additional 3 – 4 mgd can be supported based on the 2012 USGS study and will remain well within sustainable yield limits. The 20-year life cycle cost is assessed to about $3.50 per 1,000 gallons. Costs have not been assessed for well development in the Launiupoko aquifer. It is anticipated that 4 – 5 mgd can be developed with sufficient buffer to sustainable yield and maintaining more than adequate chloride levels.

Groundwater Development to Meet Population Growth

Issue and Background: Regional groundwater can feasibly provide for a population growth based need of 16 mgd in 2035, within a low to high growth range of 14 – 17 mgd. Basal groundwater is recommended for municipal and potable needs, excluding large scale irrigation and agriculture. Source development must account for peak use and water losses. Comparing MDWS base production for 2014 and high production months over 10 years, 21 percent is added to average projected production to ensure adequate source capacity, representing an additional 3 mgd. [56]Total demand needed is therefore 19 mgd (16 + 3 mgd).

Current service distribution between MDWS and the five large privately owned water purveyors in the region is divided roughly 60/40. Based on this ratio, 11.4 mgd would represent MDWS system capacity. Current MDWS source capacity is about 7 mgd (including surface water treatment facilities), requiring an additional 4.4 mgd to be developed. The methodology and projection is consistent with the 2013 *Maui Island Water Source Development Options for the Lahaina-Nāpili Area*. Groundwater development of 4 mgd represents 4 – 5 wells, distributed throughout Honolua, Honokōwai and Launiupoko aquifer systems. Infrastructure development schedule and locations are defined in the MDWS capital improvement program. As of August 2017, one well is under development in Honokōwai aquifer. The MDWS optimization study projected cost to develop new source to be about $40 M.

Assuming the service distribution of 60/40 between MDWS and private purveyors, about 7.6 mgd of 2035 peak demand would be provided by other purveyors than MDWS. Based on current pumpage of about 3.76 mgd, an additional 3.8 mgd of source capacity is needed throughout the region. No data of peak use were available for private municipal purveyors. However, installed pump capacity for private municipal wells is about 2.3 mgd in Honolua aquifer, over 7 mgd in Honokōwai aquifer and 1.54 mgd in Launiupoko aquifer. When accounting for needed backup source for active pumped wells, additional unutilized pump capacity is likely available.

As shown in the table below, regional groundwater can supply the most probable mid-growth demand scenario of 16 mgd, and considering peak source needs for a total of 19 mgd by 2035. Groundwater development to meet 2035 population growth throughout the region can also be supported under hypothetical drought yield conditions. Population growth based development in Honokōwai will need increased transport from the adjacent Honolua and Launiupoko aquifer systems to mitigate withdrawals of the Honokōwai aquifer system. The table below shows existing source capacity in each aquifer system, additional source needs that could feasibly be developed well within sustainable yield. Yield remaining is calculated by subtracting the sum of the existing source capacity and source need from the aquifer system sustainable yield.

[56] Maui County Department of Water Supply, Maui Island Water Source Development Options for the Lahaina-Napili Area, March 6, 2013

Table 19-36 Groundwater Source Development to Meet Population Growth-Based Demand in Lahaina ASEA 2035 (mgd)

Aquifer System	Existing Source Capacity	2035 Projected Demand	Sustainable Yield	Potential Drought Yield Conditions	Source Need*	Yield Remaining
Honokōhau	0	0.000	9	*7.02*	0	9
Honolua	3.4	2.74	8	*6.08*	2.0	2.6
Honokōwai	3.00	8.47	6	*4.8*	1.8	1.2
Launiupoko	0.65	4.37	7	*5.53*	4.5	1.85
Olowalu	0.07	0.11	2	*1.44*	0.3	1.63
Ukumehame	0.01	0.01	2	*1.22*	0.1	1.89
Surface WTF	3.8					
Total	10.93	**15.72**	34	*26.09*	8.7	18.17

*Projected demand, additional 21 % to account for peak demand (19.63 mgd), less developed source capacity for region
Source: MDWS Water Resources & Planning Division, 2017

Strategy #4: Develop basal groundwater wells to provide adequate water supply for planned population growth projected to 16 mgd, accounting for peak source needs up to 19 mgd by 2035. This strategy is consistent with island wide policy recommendation (Strategy # 37) to develop groundwater to provide sufficient supply for growth, maintaining a buffer to sustainable yield in order to conservatively account for potential future drought impact and prospective adjustments in aquifers lacking hydrologic studies.

Proposed development projects and existing infrastructure illustrated in Figure 19-21 above can indicate which water purveyor is most appropriate or likely to service a specific development project. However, multiple factors determine the realization and sequence of development that makes predictions uncertain. It is assumed that the Kā`anapali System will service most of proposed development projects and MIP planned growth areas within Kā`anapali and that the Kapalua System will serve development project north of the MDWS Nāpili service area. Development of Kapalua Mauka is conditioned upon Maui Land & Pineapple Co. providing adequate source and infrastructure.[57] The Launiupoko Water Company LLC and Launiupoko Irrigation Company LLC are anticipated to provide for rural development south of the MDWS Lahaina service area. Ukumehame and Olowalu systems are anticipated to provide for planned growth overlying the corresponding aquifer systems. There are a number of unutilized basal wells and high level tunnels in Launiupoko and Honokōwai aquifers. These unused wells are owned by private entities and indicate acceptable chloride levels in CWRM's well index database. Potential yield and quality of these sources are unknown and could be further explored in lieu of new well development.

Groundwater Pumping Distribution

Issue and Background: The effects of groundwater withdrawals on water quality is a consideration in assessing well development and water system efficiencies, as well as impacts

[57]Annual Report – LUC Docket No. A03-741, June 29, 2017

on water resources. An increase in groundwater withdrawals should address pumpage optimization to ensure sustainable pumping levels without detrimental impacts to the aquifers. Chloride concentrations in some pumped wells appear to increase directly in response to increased pumping. Chloride concentration of some MDWS wells in the region has exceeded the drinking water standards of 250 mg/l (1.3 percent salinity). Key to sustainable withdrawals is adequate spacing of new wells and distribution of pumpage throughout the region. Planned growth overlaying the Honokōwai aquifer, including planned development by Department of Hawaiian Homelands may require distribution from the adjacent aquifers to mitigate over development of the Honokōwai aquifer, currently pumped at about 50 percent of sustainable yield. Optimal pumpage distribution depends on collaboration between MDWS, DHHL and private purveyors.

Strategy #5: Ensure "smart source development" by MDWS and privately owned purveyors in the region that is guided by available data and modeling results to optimize pumpage, mitigate salt water intrusion and preserve regional resources. Collaboration and coordination between MDWS, privately owned purveyors and the Department of Hawaiian Homelands is needed to ensure new well development is adequately distributed to Launiupoko and Honolua aquifers and infrastructure provided for planned growth in accordance with the MIP and the DHHL land use plans. Distributing pumpage among several smaller wells rather than concentrating pumpage at a few large wells can increase capital and operation costs due to increased transmission, further distance to existing infrastructure, land ownership and number of pumps. Engineering studies are needed to evaluate future source development sites and costs.

__**Non-Potable Groundwater Development**__

Issue and Background: Brackish groundwater occurs regionally at lower elevations. Where chloride levels are above 250 mg/l, the water quality is generally considered brackish and not suitable for potable purposes. Known chloride levels for irrigation wells along the coast range from 100 to over 800 mg/l. Reported pumpage for irrigation purposes is .271 mgd for 2014/2015. Pumpage is reported from less than 25% of installed irrigation wells in the Lahaina ASEA. Additional pumpage is assumed to occur in irrigation wells developed over the last decades. Improved reporting would provide better data on chloride levels and pumpage distribution throughout the region. Small scale irrigation wells and increased use of brackish water for irrigation can conserve potable ground and surface water for domestic and municipal needs.

Although basal potable groundwater could theoretically meet most of the irrigation demand, such allocation would not support the objective of using the highest quality water for the highest end use. Projected 2035 irrigation demand of 14.8 mgd may be inflated and is anticipated to be offset by aggressive conservation and alternative sources, based on strong public support for strategies that target landscape and resort irrigation to mitigate non-potable demand. Preliminary strategies vetted in the public process to address irrigation demand were:

1. Implement planned R-1 system from Māhinahina wastewater treatment facility. Available supply; 1.16 mgd. Cost estimated at $22 per 1000 gallons

2. Explore desalination of brackish water for large irrigation needs.
   Available brackish supply: 5 mgd. Seawater: unlimited. 20 year life cycle cost per 1000 gallons assessed to $5.20 for brackish water and $12.70 for seawater
3. Maintain plantation ditch systems for affordable non-potable water conveyance. Current irrigation use estimated to 13 mgd. Water losses due to leaks and seepage, repair needs and associated costs are not assessed.

Strategies for brackish well development can be further evaluated once data on brackish water use and reporting is improved and could be considered to offset irrigation demand currently served by surface water diversions. Rising sea level due to climate change over time can increase chloride levels in coastal wells. New brackish well development should consider shoreline changes and sea level rise, projected to +3.2 ft. by 2050.[58]

Recycled water distribution expansion and desalination options are analyzed below under Alternative Resource Strategies Section 19.8.4. Improved efficiencies of ditch conveyance of surface water is addressed under Strategy# 3 in this chapter.

Surface Water Use and Development

Objectives related to surface water use in the adopted West Maui Community Plan are potentially conflicting. “Support sufficient water to support agriculture and Native Hawaiian water rights and traditional access” requires consideration of public trust uses and allocating the appropriate resource to appropriate end uses. For example, agricultural activities require abundant and affordable water supply. Gravity fed surface water was developed by the plantations for this reason. Surface water diversions have left less streamflow in the streams to support taro cultivation, native fauna and coastal discharge which Native Hawaiian traditional and customary uses depend upon.

Establishing Instream Flow Standards

Issue and Background: Supporting Native Hawaiian water rights and access must be addressed both in establishment of numerical instream flow standards (IFS) and also in Ka Pa’akai analysis where new resource uses are considered, as discussed under section 10.2. In setting numerical IFS for West Maui streams, Native Hawaiian and traditional and customary uses along with in-stream and domestic uses must be balanced with off-stream reasonable and beneficial uses.

Gages are needed to establish flow conditions and to monitor changes in stream flow over long periods of time. Gaging flow under natural and diverted conditions are important to establish baseline and impact from diversions. Data collected and monitored by the U.S. Geological Survey also becomes publicly available. Of contention is the Kanahā stream intake supplying MWDS and Lahainaluna schools, which is indicated to adversely affect taro patches and domestic kuleana uses.[59] Prioritizing the establishment of IFS for Kanahā Stream and other

[58] EcoAdapt, Climate Changes and Trends for Maui, Lanai and Kaho`olawe, 2016
[59] Maui County Council, Water Resources Committee, Testimony in regard to Agenda Item WR-27, March 8, 2017.

diverted streams with kuleana parcels would assist in resolving conflicts and facilitating future water management and use consistent with the public trust doctrine.

Strategy #6: Install a gage at Kanahā stream above existing intakes for the U.S. Geological Survey to collect stream flow data in order to initiate assessment of Instream Flow Standards. Prioritize IFS for diverted streams. The cost of gage installation is estimated at $25,000 - $35,000 in addition to annual monitoring costs. Joint funding agreements can be explored by all public water systems, CWRM and USGS.

Providing for Agricultural Needs

Issue and Background: Agriculture is not a protected public trust use. In developing IFS, further scrutiny of agricultural irrigation needs and alternative sources will be required for continued agricultural irrigation supply in the region. The MLP/PMIS had an historical estimated surface water diversion of 50 mgd according to the Hawai`i Stream Assessment, Report R84. The 2004 AWUDP cites the then-current conditions as a maximum diversion of 42 mgd, average flow of 20 mgd and storage of 48 mgd. Current actual diversions from individual streams for agricultural irrigation needs to be better defined to assess potentially competing in-stream and off-stream needs. Consumptive water use by kuleana parcels was characterized in Table 19-10 as about .132 mgd, while streamflow required for healthy wetland lo'i was roughly estimated to about 0.995 mgd within Honokōhau and Launiupoko aquifer systems. Declarations of water use were conservatively interpreted as about .447 mgd of potential future use. During low-flow conditions (Q^{90}), individual streams such as Olowalu, Launiupoko and Kahoma dip to dry or nearly dry, while Honokōhau stream, as the primary source for the Honokōhau/Honolua ditch, remains above 8 mgd. According to the AWUDP, flows are often insufficient during low-flow periods for users on the end of the system. Key to continued diversions for agricultural irrigation is alternative supply in dry season and improved efficiencies of conveyance and irrigation systems.

Inefficiencies in surface water conveyance are inherent to century old plantation ditch systems. Heavy silted reservoirs and unlined leaking ditches do not maximize use of the diverted surface water, regardless of end use. Leak proofing deteriorated ditches is cost prohibitive while weak system components can be targeted systematically. Condition assessments and planned maintenance of ditches and reservoirs by established procedures will improve reliability and efficiency for continued surface water uses. Large reservoirs, such as the MDWS Māhinahina reservoir, are subject to Dam Safety regulations that requires Operation and Maintenance Manuals, maintenance schedules and inspections. Ditches are not subject to the same scrutiny. The AWUDP update addresses agricultural irrigation system improvement needs and repairs. Strategy # 3 in this chapter addresses condition assessment and pro-active maintenance procedures to improve reliability and efficiencies of Honolua/Honokōhau ditch and currently utilized surface water conveyance systems.

Surface Water Treatment Expansion and Seasonal Use

Issue and Background: Establishing IFS may take years or even decades, judging by the timeframes for Nā Wai `Ehā and the East Maui streams. In the meantime, we can learn from the historical dividing and sharing of water, there are various systems that can be applied to ensure all needs are met. The in-stream needs, including kuleana, traditional and customary and ecosystem needs, are most vulnerable in dry season. As additional groundwater supplies are developed to meet off-stream needs, a seasonal approach can be adopted that mitigate surface water diversions during dry season, but take advantage of affordable surface water for treatment when it's plentiful during the wet winter months. In evaluation of preliminary strategies for the Lahaina sector, the following supply options were assessed:

1. Maximize surface water use in wet season, provided IFS are met (taking into account kuleana, appurtenant, traditional, customary and ecosystem needs)
2. Retrofit and expand Māhinahina Water Treatment Facility and obtain Maui Land &Pine reservoirs

Retrofitting and expanding the Māhinahina Water Treatment Facility (WTF) was evaluated as a preliminary strategy. The primary sources for Māhinahina WTF are Honokōhau, Honolua and Kahana streams by conveyance through the Honokōhau ditch. Māhinahina utilizes pre-sedimentation to treat raw surface water, followed by direct filtration and chlorination. The current average daily production is 2.1 mgd. Capacity expansion to 4.5 mgd would require 1) construction of new sludge drying beds; 2) acquisition of two existing open water reservoirs for raw water storage; 3) construction of new clarifier facility; 4) construction of two new filters and building expansion. Assuming no cost to MDWS for transfer of Waste Water Reservoir to MDWS, expansion cost was assessed at $12.9M.[60]

The two open reservoirs are owned by Maui Land & Pine and are in poor shape. The larger reservoir # 140 is rock-lined and severally compromised and may be difficult to line considering the rock surface. In addition to land acquisition and permitting, repairs to siphons and other conveyance structures would likely be necessary. Future water availability is highly uncertain, considering projected reduced rainfall and stream flow due to climate change over time. Until reliable data on ditch uses and in-stream needs are available, expansion of the WTF is not recommended. MDWS has improved water storage efficiencies at the plant. Installation of raw water reservoir cover to avoid algae growth and reduce evaporation resulted in about 0.5 mgd increase in daily water output capacity, from 1.5 mgd to the capacity of 2.1 mgd—which amounts to a 40 percent daily increase in water treatment efficiency.

Surface water is less expensive than groundwater development. Production cost for the Lahaina and Māhinahina WTFs are $1.90 and $2.15 per 1,000 gallons respectively. Increased use in wet season supports aquifer recharge. In dry season or extended droughts, the ecosystem and in-stream uses are most vulnerable as stream flow drops and water temperatures increase. As groundwater and alternative sources are developed in the region to offset surface water use, a seasonal approach is recommended. This strategy does not propose new surface water

[60] Department of Water Supply, County of Maui, Maui Island Water Source Development Options for the Lahaina-Nāpili Area, 2013

diversions or expansion of treatment plant capacity, but rather a flexible resource use to balance in-stream and off-stream needs absent instream flow standards. CWRM guidance is needed to establish targets. Allocation of new surface water diversions is not recommended as a viable option.

Strategy #7: Implement seasonal use of surface water to take advantage of affordable supply in wet season and shift non-instream needs to groundwater and alternative supply when available in dry season to promote stream restoration. Maximize surface water production up to current treatment plant capacity at the Lahaina WTF and the Māhinahina WTF at an average production cost of $1.90 and $2.15 per 1,000 gallons respectively.

<u>Increase Reliability</u>

Issue and Background: Current MDWS source capacity in the Lahaina region is about 7 mgd, which includes about 4.2 mgd surface water capacity. Surface water is inherently more vulnerable than groundwater sources. Water intakes often get blocked during severe flooding, flashy conditions cause unreliable supply and result in long down times for repairs and maintenance. Shifting surface water use to groundwater also support the planning objective to increase source and system reliability.

Interconnecting the MDWS distribution systems will not add source but improve reliability. This would enable one end of the system to more readily and effectively back up the other. The preliminary strategy to upgrade transmission between Nāpili subsystem and Lahaina subsystem was reviewed in the public process and was determined to have low implementation risk but substantial cost. The subsystems are currently interconnected by two 8-inch mains. To help facilitate the water transfer between the two subsystems, the 8-inch pipe in HonoaPi`ilani Highway at the Kahoma stream crossing should be replaced with a 16-inch waterline. Where infrastructure allows, municipal, private purveyors and DHHL can provide backup supply and storage to each other during downtime due to scheduled repairs or emergencies. Such contingency agreements between purveyors can further improve reliability throughout the region.

Strategy #8: Interconnect MDWS subsystems and develop contingency agreements between purveyors in the region to increase source and system reliability. Replacement cost for 24,000 feet pipe was assessed in the MDWS optimization study to $12.3M.

<u>Climate Adaptation</u>

Issue and Background: Data and research suggest that Hawai`i should be prepared for a future with a warmer climate, diminishing rainfall, declining stream base flows, decreasing groundwater recharge and storage, and increased coastal groundwater salinity, among other impacts associated with drought.

Reliance on surface water will become more uncertain in a future of longer droughts and varying rainfall. No streamflow projections are available for the coming century but projections include a decline in base flow and low flows, with stream flows becoming more variable and unstable (flashy), especially in wet years. [61]

In consistency with the *Climate Change Adaptation Priority Guidelines*, water purveyors should increase resilience and reduce vulnerability to risks related to climate change. Reduced rainfall would potentially increase irrigation needs in this visitor and resort oriented region. Resort end uses are concentrated in the dry coastal zone of the region. A coordinated approach between water purveyors, land use planners and the visitor industry is needed to manage growth and adapt landscaping and intensity of use to drought resistant and micro-climate appropriate design and plants. Incentives for green infrastructure and use of alternative water sources are needed to ensure such upfront investments in new development.

Strategies that address climate adaption on an island wide basis in Table 13-1 include watershed management (Strategies # 1 – 3), conservation (Strategies # 10 – 32), hydrological studies and monitoring (Strategies #36 and 40), well distribution (Strategy #41), diversifying conventional water resources (Strategies # 51and 55) and expanding alternative resource use (Strategies # 57 – 62). These are echoed in region specific strategies # 1, 2, 5 and 9 summarized in Table 19-40.

[61] Summarized from EcoAdapt. 2016. Climate Changes and Trends for Maui, Lāna'i, and Kaho'olawe. Prepared for the Hawaiian Islands Climate Synthesis Project

19.8.4 Alternative Water Source Strategies

Planning objectives related to alternative water sources identified in the WUDP update public process include:

- Maximize efficiency of water use

Qualitative criteria to evaluate and measure resource strategies against this planning objective include:

- Use of recycled water increased
- Greywater and catchment systems installed
- Infrastructure projects increase recycled water use and stormwater capture

Planning objectives and policies related to alternative water sources adopted in the 1996 West Maui Community Plan are:

- Encourage landscape and agricultural use of reclaimed wastewater
- Promote conservation of potable water via use of reclaimed water for irrigation

Recommended regional facilities identified in the MIP to serve planned development include Lahaina Flood Control Project and wastewater reuse.

Rainwater Catchment Systems

Issue and Background: Rainwater catchment is not as reliable as conventional water resources because it is extremely sensitive to the climate. Rain barrels, cisterns or infiltration wells could supplement irrigation on a very limited basis in the Lahaina region.

Recycled Wastewater

Issue and Background: The use of the recycled water for landscape irrigation can offset demand for potable water. Recycled water use for agricultural irrigation ceased when Maui Land and Pineapple Company phased-out pineapple production in West Maui. Economic feasibility and consideration of elevation changes to serve agricultural uses may require a private partner for financing. Act 170, SLH 2016 provides an incentive to utilize recycled water because it requires the utilization of reclaimed water for uses other than drinking and for potable water needs in one hundred per cent of state and county facilities by December 31, 2045.

A system upgrade to add additional UV disinfection capability and system expansion will increase R-1 water production and distribution capability and allow provision of recycled water to condominiums and resorts in the Kā`anapali area. R-1 water can also be made available to future DHHL commercial and industrial developments in the West Maui area for landscape irrigation purposes. Design capacity is 9.0 mgd with about 3.84 mgd of R-1 recycled water produced in 2014. Construction of R-1 storage to pressurize the system along with distribution lines, additional UV disinfection capacity and extension of R-1 system to Kā`anapali and Honokōwai could offset approximately 0.8 mgd of potable water. Another feasible option is extending the system to DHHL developments. Table 19-36 illustrates areas served and those that may be served under the recycled wastewater master plan with stated improvements.

Table 19-37 Option Summary of R-1 Water Use and Potable Water Displacement, Lahaina ASEA

Option	Description	Estimated Cost	Gallons of Potable Water Displaced/Day	Cost/Gallon Potable Water Displaced/Day	Comments
			Total R-1 Gallons/Day	Cost/Total R-1 Gallons/Day	
1	Construct R-1 Water Storage & Additional UV Disinfection Capacity	$14,100,000	407,800	$34.58	• Impacts nine (9) projects (5 laterals installed). • Includes core production & distribution system components that must be constructed before Options 2, 3, 4 & 5 are feasible.
			407,800	$34.58	
2	Extend System to Kaanapali Resort	$6,020,000	340,000	$17.71	• Impacts nine (9) projects. • Option 1 must be constructed before this option is feasible.
			340,000	$17.71	
3	Extend System to Honokowai	$2,180,000	94,000	$23.19	• Impacts six (6) projects. • Option 1 must be constructed before this option is feasible.
			94,000	$23.19	
4	Extend System to Upper Kaanapali Condominiums	$3,100,000	184,000	$16.85	• Impacts five (5) projects. • Requires booster pumping by projects • Option 1 must be constructed before this option is feasible.
			184,000	$16.85	
5	Extend System to DHHL Developments	$510,000	135,000	$3.78	• Impacts two (2) projects. • Option 1 must be constructed before this option is feasible.
			135,000	$3.78	
6	Deliver R-1 Water to Proposed Biofuel Agriculture	$0	0	n/a	• Impacts one (1) project. • Requires additional pumping of R-1 water
			860,000	$0.00	

Notes: **a. Costs are for CIP construction only. No operational/maintenance/finance costs are included.**
b. Detailed estimates can be found in Appendix "A".

Source: Department of Environmental Management, West Maui Recycled Water Verification Study, 2012

Existing recycled water use at the municipal wastewater reclamation facility averages 0.88 mgd. An additional 2.2 mgd could become available with the projected recycled water projects listed in Table 19-38, not including Bioenergy Crop Irrigation. Private existing recycled water use averages 0.45 mgd with an additional proposed 1.7 mgd expansion.[62]

Table 19-38 Projected Recycled Water Projects, Lahaina ASEA

Project	Ave mgd	Application	Year Online
Honua Kai, Starwood, Hyatt Regency Resorts	0.38	Landscape irrigation, improve capacity, reduce salinity	2019*
Kā`anapali Resort	0.36	Landscape irrigation	2019* (Not in 6-year County CIP)
Honokōwai Condominiums Landscape irrigation	0.09	Landscape irrigation	2018 Programmed in 6-year CIP

[62] County of Maui Environmental Management Dept., Wastewater Reclamation Division, September 28, 2015

Project	Ave mgd	Application	Year Online
The Villages of Leiali`i (DHHL) Lahaina or private system	1.25	Landscape irrigation	Not programmed in County 6-year CIP
DHHL/ Agreement to reserve capacity in exchange for placement of tank on DHHL land	0.135	Residential, commercial	2018
Bioenergy Crops (DHHL land)/ Deliver R-1 water via Maui Pineapple system	3.0	Bioenergy Crop irrigation	Not reported; not programmed County in 6-year CIP

County of Maui Environmental Management Dept., Wastewater Reclamation Division, September 28, 2015.
* Date is uncertain.

Lahaina ASEA is especially suitable for maximizing the use of recycled water. The area is irrigation intensive, there are a multitude of non-potable water needs and features associated with the resort and visitor industry, in addition to continued concerns about impact on injection wells discharge on reefs and the nearshore environment. Although expansion of the recycled water distribution system and scalping plants are not as cost effective in comparison to conventional source development, this strategy has multiple external benefits and supports planning objectives to diversify the use of water resources, reduce climate change impacts on traditional potable water supplies, reduce ocean discharge and mitigate water transports.

Strategy #9: Support capital improvement funding for recycled water projects and needed infrastructure expansion in the Lahaina region to offset potable water to the maximum extent feasible. Total cost were assessed to about $25.9M to displace 2.2 mgd of potable water. Financing of recycled water expansion to offset potable water could be shared by MDWS and private purveyors. Financing expansion to offset other non-potable water sources will depend upon end user and may include DEM, DOA and the private sector.

Decentralized wastewater treatment, especially in dry growth areas avoids costly transmission and provides an alternative source of irrigation supply on site. The Master Plan for Olowalu Town proposed use of recycled wastewater treated on site for irrigation, which could offset currently used streamwater for irrigation purposes**.** [63] Scalping plants have not been assessed for the Lahaina region but is supported in accordance with in WUDP Part II Recommended Strategy # 59, applicable island wide.

Stormwater Reuse

Issue and Background: Stream flows becoming more variable and unstable (flashy) is predicted, especially in wet years. Increased storm water flows pose opportunities for stormwater recycling and further resource diversification in the region. Stormwater capture and use can provide multiple mitigating effects on climate change, including off-setting potable supply for

[63] Munekiyo & Hiraga, Inc, Draft Environmental Impact Statement, Proposed Olowalu Town Master Plan, February 2012

irrigation needs; recharging low level and more brackish portions of the regions aquifers; and mitigating sediment runoff reaching the nearshore marine environment and reefs.

The *Study Element 3: An Appraisal of Stormwater Reclamation and Reuse Opportunities in Hawai`i*, September 2008, identified two possible stormwater reuse projects for the Lahaina region:

- Lahaina Flood Control project would use an existing stormwater drainage channel and detention pond located adjacent to the Lahaina WWRF to collect stormwater for conveyance to agricultural areas to the north, south, and east to augment agricultural irrigation water. Maui County owns the stormwater detention basin. Although most infrastructure for this opportunity is in place, modification of a flood control structure and basin would be required. Cost estimated in 2016 dollars would exceed $36M.
- Kahoma Stream Flood Control: This opportunity uses an existing stormwater drainage channel (Kahoma Stream) to collect and convey stormwater for agricultural use to the north. The drainage channel is owned by Maui County and is immediately adjacent to large tracts of agricultural land. Depending on end use, some treatment might be necessary. Infrastructure needed include bottom collection sump in the drainage channel, or inflatable dam, pumping station and transmission. Potential partnerships would include the State Department of Agriculture and the County Public Works Department. Cost was assessed in 2008 to $11.3M, roughly equivalent to $12.9M in 2016 dollars.

The volume of potentially offset potable water is not determined. However, regional rainfall can exceed 100 inches per year and generate large quantities of stormwater. Capture and reuse may also aid in preventing saltwater intrusion at the coast. Exploring the Kahoma Stream stormwater opportunity is more cost effective than the Lahaina WWRF option and recommended to augment agricultural irrigation needs. Since potable water is not provided for agricultural uses within this region, this project would not affect MDWS water supply.

Strategy #10: Explore Kahoma Stream Flood Control project to collect and convey stormwater for agricultural use. Potential funding partners include Maui County and State Department of Agriculture. Cost estimate is about $12.9M.

Stormwater reclamation and reuse can also offset landscape and other irrigation demand at the project or household level. Strategy #22 in the WUDP Part II addresses incentives and code revisions to promote incorporating green infrastructure in new development.

<u>**Desalination**</u>

Issue and Background: A preliminary strategy vetted in the public process for Lahaina sector is exploring desalination of brackish water for large irrigation needs. Available brackish supply was estimated at 5 mgd, while seawater supply is unlimited. Concerns over disposal of brine, which is a byproduct of the process, and energy costs make seawater desalination less desirable. Existing engineering studies of desalination of brackish wells are not available for the Lahaina ASEA. Desalination studies for the Central and Wailuku ASEAs assessed 20 year life cycle cost per 1000 gallons as $5.20 for brackish water and $12.70 for seawater. Desalination of existing brackish water wells should be weighed against the cost effectiveness of developing less brackish wells at higher elevation.

19.9 Recommendations

In summary, groundwater in the region can supply population growth well within sustainable yield over the planning period. Recycled water can contribute at a minimum 2 mgd of non-potable supply to offset surface water use for irrigation, supplemented by stormwater capture. A combination of targeted conservation measures discussed under Section 12.2 in WUDP Part II, seasonal use of ground and surface water resources, and alternative sources can mitigate surface water diversions in the region and further diversify our water supply to prepare us for climate changes and growth over the planning period. A shift from reliance on surface water diversions for off-stream needs, especially in dry season, will take time and requires better data on stream flows and diversions. It is prudent to anticipate and plan for less available surface water to meet agricultural and other irrigation needs. Hence, funding of recycled and stormwater strategies should not be delayed. Collaborative efforts between MDWS, private purveyors and CWRM, with MDWS taking the lead, is necessary to develop groundwater in a sustainable manner over time.

The recommended strategies for the Lahaina Aquifer Sector address the key issues identified in the public process for the region: *Alternative ways to meet the future water needs of public trust and other local uses in the region given increased growth, climatic changes and potential decreased water supplies, while managing resources in a sustainable way*. The recommendations, along with the island wide strategies defined in Part II also support and implement the overall goal and objectives for water resources established in the Maui Island Plan:

Maui will have an environmentally sustainable, reliable, safe, and efficient water system.

- More comprehensive approach to water resources planning to effectively protect, recharge, and manage water resources including watersheds, groundwater, streams, and aquifers.
- Increase the efficiency and capacity of the water systems in striving to meet the needs and balance the island’s water needs.
- Improve water quality and the monitoring of public and private water.

Table 19-39 Selected Demand Scenario: Projected Water Demand and Supply Options, Lahaina ASEA

DEMAND (MGD)	2014	2015	2020	2025	2030	2035
Domestic Potable	0.036	0.037	0.042	0.049	0.055	0.060
MDWS Potable	5.478	5.574	6.393	7.442	8.315	9.191
Municipal Private Potable	3.757	3.823	4.384	5.104	5.703	6.303
Total Potable:	**9.271**	**9.434**	**10.819**	**12.595**	**14.073**	**15.554**
Irrigation Non-Potable	13.000	13.065	13.392	13.720	14.178	14.876
Agriculture Non-Potable	4.000	4.000	4.000	4.000	4.000	4.000
Total Non-Potable	**17.000**	**17.065**	**17.392**	**17.720**	**18.178**	**18.876**
TOTAL DEMAND	**26.271**	**26.499**	**28.211**	**30.315**	**32.251**	**34.430**
SUPPLY (MGD)						
Potable Surface Water	**3.300**	**3.300**	**3.300**	**2.500**	**2.500**	**2.500**
Potable Groundwater	**5.971**	**6.134**	**7.519**	**10.095**	**11.573**	**13.054**
Honokohau Aquifer	0.000	0.000	0.000	0.000	0.000	0.000
Honolua Aquifer	2.584	2.747	3.440	4.100	4.300	4.300
Honokowai Aquifer	3.003	3.003	3.696	3.700	3.800	4.000
Launiupoko Aquifer	0.360	0.360	0.360	1.800	3.000	4.300
Olowalu Aquifer	0.000	0.000	0.000	0.370	0.370	0.370
Ukumehame Aquifer	0.025	0.025	0.007	0.110	0.110	0.110
Total Potable	**9.271**	**9.434**	**10.819**	**12.595**	**14.073**	**15.554**
Recycled R-1	**1.330**	**1.330**	**2.000**	**3.000**	**5.230**	**5.230**
Conservation 8% per capita	**0.000**	**0.000**	**0.410**	**0.820**	**1.229**	**1.639**
Non-Potable Supply (Brackish GW/Surface water subject to IIFS	**15.670**	**15.735**	**14.982**	**13.901**	**11.719**	**12.007**
TOTAL SUPPLY	**26.271**	**26.499**	**28.211**	**30.315**	**32.251**	**34.430**

Table 19-40 summarizes recommended strategies and indicates the planning objectives that each strategy supports. Estimated costs are, unless indicated otherwise, life cycle costs for the twenty-year planning period per 1,000 gallons. Life cycle costs include capital, operational and maintenance costs and include inflationary effects. The cost to develop and implement sustainability projects can be difficult to quantify per volume water supply. Lead agency, or organization to implement a strategy is proposed as a starting point. The timeframe for implementation is indicated as short term – less than 5 years, and long term 5 – 20 years. Many strategies are multi-year actions with implementation beginning within 5 years and continuing through the long term (indicated as 1, 2).

Table 19-40 Summary of Recommended Strategies, Lahaina ASEA

	STRATEGY	PLANNING OBJECTIVES	ESTIMATED COST	IMPLEMENTATION 1: Short-term 1 – 5 years 2: Long-term 5 – 20 years AGENCY	TIME-FRAME
	RESOURCE MANAGEMENT				
1.	Continue Maui County financial support for watershed management partnerships' fencing and weed eradication efforts.	Maintain sustainable resources Protect water resources Protect and restore streams	$0.7M - $0.8M - per year/$14 per watershed acre (47,321 ac)	MDWS Maui County	1
2.	Support local initiatives that seek mauka to makai/traditional ahupua`a management. Educate and raise public awareness of ahupua`a management to foster partnerships for use and management of stream waters	Maintain sustainable resources Protect water resources Protect and restore streams	N/A	Public-private partnerships Aha Moku DLNR Maui County	1
	CONSERVATION				
3.	Undertake comprehensive study of Maui Land & Pine, former Pioneer Mill and Lahainaluna ditches in AWUDP update	Maintain sustainable resources Protect water resources Protect and restore streams Protect cultural resources	N/A	DOA Private purveyors MDWS	1, 2
	CONVENTIONAL WATER SOURCE STRATEGIES				
4.	Develop basal groundwater wells to provide adequate water supply for planned population growth, maintaining a buffer to sustainable yield	Provide adequate volume of water supply Maximize reliability of water service Minimize adverse environmental impacts Minimize cost of water supply	3.50/1,000 gallons	MDSWS Public Water Systems	1, 2
5.	Ensure "smart source development" guided by available data and modeling results to optimize pumpage, mitigate salt water intrusion and preserve regional resources with adequate distribution to Launiupoko and Honolua aquifers	Maintain sustainable resources Protect water resources Minimize adverse environmental impacts Manage water equitably	N/A	MDSWS Private purveyors DHHL	1
6.	Install a gage at Kanahā stream above existing intakes to collect stream flow data in order to initiate assessment of Instream Flow Standards. Prioritize IFS for diverted streams.	Maintain sustainable resources Protect water resources Manage water equitably	$25K - $35K installation. Annual monitoring $15K/year	MDSWS CWRM USGS	1
7.	Seasonal use of surface water to take	Protect and restore	Surface water	CWRM	1,

	advantage of affordable supply in wet season and shift non-instream needs to groundwater and alternative supply when available in dry season to promote stream restoration	streams Protect cultural resources Provide adequate volume of water supply Minimize cost of water supply	use: $1.90 - $2.15/1000 gal Basal well from $3.50/1000 gal	MDWS Private purveyors	2
8.	Interconnect MDWS subsystems and develop contingency agreements between purveyors in the region.	Maximize reliability of water service Maximize efficiency of water use	$12.3M	MDWS Private purveyors DHHL	2
ALTERNATIVE WATER SOURCE STRATEGIES					
9.	Support capital improvement funding for recycled water projects and needed infrastructure expansion in the Lahaina region to offset potable water to the maximum extent feasible.	Maximize efficiency of water use Maintain consistency with General and Community Plans	$25.9M	DEM MDWS Private purveyors Private developers	2
10	Explore Kahoma Stream flood control project to collect and convey storm-water for agricultural use.	Minimize adverse environmental impacts Maximize efficiency of water use	$12.9M	DPW DOA	2

19.9.1 Implementation Program

In consistency with the Maui Island Plan, strategies recommended and adopted in the WUDP do not legally bind the agencies and organizations to execute. The recommendations provide guidance for land use and infrastructure, including the county CIP program, over the planning period.

Actions to effectuate the intent of the policies and strategies should be developed over the 20-year planning period. Estimated timeframes for implementation are indicated, allowing for flexibility to re-scope and prioritize. Timing and prioritizing of conventional and alternative resource strategies are tied to actual population growth and economic factors that drive individual development projects. Implementation and timing will also depend on available manpower and expertise by agencies and organizations tasked to scope out and execute a strategy.

Funding is of course the driving factor of implementation. Some strategies rely on funding by private water purveyors, non-government organizations and public-private partnerships that will require detailed planning and alternative funding solutions. Resource protection and augmentation strategies have support by state and county initiatives, including the following:

- The Hawai`i Fresh Water Initiative, launched in 2013 by the Hawai`i Community Foundation to increase water security for the Hawaiian Islands. A state-wide goal of 100 mgd in additional fresh water focuses on three aggressive water strategy areas and individual targets for the public and private to achieve by 2030: 1) **Conservation**: Improve the efficiency of the total underground aquifer water use rate by 8% with a target of 40 mgd in increased water availability; 2) **Recharge**: Increase Hawai`i's ability to capture rainwater in key aquifer sector areas by improving stormwater capture and nearly doubling the size of our actively protected watershed areas with a target of 30 mgd in increased water availability; and 3) **Reuse**: More than double the amount of wastewater currently being reused in the Islands with a target of 30 mgd in increased water availability by 2030.

- The watershed initiative program by the State Department of Land and Natural Resources "The Rain Follows the Forest" seeks to double the acreage of protected watershed forests by 2021.

Major capital improvements for conventional resource strategies under the jurisdiction of MDWS were roughly assessed in the Maui Island Plan to meet projected demand to year 2030. Depending on the combination of new sources pursued, cost was estimated at $100 million. The 2013 Optimization Studies for the MDWS Lahaina-Nāpili System was assessed to $41 million for source development, and $12 million for subsystem interconnection for a total of about $53 million, which corresponds closer with recommended conventional resource strategies in this section. The MDWS capital improvement program budget for the Lahaina ASEA for fiscal year 2018 – 2023 total $15.9M for source, transmission and storage expansion. The current 6-year capital improvement program supports groundwater development but not interconnection of subsystems. Implementation timeframe will depend upon available capital funding.

Over the planning period, implementation and performance of the recommended strategies can be assessed using qualitative criteria and quantitative targets formulated in the WUDP Part I, Table 3-3.

APPENDICES

Appendix 1: Statewide Framework for Updating the Hawai'i Water Plan

The Statewide Framework for Updating the Hawai'i Water Plan (Statewide Framework, 2000) for preparation of the WUDP provide guidance to insure effective implementation by the counties and utilization by CWRM for resource management purposes.[1] The Framework-recommended plan elements are intended to:

- **CWRM Coordination.** Be drafted in coordination with CWRM throughout the process, including submittal of the proposed WUDP process and project description to CWRM staff, milestone briefings to CWRM including review of demand methodologies, and discussion of how the State Water Projects Plan and State Agricultural WUDP are integrated.

- **Public Involvement.** Be drafted with substantial and credible public involvement that includes identification of essential stakeholders; gathering, analysis and incorporation of information on community values; work with advisory or other groups, stakeholder interviews; and a documented variety of public outreach methods.

- **Planning Process.** Provide a documented process to develop and refine a set of planning objectives and associated evaluation criteria to compare the efficacy of alternative resource strategies. The process must include essential stakeholders and consider available information on community values regarding water resource issues. Planning issues for which objectives may be developed include: water supply reliability, costs and/or rates, environmental impacts, water quality, appurtenant and correlative water rights, T&C gathering rights and Department of Hawaiian Homelands water rights.

- **Demand Scenarios.** Consider multiple demand scenarios, including low, medium and high forecasts; 1, 2, 3, 4, 5, 10, 15 and 20 year forecasts, and forecasts beyond 20 years if anticipated demand may be close to established sustainable limits. Incorporate least cost planning, consistency of the WUDP and land use plans; resource protection needs and plans; underlying assumptions and data; models or computer programs used in the planning process; existing systems, conveyances, resources, conservation or re-use programs; etc. Forecasts shall incorporate State Water Projects Plan, State Agricultural WUDP, and federal and private water purveyors.

- **Water System Profiles**. Include water system profiles describing supplies, major conveyance facilities, storage reservoirs, re-use programs, conservation programs, any resources committed by the County, and the ability of the current system to meet future demands.

- **Alternatives.** Include screening of resource and supply alternatives by a process that includes initial listing of a broad group of possible options for supply, including new supply, transmission, storage, conservation and use of recycled water; initial screening

[1] http://files.Hawai'i.gov/dlnr/cwrm/planning/framewrk.pdf (July 2016)

of a broad list of options by realistic criteria that is specifically defined. Initial screening should result in a "finalist" group of strategies. Finalist strategies are to be evaluated against uncertainties, contingencies and other defined objectives, with final screening to result in a flexible sequence of supply, infrastructure, storage, transmission, conservation, recycled water, resource protection and other actions to meet the County's water objectives.

- **Modeling Tools.** Describe and document the computerized modeling tools that were instrumental to completing the plan and clearly indicate all of the assumptions that underlie the plan and the sources of all data used in the plan.

- **Implementation Plan.** Include a well-described implementation plan, to include near, medium and long term actions, as well as allowance for flexibility. Implementation of an Integrated Resource Planning (IRP) process should comport with state and county environmental, health and safety laws.

Planning Objectives and Relationship to Statewide Framework

Planning Objective	Planning Objective Description	State Framework for Updating the Hawai'i Water Plan
Sustainability	Maintain Sustainable Resources	Traditional and Customary Gathering Rights, Water Supply Reliability
Resources	Protect Water Resources	Traditional and Customary Gathering Rights, Water Supply Reliability
Streams	Protect and Restore Streams	Water Supply Reliability, Traditional and Customary Gathering Rights, Appurtenant and Correlative Water Rights
Environment	Minimize Adverse Environmental Impacts	Environmental Impacts
Equity	Manage Water Equitably	Appurtenant and Correlative Water Rights
DHHL	Provide for Department of Hawaiian Homelands Needs	DHHL Water Rights, Appurtenant and Correlative Water Rights
Agriculture	Provide for Agricultural Needs	DHHL Water Rights, Traditional and Customary Gathering Rights, Water Supply Reliability

Culture	Protect Cultural Resources	Traditional and Customary Gathering Rights
Availability	Provide Adequate Volume of Water Supply	DHHL Water Rights, Traditional and Customary Gathering Rights, Water Supply Reliability
Quality	Maximize Water Quality	Water Quality
Reliability	Maximize Reliability of Water Service	Water Supply Reliability
Efficiency	Maximize Efficiency of Water Use	Water Supply Reliability
Cost	Minimize Cost of Water Supply	Costs and/or Rates
Viability	Establish Viable Plans	All
Conformity	Maintain Consistency with General and Community Plans	All

Appendix 2: County Plan Policy and Programs Relevant to the WUDP, and Consistency with the Planning Objectives

General Plan

GENERAL PLAN GOAL/OBJECTIVES	GENERAL PLAN POLICIES	CONSISTENCY WITH WUDP PLANNING OBJECTIVES
Goal: Maui County's natural environment and distinctive open spaces will be preserved, managed, and cared for in perpetuity Objective 1. Improve the opportunity to experience the natural beauty and native biodiversity of the islands for present and future generations.	a. Perpetuate native Hawaiian biodiversity by preventing the introduction of invasive species, containing or eliminating existing noxious pests, and protecting critical habitat areas. c. Restore and protect forests, wetlands, watersheds, and stream flows, and guard against wildfires, flooding, and erosion. d. Protect baseline stream flows for perennial streams, and support policies that ensure adequate stream flow to support Native Hawaiian aquatic species, traditional kalo cultivation, and self-sustaining ahupua`a.	• Maintain Sustainable Resources • Protect Water Resources • Protect and Restore Streams • Minimize Adverse Environmental Impacts
Objective 2. Improve the quality of environmentally sensitive, locally valued natural resources and native ecology of each island.	i. Restore watersheds and aquifer-recharge areas to healthy and productive status, and increase public knowledge about the importance of watershed stewardship, water conservation, and groundwater protection.	• Protect Water Resources • Protect and Restore Streams
Goal: Maui County will foster a spirit of pono and protect, perpetuate, and reinvigorate its residents' multi-cultural values and traditions to ensure that current and future generations will enjoy the benefits of their rich island heritage. Objective 1. Perpetuate the Hawaiian culture as a vital force in the lives of residents.	c. Promote the use of ahupua'a and moku management practices.	• Protect Water Resources • Protect and Restore Streams • Protect Cultural Resources

GENERAL PLAN GOAL/OBJECTIVES	GENERAL PLAN POLICIES	CONSISTENCY WITH WUDP PLANNING OBJECTIVES
Goal: Maui County's physical infrastructure will be maintained in optimum condition and will provide for and effectively serve the needs of the County through clean and sustainable technologies. Objective 1. Improve water systems to assure access to sustainable, clean, reliable, and affordable sources of water.	a. Ensure that adequate supplies of water are available prior to approval of subdivision or construction documents. b. Develop and fund improved water-delivery systems. c. Ensure a reliable and affordable supply of water for productive agricultural uses. d. Promote the reclamation of gray water, and enable the use of reclaimed, gray, and brackish water for activities that do not require potable water. e. Retain and expand public control and ownership of water resources and delivery systems. f. Improve the management of water systems so that surface-water and groundwater resources are not degraded by overuse or pollution. g. Explore and promote alternative water-source-development methods. h. Seek reliable long-term sources of water to serve developments that achieve consistency with the appropriate Community Plans.	• Maximize Water Quality • Maximize Reliability of Water Service • Minimize Cost of Water Supply • Maximize Water Quality • Maximize Efficiency of Water Use • Provide for Agricultural Needs • Maintain Sustainable Resources • Protect Water Resources • Maintain Consistency with General and Community Plans
Objective 4. Direct growth in a way that makes efficient use of existing infrastructure and to areas where there is available infrastructure capacity.	a. Capitalize on existing infrastructure capacity as a priority over infrastructure expansion. d. Promote land use patterns that can be provided with infrastructure and public facilities in a cost-effective manner. e. Support catchment systems and on-site wastewater treatment in rural areas and aggregated water and wastewater systems in urban areas if they are appropriately located.	• Maximize Efficiency of Water Use • Minimize Cost of Water
Objective 5. Improve the planning and management of infrastructure systems.	a. Provide a reliable and sufficient level of funding to enhance and maintain infrastructure systems. b. Require new developments to contribute their *pro rata* share of local and regional infrastructure costs.	• Manage Water Equitably • Minimize Cost of Water Supply

GENERAL PLAN GOAL/OBJECTIVES	GENERAL PLAN POLICIES	CONSISTENCY WITH WUDP PLANNING OBJECTIVES
	d. Maintain inventories of infrastructure capacity, and project future infrastructure needs. e. Require social-justice and -equity issues to be considered during the infrastructure-planning process. f. Discourage the development of critical infrastructure systems within hazard zones and the tsunami-inundation zone to the extent practical. g. Ensure that infrastructure is built concurrent with or prior to development. h. Ensure that basic infrastructure needs can be met during a disaster.	• Maximize Reliability of Water Service

Maui Island Plan

MIP GOALS/OBJECTIVES	MIP POLICIES	MIP IMPLEMENTATION	CONSISTENCY WITH WUDP PLANNING OBJECTIVES
Goal 6.3 - Maui will have an environmentally sustainable, reliable, safe, and efficient water system. Objective 6.3.1 - More comprehensive approach to water resources planning to effectively protect, recharge, and manage water resources including watersheds, groundwater, streams, and aquifers.	6.3.1.a - Ensure that DWS actions reflect its public trust responsibilities toward water. 6.3.1.b - Ensure the WUDP implements the State Water Code and MIP's goals, objectives, and policies. 6.3.1.c - Regularly update the WUDP, to maintain compliance with the General Plan. 6.3.1.d - Ensure that the County's CIP for water-source development is consistent with the WUDP and the MIP. 6.3.1.e - Where desirable, retain and expand public ownership and management of watersheds and fresh-water systems. 6.3.1.f - Encourage and improve data exchange and coordination among Federal, State, County, and private land use planning and water resource management agencies.	6.3.1-Action 2 - Develop site selection studies for water storage and supply facilities for each community plan area. 6.3.1-Action 3 - Prepare and implement a plan to identify and prioritize infrastructure requirements needed to accommodate nonpotable water for irrigation. 6.3.1-Action 4 -Work with the State to set standards for the amount of water withdrawn from aquifers and other groundwater sources to ensure the long-term health and sustainability of the resource. 6.3.1-Action 5 - Produce an annual evaluation of the state of available water resources on the island.	• Manage Water Equitably • Protect Cultural Resources • Protect and Restore Streams • Maintain Consistency with General and Community Plans
Objective 6.3.2 - Increase the efficiency and capacity of the water systems.	6.3.2.a - Ensure the efficiency of all water system elements including well and stream intakes, water catchment, transmission lines, reservoirs, and all other system infrastructure. 6.3.2.b- Encourage increased education about and use of private catchment systems where practicable for non-potable uses. 6.3.2.c - Maximize the efficient use of reclaimed wastewater to serve nonpotable needs. 6.3.2.d - Work with appropriate State and County agencies to achieve a balance in	6.3.2-Action 1 - Develop programs to increase the efficiency of all water system elements. 6.3.2-Action 2 - Develop, adopt, and implement water source development siting standards that implement the MIP Directed Growth Plan and the WUDP, and protect water quality for existing and future consumers. 6.3.2-Action 3 - Revise County regulations to require high-efficiency, low-flow plumbing fixtures in all new construction.	• Minimize Cost of Water Supply • Maximize Efficiency of Water Use • Maintain Sustainable Resources • Manage Water Equitably

MIP GOALS/OBJECTIVES	MIP POLICIES	MIP IMPLEMENTATION	CONSISTENCY WITH WUDP PLANNING OBJECTIVES
	resolving the needs of water users in keeping with the water allocation priorities of the MIP. 6.3.2.e - Ensure water conservation through education, incentives, and regulations. 6.3.2.f - Acquire and develop additional sources of potable water.	6.3.2-Action 4 - Pursue development of additional potable water sources to keep pace with the County's needs. 6.3.2-Action 5 - Identify and develop renewable energy systems to serve the DWS. 6.3.2-Action 6 - Develop a water rate structure that encourages conservation and discourages the excessive use of water. 6.3.2-Action 7 - Develop a comprehensive water conservation ordinance to include xeriscaping regulations to promote water conservation.	
Objective 6.3.3 - Improve water quality and the monitoring of public and private water systems.	6.3.3.a - Protect and maintain water delivery systems.	6.3.3-Action 1 - Ensure water quality and quantity report results are provided in a timely manner to consumers when water quality or quantity falls below standards. 6.3.3-Action 2 - Complete and implement DWS wellhead-protection program to protect the water quality of public and private wells.	• Protect Water Resources • Maximize Water Quality
Goal 2.3 - Healthy watersheds, streams, and riparian environments.	2.3.1.a - All present and future watershed management plans shall incorporate concepts of ahupua`a management based on the interconnectedness of upland and coastal ecosystems/species.	2.3.1-Action 1 - Develop, regularly update, and adopt watershed management plans for regions of the island not covered by existing plans.	• Maintain Sustainable Resources • Protect Water Resources

MIP GOALS/OBJECTIVES	MIP POLICIES	MIP IMPLEMENTATION	CONSISTENCY WITH WUDP PLANNING OBJECTIVES
Objective 2.3.1 - Greater protection and enhancement of watersheds, streams, and riparian environments.	2.3.1.b - Continue to support and be an active member of watershed partnerships. 2.3.1.c - Support the establishment of regional water trusts, composed of public and private members, to manage water resources. 2.3.1.d - Support regulations to require developments to utilize ahupua`a management practices. 2.3.1.e - Work with private and non-profit entities to educate the public about the connection between upland activities within the watershed and the impacts on nearshore ecosystems and coral reefs. 2.3.1.f - Provide adequate funding and staff to develop and implement watershed protection plans and policies, including acquisition and management of watershed resources and land. 2.3.1.g - Encourage the State to mandate instream assessment to provide adequate water for native species. 2.3.1.h - Maui will protect all watersheds and streams in a manner that guarantees a healthy, sustainable riparian environment.	2.3.1-Action 2 - Work with the State and Federal government to ensure instream assessment to assure the reproductive system/cycle for Native species and for other purposes.	• Protect and Restore Streams • Minimize Adverse Environmental Impacts
Objective 2.3.4 - Greater preservation of native flora and fauna biodiversity to protect native species.	2.3.4.a - Work with appropriate agencies to eliminate feral ungulate populations and invasive species. 2.3.4.b - Encourage the State to provide adequate funding to preserve biodiversity, protect native species, and contain or eliminate invasive species.		• Protect Water Resources

MIP GOALS/OBJECTIVES	MIP POLICIES	MIP IMPLEMENTATION	CONSISTENCY WITH WUDP PLANNING OBJECTIVES
	2.3.4.c - Support the work of conservation groups and organizations that protect, reestablish, manage, and nurture sensitive ecological areas and threatened indigenous ecosystems.		
Objective 2.3.6 - Enhance the vitality and functioning of streams, while balancing the multiple needs of the community.	2.3.6.b - Work with appropriate agencies to establish minimum stream flow levels and ensure adequate stream flow to sustain riparian ecosystems, traditional kalo cultivation, and self-sustaining ahupua`a. 2.3.6.c - Respect and participate in the resolution of native Hawaiian residual land and water rights issues (kuleana lands, ceded lands, and historic agricultural and gathering rights). 2.3.6.e - Work with appropriate agencies and stakeholders to establish minimum stream flow levels, promote actions to support riparian habitat and the use of available lo`i, and maintain adequate flows for the production of healthy kalo crops.	2.3.6-Action 1 - Compile and update data on the needs of the multiple users of water.	• Maintain Sustainable Resources • Protect and Restore Streams • Provide for Agricultural Needs • Protect Cultural Resources • Provide for Department of Hawaiian Homelands Needs • Manage Water Equitably
Objective 6.2.3 - Increase the reuse of wastewater.	6.2.3.a - Strengthen coordination between the Department of Water Supply (DWS) and the WWRD to promote reuse/recycling of wastewater. 6.2.3.b - Expand the reuse of wastewater from the Central Maui, Kīhei, Lahaina, and other wastewater systems.	6.2.3-Action 1 - Identify potential new users of treated effluent and implement the necessary improvements to supply this water through the County CIP. 6.2.3-Action 2 - Amend County regulations to allow for the use of grey water for approved purposes.	• Provide Adequate Volume of Water Supply • Maximize Reliability of Water Service • Maximize Efficiency of Water Use • Minimize Cost of Water Supply

MIP GOALS/OBJECTIVES	MIP POLICIES	MIP IMPLEMENTATION	CONSISTENCY WITH WUDP PLANNING OBJECTIVES
		6.2.3-Action 3 - Create education, marketing, and incentive programs that promote the reuse/recycling of wastewater.	• Establish Viable Plans • Provide for Agricultural Needs • Protect Cultural Resources • Protect and Restore Streams
Goal 6.10 - Maui will meet its energy needs through local sources of clean, renewable energy, and through conservation. Objective 6.10.1 - Reduce fossil fuel consumption by 15 percent from 2005 in 2015; 20 percent by 2020; and 30 percent by 2030.	6.10.1.a - Support energy efficient systems, processes, and methods in public and private operations, buildings, and facilities. 6.10.2.c - Support the establishment of new renewable energy facilities at appropriate locations provided that environmental, view plane, and cultural impacts are addressed. 6.10.2.d - Encourage all new County facilities completed after January 1, 2015, to produce at least 15 percent of their projected electricity needs with onsite renewable energy.	6.10.1-Action 1 - Work with the Energy Management Program to: (1) Audit County facilities, operations, and equipment; (2) Develop programs and projects to achieve greater energy efficiency and reduction in fossil fuel use; (3) Develop and maintain data and reports on island energy consumption; (4) Phase out inefficient fossil-fueled vehicles	• Minimize Cost of Water Supply • Minimize Adverse Environmental Impacts • Maximize Reliability of Water Service
Goal 7.1 - Maui will have a prosperous agricultural industry and will protect agricultural lands. Objective 7.1.2 - Reduction of the island's dependence on off-island agricultural	7.1.2.c - Actively look to acquire land and provide infrastructure to expand the agricultural park and establish new agricultural parks. 7.1.2.f - Support plans and programs to develop additional sources of water for irrigation purposes. 7.1.2.h - Support the recommendations, policies, and actions contained within the	7.1.2-Action 3 - Coordinate with the State Department of Agriculture, the development of an Agricultural Water Strategy, and incorporate an agricultural component in the Water Use and Development Plan. 7.1.2-Action 4 - Coordinate with industry stakeholders to develop alternative sources of irrigation water including wastewater reuse, recycled	• Provide for Agricultural Needs • Minimize Cost of Water Supply • Provide Adequate Volume of Water Supply • Maximize Reliability of Water Service

MIP GOALS/OBJECTIVES	MIP POLICIES	MIP IMPLEMENTATION	CONSISTENCY WITH WUDP PLANNING OBJECTIVES
products and expansion of export capacity.	Maui Agricultural Development Plan, July 2009, when consistent with the MIP. 7.1.2.i - Allow water and tax discounts for legitimate farming operations on rural and agricultural land. 7.1.2.j - Give priority in delivery and use of agricultural water and agricultural land within County agricultural parks to cultivation of food crops for local consumption.	stormwater runoff, and brackish well water.	

Summary of Maui Island Plan Policies Relevant to the WUDP by Topic

Water Resources	Water Availability and Uses	Supply Augmentation / Demand Controls
<u>Water Resources</u> Healthy watersheds, streams, and riparian environments. Greater protection and enhancement of watersheds, streams, and riparian environments. Enhance the vitality and functioning of streams, while balancing the multiple needs of the community. More comprehensive approach to water resources planning to effectively protect, recharge, and manage water resources including watersheds, groundwater, streams, and aquifers. Maui will protect all watersheds and streams in a manner that guarantees a healthy, sustainable riparian environment. Ensure adequate stream flow to sustain riparian ecosystems, adequate water for native species, traditional kalo cultivation, use of available lo`i, and self-sustaining ahupua`a. Greater preservation of native flora and fauna biodiversity to protect native species. All present and future watershed management plans shall incorporate	<u>Water Rights/Public Trust Uses</u> Ensure the WUDP implements the State Water Code and MIP's goals, objectives, and policies. Ensure that DWS actions reflect its public trust responsibilities toward water. Respect and participate in the resolution of native Hawaiian residual land and water rights issues (kuleana lands, ceded lands, and historic agricultural and gathering rights). <u>Potable Water</u> Increase the efficiency and capacity of the water systems. Protect and maintain water delivery systems. Acquire and develop additional sources of potable water. Pursue development of additional potable water sources to keep pace with the County's needs. <u>Nonpotable Water</u> Maximize the efficient use of reclaimed wastewater to serve nonpotable needs. Encourage increased education about and use of private catchment systems where practicable for non-potable uses. <u>Agricultural Irrigation</u> Support plans and programs to develop additional sources of water for irrigation purposes.	<u>Recycled Water</u> Maui will have wastewater systems that … maximize wastewater reuse where feasible. Increase the reuse of wastewater. Maximize the efficient use of reclaimed wastewater to serve nonpotable needs. Encourage increased education about and use of private catchment systems where practicable for non-potable uses. <u>Conservation</u> Ensure water conservation through education, incentives, and regulations. <u>Energy</u> Maui will meet its energy needs through local sources of clean, renewable energy, and through conservation (% goals). Increase the minimum percentage of electricity obtained from clean, renewable energy sources (% goals).

Water Resources	Water Availability and Uses	Supply Augmentation / Demand Controls
concepts of ahupua`a management based on the interconnectedness of upland and coastal ecosystems/species.	Coordinate with industry stakeholders to develop alternative sources of irrigation water including wastewater reuse, recycled stormwater runoff, and brackish well water.	

Summary of Community Plan Policies Relevant to the WUDP by Topic

Water Resources	Water Availability and Uses	Supply Augmentation / Demand Controls
West Maui CP		
Protect ground water resources. Protection and enhancement of native forest and vegetation. Protect cultural and archaeological sites: plantation ditch systems, fishponds, significant native vegetation zones, stream valley areas- lo'i and auwai. Establish a "Watershed Protection Overlay Plan" for West Maui to insure protection of (1) quantity and quality of drinking water supplies; (2) quality of coastal waters and marine resources; (3) the long term economic viability of the community. Include specifications for drainage, erosion control, water conservation, wastewater reuse, and shoreline setbacks as needed to supplement existing policies and rules. Protect all waters and wetland resources to open space and habitat for plant and animal life in the aquatic environment. They are also important for flood control and natural landscape. Establish and maintain programs which control invasive alien plant and animal species	Coordinate water system development to support development within urban growth boundaries. Sufficient water to support ag and native Hawaiian water rights and traditional practices. Encourage maintenance and development of water sources for agricultural uses that do not conflict with domestic demand for potable water. Preserve Honokohau' Valley's historic and traditional use for domestic and agricultural activities. Ensure availability of sufficient quantities and quality of water for these activities by recognizing Native Hawaiian water rights and traditional access. Establish an appropriate supply of urban land within the region to meet the needs of the community over the next 20 years. The Community Plan and its map shall define the urban growth limits for the region and all zoning and/or proposed land uses and developments shall be consistent with the Community Plan and its land use map. Lands north of Kapalua and south of Puamana should ensure the preservation of traditional lifestyles, historic sites, agriculture, recreational activities and open space.	Encourage landscape and ag use of reclaimed wastewater. Promote conservation of potable water via use of reclaimed water for irrigation. Promote water conservation. Incorporate drought-tolerant plant species in future landscape planting. Promote energy conservation and renewables.

Water Resources	Water Availability and Uses	Supply Augmentation / Demand Controls
	Encourage and protect traditional shoreline and mountain access, cultural practices and rural/ agricultural lifestyles. Improve the quality of domestic water. Reduce potable water consumption outside urban areas. Improve and expand the West Maui water development program projected by the County to meet future residential expansion needs and establish water treatment facilities where necessary. Study the feasibility of integrating all regional water systems into a public water system to be managed and operated by the County. Encourage reasonable rates for water and public utility services.	
Pa'ia-Ha'iku CP		
Protect quality of surface and groundwater. Protection/enhancement of native forest and vegetation. Protect cultural and archaeological sites: plantation ditch systems, fishponds, significant native vegetation zones, stream valleys. Encourage the restoration and traditional use of taro patches, and the re-establishment of breadfruit groves. Encourage and protect traditional mauka and makai accesses, cultural practices and rural lifestyles. Protect traditional hunting, fishing and gathering.	Improve existing potable water distribution system and new sources prior to expansion of State Urban district boundary of major subdivisions in State Ag or Rural Districts. Ensure adequate water capacity for domestic and ag needs. Ensure the development of new water sources does not adversely affect in-stream flows. Increase water storage capacity with a reserve for drought periods. Ensure adequate supply of groundwater to residents of the region before water is transported to other regions of the island.	Reduce residential home energy and water consumption. Provide incentives for water conservation practices. Promote energy conservation and renewables. Incorporate the principles of xeriscaping in all future landscape planting.

Water Resources	Water Availability and Uses	Supply Augmentation / Demand Controls
	Maintain agriculture as the primary economic activity. Propose and define growth limits around existing urbanized areas to accommodate residential development while directing growth in an organized manner. Prepare or update a water improvement master plan. In the WUDP update, include reserve capacity for drought conditions. Develop comprehensive ag water system including use of recycled water and dual water system for domestic and irrigation uses.	
Wailuku-Kahului CP		
Protect water resources in the region from contamination, including protecting ground water recharge areas, and wellhead protection areas within a 1.25-mile radius from the wells. Protect cultural and archaeological sites: 'Iao Stream, taro lo'i terraces in 'Iao Valley, Na Wai 'Eha. Promote and implement programs for ground water and wellhead protection.	Improve the quality of potable water. Preserve agricultural lands as a major element of the open space setting bordering various communities. Preserve and protect native Hawaiian rights and practices customarily and traditionally exercised for subsistence, cultural and religious purposes. Encourage traditional Hawaiian agriculture, such as taro cultivation, within the agricultural district, in areas which have been historically associated with this cultural practice.	Promote conservation of potable water through use of treated waste water effluent for irrigation. Implementing Actions Reuse treated effluent from the County’s waste water treatment system for irrigation and other suitable purposes in a manner that is environmentally sound. Promote conservation.

Water Resources	Water Availability and Uses	Supply Augmentation / Demand Controls
	Coordinate water system improvement plans with growth areas to ensure adequate supply and a program to replace deteriorating portions of the distribution system. Future growth should be phased to be in concert with the service capacity of the water system. Coordinate expansion of and improvements to the water system to coincide with development of residential expansion areas. Improve the quality of domestic water. Encourage reasonable rates for water and public utility services. Adopt a water allocation plan for the region and require use of water from Central Maui Water System for future development shall be subject to water allocation plan. Plan and construct water system improvements, including additional source, transmission, and storage capabilities.	Provide incentives for water and energy conservation practices. Promote energy conservation and renewables. Incorporate drought tolerant plant species and xeriscaping in future landscape planting.
Hāna CP		
Ensure ground and surface water resources are preserved and maintained at capacities to meet current and domestic, agricultural, commercial, ecological and traditional cultural demands of each area in the Hāna District. Hāna CP – Protect and restore native aquatic habitats and resources within and along all	Improve water source and delivery facilities to ensure water is high quality. Promote and maintain agriculture as a major economic activity with emphasis on a regional diversified agricultural industry. Maintain taro farming, ranching and floriculture as major economic activities. Maintain the visitor industry as a major economic activity.	Comprehensive waste management plan to include recycling of wastewater as one major component. Incorporate the use of gray water, including household recycling, in the County's wastewater reuse strategy.

Water Resources	Water Availability and Uses	Supply Augmentation / Demand Controls
streams by protecting existing instream flows and regulating diversions of stream flow. Protect cultural and archaeological sites: plantation ditch systems, fishponds, native vegetation zones, lo'i terraces and ‘auwai. In coordination with native Hawaiian residents and community representatives, prepare watershed management plans and a groundwater and surface water resources monitoring program to protect the district's surface and ground waters, and monitor water levels to meet current and future demands Explore methods to diminish out-of-district diversions of the district's groundwater and/or surface water resources in order to meet current and future domestic, agricultural, commercial, ecological, and traditional cultural needs within the district. Develop regulations and implement programs to protect lo`i kalo (taro terraces), and encourage their productive use. Establish and maintain feral animal control programs, and programs which control invasive alien plant species.	Provide municipal water service to Kipahulu and Upper Nāhiku. Prepare a domestic water system master plan.	Encourage water conservation. Promote energy conservation and renewables.

Water Resources	Water Availability and Uses	Supply Augmentation / Demand Controls
Kihei-Makena CP		
Protect plantation ditch systems, fishponds, significant native vegetation zones, Waiohuli Kai fishpond.	Provide source and transmission concurrent with planned growth. Support and expand Central and East Maui water systems. Encourage use of non-potable water for irrigation. Identify priority growth areas to focus public and private provision of infrastructure and amenities to serve existing residents and to accommodate new growth. Allow no further development unless infrastructure, public facilities, and services needed to service new development are available prior to or concurrent with impacts of new development. Cultural protection that preserves and protects native Hawaiian rights customarily and traditionally exercised for subsistence, cultural, and religious purposes. Encourage and protect traditional mauka and makai accesses, cultural practices and rural lifestyles. Provide for the preservation and enhancement of important agricultural lands for a variety of agricultural activities, including sugar cane, diversified agriculture and aquaculture	Encourage use of non-potable water for irrigation purposes and water features. Require use of reclaimed water for irrigation of golf courses, parks and landscaped areas. Prohibit use of potable water in large water features or require substantial mitigation fees. Develop conservation and reuse programs. Encourage use of plants with a relatively low need for water. Promote energy conservation and renewables.

Water Resources	Water Availability and Uses	Supply Augmentation / Demand Controls
	Prepare a prioritized island-wide directed and managed growth strategy to ensure development is consistent with provision of infrastructure, public facilities and services.	
Makawao-Pukalani-Kula CP		
Recognize the importance of the forested watershed areas and that their health and well-being are vital to all the residents of the Upcountry area. Support a comprehensive watershed management program which incorporates forest management and reforestation/replanting using endemic and indigenous plant species, protects the environment from exotic plants and animals; and prevents the introduction and establishment of non-native species within this native forest region that may ultimately threaten water supply and native ecosystems. Explore a comprehensive reforestation program to increase and catch more rainwater for the Upcountry area.	Prioritize the allocation of water as new resources and system improvements become available as follows: (a) for maintenance and expansion of diversified agricultural pursuits and for the Department of Hawaiian Homes projects; and then (b) for other uses including development of new housing, commercial and public/quasi-public uses. Encourage a flexible and comprehensive water management approach that recognizes the various collection and delivery improvements as one cohesive system. Restrict the use of any water developed within or imported to the Upcountry region to consumption within the Upcountry region, with exception provided for agricultural use. Recognize and support the immediate allocation of water resources for Department of Hawaiian Home Lands projects and agriculture. Recognize the Department of Hawaiian Home Lands' Waiohuli-Keokea region as a potential agricultural and affordable housing community and the eventuality of a Hawaiian sovereign entity.	Explore the development of alternative water sources (e.g., grey water, catchment systems, etc.) to meet the needs of diversified agriculture, businesses and residents. Promote agricultural practices that encourage energy efficient and environmentally sound measures such as catchment systems, and use of grey water, organic pesticides, organic fertilizers and biomass energy. Support wastewater reclamation and grey water alternatives as a means of reducing demands upon limited water resources in the Upcountry region. Support the development of separate domestic and irrigation water systems. DWS shall expand water supply and distribution systems, including catchment systems.

Water Resources	Water Availability and Uses	Supply Augmentation / Demand Controls
	Seek expanded municipal withdrawal from the lowest cost source to serve the Upcountry region. Support programs and plans to develop adequate water systems for agricultural use. The Department of Water Supply shall expand water supply and distribution systems, including catchment systems, in accordance with the Community Plan. Encourage the construction of additional storage capacity by the DWS, commercial developers, and individual farmers to help alleviate the inadequate water supply. Establish water resource availability as a major criteria in establishing land uses. Support the development of separate domestic and irrigation water systems. Encourage cooperative efforts among Federal, State, and County agencies, and developers to ensure that water storage and delivery needs of the region are met in a timely and orderly manner. Encourage the construction of additional storage capacity by the DSW, commercial developers, and individual farmers to help alleviate the inadequate water supply. Increase the deliverable capacity of the lower Kula line to 7.5 mgd and extend the line to Keokea to serve Department of Hawaiian Home Lands projects.	Increase catchment efficiency and storage capacity on the upper Kula line to achieve 4 mgd sustained delivery to farms and residences. Utilize treated effluent for irrigation of farms, golf courses, parks and highway landscaping. Provide incentives for water conservation practices. Provide tax and/or water rate incentives for construction of agricultural water storage facilities. Implement a water conservation and education program. Require the use of low water consuming trees, plants and ground covers in future landscape planting. Promote conservation and efficiency as the energy resource of first choice.

Water Resources	Water Availability and Uses	Supply Augmentation / Demand Controls
	Systematically improve and upgrade the existing water delivery system. Increase the pumping capacity from low cost sources to upper areas to supplement the surface water supply. Develop and execute an agreement which ensures for the County, long-term rights to water from the lowest cost sources. Conduct a groundwater development feasibility study for the Upcountry region.	Study and identify opportunities, including tax incentives, for developing alternative energy sources such as wind, biomass, solar and water driven electricity in the Upcountry region.

Appendix 3: Hawaiian Homes Commission Water Policy Plan

HAWAIIAN HOMES COMMISSION WATER POLICY PLAN

July 22, 2014

Policies

The HHC and the DHHL are seeking to be proactive in our management of water. Our Priority Policies are to:

1. Expressly determine and plan for future water needs and actively participate in broader water management, use and protection efforts in Hawai`i in order to secure water.
2. Aggressively exercise, reclaim, and protect Hawaiian home land water kuleana.
3. Develop, manage, and steward water in a manner that balances cost, efficiency measures, and Public Trust uses in the short and long term.
4. Affirmatively communicate our decisions, our reasoning, and our performance in managing, stewarding, and using water before and after making major water decisions.

Additionally, the HHC and the DHHL should consider in their work the following statements:

5. Educate beneficiaries, the DHHL, HHC, and other stakeholders continually on our water kuleana.
6. Foster self-sufficiency of beneficiaries by promoting the adequate supply of water for homesteading when developing or managing water.
7. Foster the self-determination of beneficiaries by seeking ways for beneficiaries to participate in the management of water by delegating authority related to water subject to the discretion of the HHC as described in the HHCA.
8. Make water decisions that incorporate traditional and place-based knowledge of our people and are clear and methodical in their reasoning.
9. Make efforts to understand, maintain, and improve the quality of water as it moves into and through our lands and is used by beneficiaries.
10. Affirmatively consider the development and use of alternative sources of water and efficiency measures in water decision-making.
11. Ensure that water decisions are consistent with other Departmental policies, programs, and plans including but not limited to the Energy Policy and Agricultural Program.
12. Explicitly consider water availability and the costs to provide adequate water when developing new homestead areas, designating land uses, issuing land dispositions, or exchanging properties.

Goals

To make progress on achieving our Mission and complying with our Policies, the Priority Goals of the HHC and the DHHL are to:

1. Affirmatively communicate with beneficiaries regarding water decisions, performance, and water rights on a regional and annual basis.
2. Aggressively, proactively, consistently and comprehensively advocate for the kuleana of the beneficiaries, the DHHL, and the HHC to water before all relevant agencies and entities.
3. Develop and manage a Water Assets Inventory (WAI).
4. Support watershed protection and restoration on DHHL lands and source areas for DHHL water.

Additional goals that DHHL and the HHC shall seek to achieve, based on the availability of resources, organized by Mission activities, are:

Part I. Understand our trust water assets

1. Revise the DHHL submittal template to the HHC for water related decisions.
2. Revise budgets to show the total costs of a) water system management b) all spending on water issues.
3. Staff and organize the DHHL consistent with importance of water to the trust.

Part II. Plan for our water needs

4. Determine current and foreseeable future needs based upon periodic reviews of water availability projections that incorporate climate change, projected beneficiary demand, alternative sources and efficiency measures.
5. Design homesteads and manage lands to create and enhance water availability, optimizing costs, use of alternative sources and efficiency measures.

Part III. Aggressively understand, exercise and assert our water rights

6. Secure adequate and enforceable reservations of water for current and foreseeable future needs for all of its lands across the islands.
7. Partner with trust beneficiaries in water advocacy efforts.
8. Engage in updates to all Hawai`i Water Plan elements to ensure DHHL water needs and rights are addressed.
9. Advocate that all Water Use Permit Applications properly address the water rights of DHHL and other Hawaiian water rights.
10. Advocate that County Boards of Water Supply and other County agencies that affect water have the spirit of the HHCA faithfully carried out to protect DHHL

Appendix 4: Inventory of Surface Water Resources

The table below lists key characteristics of each hydrologic unit, including the total area (in square miles), the number of registered and/or permitted stream diversions, the number of historic and currently active USGS gages within the unit, and the current interim IFS. In most cases the current interim IFS were established pursuant to amendments to HAR §13-169 as follows. The right-hand column provides the status of the IFS as of August 2016.

- Interim Instream Flow Standard for East Maui, HAR §13-169-44
  Date of Adoption: 6/15/1988
  Effective Date: 10/8/1988

- Interim Instream Flow Standard for West Maui, HAR §13-169-48
  Date of Adoption: 10/19/1988
  Effective Date: 12/10/1988

Inventory of Surface Water Resources

Unit	Unit Name	Aquifer System	Area (mi^2)	No. of Diversions	No. of Gages	Active Gages	Interim IFS	Status
6001	Waikapu	Waikapu	16.4	12	4	0	2.9mgd below S. Waikapu Ditch return	
6002	Pohakea	Waikapu	8.31	0	1	0	HAR §13-169-48	
6003	Papalaua	Ukumehame	4.88	0	0	0	HAR §13-169-48	
6004	Ukumehame	Ukumehame	8.28	1	2	0	HAR §13-169-48	
6005	Olowalu	Olowalu	8.4	2	3	0	HAR §13-169-48	
6006	Launiupoko	Launiupoko	6.6	1	1	0	HAR §13-169-48	
6007	Kauaula	Launiupoko	8.44	1	5	0	HAR §13-169-48	
6008	Kahoma	Launiupoko	8.5	7	8	0	HAR §13-169-48	
6009	Wahikuli	Honokowai	9.79	0	0	0	HAR §13-169-48	

Unit	Unit Name	Aquifer System	Area (mi²)	No. of Diversions	No. of Gages	Active Gages	Interim IFS	Status
6010	Honokowai	Honokowai	8.86	2	6	0	HAR §13-169-48. Amended to include SCAP MA-117 on Honokowai Stream for the installation of a flow-through desilting basin (8/17/1994).	
6011	Kahāna	Honokahua	9.07	1	1	0	HAR §13-169-48	
6012	Honokahua	Honokahua	5.35	0	0	0	HAR §13-169-48	
6013	Honolua	Honolua	4.79	4	4	0	HAR §13-169-48	
6014	Honokohau	Honokohau	11.58	8	2	1	HAR §13-169-48	
6015	Anakaluahine	Honokohau	2.73	0	0	0	HAR §13-169-48	
6016	Poelua	Kahakuloa	2.02	0	2	0	HAR §13-169-48	
6017	Honanana	Kahakuloa	4.66	2	0	0	HAR §13-169-48	
6018	Kahakuloa	Kahakuloa	4.24	10	3	1	HAR §13-169-48. Amended to include SCAP MA-133 on Kahakuloa Stream for reconstruction of an existing stream diversion (6/2/1994).	
6019	Waipili	Waihe'e	2.65	2	0	0	HAR §13-169-48	
6020	Waiolai	Waihe'e	0.97	1	0	0	HAR §13-169-48	
6021	Makamakaole	Waihe'e	2.28	4	2	0	HAR §13-169-48	
6022	Waihe'e	Waihe'e	7.11	5	4	1	10mgd below Waihe'e Ditch intake and 10mgd	

Unit	Unit Name	Aquifer System	Area (mi²)	No. of Diversions	No. of Gages	Active Gages	Interim IFS	Status
							below Spreckels Ditch intake	
6023	Waiehu	'Iao	10.14	12	5	0	1.6mgd below N. Waiehu Ditch intake on N. Waiehu and 0.9mgd below Spreckels Ditch intake on S. Waiehu	
6024	'Iao (Wailuku)	'Iao	22.55	9	6	1	10mgd below 'Iao-Waikapu Ditch at Kepaniwai Park and 5mgd at the stream mouth	
6025	Kalialinui	Makawao	30.28	0	3	0	HAR §13-169-44	
6026	Kailua Gulch	Makawao	29.76	0	0	0	HAR §13-169-44	
6027	Maliko	Ha'iku	27.38	10	2	0	HAR §13-169-44	
6028	Kuiaha	Ha'iku	8.38	30	0	0	HAR §13-169-44	
6029	Kaupakulua	Ha'iku	3.84	15	2	0	HAR §13-169-44	
6030	Manawaiiao	Ha'iku	2.37	3	0	0	HAR §13-169-44	
6031	Uaoa	Ha'iku	2.39	6	0	0	HAR §13-169-44	

Unit	Unit Name	Aquifer System	Area (mi^2)	No. of Diversions	No. of Gages	Active Gages	Interim IFS	Status
6032	Kealii	Ha'iku	0.53	4	0	0	HAR §13-169-44	
6033	Kakipi	Ha'iku	9.53	21	8	0	HAR §13-169-44	
6034	Honopou	Honopou	2.73	23	9	1	2.31mgd below Ha'iku Ditch and 1.49 below taro diversions	Contested Case CCH-MA13-01, A&B to restore 100% streamflow
6035	Hoolawa	Honopou	4.86	37	2	0	HAR §13-169-44	
6036	Waipio	Honopou	1.03	15	0	0	HAR §13-169-44	
6037	Hanehoi	Honopou	1.43	12	0	0	0.09 below Ha'iku Ditch on Huelo tributary, 0.69 below Ha'iku Ditch, 0.74mgd above community pipe, 2.21mgd at terminal waterfall	Contested Case CCH-MA13-01, A&B to restore 100% streamflow to Hanehoi (Puolua)
6038	Hoalua	Honopou	1.24	4	0	0	HAR §13-169-44	
6039	Hānawana	Honopou	0.65	5	0	0	HAR §13-169-44	
6040	Kailua	Honopou	5.25	6	13	0	HAR §13-169-44	
6041	Nailiilihaele	Waikamoi	3.57	12	8	0	HAR §13-169-44	
6042	Puehu	Waikamoi	0.36	1	0	0	HAR §13-169-44	
6043	Oopuola	Waikamoi	1.24	15	4	0	HAR §13-169-44	
6044	Kaaiea	Waikamoi	1.15	3	1	0	HAR §13-169-44	
6045	Punaluu	Waikamoi	0.22	1	0	0	HAR §13-169-44	
6046	Kolea	Waikamoi	0.71	8	3	0	0.13mgd at Hāna Hwy	Contested Case CCH-MA13-01

Unit	Unit Name	Aquifer System	Area (mi^2)	No. of Diversions	No. of Gages	Active Gages	Interim IFS	Status
6047	Waikamoi	Waikamoi	5.3	11	10	0	1.81mgd at Hāna Hwy	Contested Case CCH-MA13-01, A&B to restore 100% streamflow
6048	Puohokamoa	Waikamoi	3.18	8	12	0	0.26mgd at Hāna Hwy	Contested Case CCH-MA13-01
6049	Haipuaena	Waikamoi	1.59	5	9	0	0.06mgd at Hāna Hwy	Contested Case CCH-MA13-01
6050	Punalau	Waikamoi	1.16	3	2	0	HAR §13-169-44	Contested Case CCH-MA13-01
6051	Honomanu	Waikamoi	5.6	8	5	0	0.00mgd at Hāna Hwy	Contested Case CCH-MA13-01
6052	Nuaailua	Waikamoi	1.56	2	0	0	2.00mgd below Ko'olau Ditch	Contested Case CCH-MA13-01
6053	Piinaau	Ke'anae	21.95	14	2	0	HAR §13-169-44	Contested Case CCH-MA13-01, A&B to restore 100% streamflow to Piiinaau & Palahulu
6054	Ohia	Ke'anae	0.28	1	0	0	2.97mgd at Hāna Hwy	Contested Case CCH-MA13-01
6055	Waiokamilo	Ke'anae	2.47	18	0	0	3.17mgd below Ko'olau Ditch	Fully restored in 2007 (CCHMA1301-20141230-HC&S-WL)
6056	Wailuanui	Ke'anae	6.05	8	3	1	4.03mgd at Hāna Hwy	Contested Case CCH-MA13-01, Streamflow restored by A&B
6057	W. Wailuaiki	Ke'anae	4.18	1	1	1	2.46mgd (wet) and 0.40mgd (dry) seasonal at Hāna Hwy	Contested Case CCH-MA13-01
6058	E. Wailuaiki	Ke'anae	3.52	1	1	0	2.39mgd (wet) and 0.13mgd (dry)	Contested Case CCH-MA13-01
6059	Kopiliula	Ke'anae	5.2	2	1	0	HAR §13-169-44. Temporarily amended to include SCAP MA-352 on Kopiliula Stream for the	Contested Case CCH-MA13-01

Unit	Unit Name	Aquifer System	Area (mi²)	No. of Diversions	No. of Gages	Active Gages	Interim IFS	Status
							implementation of a Land Restoration Plan (11/20/2002).	
6060	Waiohue	Ke'anae	0.82	3	1	0	2.07mgd at Hāna Hwy	Contested Case CCH-MA13-01
6061	Paakea	Ke'anae	1.05	2	1	0	0.97mgd at Hāna Hwy	Contested Case CCH-MA13-01
6062	Waiaaka	Ke'anae	0.19	1	2	0	0.00mgd at Hāna Hwy	Contested Case CCH-MA13-01
6063	Kapaula	Ke'anae	0.84	2	2	0	0.13mgd at Hāna Hwy	Contested Case CCH-MA13-01
6064	Hānawi	Ke'anae	5.6	6	2	1	0.06mgd at Hāna Hwy	Contested Case CCH-MA13-01
6065	Makapipi	Ke'anae	3.32	3	3	0	0.60mgd at Hāna Hwy	Contested Case CCH-MA13-01
6066	Kuhiwa	Kuhiwa	3.41	0	0	0	HAR §13-169-44	
6067	Waihole	Kuhiwa	0.88	2	0	0	HAR §13-169-44	
6068	Manawaikeae	Kuhiwa	0.52	0	0	0	HAR §13-169-44	
6069	Kahawaihapapa	Kuhiwa	3.73	0	0	0	HAR §13-169-44	
6070	Keaaiki	Kuhiwa	1.03	2	0	0	HAR §13-169-44	
6071	Waioni	Kuhiwa	0.63	2	0	0	HAR §13-169-44	
6072	Lanikele	Kuhiwa	0.7	1	0	0	HAR §13-169-44	
6073	Heleleikeoha	Kuhiwa	3.48	14	0	0	HAR §13-169-44	
6074	Kawakoe	Kawaipapa	4.04	15	0	0	HAR §13-169-44	
6075	Honomaele	Kawaipapa	7.94	4	1	0	HAR §13-169-44	
6076	Kawaipapa	Kawaipapa	10.78	0	2	0	HAR §13-169-44	
6077	Moomoonui	Kawaipapa	2.95	0	1	0	HAR §13-169-44	
6078	Haneoo	Kawaipapa	2.13	0	0	0	HAR §13-169-44	

Unit	Unit Name	Aquifer System	Area (mi^2)	No. of Diversions	No. of Gages	Active Gages	Interim IFS	Status
6079	Kapia	Kawaipapa	4.71	3	0	0	HAR §13-169-44	
6080	Waiohonu	Waihoi	7.15	0	1	0	HAR §13-169-44	
6081	Papahawahawa	Waihoi	1.96	0	0	0	HAR §13-169-44	
6082	Alaalaula	Waihoi	0.48	2	0	0	HAR §13-169-44	
6083	Wailua	Waihoi	1.26	4	0	0	HAR §13-169-44	
6084	Honolewa	Waihoi	0.63	1	0	0	HAR §13-169-44	
6085	Waieli	Waihoi	0.96	0	0	0	HAR §13-169-44	
6086	Kakiweka	Waihoi	0.34	1	0	0	HAR §13-169-44	
6087	Hahalawe	Waihoi	0.74	1	1	0	HAR §13-169-44	
6088	Puaaluu	Kipahulu	0.53	4	0	0	HAR §13-169-44	
6089	Oheo	Kipahulu	9.7	0	2	1	HAR §13-169-44	
6090	Kalena	Kipahulu	0.71	1	0	0	HAR §13-169-44	
6091	Koukouai	Kipahulu	4.56	2	0	0	HAR §13-169-44	
6092	Opelu	Kipahulu	0.53	2	0	0	HAR §13-169-44	
6093	Kukuiula	Kipahulu	0.74	1	1	0	HAR §13-169-44	
6094	Kaapahu	Kipahulu	0.5	0	0	0	HAR §13-169-44	
6095	Lelekea	Kipahulu	0.78	0	0	0	HAR §13-169-44	
6096	Alelele	Kipahulu	1.2	0	0	0	HAR §13-169-44	
6097	Kalepa	Kipahulu	0.97	2	0	0	HAR §13-169-44	
6098	Nuanuaaloa	Kipahulu	4.24	3	0	0	HAR §13-169-44	
6099	Manawainui	Kipahulu	5.17	3	0	0	HAR §13-169-44	
6100	Kaupo	Kaupo	22.5	1	0	0	HAR §13-169-44	
6101	Nuu	Nakula	10.48	0	1	0	HAR §13-169-44	
6102	Pahihi	Nakula	7.85	0	0	0	HAR §13-169-44	
6103	Waiopai	Nakula	5.38	0	0	0	HAR §13-169-44	
6104	Poopoo	Nakula	1.92	0	0	0	HAR §13-169-44	

Unit	Unit Name	Aquifer System	Area (mi^2)	No. of Diversions	No. of Gages	Active Gages	Interim IFS	Status
6105	Manawainui Gulch	Nakula	6.07	0	0	0	HAR §13-169-44	
6106	Kipapa	Lualailua	28.42	0	1	0	HAR §13-169-44	
6107	Kanaio	Lualailua	34.11	0	0	0	HAR §13-169-44	
6108	Ahihi Kinau	Kamaole	3.68	0	0	0	HAR §13-169-44	
6109	Mooloa	Kamaole	1.9	0	0	0	HAR §13-169-44	
6110	Wailea	Kamaole	35.76	4	2	0	HAR §13-169-44	
6111	Hapapa	Kamaole	40.89	0	1	0	HAR §13-169-44	
6112	Waiakoa	Pa'ia	55.76	0	2	0	HAR §13-169-44	

Appendix 5: The State Water Projects Plan Update, Hawai'i Water Plan, Department of Hawaiian Homelands, Final Report, May 2017

DHHL Non-Potable Demands for Surface Water Hydrologic Units, 2031

Unit Code	Surface Water Hydrologic Unit Name	Declared Use[1] (MGD)	2031 NP-WD Dmd by Source[2] (MGD)	Transfers[3] (MGD)	2031 NP-WD Dmd by Location[4] (MGD)	2031 NP Dmd by Location[5] (MGD)
6001	Waikapu	2.507	0.000		0.000	0.000
6004	Ukumehame	4.888	0.000		0.000	0.000
6005	Olowalu	4.556	0.000		0.000	0.000
6006	Launiupoko	0.728	0.000		0.000	0.000
6007	Kauaula	6.008	0.000		0.000	0.000
6008	Kahoma	5.626	0.000		0.000	0.000
6010	Honokowai	0.000	2.081	-2.081	0.000	2.081
6011	Kahana	1.099	0.000		0.000	0.000
6013	Honolua	0.000	0.000	1.040	1.040	0.000
6014	Honokohau	0.011	0.000	1.040	1.040	0.000
6017	Honanana	0.006	0.000		0.000	0.000
6018	Kahakuloa	0.004	0.000		0.000	0.000
6019	Waipili	0.027	0.000		0.000	0.000
6021	Makamakaole	0.007	0.000		0.000	0.000
6022	Waihee	9.727	0.000		0.000	0.000
6023	Waiehu	0.105	0.000		0.000	0.000
6024	Iao	22.833	0.000		0.000	0.000
6027	Maliko	0.014	0.000		0.000	0.000
6028	Kuiaha	0.002	0.000		0.000	0.000
6029	Kaupakulua	0.012	0.000		0.000	0.000
6032	Kealii	0.001	0.000		0.000	0.000
6033	Kakipi	0.155	0.000		0.000	0.000
6034	Honopou	1.327	0.000		0.000	0.000
6035	Hoolawa	0.133	0.000		0.000	0.000
6036	Waipio	0.050	0.000		0.000	0.000

Unit Code	Surface Water Hydrologic Unit Name	Declared Use[1] (MGD)	2031 NP-WD Dmd by Source[2] (MGD)	Transfers[3] (MGD)	2031 NP-WD Dmd by Location[4] (MGD)	2031 NP Dmd by Location[5] (MGD)
6037	Hanehoi	0.007	0.000		0.000	0.000
6047	Waikamoi	0.000	0.000	0.289	0.289	0.000
6049	Haipuaena	0.000	0.000	0.289	0.289	0.000
6051	Honomanu	0.017	0.000		0.000	0.000
6053	Piinaau	0.378	4.588		4.588	4.588
6055	Waiokamilo	0.023	0.000	2.280	2.280	0.000
6056	Wailuanui	0.002	2.280	-2.280	0.000	2.280
6064	Hanawi	0.303	0.000		0.000	0.000
6067	Waihole	0.001	0.000		0.000	0.000
6073	Heleleikeoha	0.001	0.000		0.000	0.000
6074	Kawakoe	0.002	0.000		0.000	0.000
6075	Honomaele	0.000	0.209		0.209	1.083
6076	Kawaipapa	0.000	0.046		0.046	0.947
6079	Kapia	0.002	0.000		0.000	0.000
6082	Alaalaula	0.007	0.000		0.000	0.000
6083	Wailua	0.101	0.000		0.000	0.000
6088	Puaaluu	0.112	0.000		0.000	0.000
6097	Kalepa	0.018	0.000		0.000	0.000
6099	Manawainui	0.004	0.000		0.000	0.000
6106	Kipapa	0.000	0.014		0.014	0.014
6107	Kanaio	0.000	0.000		0.000	0.255
6108	Ahihi Kinau	0.000	0.000		0.000	0.479
6110	Wailea	0.000	0.096	-0.096	0.000	3.317
6111	Hapapa	0.000	0.482	-0.482	0.000	10.657
6112	Waiakoa	0.000	1.856		1.856	1.856
	Total	**60.804**	**11.652**	**0.000**	**10.033**	**27.557**

1. Declared use based on CWRM declaration files and as listed in the WRPP Appendix C
2. Water Development Demand by Source represents the non-potable demands produced within a hydrologic unit used to determine water development strategies within the 20-year planning window
3. Transfers represent the difference between water used and water produced within each hydrologic unit, e.g. a positive value represents a net inflow of water to a hydrologic unit
4. Water Development Demand by Location represents the non-potable demands used within the land area of a hydrologic unit used to determine water development strategies within the 20-year planning window
5. Demand by Location represents the total non-potable demands, including General Agriculture demands, used within the land area of a hydrologic unit not anticipated to be developed within the 20-year planning windo

Appendix B: Potable DHHL Demands – Medium Projection

Island	Aquifer Sector	Aquifer System	Project Name	Total Project Potable Demand (mgd)							
				2012	2013	2014	2015	2016	2021	2026	2031
MAUI	CENTRAL	KAHULUI	PU'UNENE	0.0000	0.0000	0.0000	0.0000	1.7340	1.7340	1.7340	1.7340
MAUI	CENTRAL	KAMA'OLE	KĒŌKEA/WAIOHULI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4608	0.4608
MAUI	CENTRAL	KAMA'OLE	KĒŌKEA-WAIOHULI DEVELOPMENT PHASE 1-4	0.0000	0.0000	0.0000	0.0000	0.0960	0.3489	0.3489	0.3489
MAUI	CENTRAL	KAMA'OLE	'ULUPALAKUA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0034
MAUI	CENTRAL	KAMA'OLE	KUALAPA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MAUI	CENTRAL	KAMA'OLE	KALIHI/KANAHENA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
			Total Central	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**1.8300**	**2.0829**	**2.5437**	**2.5471**
MAUI	HĀNA	KAWAIPAPA	WĀKIU	0.0000	0.0000	0.0000	0.0000	0.0000	0.0325	0.0565	0.1177
			Total Hāna	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0325**	**0.0565**	**0.1177**
MAUI	KAHIKINUI	LUALA'ILUA	'ĀHIHI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MAUI	KAHIKINUI	LUALA'ILUA	KAHIKINUI	0.0000	0.0000	0.0000	0.0000	0.0630	0.0630	0.0630	0.0630
			Total Kahikinui	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0630**	**0.0630**	**0.0630**	**0.0630**
MAUI	KO'OLAU	KE'ANAE	KE'ANAE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0034	0.0034	0.0034
MAUI	KO'OLAU	KE'ANAE	WAILUA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
			Total Ko'olau	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0034**	**0.0034**	**0.0034**
MAUI	LAHAINA	HONOKŌWAI	HONOKŌWAI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0612	0.3179	0.3179
MAUI	LAHAINA	HONOKŌWAI	KĀ'ANAPALI, HONOKŌWAI	0.0000	0.0000	0.0000	0.0000	0.3000	0.3000	0.3000	0.3000
MAUI	LAHAINA	HONOKŌWAI	LEIALI'I 1B	0.0000	0.0000	0.0000	0.0000	0.0000	0.1517	0.1517	0.1517
			Total Lahaina	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.3000**	**0.5129**	**0.7696**	**0.7696**
MAUI	WAILUKU	'ĪAO	WAIEHU	0.0000	0.0000	0.0000	0.0000	0.0170	0.0170	0.0170	0.0170
MAUI	WAILUKU	'ĪAO	PAUKŪKALO	0.0000	0.0000	0.0000	0.0000	0.0034	0.0034	0.0034	0.0034
MAUI	WAILUKU	'ĪAO	WAILUKU	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
			Total Wailuku	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0204**	**0.0204**	**0.0204**	**0.0204**
			Total Maui	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**2.2134**	**2.7151**	**3.4566**	**3.5212**

Appendix C: Non-Potable DHHL Demands for Water Development - Medium Projection

Island	Unit Code	Surface Water Hydrologic Unit	Project Name	Total Project Non-Potable Demand (mgd)							
				2012	2013	2014	2015	2016	2021	2026	2031
MAUI	6010	HONOKOWAI	HONOKOWAI	0.0000	0.0000	0.0000	0.0000	0.0000	2.0808	2.0808	2.0808
MAUI	6010	HONOKOWAI	KAANAPLAI, HONOKOWAI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MAUI	6023	WAIEHU	WAIEHU	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MAUI	6024	IAO	PAUKUKALO	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MAUI	6024	IAO	WAILUKU	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MAUI	6053	PIINAAU	KEANAE	0.0000	0.0000	0.0000	0.0000	0.0000	4.5878*	4.5878*	4.5878*
MAUI	6056	WAILUANUI	WAILUA	0.0000	0.0000	0.0000	0.0000	0.0000	2.2802*	2.2802*	2.2802*
MAUI	6075, 6076	HONOMAELE, KAWAIPAPA	WAIKU	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2550
MAUI	6106	KIPAPA	KAHIKINUI	0.0000	0.0000	0.0000	0.0000	0.0135	0.0135	0.0135	0.0135
MAUI	6107	KANAIO	AHIHI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MAUI	6108	AHIHI KINAU	KUALAPA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MAUI	6108	AHIHI KINAU	KALIHI/KANAHENA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MAUI	6110	WAILEA	ULUPALAKUA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MAUI	6110, 6111	WAILEA, HAPAPA	KEOKEA-WAIOHULI DEVELOPMENT PHASE 1-4	0.0000	0.0000	0.0000	0.0000	0.0000	0.5780	0.5780	0.5780
MAUI	6111	HAPAPA	KEOKEA/WAIOHULI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MAUI	6112	WAIAKOA	PUUNENE	0.0000	0.0000	0.0000	0.0000	1.8564	1.8564	1.8564	1.8564
			Total Maui	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**1.8699**	**11.3967**	**11.3967**	**11.6517**

*Part or all of water demand based on estimated lo'i kalo area; subject to change when quantity of available resources are determined

Appendix D demand is not included within the water demand strategies and is not anticipated to be developed within the 20-year planning window

Appendix D: Non-Potable DHHL Demands - Medium Projection

Island	Unit Code	Surface Water Hydrologic Unit	Project Name	Total Project Non-Potable Demand (mgd)							
				2012	2013	2014	2015	2016	2021	2026	2031
MAUI	6008	KAHOMA	LEALII 1B	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MAUI	6010	HONOKOWAI	HONOKOWAI	0.0000	0.0000	0.0000	0.0000	0.0000	2.0808	2.0808	2.0808
MAUI	6010	HONOKOWAI	KAANAPLAI, HONOKOWAI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MAUI	6023	WAIEHU	WAIEHU	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MAUI	6024	IAO	PAUKUKALO	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MAUI	6024	IAO	WAILUKU	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MAUI	6053	PIINAAU	KEANAE	0.0000	0.0000	0.0000	0.0000	0.0000	4.5878*	4.5878*	4.5878*
MAUI	6056	WAILUANUI	WAILUA	0.0000	0.0000	0.0000	0.0000	0.0000	2.2802*	2.2802*	2.2802*
MAUI	6075, 6076	HONOMAELE, KAWAIPAPA	WAIKU	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2.0298
MAUI	6106	KIPAPA	KAHIKINUI	0.0000	0.0000	0.0000	0.0000	0.0135	0.0135	0.0135	0.0135
MAUI	6107	KANAIO	AHIHI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2550
MAUI	6108	AHIHI KINAU	KUALAPA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1391
MAUI	6108	AHIHI KINAU	KALIHI/KANAHENA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3400
MAUI	6110	WAILEA	ULUPALAKUA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MAUI	6110, 6111	WAILEA, HAPAPA	KEOKEA/WAIOHULI	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	13.3960
MAUI	6110, 6111	WAILEA, HAPAPA	KEOKEA-WAIOHULI DEVELOPMENT PHASE 1-4	0.0000	0.0000	0.0000	0.0000	0.0000	0.5780	0.5780	0.5780
MAUI	6112	WAIAKOA	PUUNENE	0.0000	0.0000	0.0000	0.0000	1.8564	1.8564	1.8564	1.8564
			Total Maui	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**1.8699**	**11.3967**	**11.3967**	**27.5566**

*Part or all of water demand based on estimated lo'i kalo area; subject to change when quantity of available resources are determined

Appendix H: Estimated County Water Department Charges – Medium Projection

Island	Project Name	Estimated County Water Department Charges ($)								Strategy Option
		2012	2013	2014	2015	2016	2021	2026	2031	

MAUI	ULUPALAKUA	$0	$0	$0	$0	$0	$0	$0	$72,360	REMAIN - MDWS
MAUI	WAIKU	$0	$0	$0	$0	$0	$180,900	$0	$964,800	REMAIN - MDWS
MAUI	KEANAE	$0	$0	$0	$0	$0	$72,360	$0	$0	REMAIN - MDWS
MAUI	WAIEHU	$0	$0	$0	$0	$349,740	$0	$0	$0	REMAIN - MDWS
MAUI	PAUKUKALO	$0	$0	$0	$0	$72,360	$0	$0	$0	REMAIN - MDWS

Appendix 6: Hawai'i Climate Change Adaptation Priority Guidelines Tools

Source: Water Resources and Climate Change Adaptation in Hawai'i: Adaptive Tools in the Current Law and Policy Framework, 2012

Adaptive Tool (Lead Agency)	Description
Policy and Planning Tools	
Incorporate Climate Change Planning Into the Hawai'i Water Plan (CWRM)	WUDP planning scenarios should include potential variations in future precipitation and temperature along with population and land use scenarios into a strategic decision making process that addresses uncertainties, environmental externalities and public needs.
Enforce Five-Year Updates to the Hawai'i Water Plan (CWRM)	The 20 year time horizon should be reviewed. Climate change phenomena implicate trends much longer than 20 years and some water infrastructure is designed to last more than 20 years.
Expand Models of Water- and Climate-Conscious Land Use Plans and Policies (County Council)	Counties should adopt appropriate policies, ordinances, and plans to more fully integrate land use and water planning (e.g.: Maui County Water Availability Policy). There are potentially gaps between sustainable yield and demand under the county land use plans; WUDPs should identify potential steps and barriers for avoiding over-allocation, such as implementing demand-side conservation measures, developing non-potable water resources, or transferring water between hydrologic units.
Adopt Existing Models to Integrate Watershed Conservation with Water Resource Planning (DWS)	Initial steps toward compiling mandatory water conservation and recycling plans should be finalized and implemented by each county. Hawai'i Act 152 relating to Watershed Protection required the development of a watershed protection master plan to identify and protect priority watersheds. Monitoring and planning for specific impacts on watersheds is consistent with sustainability and the principles of the ahupua'a system.
Finalize and Implement Mandatory Water Conservation and Recycling Plans (DWS)	Water conservation is a critical component of climate adaptation and water resource management. Hawai'i can increase its resilience to declining water supply or more frequent drought, by implementing mandatory water conservation and recycling (e.g., Maui conservation policy).
Regulatory Tools	
Adopt Climate-Conscious Sustainable Yield and Instream Flow Standards (CWRM)	Sustainable yield and instream flow should account for climate change and potential impacts, and they should be regularly reevaluated.
Expand Water Management Areas (CWRM)	Under the Water Code, more adaptive tools and strategies are applicable in WMAs than in non-designated areas. Protection against climate hazards is enhanced by the designation of WMAs for both surface water and groundwater resources.
Adopt More Adaptive Conditions for Water Use, Well Construction, and Stream Diversion Permits (CWRM)	The standard and special conditions applicable to such permits should be amended to enhance adaptive capabilities such as monitoring and forward-looking flexibility. Proposed amendments are suggested, to empower use monitoring, rain and stream monitoring, and permit compliance inspections.
Market-Based Tools	

Encourage Water-Conscious Construction and Modifications with Green-Building Benefits and Credits (DWS)	New development and redevelopment present an opportunity to incorporate water-conserving infrastructure and practices. State and local government should enhance “green-building” efforts with county rebates and utility credits and state income tax credits directed specifically at water conservation.
Adopt a Public Goods Charge for Water Use (CWRM)	An across-the-board fee for water use can impart a conservation price signal, and fund the cost of water management and conservation.

Appendix 7: Initial Public and Policy Board Meetings, 2004 - 2013

Meeting	**Purpose – Major Input**
11/30/2004 WAC; Central Maui and Upcountry	Initial Meeting – Intro to WUDP
9/6/2005 WAC Upcountry	Initial List of Possible Candidate Strategies
9/6/2005 WAC Central Maui	Initial List of Possible Candidate Strategies
9/12/2006 WAC Central Maui	Preliminary Screening of Candidate Strategies
9/25/2006 WAC Upcountry	Preliminary Screening of Candidate Strategies
10/8/2007 WAC Upcountry	Final Candidate Strategies
10/9/2007 WAC Central Maui	Final Candidate Strategies
12/12/2007 WAC Upcountry	Iterative Analysis and Public Review, First Round: Integrated strategies, updated characterization of resource options, conservation and raw water storage reservoir options detailed.
1/8/2008 WAC Central Maui	Iterative Analysis and Public Review, First Round: Integrated strategies, updated characterization of resource options, conservation and raw water storage reservoir options detailed.
2/13/2008 WAC Upcountry	Iterative Analysis and Public Review, Second Round: Final Candidate Strategies. Incorporate comments on first round, assumptions used in system model refined, water conservation program refined, additional options, variation and scenarios examined for each of the final candidate strategies.
6/30/2008 WAC Upcountry	Iterative Analysis and Public Review, Third Round: Economic analysis for energy costs, 50 year economic study period to account for capital-intensive resource options added, capital costs and depreciation accounting refined, water conservation program refined, strategies refined based on updated information, comments and ongoing review, additional strategy options examined.
7/23/2008 WAC Central Maui	Iterative Analysis and Public Review, Second Round: Final Candidate Strategies. Incorporate comments on first round, water conservation program refined, options and scenarios added or reconfigured, energy price scenarios presented, capital costa and depreciation accounting refined, 50 year economic study period added to account for capital-intensive resource options.
2008 Board of Water Supply	Central Maui, Iterative Analysis and Public Review, Third Round: Economic analysis presented, strategies refined, additional scenarios examined per WAC request, optimization of strategy configurations re-examined.
7/27/2009 WAC Upcountry	Iterative Analysis and Public Review, Fourth Round: Energy price scenarios presented, Wailoa Ditch base flows analyzed, and uncertainties, contingencies and project implementation timing analyzed.

Meeting	Purpose – Major Input
2009 Wailuku	Meeting referenced in BWS letter
2009 Kihei	Meeting referenced in BWS letter
4/22/2010 Board of Water Supply (4/30/2010 letter)	Final Candidate Strategies Report, 6/17/2009 • Customary and traditional uses of Kanaka Maoli relating to water, hydrological system, reforestation, stream restoration • Consistency with kuleana user rights and state law • Consultation with OHA/ DHHL • Top priorities: Protection of watersheds, stream restoration, waste water recycling • County goal to be free of reliance on fossil fuels. County help DWS identify alternative clean energy for pumping water (e.g., wind in Hali'imaile/ Upcountry district; hydro-electric in West Maui) • Small reservoirs for water capture and storage more realistic than large reservoirs (Central District) • Eminent domain to acquire all water systems is important consistent with public trust doctrine • Relation of public trust waters to food security and sustainability Strategies: • Northward Basal Groundwater: complex/difficult/public outreach • Eastward Basal Groundwater: consistency with Consent Decree • Na Wai `Ehā Surface Water Treatment: assignment of future uses speculative; return more water to streams and lo'i; position Waihe'e WTP on equal footing with Wai'ale WTP • Desalinization of Brackish Groundwater: expensive; toxic by-products • Extensive Conservation and Wastewater Recycling: Soundest strategy; R-1 water take into account conveyance and pumping systems; look at water allocation strategies (use/community impact)
Board of Water Supply	Central District WUDP Update, 11/16/2010. Iterative Analysis and Public Review, Fourth Round: Analysis and recommendations amended to examine recycled water options, recommendations amended to consider updated circumstances, amendments to incorporate public comment, BWS recommendations, and as approved by County Council.
8/15/2012 CWRM	Revised Project Description
9/4/2012 Council WRC	WUDP Update/Revised Project Description
9/24/2012 Board of Water Supply	WUDP Update/Schedule
1/8/2013 Public Meeting Wailuku	WUDP Update • Allocation of resources regionally • Accuracy of sustainable yields • Understanding of ground/surface water connectivity • Legal authority of WUDP to regulate growth • MIP directed growth boundaries versus need for growth

Meeting	Purpose – Major Input
	• Native Hawaiian water rights and practices • Effect of litigation on WUDP • Integrate DWS catchment systems • Relation of WUDP to infrastructure planning • Water conservation education
1/9/2013 Public Meeting Upcountry	WUDP Update • Effect of reduced ag operations on water rights • Kula is experiencing less rainfall as a trend; options • Potential for new water sources • Use of Hamakuapoko Wells • Integration of county and private systems • Catchment (cisterns)/infiltration for individuals and ag • Connect catchment to county system • Effect of drought; drought regulations • Potential use of graywater (Pulehu) • Notification of these meetings
1/10/2013 Public Meeting South Maui	WUDP Update • Disparity of MIP directed growth boundaries versus need for growth • Relation of WUDP to infrastructure planning • Balance urban versus ag during drought • DWS role as utility versus WUDP balance of all demands
1/17/2013- Public Meeting West Maui	WUDP Update • Rights of kuleana lands • Well reporting • Monitoring of water rights in forest reserves • Drought scenarios • Source of water for various private public systems (Villages at Leialii, Kahoma Subdivision)
1/22/13 Public Meeting Hāna	WUDP Update • Native Hawaiian water rights • Ha'iku Consent Decree • Effect of reduced cane production on ag water allocation • Effect of aging infrastructure on water quality Upcountry Optimization Study • Water conservation is a priority - Ha'iku • Quantify water conservation • Water supply – Hali'imaile • Growth rates in MIP/water as growth control tool • Pi'iholo Reservoir option • Other areas subsidize upcountry water • Connect catchment to other sources • Water rates
1/29/2014 CWRM;	Collaborative meeting – WUDP

Meeting	Purpose – Major Input
Private Water Systems; DWS	
3/12/2015 State Workshops on SWRPP	Issues that overlap with WUDP • Water rights: streamflow, mauka to makai streamflow, public trust doctrine, DHHL, kuleana, priorities, traditional and customary practices, enforce IIFS, ag water for DHHL, diversions • Aquifer recharge, SY • Water resource availability • Economic development and water resources Efficient use and management of water resources • Watersheds: protection, ag water uses, mauka protection, native ecosystems, native forests, partnerships, funding • Waste water management • Storm water capture • Drought • Surface and ground water quality • Community involvement • Aha Moku system/community associations
6/24/15	CWRM- WUDP Approach and Update
7/20/2015	Maui Alliance of Community Associations • Tensions should be addressed such as ag v. urban users, existing v. new users, DWS systems v. others, water quality v. wastewater disposal, energy costs v. distribution system, DHHL/kuleana lands, water rights/legal cases, climate change effects, etc. • Create an organic plan that can evolve. • Maui DWS: makes sense for systems to be connected, more storage needed. • Balance environmental, DNC (???) and instream uses; future ag water: prioritize good quality water for drinking. • Look all different sources and assets beyond potable water: reuse, stormwater (storage); replace high quality use water for ag; existing plantation system- protect stream water; • Water as growth control measure creates social inequities; control over water creates monopoly on development versus reasonable and beneficial use standard. • People are willing to pay more for capital projects

Appendix 8: Agricultural Use Scenarios for Kuleana Parcels by Watershed

Hydrologic Unit			Comparison Data		Kuleana Parcels		Scenario 1: Diversified Ag		Scenario 2: Wetland Taro - Consumptive Use (Low-high range water use)				Scenario 2: Wetland Taro – Streamflow (Low-high range water use)			
Unit	Name	Aquifer System	2015 Ag Baseline Crops	Pre-Contact Stream-fed Ag	Parcels near Streams	Acres	25% of acres	50% of acres	25% of acres, low	25% of acres, high	50% of acres, low	50% of acres, high	25% of acres, low	25% of acres, high	50% of acres, low	50% of acres, high
6039	Hanawana	Honopou	Pasture	Yes	Hanawana	23.271	0.020	0.040	0.087	0.233	0.175	0.465	0.582	1.745	1.164	3.491
6064	Hanawi	Keanae				0.121	0.000	0.000	0.000	0.001	0.001	0.002	0.003	0.009	0.006	0.018
6037	Hanehoi	Honopou	Pasture	Yes	Hanehoi	34.092	0.029	0.058	0.128	0.341	0.256	0.682	0.852	2.557	1.705	5.114
6078	Haneoo	Kawaipapa	Pasture, Diversified		Haneoo	102.928	0.087	0.175	0.386	1.029	0.772	2.059	2.573	7.720	5.146	15.439
6038	Hoalua	Honopou	Pasture	Yes	Hoalua	9.503	0.008	0.016	0.036	0.095	0.071	0.190	0.238	0.713	0.475	1.425
6017	Honanana	Kahakuloa	Taro, Pasture	Yes	Honanana, Kaikaina, Waihali Gl, Analua Gl	15.928	0.014	0.027	0.060	0.159	0.119	0.319	0.398	1.195	0.796	2.389
6014	Honokohau	Honokohau	Taro	Yes	Honokohau	118.865	0.101	0.202	0.446	1.189	0.891	2.377	2.972	8.915	5.943	17.830
6010	Honokowai	Honokowai			Honokowai	74.840	0.064	0.127	0.281	0.748	0.561	1.497	1.871	5.613	3.742	11.226
6084	Honolewa	Waihoi			Honolewa	1.416	0.001	0.002	0.005	0.014	0.011	0.028	0.035	0.106	0.071	0.212
6013	Honolua	Honolua		Yes	Honolua	32.647	0.028	0.056	0.122	0.326	0.245	0.653	0.816	2.449	1.632	4.897
6051	Honomanu	Waikamoi		Yes	Honomanu	14.172	0.012	0.024	0.053	0.142	0.106	0.283	0.354	1.063	0.709	2.126
6034	Honopou	Honopou	Pasture	Yes	Honopou	64.735	0.055	0.110	0.243	0.647	0.486	1.295	1.618	4.855	3.237	9.710
6035	Hoolawa	Honopou	Pasture	Yes	Hoolawa, Honokala Gl, Mokupapa Gl	57.941	0.049	0.098	0.217	0.579	0.435	1.159	1.449	4.346	2.897	8.691
6024	Iao	Waiehu	Taro, Diversified	Yes	Iao, Puulio	681.719	0.579	1.159	2.556	6.817	5.113	13.634	17.043	51.129	34.086	102.258
6018	Kahakuloa	Kahakuloa		Yes	Kahakuloa	69.161	0.059	0.118	0.259	0.692	0.519	1.383	1.729	5.187	3.458	10.374
6011	Kahana	Launiupoko			Kaopala Gl, Honokeana	47.162	0.040	0.080	0.177	0.472	0.354	0.943	1.179	3.537	2.358	7.074
6069	Kahawaiha-papa	Kuhiwa			Kahawaihapapa	1.375	0.001	0.002	0.005	0.014	0.010	0.028	0.034	0.103	0.069	0.206

Hydrologic Unit			Comparison Data		Kuleana Parcels		Scenario 1: Diversified Ag		Scenario 2: Wetland Taro - Consumptive Use (Low-high range water use)				Scenario 2: Wetland Taro – Streamflow (Low-high range water use)			
Unit	Name	Aquifer System	2015 Ag Baseline Crops	Pre-Contact Stream-fed Ag	Parcels near Streams	Acres	25% of acres	50% of acres	25% of acres , low	25% of acres, high	50% of acres, low	50% of acres, high	25% of acres, low	25% of acres, high	50% of acres, low	50% of acres, high
6008	Kahoma	Launiupoko			Kahoma	31.806	0.027	0.054	0.119	0.318	0.239	0.636	0.795	2.385	1.590	4.771
6040	Kailua	Honopou	Pasture	Yes	Kailua	3.795	0.003	0.006	0.014	0.038	0.028	0.076	0.095	0.285	0.190	0.569
6033	Kakipi	Haiku		Yes	Kakipi	34.429	0.029	0.059	0.129	0.344	0.258	0.689	0.861	2.582	1.721	5.164
6063	Kapaula	Keanae		Yes	Kapaula	7.406	0.006	0.013	0.028	0.074	0.056	0.148	0.185	0.555	0.370	1.111
6007	Kauaula	Launiupoko	Taro		Kauaula	226.561	0.193	0.385	0.850	2.266	1.699	4.531	5.664	16.992	11.328	33.984
6029	Kaupakulua	Haiku		Yes	Kaupakulua Gl	7.650	0.007	0.013	0.029	0.076	0.057	0.153	0.191	0.574	0.382	1.147
6070	Keaaiki	Kuhiwa				1.055	0.001	0.002	0.004	0.011	0.008	0.021	0.026	0.079	0.053	0.158
6046	Kolea	Waikamoi				1.170	0.001	0.002	0.004	0.012	0.009	0.023	0.029	0.088	0.059	0.176
6028	Kuiaha	Haiku		Yes	Kuiaha	90.800	0.077	0.154	0.341	0.908	0.681	1.816	2.270	6.810	4.540	13.620
6065	Makapipi	Keanae			Makapipi	12.693	0.011	0.022	0.048	0.127	0.095	0.254	0.317	0.952	0.635	1.904
6027	Maliko	Haiku		Yes	Maliko, Kanemoeala Gl	17.765	0.015	0.030	0.067	0.178	0.133	0.355	0.444	1.332	0.888	2.665
6030	Manawaiiao	Haiku		Yes	Manawaiiao, Opana, Manawai Gl	59.583	0.051	0.101	0.223	0.596	0.447	1.192	1.490	4.469	2.979	8.937
6077	Moomoonui	Kawaipapa	Pasture		Moomoonui	19.515	0.017	0.033	0.073	0.195	0.146	0.390	0.488	1.464	0.976	2.927
6041	Nailiilihaele	Waikamoi	Pasture	Yes	Nailiilihaele	34.947	0.030	0.059	0.131	0.349	0.262	0.699	0.874	2.621	1.747	5.242
6052	Nuaailua	Waikamoi		Yes	Nua'ailua	32.728	0.028	0.056	0.123	0.327	0.245	0.655	0.818	2.455	1.636	4.909
6098	Nuanuaaloa	Kipahulu			Nuanuaaloa	23.032	0.020	0.039	0.086	0.230	0.173	0.461	0.576	1.727	1.152	3.455
6089	Oheo	Kipahulu			Oheo	24.434	0.021	0.042	0.092	0.244	0.183	0.489	0.611	1.833	1.222	3.665
6005	Olowalu	Olowalu	Diversified		Olowalu, Lihau	34.648	0.029	0.059	0.130	0.346	0.260	0.693	0.866	2.599	1.732	5.197
6043	Oopuola	Waikamoi		Yes	Oopuola	12.807	0.011	0.022	0.048	0.128	0.096	0.256	0.320	0.961	0.640	1.921
6081	Papahawa-hawa	Waihoi				3.338	0.003	0.006	0.013	0.033	0.025	0.067	0.083	0.250	0.167	0.501
6053	Piinaau	Keanae		Yes	Pi`ina`au	12.908	0.011	0.022	0.048	0.129	0.097	0.258	0.323	0.968	0.645	1.936
6088	Puaaluu	Kipahulu				1.922	0.002	0.003	0.007	0.019	0.014	0.038	0.048	0.144	0.096	0.288
6042	Puehu	Waikamoi	Pasture		Puehu	16.774	0.014	0.029	0.063	0.168	0.126	0.335	0.419	1.258	0.839	2.516

Hydrologic Unit			Comparison Data		Kuleana Parcels		Scenario 1: Diversified Ag		Scenario 2: Wetland Taro - Consumptive Use (Low-high range water use)				Scenario 2: Wetland Taro – Streamflow (Low-high range water use)			
Unit	Name	Aquifer System	2015 Ag Baseline Crops	Pre-Contact Stream-fed Ag	Parcels near Streams	Acres	25% of acres	50% of acres	25% of acres, low	25% of acres, high	50% of acres, low	50% of acres, high	25% of acres, low	25% of acres, high	50% of acres, low	50% of acres, high
6050	Punalau	Waikamoi			Punalau	8.723	0.007	0.015	0.033	0.087	0.065	0.174	0.218	0.654	0.436	1.309
6031	Uaoa	Haiku		Yes	Uaoa	13.164	0.011	0.022	0.049	0.132	0.099	0.263	0.329	0.987	0.658	1.975
6004	Ukumehame	Ukumehame			Ukumehame, Puu Kauoha, Mopua	111.675	0.095	0.190	0.419	1.117	0.838	2.233	2.792	8.376	5.584	16.751
6009	Wahikuli	Honokowai				1.560	0.001	0.003	0.006	0.016	0.012	0.031	0.039	0.117	0.078	0.234
6062	Waiaaka	Keanae				3.674	0.003	0.006	0.014	0.037	0.028	0.073	0.092	0.276	0.184	0.551
6023	Waiehu	Waiehu		Yes	Waiehu, Kalaeliili, Kalepa Gulch	669.985	0.569	1.139	2.512	6.700	5.025	13.400	16.750	50.249	33.499	100.498
6022	Waihee	Waihee	Taro, Diversified	Yes	Waihee	137.295	0.117	0.233	0.515	1.373	1.030	2.746	3.432	10.297	6.865	20.594
6047	Waikamoi	Waikamoi				2.251	0.002	0.004	0.008	0.023	0.017	0.045	0.056	0.169	0.113	0.338
6001	Waikapu	Waikapu	Taro, Diversified	Yes	Waikapu	170.852	0.145	0.290	0.641	1.709	1.281	3.417	4.271	12.814	8.543	25.628
6083	Wailua	Waihoi			Wailua	12.626	0.011	0.021	0.047	0.126	0.095	0.253	0.316	0.947	0.631	1.894
6056	Wailuanui	Keanae	Taro, Pasture	Yes	Wailuanui	66.734	0.057	0.113	0.250	0.667	0.501	1.335	1.668	5.005	3.337	10.010
6080	Waiohonu	Waihoi			Waiohonu, Pukuilua Gl	16.089	0.014	0.027	0.060	0.161	0.121	0.322	0.402	1.207	0.804	2.413
6055	Waiokamilo	Keanae			Waiokamilo	0.544	0.000	0.001	0.002	0.005	0.004	0.011	0.014	0.041	0.027	0.082
6036	Waipio	Honopou	Pasture	Yes	Waipio, Waipionui	16.822	0.014	0.029	0.063	0.168	0.126	0.336	0.421	1.262	0.841	2.523
Total						3293.635	2.800	5.599	12.351	32.936	24.702	65.873	82.341	247.023	164.682	494.045

Kuleana parcels: OHA data, 2009. MDWS: Interpretation of location of kuleana parcels by watershed and stream association

Scenarios- 25% or 50% of kuleana acreage per crop; diversified ag- 3400 gpd/ac; taro consumptive use- 15000 (low) - 40000 (high) mgd; taro streamflow- 100,000 (low) - 300,000 (high) mgd

2015 Ag Baseline: crops intersecting one or more kuleana parcels; The Nature Conservancy data: Predicted Pre-Contact Irrigated Ag (1 Stream or 3 Rain+Stream) intersecting with one or more Kuleana Parcels

Appendix 9: Ka Pa'akai Analysis Research List

- Beckwith, Martha. Hawaiian Mythology. The University Press of Hawai`i, Honolulu, 1970.
- Cooper, George, and Gavan Daws. *Land and Power in Hawai`i: The Democratic Years*. Honolulu: University of Hawai`i Press, 1985. Paperback ed., 1990
- I`i, John Papa. *Fragments of Hawaiian History.* B.P. Bishop Museum Press: Honolulu, 1959.
- Kamakau, Samuel M. *Ruling Chiefs of Hawai`i.* The Kamehameha Schools Press: Honolulu (2 vols.), 1961.
- Kamakau, Samuel Manaiakalani. *The Works of the People of Old: Na Hana a ka Po`e Kahiko*. Translated from the newspaper Ke Au okoa by Mary Kawena Pukui; arranged and edited by Dorothy B. Barrere. [Honolulu]: Bishop Museum Press, 1976.
- Kame`eleihiwa, Lilikala. *Native Land and Foreign Desires,* Honolulu: Bishop Museum Press, 1992.
- Kawa`a, Luana, *Cultural Survey & Ahupua`a Inventory: Ahupua`a of Waiehu & Waihe`e, Island of Maui*, Ka Piko O Ka Na`auao (The Hawaiian Learning Center), 2009.
- Kawa`a, Luana, *Cultural Survey & Moku Inventory: Moku of Kipahulu and Hana, Island of Maui* (Draft),Ka Piko O Ka Na`auao (The Hawaiian Learning Center), 2009.
- Kawa`a, Luana, *Cultural Survey & Moku Inventory: Moku of Honua`ula & Kula, Island of Maui* (Draft),Ka Piko O Ka Na`auao (The Hawaiian Learning Center), 2009.
- Kawa`a, Luana, *Cultural Survey of the Moku of Maui: Na Wai Eha (Waikapu, Wailuku, Wailuku, Waiehu, Waihe`e) Kula, Honua`ula, Kahikinui, Kaupo, Kipahulu, and Hana, Volumes 1-4,* Ka Piko O Ka Na`auao (The Hawaiian Learning Center), 2009.
- Kawa`a, Luana, *Summary Report of Translated Land Documents: General Overview of Traditional Ahupua`a System,* Ka Piko O Ka Na`auao (The Hawaiian Learning Center), 2009.
- Kawa`a, Luana, *Cultural Survey & Ahupua`a Inventory: Ahupua`a of Waikapu & Wailuku, Island of Maui,* (Draft) Ka Piko O Ka Na`auao (The Hawaiian Learning Center), 2009.

- Kawa`a, Luana, *Cultural Survey & Moku Inventory: Moku of Honua`ula & Kula, Island of Maui* Ka Piko O Ka Na`auao (The Hawaiian Learning Center), 2009.

- Ladefoged, T.N., et al., *Opportunities and constraints for intensive agriculture in the Hawaiian archipelago prior to European contact*, J. Archaeol. Sci. (2009), doi:10.1016/j.jas.2009.06.030

- Malo, David. *Hawaiian Antiquities*. Bishop Museum Press, Honolulu, 1959.

- Matsuoka, Jon K. *Native Hawaiian Ethnographic Study For the Hawai`i Geothermal Project Proposed for Puna and Southeast Maui*. Oak Ridge; Oak Ridge National Laboratory.

- Pukui, Mary K., Samuel H. Elbert, and Esther T. Mookini. *Place Names of Hawai`i*. The University Press of Hawai`i: Honolulu, 1976.

- Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997.

- County of Maui, Planning Department. *General Plan, Maui Island Plan, Community Plans.*

- *CWRM Findings of Fact, Conclusions of Law, and Decision and Orders – Na Wai `Eha and East Maui Streams*, and related documents.

- CWRM, *Hawai`i Water Plan*, as amended.

- Department of Hawaiian Home Lands (DHHL), *Maui Island Plan* and *Regional Plans*.

- Environmental Council, State of Hawai`i (1997). *Guidelines for Assessing Cultural Impacts*.
- Forman, David M., Susan K. Serrano. *Ho`ohana Aku, a Ho`ola Aku: A legal primer for Traditional and Customary Rights in Hawai`i,* 2012.

- *Interim Instream Flow Standards (IIFS) adopted for both East and West Maui Streams*, 1988, (Sections 13-169-44 and 48, Hawai`i Administrative Rules. According to Section 13-169-46, Hawai`i Administrative Rules).

- *Ko`olau Poko Watershed Management Plan.* Honolulu Board of Water Supply, 2012.

- Miike, Lawrence. *Water and the Law in Hawai`i.* University of Hawai`i Press, 2004.

- *Native Hawaiian Rights Handbook*. Edited by Melody Kapilialoha MacKenzie. Honolulu: Native Hawaiian Legal Corporation; Office of Hawaiian Affairs. Distributed by University of Hawai`i Press, 1991.

- *Native Hawaiian Access Rights Project Phase III. Recommendations for SMA Rules and Process.* A Publication of the Hawai`i Coastal Zone Management Program, Office of Planning Department of BEDT State of Hawai`I, Final Report December 15, 2002.

- Sproat, D. Kapuaala, Ola I Ka Wai: *A legal Primer for Water Use and Management in Hawai`i.* Ka Huli Ao Center for Excellence in Native Hawaiian Law, William S. Richardson School of Law*, 2014.*

- Department of Land and Natural Resources, State of Hawai`i. *The Rain Follows The Forest Hahai no ka ua i ka ululā`au, A Plan to Replenish Hawaii`s Source of Water*, November 2011.

- CWRM. *Hawai`i Stream Assessment*, Report R84, December 1990.

Appendix 10: Generalized Assessment of Impacts of Preliminary Measures and Strategies on Traditional and Customary Practices of Native Hawaiians

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
WATERSHED AND AQUIFER PROTECTION			
1. Invasive alien plant control, ungulate (pigs, deer, etc.) control (fencing, etc.), reforestation. Implement via watershed partnership programs (DWS supports and funds programs. Leveraging state and private funding. Invasive plants and animals and ungulates disturb watershed resources and functions by displacing or removing native plants and animals, disturbing the soil, increasing runoff and sediment, and decreasing aquifer recharge potential)	Native Hawaiian rights include gathering (PASH): 1) invasive Polynesian canoe plants and other invasive non-native plant species used by cultural practitioners including trees, ferns, flowers, bark, branches, vines and fruit; 2) introduced and native animals used for food and cultural practices; and 3) native Hawaiian trees, ferns, flowers, bark, branches, vines and fruit.	1) Native Hawaiian gathering rights (PASH) are impacted by: 1) Eradicating or reducing invasive Polynesian canoe plants (kukui nut tree for example) and other invasive non-native plant species used by cultural practitioners including trees, ferns, flowers, bark, branches, vines and fruit; 2) Eradicating or reducing introduced animals used for food and cultural practices; and 3) fencing, which limits or prohibits native Hawaiian cultural practitioners from accessing areas to hunt and gather cultural resources, including stones (pohaku), and native and introduced plants and animals used for food and cultural practices. 2) Native plant and tree reforestation enhances natural ecosystem health and increases underground fog drip flows, which helps support thriving native Hawaiian ecosystems from forests to reefs, thereby providing	1) Per PASH court decision, native Hawaiians should be allowed gathering and access rights in areas where cultural resources exist. Incorporate gathering access points into watershed fencing. 2) Fencing should be installed in remote areas inaccessible to hunters. This typically applies to higher elevation fencing above 3,000 feet but is not as easy to accomplish in the lower elevations. 3) Obtain input from individuals and groups familiar with the areas fences are to be constructed. 4) Fences and access points need to have signs posted that warn hunters that active feral ungulate animal control is in progress and that the area may

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
		more abundant resources for native Hawaiian cultural practitioners. Based on discussions with East Maui residents in the EIS planning phase of the East Maui Watershed Fenceline, fences above the 3,000 foot elevation are unlikely to be encountered due to the fact animals are caught well before anyone needs to traverse higher up the mountain.	be hazardous to dogs due to the control methods being employed, i.e. the use of tools and methods that may be fatal to pets and hunting dogs. 5) State land above constructed fences in the forest reserves should have signage that indicates it remains classified as "public hunting," and hunters should still be permitted to enter the areas for subsistence purposes. 6) Watershed programs and watershed plan development should incorporate advisors with expertise in native Hawaiian cultural practices. 7) Support conservation land trusts, nonprofit organizations that undertake or assist in land or conservation easement acquisition or stewardship of land or easements. 8) Strategy 2, expanding watershed protection to lower elevations could foster productive environments to

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
			produce more cultural resources at lower elevations. 9) Strategy 3, ahupua`a management, if it creates more connectivity and includes native Hawaiian access rights. Strategy 5, native Hawaiian consultations, are an opportunity to address gathering and use access.
2. Expand watershed protection to lower elevations (Programs now focus on higher elevations (3000+)	1) Native Hawaiian rights include gathering (PASH) - See Footnote 1. 2) Increased access to hunters may help control feral ungulate damage in the lowland native forests.	1) Expanding watershed protection to lower elevations could foster productive environments to produce more of the resources available at higher elevations. 2) Expands invasive alien plant and ungulate control conflicts stated in Strategy 1 to lower elevations. 3) Expands reforestation benefits and potential conflicts in Strategy 1 to lower elevations.	Same as Strategy 1 mitigations, applied to lower elevations.
3. Ahupua'a watershed-based planning and management approach (Ridge to ocean approach focused on stream systems)	Native Hawaiian rights include gathering (PASH) - See Footnote 1.	No adverse impacts. Ahupua`a management creates more connectivity. Strategy supports PASH court decision.	No mitigation necessary. Indigenous resource management practices should be integrated with western management practices in each moku. Strategy can be strengthened by: 1) Support conservation land trusts, nonprofit organizations

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
			that undertake or assist in land or conservation easement acquisition or stewardship of land or easements.
4. Consultation with Native Hawaiian community and local experts on resource management (Water representative of each moku, advisory role and partnership)	Native Hawaiian rights include gathering (PASH) - See Footnote 1.	1) Due diligence consultation with native Hawaiian communities and expertise should have a positive impact upon the access to and management of natural resources used by cultural practitioners. 2) Competing resource utilization could occur as a result of expanding access to more practitioners, as a result of actions resulting from consultation.	No mitigation necessary. The consultation process should ensure diverse, holistic, and comprehensive consultation with the larger native Hawaiian community in addition to the aha mokus.
5. Scientific studies to support decision making (Study hydrogeologic and ecological conditions; increased monitoring)	Native Hawaiian rights impacted by ground or surface water use.	Improved understanding of ground and water resource benefits resource management and potentially improves understanding of impacts on native uses.	No mitigation necessary.
6. Use drought conditions as baseline to evaluate water supply and effects of water use (Determine projections to use; may vary geographically.)	1) Auwai systems that travel great distances from the stream and do not return water to the stream. 2) Native Hawaiian rights impacted by ground or surface	No adverse impacts. 1) Using drought conditions as a baseline would be more protective over use of average conditions as presently occurs. Long-term hydrologic drought could impact sustainable yield of groundwater which is interconnected with surface water resources.	No mitigation necessary.

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
	water use during drought conditions.	2) If drought conditions were used as a baseline for IIFS or sustainable yield, if drought conditions do not supply sufficient flow to auwai's, if restrictions limit auwai use, or if certain auwai systems are deemed "non- instream uses," kalo growers and other native Hawaiian cultural crops could be impacted.	
7. Quantify the impact of watershed management on groundwater recharge and distribute funding proportionally (Prioritize efforts by impact, expand funding from private purveyors, state and other beneficiaries.)	Native Hawaiian rights include gathering (PASH) - See Footnote 1.	No adverse impacts. Quantifying the impact of groundwater recharge, which relates to base streamflow, can assist in monitoring whether programs that support healthy watershed conditions and accordingly cultural practices are beneficial.	No mitigation necessary.
8. Improved ground and surface water resources and diversion monitoring by CWRM	--	No adverse impacts. Improved monitoring supports effective protection of resources.	No mitigation necessary.
9. Restrict land uses with high risk of well contamination near drinking water wells (Proposed Wellhead Protection ordinance based on the capture zone of well)	Traditional animal husbandry such as keeping pigs and goats.	Locations with traditional animal husbandry could be impacted by their proximity to groundwater resources and restrictions implemented to protect drinking water wells. http://co.maui.hi.us/222/Wellhead-Protection	1) Ensure regulations do not prohibit non-commercial operations consistent with traditional and customary native Hawaiian rights. Allow

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
			limited numbers of animals in close proximity to wells.[2]
10. Protect and recharge ground water during non-drought periods to stabilize supply (Reduce pumping- increased surface water use after public trust uses are met, aggressive conservation and alternative sources)	Kuleana farmers dependent on auwai's and diversions grow kalo and other plants used by cultural practitioners.	Protection of groundwater resources which contributes to base streamflow is beneficial. Potential secondary impacts may occur relating to increased surface water use after public trust uses are met (Strategy 13).	1) Strategy 8, improved CWRM monitoring.
11. No new stream diversions for non-instream uses until interim flow standards are adopted. (Could extend to no new diversion or increased diversion)	Kuleana farmers dependent on auwai's and diversions grow kalo and other plants used by cultural practitioners. Auwai systems that travel great distances from the stream and do not return water to the stream.	No adverse impacts. Areas and resources used to gather will be expanded and return of base streamflow will facilitate native Hawaiian cultural practitioners by supporting a thriving native ecosystem that supports cultural practices with its abundance of resources produced.	No mitigation necessary.
12. Stream restoration- municipal and agricultural water returned to stream (Decrease municipal and agricultural use of streams)	1) Native Hawaiian gathering rights (PASH) - See Footnote 1. 2) Agricultural water users who receive surface water and grow crops such as Polynesian canoe	No adverse impacts. The intent of this strategy is to reduce diversion by large ag users and municipal users during low flow conditions.	No mitigation necessary.

[2] Within the proposed regulated areas, the proposed Wellhead Protection Ordinance would allow the following located more than 50 feet from wells or well fields that supply public water systems: a lot or facility (other than an aquatic animal production facility) where animals will be stabled or confined and fed or maintained for a total of 45 days or more in any 12 month period, and where crops, vegetation forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility (excludes pasture).

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
	plants, non-native plant species, and native plants used by cultural practitioners.	1) Native Hawaiian gathering rights (PASH) are positively impacted by increased stream flows due to enhancing instream growth of: 1) invasive Polynesian canoe plants and other invasive non-native plant species used by cultural practitioners including trees, ferns, flowers, bark, branches, vines and fruit; 2) introduced animals used for food and cultural practices; and 3) native and introduced plants and animals used for food and cultural practices. 2) Return of base streamflow generally facilitates native and non-native plant and animal life within the stream, thereby providing more abundant resources for native Hawaiian cultural practitioners. 3) Cultural practioners and resources along long-diverted streams may be affected by potential flooding associated with removal of diversions 4) If base flows are returned to the streams and restrictions are placed upon lo`i kalo waters that are	

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
		returned to the stream after use (i.e. not geographically removed due to auwai systems separated by distances from the stream); cultural practitioners may be affected. Alternatively, water pipes can be used to return water to the streams for those practitioners whose auwai systems move water significant distances from the stream. 5) As the strategy is intended, cultural practitioners located in areas such as the Kula Agricultural Park that receive untreated agricultural water would not be negatively impacted.	
CONVENTIONAL WATER SOURCE DEVELOPMENT			
13. Increase use of surface water for municipal needs during wet season when all public trust uses are satisfied, including kuleana and traditional and cultural users. (Expand treatment facilities and obtain reservoirs. Permitting and dam liability issues.)	Agricultural water users who receive treated water through surface water sources and grow crops such as Polynesian canoe plants, native plants and non-native plant species used by cultural practitioners.	1) The measure proposes to use surface water *in excess* of the base flow necessary for kuleana and public trust uses and should therefore *not* impact native Hawaiian agricultural and traditional and customary uses. 2) The measure may reduce water flowing to the ocean during the wet season, thereby affecting nearshore	1) Consider potential effects to nearshore ecosystems for areas potentially affected by reduced stream water prior to increased diversion. 2) Strategy 8, improved CWRM monitoring.

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
		ecosystems and cultural resources.	
14. When IFS adopted protecting kuleana and instream uses, then support water transport for diversified ("sustainable") agriculture (Support diversified ag economy with low cost untreated source)	Diversified agriculture farming.	No adverse impacts. This is a policy statement indicating a priority for water transport for diversified ag over other nonpublic trust uses. Supports availability of water for Native Hawaiian diversified farming; provide low cost untreated source reducing dependence on potable water in some areas.	No mitigation necessary.
15. Increase county oversight of well drilling in non-designated groundwater management areas (Holistic review including water quality, quantity and land use impact addressed before well construction permit issued)	Kuleana and cultural uses in East Maui, Na Wai `Eha and West Maui.	The intent of this strategy is to increase the meaningful evaluation of and opportunity for input on wells in non-designated areas. It was suggested at community meetings that an early process led by the County could assist in addressing the problem. CWRM well and pump permits are required for all wells, with notice provided on the CWRM website; any party may request to be placed on the notification list. 1) Wells may adversely affect spring and other well water availability and quality. 2) Kuleana and cultural users reliant upon streams could be negatively affected by reduced base flows feeding streams and springs due to	This strategy should be redefined. Encourage CWRM to increase analysis of well permits, including spatial distribution and evaluation of well impacts on quantity and quality of nearby water resources. Amendment to state law may be required to grant the County authority to undertake a large role in the well permit process.

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
		nearby wells with hydrogeological connections.	
16. Manage well development and operations to reduce seawater intrusion and chlorides	Native Hawaiian stream users.	No adverse impacts. Increased reliance on well water could translate into decreased reliance on surface water, positively impacting Native Hawaiian rights and resources.	No mitigation necessary.
17. Ha`iku aquifer well development (Potential resource/medium-term; within sustainable yield. For regional use and transport to growth areas.)	Kuleana and cultural uses in East Maui.	Increased ground water withdrawal potentially affecting streams and near shore ecosystems.	Ha`iku aquifer: Maintain buffer to sustainable yield pending IFS and USGS studies of the interaction between ground and surface water and potential impact from pumpage on stream flows. All well development: 1) Strategy 15, increase oversight of well distribution in non-designated groundwater management areas. 2) Strategy 5, scientific studies. 3) Strategy 8, improved CWRM monitoring. 4) Strategy 10, protect and recharge ground water during non-drought periods to stabilize supply. 5) Strategy 16, manage well development and operations to reduce seawater intrusion and chlorides.

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
			6) Strategies 38-60, alternative water sources, conservation to reduce source development needs.
18. Makawao aquifer basal well development at 1500 ft + elevation for growth and backup regionally (Aquifer not well studied. High elevation pumping costs)	No perennial streams west of Maliko; no known kuleana uses. Potential gathering and cultural uses.	1) Regional use of basal groundwater. 2) Reduction of transport from water abundant to dryer areas would maintain more water in the streams of wet areas which supports Native Hawaiian cultural and kuleana users who depend on surface water.	Same as all well development mitigation for Measure 17.
19. Waikapu Aquifer basal well development (Private wells drilled for available sustainable yield)	Kuleana and cultural uses in Na Wai `Eha.	1) Increased ground water withdrawal potentially affecting streams and near shore ecosystems. 2) Reduction of transport from water abundant to dryer areas would maintain more water in the streams of wet areas which supports Native Hawaiian cultural and kuleana users who depend on surface water.	Same as all well development mitigation for Measure 17.
20. Waihe`e Aquifer basal well development  (High capital cost, smaller wells for limited yield of N Waihe`e per USGS study)	Kuleana and cultural uses in Na Wai `Eha.	1) Increased ground water withdrawal potentially affecting streams and near shore ecosystems. 2) Reduction of transport from water abundant to dryer areas would maintain more water in the	Same as all well development mitigation for Measure 17.

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
		streams of wet areas which supports Native Hawaiian cultural and kuleana users who depend on surface water.	
21. High level well development (within sustainable yield) (Avoid transport between aquifer units)	Kuleana and cultural uses in East Maui and Na Wai `Eha.	Kuleana and cultural users of streams could be affected by reduced base flows primarily fed by high level water.	Same as all well development mitigation for Measure 17.
22. Honopou, Waikamoi, Ke`anae basal well development (Extend transmission for medium elevation well development. Aquifers not studied, sustainable yield likely to be adjusted down)	Kuleana and Native Hawaiian cultural uses in East Maui.	Increased ground water withdrawal potentially affecting streams and nearshore ecosystems.	Same as all well development mitigation for Measure 17.
23. Kamaole Aquifer, basal well development (Brackish wells for non-potable uses for new development. Dual or private systems Brackish quality appropriate for irrigation, desal and other nonpotable uses. Reported pumpage incomplete to assess available sustainable yield)	Nearshore native Hawaiian cultural practitioners' resources.	Nearshore ecosystem could be affected by a potential reduction in freshwater mixing with seawater.	Same as all well development mitigation for Measure 17.
24. Honokowai aquifer well development (within sustainable yield)	Kuleana and cultural uses in West Maui.	1) Increased ground water withdrawal potentially affecting streams and nearshore ecosystems.	Same as all well development mitigation for Measure 17.

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
(Avoid transport between aquifer units; Honokowai may be close to sustainable yield)		2) Reduction of transport from water abundant to dryer areas would maintain more water in the streams of wet areas which supports Native Hawaiian cultural and kuleana users who depend on surface water.	
25. Honolua aquifer well development (within sustainable yield) (Transmission to growth area within aquifer sector; optimize well/aquifer management)	Kuleana and cultural uses in West Maui.	1) Increased groundwater withdrawal potentially affecting streams and nearshore ecosystems. 2) Reduction of transport from water abundant to dryer areas would maintain more water in the streams of wet areas which supports Native Hawaiian cultural and kuleana users who depend on surface water.	Same as all well development mitigation for Measure 17.
26. Launiupoko aquifer wells development (within sustainable yield) (Reduce demand on Honokowai aquifer- optimize well/aquifer management)	Kuleana and cultural uses in West Maui.	Increased ground water withdrawal potentially affecting streams and nearshore ecosystems.	Same as all well development mitigation for Measure 17.
27. Add raw surface water storage at Kamole, Olinda or Pi'iholo Water Treatment Facilities	1) Kuleana and native Hawaiian cultural uses due to continued diversions.	1) Kuleana and native Hawaiian cultural uses could be enhanced by reducing diversion and enhancing	1) Strategy 10, protect and recharge ground water during non-drought periods to stabilize supply.

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
(IFS, EMI diversion permits, EMI contract, land and critical watershed issues)	2) Native Hawaiian rights including gathering (PASH) - See Footnote 1.	continuous streamflow due to increased storage capabilities. 2) Native Hawaiian gathering rights (PASH) are impacted by reduced instream abundance of cultural resources: 1) Polynesian canoe plants and other invasive non-native plant species used by cultural practitioners including trees, ferns, flowers, bark, branches, vines and fruit; and 2) native and introduced plants and animals used for food and cultural practices.	2) Strategy 11, no new or increased stream diversions on East Maui streams for non-instream uses until interim flow standards are adopted. 3) Strategy 14, when IFS adopted, protecting kuleana and instream uses, support water transport for diversified ("sustainable") agriculture.
28. Increase capacity at 'Iao Water Treatment Facility for wet season use (Appurtenant rights, water use permits)	1) Kuleana and native Hawaiian cultural uses due to continued diversion. 2) Native Hawaiian rights including gathering (PASH) - See Footnote 1.	Native Hawaiian gathering rights (PASH) are impacted by reduced instream abundance of cultural resources: 1) Polynesian canoe plants and other invasive non-native plant species used by cultural practitioners including trees, ferns, flowers, bark, branches, vines and fruit; and 2) native and introduced plants and animals used for food and cultural practices.	Same as mitigation for Measure 28.
29. Increase capacity at Kamole Water Treatment Facility for wet season use (Flow characteristics of Wailoa Ditch and intake structure configuration,	1) Kuleana and native Hawaiian cultural uses due to continued diversion. 2) Native Hawaiian rights including gathering (PASH) - See Footnote 1.	Native Hawaiian gathering rights (PASH) are impacted by reduced instream abundance of cultural resources: 1) Polynesian canoe plants and other invasive non-native plant species used by cultural practitioners	Same as mitigation for Measure 28.

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
IFS, EMI diversion permits, EMI contract)		including trees, ferns, flowers, bark, branches, vines and fruit; and 2) native and introduced plants and animals used for food and cultural practices.	
30. Connect Kamole WTF to Central Maui System	1) Kuleana and native Hawaiian cultural uses due to continued diversion. 2) Native Hawaiian rights including gathering (PASH) - See Footnote 1.	Native Hawaiian gathering rights (PASH) are impacted by reduced instream abundance of cultural resources: 1) Polynesian canoe plants and other invasive non-native plant species used by cultural practitioners including trees, ferns, flowers, bark, branches, vines and fruit; and 2) native and introduced plants and animals used for food and cultural practices.	Same as mitigation for Measure 28.
31. Expand Mahinahina WTF (Obtain MLP reservoirs; upfront costs)	1) Kuleana and native Hawaiian cultural uses due to continued diversion. 2) Native Hawaiian rights including gathering (PASH) - See Footnote 1.	Native Hawaiian gathering rights (PASH) are impacted by reduced instream abundance of cultural resources: 1) Polynesian canoe plants and other invasive non-native plant species used by cultural practitioners including trees, ferns, flowers, bark, branches, vines and fruit; and 2) native and introduced plants and animals used for food and cultural practices.	Same as mitigation for Measure 28.
INCREASE WATER SYSTEM RELIABILITY & FLEXIBILITY			
32. Develop and maintain back-up wells even if more expensive	Kuleana and cultural uses in East Maui and Na Wai `Eha.	No adverse impacts. Kuleana and cultural uses in East Maui and Na Wai `Eha could be enhanced by others'	Same as mitigation for Measure 17.

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
(Drought, equipment failure, chlorides or other source or supply problems. Avoid use restrictions)		reduction in dependence on surface water use.	
33. Develop wells for increased reliable source Upcountry (reduce surface water transport) (Drought, equipment failure, chlorides or other source or supply problems. Avoid use restrictions and mitigate stream use in dry season)	East Maui Native Hawaiian cultural practitioners' resources.	Potential decreased use of surface water resulting in less transport.	Same as mitigation for Measure 17.
34. Diversify to the most cost-effective combination of groundwater, surface water, and aggressive conservation (Policy statement. Some temporary cutbacks acceptable in situations of drought/equipment failure)	Kuleana and cultural uses in East Maui and Na Wai `Eha.	Kuleana and cultural uses in East Maui and Na Wai `Eha could be affected if surface water is deemed more cost-effective and is not returned to the streams.	Same as mitigation for Measure 17.
35. Require private public systems to develop in a manner facilitating potential interconnection with Maui DWS systems or integrated management (Amend County Code; increase costs of private systems)	---	No adverse impacts. Policy statement.	No mitigation necessary.
36. Increase connection between Maui DWS subdistricts	Kuleana and cultural uses in East and West Maui and Na Wai `Eha.	1) Increased connection which facilitates development may result	1) Strategy 11, no new or increased stream diversions for

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
		in increased use of water resources, including surface water, affecting kuleana and cultural uses. 2) Increased connection which improves efficiency of use may result in decreased use of water resources.	non-instream uses until interim flow standards are adopted. 2) Strategy 13, increase use of surface water for municipal needs during wet season when all public trust uses are satisfied, including kuleana and traditional and cultural users.
37. Expand capacity of Water Treatment Plants for seasonal use	Kuleana and cultural uses in East and West Maui and Na Wai `Eha.	Kuleana and cultural uses could be affected if surface water use increases.	1) Strategy 11, no new or increased stream diversions for non-instream uses until interim flow standards are adopted. 2) Strategy 13, increase use of surface water for municipal needs during wet season when all public trust uses are satisfied, including kuleana and traditional and cultural users.
INCREASE ALTERNATIVE RESOURCES			
38. Maximize R-1 reclaimed wastewater system capacity and use (Limited supply, relatively high cost, less reliable. Minimize underground injection)	Nearshore native Hawaiian cultural practitioners' resources.	More R-1 production could decrease use of surface water, but use of injection wells may potentially increase pollution impacts to nearshore water resources of native Hawaiian cultural practitioners. Increasing the use of R-1 water, rather than injection, should reduce impacts.	1) Obtain and conform to NPDES permit requirements addressing discharges (injection). 2) Offset injection by maximizing beneficial use of excess recycled water (e.g., expand use requirements, land

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
			application, potential to treat to drinking water standards, etc.).
39. Expand requirement for commercial properties within 100 feet of reclaimed water system to connect and use R-1 water for landscape irrigation (Amend Maui County Code, Chapter 20.30- requires connection within 100 feet)	Nearshore native Hawaiian cultural practitioners' resources.	More R-1 production and use could decrease use of surface water, but use of injection wells may potentially increase pollution impacts to nearshore water resources of native Hawaiian cultural practitioners. Expanding requirements for use of R-1 water will reduce injection.	1) Obtain and conform to NPDES permit requirements addressing discharges (related to injection). 2) In addition to increasing use requirements, offset injection by maximizing beneficial use of excess recycled water (e.g., land application, potential to treat to drinking water standards, etc.).
40. Expand R-2 Kahului Wastewater Treatment Facility distribution and/or upgrade to R-1 (Upgrade to R-1 needed, limited service areas)	Nearshore native Hawaiian cultural practitioners' resources.	More recycled water production and use could decrease use of surface water on Central isthmus, but use of injection wells may potentially increase pollution impacts to nearshore water resources of native Hawaiian cultural practitioners.	Same as mitigation for Strategy 38.
41. Expand R-1 system from Kihei Wastewater Treatment Facility (Committed service connections in dry season use leaves 0.7 mgd unused capacity. Restricted nonpotable uses)	Nearshore native Hawaiian cultural practitioners' resources.	More R-1 production and use could decrease use of surface water, but use of injection wells may potentially increase pollution impacts to nearshore water resources of native Hawaiian cultural practitioners.	Same as mitigation for Strategy 38.

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
42. Implement R-1 expansion from Mahinahina Wastewater Treatment Facility (Offset potable water use)	Nearshore native Hawaiian cultural practitioners' resources.	More R-1 production and use could decrease use of surface water, but use of injection wells may potentially increase pollution impacts to nearshore water resources of native Hawaiian cultural practitioners.	Same as mitigation for Strategy 38.
43. Program to use small greywater systems for small residential/commercial (Amend State and possibly County regulations)	--	No adverse impacts. Positive impacts may occur if resulting in reduced ground and surface water use and transport.	No mitigation necessary.
44. Incentives for residential/small commercial catchment systems (Roof, tank, underground storage systems can be used for landscape water use. Water quality issues)	--	No adverse impacts. Positive impacts may occur if resulting in reduced ground and surface water use and transport.	No mitigation necessary.
45. Low impact project design for onsite water retention (Permeable surfaces, etc. Amend County code. Cost effective)	--	No adverse impacts. Positive impacts may occur if resulting in reduced ground and surface water use and transport.	No mitigation necessary.
46. Desalination of brackish or sea water for agricultural irrigation (Energy costs. Disposal of brine)	Kuleana and cultural uses in East and West Maui and Na Wai `Eha.	1) Potential pollution impacts from brine disposal to nearshore water resources of native Hawaiian cultural practitioners. 2) Positive impacts may occur if kuleana and cultural uses have	Obtain and conform to NPDES permit requirements addressing discharges (brine).

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
		access to more water due to decreased surface water use and reduced transport of surface water.	
47. Maintain/manage plantation ditch systems for continued potable and non-potable water conveyance (Invest in existing systems, resolve ownership, management issues)	Kuleana and cultural uses in East and West Maui and Na Wai `Eha.	1) Continued use of ditch systems perpetuates transport of surface water (and limited groundwater). 2) Continued use of ditch systems facilitates conveyance to some to kuleana and cultural uses.	1) Strategy 11, no new or increased stream diversions for non-instream uses until interim flow standards are adopted. 2) Strategy 13, increase use of surface water for municipal needs during wet season when all public trust uses are satisfied, including kuleana and traditional and cultural users.
48. Stormwater reuse (Capture flash supply as raw water storage for treatment or utilize reservoirs to store irrigation supply for diverse ag)	Kuleana and cultural uses in East and West Maui and Na Wai `Eha.	1) Positive impacts may occur if kuleana and cultural uses have access to more water due to decreased surface water use and reduced transport of surface water. 2) Reductions in nonpoint flow to the ocean serving nearshore resources would be mitigated by capturing only 'flash' stormwater.	Ensure capture limited to flash supply without impacts to streamflow or nearshore resources.
INCREASE CONSERVATION			
49. WaterSense (water efficiency) standard for new development and existing retrofits (Amend County code. 20%-30% more water efficient than standard)	Kuleana and cultural uses in East Maui and Na Wai `Eha, and West Maui.	No adverse impacts. Kuleana and cultural uses could be enhanced by a reduction in dependence on surface water use through conservation.	No mitigation necessary.

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
50. Retrofit programs for existing development (Rebate, retrofit, give-away programs for residential and small commercial uses)	Kuleana and cultural uses in East Maui and Na Wai `Eha, and West Maui.	No adverse impacts. Kuleana and cultural uses could be enhanced by a reduction in dependence on surface water use through conservation.	No mitigation necessary.
51. Outdoor water wasting and use controls (Amend County code, disallow overspray, washing without hose nozzle, etc.)	Kuleana and cultural uses in East Maui and Na Wai Eha, and West Maui.	No adverse impacts. Kuleana and cultural uses could be enhanced by a reduction in dependence on surface water use through conservation.	No mitigation necessary.
52. Water conserving landscape requirements for resorts, golf courses, public facilities (Amend County code to set standard)	Kuleana and cultural uses in East Maui and Na Wai Eha, and West Maui.	No adverse impacts. 1) Kuleana and cultural uses in could be enhanced by a reduction in dependence on surface water use through conservation. 2) Nearshore water cultural resources may benefit from better water/nutrient management practices.	No mitigation necessary.
53. Incentive programs to convert existing landscape to water conserving (Turf removal programs for example)	Kuleana and cultural uses in East Maui and Na Wai Eha, and West Maui.	No adverse impacts. Beneficial impacts same as Measure 52.	No mitigation necessary.
54. Require climate adapted plants for large new developments	Kuleana and cultural uses in East Maui and Na Wai Eha, and West Maui.	No adverse impacts. Beneficial impacts same as Measure 52.	No mitigation necessary.

Preliminary Measures and Strategies	Extent to which traditional and customary native Hawaiian rights are exercised in the area which may be affected	Extent to which those resources and rights will be affected or impaired by the proposed measure	Feasible action to be taken to reasonably protect native Hawaiian cultural resources if they are found to exist.
55. Require aggressive conservation in new development in all areas (Craft program to carry out policy)	Kuleana and cultural uses in East Maui and Na Wai Eha, and West Maui.	No adverse impacts. Beneficial impacts same as Measure 52.	No mitigation necessary.
56. More aggressive landscape water conservation measures in dry areas than wet areas (Some standards or programs vary geographically)	Kuleana and cultural uses in East Maui and Na Wai Eha, and West Maui.	No adverse impacts. Beneficial impacts same as Measure 52.	No mitigation necessary.
57. Pursue a policy of aggressive water conservation at all times (not just during drought) (Craft program to carry out policy)	Kuleana and cultural uses in East Maui and Na Wai Eha, and West Maui.	No adverse impacts. Beneficial impacts same as Measure 52.	No mitigation necessary.
58. Use water rates as means to encourage conservation (Tiered pricing can have this effect; equity is an issue)	Kuleana and cultural uses in East Maui and Na Wai Eha, and West Maui.	No adverse impacts. Beneficial impacts same as Measure 52.	No mitigation necessary.
59. Surface water efficiency programs (Improvements to diversions, conveyances, storage, meters to reduce loss)	Kuleana and cultural uses in East Maui and Na Wai Eha, and West Maui.	No adverse impacts. Beneficial impacts same as Measure 52.	No mitigation necessary.
60. Reduce water loss of potable and nonpotable systems	Kuleana and cultural uses in East Maui and Na Wai Eha, and West Maui.	No adverse impacts. Beneficial impacts same as Measure 52.	No mitigation necessary.

Notes:

1. Native Hawaiian rights include gathering (PASH): A) invasive Polynesian canoe plants (e.g. kukui nut tree) and other invasive non-native plant species used by cultural practitioners including trees, ferns, flowers, bark, branches, vines and fruit; B) introduced and native animals used for food and cultural practices; and

C) native Hawaiian trees, ferns, flowers, bark, branches, vines and fruit.

2. Existing tools and processes to protect water resources and Native Hawaiian rights and resources are not stated here such as monitoring permit applications and proceedings, public access preservation, conservation land trusts, and other actions. For example, CWRM provides information on its website regarding permitting and notification of public notices, and its staff can be apprised of well use and diversion issues, and the Hawai'i State Ombudsman may be consulted on actions that may potentially affect or harm Native Hawaiian traditional and customary rights or practices.

3. Increased conservation, use of alternative sources (Strategies 39-61) reduce impacts to ground and surface water resources and are therefore generally applicable to a number of strategies. However these strategies are not always referenced as mitigation.

Prepared by County of Maui Department of Water Supply, Water Resources and Planning Division

ACRONYMS

CWRM: Commission on Water Resource Management

DOA: State of Hawai'i Department of Agriculture

DHHL: Department of Hawaiian Home Lands

DLNR: Department of Land and Natural Resources

DWS: Department of Water Supply (Maui County)

GPD: gallons per day

HC&S: Hawaiian Commercial and Sugar Company

HRS: Hawai'i Revised Statutes

HAR: Hawaii Administrative Rules

IFS: Instream Flow Standards

IIFS: Interim Instream Flow Standards

MCDWS, MDWS: Maui County Department of Water Supply

MGD: million gallons per day

MIP: Maui Island Plan

USGS: U.S. Department of the Interior, U.S. Geological Survey

WUDP: Water Use and Development Plan

REFERENCES

Beckwith, Martha. Hawaiian Mythology. The University Press of Hawai'i, Honolulu, 1970.

Carey W. King, Ph. D., *A Systems Approach for Investigating Water, Energy, and Food Scenarios in East-Central Maui.* University of Texas at Austin, November 2013.

Cheng, C.L., *Low-flow characteristics of streams in the Lahaina District, West Maui, Hawaiʻi: U.S. Geological Survey Scientific Investigations Report 2014–5087*, 2014, http://dx.doi.org/10.3133/sir20145087

Cheng, C.L., *Low-flow characteristics for streams on the Islands of Kauaʻi, Oʻahu, Molokaʻi, Maui, and Hawai'i, State of Hawaiʻi*: U.S. Geological Survey Scientific Investigations Report 2016-5103, 2016, http://dx.doi.org/10.3133/sir20165103.

Cheng, C.L., *Measurements of seepage losses and gains, East Maui Irrigation diversion system, Maui, Hawaii: U.S. Geological Survey Open-File Report 2012–1115,* 2012. http://pubs.usgs.gov/of/2012/1115/of2012-1115_full-text.pdf

Cooper, George, and Gavan Daws. *Land and Power in Hawai'i: The Democratic Years*. Honolulu: University of Hawai'i Press, 1985. Paperback ed., 1990.

County of Maui, Department of Water Supply, *Central/South Maui Desalination Feasibility Study*, *Final Report*. Brown and Caldwell for Department of Water Supply, December 2006.

County of Maui Drought Mitigation Strategies, Wilson Okamoto Corporation, October 2004 (Updated June 2012) for CWRM and Maui Drought Committee.

County of Maui Environmental Management Dept., Wastewater Reclamation Division, Various Reports.

County of Maui Environmental Management Dept., Wastewater Reclamation Division 2013 *Update of the Hawai'i Water Reuse Survey and Report*, State of Hawai'i, 2012.

County of Maui Multi-Hazard Mitigation Plan, Tetra Tech for Maui County Civil Defense Agency, 2015.

County of Maui, Planning Department, Long Range Planning Division, *Socio-Economic Forecast*, 2014 Final.

CWRM, *Declarations of Water Use, Volumes 1 and 2, Circular C-123*, September 1992.

CWRM, 'Iao Ground Water Management Area High-Level Source Water-Use Permit Applications and Petition to Amend Interim Instream Flow Standards of Waihe'e River and Waiehu, 'Iao, and Waikapu Streams Contested Case No. CCH-MAO6-O1.

CWRM East Maui Streams Contested Case No. CCH-MA 13-01
http://files.hawaii.gov/dlnr/cwrm/cch/cchma1301/CCHMA1301-20160115-HO-D&O.pdf

CWRM Meeting, January 22, 2104.
http://files.hawaii.gov/dlnr/cwrm/submittal/2014/sb201401D1.pdf

CWRM, *Na Wai 'Ehā Provisional Order on Claims That Particular Parcels Have Appurtenant Rights* (CCH-MA 13-02).

CWRM, *Hawai'i Stream Assessment, A Preliminary Appraisal of Hawai'i's Stream Resource*s, 1992, Report R84. http://files.hawaii.gov/dlnr/cwrm/publishedreports/R84_HSA.pdf

CWRM, Staff Submittal June 17, 2016.
http://files.hawaii.gov/dlnr/cwrm/submittal/2016/sb20160617C3.pdf

CWRM Staff Submittal, *Stream Diversion Works Permit (SDWP.4175.6) Wailuku River*, Maui, August 16, 2016.

CWRM, *The State Water Projects Plan Update, Hawai'i Water Plan, Department of Hawaiian Homelands, Advance Final Report*, July 2016.

CWRM Monitoring Data, http://files.Hawai'i.gov/dlnr/cwrm/monitoringdata/dmw_infos.pdf.

CWRM Reports, 2016. *CWRM Water Use Permits for 'Iao Aquifer System Area*, July 18, 2016.

CWRM Well Database.

Department of Health, Safe Drinking Water Branch, Sanitary Surveys.

Department of Land and Natural Resources, State of Hawai'i. *The Rain Follows The Forest Hahai no ka ua i ka ululā'au, A Plan to Replenish Hawaii's Source of Water*, November 2011.

Department of Hawaiian Home Lands (DHHL), Maui Island Plan and Regional Plans.

Division of Aquatic Resources Aquatic Surveys Database.
http://www.Hawai'i.gov/dlnr/dar/streams/stream_data.htm

EcoAdapt. *Climate Changes and Trends for Maui, Lāna'i, and Kaho'olawe.* Prepared for the Hawaiian Islands Climate Synthesis Project, 2016.

Effects of Agricultural Land-Use Changes and Rainfall on Ground Water Recharge in Central and West Maui, U.S. Department of the Interior, U.S. Geological Survey for County of Maui

Department of Water Supply, 1926-2004.

Federal Safe Drinking Water Act

Forman, David M., Susan K. Serrano. *Ho'ohana Aku, a Ho'ola Aku: A legal primer for Traditional and Customary Rights in Hawai'i,* 2012.

Garza, J.A., P.-S. Chu, C.W. Norton, and T.A. Schroeder *Changes of the prevailing trade winds over the islands of Hawai'i and the North Pacific. Journal of Geophysical Research*, 117, D11109, doi:10.1029/2011JD016888, (2012).

Gingerich, S.B., and Engott, J.A., 2012, *Groundwater availability in the Lahaina District, West Maui, Hawaii: U.S. Geological Survey Scientific Investigations Report 2012–5010*.

Gingerich, S.B., 2005, *Median and Low-Flow Characteristics for Streams under Natural and Diverted Conditions, Northeast Maui, Hawaii: Honolulu, HI, U.S. Geological Survey, Scientific Investigations Report 2004-5262*, http://pubs.usgs.gov/sir/2004/5262/pdf/sir2004-5262.pdf

Gingerich, S.B. and Oki, D.S., 2000, *Ground Water in Hawai'i: U.S. Geological Survey, Fact Sheet 126-00.*

Gingerich, S.B., Yeung, C.W., Ibarra, T.N., and Engott, J.A., 2007, *Water use in wetland kalo cultivation in Hawai'i: U.S. Geological Survey Open-File Report 2007-1157*.

Grubert, King and Webber, *Water for Biomass-based Energy on Maui, Hawaii*, 2011, http://www.academia.edu/1645956/Water_for_Biomass-based_Energy_on_Maui_Hawaii

Haia, Moses. *Protecting and Preserving Native Hawaiian Water Rights*. University of Hawai'i at Manoa http://www.hawaii.edu/ohelo/resources/AluLikeWorkbook/Chap7.pdf

Hawai'i Drought Plan, 2005 Update, State of Hawai`i Department of Land & Natural Resources, Commission on Water Resource Management.

Hawai'i Administrative Rules (HAR)

Hawai'i Community Foundation, *Hawai'i Fresh Water Initiative, A Blueprint for Action: Water Security for an Uncertain Future, 2016 – 2018*, 2015 http://www.Hawaiicommunityfoundation.org/strengthening/fresh-water

Hawai'i Data Book, Department of Business, Economic Development and Tourism (DBEDT).

Hawai'i Department of Agriculture (HDOA), 2/29/16. http://hdoa.hawaii.gov/wp-content/uploads/2013/02/IAL-voluntary-summary-e14_rev2-29-16.pdf

Hawai'i Department of Agriculture (HDOA), *Agricultural Water Use and Development Plan (AWUDP) update presentation*, October 23, 2013 HWWA Conference.

Hawai'i Fresh Water Initiative, *A Blueprint for Action, Water Security for an Uncertain Future*, 2016-2018, Hawai'i Community Foundation.

Hawaii Revised Statutes (HRS)

Hawai'i State Planning Act, Chapter 226 HRS Climate Adaption Guidelines

Hawai'i Stormwater Reclamation Appraisal Report. CH2MHill, prepared for the U.S. Bureau of Reclamation and the State of Hawai'i CWRM, July 2005.

Hawaii Stream Assessment: A preliminary Appraisal of Hawai'i's Stream Resources. State of Hawai'i Commission on Water Resources Management, National Park Service Rivers and Trails Conservation Assistance Program, 1990.*Hawai'i Stream Assessment*, Report R84, State of Hawai'i Commission on Water Resources Management, December 1990.

Hawai'i Water Conservation Plan, CH2MHill, prepared for the U.S. Bureau of Reclamation and the State of Hawai'i CWRM, 2013.

Hawai'i Water Plan: *Water Resources Protection Plan.* State of Hawai'i, Commission on Water Resources Management, June 2008.

Hawai'i Water Plan: *Water Quality Plan,* Hawai'i Department of Health, 2014.

Hawai'i Water Plan: *State Water Projects Plan,* Department of Land and Natural Resources, 2015.

Hawai'i Water Plan: *Agricultural Water Use and Development Plan,* State of Hawai'i department of Agriculture (AWUDP), 2003.

Hawai'i Water Plan*: Statewide Framework for Updating the Hawai'i Water Plan.* Commission on Water Resources Management*.*

Interim Instream Flow Standards (IIFS) adopted for both East and West Maui Streams, 1988, (Sections 13-169-44 and 48, Hawai'i Administrative Rules. According to Section 13-169-46, Hawai'i Administrative Rules).

I'i, John Papa. *Fragments of Hawaiian History.* B.P. Bishop Museum Press: Honolulu, 1959.

Izuka, S.K., Engott, J.A., Bassiouni, Maoya, Johnson, A.G., Miller, L.D., Rotzoll, Kolja, and Mair, Alan, 2016, *Volcanic aquifers of Hawai'i—hydrogeology, water budgets, and conceptual models: U.S. Geological Survey Scientific Investigations Report 2015-5164*, 158 p., http://dx.doi.org/10.3133/sir20155164.

Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, *Spatially distributed groundwater recharge estimated using a water-budget model for the Island of Maui, Hawai'i, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168,* 53 p., http://dx.doi.org/10.3133/sir201451

Kamakau, Samuel M. *Ruling Chiefs of Hawai'i.* The Kamehameha Schools Press: Honolulu (2 vols.), 1961.

Kamakau, Samuel Manaiakalani. *The Works of the People of Old: Na Hana a ka Poʻe Kahiko*. Translated from the newspaper Ke Au okoa by Mary Kawena Pukui; arranged and edited by Dorothy B. Barrere. [Honolulu]: Bishop Museum Press, 1976.

Kameʻeleihiwa, Lilikala. *Native Land and Foreign Desires,* Honolulu: Bishop Museum Press, 1992.

Ko'olau Poko Watershed Management Plan. Honolulu Board of Water Supply, 2012.

Ladefoged, T.N., et al., *Opportunities and constraints for intensive agriculture in the Hawaiian archipelago prior to European contact*, J. Archaeol. Sci. (2009), doi:10.1016/j.jas.2009.06.030

Malo, David. *Hawaiian Antiquities*. Bishop Museum Press, Honolulu, 1959.

Maui County Community Plans, Maui County Planning Department.

Maui County Code.

Maui County General Plan, Maui County Planning Department.

Maui Island Plan, Maui County Planning Department.

Maui Island Water Source Development Options for the Lahaina-Napili Area, County of Maui, Department of Water Supply, March 6, 2013.

Maui County Planning Department, *Socio-Economic Forecast*, July 2014

Matsuoka, Jon K. *Native Hawaiian Ethnographic Study For the Hawai'i Geothermal Project Proposed for Puna and Southeast Maui*. Oak Ridge; Oak Ridge National Laboratory.

Maupin, M.A., Kenny, J.F., Hutson, S.S., Lovelace, J.K., Barber, N.L., and Linsey, K.S., 2014*, Estimated use of water in the United States in 2010: U.S. Geological Survey Circular 1405, 56 p., http://dx.doi.org/10.3133/cir1405*

Maui County Office of Economic Development presentation, Maui County Council Budget and Finance Committee, November 3, 2015.

Maui County Department of Water Supply (MDWS) Reports.

Maui County of Department of Water Supply (MDWS), Maui Island Water Source Development Study, February 11, 2013.

Maui County of Department of Water Supply (MDWS), Maui Island Water Source Development Options for the Lahaina-Napili Area, March 6, 2013

Maui Economic Development Board, *County of Maui Comprehensive Economic Development Strategy*, December 2016.

Melrose, J., Perroy, R., and Cares, Sylvana, 2015. *Statewide Agricultural Land Use Baseline 2015*: Hawai'i Department of Agriculture. https://hdoa.Hawai'i.gov/wp-content/uploads/2016/02/StateAgLandUseBaseline2015.pdf

Miike, Lawrence. *Water and the Law in Hawai'i.* University of Hawai'i Press, 2004.

Native Hawaiian Rights Handbook. Edited by Melody Kapilialoha MacKenzie. Honolulu: Native Hawaiian Legal Corporation; Office of Hawaiian Affairs. Distributed by University of Hawai'i Press, 1991.

Native Hawaiian Access Rights Project Phase III. Recommendations for SMA Rules and Process. A Publication of the Hawai'i Coastal Zone Management Program Office of Planning Department of Business, Economic Development and Tourism State of Hawai'i Pursuant to National Oceanic and Atmospheric Administration (NOAA) Award Nos. NA970Z0161 and NA070Z0115 Final Report December 15, 2002 Daviana Pomaika'i McGregor, Jon Matsuoka, Luciano Minerbi and Panaewa Kelley Univeristy of Hawai'i, Manoa Honolulu, Hawai'i.

Office of Hawaiian Affairs, Data Book.

Oki, D.S., *Surface Water in Hawai'i: U.S. Geological Survey Fact Sheet 045-03*, 2003. https://pubs.usgs.gov/fs/fs04503/pdf/fs045-03.pdf

Oki, D.S., 2004, *Trends in Streamflow Characteristics at Long-Term Gaging Stations*, Hawaii: U.S. Geological Survey Scientific Investigations Report 2004-5080, 120 p., http://pubs.usgs.gov/sir/2004/5080/

Oki, D.S., Wolff, R.H., and Perreault, J.A., 2010, *Effects of surface-water diversion on streamflow, recharge, physical habitat, and temperature, Nā Wai 'Ehā, Maui, Hawai'i: U.S. Geological Survey Scientific Investigations Report 2010–5011*,

Pacific RISA. *Participatory Scenario Planning for Climate Change Adaption: Final Land Use Input, November, 2014*

Brown and Caldwell, et al. *Blueprint for One Water*. Water Research Foundation, 2017.

Pukui, Mary K., Samuel H. Elbert, and Esther T. Mookini. *Place Names of Hawai'i*. The University Press of Hawai'i: Honolulu, 1976.

Richard Wallsgrove and David Penn, *Water Resources and Climate Change Adaptation in Hawai'i: Adaptive Tools in the Current Law and Policy Framework*, (Center for Island Climate Adaptation and Policy, Honolulu, Hawai'i, 2012), http://icap.seagrant.soest.hawaii.edu/icap-publications *and* www.islandclimate.org

Sproat, D. Kapuaala, Ola I Ka Wai: *A legal Primer for Water Use and Management in Hawai'i.* Ka Huli Ao Center for Excellence in Native Hawaiian Law, William S. Richardson School of Law*, 2014.*

State of Hawai'i, *Statewide Framework for Updating the Hawai'i Water Plan,* 2010.

State of Hawai'i, *Agricultural Water Use and Development Plan*, 2004

State of Hawai'i Department of Land and Natural Resources, *Maui Parties Reach Agreement In Na Wai 'Eha Amended Interim Instream Flow Water Case***;** Press Release, April 21, 2014. http://files.Hawai'i.gov/dlnr/cwrm/news/2014/nr20140421.pdf (May 2015)

State of Hawai'i, Data Book, DBEDT, 12/31/2014.

State of Hawai'i, Water Code, Hawai'i Revised Statutes Chapter 174C.

State of Hawai'i, Water Projects Plan, 2003.

State of Hawai'i, *Water Resources Protection Plan Update*, 2014. http://files.Hawai'i.gov/dlnr/cwrm/planning/wrpp2014update/WRPP-2014Ch8SummaryDroughtPlanning.pdf

State of Hawai'i, *Water Projects Plan Update, Hawaii Water Plan*, *Advance Final Report,* Department of Hawaiian Homelands, July 2016.

State of Hawai'i *Water Projects Plan, 2016 Advance Report.*

State of Hawai'i *Water Projects Plan* Hawai'i Water Plan, Volume 4, SWPP for Islands of Lanai/Maui/Moloka'i, 2003.

State of Hawai'i, *2013 Update of the Hawai'i Water Reuse Survey and Report*.

Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997.

The Nature Conservancy, GIS data, Opportunities and constraints for intensive agriculture in the Hawaiian archipelago prior to European contact, and Estimated Native Hawaiian Pre-contact Land Utilization Footprint

The Pacific Islands Regional Climate Assessment (2012), East-West Center, the Department of Interior's Pacific Islands Climate Science Center, the Pacific Islands Climate Change Cooperative, and the National Oceanic and Atmospheric Administration through the Pacific Regional Integrated Sciences and Assessments (RISA) Program.

University of Hawai'i at Manoa, *Rainfall Atlas of Hawai'i*, 2011.

U.S. Census Bureau Data.

USGS, The USGS Water Science School. Website: http://water.usgs.gov/edu/hydrology.html.

USGS, Pacific Islands Water Science Center. Recent hydrologic conditions, Lahaina District, Maui, Hawai'i. Website: http://hi.water.usgs.gov/recent/lahaina/index.html

University of Hawai'i at Manoa Sea Grant College Program. *Climate Change Impacts in Hawai'i - A summary of climate change and its impacts to Hawai'i's ecosystems and communities,* 2014.

US Army Corp of Engineers, State of Hawai'i, DNLR, *West Maui Watershed Plan: Kahana, Honokahua and Honolua Watersheds Characterization Report,* Public Review Draft, March 2105.

Waiahole Water Case, and a fourth in its 2004 decision, *In the Matter of the Contested Case Hearing on Water Use, Well Construction, and Pump Installation Permit Applications,* filed by Waiola o Moloka'i, Inc. and Moloka'i Ranch, Limited.

REFERENCES CONSERVATION SECTION

Agricultural Water Conservation Clearinghouse (AWCC). http://agwaterconservation.colostate.edu/

Amy Vickers, Mary Wyatt Tiger & Shadi Eskaf. AWWA*. Guide to Customer Water-Use Indicators for Conservation and Financial Planning, October 2013*. http://www.awwa.org/Portals/0/files/resources/resource%20dev%20groups/tech%20and%20educ%20program/documents/Water%20Use%20Indicators%20for%20Conservation%20and%20Financial%20Planning.pdf

AWWA, *Water Conservation Programs—A Planning Manual, Manual of Water Supply Practices, M52*, 2006.

Benedykt Dziegielewski and Jack C. Kiefer. *Appropriate design and evaluation of water use and conservation metrics and benchmarks,* June 2010, Journal AWWA 102:6. http://www.awwa.org/publications/journal-awwa/abstract/articleid/24576/issueid/33569333.aspx?getfile=\\pers75apppcr\personify\serverfiles\dcdfiles\24576\waternet.0072065.pdf

DeOreo, William B. and Mayer, Peter W. *Insights into declining single-family residential water demands,* Journal - American Water Works Association, 2012. http://dx.doi.org/10.5942/jawwa.2012.104.0080

DeOreo, William B. et al. *The Residential End Uses of Water, Executive Report, Version 2*, Water Research Foundation, 2016.

http://www.waterrf.org/PublicReportLibrary/4309A.pdf
http://www.allianceforwaterefficiency.org/residential-end-uses-of-water-study-1999.aspx

Dziegielewski, Ben and Jack C. Kiefer. *The American Water Works Association Water Conservation Division Subcommittee Report, January 2010, WATER CONSERVATION MEASUREMENT METRICS, Guidance Report*.
http://www.awwa.org/portals/0/files/resources/resource%20dev%20groups/tech%20and%20educ%20program/documents/waterconservationmeasurementmetricsguidancereport.pdf

Fares, Ali, Ph.D., CTAHR, UHM. Irrigation Water Requirement Estimation Decision Support System (IWREDSS) to Estimate Crop Irrigation Requirements for Consumptive Use in Hawaii, Final Report prepared for CWRM, August 2013.
http://files.hawaii.gov/dlnr/cwrm/publishedreports/PR200808.pdf

Freedman, Carl, Haiku Design and Analysis. Maui County Water Use and Development Plan, Central DWS District Update, Nov. 16, 2010.

Freedman, Carl, Haiku Design and Analysis. Maui County Water Use and Development Plan, Upcountry Final Candidate Strategies WAC Draft, July 27, 2009.

Maui Tomorrow, Malama `Aina: A Conversation About Maui's Future, March 8, 2016.

USDA-NRCS, National Engineering Handbook, Part 623, Irrigation, Chapter 2, Irrigation Water Requirements, 1993. https://policy.nrcs.usda.gov/RollupViewer.aspx?hid=17092

USEPA. *USEPA Water Conservation Plan Guidelines, Appendix B.*
https://www3.epa.gov/watersense/docs/app_b508.pdf

US EPA, WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities, October 2012.

U.S. Environmental Protection Agency, Office of Water. *WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities*, October 2012.
https://www3.epa.gov/watersense/docs/ws-at-work_bmpcommercialandinstitutional_508.pdf

USDA, National Institute of Food and Agriculture, Agriculture Technology. Accessed March 17, 2017 https://nifa.usda.gov/topic/agriculture-technology