WEST MAUI REGION (LAHAINA AQUIFER SECTOR)

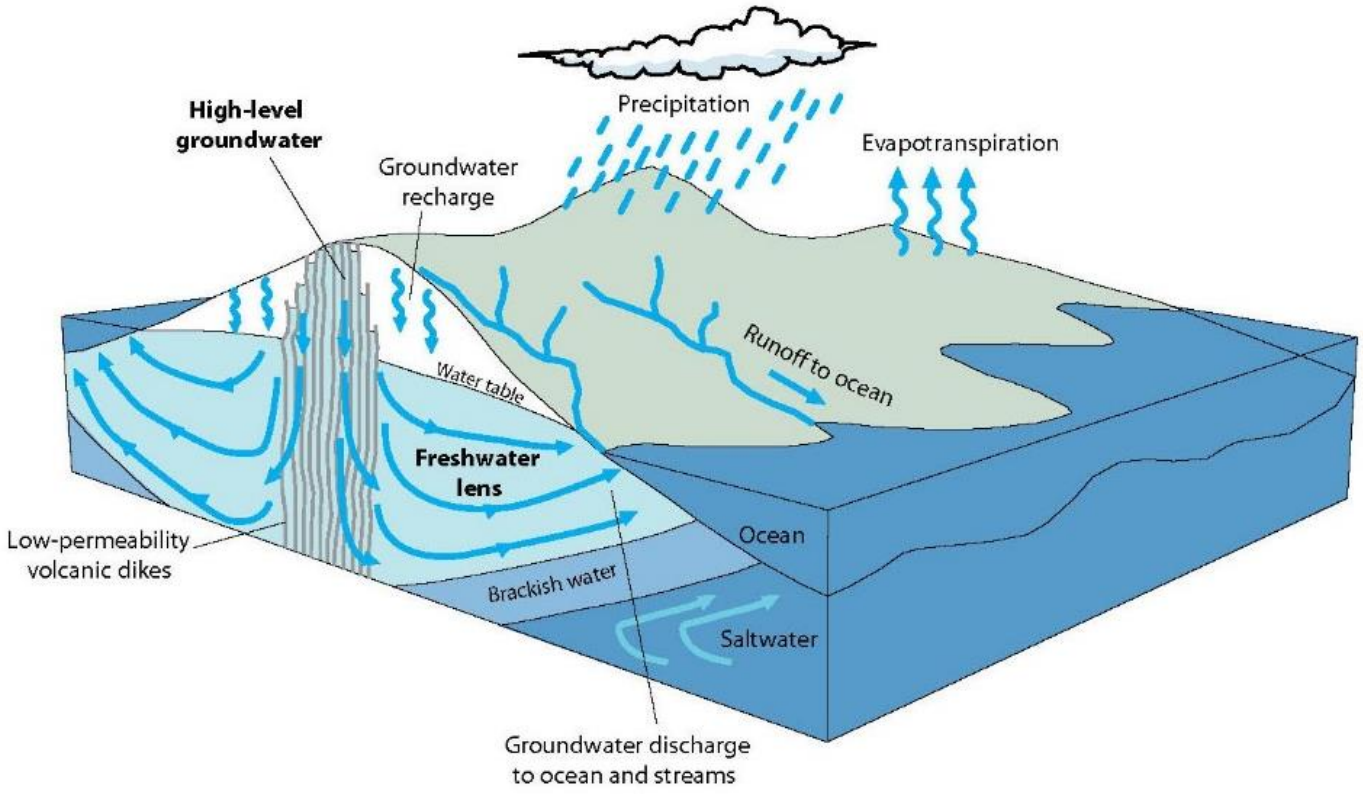
This is a synopsis of work in progress for the Lahaina aquifer sector for further public input. Analysis is ongoing and the information below has not been reviewed by the Board of Water Supply, County Council or the State Commission on Water Resource Management. Preliminary findings are subject to change based on input and further analysis.

PLANNING BOUNDARIES

The Water Use and Development Plan (WUDP) allocates water to land uses and water users consistent with the Maui Island Plan. The 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 boundaries are the same, and the various public water systems are contained within their boundaries. The region also encompasses the Lahaina and Kaʻanapali moku and underlying ahupuaʻa as discussed later.

WATER RESOURCES IN THE LAHAINA AQUIFER

Climate, hydrology, geology and human activities affect the water cycle and the surface and ground water systems which are interconnected. The fresh ground water system contains dike-impounded water in the mountainous interior part of the aquifer and a freshwater lens floating on saltwater; fresh water generally moves from the dike-impounded water body to the freshwater-lens system in volcanic rock and then to the ocean. 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.



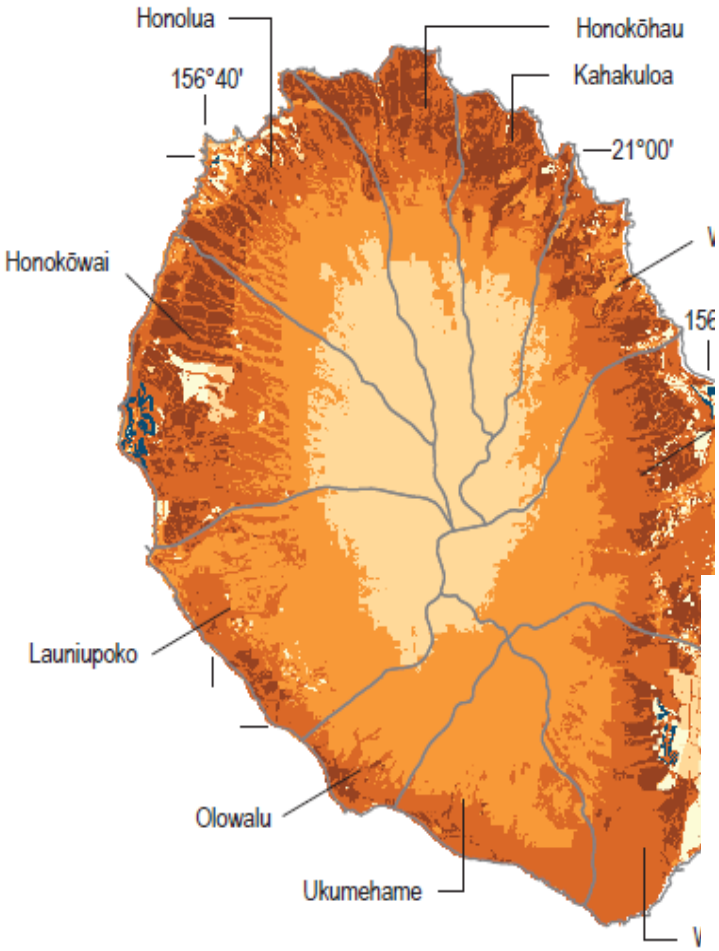
Hydrology of Ocean Islands, USGS Pacific Islands Water Science Center
http://hi.water.usgs.gov/studies/GWRP/islhydro.html

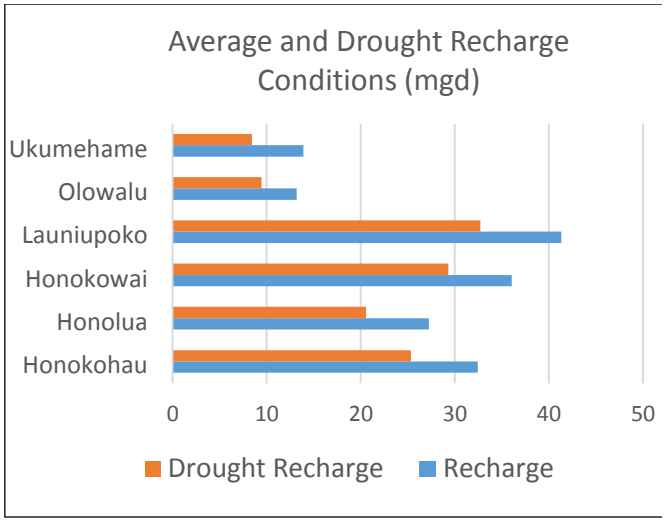
The Lahaina aquifer water budget is reliant on rain and fog for about 96% of groundwater recharge, with the remainder from irrigation and other activities. Outflow is comprised of runoff and evapotranspiration. The 2014 USGS study, *Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawai'i* evaluated aquifer recharge and recharge scenarios. The study found that overall in the Lahaina aquifer average climate recharge (based on 1978–2007 rainfall and 2010 land cover) was reduced by 24% during drought conditions (based on 1998–2002 rainfall and 2010 land cover). A drought condition scenario indicated a 24% reduction in recharge sector-wide compared to average climate conditions (using rainfall during the 1998–2002 period, which had the lowest 5-year mean rainfall during the 1978–2007 study period).

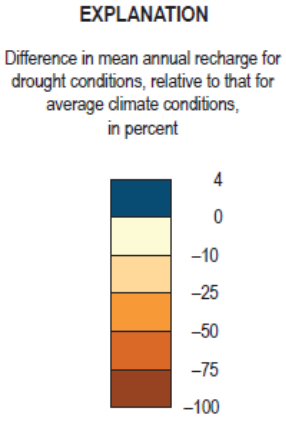
Recharge for Lahaina Aquifer (mgd)

Inflow	Outflow	Recharge - Average Climate Conditions	Recharge - Drought Climate Conditions	% Decrease – Drought Climate Conditions
352	187	164	126	24%

Source: Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawai'i, 1978–2007
Recharge was more than doubled compared to the 2008 Water Resource Protection Plan (WRPP); a more equivalent comparison to the WRPP area (to exclude caprock) produced close to the same recharge results.



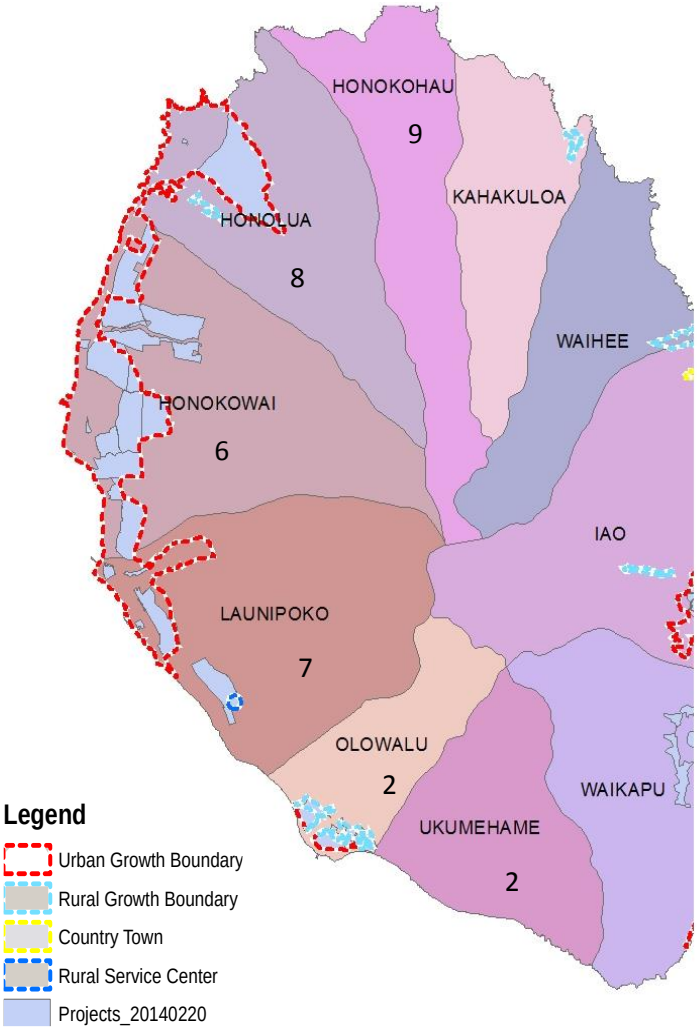




Sustainable Yield

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). The sustainable yield for the Lahaina aquifer is 34 million gallons per day (mgd); the map below shows the SY for each aquifer system. Sustainable yield accounts only for basal ground water and ignores any importation of water from outside the aquifer system area. Unlike other areas of the island, groundwater is not transported to or from the Lahaina aquifer sector from other sectors. However, there is some localized transport of ground and surface water between aquifer systems as water from wells and streams is transported to areas with demand via water transmission and distribution systems that span more than one aquifer system. There can be a variety of reasons for such transport, such as water system design, inadequate sustainable yield to serve all demand, chloride or other water quality issues, and cost-effectiveness of resource use, among others. Projected development in the Honokowai aquifer may in the future exceed sustainable yield if all wells from that aquifer were exclusively used.

Aquifers and Sustainable Yield, Growth Boundaries and Project Areas



Aquifer Systems, Watersheds and Moku

Surface Water

There are 11 perennial streams in the Lahaina aquifer. Of these, eight flow only intermittently at lower elevations. There are 27 declared stream diversions and 10 USGS gages in the Lahaina aquifer. Diversion systems (with eight separate collection systems within 11 watersheds from Honokohau to Ukumehame) that transported water to the plantations continue to support agricultural, municipal and domestic needs.

Streams flow from the wet interior of the West Maui Mountains into the low-permeability volcanic dike compartments which impound ground-water to high altitudes. Groundwater leaking from these dike compartments provides base flow in the streams even during prolonged periods of little or no rainfall. Downstream of the dike compartments, many of the streams are diverted and the water is transported by tunnels and ditches for agriculture and domestic needs within the same or other aquifer systems. http://hi.water.usgs.gov/recent/lahaina/streamflow.html

CWRM adopted interim instream flow standards for West Maui streams in 1988, reflecting diversions at that time. CWRM is currently preparing stream assessments in preparation for a process to set numerical instream flow standards. The study *"Low-Flow Characteristics of Streams in the Lahaina District, West Maui, Hawai'i" (2014)* quantified streamflow availability under natural (unregulated) streamflow conditions upstream of surface water diversions, and characterized the seepage gains and losses downstream of surface-water diversions on a subset of streams in the Lahaina District to provide the CWRM scientific information needed to establish technically defensible instream flow standards that will support equitable, reasonable, and beneficial allocation of the water resources in West Maui.

Interim Instream Flow Standards

… "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 following..."

Instream Flow 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"

The following table shows the interim instream flow standard for Lahaina aquifer sector streams, number of diversions, median (Q50) low flow conditions, and presence of kuleana parcels. Diverted streams can affect streamflow, leaving some downstream reaches dry, which can adversely affect kuleana and appurtenant rights, Hawaiian traditional and customary practices, stream ecology, water quality, recreational activities, and aesthetics. A key issue for the WUDP is seeking community input on options and policies as a basis for water use planning and for consideration during CWRM's instream flow standards process.

Stream Name	Aquifer	No. of Diversions	Interim IFS	Natural Stream Flow (base flow) during low flow conditions (Q50)	Data Source	Kuleana parcels
Papalaua	Ukumehame	0	HAR §13-169-48			
Ukumehame	Ukumehame	1	HAR §13-169-48	8 mgd Ukumehame Gulch near Olawalu / *5.0 cfs study site	1	Yes
Olowalu	Olowalu	2	HAR §13-169-48	0 mgd at Olawalu / *6.1 cfs at study site	1	Yes

Stream Name	Aquifer	No. of Diversions	Interim IFS	Natural Stream Flow (base flow) during low flow conditions (Q50)	Data Source	Kuleana parcels
Launiupoko	Launiupoko	1	HAR §13-169-48	1.5 mgd / *0.47 cfs near Lahaina	1	
Kaua'ula	Launiupoko	1	HAR §13-169-48	9.5 cfs	1	Yes
Kahoma	Launiupoko	7	HAR §13-169-48	5.7 cfs near Lahaina / *5.8 cfs study site	1	Yes
Kanaha Stream	Launiupoko	0		4.9 cfs above pipeline intake near Lahaina / *4.9 cfs study site	1	
Wahikuli	Honokowai	0	HAR §13-169-48			
Wahikuli Gulch	Honokowai	0		Dry under low flow conditions	1	
Hahakea Gulch	Honokowai	0		Dry under low flow conditions	1	
Honokowai	Honokowai	2	HAR §13-169-48 Amended to include SCAP MA-117 on Honokowai Stream for installation of flow-through desilting basin (8/17/1994)	1.1 cfs near Lahaina / * 5.4 cfs immediately downstream from confluence of Amalu and Kapaloa Streams	1	Yes
Kahana	Honokowai/ Honolua	1	HAR §13-169-48	Dry under low flow conditions	1	
Honokahua	Honolua	0	HAR §13-169-48	Dry under low flow conditions	1	Yes
Mokupe'a Gulch	Honolua	0		Dry under low flow conditions	1	
Honolua	Honolua	4	HAR §13-169-48	4.6 cfs / *3.8 cfs near Honokohau	1	Yes
Papua Gulch	Honolua	0		Dry under low flow conditions	1	
Honokohau	Honokohau	8	HAR §13-169-48	14 mgd near Honokohau upsteam of all diversions	2	
Anakaluahine	Honokohau	0 0	HAR §13-169-48			

Sources:

1 - USGS Scientific Investigations Report 2014-5087, Table 1 / * Table 6

2 - USGS Scientific Investigations Report 2010-5011, Table 13

HAR – Hawai'i Administrative Rules. Median discharge, Q-50, during a specified period of time, is the discharge that is equaled or exceeded 50 percent of the time.

Kuleana parcels- DWS review of parcels and streams based on GIS data, Office of Hawaiian Affairs data, 2009.

WATER USE AND PROJECTED DEMAND

Two alternative methods were utilized to project water demand to the year 2035: Population growth rates and build-out of permitted land use based on County zoning and Department of Hawaiian Homelands land use plans.

Population Growth Rate Demand Projection

The Water Use and Development Plan projects water demand based on projected population growth, which reflects the policy and land use of the Maui Island Plan. 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 (Draft)* prepared by the Planning Department consistent with the Maui Island Plan. An incremental volume of demand to reflect population not served by public systems is also added as shown below; estimates were generated based on well and pump size data, population served by public water systems reported to Department of Health, and census block population located in areas not served by public systems with the latter method selected.

Water consumption and demand based on population growth rates do not account for large-scale agricultural irrigation needs. However, reclaimed water that is the end product of metered consumption would be included.

It was assumed that population growth, and thus water use, from projects described in the State Water Projects Plan and for the Department of Hawaiian Homelands are already accounted for by the population projections. Therefore, information from these documents was not used to further refine the 5-year incremental population based water demand projections.

In the 2014 Draft Socioeconomic Forecast, high and low estimates are generated for key indicators by analyzing the gap between past projections and historic trends from 1990 to 2010. The high and low estimates project future scenarios, assuming that current projections include inaccuracies on the same scale as in the past. High and low alternative projections apply variance estimates for population, jobs, visitor units and average visitor census.

The Maui Island Plan projects a 20-year population increase of 64% from 2015 to 2035 for West Maui.

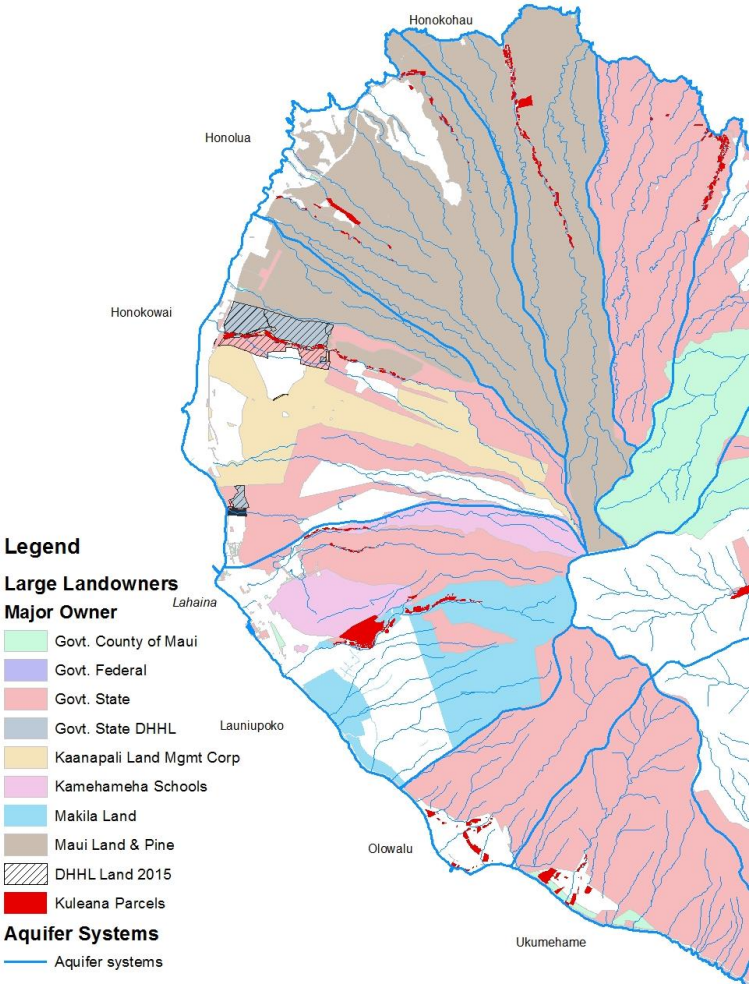
Year	**2010**	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**20 Year**	**Ave Annual**
Growth Rate			10.0%	13.9%	16.4%	11.7%	9.5%	63.8%	3.2%
Projected Pop.	22,156		24,373	27,762	32,318	36,110	39,311	14,938	747

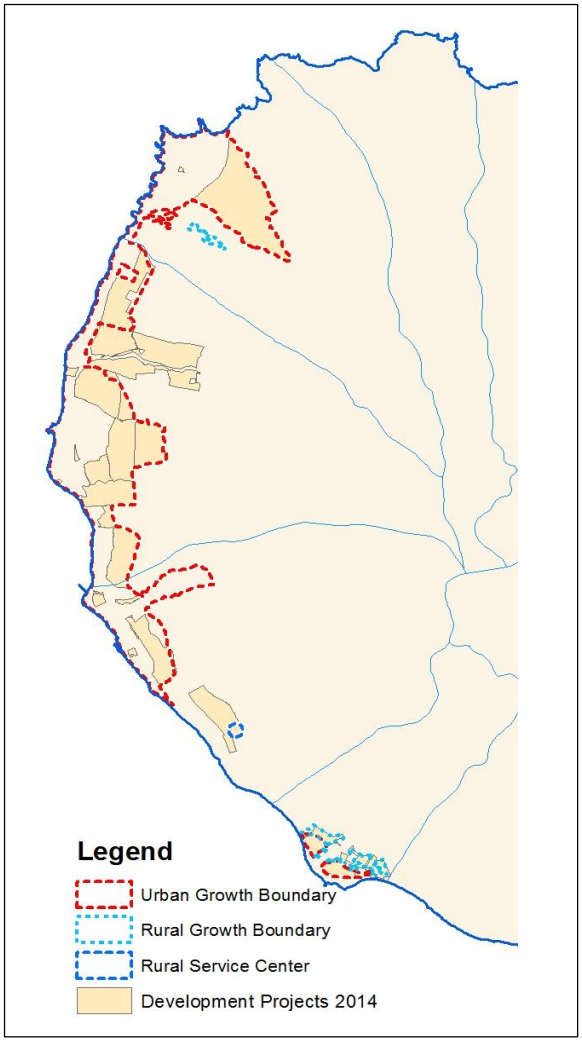
Source: Pop. Forecast: 2014 Final Draft Socio-Economic Forecast, Maui County Planning Department, Long Range Planning Division, Table R-1, West Maui Community Plan area. Water Demand: Maui County Department of Water Supply

Land Use Based Demand Projection

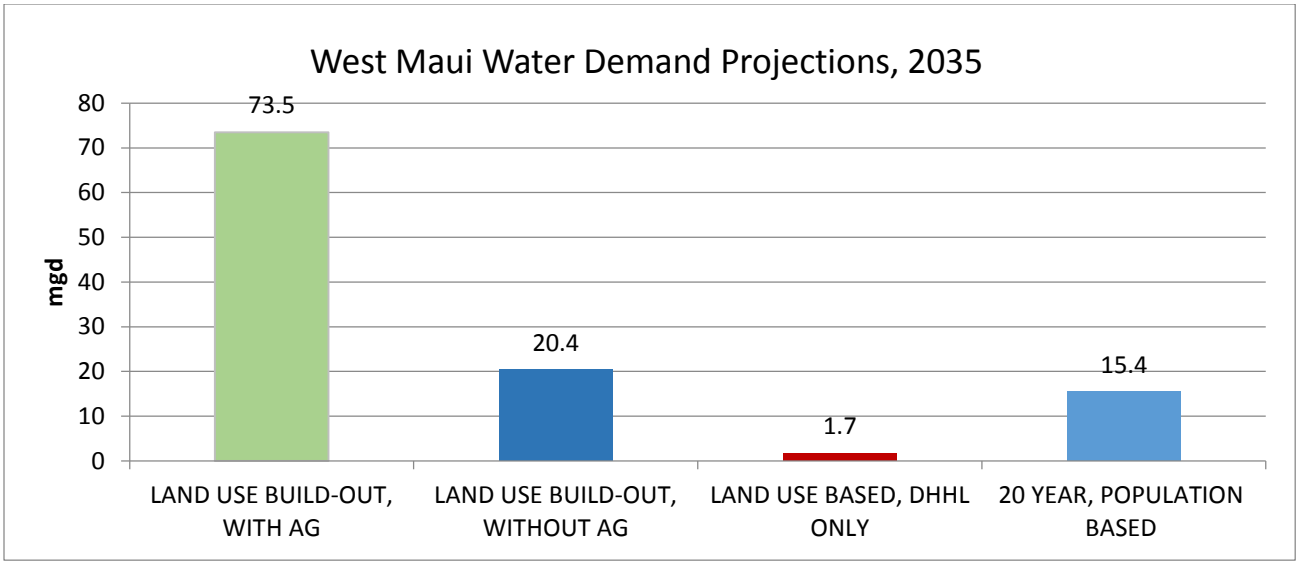
Land use based demand projections reflect the potential full build-out applying current County Zoning and the Department of Hawaiian Homelands land use plan designations. The Zoning Code implements the General Plan policies and regulates existing and future land development at the parcel level. State Land Use classifications are too limited in guidance of various types of development permitted in each district. While Community Plans provide more detail they do not supply density guidelines, are outdated, and may be more useful as guidance for future Water Use and Development Plan updates; the West Maui Community Plan is currently being updated. The County does not have zoning jurisdiction over the Department of Hawaiian Homelands lands and accordingly build-out under those plans was also applied. Since full build-out is unlikely, especially over a 20-year period, this method is not selected for projection of future water demands.

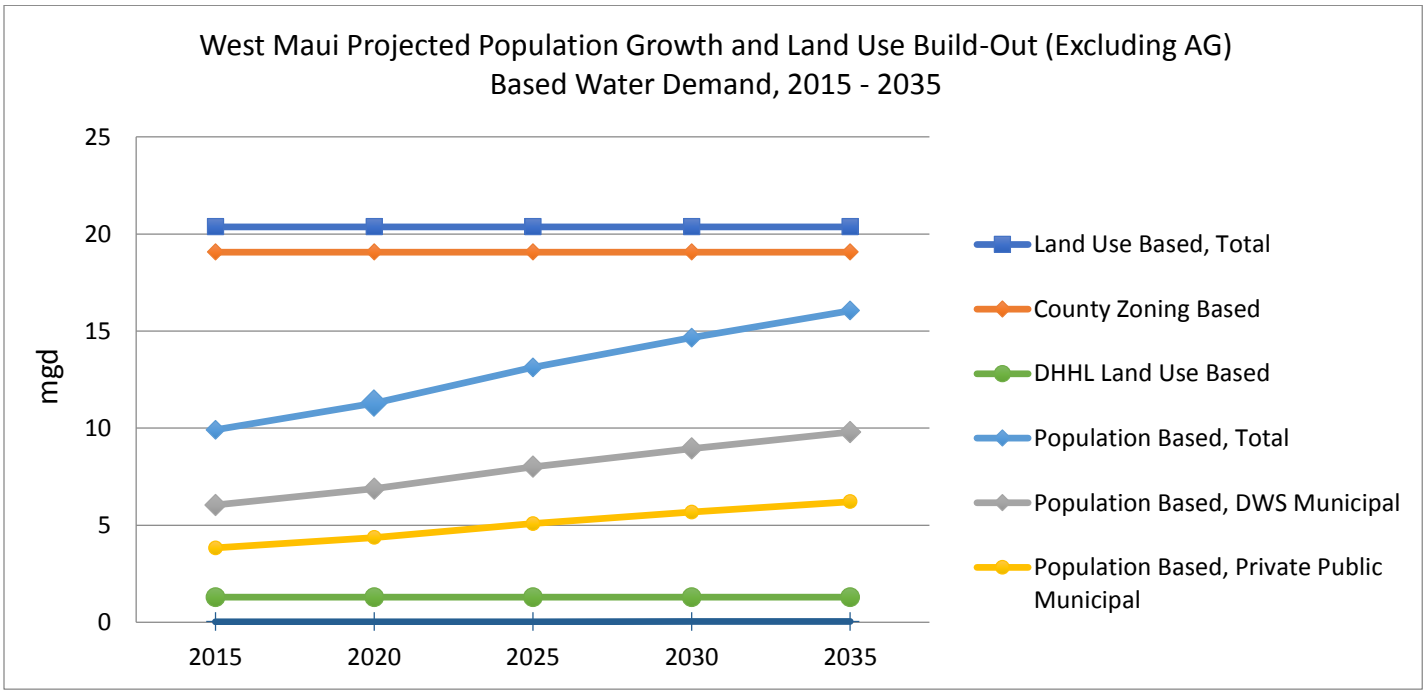
The Maui Island Plan's Directed Growth Plan identifies four sub-regions (Kā'anapali, Lahaina, Makila, and Olowalu) and seven planned growth areas: Kā'anapali Town; Lahaina Town North Lahaina Infill and Lahaina Town South; Kahoma Infill, Makila, and Olowalu Town. The Planning Department maintains a list 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 following shows the major land owners in West Maui. The map on the right shows the Growth Boundaries and the location of projects on the Development Project list (2014).



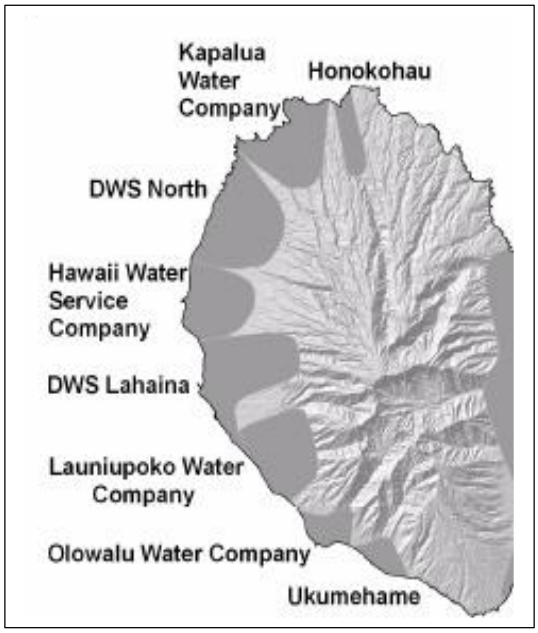


West Maui's current demand in 2014 is estimated to be 9.716 mgd, with 5.92 mgd supplied by the County DWS municipal system and 3.76 supplied by private public systems. A land use based water demand would require 73.5 mgd by 2035. Excluding agriculture, 2035 demand is projected to be 20.4 mgd. DHHL's portion of that demand is 1.7 mgd. A population based demand requires 15.4 mgd by 2035. Projected demand to serve the 2014 Project list alone based on dwelling units is 6.2 mgd, although it is unlikely all projects would be permitted or constructed.





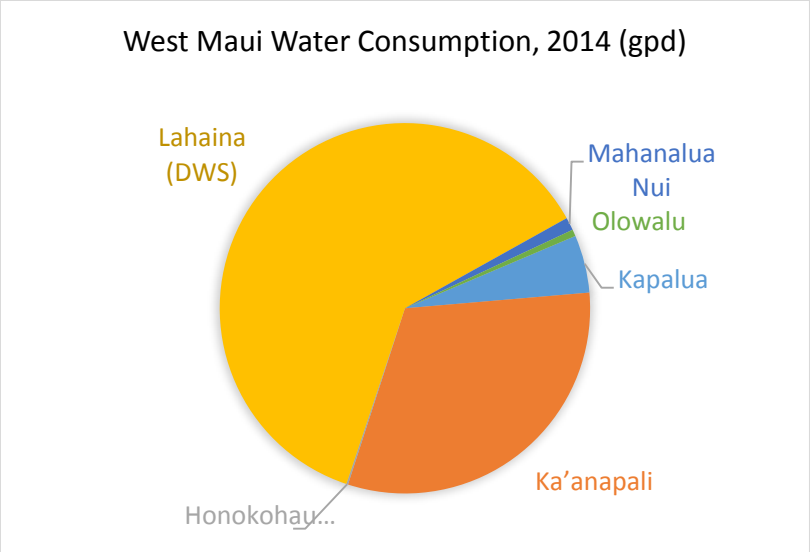
The County Department of Water Supply (DWS) and privately owned "public water systems" (systems serving more than 25 people or 15 service connections) are summarized as follows. The County Lahaina Water System serves most of the resident population with potable water. The resort areas of Kā'anapali and Kapalua are served by Hawaii Water Service and Kapalua Water Company. The Mahanalua Nui, Olowalu and Ukumehame Systems serve areas south of Lahaina town. The map shown the general areas served by the various public systems. 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.

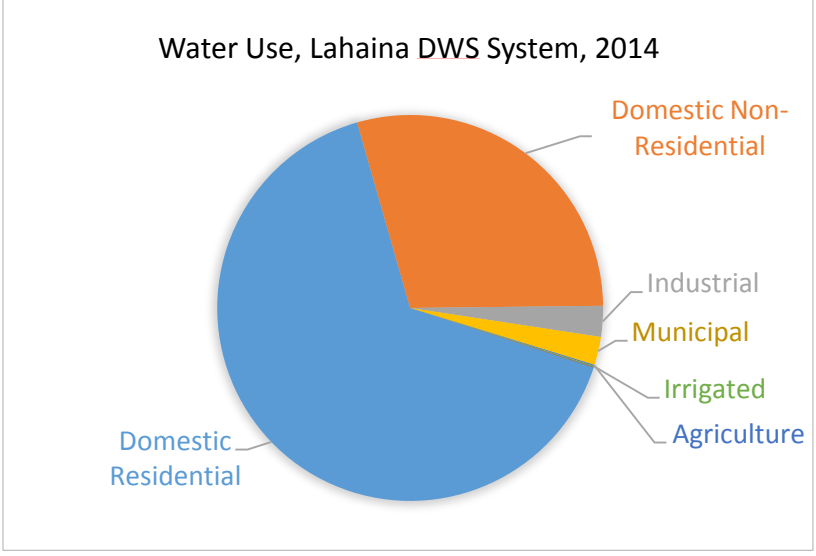


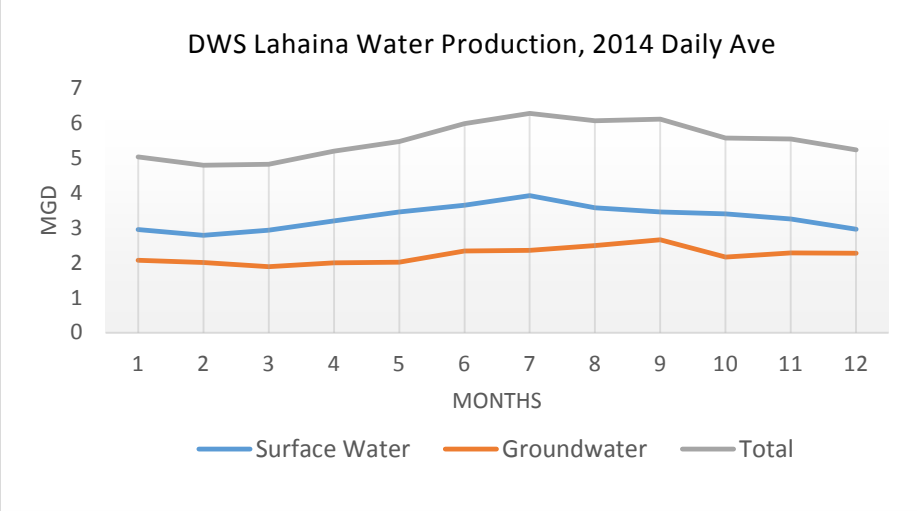
Potable Water Systems

System Name	Owner	Source	2014 Daily Ave (gpd)
Honokohau	County DWS	Groundwater purchased from Kapalua Water Co	13,000
Kapalua	Kapalua Water Co	Groundwater	450,000
Ka'anapali	Hawaii Water Service	Groundwater	2,800,000
Lahaina	County DWS	54% Surface, 46% Groundwater	5,522,000
Olowalu	Olowalu Elua Associates	Groundwater	52,000
Mahanalua Nui Subdivision	Launiupoko Water Co	Groundwater	100,000

Source: Dept. of Health Services, 2015. Based on 2013 survey of water production submitted by providers every three years.



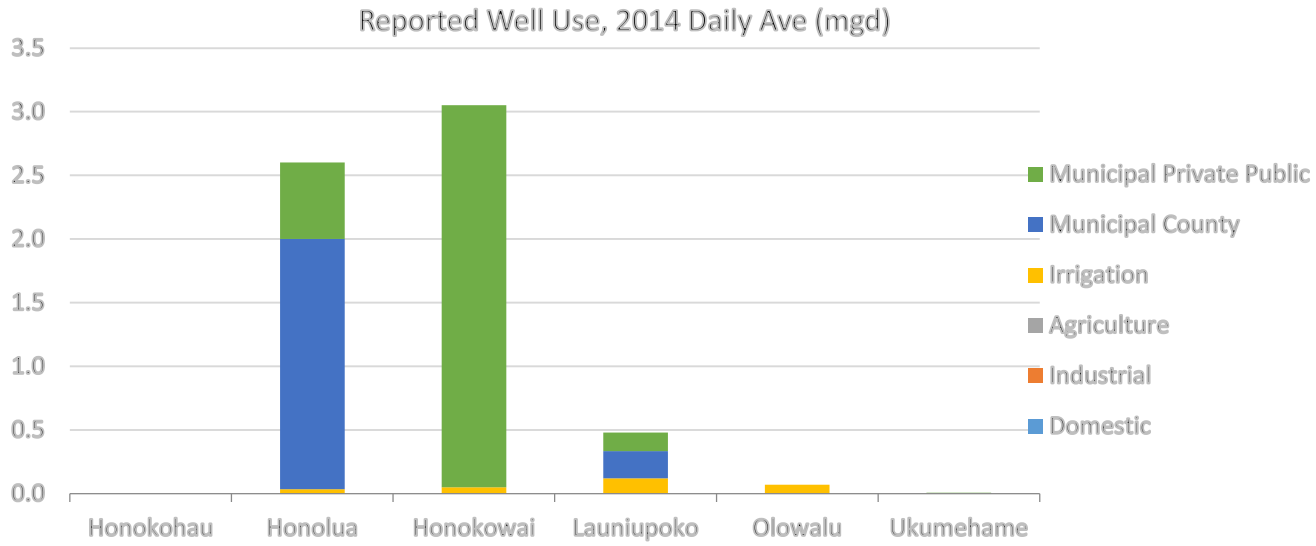




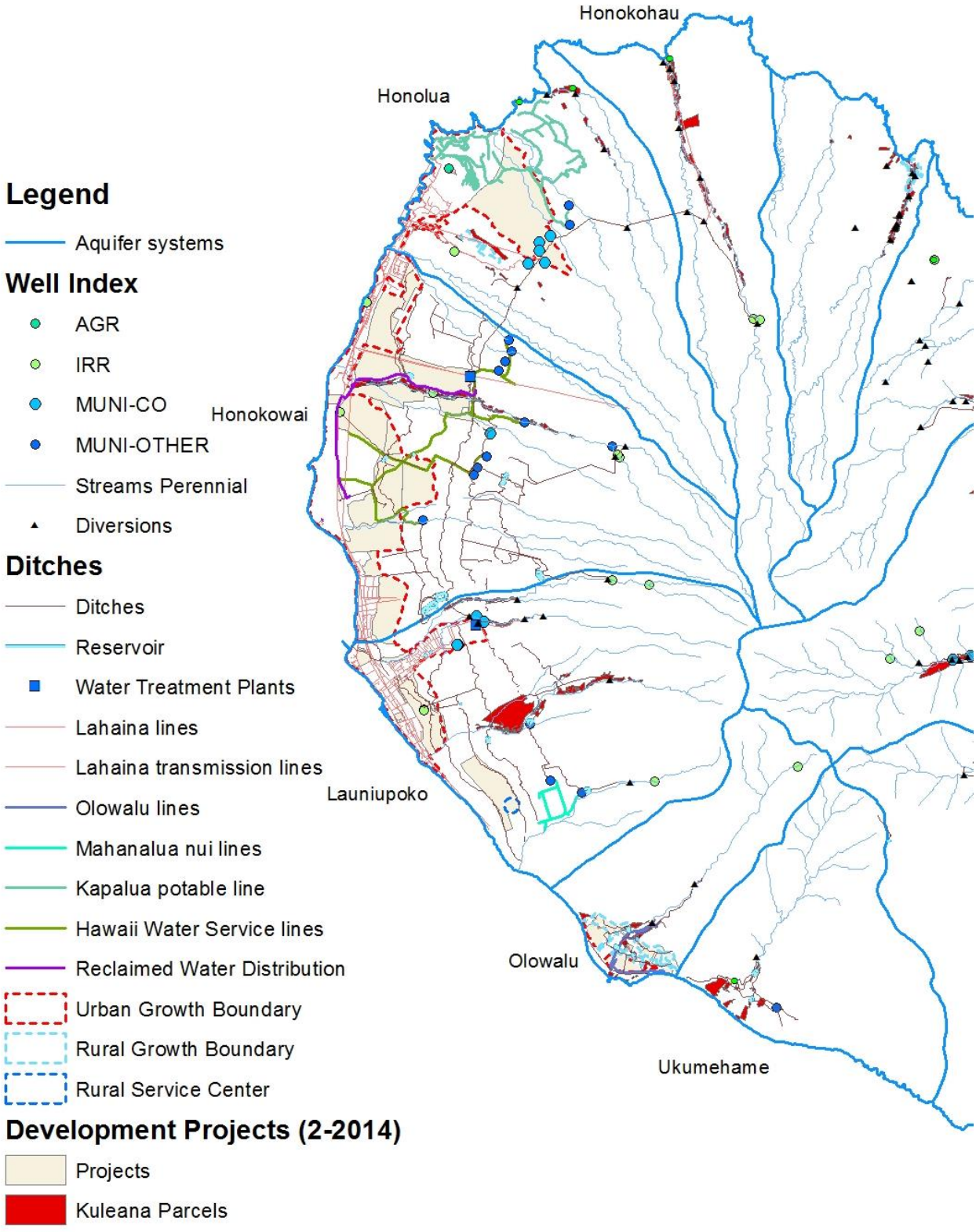
Well pumpage is required to be reported to CWRM reflecting actual periods of pumpage. However, not all active wells comply with reporting requirements and pumpage data is especially incomplete for smaller domestic and irrigation wells. The Honokowai aquifer reached 51% pumpage on average in 2014. Within the Lahaina aquifer, landscape irrigation wells accounted for 0.27 mgd pumped and no agricultural wells reported pumpage. 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.

Lahaina Aquifer Sector	Sustainable Yield	Installed Pump Capacity (Mgd)	Pump Capacity - % Sustainable Yield	Reported Pumpage (mgd)	Reported Pumpage % Sustainable Yield
Honokohau	9	0.01	9.0%	0.00	0.0%
Honolua	8	7.68	0.3%	2.60	32.5%
Honokowai	6	13.41	**-7.4%**	3.05	**50.9%**
Launiupoko	7	26.25	**-19.2%**	0.48	6.8%
Olowalu	2	0.36	1.6%	0.07	3.5%
Ukumehame	2	5.47	**-3.4%**	0.00	0.1%
Lahaina Total	**34**	**53.18**		**6.2**	**18.2%**

CWRM Well Index 5/29/2015 and 2014 pumpage reports. Does not include unused, other, unspecified, abandoned or observation wells. Numbers may not add due to rounding.



The location of the public water systems, Lahaina reclaimed water system, and ground and surface water wells and diversions and ditches is shown below. The Growth Boundaries and 2014 Development Project list are also shown.



The 2014 list of Development Projects would propose over 10,000 housing units including some hotel and timeshare units, which equates to over 20,000 people, in addition to infill development. While unlikely that all these projects will be approved as proposed or constructed they are instructive as to location and planning for water sources.

Development Projects 2/20/2014	Dwelling units (includes hotel, timeshare)	Projected Water Demand (mgd)
Honokohau	0	0.00
Honolua	890	0.53
Honokowai	7604	4.33
Launiupoko	920	0.54
Olowalu	1500	0.90
Ukumehame	0	0.00
Total	10914	6.29

West Maui's current demand in 2014 is estimated to be 9.72 mgd, with 5.92 mgd supplied by the County DWS municipal system and 3.76 supplied by private public systems. A land use based water demand would require 73.5 mgd by 2035. Excluding agriculture, 2035 demand is projected to be 20.4 mgd. DHHL's portion of that demand is 1.7 mgd. A population based demand requires 15.4 mgd by 2035. Projected demand to serve the 2014 Project list alone based on dwelling units is 6.2 mgd.

RESOURCE ADEQUACY

Water demand based on population growth rates in the Lahaina sector would require 5.7 mgd of additional supply for a total of 15.4 mgd by 2035. An additional 1.5-3 mgd would be needed to account for system losses, high growth years and other factors.

Full build-out of zoning designations and DHHL plans excluding agricultural zoned land would require an additional 10.98 mgd above current use.

Available groundwater within the Lahaina sector equate to 34 mgd. The location by aquifer indicates that the greatest water demand would be for development within the Honokowai aquifer and could exceed sustainable yield if pumped exclusively from this this aquifer. Potential options might include wells located in the Honokohau aquifer, improved interconnection of the Lahaina subsystems, increased conservation and alternative resource options. Alternative resources to be considered include reclaimed wastewater, rainwater catchment, stormwater reuse, desalination, conservation, resource augmentation, and various regulatory and planning strategies. These are briefly outlined below. Hydrological and other constraints of available conventional resources within the sector are analyzed in the Strategy Options Matrix.

OPTIONAL STRATEGIES

Rainwater Catchment

Rainwater catchment is the collection of rainwater from a roof or other surface before it reaches the ground. Rainwater catchment is not as reliable as conventional water resources because it is extremely sensitive to the climate. 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.

Reclaimed Wastewater

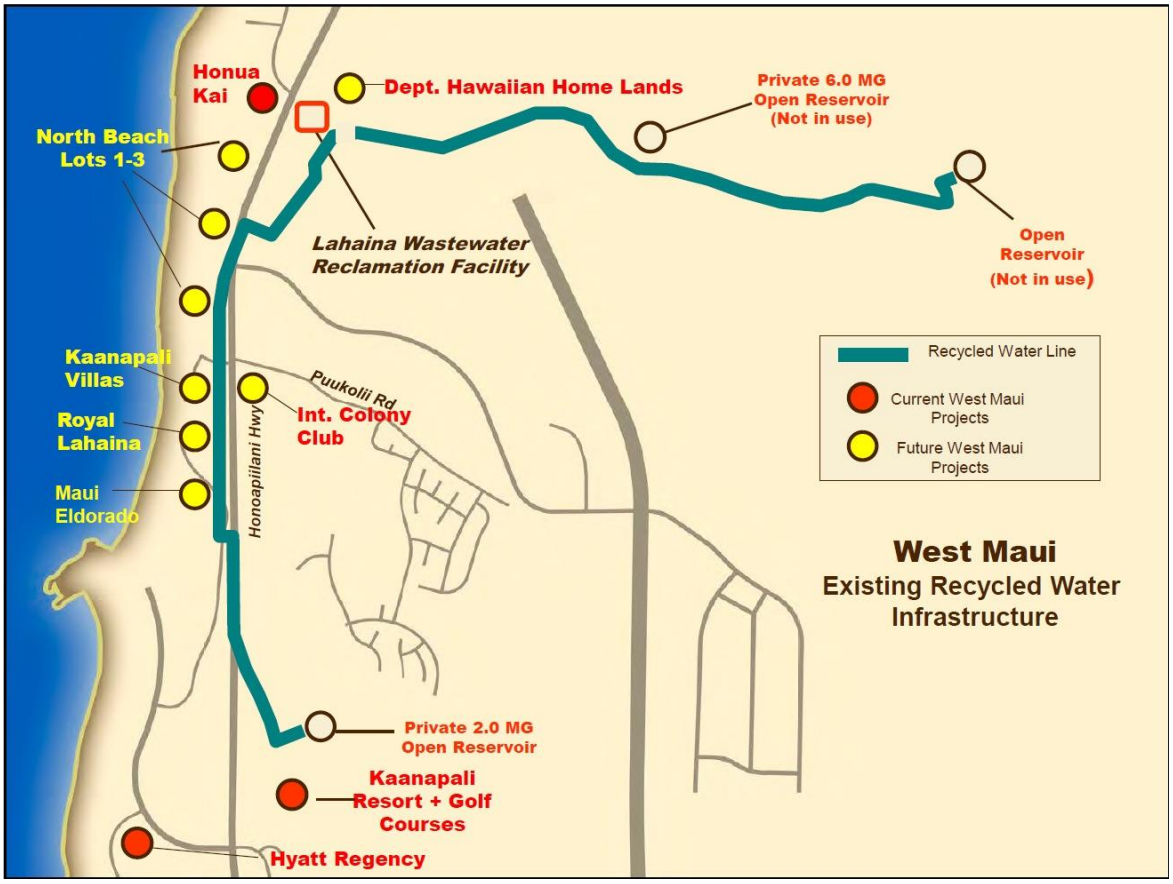
It is the policy of CWRM to promote the viable and appropriate use of recycled water provided it does not compromise beneficial uses of existing water resources. Reclaimed wastewater is a valuable resource, especially for irrigation purposes. Approximately 2.4 mgd of reclaimed wastewater is used on the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

An average of over 12 mgd of reclaimed water is produced at treatment facilities on Maui, while the design capacity is twice that volume. The reuse of wastewater from the Central Maui, Kihei, 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 behind the County of Maui, Wastewater Reclamation Division's program since most of its wastewater reclamation facilities (WWRF) rely on injection wells, including the Lahaina WWRF.

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.

WWRF	Treatment Level	WWRF Design Capacity (mgd)	Recycled Water Produced (Ave. mgd)	Recycled Water Used (Ave. mgd)	% of Total Produced Used	% of Design Capacity Used	Application
Lahaina	R-1	9	3.84	0.88	22.9%	9.8%	Golf Course, Landscape, Nursery, Agriculture

Source: County of Maui Environmental Management Dept., Wastewater Reclamation Division, 2014 Average.
http://files.hawaii.gov/dlnr/cwrm/planning/hwrsr2013.pdf



Maui County Dept. of Environmental Management, 2013

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. Due to contaminants picked up by stormwater runoff different levels of treatment may be necessary. Use of rain barrels or infiltration methods may be used by individuals or for small projects. 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 minimize infrastructure costs.

Table 7-1: 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	

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. Desalination requires significant electrical power and therefore has a high financial and potentially environmental cost. Disposal of the brine poses an environmental challenge. Injection wells or direct ocean outfall are likely options for brine disposal.

Conservation

The Hawai‘i Water Conservation Plan, 2013, defines water conservation as the reduction in fresh water use by improving the efficiency of water delivery and end uses. Conserving water and avoiding water waste are important for long-term sustainability even in times of abundant rainfall. Managing water demands and implementing viable conservation measure can delay or avoid additional capital infrastructure, decrease operating costs, and avoid environmental degradation relating to both public and private water utilities. Water conservation is a critical component of climate adaptation and can increase resilience to declining water supply or more frequent drought. The County's policy is to promote water conservation per County Code Section 14.03.010 which also states:

A. Water is a valuable natural resource that should always be used wisely and be managed as a public trust.
B. Unrestricted water use for nonessential needs may endanger the adequacy of the County's water supply for essential needs.
C. A water conservation plan is essential to preserve water resources and to reduce the risk and severity of water shortages. Such a plan will significantly reduce the long-term and short-term consumption of water, thereby preserving available water for the future requirements of the County, while minimizing the hardship caused to the general public. The enactment of a water conservation plan is further necessary in order to preserve and protect the public health, safety, and welfare.

Conservation requires a range of actions affecting a wide range or uses in order to accomplish a measurable and significant reduction over time. Potential targets to reduce water demand may include:

1. Reduce average daily water demand by ___
2. Reduce peak season water use by ____
3. Reduce water loss by ____
3. Delay the need for raw water supplies by _____
4. Delay the need for water supply by supplying __ domestic water users (accounts) with water conservation devices per year
5. Increase public education by conducting ___ outreach actions per year

Conservation programs can be implemented by water purveyors of all sizes. DWS is further developing and expanding its water conservation program, which includes both supply side and demand side measures. Anticipated program elements include:

- targeted audit and direct install programs
- rebates and incentives
- expanded conservation requirements for landscaping and other uses
- expanded marketing efforts including targeted user groups such as a hotel awards program building manager information program, and agricultural user working groups/services
- energy production and efficiency measures
- continued watershed protection and restoration
- possible major capital expenditure to support reclaimed water use

Supply Side Measures

1. Leak Detection

An effective leak detection program is critical to identifying unaccounted for water and proactively preventing as much water loss as feasible. Major benefits to a leak detection program include the ability to: respond more quickly to identified leaks; find "hidden" leaks creating ongoing water loss; reduce pressure, especially during low demand; and replace aging and weakened pipe.

2. Universal Metering, Meter Testing, Repair and Replacement

Metering all classes of customers and governmental entities and replacing old water meters ensures efficiency and can identify leaks or other anomalies in water usage. Preventive and predictive maintenance can help to reduce unaccounted-for water in the system by targeting old and substandard lines for replacement.

3. Valve Exercising Program

Water valves may leak and large amounts of water may be lost through these connections. An active valve exercising program on an annual cycle can mitigate water loss.

4. Water Use Auditing

Unaccounted for water includes line flushing, customer meter calibration inaccuracies (due to aging) and theft. Regular comparison of water produced and delivered aids in the identification of potential water waste situations and acts as a backup to the other programs.

Demand Side Measures

1. Public Information and Education

Public education measures can include advertising, community events, and other outreach.

2. Regulatory Requirements

Maui County has adopted the following regulations and rules that support water conservation:

- Maximum flow rate standards for plumbing fixtures sold by local distributors (County Code, Chapter 16.20)
- Prohibition of discharging cooling system water into the public wastewater system (County Code, Section 14.21A.015)
- Plumbing code regulations that require low flow fixtures in new development (County Code, Chapter 16.20B)
- Requirements that all commercial properties within 100 feet of a reclaimed water line utilize reclaimed water for irrigation and other non-potable uses (County Code, Section 20.30.020A)
- A water waste prohibition with provision for discontinuation of service where negligent or wasteful use of water exists (County Code, Section 14.03.050)
- A provision enabling the Water Director to enact special conservation measures in order to forestall water shortages (County Code, Section 14.06.020)
- Regulations for the Control of Water Usage During Droughts (County Code, Chapter 14.06)

Expanded regulatory options could address landscaping and irrigation, grey water use for commercial and residential purposes, and compliance with EPA WaterSense Program.

3. Plumbing Retrofits and Sub Metering

Distribution of low flow fixtures and retrofit/direct installation programs can be especially effective in combination with water audits and sub-metering of multi-family units and multi-purpose buildings. Studies indicate that metering un-metered units is among the most effective conservation measures, by billing explicitly for water use rather than hiding this cost in the rent.

4. Rebates and incentives

Rebates and incentives can include hotel awards program, a building manager information program, agricultural user working groups/services, as well as energy production and efficiency measures. State and local government can enhance “green-building” efforts with county rebates and utility credits and state income tax credits directed specifically at water conservation.

Resource Augmentation

Measures to protect, restore and enhance the resource include watershed management, wellhead protection, and stream restoration. Stream restoration can be an integral component of surface water use options and generally has strong community support. Shifting resource management to integrate the ahupua`a stream based mauka to makai concept is a more holistic approach to managing surface and groundwater rather than focusing on fragmented resources.

<u>Watershed Management</u>

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. Deforestation for agriculture and urbanization disrupts the native ecosystem resulting in an increase in erosion, siltation and impacts to the watershed, beaches and the tourist economy. Nearly two-thirds of Maui’s original forests have already been lost. 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.

Wellhead Protection

The County DWS initiated the Wellhead Protection Program to protect ground waters that supply, or potentially supply, drinking water to wells operated by the DWS. The Draft Wellhead Protection Ordinance proposed for adoption delineates two Wellhead Protection Overlay Zones based on the time it takes groundwater to migrate to the drinking water well. The ordinance would institute zoning controls that restrict land uses that pose a high risk of contamination within each Wellhead Protection Overlay Zone. Protection strategies and the Draft Ordinance were developed with community input at ten public meetings throughout Maui County; as of 2016 the ordinance continues to be under review. This program to protect the water sources is consistent with state and county objectives and is very viable from a sustainability and cost benefit perspective.

Appendix: Optional Strategies Matrix (Separate document)

Partial List of References:

West Maui Recycled Water Verification Study, Department of Environmental Management and Department of Water Supply, January 2012

Water Resources and Climate Change Adaptation in Hawai'i: Adaptive Tools in the Current Law and Policy Framework, 2012

Maui Island Water Source Development Study, Department of Water Supply, 2013

Low-Flow Characteristics of Streams in the Lahaina District, West Maui, Hawai'i, USGS Scientific Investigations Report 2014–5087 http://hi.water.usgs.gov/studies/lahaina_lowflow/

USGS website: http://hi.water.usgs.gov/recent/lahaina/streamflow.html

Cheng, C.L., 2014, Low-flow characteristics of streams in the Lahaina District, West Maui, Hawai'i: U.S. Geological Survey Scientific Investigations Report 2014–5087, 58 p., *http://dx.doi.org/10.3133/sir20145087*.

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.

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

VILLAGES OF LEIALI`I and HONOKŌWAI, DHHL , December 2009

2013 Update of the Hawaii Water Reuse Survey and Report, July 2013

Maui Island Plan and West Maui Community Plan (1996) Policy Summary

Water Resources	Water Availability and Use	Alternative Sources Conservation
Maui Island Plan + Greater protection and enhancement of watersheds, aquifers, streams, and riparian environments + Watershed management plans incorporate ahupua`a management - interconnectedness of upland and coastal ecosystems + Enhance vitality and functioning of streams, while balancing the multiple needs of the community + Ensure adequate stream flow for self-sustaining ahupua`a, riparian ecosystems, native species, traditional kalo cultivation, use of available lo`i. Protect baseflows.* + Native flora and fauna biodiversity to protect native species West Maui CP + Protect ground water resources + Protect and enhance native forest and vegetation + Protect waters and wetland resources for open space, habitat and flood control Control invasive alien plant and animal species +Protect cultural sites: plantation ditch systems, fishponds, significant native vegetation zones, stream valleys- lo'i, 'auwai +Establish Watershed Protection Overlay Plan	Maui Island Plan + Implement State Water Code + DWS actions to reflect public trust responsibilities + Respect and participate in the resolution of native Hawaiian residual land and water rights issues (kuleana lands, ceded lands, historic agricultural and gathering rights) +Enhance streams, while balancing the multiple needs of the community + Capitalize on existing infrastructure capacity as a priority over infrastructure expansion* Develop additional sources of potable water to keep pace with County's needs + Increase efficiency and capacity of the water systems + Protect and maintain water delivery systems West Maui CP + Coordinate water system development to support development within urban growth boundaries + Sufficient water to support ag and native Hawaiian water rights and traditional practices. Special reference to Honokohau Valley + Improve the quality of domestic water. + 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 services	Maui Island Plan + Maximize reclaimed water for where feasible + Use private catchment systems where practicable + Ensure water conservation through education, incentives and regulations + Support development of alternative sources of irrigation water – reclaimed water, recycled stormwater runoff, brackish well water West Maui CP + Reduce potable water consumption outside urban areas + Encourage landscape and ag use of reclaimed wastewater. + Encourage maintenance and development of water sources for agricultural uses that do not conflict with domestic demand for potable water + Promote conservation of potable water via use of reclaimed water for irrigation *General Plan