WATER CONSERVATION MASTER PLAN 2017

March 2017

Waikoloa Service District

Hawaii Water Service
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List of Acronyms

AF	Acre-feet (one AF equals 325,851 gallons)
AMI	Advanced metering infrastructure
AMR	Automatic meter reading
AWE	Alliance for Water Efficiency
AWWA	American Water Works Association
BCR	Benefit Cost Ratio
BMP	Best Management Practice
CII	Commercial, industrial, and institutional
CUWCC	California Urban Water Conservation Council
CWRM	Commission on Water Resources Management
GIS	Geographical information systems
GPCD	Gallons per capita per day
GPF	Gallons per flush
GPM	Gallons per minute
GRC	General Rate Case
HET	High efficiency toilet
HEU	High efficiency urinal
HEW	High efficiency clothes washer
HWCP	Hawaii Water Conservation Plan
IAPMO	International Association of Plumbing and Mechanical Officials
IOU	Investor-owned utility
IWA	International Water Association
M36	AWWA's Manual: Water Audits and Loss Control Programs
MaP	Maximum Performance toilet testing program
MGD	Million gallons per day
PUC	Public Utilities Commission
PWMP	Potable Water Master Plan
SB	Senate Bill
ULFT	Ultra low flow toilet
WF	Water Factor
WUDP	Water Use Development Plan

Executive Summary

The County of Hawaii completed its Water Use and Development Plan Update (WUDP) in 2010. This plan identified limits to the Waikoloa District's existing groundwater supplies to meet projected future increases in water demand. Implementation of robust conservation programs was a core recommendation in the WUDP for the two Aquifer Sector Areas – the West Mauna Kea and the Northwest Mauna Loa -- in which the Waikoloa District operates. The WUDP provided three justifications for this recommendation. First, future water use was projected to exceed aquifer sustainable yield by a potentially wide margin, although the timing of when this might occur remains uncertain. Second, unit water use rates in the two Aquifer Sector Areas are among the highest on the island. The WUDP recommended implementation of conservation programs to bring these rates down to be more in line with island averages. Third, the West Mauna Kea and Northwest Mauna Loa Aquifer Sector Areas are among the most arid on the island. With respect to the Northwest Mauna Loa Aquifer Sector Area, the WUDP concluded that "water purveyors could easier justify implementing conservation measures in [this sector area] than any other sector area, because it is the driest sector on the island."

Water Use Growth Projections

The Waikoloa District completed an update to its Potable Water Master Plan (PWMP) in 2012. The PWMP projects future annual growth in municipal water use of 3.5 percent while the WUDP projects a somewhat slower annual growth rate of 3.0 percent. The PWMP projection goes through 2021 while the WUDP projection goes through 2025. Forecasts of water use growth beyond 2025 have not been prepared. However, the PWMP does estimate the volume of Waikoloa District demand at full build-out. Assuming water demand continues to grow at 3 to 3.5 percent after 2025, full build-out demand would likely be realized by 2042.

Before this would occur, however, the WUDP projects that pumping in the Waimea aquifer upon which the Waikoloa District depends for all of its potable water supply will exceed the aquifer's sustainable yield of 24 mgd. Once pumping is within 90 percent of sustainable yield, the Commission on Water Resources Management (CWRM) is required to designate the aquifer as a Groundwater Management Area, which would likely result in new regulations and restrictions on pumping and re-assessment of the aquifer's sustainable yield. The WUDP projects 90 percent of sustainable yield could be reached sometime between 2025 and 2030.

Need for Additional Conservation Investment

The Waikoloa District serves the Waikoloa Village which is located within the West Mauna Kea Aquifer Sector Area and the Waikoloa Beach Resort, which is located within the Northwest Mauna Loa Aquifer Sector Area. With regard to the former, the WUDP states that "demand-side water conservation programs should be implemented with the goal of reducing residential unit consumption rates closer to the island average." With regard to the latter, it notes that water use unit rates are the highest on the island and that the sustainable yield of the Waimea aquifer will ultimately limit the amount of potable water that can be imported to the sector. For these reasons, the WUDP recommends more investment in conservation and expanded use of recycled water in this sector.

Waikoloa District's Existing Conservation Program

The current annual budget for conservation in the Waikoloa District is $20,000. This allows for basic education and customer outreach programs, and limited amounts of direct investment in conservation.

The current budget is not sufficient to support the types of municipal conservation Best Management Practices that will be discussed later in this plan and that were recommended in the state's water conservation plan, such as distribution system water loss control, irrigation upgrade programs, green business programs, customer water use survey programs, or WaterSense equipment retrofit programs.

Conservation Program Actions and Phasing

Successful implementation of a conservation program that leads to durable changes in water use takes time. For this reason, it is useful to think of conservation program development in terms of implementation phases. The initial phase is focused on pulling together the necessary data and analysis to support the program going forward, intensifying public outreach and education, developing partnerships with water users, and putting in place regulatory supports. With this foundation laid, the focus of the next phase is on building the organizational capacity to deploy and manage a multi-faceted conservation program and doing pilot projects to test and refine program approaches. This is followed by rollout of customer assistance programs and monitoring tasks.

Although future demand is projected to exceed the sustainable yield of the local groundwater aquifer, this is not expected to occur for another 10 to 15 years. This gives the Waikoloa District time to put in place a comprehensive water conservation program as part of its integrated water supply management strategy.

The timing and intensity of different programmatic actions is likely to change in light of new information and will ultimately depend on what is authorized by the Public Utilities Commission (PUC). The following provides a preliminary implementation timeline. All of the actions listed below were identified as important elements to advancing water use efficiency in Hawaii's statewide water conservation plan. Many correspond directly to the municipal water conservation Best Management Practices (BMPs) contained in that plan.

Over the next two to four years the focus of Hawaii Water Service should be on data collection and analysis, outreach and education, water loss control, and advancing water use efficiency regulations. Specific objectives within each of these areas include:

- Data collection and analysis
    - Develop and implement a database to track historical water use, accounts, and other information related to Waikoloa District water supply and demand
    - Digitally map landscaped areas in the Waikoloa District and link to a GIS database of customer account information
    - Conduct an analysis of Waikoloa District avoided water supply cost to be used for program screening and selection.
    - Construct a database of conservation measure costs and water savings to be used for program screening and selection.

- Outreach and education
    - Revamp and expand the conservation section of the Hawaii Water Service website.
    - Develop water use efficiency themes and logos for program branding.
    - Develop water use efficiency newsletter/flyers for inclusion with bills.

  - Create speakers bureau and forge relationships with local business and community groups.
  - Identify potential locations and partners and develop designs for demonstration gardens/landscapes.
  - Initiate residential and commercial landscape water use efficiency workshops.

- Water loss control
  - Implement staff training in the IWA/AWWA Water Audit Method
  - Annually conduct system water audits and reporting.
  - Conduct leakage component analysis and evaluate cost-effectiveness of an active leakage control intervention program.

- Water Use Efficiency Regulation
  - Engage County of Hawaii and state resource agencies and legislators to adopt a model ordinance for landscape water use efficiency.
  - Engage County of Hawaii to amend the Uniform Plumbing Code's plumbing fixture maximum flow rate standards.

Over the next four to six years, develop the organizational capacity and budgetary resources to implement customer conservation pilots and programs. Objectives with this phase include:

- Organizational capacity building
  - Conduct a formal water conservation needs analysis and program strategy, including an analysis of staffing requirements, financial cost, and ratepayer impact assessment
  - Develop a water conservation business plan and implementation timeline
  - Incorporate conservation program analysis into future GRC applications and use as justification for conservation program budget requests

- Pilots and partnerships
  - Form a water conservation working group with local business and homeowner associations
  - Implement several high-profile pilot projects to test and document water savings potential
  - Institute a water conservation recognition awards program

Over the next seven to ten years, rollout customer assistance and retrofit programs. The type, timing, and intensity of these programs will depend on the outcomes from earlier implementation phases. A possible sequence is shown below. While this is primarily for illustration, given the dominance of landscape water uses in the Waikoloa District, early emphasis is likely to be placed on landscape programs. Residential and commercial customer assistance and indoor plumbing retrofit programs would follow the rollout of the landscape programs.

- Early implementation:
  - Large landscape water use reports
  - Large landscape water use evaluations

  - Irrigation equipment upgrade programs

- Mid-period implementation:
  - Residential conservation kits
  - Home water reports
  - Home water surveys
  - Plumbing fixture replacement (rebates and/or direct install)

- Late-period implementation
  - Financial incentives for landscape transformation
  - Commercial water use evaluations

Monitoring and Plan Updating

Monitoring is a continuous task of any good water conservation program. Tracking program implementation with respect to program objectives and budgets will be key to understanding whether the program is meeting its performance goals and if not how it might be adjusted to perform better. Also important will be completing program savings evaluations to verify whether predicted water savings are in line with realized water savings.

The Water Conservation Master Plan is intended to be a living document and is expected to change in scope and specificity over time. The scope of this first plan is fairly broad and its specificity is fairly general. This will change with subsequent updates as information coming out of the early implementation phases is incorporated into the plan. The frequency with which the plan is updated is not set in stone, but should not be less frequent than every five years. More frequent updates will likely be needed in the early stages of program development and implementation. Updating the plan on a two or three year cycle initially may be required. As the program matures, updating the plan on a five year cycle would likely be appropriate. A reasonable implementation schedule might be:

- 2017: Initial Conservation Master Plan
- 2019: First update
- 2022: Second update
- 2025 and thereafter: update every five years

1 Introduction

Hawaii Water Service is committed to ensuring reliable, high quality, and affordable water service for all its customers. Planning for the future is a key part of this. Currently, the Waikoloa District (hereafter District) serves its customers high quality, local groundwater. The District's service area falls within two Aquifer Sector Areas. Waikoloa Village is within the West Mauna Kea Aquifer Sector Area. Waikoloa Beach Resort is within the Northwest Mauna Loa Aquifer Sector Area. Potable water supply serving both areas is drawn only from the Waimea aquifer underlying the West Mauna Kea Aquifer Sector Area. There are natural limits to how much demand this aquifer can reliably serve. The County of Hawaii projects that full buildout demands would greatly exceed the aquifer's sustainable yield (County of Hawaii, 2010). It also notes that water usage rates within the West Mauna Kea and Northwest Mauna Loa Aquifer Sector Areas are the highest on the island. The County's 2010 Water Use and Development Plan Update (WUDP) states that water conservation should be a primary focus in these two Aquifer Sector Areas.

Hawaii Water Service is cognizant of these usage trends and recommendations and has started planning accordingly. In 2012 it updated the District's Potable Water Master Plan (PWMP). The next step was to develop a plan to implement a robust conservation program for the District. This document constitutes Hawaii Water Service's first formal Water Conservation Master Plan for the Waikoloa District.

1.1 Master Plan Scope and Objectives

The Water Conservation Master Plan is intended to be a living document and is expected to change in scope and specificity over time. The scope of this initial plan is fairly broad and its specificity is fairly general.

The main purposes of this first Water Conservation Master Plan are to:

- Serve as a broad guidance document that helps to inform conservation program focus areas, strategies, and priorities both internally and for stakeholders.
- Provide background information and context for conservation program goals and objectives.
- Establish a timeline and process for the implementation of a robust conservation program, including compiling necessary data and conducting essential analyses, building organizational capacity, forming and extending relationships with customers, vendors, and community stakeholders, and deploying and supporting new water use efficiency programs.

Future plan updates will have narrower scope and greater specificity in terms of program design and rollout. The process and anticipated schedule for plan updates is described in Section 6.

1.2 Relationship to General Rate Cases

As an investor-owned utility, Hawaii Water Service's operations are regulated by the State of Hawaii Public Utilities Commission (PUC), which reviews and authorizes the capital expenditures, operating budgets, and rates for the Waikoloa District in a General Rate Case (GRC) proceeding. The District's conservation programs and budgets must be reviewed and authorized by the PUC through a GRC proceeding prior to implementation. The Water Conservation Master Plan will support future applications before the PUC concerning the need for, funding, and implementation of conservation programs by Hawaii Water Service.

1.3 Relationship to State, Regional, and Local Water Resources Planning Documents

The need for increased levels of water conservation is broadly recognized throughout the State of Hawaii and within the County of Hawaii. In 2013, the State of Hawaii adopted the Hawaii Water Conservation Plan. At the regional level, the County of Hawaii updated its Water Use and Development Plan in 2010. At the District level, Hawaii Water Service updated its PWMP in 2012, as previously mentioned. These planning documents have informed the development of this Water Conservation Master Plan in key ways. Each is briefly described below.

1.3.1 Hawaii Water Conservation Plan

The Hawaii Water Conservation Plan (HWCP) provides a comprehensive overview of water use in the State of Hawaii and identifies the need for increased water use efficiency to ensure future supply reliability, accommodate anticipated growth and development, and protect the state's natural environment. A major output of the HWCP is the screening and prioritization of water conservation Best Management Practices (BMPs) for the municipal, military, golf course, and agriculture water use sectors. Within each sector, BMPs were screened and ranked based on:

- **Cost-effectiveness**. Qualitative cost rankings were considered in selecting the most appropriate BMPs.
- **Technology/market maturity**. Only BMPs that have been proven to be effective were selected.
- **Service area match**. Considerations were given to climate and compatibility with local systems and practices.
- **Customer acceptance/equity**. Customers must be willing to implement BMPs and the burden of responsibility must be equitable.

A description of the municipal, landscape, and golf course BMPs is provided in the Appendix. These BMPs helped to inform the conservation program focus areas and program concepts discussed later in Section 5. There is often a direct linkage between a program concept presented in this plan and a HWCP BMP. In such cases, a cross-reference is provided to make this connection explicit.

1.3.2 County of Hawaii Water Use and Development Plan

The County of Hawaii's 2010 WUDP serves as a long-range plan for water resource development in the County. The primary objective of the WUDP is to provide guidelines for the management and use of the island's water resources. The WUDP coordinates water use with land use policies set by the Hawaii Island Plan and the State of Hawaii.

A core part of the WUDP is the development of growth and water use forecasts by Aquifer Sector Area. As stated above, the District's service area falls within two Aquifer Sector Areas. Waikoloa Village is within the West Mauna Kea Aquifer Sector Area. Waikoloa Beach Resort is within the Northwest Mauna Loa Aquifer Sector Area. The WUDP's growth and water use forecasts for these two sectors help to inform the analysis of demands and available supplies presented in Section 3.

1.3.3 Waikoloa District PWMP

The PWMP evaluates the Waikoloa District's water supply and distribution facilities, existing and projected water demands, and existing and potential future water supplies. Information from the PWMP undergirds much of the discussion and information presented in Section 2 (Service area overview) and Section 3 (Analysis of Water Demands and Supplies).

1.4 Report Organization

The remainder of this report is organized as follows:

- Section 2 provides an overview of the District, including the communities it serves, its sources of water supply, and its customer water demands.
- Section 3 summarizes existing and projected water demands and supplies and identifies the need for additional water conservation.
- Section 4 discusses the Waikoloa District's current conservation program and budget.
- Section 5 presents focus areas and program concepts for expanding the Waikoloa District's conservation program.
- Section 6 discusses conservation program phasing and timeline.

2 Service Area Overview

The Waikoloa District is located on the northwestern (Kona) coast of the Island of Hawaii as shown on Figure 1. The District provides water and wastewater services to homes, condominiums, hotels, golf courses, and shops at Waikoloa Beach Resort and in Waikoloa Village. Water use within the Waikoloa Beach Resort currently accounts for about 64 percent of total District water demand. The remaining 36 percent is associated with the Waikoloa Village.

As of 2010-11, the District served 2,125 single-family homes and 2,789 multi-family dwelling units. Almost all of the single-family homes are located in Waikoloa Village. The multi-family dwelling units are nearly evenly split between Waikoloa Village and Waikoloa Beach Resort. Within the Waikoloa Beach Resort, the District serves two hotels, the Hilton and the Marriott, with a combined total of 1,784 hotel rooms. Also within the Waikoloa Beach Resort, the District serves potable water to approximately 55 acres of commercial properties and 56 acres of landscaped area, which does not include the two golf courses within the resort. The golf courses are irrigated with recycled and brackish water. Within the Waikoloa Village, the District serves potable water to approximately 48 acres of commercial properties and 27 acres of landscaped area.

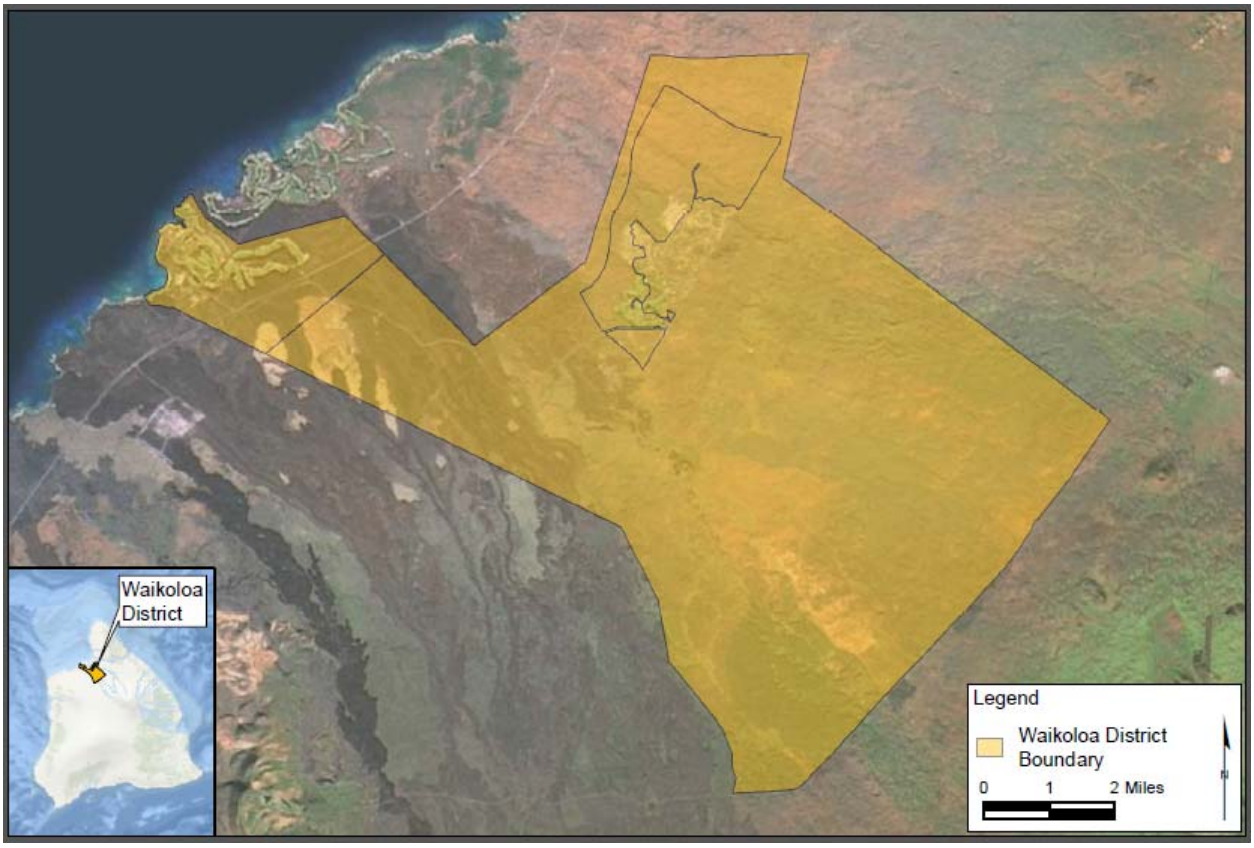
As seen in Figure 1, large parts of the District remain undeveloped, particularly east of Highway 19. A number of development projects have been identified both within the resort area and Waikoloa Village. These areas are projected to experience significant growth over the next several decades. The exact timing of this development is uncertain. Growth projections for the District are discussed in the next section.

Waikoloa Village is within the West Mauna Kea Aquifer Sector Area. The Waimea aquifer, with a sustainable yield of 24 mgd, underlies this Aquifer Sector Area. Pumping from the Waimea aquifer in 2010-11 totaled approximately 13.6 mgd, according to estimates in the PWMP.

The Waikoloa Beach Resort is within the Northwest Mauna Loa Aquifer Sector Area. The Anaehoomalu aquifer, with a sustainable yield of 30 mgd, underlies this Aquifer Sector Area. Pumping from the Anaehoomalu aquifer in 2010-11 totaled approximately 4.8 mgd.

Potable water supply for both the Waikoloa Village and the Waikoloa Beach Resort is drawn only from the Waimea aquifer underlying the West Mauna Kea Aquifer Sector Area. Although the Anaehoomalu aquifer in the Northwest Mauna Loa Aquifer Sector Area has a greater sustainable yield, the aquifer is very thin in most accessible areas, which prevents development of potable water from this source. The Anaehoomalu aquifer currently provides brackish groundwater for golf course irrigation.

Figure 1. Waikoloa Service Area

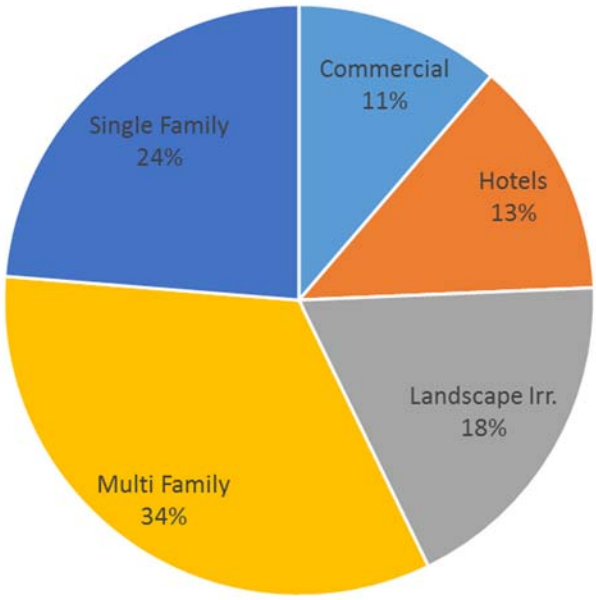


3 Analysis of Water Demands and Supplies

3.1 Customer Class Shares

Potable water demand in the District currently averages slightly more than 5 mgd. More than half of this water (58%) is delivered to single- and multi-family residential customers. The remaining 42 percent of demand is non-residential. Figure 2 shows the demand shares for each customer category. While the share for the landscape irrigation category is only 18 percent, this accounts only for water delivered through dedicated irrigation meters. Substantial amounts of irrigation water is also delivered through mixed use meters, such as meters serving individual homes and condominium complexes. As discussed below, landscape irrigation is the dominant water use in the District.

Figure 2. Waikoloa Service Area Potable Water Demand Shares



3.2 Unit Water Use Rates

Unit water use rates for the District based on 2010-11 consumption data are shown in Table 1. These rates are compared to the 2010 WUDP average daily consumption guidelines. As seen in the table, unit use rates for hotels and commercial properties are in line with the WUDP consumption guidelines. However, residential unit use rates for the overall system exceed by 40 to 50 percent the WUDP consumption guidelines. Similarly, landscape irrigation unit use rates exceed by more than 100 percent the WUDP consumption guidelines. The highest unit use rates are within the Waikoloa Beach Resort, and are likely caused by the extensive amount of landscaped area, fast draining soils, and high application of irrigation water.

Table 1. Waikoloa District Unit Rates of Water Use (gallons per day)

Category	Units	Waikoloa Beach Resort	Waikoloa Village	System Average	WUDP Consumption Guidelines
Single Family	Lot	932	557	563	400
Multi Family	Dwelling Unit	805	360	602	400
Hotel	Room	349	NA	349	400
Commercial	Acre	3,748	1,883	2,877	3,000
Landscape Irrigation	Acre	14,733	2,757	10,874	4,000*

*Unit rate for public parks and schools. University of Hawaii Cooperative Extension guidelines for irrigation of warm season turf grass suggest 1-2 inches of weekly water requirement, or about 78 inches annually. Annual rainfall may provide up to 10 inches of this amount, leaving a net irrigation requirement of 68 inches, or 5.67 feet. This is equivalent to an application rate of about 5,100 gallons per day per acre, less than half the system average unit use for landscape irrigation.

3.3 Landscape Water Use

In the residential sector, most water is used for landscape irrigation and other outdoor uses. It is estimated that outdoor water use comprises more than 70 percent of total residential water use in the District.[1] Data is not available to construct similar estimates for commercial and hotel uses, but it is believed that landscape irrigation comprises a significant share of water use for these two customer categories as well. If we assume that one-third of hotel and one-quarter of commercial water uses are associated with landscape irrigation, then approximately two-thirds of total potable water use in the District may be for landscape irrigation. The extent of outdoor water use in the District, especially water used for landscape irrigation, is important since it informs where the focus on water conservation efforts should be placed.

3.4 System Water Loss

Historically, unaccounted water, the difference between measured well production and metered customer use, has averaged between 8 and 9 percent of total production. For planning purposes, the PWMP assumes an average loss rate of 9 percent. Water losses can be divided between apparent and real losses. Apparent losses occur as a result of metering inaccuracy, data errors, and unauthorized consumption (e.g., water theft). Real losses occur as a result of system leakage and spills in the transmission, storage, and distribution components of the system. Cost-effective minimization of both types of system water loss should be a goal of any well-run water system. Acceptable rates of water loss depend on multiple factors and may vary from system to system. In general, however, water loss in excess of 10 percent of total production is considered excessive for most water systems.

3.5 Projected Water Use Growth

3.5.1 Historical Growth Rate

Growth in the District historically has been erratic. Sometimes brisk and other times slow. There are two main reasons for this. The first is the District is very small, encompassing just a few square miles and having fewer than three thousand total connections. The variance in annual regional growth is inversely proportional to the size of the region. The smaller the region, the greater the variability. It takes only one or two developments to come online to register a sharp increase in water use and these developments generally come online sporadically. The other reason is the District serves a tourism-dependent area. Tourism development in Hawaii is tied to national and global economic cycles. The periods of rapid growth typically correlate with periods of national and global economic expansion, while the periods of slow or negative growth follow times of economic contraction.

While the last 20 to 25 years have exhibited periods of slow or no growth and periods of rapid growth, on average, water use in the District has grown at a rate of 3.7 percent per year, from about 2.5 mgd in the early 1990s to about 5.2 mgd today.

[1] Based on the average unit usage rates shown in Table 1 and an estimate of indoor per capita water use. The estimate of indoor per capita water use is 58.6 gallons per day per person (gpcd). The estimate is from the 2016 Water Research Foundation Residential End Uses of Water Study. Average household size, based on data for Census Tract 217.04, Hawaii County, which encompasses all of the District, is 2.65. An estimate of average indoor use per dwelling unit is therefore 155 gpd. This implies residential outdoor use in the range of 400 to 450 gpd, which is in excess of 70 percent of the residential unit water use rates.

3.5.2 Potable Water Master Plan Growth Projections

Based on an analysis of historical growth patterns and a review of planned development projects, the PWMP projected District water supply requirements through 2021 using a 3.5 percent growth rate. Under this growth assumption, projected water use in the District would increase to about 7.1 mgd by the start of the next decade. The PWMP does not make assumptions about the annual growth in water use after 2021. However, it does estimate that District demands at full build-out will be about 13.5 mgd. If water use were to continue to grow at 3.5 percent annually after 2021, full build-out demands would be reached by 2040.

3.5.3 WUDP Growth Forecasts

The 2010 WUDP projects water demands for the West Mauna Kea Aquifer Sector Area through 2025 for three growth scenarios. These forecasts range between 19.5 and 21.1 mgd in 2025. The mid-point forecast is 20 mgd, of which 12.2 mgd is potable demand and 7.8 mgd is non-potable demand, primarily for agricultural irrigation.

The mid-point growth forecast projects municipal water uses will grow at an annual rate of 3.0 percent, 0.5 percent slower than assumed in the District's PWMP. If this rate of growth were to prevail, the District's full build-out demands would be reached by 2042 rather than 2040.

3.5.4 Summary of Growth Projections

Historically, water use in the District has grown on average by 3.7 percent per year since the early 1990s. The District's PWMP projects future growth in municipal water use of 3.5 percent while the WUDP projects a somewhat slower growth rate of 3.0 percent. The PWMP projection goes through 2021 while the WUDP projection goes through 2025. Forecasts of water use growth beyond 2025 have not been prepared. However, the PWMP does estimate the volume of District demand at full build-out. Assuming water demand continues to grow at 3 to 3.5 percent after 2025, full build-out demand would likely be realized sometime in the early 2040s.

The mid-point forecast from the WUDP of 20 mgd by 2025 is significant because if demand on the Waimea aquifer were to reach this level, the Commission on Water Resources Management (CWRM) would likely designate it a Groundwater Management Area, which could result in new regulations and restrictions on pumping and re-assessment of the aquifer's sustainable yield.

3.6 Need for Additional Conservation Investment

Because of the high unit water use rates in the West Mauna Aquifer Sector Area, which incorporates Waikoloa Village, the WUDP states that "demand-side water conservation programs should be implemented with the goal of reducing residential unit consumption rates closer to the island average."

Within the Northwest Mauna Loa Aquifer Sector Area, which incorporates the Waikoloa Beach Resort, the WUDP states that "water purveyors could easier justify implementing conservation measures in the Northwest Mauna Loa ASEA than any other sector area, because it is the driest sector on the island." The report also notes that water use unit rates in this sector are the highest on the island and that the sustainable yield of the Waimea aquifer will ultimately limit the amount of potable water that can be imported to the sector. For these reasons, the WUDP advocates increased investment in water conservation and expanded use of recycled water.

4 Existing Conservation Program and Budget

Conservation budgets must be reviewed and approved by the PUC through a General Rate Case. The current annual budget for conservation in the Waikoloa District is $20,000. This allows for basic education and customer outreach programs, and limited amounts of direct investment in water conservation projects. The current budget is not sufficient to support the types of municipal conservation Best Management Practices that will be discussed later in this plan and that were recommended in the HWCP, such as distribution system water loss control, irrigation upgrade programs, green business programs, customer water use survey programs, or WaterSense equipment retrofit programs.

Additional budget will be required in order to meet the need for conservation discussed in Section 3. The amount and timing of funding that ultimately will be needed will depend on the identification of strategies and programs best suited for meeting the District's conservation goals. This will be determined in subsequent updates to the Conservation Master Plan. A key purpose of this first plan is to lay out potential conservation focus areas and program concepts for the District. Once this is done, the next step will be to evaluate which of these are best suited to cost-effectively meet the District's water conservation requirements.

5 Conservation Focus Areas and Program Concepts

Going forward, there are a range of actions the District may take to promote water use efficiency. This section discusses six focus areas for potential action. These are:

- Education and outreach
- Regulations supporting water conservation
- Water loss control
- Data collection and analysis
- Partnerships and pilot projects
- Customer assistance and retrofit programs

The emphasis placed on any particular area will depend on the strategy ultimately selected by the District to meet its conservation goals. It will also vary over time. As will be discussed in Section 6, initial focus is expected to be placed on water loss control and data collection and analysis. This focus will likely then shift to partnerships, pilot projects, and customer assistance and retrofit programs as the District develops the capacity and budgetary resources for implementation. Education and outreach and working with local and state governments to advance regulations supporting water conservation in the District will be important at every stage of implementation.

All of the focus areas discussed in this section were identified as important elements to advancing water use efficiency in Hawaii's statewide water conservation plan. Many correspond directly to one or more municipal BMPs listed in the HWCP.

5.1 Focus Area 1: Education and Outreach

Education and Outreach is BMP MU5 in the HWCP. The Alliance for Water Efficiency (AWE) considers public and consumer education programs to be a necessary facet of every conservation program. Similarly, education and outreach is regarded as a foundational BMP by the California Urban Water

Conservation Council (CUWCC), meaning all urban water utilities in California are expected to have education and outreach programs to support their broader water conservation strategies.

The primary objectives of an education and outreach program are to inform and educate water users about:

- Reasons water conservation is necessary,
- Benefits of conserving water,
- Liabilities of not conserving water,
- Actions needed to achieve water conservation goals, and
- Programs and assistance available for undertaking these actions.

Education and outreach works in tandem with other conservation measures to increase program participation rates and program effectiveness. It has been shown empirically that providing customers with information about their water use and ways to save can significantly increase the rate of participation in utility conservation programs (Mitchell and Chesnutt, 2013).

Common ways in which information is disseminated to the public include: utility websites, utility newsletters and bill stuffers, direct mail, local street fairs and events, radio and TV spots, billboards, and newspapers. Successful public education programs often use a common theme (logo or motto) consistently across the different media platforms being utilized.

As discussed in Section 4, the District currently implements a basic education and outreach program.

Near-term actions that could be taken by the District to enhance its existing education and outreach program include:

- Adapting outreach and education materials developed by its sister company California Water Service for use in its education and outreach program.
- Linking the conservation page of its website to the Alliance for Water Efficiency's website.
- Linking the conservation page of its website to the Home Water Works website.
- Developing water use efficiency flyers for inclusion in customer bills.
- Creating a speakers bureau to disseminate information about the District, water issues, and water use efficiency via gatherings of business associations and community groups.

Longer-term actions that could be taken by the District include:

- Adapting its outreach and education materials and messaging to support the suite of conservation measures it makes available to customers.
- Developing a community presence through participation in public events and fairs promoting good environmental stewardship (e.g. Earth Day).
- Creating demonstration gardens and landscapes in public spaces to educate the public about water-wise landscape design and irrigation, per HWCP BMP MU3.
- Working with the Waikoloa Beach Resort operators and other stakeholders to promote public awareness of water use efficiency through media and messaging campaigns.

5.2 Focus Area 2: Regulations Supporting Water Conservation

Regulations prohibiting wasteful water uses and requiring installation and use of efficient plumbing fixtures can be important, low cost drivers of water conservation. In the State of Hawaii, each county is responsible for regulating water usage and implementing water conservation practices within its jurisdiction.

Expanded regulatory options could address landscaping and irrigation, grey water use for commercial and residential purposes, reduction in maximum flow rate standards for plumbing fixtures sold by local distributers and/or installed in new development, and compliance with the EPA WaterSense Program.

The HWCP, for example, recommends the development and adoption of a statewide model ordinance for efficient landscape design and irrigation that could then be adopted by county governments in Hawaii.[2] This approach has been implemented in California, where municipal and county governments can either adopt the state's model ordinance or their own, provided it is at least as effective as the state's. Given the extent of existing landscape water use and the amount of new residential and resort development projected for the Waikoloa area, a model ordinance for landscape design and irrigation could result in significant water savings over the long-run.

Another area where regulation could be used to improve water use efficiency is the reduction of maximum flow rate standards for plumbing fixtures. Currently, plumbing fixture maximum flow rate standards for the County of Hawaii are based on the "Uniform Plumbing Code, 2006 Edition" published by the International Association of Plumbing and Mechanical Officials (IAPMO). The maximum flow rate standards in the "Uniform Plumbing Code" are in turn based on federal standards. However, the "Uniform Plumbing Code" has no legal status until adopted by jurisdictions such as cities, counties and states, and there is nothing preventing a jurisdiction from amending it, as Hawaii County has done extensively. Several states have adopted more stringent maximum flow rate standards in order to promote water conservation. Table 2 compares the maximum flow rate standards for Hawaii County to standards adopted elsewhere in the United States. Adopting more efficient plumbing fixture maximum flow rate standards is in alignment with the HWCP, which recommends plumbing code changes to require that new plumbing fixture meet or exceed EPA WaterSense standards.[3]

A key advantage of using regulations to drive conservation is they do not entail direct outlays by the District and its ratepayers. Implementation of commonsense water use efficiency regulations can generate significant water savings at very low cost.

Hawaii Water Service, as a private water company, cannot on its own adopt and enforce a landscape design and irrigation ordinance or make changes to the maximum flow rate standards for plumbing fixtures. It can, however, engage with the community and County and state officials to promote such changes through local and state legislation.

[2] See municipal BMP 7 in Table 6-1 of the HWCP.
[3] See municipal BMP 10 in Table 6-1 of the HWCP.

Table 2. Comparison of Plumbing Fixture Maximum Flow Rate Standards

Fixture	Hawaii County	California	Colorado	Georgia
Toilet	1.6 gpf	1.28 gpf	1.28 gpf	1.28 gpf
Urinal	1.0 gpf	0.125 gpf	0.5 gpf	0.5 gpf
Showerhead	2.5 gpm	2.0 gpm	2.0 gpm	2.5 gpm
Lavatory faucet	2.2 gpm	1.2 gpm	1.5 gpm	1.5 gpm
Kitchen faucet	2.2 gpm	1.8 gpm	NA	2.0 gpm
Public lavatory faucet	2.2 gpm	0.5 gpm	1.5 gpm	1.5 gpm
gpf = gallons per flush	gpm = gallons per minute			

5.3 Focus Area 3: Water Loss Control

Water loss control comprises the programs and practices employed by water utilities to provide accountability in their operation by reliably auditing their water supplies and implementing controls to minimize system losses. Water utilities incur real losses from pipeline leakage and apparent losses when customer water consumption is not properly measured or billed. Collectively, real and apparent losses are termed non-revenue water. The goal of water loss control is to keep non-revenue water contained to appropriate, economically justified levels.

The American Water Works Association (AWWA) advocates the use of the water audit method it jointly developed with the International Water Association (IWA). The IWA/AWWA Water Audit Method provides the best management practices and guidance for water utilities to efficiently manage their water supplies and distribution system. These are encapsulated in AWWA's Manual: Water Audits and Loss Control Programs (M36) and the AWWA Free Water Audit Software. Implementation of water loss control programs based on the IWA/AWWA Water Audit Method received the second highest ranking among the municipal BMPs in the HWCP.[4]

In June 2016, SB 2645 was signed into law, which will implement a standardized statewide water-loss audit program. Under this new law, the CWRM will be responsible for implementing a five-year program that will require all large capacity public water systems and public water systems of any size in water management areas to complete and validate a yearly water loss audit per the IWA/AWWA Water Audit Method. All county-run water systems must prepare annual water audit reports beginning with calendar year 2017, to be filed with the state by July 2018, and each year thereafter. All other large capacity water systems such as Hawaii Water Service must prepare water audit reports beginning with calendar year 2019, to be filed with the state by July 2020, and each year thereafter. Additionally, each water loss audit report submitted to the commission is to be accompanied by information identifying steps taken in the preceding year to increase the validity of data entered into the final audit, reduce the volume of apparent losses, and reduce the volume of real losses.

Near-term water loss control actions that will be taken by the District include:

- Ensure utility staff have received training in the IWA/AWWA Water Audit Method and the use of the AWWA Free Water Audit Software.
- Annually conduct a system water audit with level 1 validation.
- Commencing July 2020, annually report water loss audit results to CWRM.

[4] The "Green Business Program" BMP, which is discussed in Section 5.5, was ranked first.

- Maintain archive of annual water audit results and track changes in real and apparent losses.

Longer-term water loss control actions that could be taken by the District include:

- Ensure utility staff have received training in water leakage component analysis methods and use of the AWWA Leakage Component Analysis Model.
- Use the results of distribution system leakage component analyses to guide the development of a leakage control intervention strategy for the District.
- Implement a leakage control intervention program.

As discussed in Section 3.4, system water loss has averaged between 8 and 9 percent of total production, which is about 0.4 mgd. The amount of real water loss as a share of the total is not known, but likely to be significant.

5.4 Focus Area 4: Data Collection and Analysis

The adage that "you can't manage what you don't measure" means you cannot know whether or not you are successful unless success is defined and tracked. This is why conducting annual water loss audits is the first step in implementing a water loss control program.

This applies more broadly to the development of a successful water conservation program. Reliable data on water use, system costs, conservation program costs, and expected program water savings are needed in order to establish conservation goals, assess water savings potential, and evaluate costs and benefits of alternative strategies.

Near-term data collection and analysis that could be taken by the District include:

- **Develop a data tool to track historical water consumption and other water system information used to analyze water use and production trends**. In order to have data needed to track and evaluate trends in water use, Hawaii Water Service should develop a tracking tool to collect and archive this data. As an example, Hawaii Water Service's sister company California Water Service has developed a tracking tool called PAWS (Projection Analysis Worksheets) for this purpose. PAWS is a spreadsheet-based tool used to maintain a historical record of services (by customer class), water sales (by customer class), production (by source of supply), non-revenue water, average day, maximum day, and peak hour demand, population, households (single- and multi-family), and weather (rainfall, temperature, and evapotranspiration) for each of its service districts. These data are key inputs to a variety of planning, forecasting, and evaluation purposes.
- **Digital mapping of type and extent of landscape in the District**. Computer processing of aerial and satellite imagery and geographical information systems (GIS) have made digital mapping of landscaped areas feasible for most water districts. Hawaii Water Service's sister company California Water Service, for example, has recently mapped the landscaped areas of nearly all the land parcels it serves and linked this information in a GIS database to other customer data so that it can provide tailored information on landscape water use and conservation recommendations to its customers. Given the dominance of landscape water use in the Waikoloa District, similar mapping should be done to support future implementation of landscape water use efficiency programs.

- **Estimate system avoided costs**. In order to assess whether a conservation program is economically justified and to compare the relative cost-effectiveness of different program strategies, Hawaii Water Service will need to undertake a detailed analysis of system avoided costs. A conservation program is economically justified only if the benefits expected from the program exceed its cost. The primary economic benefit of a water conservation program is the future water supply and facility costs that are avoided as a result of the demand reductions associated with the program. This requires a forecast of future water supply and facility costs that would be avoided as a result of projected demand reductions. Preparing an accurate forecast can be challenging. Fortunately, the California Urban Water Conservation Council (CUWCC) and Water Research Foundation (WRF) have developed a model specifically for this purpose. The model is designed to standardize and improve the accuracy of avoided supply cost forecasts, and to meet the needs of utilities of different sizes, degrees of complexity, and levels of analytical sophistication.
- **Compile information on conservation measure costs and water savings**. An assessment of alternative conservation strategies requires information on the likely cost and expected water savings of different conservation measures that could be implemented. Hawaii Water Service's sister company California Water Service has developed a library of information on implementation costs and expected water savings for a large number of residential, commercial, and landscape conservation measures. The residential and commercial indoor conservation measure specifications in most instances will be directly applicable. The outdoor conservation measure specifications will need to be adjusted to accurately reflect the District's climate and outdoor water using patterns.

Longer-term data collection and analysis would focus on program evaluations to verify whether realized water savings and implementation costs are in line with projections, and if not, adjusting the conservation program accordingly.

5.5 Focus Area 5: Partnerships and Pilot Projects

The success of a water conservation program depends on many water users making small changes in how and when they use water. Changing habits and perceptions about water use in a way that leads to durable changes in water demand does not occur over night. It requires consistent, persistent, and persuasive outreach and education. It also requires working collaboratively with the community to jointly develop strategies to achieve water use efficiency, testing and refining promising approaches through pilot projects, and highlighting and awarding successful outcomes.

The District's largest water users are the resorts and the home owner associations. As previously discussed, the Waikoloa Beach Resort accounts for almost two-thirds of the water use in the District and has very high unit water use rates. Water conservation in the District cannot succeed without the active participation of the residents and operators of the resort implementing conservation measures. The same is true for the home owner associations within the Waikoloa Village.

Near-term actions that could be taken by the District to form collaborative relationships with key water users include:

- **Formation of a water use efficiency working group**. The purpose of a working group is to provide the community a forum for addressing water management challenges facing the

District. It would serve as a conduit for disseminating information about the District to community leaders and to hear concerns, receive feedback, and solicit input from the community on ways forward. The primary benefit is the forging of relationships and sharing of information and viewpoints in order to come to a common vision. The City of Santa Cruz in California provides a useful recent case study of the potential effectiveness of this type of strategy for transforming what often is an adversarial relationship between the water provider and the broader community into a collaborative one.[5]

- **Implementation of large water user conservation pilot projects**. Working with resort and home owner associations the District could jointly implement several high-profile pilot projects to test and document the effectiveness of different conservation strategies. Given the dominance of landscape water use, the pilots should initially focus on landscape water use efficiency. Possible areas where pilot projects could be used to test and document the effectiveness of different irrigation management options include:
    - High-efficiency sprinkler systems and components (e.g. high-efficiency popup and rotating nozzles).
    - Weather-based irrigation controllers (e.g. smart controllers).
    - Use of native and low-water using landscape materials.
    - Large water user leak detection.
- **Implementation of a Water Conservation Recognition Awards Program**, per BMP MU8 in the HWCP. The intent is to highlight and celebrate local businesses or associations that have implemented water use efficiency projects and practices resulting in significant and measurable changes in their water use. The State of Hawaii has a Green Business Awards Program that could provide a template for a Hawaii Water Service program focused on local water use efficiency accomplishments.[6]

5.6 Focus Area 6: Customer Assistance and Retrofit Programs

There is a wide array of customer assistance and retrofit programs that can be implemented to promote water conservation in the District. Such programs can be grouped into four categories:

- Plumbing fixture replacements
- Irrigation equipment/landscape upgrades
- Residential assistance
- Non-residential assistance

Examples of programs within each category are discussed in the following sections. Where programs directly correspond to municipal BMPs in the HWCP, this is noted.

5.6.1 Plumbing Fixture Replacement Programs

In the residential sector, plumbing fixture replacement programs focus on accelerating the replacement of low-efficiency toilets, urinals, clothes washers, and showerheads through the provision of financial incentives, fixture distribution, and direct installation. Commercial programs focus on these fixtures but may also incentivize the replacement of non-residential fixtures in commercial kitchens, hospitals, and office buildings. Where feasible, plumbing fixture replacement programs should be linked to EPA's

[5] http://www.santacruzwatersupply.com/
[6] http://energy.hawaii.gov/green-business-program

WaterSense program, which certifies and labels water using fixtures and appliances that use 20 percent less water than existing requirements and are performance tested.

These programs correspond to BMPs MU6 and MU10 in the HWCP. Examples include:

- **Residential Conservation Kits and Showerheads** – A relatively low-cost and easy to implement program is the provision of conservation kits to residential customers. Kits are typically provided free of charge and include a variety of simple to install high-efficiency devices such as a showerhead, faucet aerators, full-stop hose nozzle, toilet leak detection tablets, and educational material on residential water savings. Conservation kits typically cost in the range of $15 to $30 per kit.

- **Toilet and Urinal Replacement** – Programs to replace old toilets with single- or dual-flush high-efficiency toilets that use 1.28 gallons or less per flush. Toilet rebate programs that provide customers a rebate for replacing an old toilet with a qualifying efficient toilet are the most common type of toilet replacement program. Other approaches include direct installation, where the utility provides and directly installs the toilets, and distribution, where the utility purchases toilets in bulk and makes them available to qualifying customers. Rebate approaches are more vulnerable to program free-riders than direct installation and distribution programs, which can reduce the program's cost-effectiveness and water savings.[7] Direct installation programs can be particularly cost-effective if there are large numbers of toilets that can be replaced all at once, such as for multi-family housing complexes and hotels, which creates economies of scale. Toilet rebates are typically in the range of $50 to $200 per toilet. Rebates for commercial toilets, which usually involve more expensive flushometer-type toilets, are typically set higher than for residential toilets. Commercial urinal replacement programs may focus only on flushometer valve replacement or both valve and bowl replacement. Incentive programs for waterless urinals are also becoming more common.

- **Clothes Washer Replacement** – Similar to toilet replacement, this program replaces old clothes washers with high-efficiency washers. Modern washers use a fraction of the water used by old washers. Typically clothes washer replacement programs target single-family customers, where rates of clothes washer ownership are greatest, but they may also incentivize the installation of efficient washers in common laundry rooms and commercial laundromats. Like toilet rebates, clothes washer rebate programs are susceptible to program free-riders. Rebates for residential clothes washers are typically in the range of $100 to $200. Commercial clothes washer rebates are typically set higher than residential rebates to reflect higher appliance costs and greater water savings potential.

- **Commercial Equipment Replacement** – These programs target high-water use fixtures and equipment in the commercial and industrial sectors. Common targets include kitchen pre-rinse spray valves, kitchen and hospital steamers and sterilizers, ice machines, and cooling towers. These programs can be much more challenging to implement than residential plumbing fixture

[7] A program free-rider is a participant that would have taken the same action within the same time period even without the program.

replacement programs. They may require specialized knowledge about commercial process water uses and it can be difficult to recruit commercial participants unless payback periods are very short.

5.6.2 Irrigation Equipment/Landscape Upgrades

This category of programs focuses on improvements to landscape water use efficiency. These programs correspond to BMP MU7 in the HWCP. Examples include:

- **High-Efficiency Irrigation Nozzle Replacement** -- Water efficient sprinkler nozzles (popup and rotating) and integrated pressure-regulated spray bodies use significantly less water than a standard sprinkler head by distributing water more slowly and uniformly to the landscape. In addition to reducing water use, water directed from these nozzles reduces run-off onto streets and sidewalks with a more directed flow. Typical programs allow customers to obtain the nozzles either directly through the utility or via a web-voucher program. Rebates are generally used to encourage adoption of high-efficiency spray bodies. Restrictions on the number of nozzles individual customers may receive usually vary by customer class and/or landscape size. High-efficiency irrigation nozzle replacement programs correspond to BMP MU7 in the HWCP.

- **Irrigation Controller Replacement** – Programs are designed to incentivize the replacement of "dumb" irrigation controllers with "smart" controllers that adjust irrigation based on real-time weather and soil-moisture data. Rebates are typically used for residential customers. Tailored projects where the utility works directly with the property manager and landscape maintenance service provider are common for large commercial landscapes. Irrigation controller replacement programs correspond to BMP MU7 in the HWCP.

- **Landscape Transformation** – Programs are designed to incentivize the replacement of high-water using ornamental landscaping with native and/or low-water using landscaping. Turf replacement programs, for example, provide financial incentives for the replacement of ornamental turf with water-wise plantings. Rebates for turf replacement typically are in the range of $0.50 to $2.00 per square foot. In areas where functional and ornamental turf is comingled, such as golf courses and parks, it is possible to evaluate foot traffic patterns to determine which turf areas receive little or no traffic and can potentially be replanted to something less water intensive.[8]

5.6.3 Residential Assistance

This category of programs focuses on providing residential customers with information and assistance in managing their water use. Programs in this category correspond to BMP MU9 in the HWCP. Examples include:

- **Home Water Reports** – Home water reports provide households with monthly reports on their water use and compare it to their prior use, their water budget, which is based on their site-specific conditions, and water use by similar households. This information is coupled with

[8] For example, Hawaii Water Service's sister company California Water Service implemented a program with golf courses to give players GPS tracking devices so that foot traffic patterns could be mapped to identify functional versus non-functional turf areas along fairways and around greens.

actionable information on ways to use water more efficiently around the home and to alert the customer of available conservation programs. Empirical evaluations of home water reports have found them to be surprisingly effective, reducing household water use by five to six percent, on average.[9] Unit costs were in the range of $300 to $600 per acre-foot of water savings, which is cost-competitive with most other conservation programs and supply options. The approach was pioneered in the energy sector by Opower.

- **Home Water Surveys** – Water use surveys entail on-premises water user assessment surveys to evaluate opportunities for water savings. Water surveys can be performed by water utility staff but many utilities outsource this function to firms specializing in water and energy auditing services.

5.6.4 Non-Residential Assistance

This category of programs focuses on providing non-residential customers with information and assistance in managing their water use. Programs in this category correspond to BMP MU9 in the HWCP. Examples include:

- **Landscape Water Use Reports** – Programs are designed to monitor and report on landscape water use relative to a benchmark irrigation budget for the site. The irrigation budget calculates the recommended amount of water for irrigation based on landscape size, plant mix, weather, and season. The monthly report indicates whether irrigation is excessive and how much the customer's water costs could be reduced by irrigating more efficiently. The program can be linked to other assistance, such as large landscape site evaluations and landscape transformation and irrigation equipment incentives.

- **Large Landscape Water Use Evaluations** – Programs are designed to provide on-premises landscape water use evaluations, recommendations, and education to commercial customers with significant landscaped area. The program can be linked to other assistance, such as landscape transformation and irrigation equipment incentives.

- **Commercial Water Use Evaluations** – Programs are designed to provide on-premises water use evaluations of commercial water use. Commercial water use evaluations can be performed by water utility staff but many utilities outsource this function to firms specializing in water and energy auditing services. Commercial water use evaluations are more complicated and expensive than residential water surveys, and may require specific technical knowledge of various commercial process water uses.

6 Conservation Program Phasing

Successful implementation of a conservation program that leads to durable changes in water use takes time. As everybody knows, trying to do too much at once seldom works. For this reason, it is useful to think of conservation program development in terms of implementation phases. The initial phase is focused on pulling together the necessary data and analysis to support the program going forward, intensifying public outreach and education, developing partnerships with water users, and putting in

[9] See Mitchell and Chesnutt (2013) and Hastings and Rustamov (2015).

place regulatory supports. With this foundation laid, the focus of the next phase is on building the organizational capacity to deploy and manage a multi-faceted conservation program and doing pilot projects to test and refine program approaches. This is followed by rollout of customer assistance programs and monitoring tasks.

While projected development in the District is expected to exceed the sustainable yield of the local groundwater aquifer, this is not expected to occur for another 10 to 15 years. This gives the District time to put in place a comprehensive water conservation program as part of its integrated water supply management strategy.

This section discusses the likely phasing of this program. This is a preliminary discussion. The timing and intensity of different actions is likely to change in light of new information and will ultimately depend on what the PUC authorizes. Future updates of the Conservation Master Plan will track and document this evolution, as will be discussed in Section 6.4.

6.1 Phase 1: Data Analysis, Outreach, Water Loss Control, Regulation

Over the next two to four years the focus of the program should be on data collection and analysis, outreach and education, water loss control, and advancing water use efficiency regulation. Specific objectives within each of these areas include:

- Data collection and analysis
    - Develop and implement a database to track historical water use, accounts, and other information related to District water supply and demand
    - Digitally map landscaped areas in the District and link to a GIS database of customer account information
    - Conduct an analysis of District avoided water supply cost to be used for program screening and selection.
    - Construct a database of conservation measure costs and water savings to be used for program screening and selection.

- Outreach and education
    - Revamp and expand the conservation section of the Hawaii Water Service website.
    - Develop water use efficiency themes and logos for program branding.
    - Develop water use efficiency newsletter/flyers for inclusion with bills.
    - Create speakers bureau and forge relationships with local business and community groups.
    - Identify potential locations and partners and develop designs for demonstration gardens/landscapes.
    - Initiate residential and commercial landscape water use efficiency workshops.

- Water loss control
    - Implement staff training in the IWA/AWWA Water Audit Method
    - Annually conduct system water audits and reporting
    - Conduct leakage component analysis and evaluate cost-effectiveness of an active leakage control intervention program

- Water Use Efficiency Regulation
    - Engage County of Hawaii and state resource agencies and legislators to adopt a model ordinance for landscape water use efficiency
    - Engage County of Hawaii to amend Uniform Plumbing Code's plumbing fixture maximum flow rate standards

6.2 Phase 2: Building Organizational Capacity and Doing Pilot Projects

Over the next four to six years, develop the organizational capacity and budgetary resources to implement customer conservation pilots and programs. Objectives within this phase include:

- Organizational capacity building
    - Conduct a formal water conservation needs analysis and program strategy, including an analysis of staffing requirements, financial cost, and ratepayer impact assessment
    - Develop a water conservation business plan and implementation timeline
    - Incorporate conservation program analysis into future GRC applications and use as justification for conservation program budget requests

- Pilots and partnerships
    - Form a water conservation working group with local business and homeowner associations
    - Implement several high-profile pilot projects to test and document water savings potential
    - Institute a water conservation recognition awards program

6.3 Phase 3: Customer Program Rollout

Over the next seven to ten years, rollout customer assistance and retrofit programs. The type, timing, and intensity of these programs will depend on the outcomes from Phases 1 and 2. A possible sequence is shown below. While this is primarily for illustration, given the dominance of landscape water uses in the District, early emphasis is likely to be placed on landscape programs. Residential and commercial customer assistance and indoor plumbing retrofit programs would follow the rollout of the landscape programs.

- Early implementation:
    - Large landscape water use reports
    - Large landscape water use evaluations
    - Irrigation equipment upgrade programs

- Mid-period implementation:
    - Residential conservation kits
    - Home water reports
    - Home water surveys
    - Plumbing fixture replacement (rebates and/or direct install)

- Late-period implementation
    - Financial incentives for landscape transformation

- Commercial water use evaluations

6.4 Phase 4: Monitoring and Plan Updating

Monitoring is a continuous task of any good water conservation program. It goes back to the adage mentioned earlier that you can't manage what you don't measure. Tracking program implementation with respect to program objectives and budgets will be key to understanding whether the program is meeting its performance goals and if not how it might be adjusted to perform better. Also important will be completing program savings evaluations to verify whether predicted water savings are in line with realized water savings.

As noted in Section 1.1., the Water Conservation Master Plan is intended to be a living document and is expected to change in scope and specificity over time. The scope of this first plan is fairly broad and its specificity is fairly general. This will change with subsequent updates as information coming out of the early implementation phases is incorporated into the plan. The frequency with which the plan is updated is not set in stone, but should not be less frequent than every five years. More frequent updates will likely be needed in the early stages of program development and implementation. Updating the plan on a two or three year cycle initially may be required. As the program matures, updating the plan on a five year cycle would likely be appropriate. A reasonable implementation schedule might be:

- 2017: Initial Conservation Master Plan
- 2019: First update
- 2022: Second update
- 2025 and thereafter: update every five years

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Appendix: State of Hawaii Water Conservation Plan Best Management Practices for Municipal, Landscape, and Golf Course Sectors

The following tables and lists of water conservation Best Management Practices are taken from the State of Hawaii Water Conservation Plan (HWCP). Note that the references in the tables to Appendix B are referring to Appendix B in the HWCP, not this report.

TABLE 6-1
Municipal BMPs
(see Appendix B for more detail)

ID/Rank	BMP	Description	Responsible Party	Possible Implementation Mechanisms
MU1	Water Loss Control	Water loss control is the calculation and reduction of water losses according to industry standard methodology.	- Municipal water systems (submit audits) - CWRM (collect and review audits)	a) Work with municipal providers to adopt, modify, or develop a procedure for conducting an annual water audit, submitting the results annually, and identifying corrective actions for implementation. b) Track and publicize annual increase in water audit validity and/or reduction in water losses.
MU2	Rain Barrel Programs	Rain barrels collect rainwater from roof gutters to be used at a later time for non-potable outdoor purposes.	- Municipal water providers	a) Provide links to municipal provider websites regarding rain barrel program information. b) Public or targeted giveaway programs or sale at a reduced or subsidized price to water users. c) Do it yourself workshops.
MU3	Irrigation Upgrade Programs	Irrigation upgrade programs are the assessment and replacement of automatic irrigation components with more water-efficient technologies.	- Municipal water providers	a) Establish an "Irrigation Upgrade Grant Program," and partner with local municipal suppliers to apply for irrigation upgrade grants. b) Targeted or public rebates. c) Water budgets to incentivize with financial penalties. d) Education/demonstration installations.
MU4	Water Reuse	Water reuse is the practice of using potable water for more than one end use before disposal. Typical implementations are distribution of highly treated wastewater for non-potable uses such as irrigation or industrial process water.	- Municipal water providers - CWRM (gray water policies)	a) Coordinate with the Hawaii Department of Health (and other appropriate agencies) to sponsor and support the adoption of a modified gray water reuse policy. b) Explore the possibility of modifying the building code to promote more rainwater reuse. c) Coordinate with various state agencies and county building/permitting entities to establish an incentive program to encourage installation of gray water reuse systems. Such incentives could include a streamlined building permitting process, reduced fees (permitting or connection fees, etc.), and a reward and recognition program for those entities that voluntarily install gray water systems. d) Work with municipal water users and/or universities to identify and establish

TABLE 6-1
Municipal BMPs
(see Appendix B for more detail)

ID/Rank	BMP	Description	Responsible Party	Possible Implementation Mechanisms
				demonstration and research projects to show the application of efficient irrigation technologies and document water savings.
MU5	Education and Outreach	Education and outreach is the development and dissemination of materials about ways to become more water efficient, and the value of water.	- CWRM (develop program) - Municipal providers (promote programs)	a) Work collaboratively with the WCAG (or its successor group) to develop key messages regarding the importance of water conservation. The key messages should include conservation themes that emphasize the importance of conservation to culture, values, potential financial savings, and the broader water resources concerns (save now for the future: energy, food production, climate change, etc.). b) Work collaboratively with the WCAG (or its successor group) to establish a water resource management public awareness campaign (using the key messages defined previously) that incorporates climate change, energy/water nexus, food security, agricultural viability, watershed management, and source protection and augmentation. c) Work with the Board of Education and the WCAG (or its successor group) to develop (or make available) a water resource and conservation education curricula (e.g., "Project WET") aimed at school children.
MU6	Efficient Commercial Equipment	Efficient commercial equipment is the identification and promotion of water using equipment for commercial users that are more water-efficient than those currently available or in use.	- Municipal water providers (education/incentives) - CWRM (policy/regulation)	a) Establish an "Efficient Commercial Equipment Rebate Program (WaterSense certified)," and partner with local municipal suppliers to apply for efficient commercial equipment rebate funds. b) Coordinate with various state agencies and county building/permitting entities to establish an incentive program to encourage installation of high efficiency commercial equipment (HECT), which exceeds state or national standards. Such incentives could include a streamlined building permitting process, reduced fees (permitting or connection fees, etc.), and a reward and recognition program for those entities that voluntarily install devices and technologies that go beyond current state or national standards.
MU7	Irrigation Technology	Irrigation technology is the promotion and installation of irrigation technology for automatic systems typically in residential or small landscape situations.	- Municipal water providers (promotion/outreach) - CWRM (develop requirements)	a) Work with LICH (and other professional associations, vendors, or selected entities with relevant expertise, etc.) to develop informational materials defining efficient irrigation practices (design, technologies, and maintenance), identifying additional informational resources, and showing documented savings and other information deemed important. b) Work with municipal water users, universities, and/or military installations to identify and establish demonstration and research projects to show the application of efficient irrigation technologies and document water savings. c) Work with LICH to develop a model ordinance for landscape and irrigation design, and encourage the requirement for the use of certified irrigation professionals. CWRM would collaborate with municipal providers in the development of the model ordinance. The model ordinance could then be adopted by county governments in Hawaii.

TABLE 6-1
Municipal BMPs
(see Appendix B for more detail)

ID/Rank	BMP	Description	Responsible Party	Possible Implementation Mechanisms
MU8	Green Business Program	Green business programs are the development of new or promotion of existing green business programs. The intent is to highlight individual businesses that have implemented green business practices.	- State Department of Business, Economic Development and Tourism has an established Green Business (recognition) Program Municipal water providers (identify/promote) - CWRM (program development)	a) Work with the WCAG (or its successor group) to create a water conservation recognition program to celebrate success and reward those (entities, organizations, individuals) that improved their water use efficiency. b) One-time or recurring rebates for certified businesses, or reduction in fees.
MU9	Water Use Surveys	Water use surveys include the development of water user assessment surveys to evaluate and benchmark opportunities for water efficiency improvements at individual customers.	- Municipal water providers - CWRM (create survey)	a) Work with municipal suppliers to develop a water use survey tool (or modify existing templates). b) One-time financial credit for participating in a survey or audit.
MU10	WaterSense Certified/Labeled Equipment	WaterSense certified/labeled equipment is the promotion of the U.S. Environmental Protection Agency (EPA) WaterSense program	- Municipal water providers/CWRM (as well as policy/regulation changes)	a) Work with the WCAG (or its successor group) to adopt a policy in support of the EPA WaterSense program (partnership, labeling and requirements). b) Code changes to adopt WaterSense equipment. c) Rebate programs established by water utilities with funding support from CWRM.

TABLE 6-4
Golf Course BMPs
(see Appendix B for more detail)

ID/Rank	BMP	Description	Responsibility	Possible Implementation Mechanisms
GC1	Use of Qualified Irrigation Designers and Contractors	Use of qualified and experienced designers and contractors is the best way to ensure a water efficient irrigation system.	- Hawaii Golf Course Superintendants Association	a) Developing a registry of qualified irrigation design and construction contractors with proven experience and certification by the Irrigation Association
GC2	Onsite Weather Station and Climate Based Scheduling	Climate based scheduling is the use of real-time climate data to adjust irrigation schedules. Use of an onsite weather station is especially important in Hawaii where precipitation gradients can be extreme over short distances.	- Water purveyors/golf courses - CWRM/HGCSA (promotion/outreach)	a) Collaborate with GCSAA to develop an education program promoting the benefits of onsite weather station and climate-based scheduling. b) Establish an award and recognition program for golf courses that adopt this and other BMPs. c) Use of rebates.
GC3	Daily Inspection and Repairs	Maintaining good operating conditions of an irrigation system through daily inspection and repairs is an important part of conserving water.	- Water purveyors/golf courses - CWRM/HGCSA (promotion/outreach)	a) Explore water use permitting or other regulations to require golf course managers to perform daily inspections and repairs and immediately correct any major leaks.
GC4	Regularly Scheduled Irrigation System Audits	Regularly scheduled irrigation system audits are a good way to assess the performance of an irrigation system against industry benchmarks and design standards and to create a punch list of repairs or upgrades that may be needed to correct performance problems.	- Water purveyors/golf courses - CWRM/HGCSA (promotion/outreach and develop guidelines)	a) Explore water use permitting or other regulations to require golf course managers to perform regular system audits and develop a program for corrective actions, with a requirement to report on progress annually. b) Reward the reduction of leaks and other water losses.

TABLE 6-4
Golf Course BMPs
(see Appendix B for more detail)

ID/Rank	BMP	Description	Responsibility	Possible Implementation Mechanisms
GC5	Aeration of High Traffic Areas for Improved Infiltration	Regular aeration programs can be used to alleviate surface compaction with the additional benefits of improving turf quality and playability.	- Water purveyors/golf courses - CWRM/HGCSA (promotion/outreach)	a) Explore water use permitting or other regulations to require golf course managers to develop a program for surface runoff control
GC6	Centralized Irrigation System Control	Centralized irrigation system control provides greater flexibility in changing schedules to match water demands and to coordinate the rotation of irrigation run times around the system.	- Water purveyors/golf courses - CWRM/HGCSA (promotion/outreach)	a) Collaborate with the GCSAA to develop and/or promote an education/demonstration project, showing the installation, water savings, O&M impacts, etc., of a centralized irrigation control system used on a golf course. b) Establish an award and recognition program for golf courses that adopt this and other BMPs. c) Use of rebates.
GC7	Multiple Flow Meters in Distribution System for Leak Detection	Installing flow meters on different zones or regions within an irrigation system can aid in the detection and repair of leaks.	- Water purveyors/golf courses - CWRM/HGCSA (promotion/outreach)	a) Collaborate with the GCSAA to develop and promote a rebate (or other financial incentive program) to incentivize the installation of more water meters distributed across the golf course water/irrigation delivery system to enable the detection of system leaks.
GC8	Drip Systems for Trees/Shrubs	In tree and shrub landscaping areas, sprinkler systems can be replaced with drip or micro irrigation systems to deliver the required amount of water directly to plant root systems without overwatering adjacent areas.	- Water purveyors/golf courses - CWRM/HGCSA (promotion/outreach)	a) Collaborate with the GCSAA to develop and/or promote an education/demonstration project, showing the installation, water savings, O&M impacts, etc., of a drip irrigation system for non-turf areas (specifically trees and shrubs) used on a golf course.
GC9	Replacing Non-Play Turf Areas with Xeriscaping	Water efficient landscape design and plant selection can significantly reduce irrigation water requirements in comparison to turf areas.	- Water purveyors/golf courses - CWRM/HGCSA (promotion/outreach)	a) Collaborate with the GCSAA to develop and/or promote an education/demonstration project, showing the installation, water savings, O&M impacts, etc., of replacing non-play turf areas on a golf course with xeriscaping (or native, non-water intensive landscaping) b) Develop a rebate (or other financial incentive program) to incentivize the replacement of non-play turf areas with xeriscaping (or native, non-water intensive

TABLE 6-4
Golf Course BMPs
(see Appendix B for more detail)

ID/Rank	BMP	Description	Responsibility	Possible Implementation Mechanisms
				landscaping).
GC10	Use of Non-Potable Water Sources	Use of non-potable water sources can help to reduce demand pressures on potable water supplies.	- Water purveyors - CWRM/HGCSA (promotion/outreach)	a) Develop educational materials pertaining to the availability of local/municipal wastewater, industrial wastewater, or other non-potable water sources that could be used to offset potable water that is currently used for golf course irrigation.

HGCSA = Hawaii Golf Course Superintendants Association.

Landscape BMPs

Building upon the work developed by the LICH, the list of recommended BMPs developed in the LICH position statement on irrigation water conservation (LICH, 2011) were utilized in developing the initial lists of BMPs for the HWCP. The BMPs that LICH supports and encourages are as follows:

For new installations and major renovations

- Design irrigation system with sprinklers spaced with head to head coverage or better.
- Irrigation system plans and specifications shall include post-construction documentation, including drawings of record (as-built drawings), maintenance recommendations, seasonal operational schedules, design precipitation rates, manufacturer's operational guide, which shall remain onsite.
- Specifications shall require a coverage test prior to acceptance and LICH water conservation BMPs.
- Irrigate with a precipitation rate not exceeding soil infiltration rate.
- Design systems to irrigate similar hydrozones (similar site, slope, sun exposure, soil conditions, and plant materials with similar water use) on same circuit. Avoid irrigation overlap between high and low water demand hydrozones.
- Use a climate based irrigation controller (Smart Controller). Automatic irrigation controllers utilizing evapotranspiration, weather sensor, or soil moisture sensor.
- Encourage the use of drip irrigation for individual specimen plants.
- Use of flow sensors with malfunction valve shutoff system capability at irrigation controller.
- Use irrigation submeter that measures water use on large sites.
- Use water conservation irrigation components including but not limited to rotary nozzles, pressure regulated spray heads & valves, rain switches, and matched precipitation rate nozzles.
- Sprinklers in low-lying areas shall be equipped with check valves.
- Incorporate low impact development storm water design methods including rain gardens, infiltration beds, swales, and basins that allow water to collect and soak into the ground on site.
- Preserve existing native trees and non-invasive vegetation where feasible during development and do not install irrigation in these areas.
- Encourage the use of non-potable water sources when available.
- Encourage the use of xeriscaping practices to include drought tolerant plants or plants that are naturally occurring at the site and surroundings.
- Use a qualified irrigation designer and installation contractor such as those certified by the Irrigation Association and a maintenance contractor with water conservation expertise.

For maintenance

- At a minimum, adjust irrigation controller run times seasonally.
- Conduct a practical water audit annually. Review the system components to verify that the components meet the original design criteria for efficient operation and uniform distribution of water.
- At a minimum, conduct a monthly inspection to verify system operation and correct deficiencies.
- Water in 2 to 3 short run time cycles in areas where run off and ponding occurs.
- Program irrigation controllers to encourage deep watering to improve deep rooting and increase drought resistance. Avoid daily watering except for sandy soils.
- Mulch plantings and refresh as necessary to maintain a minimum of 2 inches.
- Encourage the incorporation of organic matter like compost into soils.

- Schedule night or early morning runtimes for established plantings (5:00 p.m. to 9:00 a.m.)
- Allow grass to grow taller to conserve water.
- Aerate lawns when compaction occurs.
- Encourage landscape professionals to attend water conservation seminars with continuing education units including American Water Works Association, Landscape Industry Council of Hawaii, American Society of Landscape Architects, U.S. Green Building Council, and the Irrigation Association.
- Use a maintenance contractor with water conservation expertise.